GNU Guix Reference Manual

Using the GNU Guix Functional Package Manager

The GNU Guix Developers

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1 Introduction

GNU Guix[1] is a package management tool for and distribution of the GNU system. Guix makes it easy for unprivileged users to install, upgrade, or remove software packages, to roll back to a previous package set, to build packages from source, and generally assists with the creation and maintenance of software environments.

You can install GNU Guix on top of an existing GNU/Linux system where it complements the available tools without interference (see Chapter 2 [Installation], page 4), or you can use it as a standalone operating system distribution, *Guix System*[2]. See Section 1.2 [GNU Distribution], page 2.

1.1 Managing Software the Guix Way

Guix provides a command-line package management interface (see Chapter 6 [Package Management], page 38), tools to help with software development (see Chapter 8 [Development], page 76), command-line utilities for more advanced usage (see Chapter 10 [Utilities], page 166), as well as Scheme programming interfaces (see Chapter 9 [Programming Interface], page 95). Its *build daemon* is responsible for building packages on behalf of users (see Section 2.4 [Setting Up the Daemon], page 9) and for downloading pre-built binaries from authorized sources (see Section 6.3 [Substitutes], page 48).

Guix includes package definitions for many GNU and non-GNU packages, all of which respect the user's computing freedom (`https://www.gnu.org/philosophy/free-sw.html`). It is *extensible*: users can write their own package definitions (see Section 9.2 [Defining Packages], page 96) and make them available as independent package modules (see Section 9.1 [Package Modules], page 95). It is also *customizable*: users can *derive* specialized package definitions from existing ones, including from the command line (see Section 10.1.2 [Package Transformation Options], page 168).

Under the hood, Guix implements the *functional package management* discipline pioneered by Nix (see Chapter 23 [Acknowledgments], page 656). In Guix, the package build and installation process is seen as a *function*, in the mathematical sense. That function takes inputs, such as build scripts, a compiler, and libraries, and returns an installed package. As a pure function, its result depends solely on its inputs—for instance, it cannot refer to software or scripts that were not explicitly passed as inputs. A build function always produces the same result when passed a given set of inputs. It cannot alter the environment of the running system in any way; for instance, it cannot create, modify, or delete files outside of its build and installation directories. This is achieved by running build processes in isolated environments (or *containers*), where only their explicit inputs are visible.

The result of package build functions is *cached* in the file system, in a special directory called *the store* (see Section 9.9 [The Store], page 144). Each package is installed in a directory of its own in the store—by default under `/gnu/store`. The directory name contains a hash of all the inputs used to build that package; thus, changing an input yields a different directory name.

[1] "Guix" is pronounced like "geeks", or "iks" using the international phonetic alphabet (IPA).

[2] We used to refer to Guix System as "Guix System Distribution" or "GuixSD". We now consider it makes more sense to group everything under the "Guix" banner since, after all, Guix System is readily available through the `guix system` command, even if you're using a different distro underneath!

This approach is the foundation for the salient features of Guix: support for transactional package upgrade and rollback, per-user installation, and garbage collection of packages (see Section 6.1 [Features], page 38).

1.2 GNU Distribution

Guix comes with a distribution of the GNU system consisting entirely of free software[3]. The distribution can be installed on its own (see Chapter 3 [System Installation], page 23), but it is also possible to install Guix as a package manager on top of an installed GNU/Linux system (see Chapter 2 [Installation], page 4). When we need to distinguish between the two, we refer to the standalone distribution as Guix System.

The distribution provides core GNU packages such as GNU libc, GCC, and Binutils, as well as many GNU and non-GNU applications. The complete list of available packages can be browsed on-line (`https://www.gnu.org/software/guix/packages`) or by running `guix package` (see Section 6.2 [Invoking guix package], page 39):

```
guix package --list-available
```

Our goal is to provide a practical 100% free software distribution of Linux-based and other variants of GNU, with a focus on the promotion and tight integration of GNU components, and an emphasis on programs and tools that help users exert that freedom.

Packages are currently available on the following platforms:

`x86_64-linux`
: Intel/AMD `x86_64` architecture, Linux-Libre kernel.

`i686-linux`
: Intel 32-bit architecture (IA32), Linux-Libre kernel.

`armhf-linux`
: ARMv7-A architecture with hard float, Thumb-2 and NEON, using the EABI hard-float application binary interface (ABI), and Linux-Libre kernel.

`aarch64-linux`
: little-endian 64-bit ARMv8-A processors, Linux-Libre kernel.

`i586-gnu`
: GNU/Hurd (`https://hurd.gnu.org`) on the Intel 32-bit architecture (IA32).

  This configuration is experimental and under development. The easiest way for you to give it a try is by setting up an instance of `hurd-vm-service-type` on your GNU/Linux machine (see [transparent-emulation-qemu], page 479). See Chapter 22 [Contributing], page 625, on how to help!

`mips64el-linux (unsupported)`
: little-endian 64-bit MIPS processors, specifically the Loongson series, n32 ABI, and Linux-Libre kernel. This configuration is no longer fully supported; in particular, there is no ongoing work to ensure that this architecture still works. Should someone decide they wish to revive this architecture then the code is still available.

[3] The term "free" here refers to the freedom provided to users of that software (`https://www.gnu.org/philosophy/free-sw.html`).

`powerpc-linux (unsupported)`
: big-endian 32-bit PowerPC processors, specifically the PowerPC G4 with AltiVec support, and Linux-Libre kernel. This configuration is not fully supported and there is no ongoing work to ensure this architecture works.

`powerpc64le-linux`
: little-endian 64-bit Power ISA processors, Linux-Libre kernel. This includes POWER9 systems such as the RYF Talos II mainboard (`https://www.fsf.org/news/talos-ii-mainboard-and-talos-ii-lite-mainboard-now-fsf-certified-to-resp` This platform is available as a "technology preview": although it is supported, substitutes are not yet available from the build farm (see Section 6.3 [Substitutes], page 48), and some packages may fail to build (see Section 22.7 [Tracking Bugs and Patches], page 645). That said, the Guix community is actively working on improving this support, and now is a great time to try it and get involved!

`riscv64-linux`
: little-endian 64-bit RISC-V processors, specifically RV64GC, and Linux-Libre kernel. This platform is available as a "technology preview": although it is supported, substitutes are not yet available from the build farm (see Section 6.3 [Substitutes], page 48), and some packages may fail to build (see Section 22.7 [Tracking Bugs and Patches], page 645). That said, the Guix community is actively working on improving this support, and now is a great time to try it and get involved!

With Guix System, you *declare* all aspects of the operating system configuration and Guix takes care of instantiating the configuration in a transactional, reproducible, and stateless fashion (see Chapter 12 [System Configuration], page 220). Guix System uses the Linux-libre kernel, the Shepherd initialization system (see Section “Introduction” in *The GNU Shepherd Manual*), the well-known GNU utilities and tool chain, as well as the graphical environment or system services of your choice.

Guix System is available on all the above platforms except `mips64el-linux`, `powerpc-linux`, `powerpc64le-linux` and `riscv64-linux`.

For information on porting to other architectures or kernels, see Chapter 21 [Porting], page 624.

Building this distribution is a cooperative effort, and you are invited to join! See Chapter 22 [Contributing], page 625, for information about how you can help.

2 Installation

> **Note:** We recommend the use of this shell installer script (`https://git.savannah.gnu.org/gitweb/?p=guix.git;a=blob_plain;f=etc/guix-install.sh;hb=HEAD`) to install Guix on top of a running GNU/Linux system, thereafter called a *foreign distro*.[1] The script automates the download, installation, and initial configuration of Guix. It should be run as the root user.

When installed on a foreign distro, GNU Guix complements the available tools without interference. Its data lives exclusively in two directories, usually `/gnu/store` and `/var/guix`; other files on your system, such as `/etc`, are left untouched.

Once installed, Guix can be updated by running `guix pull` (see Section 6.6 [Invoking guix pull], page 56).

If you prefer to perform the installation steps manually or want to tweak them, you may find the following subsections useful. They describe the software requirements of Guix, as well as how to install it manually and get ready to use it.

2.1 Binary Installation

This section describes how to install Guix on an arbitrary system from a self-contained tarball providing binaries for Guix and for all its dependencies. This is often quicker than installing from source, which is described in the next sections. The only requirement is to have GNU tar and Xz.

> **Note:** We recommend the use of this shell installer script (`https://git.savannah.gnu.org/gitweb/?p=guix.git;a=blob_plain;f=etc/guix-install.sh;hb=HEAD`). The script automates the download, installation, and initial configuration steps described below. It should be run as the root user. As root, you can thus run this:
>
> ```
> cd /tmp
> wget 'https://git.savannah.gnu.org/gitweb/?p=guix.git;a=blob_plain;f=etc/guix-ins
> chmod +x guix-install.sh
> ./guix-install.sh
> ```
>
> If you're running Debian or a derivative such as Ubuntu, you can instead install the package (it might be a version older than 1.4.0 but you can update it afterwards by running '`guix pull`'):
>
> ```
> sudo apt install guix
> ```
>
> Likewise on openSUSE:
>
> ```
> sudo zypper install guix
> ```
>
> When you're done, see Section 2.6 [Application Setup], page 19, for extra configuration you might need, and Chapter 5 [Getting Started], page 35, for your first steps!

[1] This section is concerned with the installation of the package manager, which can be done on top of a running GNU/Linux system. If, instead, you want to install the complete GNU operating system, see Chapter 3 [System Installation], page 23.

Installing goes along these lines:

1. Download the binary tarball from ‘`https://ftp.gnu.org/gnu/guix/guix-binary-1.4.0.x86_64-linux` where `x86_64-linux` can be replaced with `i686-linux` for an `i686` (32-bits) machine already running the kernel Linux, and so on (see Section 1.2 [GNU Distribution], page 2).

   Make sure to download the associated `.sig` file and to verify the authenticity of the tarball against it, along these lines:

   ```
   $ wget https://ftp.gnu.org/gnu/guix/guix-binary-1.4.0.x86_64-linux.tar.xz.sig
   $ gpg --verify guix-binary-1.4.0.x86_64-linux.tar.xz.sig
   ```

   If that command fails because you do not have the required public key, then run this command to import it:

   ```
   $ wget 'https://sv.gnu.org/people/viewgpg.php?user_id=15145' \
         -qO - | gpg --import -
   ```

   and rerun the `gpg --verify` command.

   Take note that a warning like “This key is not certified with a trusted signature!” is normal.

2. Now, you need to become the `root` user. Depending on your distribution, you may have to run `su -` or `sudo -i`. As `root`, run:

   ```
   # cd /tmp
   # tar --warning=no-timestamp -xf \
        /path/to/guix-binary-1.4.0.x86_64-linux.tar.xz
   # mv var/guix /var/ && mv gnu /
   ```

   This creates `/gnu/store` (see Section 9.9 [The Store], page 144) and `/var/guix`. The latter contains a ready-to-use profile for `root` (see next step).

   Do *not* unpack the tarball on a working Guix system since that would overwrite its own essential files.

   The `--warning=no-timestamp` option makes sure GNU tar does not emit warnings about “implausibly old time stamps” (such warnings were triggered by GNU tar 1.26 and older; recent versions are fine). They stem from the fact that all the files in the archive have their modification time set to 1 (which means January 1st, 1970). This is done on purpose to make sure the archive content is independent of its creation time, thus making it reproducible.

3. Make the profile available under `~root/.config/guix/current`, which is where `guix pull` will install updates (see Section 6.6 [Invoking guix pull], page 56):

   ```
   # mkdir -p ~root/.config/guix
   # ln -sf /var/guix/profiles/per-user/root/current-guix \
            ~root/.config/guix/current
   ```

   Source `etc/profile` to augment `PATH` and other relevant environment variables:

   ```
   # GUIX_PROFILE="`echo ~root`/.config/guix/current" ; \
     source $GUIX_PROFILE/etc/profile
   ```

4. Create the group and user accounts for build users as explained below (see Section 2.4.1 [Build Environment Setup], page 9).

5. Run the daemon, and set it to automatically start on boot.

   If your host distro uses the systemd init system, this can be achieved with these commands:

   ```
   # cp ~root/.config/guix/current/lib/systemd/system/gnu-store.mount \
        ~root/.config/guix/current/lib/systemd/system/guix-daemon.service \
        /etc/systemd/system/
   # systemctl enable --now gnu-store.mount guix-daemon
   ```

   You may also want to arrange for `guix gc` to run periodically:

   ```
   # cp ~root/.config/guix/current/lib/systemd/system/guix-gc.service \
        ~root/.config/guix/current/lib/systemd/system/guix-gc.timer \
        /etc/systemd/system/
   # systemctl enable --now guix-gc.timer
   ```

   You may want to edit `guix-gc.service` to adjust the command line options to fit your needs (see Section 6.5 [Invoking guix gc], page 53).

   If your host distro uses the Upstart init system:

   ```
   # initctl reload-configuration
   # cp ~root/.config/guix/current/lib/upstart/system/guix-daemon.conf \
        /etc/init/
   # start guix-daemon
   ```

   Otherwise, you can still start the daemon manually with:

   ```
   # ~root/.config/guix/current/bin/guix-daemon \
          --build-users-group=guixbuild
   ```

6. Make the `guix` command available to other users on the machine, for instance with:

   ```
   # mkdir -p /usr/local/bin
   # cd /usr/local/bin
   # ln -s /var/guix/profiles/per-user/root/current-guix/bin/guix
   ```

   It is also a good idea to make the Info version of this manual available there:

   ```
   # mkdir -p /usr/local/share/info
   # cd /usr/local/share/info
   # for i in /var/guix/profiles/per-user/root/current-guix/share/info/* ;
     do ln -s $i ; done
   ```

   That way, assuming `/usr/local/share/info` is in the search path, running `info guix` will open this manual (see Section "Other Info Directories" in *GNU Texinfo*, for more details on changing the Info search path).

7. To use substitutes from `ci.guix.gnu.org`, `bordeaux.guix.gnu.org` or a mirror (see Section 6.3 [Substitutes], page 48), authorize them:

   ```
   # guix archive --authorize < \
        ~root/.config/guix/current/share/guix/ci.guix.gnu.org.pub
   # guix archive --authorize < \
        ~root/.config/guix/current/share/guix/bordeaux.guix.gnu.org.pub
   ```

   > **Note:** If you do not enable substitutes, Guix will end up building *everything* from source on your machine, making each installation and upgrade very expensive. See Section 6.3.7 [On Trusting Binaries], page 52, for a discussion of reasons why one might want do disable substitutes.

8. Each user may need to perform a few additional steps to make their Guix environment ready for use, see Section 2.6 [Application Setup], page 19.

Voilà, the installation is complete!

You can confirm that Guix is working by installing a sample package into the root profile:

```
# guix install hello
```

The binary installation tarball can be (re)produced and verified simply by running the following command in the Guix source tree:

```
make guix-binary.system.tar.xz
```

... which, in turn, runs:

```
guix pack -s system --localstatedir \
  --profile-name=current-guix guix
```

See Section 8.3 [Invoking guix pack], page 87, for more info on this handy tool.

2.2 Requirements

This section lists requirements when building Guix from source. The build procedure for Guix is the same as for other GNU software, and is not covered here. Please see the files `README` and `INSTALL` in the Guix source tree for additional details.

GNU Guix is available for download from its website at `https://www.gnu.org/software/guix/`.

GNU Guix depends on the following packages:

- GNU Guile (`https://gnu.org/software/guile/`), version 3.0.x, version 3.0.3 or later;
- Guile-Gcrypt (`https://notabug.org/cwebber/guile-gcrypt`), version 0.1.0 or later;
- Guile-GnuTLS (`https://gitlab.com/gnutls/guile/`) (see Section "Guile Preparations" in *GnuTLS-Guile*)[2];
- Guile-SQLite3 (`https://notabug.org/guile-sqlite3/guile-sqlite3`), version 0.1.0 or later;
- Guile-zlib (`https://notabug.org/guile-zlib/guile-zlib`), version 0.1.0 or later;
- Guile-lzlib (`https://notabug.org/guile-lzlib/guile-lzlib`);
- Guile-Avahi (`https://www.nongnu.org/guile-avahi/`);
- Guile-Git (`https://gitlab.com/guile-git/guile-git`), version 0.5.0 or later;
- Guile-JSON (`https://savannah.nongnu.org/projects/guile-json/`) 4.3.0 or later;
- GNU Make (`https://www.gnu.org/software/make/`).

The following dependencies are optional:

- Support for build offloading (see Section 2.4.2 [Daemon Offload Setup], page 11) and `guix copy` (see Section 10.13 [Invoking guix copy], page 212) depends on Guile-SSH (`https://github.com/artyom-poptsov/guile-ssh`), version 0.13.0 or later.
- Guile-zstd (`https://notabug.org/guile-zstd/guile-zstd`), for zstd compression and decompression in `guix publish` and for substitutes (see Section 10.11 [Invoking guix publish], page 205).

[2] The Guile bindings to GnuTLS (`https://gnutls.org/`) were distributed as part of GnuTLS until version 3.7.8 included.

- Guile-Semver (`https://ngyro.com/software/guile-semver.html`) for the `crate` importer (see Section 10.5 [Invoking guix import], page 181).
- Guile-Lib (`https://www.nongnu.org/guile-lib/doc/ref/htmlprag/`) for the `go` importer (see Section 10.5 [Invoking guix import], page 181) and for some of the "updaters" (see Section 10.6 [Invoking guix refresh], page 189).
- When libbz2 (`http://www.bzip.org`) is available, `guix-daemon` can use it to compress build logs.

Unless `--disable-daemon` was passed to `configure`, the following packages are also needed:

- GNU libgcrypt (`https://gnupg.org/`);
- SQLite 3 (`https://sqlite.org`);
- GCC's g++ (`https://gcc.gnu.org`), with support for the C++11 standard.

When configuring Guix on a system that already has a Guix installation, be sure to specify the same state directory as the existing installation using the `--localstatedir` option of the `configure` script (see Section "Directory Variables" in *GNU Coding Standards*). Usually, this *localstatedir* option is set to the value `/var`. The `configure` script protects against unintended misconfiguration of *localstatedir* so you do not inadvertently corrupt your store (see Section 9.9 [The Store], page 144).

2.3 Running the Test Suite

After a successful `configure` and `make` run, it is a good idea to run the test suite. It can help catch issues with the setup or environment, or bugs in Guix itself—and really, reporting test failures is a good way to help improve the software. To run the test suite, type:

```
make check
```

Test cases can run in parallel: you can use the `-j` option of GNU make to speed things up. The first run may take a few minutes on a recent machine; subsequent runs will be faster because the store that is created for test purposes will already have various things in cache.

It is also possible to run a subset of the tests by defining the `TESTS` makefile variable as in this example:

```
make check TESTS="tests/store.scm tests/cpio.scm"
```

By default, tests results are displayed at a file level. In order to see the details of every individual test cases, it is possible to define the `SCM_LOG_DRIVER_FLAGS` makefile variable as in this example:

```
make check TESTS="tests/base64.scm" SCM_LOG_DRIVER_FLAGS="--brief=no"
```

The underlying SRFI 64 custom Automake test driver used for the 'check' test suite (located at `build-aux/test-driver.scm`) also allows selecting which test cases to run at a finer level, via its `--select` and `--exclude` options. Here's an example, to run all the test cases from the `tests/packages.scm` test file whose names start with "transaction-upgrade-entry":

```
export SCM_LOG_DRIVER_FLAGS="--select=^transaction-upgrade-entry"
make check TESTS="tests/packages.scm"
```

Those wishing to inspect the results of failed tests directly from the command line can add the `--errors-only=yes` option to the `SCM_LOG_DRIVER_FLAGS` makefile variable and set the `VERBOSE` Automake makefile variable, as in:

```
make check SCM_LOG_DRIVER_FLAGS="--brief=no --errors-only=yes" VERBOSE=1
```

The `--show-duration=yes` option can be used to print the duration of the individual test cases, when used in combination with `--brief=no`:

```
make check SCM_LOG_DRIVER_FLAGS="--brief=no --show-duration=yes"
```

See Section "Parallel Test Harness" in *GNU Automake* for more information about the Automake Parallel Test Harness.

Upon failure, please email `bug-guix@gnu.org` and attach the `test-suite.log` file. Please specify the Guix version being used as well as version numbers of the dependencies (see Section 2.2 [Requirements], page 7) in your message.

Guix also comes with a whole-system test suite that tests complete Guix System instances. It can only run on systems where Guix is already installed, using:

```
make check-system
```

or, again, by defining `TESTS` to select a subset of tests to run:

```
make check-system TESTS="basic mcron"
```

These system tests are defined in the `(gnu tests ...)` modules. They work by running the operating systems under test with lightweight instrumentation in a virtual machine (VM). They can be computationally intensive or rather cheap, depending on whether substitutes are available for their dependencies (see Section 6.3 [Substitutes], page 48). Some of them require a lot of storage space to hold VM images.

Again in case of test failures, please send `bug-guix@gnu.org` all the details.

2.4 Setting Up the Daemon

Operations such as building a package or running the garbage collector are all performed by a specialized process, the *build daemon*, on behalf of clients. Only the daemon may access the store and its associated database. Thus, any operation that manipulates the store goes through the daemon. For instance, command-line tools such as `guix package` and `guix build` communicate with the daemon (*via* remote procedure calls) to instruct it what to do.

The following sections explain how to prepare the build daemon's environment. See also Section 6.3 [Substitutes], page 48, for information on how to allow the daemon to download pre-built binaries.

2.4.1 Build Environment Setup

In a standard multi-user setup, Guix and its daemon—the `guix-daemon` program—are installed by the system administrator; `/gnu/store` is owned by `root` and `guix-daemon` runs as `root`. Unprivileged users may use Guix tools to build packages or otherwise access the store, and the daemon will do it on their behalf, ensuring that the store is kept in a consistent state, and allowing built packages to be shared among users.

When `guix-daemon` runs as `root`, you may not want package build processes themselves to run as `root` too, for obvious security reasons. To avoid that, a special pool of *build* *users* should be created for use by build processes started by the daemon. These build users need not have a shell and a home directory: they will just be used when the daemon drops `root` privileges in build processes. Having several such users allows the daemon to launch distinct build processes under separate UIDs, which guarantees that they do not interfere with each other—an essential feature since builds are regarded as pure functions (see Chapter 1 [Introduction], page 1).

On a GNU/Linux system, a build user pool may be created like this (using Bash syntax and the `shadow` commands):

```
# groupadd --system guixbuild
# for i in $(seq -w 1 10);
  do
    useradd -g guixbuild -G guixbuild           \
            -d /var/empty -s $(which nologin)   \
            -c "Guix build user $i" --system    \
            guixbuilder$i;
  done
```

The number of build users determines how many build jobs may run in parallel, as specified by the `--max-jobs` option (see Section 2.5 [Invoking guix-daemon], page 15). To use `guix system vm` and related commands, you may need to add the build users to the `kvm` group so they can access `/dev/kvm`, using `-G guixbuild,kvm` instead of `-G guixbuild` (see Section 12.15 [Invoking guix system], page 545).

The `guix-daemon` program may then be run as `root` with the following command[3]:

```
# guix-daemon --build-users-group=guixbuild
```

This way, the daemon starts build processes in a chroot, under one of the `guixbuilder` users. On GNU/Linux, by default, the chroot environment contains nothing but:

- a minimal `/dev` directory, created mostly independently from the host `/dev`[4];
- the `/proc` directory; it only shows the processes of the container since a separate PID name space is used;
- `/etc/passwd` with an entry for the current user and an entry for user `nobody`;
- `/etc/group` with an entry for the user's group;
- `/etc/hosts` with an entry that maps `localhost` to `127.0.0.1`;
- a writable `/tmp` directory.

The chroot does not contain a `/home` directory, and the `HOME` environment variable is set to the non-existent `/homeless-shelter`. This helps to highlight inappropriate uses of `HOME` in the build scripts of packages.

You can influence the directory where the daemon stores build trees *via* the `TMPDIR` environment variable. However, the build tree within the chroot is always called `/tmp/guix-build-`*`name`*`.drv-0`, where *name* is the derivation name—e.g., `coreutils-8.24`. This way,

[3] If your machine uses the systemd init system, copying the *`prefix`*`/lib/systemd/system/guix-daemon.service` file to `/etc/systemd/system` will ensure that `guix-daemon` is automatically started. Similarly, if your machine uses the Upstart init system, copy the *`prefix`*`/lib/upstart/system/guix-daemon.conf` file to `/etc/init`.

[4] "Mostly", because while the set of files that appear in the chroot's `/dev` is fixed, most of these files can only be created if the host has them.

the value of `TMPDIR` does not leak inside build environments, which avoids discrepancies in cases where build processes capture the name of their build tree.

The daemon also honors the `http_proxy` and `https_proxy` environment variables for HTTP and HTTPS downloads it performs, be it for fixed-output derivations (see Section 9.10 [Derivations], page 146) or for substitutes (see Section 6.3 [Substitutes], page 48).

If you are installing Guix as an unprivileged user, it is still possible to run `guix-daemon` provided you pass `--disable-chroot`. However, build processes will not be isolated from one another, and not from the rest of the system. Thus, build processes may interfere with each other, and may access programs, libraries, and other files available on the system—making it much harder to view them as *pure* functions.

2.4.2 Using the Offload Facility

When desired, the build daemon can *offload* derivation builds to other machines running Guix, using the `offload` *build hook*[5]. When that feature is enabled, a list of user-specified build machines is read from `/etc/guix/machines.scm`; every time a build is requested, for instance via `guix build`, the daemon attempts to offload it to one of the machines that satisfy the constraints of the derivation, in particular its system types—e.g., `x86_64-linux`. A single machine can have multiple system types, either because its architecture natively supports it, via emulation (see [transparent-emulation-qemu], page 479), or both. Missing prerequisites for the build are copied over SSH to the target machine, which then proceeds with the build; upon success the output(s) of the build are copied back to the initial machine. The offload facility comes with a basic scheduler that attempts to select the best machine. The best machine is chosen among the available machines based on criteria such as:

1. The availability of a build slot. A build machine can have as many build slots (connections) as the value of the `parallel-builds` field of its `build-machine` object.
2. Its relative speed, as defined via the `speed` field of its `build-machine` object.
3. Its load. The normalized machine load must be lower than a threshold value, configurable via the `overload-threshold` field of its `build-machine` object.
4. Disk space availability. More than a 100 MiB must be available.

The `/etc/guix/machines.scm` file typically looks like this:

```
(list (build-machine
        (name "eightysix.example.org")
        (systems (list "x86_64-linux" "i686-linux"))
        (host-key "ssh-ed25519 AAAAC3Nza...")
        (user "bob")
        (speed 2.))     ;incredibly fast!

      (build-machine
        (name "armeight.example.org")
        (systems (list "aarch64-linux"))
        (host-key "ssh-rsa AAAAB3Nza...")
        (user "alice")
```

[5] This feature is available only when Guile-SSH (`https://github.com/artyom-poptsov/guile-ssh`) is present.

```
              ;; Remember 'guix offload' is spawned by
              ;; 'guix-daemon' as root.
              (private-key "/root/.ssh/identity-for-guix")))
```

In the example above we specify a list of two build machines, one for the `x86_64` and `i686` architectures and one for the `aarch64` architecture.

In fact, this file is—not surprisingly!—a Scheme file that is evaluated when the `offload` hook is started. Its return value must be a list of `build-machine` objects. While this example shows a fixed list of build machines, one could imagine, say, using DNS-SD to return a list of potential build machines discovered in the local network (see Section "Introduction" in *Using Avahi in Guile Scheme Programs*). The `build-machine` data type is detailed below.

`build-machine` [Data Type]

This data type represents build machines to which the daemon may offload builds. The important fields are:

`name` The host name of the remote machine.

`systems` The system types the remote machine supports—e.g., `(list "x86_64-linux" "i686-linux")`.

`user` The user account to use when connecting to the remote machine over SSH. Note that the SSH key pair must *not* be passphrase-protected, to allow non-interactive logins.

`host-key` This must be the machine's SSH *public host key* in OpenSSH format. This is used to authenticate the machine when we connect to it. It is a long string that looks like this:

```
ssh-ed25519 AAAAC3NzaC...mde+UhL hint@example.org
```

If the machine is running the OpenSSH daemon, `sshd`, the host key can be found in a file such as `/etc/ssh/ssh_host_ed25519_key.pub`.

If the machine is running the SSH daemon of GNU lsh, `lshd`, the host key is in `/etc/lsh/host-key.pub` or a similar file. It can be converted to the OpenSSH format using `lsh-export-key` (see Section "Converting keys" in *LSH Manual*):

```
$ lsh-export-key --openssh < /etc/lsh/host-key.pub
ssh-rsa AAAAB3NzaC1yc2EAAAAEOp8FoQAAAQEAs1eB46LV...
```

A number of optional fields may be specified:

`port` (default: `22`)
Port number of SSH server on the machine.

`private-key` (default: `~root/.ssh/id_rsa`)
The SSH private key file to use when connecting to the machine, in OpenSSH format. This key must not be protected with a passphrase.

Note that the default value is the private key *of the root account*. Make sure it exists if you use the default.

`compression` (default: `"zlib@openssh.com,zlib"`)
`compression-level` (default: `3`)
: The SSH-level compression methods and compression level requested.

  Note that offloading relies on SSH compression to reduce bandwidth usage when transferring files to and from build machines.

`daemon-socket` (default: `"/var/guix/daemon-socket/socket"`)
: File name of the Unix-domain socket `guix-daemon` is listening to on that machine.

`overload-threshold` (default: `0.8`)
: The load threshold above which a potential offload machine is disregarded by the offload scheduler. The value roughly translates to the total processor usage of the build machine, ranging from 0.0 (0%) to 1.0 (100%). It can also be disabled by setting `overload-threshold` to `#f`.

`parallel-builds` (default: `1`)
: The number of builds that may run in parallel on the machine.

`speed` (default: `1.0`)
: A "relative speed factor". The offload scheduler will tend to prefer machines with a higher speed factor.

`features` (default: `'()`)
: A list of strings denoting specific features supported by the machine. An example is `"kvm"` for machines that have the KVM Linux modules and corresponding hardware support. Derivations can request features by name, and they will be scheduled on matching build machines.

The `guix` command must be in the search path on the build machines. You can check whether this is the case by running:

```
ssh build-machine guix repl --version
```

There is one last thing to do once `machines.scm` is in place. As explained above, when offloading, files are transferred back and forth between the machine stores. For this to work, you first need to generate a key pair on each machine to allow the daemon to export signed archives of files from the store (see Section 6.10 [Invoking guix archive], page 64):

```
# guix archive --generate-key
```

Each build machine must authorize the key of the master machine so that it accepts store items it receives from the master:

```
# guix archive --authorize < master-public-key.txt
```

Likewise, the master machine must authorize the key of each build machine.

All the fuss with keys is here to express pairwise mutual trust relations between the master and the build machines. Concretely, when the master receives files from a build machine (and *vice versa*), its build daemon can make sure they are genuine, have not been tampered with, and that they are signed by an authorized key.

To test whether your setup is operational, run this command on the master node:

```
# guix offload test
```

This will attempt to connect to each of the build machines specified in `/etc/guix/machines.scm`, make sure Guix is available on each machine, attempt to export to the machine and import from it, and report any error in the process.

If you want to test a different machine file, just specify it on the command line:

```
# guix offload test machines-qualif.scm
```

Last, you can test the subset of the machines whose name matches a regular expression like this:

```
# guix offload test machines.scm '\.gnu\.org$'
```

To display the current load of all build hosts, run this command on the main node:

```
# guix offload status
```

2.4.3 SELinux Support

Guix includes an SELinux policy file at `etc/guix-daemon.cil` that can be installed on a system where SELinux is enabled, in order to label Guix files and to specify the expected behavior of the daemon. Since Guix System does not provide an SELinux base policy, the daemon policy cannot be used on Guix System.

2.4.3.1 Installing the SELinux policy

To install the policy run this command as root:

```
semodule -i etc/guix-daemon.cil
```

Then relabel the file system with `restorecon` or by a different mechanism provided by your system.

Once the policy is installed, the file system has been relabeled, and the daemon has been restarted, it should be running in the `guix_daemon_t` context. You can confirm this with the following command:

```
ps -Zax | grep guix-daemon
```

Monitor the SELinux log files as you run a command like `guix build hello` to convince yourself that SELinux permits all necessary operations.

2.4.3.2 Limitations

This policy is not perfect. Here is a list of limitations or quirks that should be considered when deploying the provided SELinux policy for the Guix daemon.

1. `guix_daemon_socket_t` isn't actually used. None of the socket operations involve contexts that have anything to do with `guix_daemon_socket_t`. It doesn't hurt to have this unused label, but it would be preferable to define socket rules for only this label.
2. `guix gc` cannot access arbitrary links to profiles. By design, the file label of the destination of a symlink is independent of the file label of the link itself. Although all profiles under $localstatedir are labelled, the links to these profiles inherit the label of the directory they are in. For links in the user's home directory this will be `user_home_t`. But for links from the root user's home directory, or `/tmp`, or the HTTP server's working directory, etc, this won't work. `guix gc` would be prevented from reading and following these links.

3. The daemon's feature to listen for TCP connections might no longer work. This might require extra rules, because SELinux treats network sockets differently from files.
4. Currently all files with a name matching the regular expression `/gnu/store/.+-(guix-.+|profile)/bin/guix-daemon` are assigned the label `guix_daemon_exec_t`; this means that *any* file with that name in any profile would be permitted to run in the `guix_daemon_t` domain. This is not ideal. An attacker could build a package that provides this executable and convince a user to install and run it, which lifts it into the `guix_daemon_t` domain. At that point SELinux could not prevent it from accessing files that are allowed for processes in that domain.

   You will need to relabel the store directory after all upgrades to `guix-daemon`, such as after running `guix pull`. Assuming the store is in `/gnu`, you can do this with `restorecon -vR /gnu`, or by other means provided by your operating system.

   We could generate a much more restrictive policy at installation time, so that only the *exact* file name of the currently installed `guix-daemon` executable would be labelled with `guix_daemon_exec_t`, instead of using a broad regular expression. The downside is that root would have to install or upgrade the policy at installation time whenever the Guix package that provides the effectively running `guix-daemon` executable is upgraded.

2.5 Invoking guix-daemon

The `guix-daemon` program implements all the functionality to access the store. This includes launching build processes, running the garbage collector, querying the availability of a build result, etc. It is normally run as `root` like this:

```
# guix-daemon --build-users-group=guixbuild
```

This daemon can also be started following the systemd "socket activation" protocol (see Section "Service De- and Constructors" in *The GNU Shepherd Manual*).

For details on how to set it up, see Section 2.4 [Setting Up the Daemon], page 9.

By default, `guix-daemon` launches build processes under different UIDs, taken from the build group specified with `--build-users-group`. In addition, each build process is run in a chroot environment that only contains the subset of the store that the build process depends on, as specified by its derivation (see Chapter 9 [Programming Interface], page 95), plus a set of specific system directories. By default, the latter contains `/dev` and `/dev/pts`. Furthermore, on GNU/Linux, the build environment is a *container*: in addition to having its own file system tree, it has a separate mount name space, its own PID name space, network name space, etc. This helps achieve reproducible builds (see Section 6.1 [Features], page 38).

When the daemon performs a build on behalf of the user, it creates a build directory under `/tmp` or under the directory specified by its `TMPDIR` environment variable. This directory is shared with the container for the duration of the build, though within the container, the build tree is always called `/tmp/guix-build-`*`name`*`.drv-0`.

The build directory is automatically deleted upon completion, unless the build failed and the client specified `--keep-failed` (see Section 10.1.1 [Common Build Options], page 166).

The daemon listens for connections and spawns one sub-process for each session started by a client (one of the `guix` sub-commands). The `guix processes` command allows you to get an overview of the activity on your system by viewing each of the active sessions and clients. See Section 10.16 [Invoking guix processes], page 215, for more information.

The following command-line options are supported:

`--build-users-group=`*`group`*
: Take users from *group* to run build processes (see Section 2.4 [Setting Up the Daemon], page 9).

`--no-substitutes`
: Do not use substitutes for build products. That is, always build things locally instead of allowing downloads of pre-built binaries (see Section 6.3 [Substitutes], page 48).

  When the daemon runs with `--no-substitutes`, clients can still explicitly enable substitution *via* the `set-build-options` remote procedure call (see Section 9.9 [The Store], page 144).

`--substitute-urls=`*`urls`*
: Consider *urls* the default whitespace-separated list of substitute source URLs. When this option is omitted, '`https://ci.guix.gnu.org https://bordeaux.guix.gnu.org`' is used.

  This means that substitutes may be downloaded from *urls*, as long as they are signed by a trusted signature (see Section 6.3 [Substitutes], page 48).

  See Section 6.3.3 [Getting Substitutes from Other Servers], page 50, for more information on how to configure the daemon to get substitutes from other servers.

`--no-offload`
: Do not use offload builds to other machines (see Section 2.4.2 [Daemon Offload Setup], page 11). That is, always build things locally instead of offloading builds to remote machines.

`--cache-failures`
: Cache build failures. By default, only successful builds are cached.

  When this option is used, `guix gc --list-failures` can be used to query the set of store items marked as failed; `guix gc --clear-failures` removes store items from the set of cached failures. See Section 6.5 [Invoking guix gc], page 53.

`--cores=`*`n`*
`-c `*`n`*
: Use *n* CPU cores to build each derivation; `0` means as many as available.

  The default value is `0`, but it may be overridden by clients, such as the `--cores` option of `guix build` (see Section 10.1 [Invoking guix build], page 166).

  The effect is to define the `NIX_BUILD_CORES` environment variable in the build process, which can then use it to exploit internal parallelism—for instance, by running `make -j$NIX_BUILD_CORES`.

`--max-jobs=`*`n`*
`-M `*`n`*
: Allow at most *n* build jobs in parallel. The default value is `1`. Setting it to `0` means that no builds will be performed locally; instead, the daemon will offload builds (see Section 2.4.2 [Daemon Offload Setup], page 11), or simply fail.

`--max-silent-time=`*`seconds`*
: When the build or substitution process remains silent for more than *seconds*, terminate it and report a build failure.

  The default value is `0`, which disables the timeout.

  The value specified here can be overridden by clients (see Section 10.1.1 [Common Build Options], page 166).

`--timeout=`*`seconds`*
: Likewise, when the build or substitution process lasts for more than *seconds*, terminate it and report a build failure.

  The default value is `0`, which disables the timeout.

  The value specified here can be overridden by clients (see Section 10.1.1 [Common Build Options], page 166).

`--rounds=`*`N`*
: Build each derivation *n* times in a row, and raise an error if consecutive build results are not bit-for-bit identical. Note that this setting can be overridden by clients such as `guix build` (see Section 10.1 [Invoking guix build], page 166).

  When used in conjunction with `--keep-failed`, the differing output is kept in the store, under `/gnu/store/...-check`. This makes it easy to look for differences between the two results.

`--debug`
: Produce debugging output.

  This is useful to debug daemon start-up issues, but then it may be overridden by clients, for example the `--verbosity` option of `guix build` (see Section 10.1 [Invoking guix build], page 166).

`--chroot-directory=`*`dir`*
: Add *dir* to the build chroot.

  Doing this may change the result of build processes—for instance if they use optional dependencies found in *dir* when it is available, and not otherwise. For that reason, it is not recommended to do so. Instead, make sure that each derivation declares all the inputs that it needs.

`--disable-chroot`
: Disable chroot builds.

  Using this option is not recommended since, again, it would allow build processes to gain access to undeclared dependencies. It is necessary, though, when `guix-daemon` is running under an unprivileged user account.

`--log-compression=`*`type`*
: Compress build logs according to *type*, one of `gzip`, `bzip2`, or `none`.

  Unless `--lose-logs` is used, all the build logs are kept in the *localstatedir*. To save space, the daemon automatically compresses them with gzip by default.

`--discover[=yes|no]`
: Whether to discover substitute servers on the local network using mDNS and DNS-SD.

This feature is still experimental. However, here are a few considerations.

1. It might be faster/less expensive than fetching from remote servers;
2. There are no security risks, only genuine substitutes will be used (see Section 6.3.4 [Substitute Authentication], page 51);
3. An attacker advertising `guix publish` on your LAN cannot serve you malicious binaries, but they can learn what software you're installing;
4. Servers may serve substitute over HTTP, unencrypted, so anyone on the LAN can see what software you're installing.

It is also possible to enable or disable substitute server discovery at run-time by running:

```
herd discover guix-daemon on
herd discover guix-daemon off
```

`--disable-deduplication`

Disable automatic file "deduplication" in the store.

By default, files added to the store are automatically "deduplicated": if a newly added file is identical to another one found in the store, the daemon makes the new file a hard link to the other file. This can noticeably reduce disk usage, at the expense of slightly increased input/output load at the end of a build process. This option disables this optimization.

`--gc-keep-outputs[=yes|no]`

Tell whether the garbage collector (GC) must keep outputs of live derivations.

When set to `yes`, the GC will keep the outputs of any live derivation available in the store—the `.drv` files. The default is `no`, meaning that derivation outputs are kept only if they are reachable from a GC root. See Section 6.5 [Invoking guix gc], page 53, for more on GC roots.

`--gc-keep-derivations[=yes|no]`

Tell whether the garbage collector (GC) must keep derivations corresponding to live outputs.

When set to `yes`, as is the case by default, the GC keeps derivations—i.e., `.drv` files—as long as at least one of their outputs is live. This allows users to keep track of the origins of items in their store. Setting it to `no` saves a bit of disk space.

In this way, setting `--gc-keep-derivations` to `yes` causes liveness to flow from outputs to derivations, and setting `--gc-keep-outputs` to `yes` causes liveness to flow from derivations to outputs. When both are set to `yes`, the effect is to keep all the build prerequisites (the sources, compiler, libraries, and other build-time tools) of live objects in the store, regardless of whether these prerequisites are reachable from a GC root. This is convenient for developers since it saves rebuilds or downloads.

`--impersonate-linux-2.6`

On Linux-based systems, impersonate Linux 2.6. This means that the kernel's `uname` system call will report 2.6 as the release number.

This might be helpful to build programs that (usually wrongfully) depend on the kernel version number.

`--lose-logs`
: Do not keep build logs. By default they are kept under `*localstatedir*/guix/log`.

`--system=*system*`
: Assume *system* as the current system type. By default it is the architecture/kernel pair found at configure time, such as `x86_64-linux`.

`--listen=*endpoint*`
: Listen for connections on *endpoint*. *endpoint* is interpreted as the file name of a Unix-domain socket if it starts with `/` (slash sign). Otherwise, *endpoint* is interpreted as a host name or host name and port to listen to. Here are a few examples:

  `--listen=/gnu/var/daemon`
  : Listen for connections on the `/gnu/var/daemon` Unix-domain socket, creating it if needed.

  `--listen=localhost`
  : Listen for TCP connections on the network interface corresponding to `localhost`, on port 44146.

  `--listen=128.0.0.42:1234`
  : Listen for TCP connections on the network interface corresponding to `128.0.0.42`, on port 1234.

  This option can be repeated multiple times, in which case `guix-daemon` accepts connections on all the specified endpoints. Users can tell client commands what endpoint to connect to by setting the `GUIX_DAEMON_SOCKET` environment variable (see Section 9.9 [The Store], page 144).

  > **Note:** The daemon protocol is *unauthenticated and unencrypted*. Using `--listen=*host*` is suitable on local networks, such as clusters, where only trusted nodes may connect to the build daemon. In other cases where remote access to the daemon is needed, we recommend using Unix-domain sockets along with SSH.

  When `--listen` is omitted, `guix-daemon` listens for connections on the Unix-domain socket located at `*localstatedir*/guix/daemon-socket/socket`.

2.6 Application Setup

When using Guix on top of GNU/Linux distribution other than Guix System—a so-called *foreign distro*—a few additional steps are needed to get everything in place. Here are some of them.

2.6.1 Locales

Packages installed *via* Guix will not use the locale data of the host system. Instead, you must first install one of the locale packages available with Guix and then define the `GUIX_LOCPATH` environment variable:

```
$ guix install glibc-locales
$ export GUIX_LOCPATH=$HOME/.guix-profile/lib/locale
```

Note that the `glibc-locales` package contains data for all the locales supported by the GNU libc and weighs in at around 930 MiB[6]. If you only need a few locales, you can define your custom locales package via the `make-glibc-utf8-locales` procedure from the `(gnu packages base)` module. The following example defines a package containing the various Canadian UTF-8 locales known to the GNU libc, that weighs around 14 MiB:

```
(use-modules (gnu packages base))

(define my-glibc-locales
  (make-glibc-utf8-locales
   glibc
   #:locales (list "en_CA" "fr_CA" "ik_CA" "iu_CA" "shs_CA")
   #:name "glibc-canadian-utf8-locales"))
```

The `GUIX_LOCPATH` variable plays a role similar to `LOCPATH` (see Section "Locale Names" in *The GNU C Library Reference Manual*). There are two important differences though:

1. `GUIX_LOCPATH` is honored only by the libc in Guix, and not by the libc provided by foreign distros. Thus, using `GUIX_LOCPATH` allows you to make sure the programs of the foreign distro will not end up loading incompatible locale data.
2. libc suffixes each entry of `GUIX_LOCPATH` with `/X.Y`, where `X.Y` is the libc version—e.g., `2.22`. This means that, should your Guix profile contain a mixture of programs linked against different libc version, each libc version will only try to load locale data in the right format.

This is important because the locale data format used by different libc versions may be incompatible.

2.6.2 Name Service Switch

When using Guix on a foreign distro, we *strongly recommend* that the system run the GNU C library's *name service cache daemon*, `nscd`, which should be listening on the `/var/run/nscd/socket` socket. Failing to do that, applications installed with Guix may fail to look up host names or user accounts, or may even crash. The next paragraphs explain why.

The GNU C library implements a *name service switch* (NSS), which is an extensible mechanism for "name lookups" in general: host name resolution, user accounts, and more (see Section "Name Service Switch" in *The GNU C Library Reference Manual*).

Being extensible, the NSS supports *plugins*, which provide new name lookup implementations: for example, the `nss-mdns` plugin allow resolution of `.local` host names, the `nis` plugin allows user account lookup using the Network information service (NIS), and so on. These extra "lookup services" are configured system-wide in `/etc/nsswitch.conf`, and all the programs running on the system honor those settings (see Section "NSS Configuration File" in *The GNU C Reference Manual*).

When they perform a name lookup—for instance by calling the `getaddrinfo` function in C—applications first try to connect to the nscd; on success, nscd performs name lookups on

[6] The size of the `glibc-locales` package is reduced down to about 213 MiB with store deduplication and further down to about 67 MiB when using a zstd-compressed Btrfs file system.

their behalf. If the nscd is not running, then they perform the name lookup by themselves, by loading the name lookup services into their own address space and running it. These name lookup services—the `libnss_*.so` files—are `dlopen`'d, but they may come from the host system's C library, rather than from the C library the application is linked against (the C library coming from Guix).

And this is where the problem is: if your application is linked against Guix's C library (say, glibc 2.24) and tries to load NSS plugins from another C library (say, `libnss_mdns.so` for glibc 2.22), it will likely crash or have its name lookups fail unexpectedly.

Running `nscd` on the system, among other advantages, eliminates this binary incompatibility problem because those `libnss_*.so` files are loaded in the `nscd` process, not in applications themselves.

2.6.3 X11 Fonts

The majority of graphical applications use Fontconfig to locate and load fonts and perform X11-client-side rendering. The `fontconfig` package in Guix looks for fonts in `$HOME/.guix-profile` by default. Thus, to allow graphical applications installed with Guix to display fonts, you have to install fonts with Guix as well. Essential font packages include `font-ghostscript`, `font-dejavu`, and `font-gnu-freefont`.

Once you have installed or removed fonts, or when you notice an application that does not find fonts, you may need to install Fontconfig and to force an update of its font cache by running:

```
guix install fontconfig
fc-cache -rv
```

To display text written in Chinese languages, Japanese, or Korean in graphical applications, consider installing `font-adobe-source-han-sans` or `font-wqy-zenhei`. The former has multiple outputs, one per language family (see Section 6.4 [Packages with Multiple Outputs], page 53). For instance, the following command installs fonts for Chinese languages:

```
guix install font-adobe-source-han-sans:cn
```

Older programs such as `xterm` do not use Fontconfig and instead rely on server-side font rendering. Such programs require to specify a full name of a font using XLFD (X Logical Font Description), like this:

```
-*-dejavu sans-medium-r-normal-*-*-100-*-*-*-*-*-1
```

To be able to use such full names for the TrueType fonts installed in your Guix profile, you need to extend the font path of the X server:

```
xset +fp $(dirname $(readlink -f ~/.guix-profile/share/fonts/truetype/fonts.dir))
```

After that, you can run `xlsfonts` (from `xlsfonts` package) to make sure your TrueType fonts are listed there.

2.6.4 X.509 Certificates

The `nss-certs` package provides X.509 certificates, which allow programs to authenticate Web servers accessed over HTTPS.

When using Guix on a foreign distro, you can install this package and define the relevant environment variables so that packages know where to look for certificates. See Section 12.11 [X.509 Certificates], page 535, for detailed information.

2.6.5 Emacs Packages

When you install Emacs packages with Guix, the Elisp files are placed under the `share/emacs/site-lisp/` directory of the profile in which they are installed. The Elisp libraries are made available to Emacs through the `EMACSLOADPATH` environment variable, which is set when installing Emacs itself.

Additionally, autoload definitions are automatically evaluated at the initialization of Emacs, by the Guix-specific `guix-emacs-autoload-packages` procedure. If, for some reason, you want to avoid auto-loading the Emacs packages installed with Guix, you can do so by running Emacs with the `--no-site-file` option (see Section "Init File" in *The GNU Emacs Manual*).

> **Note:** Emacs can now compile packages natively. Under the default configuration, this means that Emacs packages will now be just-in-time (JIT) compiled as you use them, and the results stored in a subdirectory of your `user-emacs-directory`.
>
> Furthermore, the build system for Emacs packages transparently supports native compilation, but note, that `emacs-minimal`—the default Emacs for building packages—has been configured without native compilation. To natively compile your emacs packages ahead of time, use a transformation like `--with-input=emacs-minimal=emacs`.

2.7 Upgrading Guix

To upgrade Guix, run:

```
guix pull
```

See Section 6.6 [Invoking guix pull], page 56, for more information.

On a foreign distro, you can upgrade the build daemon by running:

```
sudo -i guix pull
```

followed by (assuming your distro uses the systemd service management tool):

```
systemctl restart guix-daemon.service
```

On Guix System, upgrading the daemon is achieved by reconfiguring the system (see Section 12.15 [Invoking guix system], page 545).

3 System Installation

This section explains how to install Guix System on a machine. Guix, as a package manager, can also be installed on top of a running GNU/Linux system, see Chapter 2 [Installation], page 4.

3.1 Limitations

We consider Guix System to be ready for a wide range of "desktop" and server use cases. The reliability guarantees it provides—transactional upgrades and rollbacks, reproducibility—make it a solid foundation.

Nevertheless, before you proceed with the installation, be aware of the following noteworthy limitations applicable to version 1.4.0:

- More and more system services are provided (see Section 12.9 [Services], page 247), but some may be missing.
- GNOME, Xfce, LXDE, and Enlightenment are available (see Section 12.9.9 [Desktop Services], page 322), as well as a number of X11 window managers. However, KDE is currently missing.

More than a disclaimer, this is an invitation to report issues (and success stories!), and to join us in improving it. See Chapter 22 [Contributing], page 625, for more info.

3.2 Hardware Considerations

GNU Guix focuses on respecting the user's computing freedom. It builds around the kernel Linux-libre, which means that only hardware for which free software drivers and firmware exist is supported. Nowadays, a wide range of off-the-shelf hardware is supported on GNU/Linux-libre—from keyboards to graphics cards to scanners and Ethernet controllers. Unfortunately, there are still areas where hardware vendors deny users control over their own computing, and such hardware is not supported on Guix System.

One of the main areas where free drivers or firmware are lacking is WiFi devices. WiFi devices known to work include those using Atheros chips (AR9271 and AR7010), which corresponds to the `ath9k` Linux-libre driver, and those using Broadcom/AirForce chips (BCM43xx with Wireless-Core Revision 5), which corresponds to the `b43-open` Linux-libre driver. Free firmware exists for both and is available out-of-the-box on Guix System, as part of `%base-firmware` (see Section 12.2 [operating-system Reference], page 228).

The installer warns you early on if it detects devices that are known *not* to work due to the lack of free firmware or free drivers.

The Free Software Foundation (`https://www.fsf.org/`) runs *Respects Your Freedom* (`https://www.fsf.org/ryf`) (RYF), a certification program for hardware products that respect your freedom and your privacy and ensure that you have control over your device. We encourage you to check the list of RYF-certified devices.

Another useful resource is the H-Node (`https://www.h-node.org/`) web site. It contains a catalog of hardware devices with information about their support in GNU/Linux.

3.3 USB Stick and DVD Installation

An ISO-9660 installation image that can be written to a USB stick or burnt to a DVD can be downloaded from '`https://ftp.gnu.org/gnu/guix/guix-system-install-1.4.0.x86_64-linux.iso`', where you can replace `x86_64-linux` with one of:

`x86_64-linux`
: for a GNU/Linux system on Intel/AMD-compatible 64-bit CPUs;

`i686-linux`
: for a 32-bit GNU/Linux system on Intel-compatible CPUs.

Make sure to download the associated `.sig` file and to verify the authenticity of the image against it, along these lines:

```
$ wget https://ftp.gnu.org/gnu/guix/guix-system-install-1.4.0.x86_64-linux.iso.sig
$ gpg --verify guix-system-install-1.4.0.x86_64-linux.iso.sig
```

If that command fails because you do not have the required public key, then run this command to import it:

```
$ wget https://sv.gnu.org/people/viewgpg.php?user_id=15145 \
      -qO - | gpg --import -
```

and rerun the `gpg --verify` command.

Take note that a warning like "This key is not certified with a trusted signature!" is normal.

This image contains the tools necessary for an installation. It is meant to be copied *as is* to a large-enough USB stick or DVD.

Copying to a USB Stick

Insert a USB stick of 1 GiB or more into your machine, and determine its device name. Assuming that the USB stick is known as `/dev/sdX`, copy the image with:

```
dd if=guix-system-install-1.4.0.x86_64-linux.iso of=/dev/sdX status=progress
sync
```

Access to `/dev/sdX` usually requires root privileges.

Burning on a DVD

Insert a blank DVD into your machine, and determine its device name. Assuming that the DVD drive is known as `/dev/srX`, copy the image with:

```
growisofs -dvd-compat -Z /dev/srX=guix-system-install-1.4.0.x86_64-linux.iso
```

Access to `/dev/srX` usually requires root privileges.

Booting

Once this is done, you should be able to reboot the system and boot from the USB stick or DVD. The latter usually requires you to get in the BIOS or UEFI boot menu, where you can choose to boot from the USB stick. In order to boot from Libreboot, switch to the command mode by pressing the *c* key and type `search_grub usb`.

See Section 3.8 [Installing Guix in a VM], page 31, if, instead, you would like to install Guix System in a virtual machine (VM).

3.4 Preparing for Installation

Once you have booted, you can use the guided graphical installer, which makes it easy to get started (see Section 3.5 [Guided Graphical Installation], page 25). Alternatively, if you are already familiar with GNU/Linux and if you want more control than what the graphical installer provides, you can choose the "manual" installation process (see Section 3.6 [Manual Installation], page 27).

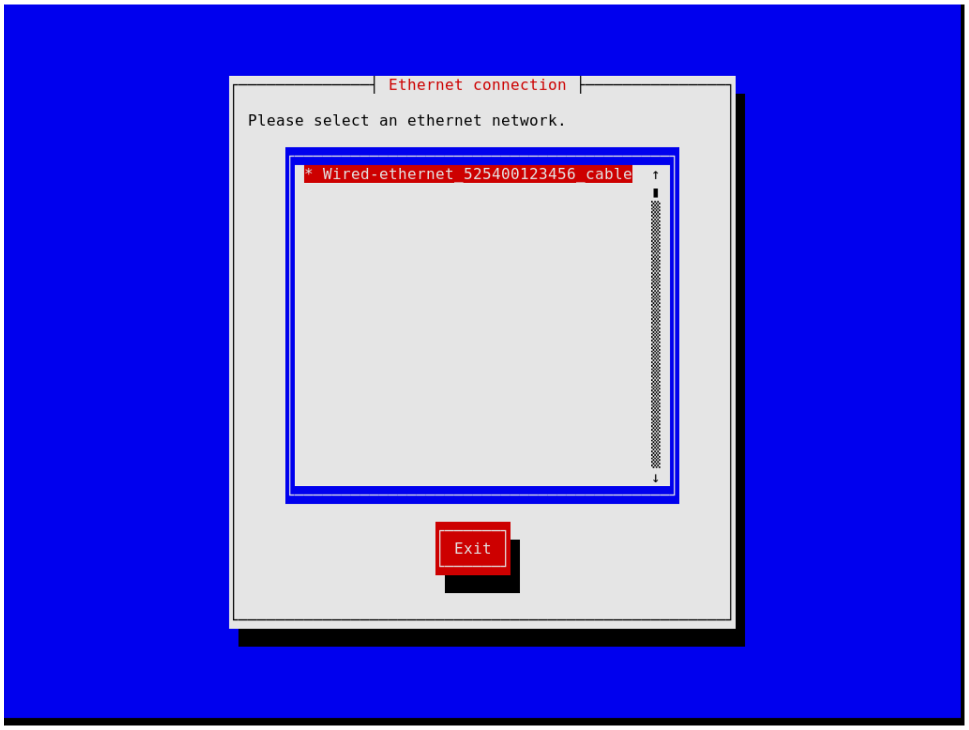
The graphical installer is available on TTY1. You can obtain root shells on TTYs 3 to 6 by hitting *`ctrl-alt-f3`*, *`ctrl-alt-f4`*, etc. TTY2 shows this documentation and you can reach it with *`ctrl-alt-f2`*. Documentation is browsable using the Info reader commands (see *Stand-alone GNU Info*). The installation system runs the GPM mouse daemon, which allows you to select text with the left mouse button and to paste it with the middle button.

> **Note:** Installation requires access to the Internet so that any missing dependencies of your system configuration can be downloaded. See the "Networking" section below.

3.5 Guided Graphical Installation

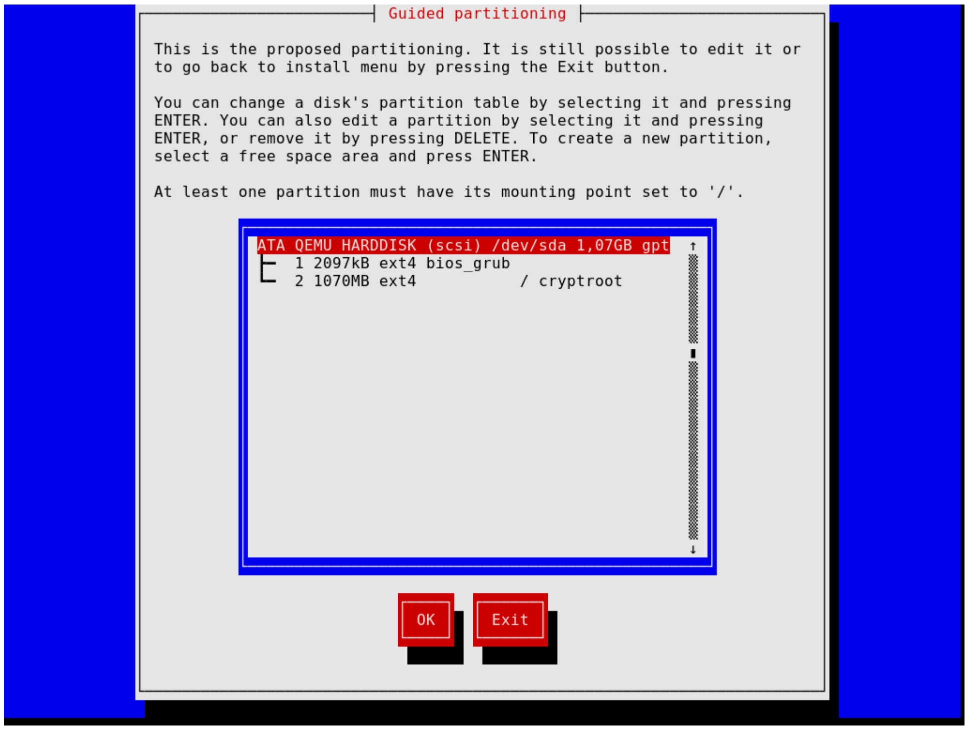
The graphical installer is a text-based user interface. It will guide you, with dialog boxes, through the steps needed to install GNU Guix System.

The first dialog boxes allow you to set up the system as you use it during the installation: you can choose the language, keyboard layout, and set up networking, which will be used during the installation. The image below shows the networking dialog.



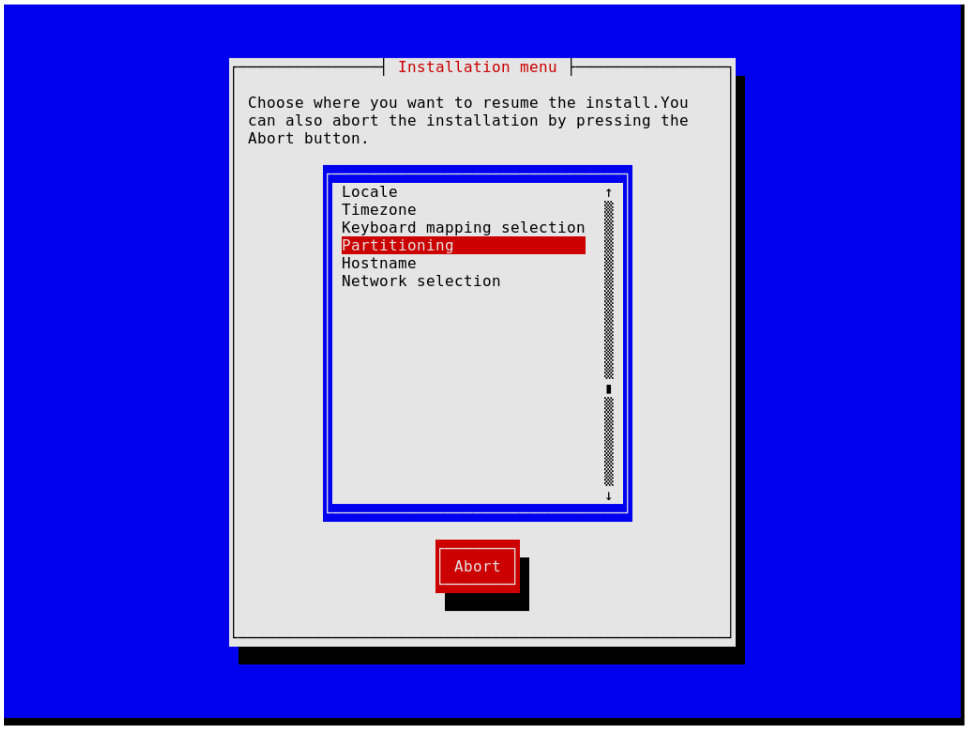
```
Ethernet connection

Please select an ethernet network.

* Wired-ethernet_525400123456_cable
```

Later steps allow you to partition your hard disk, as shown in the image below, to choose whether or not to use encrypted file systems, to enter the host name and root password, and to create an additional account, among other things.



```
Guided partitioning

This is the proposed partitioning. It is still possible to edit it or
to go back to install menu by pressing the Exit button.

You can change a disk's partition table by selecting it and pressing
ENTER. You can also edit a partition by selecting it and pressing
ENTER, or remove it by pressing DELETE. To create a new partition,
select a free space area and press ENTER.

At least one partition must have its mounting point set to '/'.

ATA QEMU HARDDISK (scsi) /dev/sda 1,07GB gpt
├ 1 2097kB ext4 bios_grub
└ 2 1070MB ext4           / cryptroot
```

Note that, at any time, the installer allows you to exit the current installation step and resume at a previous step, as show in the image below.



```
Installation menu

Choose where you want to resume the install.You
can also abort the installation by pressing the
Abort button.

Locale
Timezone
Keyboard mapping selection
Partitioning
Hostname
Network selection
```

Once you're done, the installer produces an operating system configuration and displays it (see Section 12.1 [Using the Configuration System], page 220). At that point you can hit

"OK" and installation will proceed. On success, you can reboot into the new system and enjoy. See Section 3.7 [After System Installation], page 31, for what's next!

3.6 Manual Installation

This section describes how you would "manually" install GNU Guix System on your machine. This option requires familiarity with GNU/Linux, with the shell, and with common administration tools. If you think this is not for you, consider using the guided graphical installer (see Section 3.5 [Guided Graphical Installation], page 25).

The installation system provides root shells on TTYs 3 to 6; press *`ctrl-alt-f3`*, *`ctrl-alt-f4`*, and so on to reach them. It includes many common tools needed to install the system, but is also a full-blown Guix System. This means that you can install additional packages, should you need it, using `guix package` (see Section 6.2 [Invoking guix package], page 39).

3.6.1 Keyboard Layout, Networking, and Partitioning

Before you can install the system, you may want to adjust the keyboard layout, set up networking, and partition your target hard disk. This section will guide you through this.

3.6.1.1 Keyboard Layout

The installation image uses the US qwerty keyboard layout. If you want to change it, you can use the `loadkeys` command. For example, the following command selects the Dvorak keyboard layout:

```
loadkeys dvorak
```

See the files under `/run/current-system/profile/share/keymaps` for a list of available keyboard layouts. Run `man loadkeys` for more information.

3.6.1.2 Networking

Run the following command to see what your network interfaces are called:

```
ifconfig -a
```

. . . or, using the GNU/Linux-specific `ip` command:

```
ip address
```

Wired interfaces have a name starting with '`e`'; for example, the interface corresponding to the first on-board Ethernet controller is called '`eno1`'. Wireless interfaces have a name starting with '`w`', like '`w1p2s0`'.

Wired connection

To configure a wired network run the following command, substituting *interface* with the name of the wired interface you want to use.

```
ifconfig interface up
```

. . . or, using the GNU/Linux-specific `ip` command:

```
ip link set interface up
```

Wireless connection

To configure wireless networking, you can create a configuration file for the `wpa_supplicant` configuration tool (its location is not important) using one of the available text editors such as `nano`:

```
nano wpa_supplicant.conf
```

As an example, the following stanza can go to this file and will work for many wireless networks, provided you give the actual SSID and passphrase for the network you are connecting to:

```
network={
  ssid="my-ssid"
  key_mgmt=WPA-PSK
  psk="the network's secret passphrase"
}
```

Start the wireless service and run it in the background with the following command (substitute *interface* with the name of the network interface you want to use):

```
wpa_supplicant -c wpa_supplicant.conf -i interface -B
```

Run `man wpa_supplicant` for more information.

At this point, you need to acquire an IP address. On a network where IP addresses are automatically assigned *via* DHCP, you can run:

```
dhclient -v interface
```

Try to ping a server to see if networking is up and running:

```
ping -c 3 gnu.org
```

Setting up network access is almost always a requirement because the image does not contain all the software and tools that may be needed.

If you need HTTP and HTTPS access to go through a proxy, run the following command:

```
herd set-http-proxy guix-daemon URL
```

where *URL* is the proxy URL, for example `http://example.org:8118`.

If you want to, you can continue the installation remotely by starting an SSH server:

```
herd start ssh-daemon
```

Make sure to either set a password with `passwd`, or configure OpenSSH public key authentication before logging in.

3.6.1.3 Disk Partitioning

Unless this has already been done, the next step is to partition, and then format the target partition(s).

The installation image includes several partitioning tools, including Parted (see Section "Overview" in *GNU Parted User Manual*), `fdisk`, and `cfdisk`. Run it and set up your disk with the partition layout you want:

```
cfdisk
```

If your disk uses the GUID Partition Table (GPT) format and you plan to install BIOS-based GRUB (which is the default), make sure a BIOS Boot Partition is available (see Section "BIOS installation" in *GNU GRUB manual*).

If you instead wish to use EFI-based GRUB, a FAT32 *EFI System Partition* (ESP) is required. This partition can be mounted at `/boot/efi` for instance and must have the `esp` flag set. E.g., for `parted`:

```
parted /dev/sda set 1 esp on
```

> **Note:** Unsure whether to use EFI- or BIOS-based GRUB? If the directory `/sys/firmware/efi` exists in the installation image, then you should probably perform an EFI installation, using `grub-efi-bootloader`. Otherwise you should use the BIOS-based GRUB, known as `grub-bootloader`. See Section 12.14 [Bootloader Configuration], page 540, for more info on bootloaders.

Once you are done partitioning the target hard disk drive, you have to create a file system on the relevant partition(s)[1]. For the ESP, if you have one and assuming it is `/dev/sda1`, run:

```
mkfs.fat -F32 /dev/sda1
```

For the root file system, ext4 is the most widely used format. Other file systems, such as Btrfs, support compression, which is reported to nicely complement file deduplication that the daemon performs independently of the file system (see Section 2.5 [Invoking guix-daemon], page 15).

Preferably, assign file systems a label so that you can easily and reliably refer to them in `file-system` declarations (see Section 12.3 [File Systems], page 232). This is typically done using the `-L` option of `mkfs.ext4` and related commands. So, assuming the target root partition lives at `/dev/sda2`, a file system with the label `my-root` can be created with:

```
mkfs.ext4 -L my-root /dev/sda2
```

If you are instead planning to encrypt the root partition, you can use the Cryptsetup/LUKS utilities to do that (see `man cryptsetup` for more information).

> **Warning:** Note that GRUB can unlock LUKS2 devices since version 2.06, but only supports the PBKDF2 key derivation function, which is not the default for `cryptsetup luksFormat`. You can check which key derivation function is being used by a device by running `cryptsetup luksDump` *`device`*, and looking for the PBKDF field of your keyslots.

Assuming you want to store the root partition on `/dev/sda2`, the command sequence to format it as a LUKS2 partition would be along these lines:

```
cryptsetup luksFormat --type luks2 --pbkdf pbkdf2 /dev/sda2
cryptsetup open /dev/sda2 my-partition
mkfs.ext4 -L my-root /dev/mapper/my-partition
```

Once that is done, mount the target file system under `/mnt` with a command like (again, assuming `my-root` is the label of the root file system):

```
mount LABEL=my-root /mnt
```

Also mount any other file systems you would like to use on the target system relative to this path. If you have opted for `/boot/efi` as an EFI mount point for example, mount it at `/mnt/boot/efi` now so it is found by `guix system init` afterwards.

Finally, if you plan to use one or more swap partitions (see Section 12.5 [Swap Space], page 239), make sure to initialize them with `mkswap`. Assuming you have one swap partition on `/dev/sda3`, you would run:

```
mkswap /dev/sda3
swapon /dev/sda3
```

[1] Currently Guix System only supports ext4, btrfs, JFS, F2FS, and XFS file systems. In particular, code that reads file system UUIDs and labels only works for these file system types.

Alternatively, you may use a swap file. For example, assuming that in the new system you want to use the file `/swapfile` as a swap file, you would run[2]:

```
# This is 10 GiB of swap space.  Adjust "count" to change the size.
dd if=/dev/zero of=/mnt/swapfile bs=1MiB count=10240
# For security, make the file readable and writable only by root.
chmod 600 /mnt/swapfile
mkswap /mnt/swapfile
swapon /mnt/swapfile
```

Note that if you have encrypted the root partition and created a swap file in its file system as described above, then the encryption also protects the swap file, just like any other file in that file system.

3.6.2 Proceeding with the Installation

With the target partitions ready and the target root mounted on `/mnt`, we're ready to go. First, run:

```
herd start cow-store /mnt
```

This makes `/gnu/store` copy-on-write, such that packages added to it during the installation phase are written to the target disk on `/mnt` rather than kept in memory. This is necessary because the first phase of the `guix system init` command (see below) entails downloads or builds to `/gnu/store` which, initially, is an in-memory file system.

Next, you have to edit a file and provide the declaration of the operating system to be installed. To that end, the installation system comes with three text editors. We recommend GNU nano (see *GNU nano Manual*), which supports syntax highlighting and parentheses matching; other editors include mg (an Emacs clone), and nvi (a clone of the original BSD `vi` editor). We strongly recommend storing that file on the target root file system, say, as `/mnt/etc/config.scm`. Failing to do that, you will have lost your configuration file once you have rebooted into the newly-installed system.

See Section 12.1 [Using the Configuration System], page 220, for an overview of the configuration file. The example configurations discussed in that section are available under `/etc/configuration` in the installation image. Thus, to get started with a system configuration providing a graphical display server (a "desktop" system), you can run something along these lines:

```
# mkdir /mnt/etc
# cp /etc/configuration/desktop.scm /mnt/etc/config.scm
# nano /mnt/etc/config.scm
```

You should pay attention to what your configuration file contains, and in particular:

- Make sure the `bootloader-configuration` form refers to the targets you want to install GRUB on. It should mention `grub-bootloader` if you are installing GRUB in the legacy way, or `grub-efi-bootloader` for newer UEFI systems. For legacy systems, the `targets` field contain the names of the devices, like `(list "/dev/sda")`; for UEFI systems it names the paths to mounted EFI partitions, like `(list "/boot/efi")`; do

[2] This example will work for many types of file systems (e.g., ext4). However, for copy-on-write file systems (e.g., btrfs), the required steps may be different. For details, see the manual pages for `mkswap` and `swapon`.

make sure the paths are currently mounted and a `file-system` entry is specified in your configuration.

- Be sure that your file system labels match the value of their respective `device` fields in your `file-system` configuration, assuming your `file-system` configuration uses the `file-system-label` procedure in its `device` field.
- If there are encrypted or RAID partitions, make sure to add a `mapped-devices` field to describe them (see Section 12.4 [Mapped Devices], page 237).

Once you are done preparing the configuration file, the new system must be initialized (remember that the target root file system is mounted under `/mnt`):

```
guix system init /mnt/etc/config.scm /mnt
```

This copies all the necessary files and installs GRUB on `/dev/sdX`, unless you pass the `--no-bootloader` option. For more information, see Section 12.15 [Invoking guix system], page 545. This command may trigger downloads or builds of missing packages, which can take some time.

Once that command has completed—and hopefully succeeded!—you can run `reboot` and boot into the new system. The `root` password in the new system is initially empty; other users' passwords need to be initialized by running the `passwd` command as `root`, unless your configuration specifies otherwise (see [user-account-password], page 242). See Section 3.7 [After System Installation], page 31, for what's next!

3.7 After System Installation

Success, you've now booted into Guix System! From then on, you can update the system whenever you want by running, say:

```
guix pull
sudo guix system reconfigure /etc/config.scm
```

This builds a new system generation with the latest packages and services (see Section 12.15 [Invoking guix system], page 545). We recommend doing that regularly so that your system includes the latest security updates (see Chapter 19 [Security Updates], page 616).

> **Note:** Note that `sudo guix` runs your user's `guix` command and *not* root's, because `sudo` leaves `PATH` unchanged. To explicitly run root's `guix`, type `sudo -i guix ...`.
>
> The difference matters here, because `guix pull` updates the `guix` command and package definitions only for the user it is run as. This means that if you choose to use `guix system reconfigure` in root's login shell, you'll need to `guix pull` separately.

Now, see Chapter 5 [Getting Started], page 35, and join us on `#guix` on the Libera Chat IRC network or on `guix-devel@gnu.org` to share your experience!

3.8 Installing Guix in a Virtual Machine

If you'd like to install Guix System in a virtual machine (VM) or on a virtual private server (VPS) rather than on your beloved machine, this section is for you.

To boot a QEMU (`https://qemu.org/`) VM for installing Guix System in a disk image, follow these steps:

1. First, retrieve and decompress the Guix system installation image as described previously (see Section 3.3 [USB Stick and DVD Installation], page 24).
2. Create a disk image that will hold the installed system. To make a qcow2-formatted disk image, use the `qemu-img` command:

   ```
   qemu-img create -f qcow2 guix-system.img 50G
   ```

   The resulting file will be much smaller than 50 GB (typically less than 1 MB), but it will grow as the virtualized storage device is filled up.
3. Boot the USB installation image in an VM:

   ```
   qemu-system-x86_64 -m 1024 -smp 1 -enable-kvm \
     -nic user,model=virtio-net-pci -boot menu=on,order=d \
     -drive file=guix-system.img \
     -drive media=cdrom,file=guix-system-install-1.4.0.system.iso
   ```

   `-enable-kvm` is optional, but significantly improves performance, see Section 12.17 [Running Guix in a VM], page 558.
4. You're now root in the VM, proceed with the installation process. See Section 3.4 [Preparing for Installation], page 25, and follow the instructions.

Once installation is complete, you can boot the system that's on your `guix-system.img` image. See Section 12.17 [Running Guix in a VM], page 558, for how to do that.

3.9 Building the Installation Image

The installation image described above was built using the `guix system` command, specifically:

```
guix system image -t iso9660 gnu/system/install.scm
```

Have a look at `gnu/system/install.scm` in the source tree, and see also Section 12.15 [Invoking guix system], page 545, for more information about the installation image.

3.10 Building the Installation Image for ARM Boards

Many ARM boards require a specific variant of the U-Boot (`https://www.denx.de/wiki/U-Boot/`) bootloader.

If you build a disk image and the bootloader is not available otherwise (on another boot drive etc), it's advisable to build an image that includes the bootloader, specifically:

```
guix system image --system=armhf-linux -e '((@ (gnu system install) os-with-u-boot) (@
```

`A20-OLinuXino-Lime2` is the name of the board. If you specify an invalid board, a list of possible boards will be printed.

4 System Troubleshooting Tips

Guix System allows rebooting into a previous generation should the last one be malfunctioning, which makes it quite robust against being broken irreversibly. This feature depends on GRUB being correctly functioning though, which means that if for whatever reasons your GRUB installation becomes corrupted during a system reconfiguration, you may not be able to easily boot into a previous generation. A technique that can be used in this case is to *chroot* into your broken system and reconfigure it from there. Such technique is explained below.

4.1 Chrooting into an existing system

This section details how to *chroot* to an already installed Guix System with the aim of reconfiguring it, for example to fix a broken GRUB installation. The process is similar to how it would be done on other GNU/Linux systems, but there are some Guix System particularities such as the daemon and profiles that make it worthy of explaining here.

1. Obtain a bootable image of Guix System. It is recommended the latest development snapshot so the kernel and the tools used are at least as as new as those of your installed system; it can be retrieved from the https://ci.guix.gnu.org (`https://ci.guix.gnu.org/search/latest/ISO-9660?query=spec:images+status:success+system:x86_64-linux+image.iso`) URL. Follow the see Section 3.3 [USB Stick and DVD Installation], page 24, section for copying it to a bootable media.
2. Boot the image, and proceed with the graphical text-based installer until your network is configured. Alternatively, you could configure the network manually by following the [manual-installation-networking], page 27, section. If you get the error '`RTNETLINK answers: Operation not possible due to RF-kill`', try '`rfkill list`' followed by '`rfkill unblock 0`', where '`0`' is your device identifier (ID).
3. Switch to a virtual console (tty) if you haven't already by pressing simultaneously the *`Control`* + *`Alt`* + *`F4`* keys. Mount your file system at `/mnt`. Assuming your root partition is `/dev/sda2`, you would do:

   ```
   mount /dev/sda2 /mnt
   ```
4. Mount special block devices and Linux-specific directories:

   ```
   mount --bind /proc /mnt/proc
   mount --bind /sys /mnt/sys
   mount --bind /dev /mnt/dev
   ```

   If your system is EFI-based, you must also mount the ESP partition. Assuming it is `/dev/sda1`, you can do so with:

   ```
   mount /dev/sda1 /mnt/boot/efi
   ```
5. Enter your system via chroot:

   ```
   chroot /mnt /bin/sh
   ```
6. Source the system profile as well as your *user* profile to setup the environment, where *user* is the user name used for the Guix System you are attempting to repair:

   ```
   source /var/guix/profiles/system/profile/etc/profile
   ```

```
source /home/user/.guix-profile/etc/profile
```

To ensure you are working with the Guix revision you normally would as your normal user, also source your current Guix profile:

```
source /home/user/.config/guix/current/etc/profile
```

7. Start a minimal `guix-daemon` in the background:

   ```
   guix-daemon --build-users-group=guixbuild --disable-chroot &
   ```

8. Edit your Guix System configuration if needed, then reconfigure with:

   ```
   guix system reconfigure your-config.scm
   ```

9. Finally, you should be good to reboot the system to test your fix.

5 Getting Started

Presumably, you've reached this section because either you have installed Guix on top of another distribution (see Chapter 2 [Installation], page 4), or you've installed the standalone Guix System (see Chapter 3 [System Installation], page 23). It's time for you to get started using Guix and this section aims to help you do that and give you a feel of what it's like.

Guix is about installing software, so probably the first thing you'll want to do is to actually look for software. Let's say you're looking for a text editor, you can run:

```
guix search text editor
```

This command shows you a number of matching *packages*, each time showing the package's name, version, a description, and additional info. Once you've found out the one you want to use, let's say Emacs (ah ha!), you can go ahead and install it (run this command as a regular user, *no need for root privileges*!):

```
guix install emacs
```

You've installed your first package, congrats! The package is now visible in your default *profile*, `$HOME/.guix-profile`—a profile is a directory containing installed packages. In the process, you've probably noticed that Guix downloaded pre-built binaries; or, if you explicitly chose to *not* use pre-built binaries, then probably Guix is still building software (see Section 6.3 [Substitutes], page 48, for more info).

Unless you're using Guix System, the `guix install` command must have printed this hint:

```
hint: Consider setting the necessary environment variables by running:

     GUIX_PROFILE="$HOME/.guix-profile"
     . "$GUIX_PROFILE/etc/profile"

Alternately, see `guix package --search-paths -p "$HOME/.guix-profile"'.
```

Indeed, you must now tell your shell where `emacs` and other programs installed with Guix are to be found. Pasting the two lines above will do just that: it will add `$HOME/.guix-profile/bin`—which is where the installed package is—to the `PATH` environment variable. You can paste these two lines in your shell so they take effect right away, but more importantly you should add them to `~/.bash_profile` (or equivalent file if you do not use Bash) so that environment variables are set next time you spawn a shell. You only need to do this once and other search paths environment variables will be taken care of similarly—e.g., if you eventually install `python` and Python libraries, `GUIX_PYTHONPATH` will be defined.

You can go on installing packages at your will. To list installed packages, run:

```
guix package --list-installed
```

To remove a package, you would unsurprisingly run `guix remove`. A distinguishing feature is the ability to *roll back* any operation you made—installation, removal, upgrade—by simply typing:

```
guix package --roll-back
```

This is because each operation is in fact a *transaction* that creates a new *generation*. These generations and the difference between them can be displayed by running:

```
guix package --list-generations
```

Now you know the basics of package management!

> **Going further:** See Chapter 6 [Package Management], page 38, for more about package management. You may like *declarative* package management with `guix package --manifest`, managing separate *profiles* with `--profile`, deleting old generations, collecting garbage, and other nifty features that will come in handy as you become more familiar with Guix. If you are a developer, see Chapter 8 [Development], page 76, for additional tools. And if you're curious, see Section 6.1 [Features], page 38, to peek under the hood.

Once you've installed a set of packages, you will want to periodically *upgrade* them to the latest and greatest version. To do that, you will first pull the latest revision of Guix and its package collection:

```
guix pull
```

The end result is a new `guix` command, under `~/.config/guix/current/bin`. Unless you're on Guix System, the first time you run `guix pull`, be sure to follow the hint that the command prints and, similar to what we saw above, paste these two lines in your terminal and `.bash_profile`:

```
GUIX_PROFILE="$HOME/.config/guix/current"
. "$GUIX_PROFILE/etc/profile"
```

You must also instruct your shell to point to this new `guix`:

```
hash guix
```

At this point, you're running a brand new Guix. You can thus go ahead and actually upgrade all the packages you previously installed:

```
guix upgrade
```

As you run this command, you will see that binaries are downloaded (or perhaps some packages are built), and eventually you end up with the upgraded packages. Should one of these upgraded packages not be to your liking, remember you can always roll back!

You can display the exact revision of Guix you're currently using by running:

```
guix describe
```

The information it displays is *all it takes to reproduce the exact same Guix*, be it at a different point in time or on a different machine.

> **Going further:** See Section 6.6 [Invoking guix pull], page 56, for more information. See Chapter 7 [Channels], page 68, on how to specify additional *channels* to pull packages from, how to replicate Guix, and more. You may also find `time-machine` handy (see Section 6.7 [Invoking guix time-machine], page 60).

If you installed Guix System, one of the first things you'll want to do is to upgrade your system. Once you've run `guix pull` to get the latest Guix, you can upgrade the system like this:

```
sudo guix system reconfigure /etc/config.scm
```

Upon completion, the system runs the latest versions of its software packages. When you eventually reboot, you'll notice a sub-menu in the bootloader that reads "Old system generations": it's what allows you to boot *an older generation of your system*, should the latest generation be "broken" or otherwise unsatisfying. Just like for packages, you can always *roll back* to a previous generation *of the whole system*:

```
sudo guix system roll-back
```

There are many things you'll probably want to tweak on your system: adding new user accounts, adding new system services, fiddling with the configuration of those services, etc. The system configuration is *entirely* described in the `/etc/config.scm` file. See Section 12.1 [Using the Configuration System], page 220, to learn how to change it.

Now you know enough to get started!

Resources: The rest of this manual provides a reference for all things Guix. Here are some additional resources you may find useful:

- See *The GNU Guix Cookbook*, for a list of "how-to" style of recipes for a variety of applications.
- The GNU Guix Reference Card (`https://guix.gnu.org/guix-refcard.pdf`) lists in two pages most of the commands and options you'll ever need.
- The web site contains instructional videos (`https://guix.gnu.org/en/videos/`) covering topics such as everyday use of Guix, how to get help, and how to become a contributor.
- See Chapter 14 [Documentation], page 600, to learn how to access documentation on your computer.

We hope you will enjoy Guix as much as the community enjoys building it!

6 Package Management

The purpose of GNU Guix is to allow users to easily install, upgrade, and remove software packages, without having to know about their build procedures or dependencies. Guix also goes beyond this obvious set of features.

This chapter describes the main features of Guix, as well as the package management tools it provides. Along with the command-line interface described below (see Section 6.2 [Invoking guix package], page 39), you may also use the Emacs-Guix interface (see *The Emacs-Guix Reference Manual*), after installing `emacs-guix` package (run *`M-x guix-help`* command to start with it):

```
guix install emacs-guix
```

6.1 Features

Here we assume you've already made your first steps with Guix (see Chapter 5 [Getting Started], page 35) and would like to get an overview about what's going on under the hood.

When using Guix, each package ends up in the *package store*, in its own directory—something that resembles `/gnu/store/xxx-package-1.2`, where `xxx` is a base32 string.

Instead of referring to these directories, users have their own *profile*, which points to the packages that they actually want to use. These profiles are stored within each user's home directory, at `$HOME/.guix-profile`.

For example, `alice` installs GCC 4.7.2. As a result, `/home/alice/.guix-profile/bin/gcc` points to `/gnu/store/...-gcc-4.7.2/bin/gcc`. Now, on the same machine, `bob` had already installed GCC 4.8.0. The profile of `bob` simply continues to point to `/gnu/store/...-gcc-4.8.0/bin/gcc`—i.e., both versions of GCC coexist on the same system without any interference.

The `guix package` command is the central tool to manage packages (see Section 6.2 [Invoking guix package], page 39). It operates on the per-user profiles, and can be used *with normal user privileges*.

The command provides the obvious install, remove, and upgrade operations. Each invocation is actually a *transaction*: either the specified operation succeeds, or nothing happens. Thus, if the `guix package` process is terminated during the transaction, or if a power outage occurs during the transaction, then the user's profile remains in its previous state, and remains usable.

In addition, any package transaction may be *rolled back*. So, if, for example, an upgrade installs a new version of a package that turns out to have a serious bug, users may roll back to the previous instance of their profile, which was known to work well. Similarly, the global system configuration on Guix is subject to transactional upgrades and roll-back (see Section 12.1 [Using the Configuration System], page 220).

All packages in the package store may be *garbage-collected*. Guix can determine which packages are still referenced by user profiles, and remove those that are provably no longer referenced (see Section 6.5 [Invoking guix gc], page 53). Users may also explicitly remove old generations of their profile so that the packages they refer to can be collected.

Guix takes a *purely functional* approach to package management, as described in the introduction (see Chapter 1 [Introduction], page 1). Each `/gnu/store` package directory name contains a hash of all the inputs that were used to build that package—compiler, libraries, build scripts, etc. This direct correspondence allows users to make sure a given package installation matches the current state of their distribution. It also helps maximize *build reproducibility*: thanks to the isolated build environments that are used, a given build is likely to yield bit-identical files when performed on different machines (see Section 2.5 [Invoking guix-daemon], page 15).

This foundation allows Guix to support *transparent binary/source deployment*. When a pre-built binary for a `/gnu/store` item is available from an external source—a *substitute*, Guix just downloads it and unpacks it; otherwise, it builds the package from source, locally (see Section 6.3 [Substitutes], page 48). Because build results are usually bit-for-bit reproducible, users do not have to trust servers that provide substitutes: they can force a local build and *challenge* providers (see Section 10.12 [Invoking guix challenge], page 209).

Control over the build environment is a feature that is also useful for developers. The `guix shell` command allows developers of a package to quickly set up the right development environment for their package, without having to manually install the dependencies of the package into their profile (see Section 8.1 [Invoking guix shell], page 76).

All of Guix and its package definitions is version-controlled, and `guix pull` allows you to "travel in time" on the history of Guix itself (see Section 6.6 [Invoking guix pull], page 56). This makes it possible to replicate a Guix instance on a different machine or at a later point in time, which in turn allows you to *replicate complete software environments*, while retaining precise *provenance tracking* of the software.

6.2 Invoking `guix package`

The `guix package` command is the tool that allows users to install, upgrade, and remove packages, as well as rolling back to previous configurations. These operations work on a user *profile*—a directory of installed packages. Each user has a default profile in `$HOME/.guix-profile`. The command operates only on the user's own profile, and works with normal user privileges (see Section 6.1 [Features], page 38). Its syntax is:

```
guix package options
```

Primarily, *options* specifies the operations to be performed during the transaction. Upon completion, a new profile is created, but previous *generations* of the profile remain available, should the user want to roll back.

For example, to remove `lua` and install `guile` and `guile-cairo` in a single transaction:

```
guix package -r lua -i guile guile-cairo
```

For your convenience, we also provide the following aliases:

- `guix search` is an alias for `guix package -s`,
- `guix install` is an alias for `guix package -i`,
- `guix remove` is an alias for `guix package -r`,
- `guix upgrade` is an alias for `guix package -u`,
- and `guix show` is an alias for `guix package --show=`.

These aliases are less expressive than `guix package` and provide fewer options, so in some cases you'll probably want to use `guix package` directly.

`guix package` also supports a *declarative approach* whereby the user specifies the exact set of packages to be available and passes it *via* the `--manifest` option (see [profile-manifest], page 43).

For each user, a symlink to the user's default profile is automatically created in `$HOME/.guix-profile`. This symlink always points to the current generation of the user's default profile. Thus, users can add `$HOME/.guix-profile/bin` to their `PATH` environment variable, and so on. If you are not using Guix System, consider adding the following lines to your `~/.bash_profile` (see Section "Bash Startup Files" in *The GNU Bash Reference Manual*) so that newly-spawned shells get all the right environment variable definitions:

```
GUIX_PROFILE="$HOME/.guix-profile" ; \
source "$GUIX_PROFILE/etc/profile"
```

In a multi-user setup, user profiles are stored in a place registered as a *garbage-collector root*, which `$HOME/.guix-profile` points to (see Section 6.5 [Invoking guix gc], page 53). That directory is normally `localstatedir/guix/profiles/per-user/user`, where *localstatedir* is the value passed to `configure` as `--localstatedir`, and *user* is the user name. The `per-user` directory is created when `guix-daemon` is started, and the *user* sub-directory is created by `guix package`.

The *options* can be among the following:

`--install=package ...`
`-i package ...`

Install the specified *packages*.

Each *package* may specify a simple package name, such as `guile`, optionally followed by an at-sign and version number, such as `guile@3.0.7` or simply `guile@3.0`. In the latter case, the newest version prefixed by `3.0` is selected.

If no version number is specified, the newest available version will be selected. In addition, such a *package* specification may contain a colon, followed by the name of one of the outputs of the package, as in `gcc:doc` or `binutils@2.22:lib` (see Section 6.4 [Packages with Multiple Outputs], page 53).

Packages with a corresponding name (and optionally version) are searched for among the GNU distribution modules (see Section 9.1 [Package Modules], page 95).

Alternatively, a *package* can directly specify a store file name such as `/gnu/store/...-guile-3.0.7`, as produced by, e.g., `guix build`.

Sometimes packages have *propagated inputs*: these are dependencies that automatically get installed along with the required package (see [package-propagated-inputs], page 100, for information about propagated inputs in package definitions).

An example is the GNU MPC library: its C header files refer to those of the GNU MPFR library, which in turn refer to those of the GMP library. Thus, when installing MPC, the MPFR and GMP libraries also get installed in the profile; removing MPC also removes MPFR and GMP—unless they had also been explicitly installed by the user.

Besides, packages sometimes rely on the definition of environment variables for their search paths (see explanation of `--search-paths` below). Any missing or possibly incorrect environment variable definitions are reported here.

`--install-from-expression=`*`exp`*
`-e` *`exp`* Install the package *exp* evaluates to.

exp must be a Scheme expression that evaluates to a `<package>` object. This option is notably useful to disambiguate between same-named variants of a package, with expressions such as `(@ (gnu packages base) guile-final)`.

Note that this option installs the first output of the specified package, which may be insufficient when needing a specific output of a multiple-output package.

`--install-from-file=`*`file`*
`-f` *`file`* Install the package that the code within *file* evaluates to.

As an example, *file* might contain a definition like this (see Section 9.2 [Defining Packages], page 96):

```
(use-modules (guix)
             (guix build-system gnu)
             (guix licenses))

(package
  (name "hello")
  (version "2.10")
  (source (origin
           (method url-fetch)
           (uri (string-append "mirror://gnu/hello/hello-" version
                               ".tar.gz"))
           (sha256
            (base32
             "0ssi1wpaf7plaswqqjwigppsg5fyh99vdlb9kzl7c9lng89ndq1i"))))
  (build-system gnu-build-system)
  (synopsis "Hello, GNU world: An example GNU package")
  (description "Guess what GNU Hello prints!")
  (home-page "http://www.gnu.org/software/hello/")
  (license gpl3+))
```

Developers may find it useful to include such a `guix.scm` file in the root of their project source tree that can be used to test development snapshots and create reproducible development environments (see Section 8.1 [Invoking guix shell], page 76).

The *file* may also contain a JSON representation of one or more package definitions. Running `guix package -f` on `hello.json` with the following contents would result in installing the package `greeter` after building `myhello`:

```
[
  {
    "name": "myhello",
    "version": "2.10",
    "source": "mirror://gnu/hello/hello-2.10.tar.gz",
    "build-system": "gnu",
    "arguments": {
      "tests?": false
```

```
                  }
                  "home-page": "https://www.gnu.org/software/hello/",
                  "synopsis": "Hello, GNU world: An example GNU package",
                  "description": "GNU Hello prints a greeting.",
                  "license": "GPL-3.0+",
                  "native-inputs": ["gettext"]
                },
                {
                  "name": "greeter",
                  "version": "1.0",
                  "source": "https://example.com/greeter-1.0.tar.gz",
                  "build-system": "gnu",
                  "arguments": {
                    "test-target": "foo",
                    "parallel-build?": false,
                  },
                  "home-page": "https://example.com/",
                  "synopsis": "Greeter using GNU Hello",
                  "description": "This is a wrapper around GNU Hello.",
                  "license": "GPL-3.0+",
                  "inputs": ["myhello", "hello"]
                }
              ]
```

`--remove=`*`package`* ...
`-r` *`package`* ...

Remove the specified *package*s.

As for `--install`, each *package* may specify a version number and/or output name in addition to the package name. For instance, '`-r glibc:debug`' would remove the `debug` output of `glibc`.

`--upgrade[=`*`regexp`* ...`]`
`-u [`*`regexp`* ...`]`

Upgrade all the installed packages. If one or more *regexp*s are specified, upgrade only installed packages whose name matches a *regexp*. Also see the `--do-not-upgrade` option below.

Note that this upgrades package to the latest version of packages found in the distribution currently installed. To update your distribution, you should regularly run `guix pull` (see Section 6.6 [Invoking guix pull], page 56).

When upgrading, package transformations that were originally applied when creating the profile are automatically re-applied (see Section 10.1.2 [Package Transformation Options], page 168). For example, assume you first installed Emacs from the tip of its development branch with:

```
guix install emacs-next --with-branch=emacs-next=master
```

Next time you run `guix upgrade`, Guix will again pull the tip of the Emacs development branch and build `emacs-next` from that checkout.

Note that transformation options such as `--with-branch` and `--with-source` depend on external state; it is up to you to ensure that they work as expected. You can also discard a transformations that apply to a package by running:

```
guix install package
```

`--do-not-upgrade[=regexp ...]`
: When used together with the `--upgrade` option, do *not* upgrade any packages whose name matches a *regexp*. For example, to upgrade all packages in the current profile except those containing the substring "emacs":

```
$ guix package --upgrade . --do-not-upgrade emacs
```

`--manifest=file`
`-m file`
: Create a new generation of the profile from the manifest object returned by the Scheme code in *file*. This option can be repeated several times, in which case the manifests are concatenated.

This allows you to *declare* the profile's contents rather than constructing it through a sequence of `--install` and similar commands. The advantage is that *file* can be put under version control, copied to different machines to reproduce the same profile, and so on.

file must return a *manifest* object, which is roughly a list of packages:

```
(use-package-modules guile emacs)

(packages->manifest
 (list emacs
       guile-2.0
       ;; Use a specific package output.
       (list guile-2.0 "debug")))
```

See Section 9.4 [Writing Manifests], page 110, for information on how to write a manifest. See [export-manifest], page 47, to learn how to obtain a manifest file from an existing profile.

`--roll-back`
: Roll back to the previous *generation* of the profile—i.e., undo the last transaction.

When combined with options such as `--install`, roll back occurs before any other actions.

When rolling back from the first generation that actually contains installed packages, the profile is made to point to the *zeroth generation*, which contains no files apart from its own metadata.

After having rolled back, installing, removing, or upgrading packages overwrites previous future generations. Thus, the history of the generations in a profile is always linear.

`--switch-generation=pattern`
`-S pattern`
: Switch to a particular generation defined by *pattern*.

pattern may be either a generation number or a number prefixed with "+" or "-". The latter means: move forward/backward by a specified number of generations. For example, if you want to return to the latest generation after `--roll-back`, use `--switch-generation=+1`.

The difference between `--roll-back` and `--switch-generation=-1` is that `--switch-generation` will not make a zeroth generation, so if a specified generation does not exist, the current generation will not be changed.

`--search-paths[=kind]`
: Report environment variable definitions, in Bash syntax, that may be needed in order to use the set of installed packages. These environment variables are used to specify *search paths* for files used by some of the installed packages.

For example, GCC needs the `CPATH` and `LIBRARY_PATH` environment variables to be defined so it can look for headers and libraries in the user's profile (see Section "Environment Variables" in *Using the GNU Compiler Collection (GCC)*). If GCC and, say, the C library are installed in the profile, then `--search-paths` will suggest setting these variables to `profile/include` and `profile/lib`, respectively (see Section 9.8 [Search Paths], page 141, for info on search path specifications associated with packages.)

The typical use case is to define these environment variables in the shell:

```
$ eval $(guix package --search-paths)
```

kind may be one of `exact`, `prefix`, or `suffix`, meaning that the returned environment variable definitions will either be exact settings, or prefixes or suffixes of the current value of these variables. When omitted, *kind* defaults to `exact`.

This option can also be used to compute the *combined* search paths of several profiles. Consider this example:

```
$ guix package -p foo -i guile
$ guix package -p bar -i guile-json
$ guix package -p foo -p bar --search-paths
```

The last command above reports about the `GUILE_LOAD_PATH` variable, even though, taken individually, neither `foo` nor `bar` would lead to that recommendation.

`--profile=profile`
`-p profile`
: Use *profile* instead of the user's default profile.

profile must be the name of a file that will be created upon completion. Concretely, *profile* will be a mere symbolic link ("symlink") pointing to the actual profile where packages are installed:

```
$ guix install hello -p ~/code/my-profile
...
$ ~/code/my-profile/bin/hello
Hello, world!
```

All it takes to get rid of the profile is to remove this symlink and its siblings that point to specific generations:

```
$ rm ~/code/my-profile ~/code/my-profile-*-link
```

`--list-profiles`
: List all the user's profiles:

```
$ guix package --list-profiles
/home/charlie/.guix-profile
/home/charlie/code/my-profile
/home/charlie/code/devel-profile
/home/charlie/tmp/test
```

When running as root, list all the profiles of all the users.

`--allow-collisions`
: Allow colliding packages in the new profile. Use at your own risk!

By default, `guix package` reports as an error *collisions* in the profile. Collisions happen when two or more different versions or variants of a given package end up in the profile.

`--bootstrap`
: Use the bootstrap Guile to build the profile. This option is only useful to distribution developers.

In addition to these actions, `guix package` supports the following options to query the current state of a profile, or the availability of packages:

`--search=`*regexp*
`-s` *regexp* List the available packages whose name, synopsis, or description matches *regexp* (in a case-insensitive fashion), sorted by relevance. Print all the metadata of matching packages in `recutils` format (see *GNU recutils manual*).

This allows specific fields to be extracted using the `recsel` command, for instance:

```
$ guix package -s malloc | recsel -p name,version,relevance
name: jemalloc
version: 4.5.0
relevance: 6

name: glibc
version: 2.25
relevance: 1

name: libgc
version: 7.6.0
relevance: 1
```

Similarly, to show the name of all the packages available under the terms of the GNU LGPL version 3:

```
$ guix package -s "" | recsel -p name -e 'license ~ "LGPL 3"'
name: elfutils

name: gmp
...
```

It is also possible to refine search results using several `-s` flags to `guix package`, or several arguments to `guix search`. For example, the following command returns a list of board games (this time using the `guix search` alias):

```
$ guix search '\<board\>' game | recsel -p name
name: gnubg
...
```

If we were to omit `-s game`, we would also get software packages that deal with printed circuit boards; removing the angle brackets around `board` would further add packages that have to do with keyboards.

And now for a more elaborate example. The following command searches for cryptographic libraries, filters out Haskell, Perl, Python, and Ruby libraries, and prints the name and synopsis of the matching packages:

```
$ guix search crypto library | \
    recsel -e '! (name ~ "^(ghc|perl|python|ruby)")' -p name,synopsis
```

See Section "Selection Expressions" in *GNU recutils manual*, for more information on *selection expressions* for `recsel -e`.

`--show=`*package*

Show details about *package*, taken from the list of available packages, in `recutils` format (see *GNU recutils manual*).

```
$ guix package --show=guile | recsel -p name,version
name: guile
version: 3.0.5

name: guile
version: 3.0.2

name: guile
version: 2.2.7
...
```

You may also specify the full name of a package to only get details about a specific version of it (this time using the `guix show` alias):

```
$ guix show guile@3.0.5 | recsel -p name,version
name: guile
version: 3.0.5
```

`--list-installed[=`*regexp*`]`
`-I [`*regexp*`]`

List the currently installed packages in the specified profile, with the most recently installed packages shown last. When *regexp* is specified, list only installed packages whose name matches *regexp*.

For each installed package, print the following items, separated by tabs: the package name, its version string, the part of the package that is installed (for instance, `out` for the default output, `include` for its headers, etc.), and the path of this package in the store.

`--list-available[=`*regexp*`]`
`-A [`*regexp*`]`

List packages currently available in the distribution for this system (see Section 1.2 [GNU Distribution], page 2). When *regexp* is specified, list only available packages whose name matches *regexp*.

For each package, print the following items separated by tabs: its name, its version string, the parts of the package (see Section 6.4 [Packages with Multiple Outputs], page 53), and the source location of its definition.

`--list-generations[=`*pattern*`]`
`-l [`*pattern*`]`

Return a list of generations along with their creation dates; for each generation, show the installed packages, with the most recently installed packages shown last. Note that the zeroth generation is never shown.

For each installed package, print the following items, separated by tabs: the name of a package, its version string, the part of the package that is installed (see Section 6.4 [Packages with Multiple Outputs], page 53), and the location of this package in the store.

When *pattern* is used, the command returns only matching generations. Valid patterns include:

- *Integers and comma-separated integers*. Both patterns denote generation numbers. For instance, `--list-generations=1` returns the first one.

  And `--list-generations=1,8,2` outputs three generations in the specified order. Neither spaces nor trailing commas are allowed.
- *Ranges*. `--list-generations=2..9` prints the specified generations and everything in between. Note that the start of a range must be smaller than its end.

  It is also possible to omit the endpoint. For example, `--list-generations=2..`, returns all generations starting from the second one.
- *Durations*. You can also get the last *N* days, weeks, or months by passing an integer along with the first letter of the duration. For example, `--list-generations=20d` lists generations that are up to 20 days old.

`--delete-generations[=`*pattern*`]`
`-d [`*pattern*`]`

When *pattern* is omitted, delete all generations except the current one.

This command accepts the same patterns as `--list-generations`. When *pattern* is specified, delete the matching generations. When *pattern* specifies a duration, generations *older* than the specified duration match. For instance, `--delete-generations=1m` deletes generations that are more than one month old.

If the current generation matches, it is *not* deleted. Also, the zeroth generation is never deleted.

Note that deleting generations prevents rolling back to them. Consequently, this command must be used with care.

`--export-manifest`
: Write to standard output a manifest suitable for `--manifest` corresponding to the chosen profile(s).

  This option is meant to help you migrate from the "imperative" operating mode—running `guix install`, `guix upgrade`, etc.—to the declarative mode that `--manifest` offers.

  Be aware that the resulting manifest *approximates* what your profile actually contains; for instance, depending on how your profile was created, it can refer to packages or package versions that are not exactly what you specified.

  Keep in mind that a manifest is purely symbolic: it only contains package names and possibly versions, and their meaning varies over time. If you wish to "pin" channels to the revisions that were used to build the profile(s), see `--export-channels` below.

`--export-channels`
: Write to standard output the list of channels used by the chosen profile(s), in a format suitable for `guix pull --channels` or `guix time-machine --channels` (see Chapter 7 [Channels], page 68).

  Together with `--export-manifest`, this option provides information allowing you to replicate the current profile (see Section 7.3 [Replicating Guix], page 69).

  However, note that the output of this command *approximates* what was actually used to build this profile. In particular, a single profile might have been built from several different revisions of the same channel. In that case, `--export-manifest` chooses the last one and writes the list of other revisions in a comment. If you really need to pick packages from different channel revisions, you can use inferiors in your manifest to do so (see Section 6.8 [Inferiors], page 61).

  Together with `--export-manifest`, this is a good starting point if you are willing to migrate from the "imperative" model to the fully declarative model consisting of a manifest file along with a channels file pinning the exact channel revision(s) you want.

Finally, since `guix package` may actually start build processes, it supports all the common build options (see Section 10.1.1 [Common Build Options], page 166). It also supports package transformation options, such as `--with-source`, and preserves them across upgrades (see Section 10.1.2 [Package Transformation Options], page 168).

6.3 Substitutes

Guix supports transparent source/binary deployment, which means that it can either build things locally, or download pre-built items from a server, or both. We call these pre-built items *substitutes*—they are substitutes for local build results. In many cases, downloading a substitute is much faster than building things locally.

Substitutes can be anything resulting from a derivation build (see Section 9.10 [Derivations], page 146). Of course, in the common case, they are pre-built package binaries, but source tarballs, for instance, which also result from derivation builds, can be available as substitutes.

6.3.1 Official Substitute Servers

`ci.guix.gnu.org` and `bordeaux.guix.gnu.org` are both front-ends to official build farms that build packages from Guix continuously for some architectures, and make them available as substitutes. These are the default source of substitutes; which can be overridden by passing the `--substitute-urls` option either to `guix-daemon` (see [`guix-daemon --substitute-urls`], page 16) or to client tools such as `guix package` (see [client `--substitute-urls` option], page 167).

Substitute URLs can be either HTTP or HTTPS. HTTPS is recommended because communications are encrypted; conversely, using HTTP makes all communications visible to an eavesdropper, who could use the information gathered to determine, for instance, whether your system has unpatched security vulnerabilities.

Substitutes from the official build farms are enabled by default when using Guix System (see Section 1.2 [GNU Distribution], page 2). However, they are disabled by default when using Guix on a foreign distribution, unless you have explicitly enabled them via one of the recommended installation steps (see Chapter 2 [Installation], page 4). The following paragraphs describe how to enable or disable substitutes for the official build farm; the same procedure can also be used to enable substitutes for any other substitute server.

6.3.2 Substitute Server Authorization

To allow Guix to download substitutes from `ci.guix.gnu.org`, `bordeaux.guix.gnu.org` or a mirror, you must add the relevant public key to the access control list (ACL) of archive imports, using the `guix archive` command (see Section 6.10 [Invoking guix archive], page 64). Doing so implies that you trust the substitute server to not be compromised and to serve genuine substitutes.

> **Note:** If you are using Guix System, you can skip this section: Guix System authorizes substitutes from `ci.guix.gnu.org` and `bordeaux.guix.gnu.org` by default.

The public keys for each of the project maintained substitute servers are installed along with Guix, in *`prefix`*`/share/guix/`, where *prefix* is the installation prefix of Guix. If you installed Guix from source, make sure you checked the GPG signature of `guix-1.4.0.tar.gz`, which contains this public key file. Then, you can run something like this:

```
# guix archive --authorize < prefix/share/guix/ci.guix.gnu.org.pub
# guix archive --authorize < prefix/share/guix/bordeaux.guix.gnu.org.pub
```

Once this is in place, the output of a command like `guix build` should change from something like:

```
$ guix build emacs --dry-run
The following derivations would be built:
   /gnu/store/yr7bnx8xwcayd6j95r2clmkdl1qh688w-emacs-24.3.drv
   /gnu/store/x8qsh1hlhgjx6cwsjyvybnfv2i37z23w-dbus-1.6.4.tar.gz.drv
   /gnu/store/1ixwp12fl950d15h2cj11c73733jay0z-alsa-lib-1.0.27.1.tar.bz2.drv
   /gnu/store/nlma1pw0p603fpfiqy7kn4zm105r5dmw-util-linux-2.21.drv
...
```

to something like:

```
$ guix build emacs --dry-run
```

```
112.3 MB would be downloaded:
   /gnu/store/pk3n22lbq6ydamyymqkkz7i69wiwjiwi-emacs-24.3
   /gnu/store/2ygn4ncnhrpr61rssa6z0d9x22si0va3-libjpeg-8d
   /gnu/store/71yz6lgx4dazma9dwn2mcjxaah9w77jq-cairo-1.12.16
   /gnu/store/7zdhgp0n1518lvfn8mb96sxqfmvqrl7v-libxrender-0.9.7
...
```

The text changed from "The following derivations would be built" to "112.3 MB would be downloaded". This indicates that substitutes from the configured substitute servers are usable and will be downloaded, when possible, for future builds.

The substitute mechanism can be disabled globally by running `guix-daemon` with `--no-substitutes` (see Section 2.5 [Invoking guix-daemon], page 15). It can also be disabled temporarily by passing the `--no-substitutes` option to `guix package`, `guix build`, and other command-line tools.

6.3.3 Getting Substitutes from Other Servers

Guix can look up and fetch substitutes from several servers. This is useful when you are using packages from additional channels for which the official server does not have substitutes but another server provides them. Another situation where this is useful is when you would prefer to download from your organization's substitute server, resorting to the official server only as a fallback or dismissing it altogether.

You can give Guix a list of substitute server URLs and it will check them in the specified order. You also need to explicitly authorize the public keys of substitute servers to instruct Guix to accept the substitutes they sign.

On Guix System, this is achieved by modifying the configuration of the `guix` service. Since the `guix` service is part of the default lists of services, `%base-services` and `%desktop-services`, you can use `modify-services` to change its configuration and add the URLs and substitute keys that you want (see Section 12.18.3 [Service Reference], page 563).

As an example, suppose you want to fetch substitutes from `guix.example.org` and to authorize the signing key of that server, in addition to the default `ci.guix.gnu.org` and `bordeaux.guix.gnu.org`. The resulting operating system configuration will look something like:

```
(operating-system
  ;; ...
  (services
    ;; Assume we're starting from '%desktop-services'.  Replace it
    ;; with the list of services you're actually using.
    (modify-services %desktop-services
      (guix-service-type config =>
                        (guix-configuration
                          (inherit config)
                          (substitute-urls
                            (append (list "https://guix.example.org")
                                    %default-substitute-urls))
                          (authorized-keys
                            (append (list (local-file "./key.pub"))
                                            %default-authorized-guix-keys)))))))
```

This assumes that the file `key.pub` contains the signing key of `guix.example.org`. With this change in place in your operating system configuration file (say `/etc/config.scm`), you can reconfigure and restart the `guix-daemon` service or reboot so the changes take effect:

```
$ sudo guix system reconfigure /etc/config.scm
$ sudo herd restart guix-daemon
```

If you're running Guix on a "foreign distro", you would instead take the following steps to get substitutes from additional servers:

1. Edit the service configuration file for `guix-daemon`; when using systemd, this is normally `/etc/systemd/system/guix-daemon.service`. Add the `--substitute-urls` option on the `guix-daemon` command line and list the URLs of interest (see [daemon-substitute-urls], page 16):

   ```
   ... --substitute-urls='https://guix.example.org https://ci.guix.gnu.org
   https://bordeaux.guix.gnu.org'
   ```

2. Restart the daemon. For systemd, it goes like this:

   ```
   systemctl daemon-reload
   systemctl restart guix-daemon.service
   ```

3. Authorize the key of the new server (see Section 6.10 [Invoking guix archive], page 64):

   ```
   guix archive --authorize < key.pub
   ```

   Again this assumes `key.pub` contains the public key that `guix.example.org` uses to sign substitutes.

Now you're all set! Substitutes will be preferably taken from `https://guix.example.org`, using `ci.guix.gnu.org` then `bordeaux.guix.gnu.org` as fallback options. Of course you can list as many substitute servers as you like, with the caveat that substitute lookup can be slowed down if too many servers need to be contacted.

Note that there are also situations where one may want to add the URL of a substitute server *without* authorizing its key. See Section 6.3.4 [Substitute Authentication], page 51, to understand this fine point.

6.3.4 Substitute Authentication

Guix detects and raises an error when attempting to use a substitute that has been tampered with. Likewise, it ignores substitutes that are not signed, or that are not signed by one of the keys listed in the ACL.

There is one exception though: if an unauthorized server provides substitutes that are *bit-for-bit identical* to those provided by an authorized server, then the unauthorized server becomes eligible for downloads. For example, assume we have chosen two substitute servers with this option:

```
--substitute-urls="https://a.example.org https://b.example.org"
```

If the ACL contains only the key for '`b.example.org`', and if '`a.example.org`' happens to serve the *exact same* substitutes, then Guix will download substitutes from '`a.example.org`' because it comes first in the list and can be considered a mirror of '`b.example.org`'. In practice, independent build machines usually produce the same binaries, thanks to bit-reproducible builds (see below).

When using HTTPS, the server's X.509 certificate is *not* validated (in other words, the server is not authenticated), contrary to what HTTPS clients such as Web browsers usually do. This is because Guix authenticates substitute information itself, as explained above, which is what we care about (whereas X.509 certificates are about authenticating bindings between domain names and public keys).

6.3.5 Proxy Settings

Substitutes are downloaded over HTTP or HTTPS. The `http_proxy` and `https_proxy` environment variables can be set in the environment of `guix-daemon` and are honored for downloads of substitutes. Note that the value of those environment variables in the environment where `guix build`, `guix package`, and other client commands are run has *absolutely no effect*.

6.3.6 Substitution Failure

Even when a substitute for a derivation is available, sometimes the substitution attempt will fail. This can happen for a variety of reasons: the substitute server might be offline, the substitute may recently have been deleted, the connection might have been interrupted, etc.

When substitutes are enabled and a substitute for a derivation is available, but the substitution attempt fails, Guix will attempt to build the derivation locally depending on whether or not `--fallback` was given (see [common build option `--fallback`], page 167). Specifically, if `--fallback` was omitted, then no local build will be performed, and the derivation is considered to have failed. However, if `--fallback` was given, then Guix will attempt to build the derivation locally, and the success or failure of the derivation depends on the success or failure of the local build. Note that when substitutes are disabled or no substitute is available for the derivation in question, a local build will *always* be performed, regardless of whether or not `--fallback` was given.

To get an idea of how many substitutes are available right now, you can try running the `guix weather` command (see Section 10.15 [Invoking guix weather], page 213). This command provides statistics on the substitutes provided by a server.

6.3.7 On Trusting Binaries

Today, each individual's control over their own computing is at the mercy of institutions, corporations, and groups with enough power and determination to subvert the computing infrastructure and exploit its weaknesses. While using substitutes can be convenient, we encourage users to also build on their own, or even run their own build farm, such that the project run substitute servers are less of an interesting target. One way to help is by publishing the software you build using `guix publish` so that others have one more choice of server to download substitutes from (see Section 10.11 [Invoking guix publish], page 205).

Guix has the foundations to maximize build reproducibility (see Section 6.1 [Features], page 38). In most cases, independent builds of a given package or derivation should yield bit-identical results. Thus, through a diverse set of independent package builds, we can strengthen the integrity of our systems. The `guix challenge` command aims to help users assess substitute servers, and to assist developers in finding out about non-deterministic package builds (see Section 10.12 [Invoking guix challenge], page 209). Similarly, the

`--check` option of `guix build` allows users to check whether previously-installed substitutes are genuine by rebuilding them locally (see [build-check], page 177).

In the future, we want Guix to have support to publish and retrieve binaries to/from other users, in a peer-to-peer fashion. If you would like to discuss this project, join us on `guix-devel@gnu.org`.

6.4 Packages with Multiple Outputs

Often, packages defined in Guix have a single *output*—i.e., the source package leads to exactly one directory in the store. When running `guix install glibc`, one installs the default output of the GNU libc package; the default output is called `out`, but its name can be omitted as shown in this command. In this particular case, the default output of `glibc` contains all the C header files, shared libraries, static libraries, Info documentation, and other supporting files.

Sometimes it is more appropriate to separate the various types of files produced from a single source package into separate outputs. For instance, the GLib C library (used by GTK+ and related packages) installs more than 20 MiB of reference documentation as HTML pages. To save space for users who do not need it, the documentation goes to a separate output, called `doc`. To install the main GLib output, which contains everything but the documentation, one would run:

```
guix install glib
```

The command to install its documentation is:

```
guix install glib:doc
```

Some packages install programs with different "dependency footprints". For instance, the WordNet package installs both command-line tools and graphical user interfaces (GUIs). The former depend solely on the C library, whereas the latter depend on Tcl/Tk and the underlying X libraries. In this case, we leave the command-line tools in the default output, whereas the GUIs are in a separate output. This allows users who do not need the GUIs to save space. The `guix size` command can help find out about such situations (see Section 10.9 [Invoking guix size], page 199). `guix graph` can also be helpful (see Section 10.10 [Invoking guix graph], page 201).

There are several such multiple-output packages in the GNU distribution. Other conventional output names include `lib` for libraries and possibly header files, `bin` for stand-alone programs, and `debug` for debugging information (see Chapter 17 [Installing Debugging Files], page 611). The outputs of a packages are listed in the third column of the output of `guix package --list-available` (see Section 6.2 [Invoking guix package], page 39).

6.5 Invoking `guix gc`

Packages that are installed, but not used, may be *garbage-collected*. The `guix gc` command allows users to explicitly run the garbage collector to reclaim space from the `/gnu/store` directory. It is the *only* way to remove files from `/gnu/store`—removing files or directories manually may break it beyond repair!

The garbage collector has a set of known *roots*: any file under `/gnu/store` reachable from a root is considered *live* and cannot be deleted; any other file is considered *dead* and may be deleted. The set of garbage collector roots ("GC roots" for short) includes default user profiles; by default, the symlinks under `/var/guix/gcroots` represent these GC roots. New GC roots can be added with `guix build --root`, for example (see Section 10.1 [Invoking guix build], page 166). The `guix gc --list-roots` command lists them.

Prior to running `guix gc --collect-garbage` to make space, it is often useful to remove old generations from user profiles; that way, old package builds referenced by those generations can be reclaimed. This is achieved by running `guix package --delete-generations` (see Section 6.2 [Invoking guix package], page 39).

Our recommendation is to run a garbage collection periodically, or when you are short on disk space. For instance, to guarantee that at least 5 GB are available on your disk, simply run:

```
guix gc -F 5G
```

It is perfectly safe to run as a non-interactive periodic job (see Section 12.9.2 [Scheduled Job Execution], page 265, for how to set up such a job). Running `guix gc` with no arguments will collect as much garbage as it can, but that is often inconvenient: you may find yourself having to rebuild or re-download software that is "dead" from the GC viewpoint but that is necessary to build other pieces of software—e.g., the compiler tool chain.

The `guix gc` command has three modes of operation: it can be used to garbage-collect any dead files (the default), to delete specific files (the `--delete` option), to print garbage-collector information, or for more advanced queries. The garbage collection options are as follows:

`--collect-garbage[=`*`min`*`]`
`-C [`*`min`*`]`
: Collect garbage—i.e., unreachable `/gnu/store` files and sub-directories. This is the default operation when no option is specified.

  When *min* is given, stop once *min* bytes have been collected. *min* may be a number of bytes, or it may include a unit as a suffix, such as `MiB` for mebibytes and `GB` for gigabytes (see Section "Block size" in *GNU Coreutils*).

  When *min* is omitted, collect all the garbage.

`--free-space=`*`free`*
`-F `*`free`*
: Collect garbage until *free* space is available under `/gnu/store`, if possible; *free* denotes storage space, such as `500MiB`, as described above.

  When *free* or more is already available in `/gnu/store`, do nothing and exit immediately.

`--delete-generations[=`*`duration`*`]`
`-d [`*`duration`*`]`
: Before starting the garbage collection process, delete all the generations older than *duration*, for all the user profiles and home environment generations; when run as root, this applies to all the profiles *of all the users*.

  For example, this command deletes all the generations of all your profiles that are older than 2 months (except generations that are current), and then proceeds to free space until at least 10 GiB are available:

```
guix gc -d 2m -F 10G
```

`--delete`
`-D`
: Attempt to delete all the store files and directories specified as arguments. This fails if some of the files are not in the store, or if they are still live.

`--list-failures`
: List store items corresponding to cached build failures.

  This prints nothing unless the daemon was started with `--cache-failures` (see Section 2.5 [Invoking guix-daemon], page 15).

`--list-roots`
: List the GC roots owned by the user; when run as root, list *all* the GC roots.

`--list-busy`
: List store items in use by currently running processes. These store items are effectively considered GC roots: they cannot be deleted.

`--clear-failures`
: Remove the specified store items from the failed-build cache.

  Again, this option only makes sense when the daemon is started with `--cache-failures`. Otherwise, it does nothing.

`--list-dead`
: Show the list of dead files and directories still present in the store—i.e., files and directories no longer reachable from any root.

`--list-live`
: Show the list of live store files and directories.

In addition, the references among existing store files can be queried:

`--references`
`--referrers`
: List the references (respectively, the referrers) of store files given as arguments.

`--requisites`
`-R`
: List the requisites of the store files passed as arguments. Requisites include the store files themselves, their references, and the references of these, recursively. In other words, the returned list is the *transitive closure* of the store files.

  See Section 10.9 [Invoking guix size], page 199, for a tool to profile the size of the closure of an element. See Section 10.10 [Invoking guix graph], page 201, for a tool to visualize the graph of references.

`--derivers`
: Return the derivation(s) leading to the given store items (see Section 9.10 [Derivations], page 146).

  For example, this command:

  ```
  guix gc --derivers $(guix package -I ^emacs$ | cut -f4)
  ```

  returns the `.drv` file(s) leading to the `emacs` package installed in your profile.

  Note that there may be zero matching `.drv` files, for instance because these files have been garbage-collected. There can also be more than one matching `.drv` due to fixed-output derivations.

Lastly, the following options allow you to check the integrity of the store and to control disk usage.

`--verify[=`*`options`*`]`
: Verify the integrity of the store.

By default, make sure that all the store items marked as valid in the database of the daemon actually exist in `/gnu/store`.

When provided, *options* must be a comma-separated list containing one or more of `contents` and `repair`.

When passing `--verify=contents`, the daemon computes the content hash of each store item and compares it against its hash in the database. Hash mismatches are reported as data corruptions. Because it traverses *all the files in the store*, this command can take a long time, especially on systems with a slow disk drive.

Using `--verify=repair` or `--verify=contents,repair` causes the daemon to try to repair corrupt store items by fetching substitutes for them (see Section 6.3 [Substitutes], page 48). Because repairing is not atomic, and thus potentially dangerous, it is available only to the system administrator. A lightweight alternative, when you know exactly which items in the store are corrupt, is `guix build --repair` (see Section 10.1 [Invoking guix build], page 166).

`--optimize`

Optimize the store by hard-linking identical files—this is *deduplication*.

The daemon performs deduplication after each successful build or archive import, unless it was started with `--disable-deduplication` (see Section 2.5 [Invoking guix-daemon], page 15). Thus, this option is primarily useful when the daemon was running with `--disable-deduplication`.

`--vacuum-database`

Guix uses an sqlite database to keep track of the items in (see Section 9.9 [The Store], page 144). Over time it is possible that the database may grow to a large size and become fragmented. As a result, one may wish to clear the freed space and join the partially used pages in the database left behind from removed packages or after running the garbage collector. Running `sudo guix gc --vacuum-database` will lock the database and `VACUUM` the store, defragmenting the database and purging freed pages, unlocking the database when it finishes.

6.6 Invoking `guix pull`

Packages are installed or upgraded to the latest version available in the distribution currently available on your local machine. To update that distribution, along with the Guix tools, you must run `guix pull`: the command downloads the latest Guix source code and package descriptions, and deploys it. Source code is downloaded from a Git (`https://git-scm.com/book/en/`) repository, by default the official GNU Guix repository, though this can be customized. `guix pull` ensures that the code it downloads is *authentic* by verifying that commits are signed by Guix developers.

Specifically, `guix pull` downloads code from the *channels* (see Chapter 7 [Channels], page 68) specified by one of the followings, in this order:

1. the `--channels` option;
2. the user's `~/.config/guix/channels.scm` file;
3. the system-wide `/etc/guix/channels.scm` file;

4. the built-in default channels specified in the `%default-channels` variable.

On completion, `guix package` will use packages and package versions from this just-retrieved copy of Guix. Not only that, but all the Guix commands and Scheme modules will also be taken from that latest version. New `guix` sub-commands added by the update also become available.

Any user can update their Guix copy using `guix pull`, and the effect is limited to the user who ran `guix pull`. For instance, when user `root` runs `guix pull`, this has no effect on the version of Guix that user `alice` sees, and vice versa.

The result of running `guix pull` is a *profile* available under `~/.config/guix/current` containing the latest Guix. Thus, make sure to add it to the beginning of your search path so that you use the latest version, and similarly for the Info manual (see Chapter 14 [Documentation], page 600):

```
export PATH="$HOME/.config/guix/current/bin:$PATH"
export INFOPATH="$HOME/.config/guix/current/share/info:$INFOPATH"
```

The `--list-generations` or `-l` option lists past generations produced by `guix pull`, along with details about their provenance:

```
$ guix pull -l
Generation 1 Jun 10 2018 00:18:18
  guix 65956ad
    repository URL: https://git.savannah.gnu.org/git/guix.git
    branch: origin/master
    commit: 65956ad3526ba09e1f7a40722c96c6ef7c0936fe

Generation 2 Jun 11 2018 11:02:49
  guix e0cc7f6
    repository URL: https://git.savannah.gnu.org/git/guix.git
    branch: origin/master
    commit: e0cc7f669bec22c37481dd03a7941c7d11a64f1d

Generation 3 Jun 13 2018 23:31:07 (current)
  guix 844cc1c
    repository URL: https://git.savannah.gnu.org/git/guix.git
    branch: origin/master
    commit: 844cc1c8f394f03b404c5bb3aee086922373490c
```

See Section 6.9 [Invoking guix describe], page 63, for other ways to describe the current status of Guix.

This `~/.config/guix/current` profile works exactly like the profiles created by `guix package` (see Section 6.2 [Invoking guix package], page 39). That is, you can list generations, roll back to the previous generation—i.e., the previous Guix—and so on:

```
$ guix pull --roll-back
switched from generation 3 to 2
$ guix pull --delete-generations=1
deleting /var/guix/profiles/per-user/charlie/current-guix-1-link
```

You can also use `guix package` (see Section 6.2 [Invoking guix package], page 39) to manage the profile by naming it explicitly:

```
$ guix package -p ~/.config/guix/current --roll-back
switched from generation 3 to 2
$ guix package -p ~/.config/guix/current --delete-generations=1
deleting /var/guix/profiles/per-user/charlie/current-guix-1-link
```

The `guix pull` command is usually invoked with no arguments, but it supports the following options:

`--url=`*`url`*
`--commit=`*`commit`*
`--branch=`*`branch`*
: Download code for the `guix` channel from the specified *url*, at the given *commit* (a valid Git commit ID represented as a hexadecimal string or the name of a tag), or *branch*.

  These options are provided for convenience, but you can also specify your configuration in the `~/.config/guix/channels.scm` file or using the `--channels` option (see below).

`--channels=`*`file`*
`-C `*`file`*
: Read the list of channels from *file* instead of `~/.config/guix/channels.scm` or `/etc/guix/channels.scm`. *file* must contain Scheme code that evaluates to a list of channel objects. See Chapter 7 [Channels], page 68, for more information.

`--news`
`-N`
: Display news written by channel authors for their users for changes made since the previous generation (see Chapter 7 [Channels], page 68). When `--details` is passed, additionally display new and upgraded packages.

  You can view that information for previous generations with `guix pull -l`.

`--list-generations[=`*`pattern`*`]`
`-l [`*`pattern`*`]`
: List all the generations of `~/.config/guix/current` or, if *pattern* is provided, the subset of generations that match *pattern*. The syntax of *pattern* is the same as with `guix package --list-generations` (see Section 6.2 [Invoking guix package], page 39).

  By default, this prints information about the channels used in each revision as well as the corresponding news entries. If you pass `--details`, it will also print the list of packages added and upgraded in each generation compared to the previous one.

`--details`
: Instruct `--list-generations` or `--news` to display more information about the differences between subsequent generations—see above.

`--roll-back`
: Roll back to the previous *generation* of `~/.config/guix/current`—i.e., undo the last transaction.

`--switch-generation=`*`pattern`*
`-S `*`pattern`*
: Switch to a particular generation defined by *pattern*.

pattern may be either a generation number or a number prefixed with "+" or "-". The latter means: move forward/backward by a specified number of generations. For example, if you want to return to the latest generation after `--roll-back`, use `--switch-generation=+1`.

`--delete-generations[=`*pattern*`]`
`-d [`*pattern*`]`
When *pattern* is omitted, delete all generations except the current one.

This command accepts the same patterns as `--list-generations`. When *pattern* is specified, delete the matching generations. When *pattern* specifies a duration, generations *older* than the specified duration match. For instance, `--delete-generations=1m` deletes generations that are more than one month old.

If the current generation matches, it is *not* deleted.

Note that deleting generations prevents rolling back to them. Consequently, this command must be used with care.

See Section 6.9 [Invoking guix describe], page 63, for a way to display information about the current generation only.

`--profile=`*profile*
`-p` *profile*
Use *profile* instead of `~/.config/guix/current`.

`--dry-run`
`-n` Show which channel commit(s) would be used and what would be built or substituted but do not actually do it.

`--allow-downgrades`
Allow pulling older or unrelated revisions of channels than those currently in use.

By default, `guix pull` protects against so-called "downgrade attacks" whereby the Git repository of a channel would be reset to an earlier or unrelated revision of itself, potentially leading you to install older, known-vulnerable versions of software packages.

> **Note:** Make sure you understand its security implications before using `--allow-downgrades`.

`--disable-authentication`
Allow pulling channel code without authenticating it.

By default, `guix pull` authenticates code downloaded from channels by verifying that its commits are signed by authorized developers, and raises an error if this is not the case. This option instructs it to not perform any such verification.

> **Note:** Make sure you understand its security implications before using `--disable-authentication`.

`--system=`*system*
`-s` *system* Attempt to build for *system*—e.g., `i686-linux`—instead of the system type of the build host.

`--bootstrap`
: Use the bootstrap Guile to build the latest Guix. This option is only useful to Guix developers.

The *channel* mechanism allows you to instruct `guix pull` which repository and branch to pull from, as well as *additional* repositories containing package modules that should be deployed. See Chapter 7 [Channels], page 68, for more information.

In addition, `guix pull` supports all the common build options (see Section 10.1.1 [Common Build Options], page 166).

6.7 Invoking `guix time-machine`

The `guix time-machine` command provides access to other revisions of Guix, for example to install older versions of packages, or to reproduce a computation in an identical environment. The revision of Guix to be used is defined by a commit or by a channel description file created by `guix describe` (see Section 6.9 [Invoking guix describe], page 63).

Let's assume that you want to travel to those days of November 2020 when version 1.2.0 of Guix was released and, once you're there, run the `guile` of that time:

```
guix time-machine --commit=v1.2.0 -- \
  environment -C --ad-hoc guile -- guile
```

The command above fetches Guix 1.2.0 and runs its `guix environment` command to spawn an environment in a container running `guile` (`guix environment` has since been subsumed by `guix shell`; see Section 8.1 [Invoking guix shell], page 76). It's like driving a DeLorean[1]! The first `guix time-machine` invocation can be expensive: it may have to download or even build a large number of packages; the result is cached though and subsequent commands targeting the same commit are almost instantaneous.

> **Note:** The history of Guix is immutable and `guix time-machine` provides the exact same software as they are in a specific Guix revision. Naturally, no security fixes are provided for old versions of Guix or its channels. A careless use of `guix time-machine` opens the door to security vulnerabilities. See Section 6.6 [Invoking guix pull], page 56.

The general syntax is:

```
guix time-machine options... -- command  arg...
```

where *command* and *arg*... are passed unmodified to the `guix` command of the specified revision. The *options* that define this revision are the same as for `guix pull` (see Section 6.6 [Invoking guix pull], page 56):

`--url=`*`url`*
`--commit=`*`commit`*
`--branch=`*`branch`*
: Use the `guix` channel from the specified *url*, at the given *commit* (a valid Git commit ID represented as a hexadecimal string or the name of a tag), or *branch*.

[1] If you don't know what a DeLorean is, consider traveling back to the 1980's.

`--channels=`*`file`*
`-C `*`file`*
: Read the list of channels from *file*. *file* must contain Scheme code that evaluates to a list of channel objects. See Chapter 7 [Channels], page 68, for more information.

As for `guix pull`, the absence of any options means that the latest commit on the master branch will be used. The command

```
guix time-machine -- build hello
```

will thus build the package `hello` as defined in the master branch, which is in general a newer revision of Guix than you have installed. Time travel works in both directions!

Note that `guix time-machine` can trigger builds of channels and their dependencies, and these are controlled by the standard build options (see Section 10.1.1 [Common Build Options], page 166).

6.8 Inferiors

> **Note:** The functionality described here is a "technology preview" as of version 1.4.0. As such, the interface is subject to change.

Sometimes you might need to mix packages from the revision of Guix you're currently running with packages available in a different revision of Guix. Guix *inferiors* allow you to achieve that by composing different Guix revisions in arbitrary ways.

Technically, an "inferior" is essentially a separate Guix process connected to your main Guix process through a REPL (see Section 9.13 [Invoking guix repl], page 162). The `(guix inferior)` module allows you to create inferiors and to communicate with them. It also provides a high-level interface to browse and manipulate the packages that an inferior provides—*inferior packages*.

When combined with channels (see Chapter 7 [Channels], page 68), inferiors provide a simple way to interact with a separate revision of Guix. For example, let's assume you want to install in your profile the current `guile` package, along with the `guile-json` as it existed in an older revision of Guix—perhaps because the newer `guile-json` has an incompatible API and you want to run your code against the old API. To do that, you could write a manifest for use by `guix package --manifest` (see Section 9.4 [Writing Manifests], page 110); in that manifest, you would create an inferior for that old Guix revision you care about, and you would look up the `guile-json` package in the inferior:

```
(use-modules (guix inferior) (guix channels)
             (srfi srfi-1))   ;for 'first'

(define channels
  ;; This is the old revision from which we want to
  ;; extract guile-json.
  (list (channel
         (name 'guix)
         (url "https://git.savannah.gnu.org/git/guix.git")
         (commit
          "65956ad3526ba09e1f7a40722c96c6ef7c0936fe"))))
```

```
(define inferior
  ;; An inferior representing the above revision.
  (inferior-for-channels channels))

;; Now create a manifest with the current "guile" package
;; and the old "guile-json" package.
(packages->manifest
 (list (first (lookup-inferior-packages inferior "guile-json"))
       (specification->package "guile")))
```

On its first run, `guix package --manifest` might have to build the channel you specified before it can create the inferior; subsequent runs will be much faster because the Guix revision will be cached.

The `(guix inferior)` module provides the following procedures to open an inferior:

`inferior-for-channels` *`channels`* [*#:cache-directory*] [*#:ttl*] [Scheme Procedure]

Return an inferior for *channels*, a list of channels. Use the cache at *cache-directory*, where entries can be reclaimed after *ttl* seconds. This procedure opens a new connection to the build daemon.

As a side effect, this procedure may build or substitute binaries for *channels*, which can take time.

`open-inferior` *`directory`* [*#:command* "*bin/guix*"] [Scheme Procedure]

Open the inferior Guix in *directory*, running *`directory/command`* `repl` or equivalent. Return `#f` if the inferior could not be launched.

The procedures listed below allow you to obtain and manipulate inferior packages.

`inferior-packages` *`inferior`* [Scheme Procedure]

Return the list of packages known to *inferior*.

`lookup-inferior-packages` *`inferior name`* [*`version`*] [Scheme Procedure]

Return the sorted list of inferior packages matching *name* in *inferior*, with highest version numbers first. If *version* is true, return only packages with a version number prefixed by *version*.

`inferior-package?` *`obj`* [Scheme Procedure]

Return true if *obj* is an inferior package.

`inferior-package-name` *`package`* [Scheme Procedure]
`inferior-package-version` *`package`* [Scheme Procedure]
`inferior-package-synopsis` *`package`* [Scheme Procedure]
`inferior-package-description` *`package`* [Scheme Procedure]
`inferior-package-home-page` *`package`* [Scheme Procedure]
`inferior-package-location` *`package`* [Scheme Procedure]
`inferior-package-inputs` *`package`* [Scheme Procedure]
`inferior-package-native-inputs` *`package`* [Scheme Procedure]
`inferior-package-propagated-inputs` *`package`* [Scheme Procedure]

inferior-package-transitive-propagated-inputs *package* [Scheme Procedure]
inferior-package-native-search-paths *package* [Scheme Procedure]
inferior-package-transitive-native-search-paths *package* [Scheme Procedure]
inferior-package-search-paths *package* [Scheme Procedure]

These procedures are the counterpart of package record accessors (see Section 9.2.1 [package Reference], page 99). Most of them work by querying the inferior *package* comes from, so the inferior must still be live when you call these procedures.

Inferior packages can be used transparently like any other package or file-like object in G-expressions (see Section 9.12 [G-Expressions], page 154). They are also transparently handled by the `packages->manifest` procedure, which is commonly used in manifests (see Section 6.2 [Invoking guix package], page 39). Thus you can insert an inferior package pretty much anywhere you would insert a regular package: in manifests, in the `packages` field of your `operating-system` declaration, and so on.

6.9 Invoking `guix describe`

Often you may want to answer questions like: "Which revision of Guix am I using?" or "Which channels am I using?" This is useful information in many situations: if you want to *replicate* an environment on a different machine or user account, if you want to report a bug or to determine what change in the channels you are using caused it, or if you want to record your system state for reproducibility purposes. The `guix describe` command answers these questions.

When run from a `guix pull`ed `guix`, `guix describe` displays the channel(s) that it was built from, including their repository URL and commit IDs (see Chapter 7 [Channels], page 68):

```
$ guix describe
Generation 10 Sep 03 2018 17:32:44 (current)
  guix e0fa68c
    repository URL: https://git.savannah.gnu.org/git/guix.git
    branch: master
    commit: e0fa68c7718fffd33d81af415279d6ddb518f727
```

If you're familiar with the Git version control system, this is similar in spirit to `git describe`; the output is also similar to that of `guix pull --list-generations`, but limited to the current generation (see Section 6.6 [Invoking guix pull], page 56). Because the Git commit ID shown above unambiguously refers to a snapshot of Guix, this information is all it takes to describe the revision of Guix you're using, and also to replicate it.

To make it easier to replicate Guix, `guix describe` can also be asked to return a list of channels instead of the human-readable description above:

```
$ guix describe -f channels
(list (channel
        (name 'guix)
        (url "https://git.savannah.gnu.org/git/guix.git")
        (commit
          "e0fa68c7718fffd33d81af415279d6ddb518f727")
        (introduction
          (make-channel-introduction
            "9edb3f66fd807b096b48283debdcddccfea34bad"
            (openpgp-fingerprint
              "BBB0 2DDF 2CEA F6A8 0D1D  E643 A2A0 6DF2 A33A 54FA")))))
```

You can save this to a file and feed it to `guix pull -C` on some other machine or at a later point in time, which will instantiate *this exact Guix revision* (see Section 6.6 [Invoking guix pull], page 56). From there on, since you're able to deploy the same revision of Guix, you can just as well *replicate a complete software environment*. We humbly think that this is *awesome*, and we hope you'll like it too!

The details of the options supported by `guix describe` are as follows:

`--format=`*format*
`-f` *format* Produce output in the specified *format*, one of:

- `human` produce human-readable output;
- `channels` produce a list of channel specifications that can be passed to `guix pull -C` or installed as `~/.config/guix/channels.scm` (see Section 6.6 [Invoking guix pull], page 56);
- `channels-sans-intro`
  like `channels`, but omit the `introduction` field; use it to produce a channel specification suitable for Guix version 1.1.0 or earlier—the `introduction` field has to do with channel authentication (see Chapter 7 [Channels], page 68) and is not supported by these older versions;
- `json` produce a list of channel specifications in JSON format;
- `recutils` produce a list of channel specifications in Recutils format.

`--list-formats`
Display available formats for `--format` option.

`--profile=`*profile*
`-p` *profile*
Display information about *profile*.

6.10 Invoking `guix archive`

The `guix archive` command allows users to *export* files from the store into a single archive, and to later *import* them on a machine that runs Guix. In particular, it allows store files to be transferred from one machine to the store on another machine.

> **Note:** If you're looking for a way to produce archives in a format suitable for tools other than Guix, see Section 8.3 [Invoking guix pack], page 87.

To export store files as an archive to standard output, run:

```
guix archive --export options specifications...
```

specifications may be either store file names or package specifications, as for `guix package` (see Section 6.2 [Invoking guix package], page 39). For instance, the following command creates an archive containing the `gui` output of the `git` package and the main output of `emacs`:

```
guix archive --export git:gui /gnu/store/...-emacs-24.3 > great.nar
```

If the specified packages are not built yet, `guix archive` automatically builds them. The build process may be controlled with the common build options (see Section 10.1.1 [Common Build Options], page 166).

To transfer the `emacs` package to a machine connected over SSH, one would run:

```
guix archive --export -r emacs | ssh the-machine guix archive --import
```

Similarly, a complete user profile may be transferred from one machine to another like this:

```
guix archive --export -r $(readlink -f ~/.guix-profile) | \
  ssh the-machine guix archive --import
```

However, note that, in both examples, all of `emacs` and the profile as well as all of their dependencies are transferred (due to `-r`), regardless of what is already available in the store on the target machine. The `--missing` option can help figure out which items are missing from the target store. The `guix copy` command simplifies and optimizes this whole process, so this is probably what you should use in this case (see Section 10.13 [Invoking guix copy], page 212).

Each store item is written in the *normalized archive* or *nar* format (described below), and the output of `guix archive --export` (and input of `guix archive --import`) is a *nar bundle*.

The nar format is comparable in spirit to 'tar', but with differences that make it more appropriate for our purposes. First, rather than recording all Unix metadata for each file, the nar format only mentions the file type (regular, directory, or symbolic link); Unix permissions and owner/group are dismissed. Second, the order in which directory entries are stored always follows the order of file names according to the C locale collation order. This makes archive production fully deterministic.

That nar bundle format is essentially the concatenation of zero or more nars along with metadata for each store item it contains: its file name, references, corresponding derivation, and a digital signature.

When exporting, the daemon digitally signs the contents of the archive, and that digital signature is appended. When importing, the daemon verifies the signature and rejects the import in case of an invalid signature or if the signing key is not authorized.

The main options are:

`--export`
: Export the specified store files or packages (see below). Write the resulting archive to the standard output.

  Dependencies are *not* included in the output, unless `--recursive` is passed.

`-r`
`--recursive`
: When combined with `--export`, this instructs `guix archive` to include dependencies of the given items in the archive. Thus, the resulting archive is self-contained: it contains the closure of the exported store items.

`--import`
: Read an archive from the standard input, and import the files listed therein into the store. Abort if the archive has an invalid digital signature, or if it is signed by a public key not among the authorized keys (see `--authorize` below).

`--missing`
: Read a list of store file names from the standard input, one per line, and write on the standard output the subset of these files missing from the store.

`--generate-key[=`*`parameters`*`]`
: Generate a new key pair for the daemon. This is a prerequisite before archives can be exported with `--export`. This operation is usually instantaneous but it can take time if the system's entropy pool needs to be refilled. On Guix System, `guix-service-type` takes care of generating this key pair the first boot.

  The generated key pair is typically stored under `/etc/guix`, in `signing-key.pub` (public key) and `signing-key.sec` (private key, which must be kept secret). When *parameters* is omitted, an ECDSA key using the Ed25519 curve is generated, or, for Libgcrypt versions before 1.6.0, it is a 4096-bit RSA key. Alternatively, *parameters* can specify `genkey` parameters suitable for Libgcrypt (see Section "General public-key related Functions" in *The Libgcrypt Reference Manual*).

`--authorize`
: Authorize imports signed by the public key passed on standard input. The public key must be in "s-expression advanced format"—i.e., the same format as the `signing-key.pub` file.

  The list of authorized keys is kept in the human-editable file `/etc/guix/acl`. The file contains "advanced-format s-expressions" (`https://people.csail.mit.edu/rivest/Sexp.txt`) and is structured as an access-control list in the Simple Public-Key Infrastructure (SPKI) (`https://theworld.com/~cme/spki.txt`).

`--extract=`*`directory`*
`-x` *`directory`*
: Read a single-item archive as served by substitute servers (see Section 6.3 [Substitutes], page 48) and extract it to *directory*. This is a low-level operation needed in only very narrow use cases; see below.

  For example, the following command extracts the substitute for Emacs served by `ci.guix.gnu.org` to `/tmp/emacs`:

```
$ wget -O - \
  https://ci.guix.gnu.org/nar/gzip/...-emacs-24.5 \
  | gunzip | guix archive -x /tmp/emacs
```

  Single-item archives are different from multiple-item archives produced by `guix archive --export`; they contain a single store item, and they do *not* embed a signature. Thus this operation does *no* signature verification and its output should be considered unsafe.

  The primary purpose of this operation is to facilitate inspection of archive contents coming from possibly untrusted substitute servers (see Section 10.12 [Invoking guix challenge], page 209).

`--list`
`-t`
: Read a single-item archive as served by substitute servers (see Section 6.3 [Substitutes], page 48) and print the list of files it contains, as in this example:

```
$ wget -O - \
  https://ci.guix.gnu.org/nar/lzip/...-emacs-26.3 \
  | lzip -d | guix archive -t
```

7 Channels

Guix and its package collection are updated by running `guix pull` (see Section 6.6 [Invoking guix pull], page 56). By default `guix pull` downloads and deploys Guix itself from the official GNU Guix repository. This can be customized by defining *channels* in the `~/.config/guix/channels.scm` file. A channel specifies a URL and branch of a Git repository to be deployed, and `guix pull` can be instructed to pull from one or more channels. In other words, channels can be used to *customize* and to *extend* Guix, as we will see below. Guix is able to take into account security concerns and deal with authenticated updates.

7.1 Specifying Additional Channels

You can specify *additional channels* to pull from. To use a channel, write `~/.config/guix/channels.scm` to instruct `guix pull` to pull from it *in addition* to the default Guix channel(s):

```
;; Add variant packages to those Guix provides.
(cons (channel
        (name 'variant-packages)
        (url "https://example.org/variant-packages.git"))
      %default-channels)
```

Note that the snippet above is (as always!) Scheme code; we use `cons` to add a channel the list of channels that the variable `%default-channels` is bound to (see Section "Pairs" in *GNU Guile Reference Manual*). With this file in place, `guix pull` builds not only Guix but also the package modules from your own repository. The result in `~/.config/guix/current` is the union of Guix with your own package modules:

```
$ guix describe
Generation 19 Aug 27 2018 16:20:48
  guix d894ab8
    repository URL: https://git.savannah.gnu.org/git/guix.git
    branch: master
    commit: d894ab8e9bfabcefa6c49d9ba2e834dd5a73a300
  variant-packages dd3df5e
    repository URL: https://example.org/variant-packages.git
    branch: master
    commit: dd3df5e2c8818760a8fc0bd699e55d3b69fef2bb
```

The output of `guix describe` above shows that we're now running Generation 19 and that it includes both Guix and packages from the `variant-personal-packages` channel (see Section 6.9 [Invoking guix describe], page 63).

7.2 Using a Custom Guix Channel

The channel called `guix` specifies where Guix itself—its command-line tools as well as its package collection—should be downloaded. For instance, suppose you want to update from another copy of the Guix repository at `example.org`, and specifically the `super-hacks` branch, you can write in `~/.config/guix/channels.scm` this specification:

```
;; Tell 'guix pull' to use another repo.
```

```
(list (channel
        (name 'guix)
        (url "https://example.org/another-guix.git")
        (branch "super-hacks")))
```

From there on, `guix pull` will fetch code from the `super-hacks` branch of the repository at `example.org`. The authentication concern is addressed below (see Section 7.4 [Channel Authentication], page 70).

7.3 Replicating Guix

The `guix describe` command shows precisely which commits were used to build the instance of Guix we're using (see Section 6.9 [Invoking guix describe], page 63). We can replicate this instance on another machine or at a different point in time by providing a channel specification "pinned" to these commits that looks like this:

```
;; Deploy specific commits of my channels of interest.
(list (channel
       (name 'guix)
       (url "https://git.savannah.gnu.org/git/guix.git")
       (commit "6298c3ffd9654d3231a6f25390b056483e8f407c"))
      (channel
       (name 'variant-packages)
       (url "https://example.org/variant-packages.git")
       (commit "dd3df5e2c8818760a8fc0bd699e55d3b69fef2bb")))
```

To obtain this pinned channel specification, the easiest way is to run `guix describe` and to save its output in the `channels` format in a file, like so:

```
guix describe -f channels > channels.scm
```

The resulting `channels.scm` file can be passed to the `-C` option of `guix pull` (see Section 6.6 [Invoking guix pull], page 56) or `guix time-machine` (see Section 6.7 [Invoking guix time-machine], page 60), as in this example:

```
guix time-machine -C channels.scm -- shell python -- python3
```

Given the `channels.scm` file, the command above will always fetch the *exact same Guix instance*, then use that instance to run the exact same Python (see Section 8.1 [Invoking guix shell], page 76). On any machine, at any time, it ends up running the exact same binaries, bit for bit.

Pinned channels address a problem similar to "lock files" as implemented by some deployment tools—they let you pin and reproduce a set of packages. In the case of Guix though, you are effectively pinning the entire package set as defined at the given channel commits; in fact, you are pinning all of Guix, including its core modules and command-line tools. You're also getting strong guarantees that you are, indeed, obtaining the exact same software.

This gives you super powers, allowing you to track the provenance of binary artifacts with very fine grain, and to reproduce software environments at will—some sort of "meta reproducibility" capabilities, if you will. See Section 6.8 [Inferiors], page 61, for another way to take advantage of these super powers.

7.4 Channel Authentication

The `guix pull` and `guix time-machine` commands *authenticate* the code retrieved from channels: they make sure each commit that is fetched is signed by an authorized developer. The goal is to protect from unauthorized modifications to the channel that would lead users to run malicious code.

As a user, you must provide a *channel introduction* in your channels file so that Guix knows how to authenticate its first commit. A channel specification, including its introduction, looks something along these lines:

```
(channel
  (name 'some-channel)
  (url "https://example.org/some-channel.git")
  (introduction
   (make-channel-introduction
    "6f0d8cc0d88abb59c324b2990bfee2876016bb86"
    (openpgp-fingerprint
     "CABB A931 C0FF EEC6 900D  0CFB 090B 1199 3D9A EBB5"))))
```

The specification above shows the name and URL of the channel. The call to `make-channel-introduction` above specifies that authentication of this channel starts at commit `6f0d8cc...`, which is signed by the OpenPGP key with fingerprint `CABB A931...`.

For the main channel, called `guix`, you automatically get that information from your Guix installation. For other channels, include the channel introduction provided by the channel authors in your `channels.scm` file. Make sure you retrieve the channel introduction from a trusted source since that is the root of your trust.

If you're curious about the authentication mechanics, read on!

7.5 Channels with Substitutes

When running `guix pull`, Guix will first compile the definitions of every available package. This is an expensive operation for which substitutes (see Section 6.3 [Substitutes], page 48) may be available. The following snippet in `channels.scm` will ensure that `guix pull` uses the latest commit with available substitutes for the package definitions: this is done by querying the continuous integration server at `https://ci.guix.gnu.org`.

```
(use-modules (guix ci))

(list (channel-with-substitutes-available
       %default-guix-channel
       "https://ci.guix.gnu.org"))
```

Note that this does not mean that all the packages that you will install after running `guix pull` will have available substitutes. It only ensures that `guix pull` will not try to compile package definitions. This is particularly useful when using machines with limited resources.

7.6 Creating a Channel

Let's say you have a bunch of custom package variants or personal packages that you think would make little sense to contribute to the Guix project, but would like to have these packages transparently available to you at the command line. You would first write modules containing those package definitions (see Section 9.1 [Package Modules], page 95), maintain them in a Git repository, and then you and anyone else can use it as an additional channel to get packages from. Neat, no?

> **Warning:** Before you, dear user, shout—"woow this is *soooo coool*!"—and publish your personal channel to the world, we would like to share a few words of caution:
>
> - Before publishing a channel, please consider contributing your package definitions to Guix proper (see Chapter 22 [Contributing], page 625). Guix as a project is open to free software of all sorts, and packages in Guix proper are readily available to all Guix users and benefit from the project's quality assurance process.
> - When you maintain package definitions outside Guix, we, Guix developers, consider that *the compatibility burden is on you*. Remember that package modules and package definitions are just Scheme code that uses various programming interfaces (APIs). We want to remain free to change these APIs to keep improving Guix, possibly in ways that break your channel. We never change APIs gratuitously, but we will *not* commit to freezing APIs either.
> - Corollary: if you're using an external channel and that channel breaks, please *report the issue to the channel authors*, not to the Guix project.
>
> You've been warned! Having said this, we believe external channels are a practical way to exert your freedom to augment Guix' package collection and to share your improvements, which are basic tenets of free software (`https://www.gnu.org/philosophy/free-sw.html`). Please email us at `guix-devel@gnu.org` if you'd like to discuss this.

To create a channel, create a Git repository containing your own package modules and make it available. The repository can contain anything, but a useful channel will contain Guile modules that export packages. Once you start using a channel, Guix will behave as if the root directory of that channel's Git repository has been added to the Guile load path (see Section "Load Paths" in *GNU Guile Reference Manual*). For example, if your channel contains a file at `my-packages/my-tools.scm` that defines a Guile module, then the module will be available under the name `(my-packages my-tools)`, and you will be able to use it like any other module (see Section "Modules" in *GNU Guile Reference Manual*).

As a channel author, consider bundling authentication material with your channel so that users can authenticate it. See Section 7.4 [Channel Authentication], page 70, and Section 7.9 [Specifying Channel Authorizations], page 72, for info on how to do it.

7.7 Package Modules in a Sub-directory

As a channel author, you may want to keep your channel modules in a sub-directory. If your modules are in the sub-directory `guix`, you must add a meta-data file `.guix-channel` that contains:

```
(channel
  (version 0)
  (directory "guix"))
```

7.8 Declaring Channel Dependencies

Channel authors may decide to augment a package collection provided by other channels. They can declare their channel to be dependent on other channels in a meta-data file `.guix-channel`, which is to be placed in the root of the channel repository.

The meta-data file should contain a simple S-expression like this:

```
(channel
 (version 0)
 (dependencies
  (channel
   (name some-collection)
   (url "https://example.org/first-collection.git")

   ;; The 'introduction' bit below is optional: you would
   ;; provide it for dependencies that can be authenticated.
   (introduction
    (channel-introduction
      (version 0)
      (commit "a8883b58dc82e167c96506cf05095f37c2c2c6cd")
      (signer "CABB A931 C0FF EEC6 900D  0CFB 090B 1199 3D9A EBB5"))))
  (channel
   (name some-other-collection)
   (url "https://example.org/second-collection.git")
   (branch "testing"))))
```

In the above example this channel is declared to depend on two other channels, which will both be fetched automatically. The modules provided by the channel will be compiled in an environment where the modules of all these declared channels are available.

For the sake of reliability and maintainability, you should avoid dependencies on channels that you don't control, and you should aim to keep the number of dependencies to a minimum.

7.9 Specifying Channel Authorizations

As we saw above, Guix ensures the source code it pulls from channels comes from authorized developers. As a channel author, you need to specify the list of authorized developers in the `.guix-authorizations` file in the channel's Git repository. The authentication rule is simple: each commit must be signed by a key listed in the `.guix-authorizations` file of its parent commit(s)[1] The `.guix-authorizations` file looks like this:

```
;; Example '.guix-authorizations' file.

(authorizations
 (version 0)               ;current file format version
```

[1] Git commits form a *directed acyclic graph* (DAG). Each commit can have zero or more parents; "regular" commits have one parent and merge commits have two parent commits. Read *Git for Computer Scientists* (`https://eagain.net/articles/git-for-computer-scientists/`) for a great overview.

```
  (("AD17 A21E F8AE D8F1 CC02  DBD9 F8AE D8F1 765C 61E3"
    (name "alice"))
   ("2A39 3FFF 68F4 EF7A 3D29  12AF 68F4 EF7A 22FB B2D5"
    (name "bob"))
   ("CABB A931 C0FF EEC6 900D  0CFB 090B 1199 3D9A EBB5"
    (name "charlie"))))
```

Each fingerprint is followed by optional key/value pairs, as in the example above. Currently these key/value pairs are ignored.

This authentication rule creates a chicken-and-egg issue: how do we authenticate the first commit? Related to that: how do we deal with channels whose repository history contains unsigned commits and lack `.guix-authorizations`? And how do we fork existing channels?

Channel introductions answer these questions by describing the first commit of a channel that should be authenticated. The first time a channel is fetched with `guix pull` or `guix time-machine`, the command looks up the introductory commit and verifies that it is signed by the specified OpenPGP key. From then on, it authenticates commits according to the rule above. Authentication fails if the target commit is neither a descendant nor an ancestor of the introductory commit.

Additionally, your channel must provide all the OpenPGP keys that were ever mentioned in `.guix-authorizations`, stored as `.key` files, which can be either binary or "ASCII-armored". By default, those `.key` files are searched for in the branch named `keyring` but you can specify a different branch name in `.guix-channel` like so:

```
(channel
  (version 0)
  (keyring-reference "my-keyring-branch"))
```

To summarize, as the author of a channel, there are three things you have to do to allow users to authenticate your code:

1. Export the OpenPGP keys of past and present committers with `gpg --export` and store them in `.key` files, by default in a branch named `keyring` (we recommend making it an *orphan branch*).
2. Introduce an initial `.guix-authorizations` in the channel's repository. Do that in a signed commit (see Section 22.8 [Commit Access], page 646, for information on how to sign Git commits.)
3. Advertise the channel introduction, for instance on your channel's web page. The channel introduction, as we saw above, is the commit/key pair—i.e., the commit that introduced `.guix-authorizations`, and the fingerprint of the OpenPGP used to sign it.

Before pushing to your public Git repository, you can run `guix git-authenticate` to verify that you did sign all the commits you are about to push with an authorized key:

```
guix git authenticate commit signer
```

where *commit* and *signer* are your channel introduction. See Section 8.5 [Invoking guix git authenticate], page 93, for details.

Publishing a signed channel requires discipline: any mistake, such as an unsigned commit or a commit signed by an unauthorized key, will prevent users from pulling from your channel—well, that's the whole point of authentication! Pay attention to merges in particular: merge commits are considered authentic if and only if they are signed by a key present in the `.guix-authorizations` file of *both* branches.

7.10 Primary URL

Channel authors can indicate the primary URL of their channel's Git repository in the `.guix-channel` file, like so:

```
(channel
  (version 0)
  (url "https://example.org/guix.git"))
```

This allows `guix pull` to determine whether it is pulling code from a mirror of the channel; when that is the case, it warns the user that the mirror might be stale and displays the primary URL. That way, users cannot be tricked into fetching code from a stale mirror that does not receive security updates.

This feature only makes sense for authenticated repositories, such as the official `guix` channel, for which `guix pull` ensures the code it fetches is authentic.

7.11 Writing Channel News

Channel authors may occasionally want to communicate to their users information about important changes in the channel. You'd send them all an email, but that's not convenient.

Instead, channels can provide a *news file*; when the channel users run `guix pull`, that news file is automatically read and `guix pull --news` can display the announcements that correspond to the new commits that have been pulled, if any.

To do that, channel authors must first declare the name of the news file in their `.guix-channel` file:

```
(channel
  (version 0)
  (news-file "etc/news.txt"))
```

The news file itself, `etc/news.txt` in this example, must look something like this:

```
(channel-news
  (version 0)
  (entry (tag "the-bug-fix")
         (title (en "Fixed terrible bug")
                (fr "Oh la la"))
         (body (en "@emph{Good news}!  It's fixed!")
               (eo "Certe ĝi pli bone funkcias nun!")))
  (entry (commit "bdcabe815cd28144a2d2b4bc3c5057b051fa9906")
         (title (en "Added a great package")
                (ca "Què vol dir guix?"))
         (body (en "Don't miss the @code{hello} package!"))))
```

While the news file is using the Scheme syntax, avoid naming it with a `.scm` extension or else it will get picked up when building the channel and yield an error since it is not a valid module. Alternatively, you can move the channel module to a subdirectory and store the news file in another directory.

The file consists of a list of *news entries*. Each entry is associated with a commit or tag: it describes changes made in this commit, possibly in preceding commits as well. Users see entries only the first time they obtain the commit the entry refers to.

The `title` field should be a one-line summary while `body` can be arbitrarily long, and both can contain Texinfo markup (see Section "Overview" in *GNU Texinfo*). Both the title and body are a list of language tag/message tuples, which allows `guix pull` to display news in the language that corresponds to the user's locale.

If you want to translate news using a gettext-based workflow, you can extract translatable strings with `xgettext` (see Section "xgettext Invocation" in *GNU Gettext Utilities*). For example, assuming you write news entries in English first, the command below creates a PO file containing the strings to translate:

```
xgettext -o news.po -l scheme -ken etc/news.txt
```

To sum up, yes, you could use your channel as a blog. But beware, this is *not quite* what your users might expect.

8 Development

If you are a software developer, Guix provides tools that you should find helpful—independently of the language you're developing in. This is what this chapter is about.

The `guix shell` command provides a convenient way to set up one-off software environments, be it for development purposes or to run a command without installing it in your profile. The `guix pack` command allows you to create *application bundles* that can be easily distributed to users who do not run Guix.

8.1 Invoking `guix shell`

The purpose of `guix shell` is to make it easy to create one-off software environments, without changing one's profile. It is typically used to create development environments; it is also a convenient way to run applications without "polluting" your profile.

> **Note:** The `guix shell` command was recently introduced to supersede `guix environment` (see Section 8.2 [Invoking guix environment], page 82). If you are familiar with `guix environment`, you will notice that it is similar but also—we hope!—more convenient.

The general syntax is:

```
guix shell [options] [package...]
```

The following example creates an environment containing Python and NumPy, building or downloading any missing package, and runs the `python3` command in that environment:

```
guix shell python python-numpy -- python3
```

Development environments can be created as in the example below, which spawns an interactive shell containing all the dependencies and environment variables needed to work on Inkscape:

```
guix shell --development inkscape
```

Exiting the shell places the user back in the original environment before `guix shell` was invoked. The next garbage collection (see Section 6.5 [Invoking guix gc], page 53) may clean up packages that were installed in the environment and that are no longer used outside of it.

As an added convenience, `guix shell` will try to do what you mean when it is invoked interactively without any other arguments as in:

```
guix shell
```

If it finds a `manifest.scm` in the current working directory or any of its parents, it uses this manifest as though it was given via `--manifest`. Likewise, if it finds a `guix.scm` in the same directories, it uses it to build a development profile as though both `--development` and `--file` were present. In either case, the file will only be loaded if the directory it resides in is listed in `~/.config/guix/shell-authorized-directories`. This provides an easy way to define, share, and enter development environments.

By default, the shell session or command runs in an *augmented* environment, where the new packages are added to search path environment variables such as `PATH`. You can, instead, choose to create an *isolated* environment containing nothing but the packages you asked for. Passing the `--pure` option clears environment variable definitions found in the parent environment[1]; passing `--container` goes one step further by spawning a *container* isolated from the rest of the system:

```
guix shell --container emacs gcc-toolchain
```

The command above spawns an interactive shell in a container where nothing but `emacs`, `gcc-toolchain`, and their dependencies is available. The container lacks network access and shares no files other than the current working directory with the surrounding environment. This is useful to prevent access to system-wide resources such as `/usr/bin` on foreign distros.

This `--container` option can also prove useful if you wish to run a security-sensitive application, such as a web browser, in an isolated environment. For example, the command below launches Ungoogled-Chromium in an isolated environment, this time sharing network access with the host and preserving its `DISPLAY` environment variable, but without even sharing the current directory:

```
guix shell --container --network --no-cwd ungoogled-chromium \
  --preserve='^DISPLAY$' -- chromium
```

`guix shell` defines the `GUIX_ENVIRONMENT` variable in the shell it spawns; its value is the file name of the profile of this environment. This allows users to, say, define a specific prompt for development environments in their `.bashrc` (see Section "Bash Startup Files" in *The GNU Bash Reference Manual*):

```
if [ -n "$GUIX_ENVIRONMENT" ]
then
    export PS1="\u@\h \w [dev]\$ "
fi
```

... or to browse the profile:

```
$ ls "$GUIX_ENVIRONMENT/bin"
```

The available options are summarized below.

`--check`
: Set up the environment and check whether the shell would clobber environment variables. It's a good idea to use this option the first time you run `guix shell` for an interactive session to make sure your setup is correct.

  For example, if the shell modifies the `PATH` environment variable, report it since you would get a different environment than what you asked for.

  Such problems usually indicate that the shell startup files are unexpectedly modifying those environment variables. For example, if you are using Bash, make sure that environment variables are set or modified in `~/.bash_profile` and *not* in `~/.bashrc`—the former is sourced only by log-in shells. See Section "Bash Startup Files" in *The GNU Bash Reference Manual*, for details on Bash start-up files.

`--development`
`-D`
: Cause `guix shell` to include in the environment the dependencies of the following package rather than the package itself. This can be combined with other

[1] Be sure to use the `--check` option the first time you use `guix shell` interactively to make sure the shell does not undo the effect of `--pure`.

packages. For instance, the command below starts an interactive shell containing the build-time dependencies of GNU Guile, plus Autoconf, Automake, and Libtool:

```
guix shell -D guile autoconf automake libtool
```

`--expression=`*`expr`*
`-e` *`expr`* Create an environment for the package or list of packages that *expr* evaluates to.

For example, running:

```
guix shell -D -e '(@ (gnu packages maths) petsc-openmpi)'
```

starts a shell with the environment for this specific variant of the PETSc package.

Running:

```
guix shell -e '(@ (gnu) %base-packages)'
```

starts a shell with all the base system packages available.

The above commands only use the default output of the given packages. To select other outputs, two element tuples can be specified:

```
guix shell -e '(list (@ (gnu packages bash) bash) "include")'
```

See [package-development-manifest], page 113, for information on how to write a manifest for the development environment of a package.

`--file=`*`file`*
`-f` *`file`* Create an environment containing the package or list of packages that the code within *file* evaluates to.

As an example, *file* might contain a definition like this (see Section 9.2 [Defining Packages], page 96):

```
(use-modules (guix)
             (gnu packages gdb)
             (gnu packages autotools)
             (gnu packages texinfo))

;; Augment the package definition of GDB with the build tools
;; needed when developing GDB (and which are not needed when
;; simply installing it.)
(package
  (inherit gdb)
  (native-inputs (modify-inputs (package-native-inputs gdb)
                   (prepend autoconf-2.64 automake texinfo))))
```

With the file above, you can enter a development environment for GDB by running:

```
guix shell -D -f gdb-devel.scm
```

`--manifest=`*`file`*
`-m` *`file`* Create an environment for the packages contained in the manifest object returned by the Scheme code in *file*. This option can be repeated several times, in which case the manifests are concatenated.

This is similar to the same-named option in `guix package` (see [profile-manifest], page 43) and uses the same manifest files.

See Section 9.4 [Writing Manifests], page 110, for information on how to write a manifest. See `--export-manifest` below on how to obtain a first manifest.

`--export-manifest`
: Write to standard output a manifest suitable for `--manifest` corresponding to given command-line options.

This is a way to "convert" command-line arguments into a manifest. For example, imagine you are tired of typing long lines and would like to get a manifest equivalent to this command line:

```
guix shell -D guile git emacs emacs-geiser emacs-geiser-guile
```

Just add `--export-manifest` to the command line above:

```
guix shell --export-manifest \
  -D guile git emacs emacs-geiser emacs-geiser-guile
```

... and you get a manifest along these lines:

```
(concatenate-manifests
  (list (specifications->manifest
          (list "git"
                "emacs"
                "emacs-geiser"
                "emacs-geiser-guile"))
        (package->development-manifest
          (specification->package "guile"))))
```

You can store it into a file, say `manifest.scm`, and from there pass it to `guix shell` or indeed pretty much any `guix` command:

```
guix shell -m manifest.scm
```

Voilà, you've converted a long command line into a manifest! That conversion process honors package transformation options (see Section 10.1.2 [Package Transformation Options], page 168) so it should be lossless.

`--profile=`*`profile`*
`-p` *`profile`*
: Create an environment containing the packages installed in *profile*. Use `guix package` (see Section 6.2 [Invoking guix package], page 39) to create and manage profiles.

`--pure`
: Unset existing environment variables when building the new environment, except those specified with `--preserve` (see below). This has the effect of creating an environment in which search paths only contain package inputs.

`--preserve=`*`regexp`*
`-E` *`regexp`*
: When used alongside `--pure`, preserve the environment variables matching *regexp*—in other words, put them on a "white list" of environment variables that must be preserved. This option can be repeated several times.

```
guix shell --pure --preserve=^SLURM openmpi ... \
  -- mpirun ...
```

This example runs `mpirun` in a context where the only environment variables defined are `PATH`, environment variables whose name starts with '`SLURM`', as well as the usual "precious" variables (`HOME`, `USER`, etc.).

`--search-paths`
: Display the environment variable definitions that make up the environment.

`--system=`*`system`*
`-s` *`system`*
: Attempt to build for *system*—e.g., `i686-linux`.

`--container`
`-C`
: Run *command* within an isolated container. The current working directory outside the container is mapped inside the container. Additionally, unless overridden with `--user`, a dummy home directory is created that matches the current user's home directory, and `/etc/passwd` is configured accordingly.

  The spawned process runs as the current user outside the container. Inside the container, it has the same UID and GID as the current user, unless `--user` is passed (see below).

`--network`
`-N`
: For containers, share the network namespace with the host system. Containers created without this flag only have access to the loopback device.

`--link-profile`
`-P`
: For containers, link the environment profile to `~/.guix-profile` within the container and set `GUIX_ENVIRONMENT` to that. This is equivalent to making `~/.guix-profile` a symlink to the actual profile within the container. Linking will fail and abort the environment if the directory already exists, which will certainly be the case if `guix shell` was invoked in the user's home directory.

  Certain packages are configured to look in `~/.guix-profile` for configuration files and data;[2] `--link-profile` allows these programs to behave as expected within the environment.

`--user=`*`user`*
`-u` *`user`*
: For containers, use the username *user* in place of the current user. The generated `/etc/passwd` entry within the container will contain the name *user*, the home directory will be `/home/`*`user`*, and no user GECOS data will be copied. Furthermore, the UID and GID inside the container are 1000. *user* need not exist on the system.

  Additionally, any shared or exposed path (see `--share` and `--expose` respectively) whose target is within the current user's home directory will be remapped relative to `/home/USER`; this includes the automatic mapping of the current working directory.

```
# will expose paths as /home/foo/wd, /home/foo/test, and /home/foo/target
cd $HOME/wd
guix shell --container --user=foo \
     --expose=$HOME/test \
     --expose=/tmp/target=$HOME/target
```

[2] For example, the `fontconfig` package inspects `~/.guix-profile/share/fonts` for additional fonts.

While this will limit the leaking of user identity through home paths and each of the user fields, this is only one useful component of a broader privacy/anonymity solution—not one in and of itself.

`--no-cwd` For containers, the default behavior is to share the current working directory with the isolated container and immediately change to that directory within the container. If this is undesirable, `--no-cwd` will cause the current working directory to *not* be automatically shared and will change to the user's home directory within the container instead. See also `--user`.

`--expose=`*source*`[=`*target*`]`
`--share=`*source*`[=`*target*`]`
For containers, `--expose` (resp. `--share`) exposes the file system *source* from the host system as the read-only (resp. writable) file system *target* within the container. If *target* is not specified, *source* is used as the target mount point in the container.

The example below spawns a Guile REPL in a container in which the user's home directory is accessible read-only via the `/exchange` directory:

```
guix shell --container --expose=$HOME=/exchange guile -- guile
```

`--symlink=`*spec*
`-S` *spec* For containers, create the symbolic links specified by *spec*, as documented in [pack-symlink-option], page 92.

`--emulate-fhs`
`-F` When used with `--container`, emulate a Filesystem Hierarchy Standard (FHS) (`https://refspecs.linuxfoundation.org/fhs.shtml`) configuration within the container, providing `/bin`, `/lib`, and other directories and files specified by the FHS.

As Guix deviates from the FHS specification, this option sets up the container to more closely mimic that of other GNU/Linux distributions. This is useful for reproducing other development environments, testing, and using programs which expect the FHS specification to be followed. With this option, the container will include a version of glibc that will read `/etc/ld.so.cache` within the container for the shared library cache (contrary to glibc in regular Guix usage) and set up the expected FHS directories: `/bin`, `/etc`, `/lib`, and `/usr` from the container's profile.

`--rebuild-cache`
In most cases, `guix shell` caches the environment so that subsequent uses are instantaneous. Least-recently used cache entries are periodically removed. The cache is also invalidated, when using `--file` or `--manifest`, anytime the corresponding file is modified.

The `--rebuild-cache` forces the cached environment to be refreshed. This is useful when using `--file` or `--manifest` and the `guix.scm` or `manifest.scm` file has external dependencies, or if its behavior depends, say, on environment variables.

`--root=`*`file`*

`-r` *`file`* Make *file* a symlink to the profile for this environment, and register it as a garbage collector root.

This is useful if you want to protect your environment from garbage collection, to make it "persistent".

When this option is omitted, `guix shell` caches profiles so that subsequent uses of the same environment are instantaneous—this is comparable to using `--root` except that `guix shell` takes care of periodically removing the least-recently used garbage collector roots.

In some cases, `guix shell` does not cache profiles—e.g., if transformation options such as `--with-latest` are used. In those cases, the environment is protected from garbage collection only for the duration of the `guix shell` session. This means that next time you recreate the same environment, you could have to rebuild or re-download packages.

See Section 6.5 [Invoking guix gc], page 53, for more on GC roots.

`guix shell` also supports all of the common build options that `guix build` supports (see Section 10.1.1 [Common Build Options], page 166) as well as package transformation options (see Section 10.1.2 [Package Transformation Options], page 168).

8.2 Invoking `guix environment`

The purpose of `guix environment` is to assist in creating development environments.

> **Deprecation warning:** The `guix environment` command is deprecated in favor of `guix shell`, which performs similar functions but is more convenient to use. See Section 8.1 [Invoking guix shell], page 76.
>
> Being deprecated, `guix environment` is slated for eventual removal, but the Guix project is committed to keeping it until May 1st, 2023. Please get in touch with us at `guix-devel@gnu.org` if you would like to discuss it.

The general syntax is:

```
guix environment options package...
```

The following example spawns a new shell set up for the development of GNU Guile:

```
guix environment guile
```

If the needed dependencies are not built yet, `guix environment` automatically builds them. The environment of the new shell is an augmented version of the environment that `guix environment` was run in. It contains the necessary search paths for building the given package added to the existing environment variables. To create a "pure" environment, in which the original environment variables have been unset, use the `--pure` option[3].

Exiting from a Guix environment is the same as exiting from the shell, and will place the user back in the old environment before `guix environment` was invoked. The next garbage

[3] Users sometimes wrongfully augment environment variables such as `PATH` in their `~/.bashrc` file. As a consequence, when `guix environment` launches it, Bash may read `~/.bashrc`, thereby introducing "impurities" in these environment variables. It is an error to define such environment variables in `.bashrc`; instead, they should be defined in `.bash_profile`, which is sourced only by log-in shells. See Section "Bash Startup Files" in *The GNU Bash Reference Manual*, for details on Bash start-up files.

collection (see Section 6.5 [Invoking guix gc], page 53) will clean up packages that were installed from within the environment and are no longer used outside of it.

`guix environment` defines the `GUIX_ENVIRONMENT` variable in the shell it spawns; its value is the file name of the profile of this environment. This allows users to, say, define a specific prompt for development environments in their `.bashrc` (see Section "Bash Startup Files" in *The GNU Bash Reference Manual*):

```
if [ -n "$GUIX_ENVIRONMENT" ]
then
    export PS1="\u@\h \w [dev]\$ "
fi
```

... or to browse the profile:

```
$ ls "$GUIX_ENVIRONMENT/bin"
```

Additionally, more than one package may be specified, in which case the union of the inputs for the given packages are used. For example, the command below spawns a shell where all of the dependencies of both Guile and Emacs are available:

```
guix environment guile emacs
```

Sometimes an interactive shell session is not desired. An arbitrary command may be invoked by placing the `--` token to separate the command from the rest of the arguments:

```
guix environment guile -- make -j4
```

In other situations, it is more convenient to specify the list of packages needed in the environment. For example, the following command runs `python` from an environment containing Python 3 and NumPy:

```
guix environment --ad-hoc python-numpy python -- python3
```

Furthermore, one might want the dependencies of a package and also some additional packages that are not build-time or runtime dependencies, but are useful when developing nonetheless. Because of this, the `--ad-hoc` flag is positional. Packages appearing before `--ad-hoc` are interpreted as packages whose dependencies will be added to the environment. Packages appearing after are interpreted as packages that will be added to the environment directly. For example, the following command creates a Guix development environment that additionally includes Git and strace:

```
guix environment --pure guix --ad-hoc git strace
```

Sometimes it is desirable to isolate the environment as much as possible, for maximal purity and reproducibility. In particular, when using Guix on a host distro that is not Guix System, it is desirable to prevent access to `/usr/bin` and other system-wide resources from the development environment. For example, the following command spawns a Guile REPL in a "container" where only the store and the current working directory are mounted:

```
guix environment --ad-hoc --container guile -- guile
```

Note: The `--container` option requires Linux-libre 3.19 or newer.

Another typical use case for containers is to run security-sensitive applications such as a web browser. To run Eolie, we must expose and share some files and directories; we include `nss-certs` and expose `/etc/ssl/certs/` for HTTPS authentication; finally we preserve the `DISPLAY` environment variable since containerized graphical applications won't display without it.

```
guix environment --preserve='^DISPLAY$' --container --network \
    --expose=/etc/machine-id \
    --expose=/etc/ssl/certs/ \
    --share=$HOME/.local/share/eolie/=$HOME/.local/share/eolie/ \
    --ad-hoc eolie nss-certs dbus --  eolie
```

The available options are summarized below.

`--check` Set up the environment and check whether the shell would clobber environment variables. See Section 8.1 [Invoking guix shell], page 76, for more info.

`--root=`*`file`*
`-r `*`file`* Make *file* a symlink to the profile for this environment, and register it as a garbage collector root.

This is useful if you want to protect your environment from garbage collection, to make it "persistent".

When this option is omitted, the environment is protected from garbage collection only for the duration of the `guix environment` session. This means that next time you recreate the same environment, you could have to rebuild or re-download packages. See Section 6.5 [Invoking guix gc], page 53, for more on GC roots.

`--expression=`*`expr`*
`-e `*`expr`* Create an environment for the package or list of packages that *expr* evaluates to.

For example, running:

```
guix environment -e '(@ (gnu packages maths) petsc-openmpi)'
```

starts a shell with the environment for this specific variant of the PETSc package.

Running:

```
guix environment --ad-hoc -e '(@ (gnu) %base-packages)'
```

starts a shell with all the base system packages available.

The above commands only use the default output of the given packages. To select other outputs, two element tuples can be specified:

```
guix environment --ad-hoc -e '(list (@ (gnu packages bash) bash) "include")'
```

`--load=`*`file`*
`-l `*`file`* Create an environment for the package or list of packages that the code within *file* evaluates to.

As an example, *file* might contain a definition like this (see Section 9.2 [Defining Packages], page 96):

```
(use-modules (guix)
             (gnu packages gdb)
             (gnu packages autotools)
             (gnu packages texinfo))

;; Augment the package definition of GDB with the build tools
;; needed when developing GDB (and which are not needed when
;; simply installing it.)
(package
  (inherit gdb)
  (native-inputs (modify-inputs (package-native-inputs gdb)
                   (prepend autoconf-2.64 automake texinfo))))
```

`--manifest=`*`file`*
`-m` *`file`*
: Create an environment for the packages contained in the manifest object returned by the Scheme code in *file*. This option can be repeated several times, in which case the manifests are concatenated.

  This is similar to the same-named option in `guix package` (see [profile-manifest], page 43) and uses the same manifest files.

  See [shell-export-manifest], page 79, for information on how to "convert" command-line options into a manifest.

`--ad-hoc`
: Include all specified packages in the resulting environment, as if an *ad hoc* package were defined with them as inputs. This option is useful for quickly creating an environment without having to write a package expression to contain the desired inputs.

  For instance, the command:

  ```
  guix environment --ad-hoc guile guile-sdl -- guile
  ```

  runs `guile` in an environment where Guile and Guile-SDL are available.

  Note that this example implicitly asks for the default output of `guile` and `guile-sdl`, but it is possible to ask for a specific output—e.g., `glib:bin` asks for the `bin` output of `glib` (see Section 6.4 [Packages with Multiple Outputs], page 53).

  This option may be composed with the default behavior of `guix environment`. Packages appearing before `--ad-hoc` are interpreted as packages whose dependencies will be added to the environment, the default behavior. Packages appearing after are interpreted as packages that will be added to the environment directly.

`--profile=`*`profile`*
`-p` *`profile`*
: Create an environment containing the packages installed in *profile*. Use `guix package` (see Section 6.2 [Invoking guix package], page 39) to create and manage profiles.

`--pure`
: Unset existing environment variables when building the new environment, except those specified with `--preserve` (see below). This has the effect of creating an environment in which search paths only contain package inputs.

`--preserve=`*`regexp`*
`-E` *`regexp`*
: When used alongside `--pure`, preserve the environment variables matching *regexp*—in other words, put them on a "white list" of environment variables that must be preserved. This option can be repeated several times.

  ```
  guix environment --pure --preserve=^SLURM --ad-hoc openmpi ... \
    -- mpirun ...
  ```

This example runs `mpirun` in a context where the only environment variables defined are `PATH`, environment variables whose name starts with '`SLURM`', as well as the usual "precious" variables (`HOME`, `USER`, etc.).

`--search-paths`
: Display the environment variable definitions that make up the environment.

`--system=`*`system`*
`-s` *`system`*
: Attempt to build for *system*—e.g., `i686-linux`.

`--container`
`-C`
: Run *command* within an isolated container. The current working directory outside the container is mapped inside the container. Additionally, unless overridden with `--user`, a dummy home directory is created that matches the current user's home directory, and `/etc/passwd` is configured accordingly.

  The spawned process runs as the current user outside the container. Inside the container, it has the same UID and GID as the current user, unless `--user` is passed (see below).

`--network`
`-N`
: For containers, share the network namespace with the host system. Containers created without this flag only have access to the loopback device.

`--link-profile`
`-P`
: For containers, link the environment profile to `~/.guix-profile` within the container and set `GUIX_ENVIRONMENT` to that. This is equivalent to making `~/.guix-profile` a symlink to the actual profile within the container. Linking will fail and abort the environment if the directory already exists, which will certainly be the case if `guix environment` was invoked in the user's home directory.

  Certain packages are configured to look in `~/.guix-profile` for configuration files and data;[4] `--link-profile` allows these programs to behave as expected within the environment.

`--user=`*`user`*
`-u` *`user`*
: For containers, use the username *user* in place of the current user. The generated `/etc/passwd` entry within the container will contain the name *user*, the home directory will be `/home/`*`user`*, and no user GECOS data will be copied. Furthermore, the UID and GID inside the container are 1000. *user* need not exist on the system.

  Additionally, any shared or exposed path (see `--share` and `--expose` respectively) whose target is within the current user's home directory will be remapped relative to `/home/USER`; this includes the automatic mapping of the current working directory.

```
# will expose paths as /home/foo/wd, /home/foo/test, and /home/foo/target
cd $HOME/wd
guix environment --container --user=foo \
     --expose=$HOME/test \
```

[4] For example, the `fontconfig` package inspects `~/.guix-profile/share/fonts` for additional fonts.

```
--expose=/tmp/target=$HOME/target
```

While this will limit the leaking of user identity through home paths and each of the user fields, this is only one useful component of a broader privacy/anonymity solution—not one in and of itself.

`--no-cwd`
: For containers, the default behavior is to share the current working directory with the isolated container and immediately change to that directory within the container. If this is undesirable, `--no-cwd` will cause the current working directory to *not* be automatically shared and will change to the user's home directory within the container instead. See also `--user`.

`--expose=`*`source`*`[=`*`target`*`]`
`--share=`*`source`*`[=`*`target`*`]`
: For containers, `--expose` (resp. `--share`) exposes the file system *source* from the host system as the read-only (resp. writable) file system *target* within the container. If *target* is not specified, *source* is used as the target mount point in the container.

The example below spawns a Guile REPL in a container in which the user's home directory is accessible read-only via the `/exchange` directory:

```
guix environment --container --expose=$HOME=/exchange --ad-hoc guile -- guil
```

`--emulate-fhs`
`-F`
: For containers, emulate a Filesystem Hierarchy Standard (FHS) configuration within the container, see the official specification (`https://refspecs.linuxfoundation.org/fhs.shtml`). As Guix deviates from the FHS specification, this option sets up the container to more closely mimic that of other GNU/Linux distributions. This is useful for reproducing other development environments, testing, and using programs which expect the FHS specification to be followed. With this option, the container will include a version of `glibc` which will read `/etc/ld.so.cache` within the container for the shared library cache (contrary to `glibc` in regular Guix usage) and set up the expected FHS directories: `/bin`, `/etc`, `/lib`, and `/usr` from the container's profile.

`guix environment` also supports all of the common build options that `guix build` supports (see Section 10.1.1 [Common Build Options], page 166) as well as package transformation options (see Section 10.1.2 [Package Transformation Options], page 168).

8.3 Invoking `guix pack`

Occasionally you want to pass software to people who are not (yet!) lucky enough to be using Guix. You'd tell them to run `guix package -i` *`something`*, but that's not possible in this case. This is where `guix pack` comes in.

> **Note:** If you are looking for ways to exchange binaries among machines that already run Guix, see Section 10.13 [Invoking guix copy], page 212, Section 10.11 [Invoking guix publish], page 205, and Section 6.10 [Invoking guix archive], page 64.

The `guix pack` command creates a shrink-wrapped *pack* or *software bundle*: it creates a tarball or some other archive containing the binaries of the software you're interested in, and all its dependencies. The resulting archive can be used on any machine that does not have Guix, and people can run the exact same binaries as those you have with Guix. The pack itself is created in a bit-reproducible fashion, so anyone can verify that it really contains the build results that you pretend to be shipping.

For example, to create a bundle containing Guile, Emacs, Geiser, and all their dependencies, you can run:

```
$ guix pack guile emacs emacs-geiser
...
/gnu/store/...-pack.tar.gz
```

The result here is a tarball containing a `/gnu/store` directory with all the relevant packages. The resulting tarball contains a *profile* with the three packages of interest; the profile is the same as would be created by `guix package -i`. It is this mechanism that is used to create Guix's own standalone binary tarball (see Section 2.1 [Binary Installation], page 4).

Users of this pack would have to run `/gnu/store/...-profile/bin/guile` to run Guile, which you may find inconvenient. To work around it, you can create, say, a `/opt/gnu/bin` symlink to the profile:

```
guix pack -S /opt/gnu/bin=bin guile emacs emacs-geiser
```

That way, users can happily type `/opt/gnu/bin/guile` and enjoy.

What if the recipient of your pack does not have root privileges on their machine, and thus cannot unpack it in the root file system? In that case, you will want to use the `--relocatable` option (see below). This option produces *relocatable binaries*, meaning they they can be placed anywhere in the file system hierarchy: in the example above, users can unpack your tarball in their home directory and directly run `./opt/gnu/bin/guile`.

Alternatively, you can produce a pack in the Docker image format using the following command:

```
guix pack -f docker -S /bin=bin guile guile-readline
```

The result is a tarball that can be passed to the `docker load` command, followed by `docker run`:

```
docker load < file
docker run -ti guile-guile-readline /bin/guile
```

where *file* is the image returned by *guix pack*, and `guile-guile-readline` is its "image tag". See the Docker documentation (`https://docs.docker.com/engine/reference/commandline/load/`) for more information.

Yet another option is to produce a SquashFS image with the following command:

```
guix pack -f squashfs bash guile emacs emacs-geiser
```

The result is a SquashFS file system image that can either be mounted or directly be used as a file system container image with the Singularity container execution environment (`https://www.sylabs.io/docs/`), using commands like `singularity shell` or `singularity exec`.

Several command-line options allow you to customize your pack:

`--format=`*`format`*
`-f` *`format`* Produce a pack in the given *format*.

The available formats are:

`tarball` This is the default format. It produces a tarball containing all the specified binaries and symlinks.

`docker` This produces a tarball that follows the Docker Image Specification (`https://github.com/docker/docker/blob/master/image/spec/v1.2.md`). The “repository name” as it appears in the output of the `docker images` command is computed from package names passed on the command line or in the manifest file.

`squashfs` This produces a SquashFS image containing all the specified binaries and symlinks, as well as empty mount points for virtual file systems like procfs.

> **Note:** Singularity *requires* you to provide `/bin/sh` in the image. For that reason, `guix pack -f squashfs` always implies `-S /bin=bin`. Thus, your `guix pack` invocation must always start with something like:
>
> ```
> guix pack -f squashfs bash ...
> ```
>
> If you forget the `bash` (or similar) package, `singularity run` and `singularity exec` will fail with an unhelpful “no such file or directory” message.

`deb` This produces a Debian archive (a package with the ‘`.deb`’ file extension) containing all the specified binaries and symbolic links, that can be installed on top of any dpkg-based GNU(/Linux) distribution. Advanced options can be revealed via the `--help-deb-format` option. They allow embedding control files for more fine-grained control, such as activating specific triggers or providing a maintainer configure script to run arbitrary setup code upon installation.

```
guix pack -f deb -C xz -S /usr/bin/hello=bin/hello hello
```

> **Note:** Because archives produced with `guix pack` contain a collection of store items and because each `dpkg` package must not have conflicting files, in practice that means you likely won’t be able to install more than one such archive on a given system.

> **Warning:** `dpkg` will assume ownership of any files contained in the pack that it does *not* know about. It is unwise to install Guix-produced ‘`.deb`’ files on a system where `/gnu/store` is shared by other software, such as a Guix installation or other, non-deb packs.

`--relocatable`
`-R` Produce *relocatable binaries*—i.e., binaries that can be placed anywhere in the file system hierarchy and run from there.

When this option is passed once, the resulting binaries require support for *user namespaces* in the kernel Linux; when passed *twice*[5], relocatable binaries fall to back to other techniques if user namespaces are unavailable, and essentially work anywhere—see below for the implications.

For example, if you create a pack containing Bash with:

```
guix pack -RR -S /mybin=bin bash
```

... you can copy that pack to a machine that lacks Guix, and from your home directory as a normal user, run:

```
tar xf pack.tar.gz
./mybin/sh
```

In that shell, if you type `ls /gnu/store`, you'll notice that `/gnu/store` shows up and contains all the dependencies of `bash`, even though the machine actually lacks `/gnu/store` altogether! That is probably the simplest way to deploy Guix-built software on a non-Guix machine.

> **Note:** By default, relocatable binaries rely on the *user namespace* feature of the kernel Linux, which allows unprivileged users to mount or change root. Old versions of Linux did not support it, and some GNU/Linux distributions turn it off.
>
> To produce relocatable binaries that work even in the absence of user namespaces, pass `--relocatable` or `-R` *twice*. In that case, binaries will try user namespace support and fall back to another *execution engine* if user namespaces are not supported. The following execution engines are supported:
>
> `default` Try user namespaces and fall back to PRoot if user namespaces are not supported (see below).
>
> `performance`
> Try user namespaces and fall back to Fakechroot if user namespaces are not supported (see below).
>
> `userns` Run the program through user namespaces and abort if they are not supported.
>
> `proot` Run through PRoot. The PRoot (`https://proot-me.github.io/`) program provides the necessary support for file system virtualization. It achieves that by using the `ptrace` system call on the running program. This approach has the advantage to work without requiring special kernel support, but it incurs run-time overhead every time a system call is made.
>
> `fakechroot`
> Run through Fakechroot. Fakechroot (`https://github.com/dex4er/fakechroot/`) virtualizes file system accesses by intercepting calls to C library functions

[5] Here's a trick to memorize it: `-RR`, which adds PRoot support, can be thought of as the abbreviation of "Really Relocatable". Neat, isn't it?

such as `open`, `stat`, `exec`, and so on. Unlike PRoot, it incurs very little overhead. However, it does not always work: for example, some file system accesses made from within the C library are not intercepted, and file system accesses made *via* direct syscalls are not intercepted either, leading to erratic behavior.

When running a wrapped program, you can explicitly request one of the execution engines listed above by setting the `GUIX_EXECUTION_ENGINE` environment variable accordingly.

`--entry-point=`*`command`*
: Use *command* as the *entry point* of the resulting pack, if the pack format supports it—currently `docker` and `squashfs` (Singularity) support it. *command* must be relative to the profile contained in the pack.

The entry point specifies the command that tools like `docker run` or `singularity run` automatically start by default. For example, you can do:

```
guix pack -f docker --entry-point=bin/guile guile
```

The resulting pack can easily be loaded and `docker run` with no extra arguments will spawn `bin/guile`:

```
docker load -i pack.tar.gz
docker run image-id
```

`--expression=`*`expr`*
`-e `*`expr`* Consider the package *expr* evaluates to.

This has the same purpose as the same-named option in `guix build` (see Section 10.1.3 [Additional Build Options], page 174).

`--manifest=`*`file`*
`-m `*`file`* Use the packages contained in the manifest object returned by the Scheme code in *file*. This option can be repeated several times, in which case the manifests are concatenated.

This has a similar purpose as the same-named option in `guix package` (see [profile-manifest], page 43) and uses the same manifest files. It allows you to define a collection of packages once and use it both for creating profiles and for creating archives for use on machines that do not have Guix installed. Note that you can specify *either* a manifest file *or* a list of packages, but not both.

See Section 9.4 [Writing Manifests], page 110, for information on how to write a manifest. See [shell-export-manifest], page 79, for information on how to "convert" command-line options into a manifest.

`--system=`*`system`*
`-s `*`system`* Attempt to build for *system*—e.g., `i686-linux`—instead of the system type of the build host.

`--target=`*`triplet`*
: Cross-build for *triplet*, which must be a valid GNU triplet, such as `"aarch64-linux-gnu"` (see Section "Specifying target triplets" in *Autoconf*).

`--compression=`*`tool`*
`-C `*`tool`*
: Compress the resulting tarball using *tool*—one of `gzip`, `zstd`, `bzip2`, `xz`, `lzip`, or `none` for no compression.

`--symlink=`*`spec`*
`-S `*`spec`*
: Add the symlinks specified by *spec* to the pack. This option can appear several times.

  spec has the form *`source`*`=`*`target`*, where *source* is the symlink that will be created and *target* is the symlink target.

  For instance, `-S /opt/gnu/bin=bin` creates a `/opt/gnu/bin` symlink pointing to the `bin` sub-directory of the profile.

`--save-provenance`
: Save provenance information for the packages passed on the command line. Provenance information includes the URL and commit of the channels in use (see Chapter 7 [Channels], page 68).

  Provenance information is saved in the `/gnu/store/...-profile/manifest` file in the pack, along with the usual package metadata—the name and version of each package, their propagated inputs, and so on. It is useful information to the recipient of the pack, who then knows how the pack was (supposedly) obtained.

  This option is not enabled by default because, like timestamps, provenance information contributes nothing to the build process. In other words, there is an infinity of channel URLs and commit IDs that can lead to the same pack. Recording such “silent” metadata in the output thus potentially breaks the source-to-binary bitwise reproducibility property.

`--root=`*`file`*
`-r `*`file`*
: Make *file* a symlink to the resulting pack, and register it as a garbage collector root.

`--localstatedir`
`--profile-name=`*`name`*
: Include the “local state directory”, `/var/guix`, in the resulting pack, and notably the `/var/guix/profiles/per-user/root/`*`name`* profile—by default *name* is `guix-profile`, which corresponds to `~root/.guix-profile`.

  `/var/guix` contains the store database (see Section 9.9 [The Store], page 144) as well as garbage-collector roots (see Section 6.5 [Invoking guix gc], page 53). Providing it in the pack means that the store is “complete” and manageable by Guix; not providing it pack means that the store is “dead”: items cannot be added to it or removed from it after extraction of the pack.

  One use case for this is the Guix self-contained binary tarball (see Section 2.1 [Binary Installation], page 4).

`--derivation`
`-d`
: Print the name of the derivation that builds the pack.

`--bootstrap`
: Use the bootstrap binaries to build the pack. This option is only useful to Guix developers.

In addition, `guix pack` supports all the common build options (see Section 10.1.1 [Common Build Options], page 166) and all the package transformation options (see Section 10.1.2 [Package Transformation Options], page 168).

8.4 The GCC toolchain

If you need a complete toolchain for compiling and linking C or C++ source code, use the `gcc-toolchain` package. This package provides a complete GCC toolchain for C/C++ development, including GCC itself, the GNU C Library (headers and binaries, plus debugging symbols in the `debug` output), Binutils, and a linker wrapper.

The wrapper's purpose is to inspect the `-L` and `-l` switches passed to the linker, add corresponding `-rpath` arguments, and invoke the actual linker with this new set of arguments. You can instruct the wrapper to refuse to link against libraries not in the store by setting the `GUIX_LD_WRAPPER_ALLOW_IMPURITIES` environment variable to `no`.

The package `gfortran-toolchain` provides a complete GCC toolchain for Fortran development. For other languages, please use '`guix search gcc toolchain`' (see [Invoking guix package], page 45).

8.5 Invoking `guix git authenticate`

The `guix git authenticate` command authenticates a Git checkout following the same rule as for channels (see [channel-authentication], page 70). That is, starting from a given commit, it ensures that all subsequent commits are signed by an OpenPGP key whose fingerprint appears in the `.guix-authorizations` file of its parent commit(s).

You will find this command useful if you maintain a channel. But in fact, this authentication mechanism is useful in a broader context, so you might want to use it for Git repositories that have nothing to do with Guix.

The general syntax is:

```
guix git authenticate commit signer [options...]
```

By default, this command authenticates the Git checkout in the current directory; it outputs nothing and exits with exit code zero on success and non-zero on failure. *commit* above denotes the first commit where authentication takes place, and *signer* is the OpenPGP fingerprint of public key used to sign *commit*. Together, they form a "channel introduction" (see [channel-authentication], page 70). The options below allow you to fine-tune the process.

`--repository=`*`directory`*
`-r` *`directory`*
: Open the Git repository in *directory* instead of the current directory.

`--keyring=`*`reference`*
`-k` *`reference`*
: Load OpenPGP keyring from *reference*, the reference of a branch such as `origin/keyring` or `my-keyring`. The branch must contain OpenPGP public keys in `.key` files, either in binary form or "ASCII-armored". By default the keyring is loaded from the branch named `keyring`.

`--stats`
: Display commit signing statistics upon completion.

`--cache-key=`*`key`*
: Previously-authenticated commits are cached in a file under `~/.cache/guix/authentication`. This option forces the cache to be stored in file *key* in that directory.

`--historical-authorizations=`*`file`*
: By default, any commit whose parent commit(s) lack the `.guix-authorizations` file is considered inauthentic. In contrast, this option considers the authorizations in *file* for any commit that lacks `.guix-authorizations`. The format of *file* is the same as that of `.guix-authorizations` (see [channel-authorizations], page 72).

9 Programming Interface

GNU Guix provides several Scheme programming interfaces (APIs) to define, build, and query packages. The first interface allows users to write high-level package definitions. These definitions refer to familiar packaging concepts, such as the name and version of a package, its build system, and its dependencies. These definitions can then be turned into concrete build actions.

Build actions are performed by the Guix daemon, on behalf of users. In a standard setup, the daemon has write access to the store—the `/gnu/store` directory—whereas users do not. The recommended setup also has the daemon perform builds in chroots, under specific build users, to minimize interference with the rest of the system.

Lower-level APIs are available to interact with the daemon and the store. To instruct the daemon to perform a build action, users actually provide it with a *derivation*. A derivation is a low-level representation of the build actions to be taken, and the environment in which they should occur—derivations are to package definitions what assembly is to C programs. The term "derivation" comes from the fact that build results *derive* from them.

This chapter describes all these APIs in turn, starting from high-level package definitions.

9.1 Package Modules

From a programming viewpoint, the package definitions of the GNU distribution are provided by Guile modules in the `(gnu packages ...)` name space[1] (see Section "Modules" in *GNU Guile Reference Manual*). For instance, the `(gnu packages emacs)` module exports a variable named `emacs`, which is bound to a `<package>` object (see Section 9.2 [Defining Packages], page 96).

The `(gnu packages ...)` module name space is automatically scanned for packages by the command-line tools. For instance, when running `guix install emacs`, all the `(gnu packages ...)` modules are scanned until one that exports a package object whose name is `emacs` is found. This package search facility is implemented in the `(gnu packages)` module.

Users can store package definitions in modules with different names—e.g., `(my-packages emacs)`[2]. There are two ways to make these package definitions visible to the user interfaces:

1. By adding the directory containing your package modules to the search path with the `-L` flag of `guix package` and other commands (see Section 10.1.1 [Common Build Options], page 166), or by setting the `GUIX_PACKAGE_PATH` environment variable described below.
2. By defining a *channel* and configuring `guix pull` so that it pulls from it. A channel is essentially a Git repository containing package modules. See Chapter 7 [Channels], page 68, for more information on how to define and use channels.

`GUIX_PACKAGE_PATH` works similarly to other search path variables:

[1] Note that packages under the `(gnu packages ...)` module name space are not necessarily "GNU packages". This module naming scheme follows the usual Guile module naming convention: `gnu` means that these modules are distributed as part of the GNU system, and `packages` identifies modules that define packages.

[2] Note that the file name and module name must match. For instance, the `(my-packages emacs)` module must be stored in a `my-packages/emacs.scm` file relative to the load path specified with `--load-path` or `GUIX_PACKAGE_PATH`. See Section "Modules and the File System" in *GNU Guile Reference Manual*, for details.

`GUIX_PACKAGE_PATH` [Environment Variable]

This is a colon-separated list of directories to search for additional package modules. Directories listed in this variable take precedence over the own modules of the distribution.

The distribution is fully *bootstrapped* and *self-contained*: each package is built based solely on other packages in the distribution. The root of this dependency graph is a small set of *bootstrap binaries*, provided by the `(gnu packages bootstrap)` module. For more information on bootstrapping, see Chapter 20 [Bootstrapping], page 618.

9.2 Defining Packages

The high-level interface to package definitions is implemented in the `(guix packages)` and `(guix build-system)` modules. As an example, the package definition, or *recipe*, for the GNU Hello package looks like this:

```
(define-module (gnu packages hello)
  #:use-module (guix packages)
  #:use-module (guix download)
  #:use-module (guix build-system gnu)
  #:use-module (guix licenses)
  #:use-module (gnu packages gawk))

(define-public hello
  (package
    (name "hello")
    (version "2.10")
    (source (origin
              (method url-fetch)
              (uri (string-append "mirror://gnu/hello/hello-" version
                                  ".tar.gz"))
              (sha256
               (base32
                "0ssi1wpaf7plaswqqjwigppsg5fyh99vdlb9kzl7c9lng89ndq1i"))))
    (build-system gnu-build-system)
    (arguments '(#:configure-flags '("--enable-silent-rules")))
    (inputs (list gawk))
    (synopsis "Hello, GNU world: An example GNU package")
    (description "Guess what GNU Hello prints!")
    (home-page "https://www.gnu.org/software/hello/")
    (license gpl3+)))
```

Without being a Scheme expert, the reader may have guessed the meaning of the various fields here. This expression binds the variable `hello` to a `<package>` object, which is essentially a record (see Section "SRFI-9" in *GNU Guile Reference Manual*). This package object can be inspected using procedures found in the `(guix packages)` module; for instance, `(package-name hello)` returns—surprise!—`"hello"`.

With luck, you may be able to import part or all of the definition of the package you are interested in from another repository, using the `guix import` command (see Section 10.5 [Invoking guix import], page 181).

In the example above, `hello` is defined in a module of its own, `(gnu packages hello)`. Technically, this is not strictly necessary, but it is convenient to do so: all the packages defined in modules under `(gnu packages ...)` are automatically known to the command-line tools (see Section 9.1 [Package Modules], page 95).

There are a few points worth noting in the above package definition:

- The `source` field of the package is an `<origin>` object (see Section 9.2.2 [origin Reference], page 103, for the complete reference). Here, the `url-fetch` method from `(guix download)` is used, meaning that the source is a file to be downloaded over FTP or HTTP.

  The `mirror://gnu` prefix instructs `url-fetch` to use one of the GNU mirrors defined in `(guix download)`.

  The `sha256` field specifies the expected SHA256 hash of the file being downloaded. It is mandatory, and allows Guix to check the integrity of the file. The `(base32 ...)` form introduces the base32 representation of the hash. You can obtain this information with `guix download` (see Section 10.3 [Invoking guix download], page 179) and `guix hash` (see Section 10.4 [Invoking guix hash], page 180).

  When needed, the `origin` form can also have a `patches` field listing patches to be applied, and a `snippet` field giving a Scheme expression to modify the source code.

- The `build-system` field specifies the procedure to build the package (see Section 9.5 [Build Systems], page 114). Here, `gnu-build-system` represents the familiar GNU Build System, where packages may be configured, built, and installed with the usual `./configure && make && make check && make install` command sequence.

  When you start packaging non-trivial software, you may need tools to manipulate those build phases, manipulate files, and so on. See Section 9.7 [Build Utilities], page 135, for more on this.

- The `arguments` field specifies options for the build system (see Section 9.5 [Build Systems], page 114). Here it is interpreted by `gnu-build-system` as a request run `configure` with the `--enable-silent-rules` flag.

  What about these quote (`'`) characters? They are Scheme syntax to introduce a literal list; `'` is synonymous with `quote`. Sometimes you'll also see `` ` `` (a backquote, synonymous with `quasiquote`) and `,` (a comma, synonymous with `unquote`). See Section "Expression Syntax" in *GNU Guile Reference Manual*, for details. Here the value of the `arguments` field is a list of arguments passed to the build system down the road, as with `apply` (see Section "Fly Evaluation" in *GNU Guile Reference Manual*).

  The hash-colon (`#:`) sequence defines a Scheme *keyword* (see Section "Keywords" in *GNU Guile Reference Manual*), and `#:configure-flags` is a keyword used to pass a keyword argument to the build system (see Section "Coding With Keywords" in *GNU Guile Reference Manual*).

- The `inputs` field specifies inputs to the build process—i.e., build-time or run-time dependencies of the package. Here, we add an input, a reference to the `gawk` variable; `gawk` is itself bound to a `<package>` object.

Note that GCC, Coreutils, Bash, and other essential tools do not need to be specified as inputs here. Instead, `gnu-build-system` takes care of ensuring that they are present (see Section 9.5 [Build Systems], page 114).

However, any other dependencies need to be specified in the `inputs` field. Any dependency not specified here will simply be unavailable to the build process, possibly leading to a build failure.

See Section 9.2.1 [package Reference], page 99, for a full description of possible fields.

> **Going further:** Intimidated by the Scheme language or curious about it? The Cookbook has a short section to get started that recaps some of the things shown above and explains the fundamentals. See Section "A Scheme Crash Course" in *GNU Guix Cookbook*, for more information.

Once a package definition is in place, the package may actually be built using the `guix build` command-line tool (see Section 10.1 [Invoking guix build], page 166), troubleshooting any build failures you encounter (see Section 10.1.4 [Debugging Build Failures], page 178). You can easily jump back to the package definition using the `guix edit` command (see Section 10.2 [Invoking guix edit], page 179). See Section 22.4 [Packaging Guidelines], page 629, for more information on how to test package definitions, and Section 10.8 [Invoking guix lint], page 196, for information on how to check a definition for style conformance. Lastly, see Chapter 7 [Channels], page 68, for information on how to extend the distribution by adding your own package definitions in a "channel".

Finally, updating the package definition to a new upstream version can be partly automated by the `guix refresh` command (see Section 10.6 [Invoking guix refresh], page 189).

Behind the scenes, a derivation corresponding to the `<package>` object is first computed by the `package-derivation` procedure. That derivation is stored in a `.drv` file under `/gnu/store`. The build actions it prescribes may then be realized by using the `build-derivations` procedure (see Section 9.9 [The Store], page 144).

`package-derivation` *store package* [*system*] [Scheme Procedure]

Return the `<derivation>` object of *package* for *system* (see Section 9.10 [Derivations], page 146).

package must be a valid `<package>` object, and *system* must be a string denoting the target system type—e.g., `"x86_64-linux"` for an x86_64 Linux-based GNU system. *store* must be a connection to the daemon, which operates on the store (see Section 9.9 [The Store], page 144).

Similarly, it is possible to compute a derivation that cross-builds a package for some other system:

`package-cross-derivation` *store package target* [*system*] [Scheme Procedure]

Return the `<derivation>` object of *package* cross-built from *system* to *target*.

target must be a valid GNU triplet denoting the target hardware and operating system, such as `"aarch64-linux-gnu"` (see Section "Specifying Target Triplets" in *Autoconf*).

Once you have package definitions, you can easily define *variants* of those packages. See Section 9.3 [Defining Package Variants], page 106, for more on that.

9.2.1 `package` Reference

This section summarizes all the options available in `package` declarations (see Section 9.2 [Defining Packages], page 96).

`package` [Data Type]

This is the data type representing a package recipe.

`name` The name of the package, as a string.

`version` The version of the package, as a string. See Section 22.4.3 [Version Numbers], page 631, for guidelines.

`source` An object telling how the source code for the package should be acquired. Most of the time, this is an `origin` object, which denotes a file fetched from the Internet (see Section 9.2.2 [origin Reference], page 103). It can also be any other "file-like" object such as a `local-file`, which denotes a file from the local file system (see Section 9.12 [G-Expressions], page 154).

`build-system`
The build system that should be used to build the package (see Section 9.5 [Build Systems], page 114).

`arguments` (default: `'()`)
The arguments that should be passed to the build system (see Section 9.5 [Build Systems], page 114). This is a list, typically containing sequential keyword-value pairs, as in this example:

```
(package
  (name "example")
  ;; several fields omitted
  (arguments
    (list #:tests? #f                     ;skip tests
          #:make-flags #~'("VERBOSE=1")   ;pass flags to 'make'
          #:configure-flags #~'("--enable-frobbing"))))
```

The exact set of supported keywords depends on the build system (see Section 9.5 [Build Systems], page 114), but you will find that almost all of them honor `#:configure-flags`, `#:make-flags`, `#:tests?`, and `#:phases`. The `#:phases` keyword in particular lets you modify the set of build phases for your package (see Section 9.6 [Build Phases], page 131).

`inputs` (default: `'()`)
`native-inputs` (default: `'()`)
`propagated-inputs` (default: `'()`)
These fields list dependencies of the package. Each element of these lists is either a package, origin, or other "file-like object" (see Section 9.12 [G-Expressions], page 154); to specify the output of that file-like object that should be used, pass a two-element list where the second element is the output (see Section 6.4 [Packages with Multiple Outputs], page 53, for more on package outputs). For example, the list below specifies three inputs:

```
(list libffi libunistring
          `(,glib "bin"))      ;the "bin" output of GLib
```

In the example above, the "out" output of `libffi` and `libunistring` is used.

> **Compatibility Note:** Until version 1.3.0, input lists were a list of tuples, where each tuple has a label for the input (a string) as its first element, a package, origin, or derivation as its second element, and optionally the name of the output thereof that should be used, which defaults to "out". For example, the list below is equivalent to the one above, but using the *old input style*:
>
> ```
> ;; Old input style (deprecated).
> `(("libffi" ,libffi)
>   ("libunistring" ,libunistring)
>   ("glib:bin" ,glib "bin"))  ;the "bin" output of GLib
> ```
>
> This style is now deprecated; it is still supported but support will be removed in a future version. It should not be used for new package definitions. See Section 10.7 [Invoking guix style], page 194, on how to migrate to the new style.

The distinction between `native-inputs` and `inputs` is necessary when considering cross-compilation. When cross-compiling, dependencies listed in `inputs` are built for the *target* architecture; conversely, dependencies listed in `native-inputs` are built for the architecture of the *build* machine.

`native-inputs` is typically used to list tools needed at build time, but not at run time, such as Autoconf, Automake, pkg-config, Gettext, or Bison. `guix lint` can report likely mistakes in this area (see Section 10.8 [Invoking guix lint], page 196).

Lastly, `propagated-inputs` is similar to `inputs`, but the specified packages will be automatically installed to profiles (see Section 6.1 [Features], page 38) alongside the package they belong to (see [package-cmd-propagated-inputs], page 40, for information on how `guix package` deals with propagated inputs).

For example this is necessary when packaging a C/C++ library that needs headers of another library to compile, or when a pkg-config file refers to another one *via* its `Requires` field.

Another example where `propagated-inputs` is useful is for languages that lack a facility to record the run-time search path akin to the `RUNPATH` of ELF files; this includes Guile, Python, Perl, and more. When packaging libraries written in those languages, ensure they can find library code they depend on at run time by listing run-time dependencies in `propagated-inputs` rather than `inputs`.

`outputs` (default: `'("out")`)

The list of output names of the package. See Section 6.4 [Packages with Multiple Outputs], page 53, for typical uses of additional outputs.

`native-search-paths` (default: `'()`)
`search-paths` (default: `'()`)
: A list of `search-path-specification` objects describing search-path environment variables honored by the package. See Section 9.8 [Search Paths], page 141, for more on search path specifications.

  As for inputs, the distinction between `native-search-paths` and `search-paths` only matters when cross-compiling. In a cross-compilation context, `native-search-paths` applies exclusively to native inputs whereas `search-paths` applies only to host inputs.

  Packages such as cross-compilers care about target inputs—for instance, our (modified) GCC cross-compiler has `CROSS_C_INCLUDE_PATH` in `search-paths`, which allows it to pick `.h` files for the target system and *not* those of native inputs. For the majority of packages though, only `native-search-paths` makes sense.

`replacement` (default: `#f`)
: This must be either `#f` or a package object that will be used as a *replacement* for this package. See Chapter 19 [Security Updates], page 616, for details.

`synopsis`
: A one-line description of the package.

`description`
: A more elaborate description of the package, as a string in Texinfo syntax.

`license`
: The license of the package; a value from `(guix licenses)`, or a list of such values.

`home-page`
: The URL to the home-page of the package, as a string.

`supported-systems` (default: `%supported-systems`)
: The list of systems supported by the package, as strings of the form `architecture-kernel`, for example `"x86_64-linux"`.

`location` (default: source location of the `package` form)
: The source location of the package. It is useful to override this when inheriting from another package, in which case this field is not automatically corrected.

`this-package` [Scheme Syntax]

When used in the *lexical scope* of a package field definition, this identifier resolves to the package being defined.

The example below shows how to add a package as a native input of itself when cross-compiling:

```
(package
  (name "guile")
  ;; ...

  ;; When cross-compiled, Guile, for example, depends on
```

```
    ;; a native version of itself.  Add it here.
    (native-inputs (if (%current-target-system)
                       (list this-package)
                       '())))
```

It is an error to refer to `this-package` outside a package definition.

The following helper procedures are provided to help deal with package inputs.

`lookup-package-input` *package name* [Scheme Procedure]
`lookup-package-native-input` *package name* [Scheme Procedure]
`lookup-package-propagated-input` *package name* [Scheme Procedure]
`lookup-package-direct-input` *package name* [Scheme Procedure]

Look up *name* among *package*'s inputs (or native, propagated, or direct inputs). Return it if found, `#f` otherwise.

name is the name of a package depended on. Here's how you might use it:

```
(use-modules (guix packages) (gnu packages base))

(lookup-package-direct-input coreutils "gmp")
⇒ #<package gmp@6.2.1 ...>
```

In this example we obtain the `gmp` package that is among the direct inputs of `coreutils`.

Sometimes you will want to obtain the list of inputs needed to *develop* a package—all the inputs that are visible when the package is compiled. This is what the `package-development-inputs` procedure returns.

`package-development-inputs` *package* [*system*] [*#:target #f*] [Scheme Procedure]

Return the list of inputs required by *package* for development purposes on *system*. When *target* is true, return the inputs needed to cross-compile *package* from *system* to *target*, where *target* is a triplet such as `"aarch64-linux-gnu"`.

Note that the result includes both explicit inputs and implicit inputs—inputs automatically added by the build system (see Section 9.5 [Build Systems], page 114). Let us take the `hello` package to illustrate that:

```
(use-modules (gnu packages base) (guix packages))

hello
⇒ #<package hello@2.10 gnu/packages/base.scm:79 7f585d4f6790>

(package-direct-inputs hello)
⇒ ()

(package-development-inputs hello)
⇒ (("source" ...) ("tar" #<package tar@1.32 ...>) ...)
```

In this example, `package-direct-inputs` returns the empty list, because `hello` has zero explicit dependencies. Conversely, `package-development-inputs` includes inputs implicitly added by `gnu-build-system` that are required to build `hello`: tar, gzip, GCC, libc, Bash, and more. To visualize it, `guix graph hello` would show you explicit inputs, whereas `guix graph -t bag hello` would include implicit inputs (see Section 10.10 [Invoking guix graph], page 201).

Because packages are regular Scheme objects that capture a complete dependency graph and associated build procedures, it is often useful to write procedures that take a package and return a modified version thereof according to some parameters. Below are a few examples.

`package-with-c-toolchain` *package toolchain* [Scheme Procedure]

Return a variant of *package* that uses *toolchain* instead of the default GNU C/C++ toolchain. *toolchain* must be a list of inputs (label/package tuples) providing equivalent functionality, such as the `gcc-toolchain` package.

The example below returns a variant of the `hello` package built with GCC 10.x and the rest of the GNU tool chain (Binutils and the GNU C Library) instead of the default tool chain:

```
(let ((toolchain (specification->package "gcc-toolchain@10")))
  (package-with-c-toolchain hello `(("toolchain" ,toolchain))))
```

The build tool chain is part of the *implicit inputs* of packages—it's usually not listed as part of the various "inputs" fields and is instead pulled in by the build system. Consequently, this procedure works by changing the build system of *package* so that it pulls in *toolchain* instead of the defaults. Section 9.5 [Build Systems], page 114, for more on build systems.

9.2.2 `origin` Reference

This section documents *origins*. An `origin` declaration specifies data that must be "produced"—downloaded, usually—and whose content hash is known in advance. Origins are primarily used to represent the source code of packages (see Section 9.2 [Defining Packages], page 96). For that reason, the `origin` form allows you to declare patches to apply to the original source code as well as code snippets to modify it.

`origin` [Data Type]

This is the data type representing a source code origin.

`uri` An object containing the URI of the source. The object type depends on the `method` (see below). For example, when using the *url-fetch* method of `(guix download)`, the valid `uri` values are: a URL represented as a string, or a list thereof.

`method` A monadic procedure that handles the given URI. The procedure must accept at least three arguments: the value of the `uri` field and the hash algorithm and hash value specified by the `hash` field. It must return a store item or a derivation in the store monad (see Section 9.11 [The Store Monad], page 149); most methods return a fixed-output derivation (see Section 9.10 [Derivations], page 146).

Commonly used methods include `url-fetch`, which fetches data from a URL, and `git-fetch`, which fetches data from a Git repository (see below).

`sha256` A bytevector containing the SHA-256 hash of the source. This is equivalent to providing a `content-hash` SHA256 object in the `hash` field described below.

`hash` The `content-hash` object of the source—see below for how to use `content-hash`.

You can obtain this information using `guix download` (see Section 10.3 [Invoking guix download], page 179) or `guix hash` (see Section 10.4 [Invoking guix hash], page 180).

`file-name` (default: `#f`)
: The file name under which the source code should be saved. When this is `#f`, a sensible default value will be used in most cases. In case the source is fetched from a URL, the file name from the URL will be used. For version control checkouts, it is recommended to provide the file name explicitly because the default is not very descriptive.

`patches` (default: `'()`)
: A list of file names, origins, or file-like objects (see Section 9.12 [G-Expressions], page 154) pointing to patches to be applied to the source.

This list of patches must be unconditional. In particular, it cannot depend on the value of `%current-system` or `%current-target-system`.

`snippet` (default: `#f`)
: A G-expression (see Section 9.12 [G-Expressions], page 154) or S-expression that will be run in the source directory. This is a convenient way to modify the source, sometimes more convenient than a patch.

`patch-flags` (default: `'("-p1")`)
: A list of command-line flags that should be passed to the `patch` command.

`patch-inputs` (default: `#f`)
: Input packages or derivations to the patching process. When this is `#f`, the usual set of inputs necessary for patching are provided, such as GNU Patch.

`modules` (default: `'()`)
: A list of Guile modules that should be loaded during the patching process and while running the code in the `snippet` field.

`patch-guile` (default: `#f`)
: The Guile package that should be used in the patching process. When this is `#f`, a sensible default is used.

`content-hash` *`value`* [*`algorithm`*] [Data Type]

Construct a content hash object for the given *algorithm*, and with *value* as its hash value. When *algorithm* is omitted, assume it is `sha256`.

value can be a literal string, in which case it is base32-decoded, or it can be a bytevector.

The following forms are all equivalent:

```
(content-hash "05zxkyz9bv3j9h0xyid1rhvh3klhsmrpkf3bcs6frvlgyr2gwilj")
```

```
(content-hash "05zxkyz9bv3j9h0xyid1rhvh3klhsmrpkf3bcs6frvlgyr2gwilj"
              sha256)
(content-hash (base32
               "05zxkyz9bv3j9h0xyid1rhvh3klhsmrpkf3bcs6frvlgyr2gwilj"))
(content-hash (base64 "kkb+RPaP7uyMZmu4eXPVkM4BN8yhRd8BTHLslb6f/Rc=")
              sha256)
```

Technically, `content-hash` is currently implemented as a macro. It performs sanity checks at macro-expansion time, when possible, such as ensuring that *value* has the right size for *algorithm*.

As we have seen above, how exactly the data an origin refers to is retrieved is determined by its `method` field. The `(guix download)` module provides the most common method, `url-fetch`, described below.

`url-fetch` ***`url hash-algo hash`*** [*name*] [*#:executable? #f*] [Scheme Procedure]

Return a fixed-output derivation that fetches data from *url* (a string, or a list of strings denoting alternate URLs), which is expected to have hash *hash* of type *hash-algo* (a symbol). By default, the file name is the base name of URL; optionally, *name* can specify a different file name. When *executable?* is true, make the downloaded file executable.

When one of the URL starts with `mirror://`, then its host part is interpreted as the name of a mirror scheme, taken from `%mirror-file`.

Alternatively, when URL starts with `file://`, return the corresponding file name in the store.

Likewise, the `(guix git-download)` module defines the `git-fetch` origin method, which fetches data from a Git version control repository, and the `git-reference` data type to describe the repository and revision to fetch.

`git-fetch` ***`ref hash-algo hash`*** [Scheme Procedure]

Return a fixed-output derivation that fetches *ref*, a `<git-reference>` object. The output is expected to have recursive hash *hash* of type *hash-algo* (a symbol). Use *name* as the file name, or a generic name if `#f`.

`git-reference` [Data Type]

This data type represents a Git reference for `git-fetch` to retrieve.

`url` The URL of the Git repository to clone.

`commit` This string denotes either the commit to fetch (a hexadecimal string), or the tag to fetch. You can also use a “short” commit ID or a `git describe` style identifier such as `v1.0.1-10-g58d7909c97`.

`recursive?` (default: `#f`)
This Boolean indicates whether to recursively fetch Git sub-modules.

The example below denotes the `v2.10` tag of the GNU Hello repository:

```
(git-reference
  (url "https://git.savannah.gnu.org/git/hello.git")
  (commit "v2.10"))
```

This is equivalent to the reference below, which explicitly names the commit:

```
(git-reference
  (url "https://git.savannah.gnu.org/git/hello.git")
  (commit "dc7dc56a00e48fe6f231a58f6537139fe2908fb9"))
```

For Mercurial repositories, the module `(guix hg-download)` defines the `hg-fetch` origin method and `hg-reference` data type for support of the Mercurial version control system.

`hg-fetch` ***ref hash-algo hash*** [*name*] [Scheme Procedure]

Return a fixed-output derivation that fetches *ref*, a `<hg-reference>` object. The output is expected to have recursive hash *hash* of type *hash-algo* (a symbol). Use *name* as the file name, or a generic name if `#false`.

9.3 Defining Package Variants

One of the nice things with Guix is that, given a package definition, you can easily *derive* variants of that package—for a different upstream version, with different dependencies, different compilation options, and so on. Some of these custom packages can be defined straight from the command line (see Section 10.1.2 [Package Transformation Options], page 168). This section describes how to define package variants in code. This can be useful in "manifests" (see Section 9.4 [Writing Manifests], page 110) and in your own package collection (see Section 7.6 [Creating a Channel], page 70), among others!

As discussed earlier, packages are first-class objects in the Scheme language. The `(guix packages)` module provides the `package` construct to define new package objects (see Section 9.2.1 [package Reference], page 99). The easiest way to define a package variant is using the `inherit` keyword together with `package`. This allows you to inherit from a package definition while overriding the fields you want.

For example, given the `hello` variable, which contains a definition for the current version of GNU Hello, here's how you would define a variant for version 2.2 (released in 2006, it's vintage!):

```
(use-modules (gnu packages base))    ;for 'hello'

(define hello-2.2
  (package
    (inherit hello)
    (version "2.2")
    (source (origin
              (method url-fetch)
              (uri (string-append "mirror://gnu/hello/hello-" version
                                  ".tar.gz"))
              (sha256
               (base32
                "0lappv4slgb5spyqbh6yl5r013zv72yqg2pcl30mginf3wdqd8k9"))))))
```

The example above corresponds to what the `--with-source` package transformation option does. Essentially `hello-2.2` preserves all the fields of `hello`, except `version` and `source`, which it overrides. Note that the original `hello` variable is still there, in the `(gnu` `packages base)` module, unchanged. When you define a custom package like this, you are really *adding* a new package definition; the original one remains available.

You can just as well define variants with a different set of dependencies than the original package. For example, the default `gdb` package depends on `guile`, but since that is an optional dependency, you can define a variant that removes that dependency like so:

```
(use-modules (gnu packages gdb))   ;for 'gdb'

(define gdb-sans-guile
  (package
    (inherit gdb)
    (inputs (modify-inputs (package-inputs gdb)
              (delete "guile")))))
```

The `modify-inputs` form above removes the `"guile"` package from the `inputs` field of `gdb`. The `modify-inputs` macro is a helper that can prove useful anytime you want to remove, add, or replace package inputs.

`modify-inputs` *`inputs clauses`* [Scheme Syntax]

Modify the given package inputs, as returned by `package-inputs` & co., according to the given clauses. Each clause must have one of the following forms:

`(delete` *`name`*`...)`
: Delete from the inputs packages with the given *name*s (strings).

`(prepend` *`package`*`...)`
: Add *package*s to the front of the input list.

`(append` *`package`*`...)`
: Add *package*s to the end of the input list.

The example below removes the GMP and ACL inputs of Coreutils and adds libcap to the front of the input list:

```
(modify-inputs (package-inputs coreutils)
  (delete "gmp" "acl")
  (prepend libcap))
```

The example below replaces the `guile` package from the inputs of `guile-redis` with `guile-2.2`:

```
(modify-inputs (package-inputs guile-redis)
  (replace "guile" guile-2.2))
```

The last type of clause is `append`, to add inputs at the back of the list.

In some cases, you may find it useful to write functions ("procedures", in Scheme parlance) that return a package based on some parameters. For example, consider the `luasocket` library for the Lua programming language. We want to create `luasocket` packages for major versions of Lua. One way to do that is to define a procedure that takes a Lua package and returns a `luasocket` package that depends on it:

```
(define (make-lua-socket name lua)
  ;; Return a luasocket package built with LUA.
  (package
    (name name)
    (version "3.0")
    ;; several fields omitted
    (inputs (list lua))
    (synopsis "Socket library for Lua")))

(define-public lua5.1-socket
  (make-lua-socket "lua5.1-socket" lua-5.1))

(define-public lua5.2-socket
  (make-lua-socket "lua5.2-socket" lua-5.2))
```

Here we have defined packages `lua5.1-socket` and `lua5.2-socket` by calling `make-lua-socket` with different arguments. See Section “Procedures” in *GNU Guile Reference Manual*, for more info on procedures. Having top-level public definitions for these two packages means that they can be referred to from the command line (see Section 9.1 [Package Modules], page 95).

These are pretty simple package variants. As a convenience, the `(guix transformations)` module provides a high-level interface that directly maps to the more sophisticated package transformation options (see Section 10.1.2 [Package Transformation Options], page 168):

`options->transformation` *opts* [Scheme Procedure]

Return a procedure that, when passed an object to build (package, derivation, etc.), applies the transformations specified by *opts* and returns the resulting objects. *opts* must be a list of symbol/string pairs such as:

```
((with-branch . "guile-gcrypt=master")
 (without-tests . "libgcrypt"))
```

Each symbol names a transformation and the corresponding string is an argument to that transformation.

For instance, a manifest equivalent to this command:

```
guix build guix \
  --with-branch=guile-gcrypt=master \
  --with-debug-info=zlib
```

... would look like this:

```
(use-modules (guix transformations))

(define transform
  ;; The package transformation procedure.
  (options->transformation
   '((with-branch . "guile-gcrypt=master")
     (with-debug-info . "zlib"))))

(packages->manifest
 (list (transform (specification->package "guix"))))
```

The `options->transformation` procedure is convenient, but it's perhaps also not as flexible as you may like. How is it implemented? The astute reader probably noticed that most package transformation options go beyond the superficial changes shown in the first examples of this section: they involve *input rewriting*, whereby the dependency graph of a package is rewritten by replacing specific inputs by others.

Dependency graph rewriting, for the purposes of swapping packages in the graph, is what the `package-input-rewriting` procedure in `(guix packages)` implements.

`package-input-rewriting` ***`replacements`*** [***`rewrite-name`***] [*#:deep? #t*] [Scheme Procedure]

Return a procedure that, when passed a package, replaces its direct and indirect dependencies, including implicit inputs when *deep?* is true, according to *replacements*. *replacements* is a list of package pairs; the first element of each pair is the package to replace, and the second one is the replacement.

Optionally, *rewrite-name* is a one-argument procedure that takes the name of a package and returns its new name after rewrite.

Consider this example:

```
(define libressl-instead-of-openssl
  ;; This is a procedure to replace OPENSSL by LIBRESSL,
  ;; recursively.
  (package-input-rewriting `((,openssl . ,libressl))))

(define git-with-libressl
  (libressl-instead-of-openssl git))
```

Here we first define a rewriting procedure that replaces *openssl* with *libressl*. Then we use it to define a *variant* of the *git* package that uses *libressl* instead of *openssl*. This is exactly what the `--with-input` command-line option does (see Section 10.1.2 [Package Transformation Options], page 168).

The following variant of `package-input-rewriting` can match packages to be replaced by name rather than by identity.

`package-input-rewriting/spec` ***`replacements`*** [*#:deep? #t*] [Scheme Procedure]

Return a procedure that, given a package, applies the given *replacements* to all the package graph, including implicit inputs unless *deep?* is false. *replacements* is a list of spec/procedures pair; each spec is a package specification such as `"gcc"` or `"guile@2"`, and each procedure takes a matching package and returns a replacement for that package.

The example above could be rewritten this way:

```
(define libressl-instead-of-openssl
  ;; Replace all the packages called "openssl" with LibreSSL.
  (package-input-rewriting/spec `(("openssl" . ,(const libressl)))))
```

The key difference here is that, this time, packages are matched by spec and not by identity. In other words, any package in the graph that is called `openssl` will be replaced.

A more generic procedure to rewrite a package dependency graph is `package-mapping`: it supports arbitrary changes to nodes in the graph.

`package-mapping` *proc* [*cut?*] [*#:deep? #f*] [Scheme Procedure]

Return a procedure that, given a package, applies *proc* to all the packages depended on and returns the resulting package. The procedure stops recursion when *cut?* returns true for a given package. When *deep?* is true, *proc* is applied to implicit inputs as well.

9.4 Writing Manifests

`guix` commands let you specify package lists on the command line. This is convenient, but as the command line becomes longer and less trivial, it quickly becomes more convenient to have that package list in what we call a *manifest*. A manifest is some sort of a "bill of materials" that defines a package set. You would typically come up with a code snippet that builds the manifest, store it in a file, say `manifest.scm`, and then pass that file to the `-m` (or `--manifest`) option that many `guix` commands support. For example, here's what a manifest for a simple package set might look like:

```
;; Manifest for three packages.
(specifications->manifest '("gcc-toolchain" "make" "git"))
```

Once you have that manifest, you can pass it, for example, to `guix package` to install just those three packages to your profile (see [profile-manifest], page 43):

```
guix package -m manifest.scm
```

... or you can pass it to `guix shell` (see [shell-manifest], page 78) to spawn an ephemeral environment:

```
guix shell -m manifest.scm
```

... or you can pass it to `guix pack` in pretty much the same way (see [pack-manifest], page 91). You can store the manifest under version control, share it with others so they can easily get set up, etc.

But how do you write your first manifest? To get started, maybe you'll want to write a manifest that mirrors what you already have in a profile. Rather than start from a blank page, `guix package` can generate a manifest for you (see [export-manifest], page 47):

```
# Write to 'manifest.scm' a manifest corresponding to the
# default profile, ~/.guix-profile.
guix package --export-manifest > manifest.scm
```

Or maybe you'll want to "translate" command-line arguments into a manifest. In that case, `guix shell` can help (see [shell-export-manifest], page 79):

```
# Write a manifest for the packages specified on the command line.
guix shell --export-manifest gcc-toolchain make git > manifest.scm
```

In both cases, the `--export-manifest` option tries hard to generate a faithful manifest; in particular, it takes package transformation options into account (see Section 10.1.2 [Package Transformation Options], page 168).

> **Note:** Manifests are *symbolic*: they refer to packages of the channels *currently in use* (see Chapter 7 [Channels], page 68). In the example above, `gcc-toolchain`

might refer to version 11 today, but it might refer to version 13 two years from now.

If you want to "pin" your software environment to specific package versions and variants, you need an additional piece of information: the list of channel revisions in use, as returned by `guix describe`. See Section 7.3 [Replicating Guix], page 69, for more information.

Once you've obtained your first manifest, perhaps you'll want to customize it. Since your manifest is code, you now have access to all the Guix programming interfaces!

Let's assume you want a manifest to deploy a custom variant of GDB, the GNU Debugger, that does not depend on Guile, together with another package. Building on the example seen in the previous section (see Section 9.3 [Defining Package Variants], page 106), you can write a manifest along these lines:

```
(use-modules (guix packages)
             (gnu packages gdb)               ;for 'gdb'
             (gnu packages version-control))  ;for 'git'

;; Define a variant of GDB without a dependency on Guile.
(define gdb-sans-guile
  (package
    (inherit gdb)
    (inputs (modify-inputs (package-inputs gdb)
              (delete "guile")))))

;; Return a manifest containing that one package plus Git.
(packages->manifest (list gdb-sans-guile git))
```

Note that in this example, the manifest directly refers to the `gdb` and `git` variables, which are bound to a `package` object (see Section 9.2.1 [package Reference], page 99), instead of calling `specifications->manifest` to look up packages by name as we did before. The `use-modules` form at the top lets us access the core package interface (see Section 9.2 [Defining Packages], page 96) and the modules that define `gdb` and `git` (see Section 9.1 [Package Modules], page 95). Seamlessly, we're weaving all this together—the possibilities are endless, unleash your creativity!

The data type for manifests as well as supporting procedures are defined in the `(guix profiles)` module, which is automatically available to code passed to `-m`. The reference follows.

`manifest` [Data Type]

Data type representing a manifest.

It currently has one field:

`entries` This must be a list of `manifest-entry` records—see below.

`manifest-entry` [Data Type]

Data type representing a manifest entry. A manifest entry contains essential metadata: a name and version string, the object (usually a package) for that entry, the desired output (see Section 6.4 [Packages with Multiple Outputs], page 53), and a number of optional pieces of information detailed below.

Most of the time, you won't build a manifest entry directly; instead, you will pass a package to `package->manifest-entry`, described below. In some unusual cases though, you might want to create manifest entries for things that are *not* packages, as in this example:

```
;; Manually build a single manifest entry for a non-package object.
(let ((hello (program-file "hello" #~(display "Hi!"))))
  (manifest-entry
    (name "foo")
    (version "42")
    (item
     (computed-file "hello-directory"
                     #~(let ((bin (string-append #$output "/bin")))
                         (mkdir #$output) (mkdir bin)
                          (symlink #$hello
                                   (string-append bin "/hello")))))))
```

The available fields are the following:

`name`
`version` Name and version string for this entry.

`item` A package or other file-like object (see Section 9.12 [G-Expressions], page 154).

`output` (default: `"out"`)
: Output of `item` to use, in case `item` has multiple outputs (see Section 6.4 [Packages with Multiple Outputs], page 53).

`dependencies` (default: `'()`)
: List of manifest entries this entry depends on. When building a profile, dependencies are added to the profile.

  Typically, the propagated inputs of a package (see Section 9.2.1 [package Reference], page 99) end up having a corresponding manifest entry in among the dependencies of the package's own manifest entry.

`search-paths` (default: `'()`)
: The list of search path specifications honored by this entry (see Section 9.8 [Search Paths], page 141).

`properties` (default: `'()`)
: List of symbol/value pairs. When building a profile, those properties get serialized.

  This can be used to piggyback additional metadata—e.g., the transformations applied to a package (see Section 10.1.2 [Package Transformation Options], page 168).

`parent` (default: `(delay #f)`)
: A promise pointing to the "parent" manifest entry.

  This is used as a hint to provide context when reporting an error related to a manifest entry coming from a `dependencies` field.

concatenate-manifests *lst* [Scheme Procedure]

Concatenate the manifests listed in *lst* and return the resulting manifest.

package->manifest-entry *package* [*output*] [*#:properties*] [Scheme Procedure]

Return a manifest entry for the *output* of package *package*, where *output* defaults to `"out"`, and with the given *properties*. By default *properties* is the empty list or, if one or more package transformations were applied to *package*, it is an association list representing those transformations, suitable as an argument to `options->transformation` (see Section 9.3 [Defining Package Variants], page 106).

The code snippet below builds a manifest with an entry for the default output and the `send-email` output of the `git` package:

```
(use-modules (gnu packages version-control))

(manifest (list (package->manifest-entry git)
                (package->manifest-entry git "send-email")))
```

packages->manifest *packages* [Scheme Procedure]

Return a list of manifest entries, one for each item listed in *packages*. Elements of *packages* can be either package objects or package/string tuples denoting a specific output of a package.

Using this procedure, the manifest above may be rewritten more concisely:

```
(use-modules (gnu packages version-control))

(packages->manifest (list git `(,git "send-email")))
```

package->development-manifest *package* [*system*] [*#:target*] [Scheme Procedure]

Return a manifest for the *development inputs* of *package* for *system*, optionally when cross-compiling to *target*. Development inputs include both explicit and implicit inputs of *package*.

Like the `-D` option of `guix shell` (see [shell-development-option], page 77), the resulting manifest describes the environment in which one can develop *package*. For example, suppose you're willing to set up a development environment for Inkscape, with the addition of Git for version control; you can describe that "bill of materials" with the following manifest:

```
(use-modules (gnu packages inkscape)          ;for 'inkscape'
             (gnu packages version-control))  ;for 'git'

(concatenate-manifests
 (list (package->development-manifest inkscape)
       (packages->manifest (list git))))
```

In this example, the development manifest that `package->development-manifest` returns includes the compiler (GCC), the many supporting libraries (Boost, GLib, GTK, etc.), and a couple of additional development tools—these are the dependencies `guix show inkscape` lists.

Last, the `(gnu packages)` module provides higher-level facilities to build manifests. In particular, it lets you look up packages by name—see below.

`specifications->manifest` *specs* [Scheme Procedure]

Given *specs*, a list of specifications such as `"emacs@25.2"` or `"guile:debug"`, return a manifest. Specs have the format that command-line tools such as `guix install` and `guix package` understand (see Section 6.2 [Invoking guix package], page 39).

As an example, it lets you rewrite the Git manifest that we saw earlier like this:

```
(specifications->manifest '("git" "git:send-email"))
```

Notice that we do not need to worry about `use-modules`, importing the right set of modules, and referring to the right variables. Instead, we directly refer to packages in the same way as on the command line, which can often be more convenient.

9.5 Build Systems

Each package definition specifies a *build system* and arguments for that build system (see Section 9.2 [Defining Packages], page 96). This `build-system` field represents the build procedure of the package, as well as implicit dependencies of that build procedure.

Build systems are `<build-system>` objects. The interface to create and manipulate them is provided by the `(guix build-system)` module, and actual build systems are exported by specific modules.

Under the hood, build systems first compile package objects to *bags*. A *bag* is like a package, but with less ornamentation—in other words, a bag is a lower-level representation of a package, which includes all the inputs of that package, including some that were implicitly added by the build system. This intermediate representation is then compiled to a derivation (see Section 9.10 [Derivations], page 146). The `package-with-c-toolchain` is an example of a way to change the implicit inputs that a package's build system pulls in (see Section 9.2.1 [package Reference], page 99).

Build systems accept an optional list of *arguments*. In package definitions, these are passed *via* the `arguments` field (see Section 9.2 [Defining Packages], page 96). They are typically keyword arguments (see Section "Optional Arguments" in *GNU Guile Reference Manual*). The value of these arguments is usually evaluated in the *build stratum*—i.e., by a Guile process launched by the daemon (see Section 9.10 [Derivations], page 146).

The main build system is `gnu-build-system`, which implements the standard build procedure for GNU and many other packages. It is provided by the `(guix build-system gnu)` module.

`gnu-build-system` [Scheme Variable]

`gnu-build-system` represents the GNU Build System, and variants thereof (see Section "Configuration" in *GNU Coding Standards*).

In a nutshell, packages using it are configured, built, and installed with the usual `./configure && make && make check && make install` command sequence. In practice, a few additional steps are often needed. All these steps are split up in separate *phases*. See Section 9.6 [Build Phases], page 131, for more info on build phases and ways to customize them.

In addition, this build system ensures that the “standard” environment for GNU packages is available. This includes tools such as GCC, libc, Coreutils, Bash, Make, Diffutils, grep, and sed (see the `(guix build-system gnu)` module for a complete list). We call these the *implicit inputs* of a package, because package definitions do not have to mention them.

This build system supports a number of keyword arguments, which can be passed *via* the `arguments` field of a package. Here are some of the main parameters:

`#:phases`
: This argument specifies build-side code that evaluates to an alist of build phases. See Section 9.6 [Build Phases], page 131, for more information.

`#:configure-flags`
: This is a list of flags (strings) passed to the `configure` script. See Section 9.2 [Defining Packages], page 96, for an example.

`#:make-flags`
: This list of strings contains flags passed as arguments to `make` invocations in the `build`, `check`, and `install` phases.

`#:out-of-source?`
: This Boolean, `#f` by default, indicates whether to run builds in a build directory separate from the source tree.

  When it is true, the `configure` phase creates a separate build directory, changes to that directory, and runs the `configure` script from there. This is useful for packages that require it, such as `glibc`.

`#:tests?`
: This Boolean, `#t` by default, indicates whether the `check` phase should run the package’s test suite.

`#:test-target`
: This string, `"check"` by default, gives the name of the makefile target used by the `check` phase.

`#:parallel-build?`
`#:parallel-tests?`
: These Boolean values specify whether to build, respectively run the test suite, in parallel, with the `-j` flag of `make`. When they are true, `make` is passed `-jn`, where *n* is the number specified as the `--cores` option of `guix-daemon` or that of the `guix` client command (see Section 10.1.1 [Common Build Options], page 166).

`#:validate-runpath?`
: This Boolean, `#t` by default, determines whether to “validate” the `RUNPATH` of ELF binaries (`.so` shared libraries as well as executables) previously installed by the `install` phase. See [phase-validate-runpath], page 132, for details.

`#:substitutable?`
: This Boolean, `#t` by default, tells whether the package outputs should be substitutable—i.e., whether users should be able to obtain substitutes for them instead of building locally (see Section 6.3 [Substitutes], page 48).

`#:allowed-references`
`#:disallowed-references`
: When true, these arguments must be a list of dependencies that must not appear among the references of the build results. If, upon build completion, some of these references are retained, the build process fails.

  This is useful to ensure that a package does not erroneously keep a reference to some of it build-time inputs, in cases where doing so would, for example, unnecessarily increase its size (see Section 10.9 [Invoking guix size], page 199).

Most other build systems support these keyword arguments.

Other `<build-system>` objects are defined to support other conventions and tools used by free software packages. They inherit most of `gnu-build-system`, and differ mainly in the set of inputs implicitly added to the build process, and in the list of phases executed. Some of these build systems are listed below.

`ant-build-system` [Scheme Variable]

This variable is exported by `(guix build-system ant)`. It implements the build procedure for Java packages that can be built with Ant build tool (`https://ant.apache.org/`).

It adds both `ant` and the *Java Development Kit* (JDK) as provided by the `icedtea` package to the set of inputs. Different packages can be specified with the `#:ant` and `#:jdk` parameters, respectively.

When the original package does not provide a suitable Ant build file, the parameter `#:jar-name` can be used to generate a minimal Ant build file `build.xml` with tasks to build the specified jar archive. In this case the parameter `#:source-dir` can be used to specify the source sub-directory, defaulting to “src”.

The `#:main-class` parameter can be used with the minimal ant buildfile to specify the main class of the resulting jar. This makes the jar file executable. The `#:test-include` parameter can be used to specify the list of junit tests to run. It defaults to `(list "**/*Test.java")`. The `#:test-exclude` can be used to disable some tests. It defaults to `(list "**/Abstract*.java")`, because abstract classes cannot be run as tests.

The parameter `#:build-target` can be used to specify the Ant task that should be run during the `build` phase. By default the “jar” task will be run.

`android-ndk-build-system` [Scheme Variable]

This variable is exported by `(guix build-system android-ndk)`. It implements a build procedure for Android NDK (native development kit) packages using a Guix-specific build process.

The build system assumes that packages install their public interface (header) files to the subdirectory `include` of the `out` output and their libraries to the subdirectory `lib` the `out` output.

It’s also assumed that the union of all the dependencies of a package has no conflicting files.

For the time being, cross-compilation is not supported - so right now the libraries and header files are assumed to be host tools.

`asdf-build-system/source` [Scheme Variable]
`asdf-build-system/sbcl` [Scheme Variable]
`asdf-build-system/ecl` [Scheme Variable]

These variables, exported by `(guix build-system asdf)`, implement build procedures for Common Lisp packages using "ASDF" (`https://common-lisp.net/project/asdf/`). ASDF is a system definition facility for Common Lisp programs and libraries.

The `asdf-build-system/source` system installs the packages in source form, and can be loaded using any common lisp implementation, via ASDF. The others, such as `asdf-build-system/sbcl`, install binary systems in the format which a particular implementation understands. These build systems can also be used to produce executable programs, or lisp images which contain a set of packages pre-loaded.

The build system uses naming conventions. For binary packages, the package name should be prefixed with the lisp implementation, such as `sbcl-` for `asdf-build-system/sbcl`.

Additionally, the corresponding source package should be labeled using the same convention as python packages (see Section 22.4.7 [Python Modules], page 634), using the `cl-` prefix.

In order to create executable programs and images, the build-side procedures `build-program` and `build-image` can be used. They should be called in a build phase after the `create-asdf-configuration` phase, so that the system which was just built can be used within the resulting image. `build-program` requires a list of Common Lisp expressions to be passed as the `#:entry-program` argument.

By default, all the `.asd` files present in the sources are read to find system definitions. The `#:asd-files` parameter can be used to specify the list of `.asd` files to read. Furthermore, if the package defines a system for its tests in a separate file, it will be loaded before the tests are run if it is specified by the `#:test-asd-file` parameter. If it is not set, the files `<system>-tests.asd`, `<system>-test.asd`, `tests.asd`, and `test.asd` will be tried if they exist.

If for some reason the package must be named in a different way than the naming conventions suggest, or if several systems must be compiled, the `#:asd-systems` parameter can be used to specify the list of system names.

`cargo-build-system` [Scheme Variable]

This variable is exported by `(guix build-system cargo)`. It supports builds of packages using Cargo, the build tool of the Rust programming language (`https://www.rust-lang.org`).

It adds `rustc` and `cargo` to the set of inputs. A different Rust package can be specified with the `#:rust` parameter.

Regular cargo dependencies should be added to the package definition similarly to other packages; those needed only at build time to native-inputs, others to inputs. If you need to add source-only crates then you should add them to via the `#:cargo-inputs` parameter as a list of name and spec pairs, where the spec can be a package or a source definition. Note that the spec must evaluate to a path to a gzipped tarball which includes a `Cargo.toml` file at its root, or it will be ignored. Similarly, cargo dev-dependencies should be added to the package definition via the `#:cargo-development-inputs` parameter.

In its `configure` phase, this build system will make any source inputs specified in the `#:cargo-inputs` and `#:cargo-development-inputs` parameters available to cargo. It will also remove an included `Cargo.lock` file to be recreated by `cargo` during the `build` phase. The `package` phase will run `cargo package` to create a source crate for future use. The `install` phase installs the binaries defined by the crate. Unless `install-source? #f` is defined it will also install a source crate repository of itself and unpacked sources, to ease in future hacking on rust packages.

`chicken-build-system` [Scheme Variable]

This variable is exported by `(guix build-system chicken)`. It builds CHICKEN Scheme (`https://call-cc.org/`) modules, also called "eggs" or "extensions". CHICKEN generates C source code, which then gets compiled by a C compiler, in this case GCC.

This build system adds `chicken` to the package inputs, as well as the packages of `gnu-build-system`.

The build system can't (yet) deduce the egg's name automatically, so just like with `go-build-system` and its `#:import-path`, you should define `#:egg-name` in the package's `arguments` field.

For example, if you are packaging the `srfi-1` egg:

```
(arguments '(#:egg-name "srfi-1"))
```

Egg dependencies must be defined in `propagated-inputs`, not `inputs` because CHICKEN doesn't embed absolute references in compiled eggs. Test dependencies should go to `native-inputs`, as usual.

`copy-build-system` [Scheme Variable]

This variable is exported by `(guix build-system copy)`. It supports builds of simple packages that don't require much compiling, mostly just moving files around.

It adds much of the `gnu-build-system` packages to the set of inputs. Because of this, the `copy-build-system` does not require all the boilerplate code often needed for the `trivial-build-system`.

To further simplify the file installation process, an `#:install-plan` argument is exposed to let the packager specify which files go where. The install plan is a list of `(`*`source target`* `[`*`filters`*`])`. *filters* are optional.

- When *source* matches a file or directory without trailing slash, install it to *target*.
  - If *target* has a trailing slash, install *source* basename beneath *target*.
  - Otherwise install *source* as *target*.
- When *source* is a directory with a trailing slash, or when *filters* are used, the trailing slash of *target* is implied with the same meaning as above.
  - Without *filters*, install the full *source content* to *target*.
  - With *filters* among `#:include`, `#:include-regexp`, `#:exclude`, `#:exclude-regexp`, only select files are installed depending on the filters. Each filters is specified by a list of strings.

- With `#:include`, install all the files which the path suffix matches at least one of the elements in the given list.
- With `#:include-regexp`, install all the files which the subpaths match at least one of the regular expressions in the given list.
- The `#:exclude` and `#:exclude-regexp` filters are the complement of their inclusion counterpart. Without `#:include` flags, install all files but those matching the exclusion filters. If both inclusions and exclusions are specified, the exclusions are done on top of the inclusions.

In all cases, the paths relative to *source* are preserved within *target*.

Examples:

- `("foo/bar" "share/my-app/")`: Install `bar` to `share/my-app/bar`.
- `("foo/bar" "share/my-app/baz")`: Install `bar` to `share/my-app/baz`.
- `("foo/" "share/my-app")`: Install the content of `foo` inside `share/my-app`, e.g., install `foo/sub/file` to `share/my-app/sub/file`.
- `("foo/" "share/my-app" #:include ("sub/file"))`: Install only `foo/sub/file` to `share/my-app/sub/file`.
- `("foo/sub" "share/my-app" #:include ("file"))`: Install `foo/sub/file` to `share/my-app/file`.

`clojure-build-system` [Scheme Variable]

This variable is exported by `(guix build-system clojure)`. It implements a simple build procedure for Clojure (`https://clojure.org/`) packages using plain old `compile` in Clojure. Cross-compilation is not supported yet.

It adds `clojure`, `icedtea` and `zip` to the set of inputs. Different packages can be specified with the `#:clojure`, `#:jdk` and `#:zip` parameters, respectively.

A list of source directories, test directories and jar names can be specified with the `#:source-dirs`, `#:test-dirs` and `#:jar-names` parameters, respectively. Compile directory and main class can be specified with the `#:compile-dir` and `#:main-class` parameters, respectively. Other parameters are documented below.

This build system is an extension of `ant-build-system`, but with the following phases changed:

`build` This phase calls `compile` in Clojure to compile source files and runs `jar` to create jars from both source files and compiled files according to the include list and exclude list specified in `#:aot-include` and `#:aot-exclude`, respectively. The exclude list has priority over the include list. These lists consist of symbols representing Clojure libraries or the special keyword `#:all` representing all Clojure libraries found under the source directories. The parameter `#:omit-source?` decides if source should be included into the jars.

`check` This phase runs tests according to the include list and exclude list specified in `#:test-include` and `#:test-exclude`, respectively. Their meanings are analogous to that of `#:aot-include` and `#:aot-exclude`, except that the special keyword `#:all` now stands for all Clojure libraries found under the test directories. The parameter `#:tests?` decides if tests should be run.

`install` This phase installs all jars built previously.

Apart from the above, this build system also contains an additional phase:

`install-doc`
This phase installs all top-level files with base name matching `%doc-regex`. A different regex can be specified with the `#:doc-regex` parameter. All files (recursively) inside the documentation directories specified in `#:doc-dirs` are installed as well.

`cmake-build-system` [Scheme Variable]

This variable is exported by `(guix build-system cmake)`. It implements the build procedure for packages using the CMake build tool (`https://www.cmake.org`).

It automatically adds the `cmake` package to the set of inputs. Which package is used can be specified with the `#:cmake` parameter.

The `#:configure-flags` parameter is taken as a list of flags passed to the `cmake` command. The `#:build-type` parameter specifies in abstract terms the flags passed to the compiler; it defaults to `"RelWithDebInfo"` (short for "release mode with debugging information"), which roughly means that code is compiled with `-O2 -g`, as is the case for Autoconf-based packages by default.

`dune-build-system` [Scheme Variable]

This variable is exported by `(guix build-system dune)`. It supports builds of packages using Dune (`https://dune.build/`), a build tool for the OCaml programming language. It is implemented as an extension of the `ocaml-build-system` which is described below. As such, the `#:ocaml` and `#:findlib` parameters can be passed to this build system.

It automatically adds the `dune` package to the set of inputs. Which package is used can be specified with the `#:dune` parameter.

There is no `configure` phase because dune packages typically don't need to be configured. The `#:build-flags` parameter is taken as a list of flags passed to the `dune` command during the build.

The `#:jbuild?` parameter can be passed to use the `jbuild` command instead of the more recent `dune` command while building a package. Its default value is `#f`.

The `#:package` parameter can be passed to specify a package name, which is useful when a package contains multiple packages and you want to build only one of them. This is equivalent to passing the `-p` argument to `dune`.

`elm-build-system` [Scheme variable]

This variable is exported by `(guix build-system elm)`. It implements a build procedure for Elm (`https://elm-lang.org`) packages similar to '`elm install`'.

The build system adds an Elm compiler package to the set of inputs. The default compiler package (currently `elm-sans-reactor`) can be overridden using the `#:elm` argument. Additionally, Elm packages needed by the build system itself are added as implicit inputs if they are not already present: to suppress this behavior, use the

`#:implicit-elm-package-inputs?` argument, which is primarily useful for bootstrapping.

The `"dependencies"` and `"test-dependencies"` in an Elm package's `elm.json` file correspond to `propagated-inputs` and `inputs`, respectively.

Elm requires a particular structure for package names: see Section 22.4.11 [Elm Packages], page 636, for more details, including utilities provided by `(guix build-system elm)`.

There are currently a few noteworthy limitations to `elm-build-system`:

- The build system is focused on *packages* in the Elm sense of the word: Elm *projects* which declare `{ "type": "package" }` in their `elm.json` files. Using `elm-build-system` to build Elm *applications* (which declare `{ "type": "application" }`) is possible, but requires ad-hoc modifications to the build phases. For examples, see the definitions of the `elm-todomvc` example application and the `elm` package itself (because the front-end for the '`elm reactor`' command is an Elm application).
- Elm supports multiple versions of a package coexisting simultaneously under `ELM_HOME`, but this does not yet work well with `elm-build-system`. This limitation primarily affects Elm applications, because they specify exact versions for their dependencies, whereas Elm packages specify supported version ranges. As a workaround, the example applications mentioned above use the `patch-application-dependencies` procedure provided by `(guix build elm-build-system)` to rewrite their `elm.json` files to refer to the package versions actually present in the build environment. Alternatively, Guix package transformations (see Section 9.3 [Defining Package Variants], page 106) could be used to rewrite an application's entire dependency graph.
- We are not yet able to run tests for Elm projects because neither `elm-test-rs` (`https://github.com/mpizenberg/elm-test-rs`) nor the Node.js-based `elm-test` (`https://github.com/rtfeldman/node-test-runner`) runner has been packaged for Guix yet.

`go-build-system` [Scheme Variable]

This variable is exported by `(guix build-system go)`. It implements a build procedure for Go packages using the standard Go build mechanisms (`https://golang.org/cmd/go/#hdr-Compile_packages_and_dependencies`).

The user is expected to provide a value for the key `#:import-path` and, in some cases, `#:unpack-path`. The import path (`https://golang.org/doc/code.html#ImportPaths`) corresponds to the file system path expected by the package's build scripts and any referring packages, and provides a unique way to refer to a Go package. It is typically based on a combination of the package source code's remote URI and file system hierarchy structure. In some cases, you will need to unpack the package's source code to a different directory structure than the one indicated by the import path, and `#:unpack-path` should be used in such cases.

Packages that provide Go libraries should install their source code into the built output. The key `#:install-source?`, which defaults to `#t`, controls whether or not the source code is installed. It can be set to `#f` for packages that only provide executable files.

Packages can be cross-built, and if a specific architecture or operating system is desired then the keywords `#:goarch` and `#:goos` can be used to force the package to be built for that architecture and operating system. The combinations known to Go can be found in their documentation (`"https://golang.org/doc/install/source#environment"`).

`glib-or-gtk-build-system` [Scheme Variable]

This variable is exported by `(guix build-system glib-or-gtk)`. It is intended for use with packages making use of GLib or GTK+.

This build system adds the following two phases to the ones defined by `gnu-build-system`:

`glib-or-gtk-wrap`
: The phase `glib-or-gtk-wrap` ensures that programs in `bin/` are able to find GLib "schemas" and GTK+ modules (`https://developer.gnome.org/gtk3/stable/gtk-running.html`). This is achieved by wrapping the programs in launch scripts that appropriately set the `XDG_DATA_DIRS` and `GTK_PATH` environment variables.

  It is possible to exclude specific package outputs from that wrapping process by listing their names in the `#:glib-or-gtk-wrap-excluded-outputs` parameter. This is useful when an output is known not to contain any GLib or GTK+ binaries, and where wrapping would gratuitously add a dependency of that output on GLib and GTK+.

`glib-or-gtk-compile-schemas`
: The phase `glib-or-gtk-compile-schemas` makes sure that all GSettings schemas (`https://developer.gnome.org/gio/stable/glib-compile-schemas.html`) of GLib are compiled. Compilation is performed by the `glib-compile-schemas` program. It is provided by the package `glib:bin` which is automatically imported by the build system. The `glib` package providing `glib-compile-schemas` can be specified with the `#:glib` parameter.

Both phases are executed after the `install` phase.

`guile-build-system` [Scheme Variable]

This build system is for Guile packages that consist exclusively of Scheme code and that are so lean that they don't even have a makefile, let alone a `configure` script. It compiles Scheme code using `guild compile` (see Section "Compilation" in *GNU Guile Reference Manual*) and installs the `.scm` and `.go` files in the right place. It also installs documentation.

This build system supports cross-compilation by using the `--target` option of '`guild compile`'.

Packages built with `guile-build-system` must provide a Guile package in their `native-inputs` field.

`julia-build-system` [Scheme Variable]

This variable is exported by `(guix build-system julia)`. It implements the build procedure used by julia (`https://julialang.org/`) packages, which essentially is similar to running '`julia -e 'using Pkg; Pkg.add(package)'`' in an environment where `JULIA_LOAD_PATH` contains the paths to all Julia package inputs. Tests are run by calling `/test/runtests.jl`.

The Julia package name and uuid is read from the file `Project.toml`. These values can be overridden by passing the argument `#:julia-package-name` (which must be correctly capitalized) or `#:julia-package-uuid`.

Julia packages usually manage their binary dependencies via `JLLWrappers.jl`, a Julia package that creates a module (named after the wrapped library followed by `_jll.jl`.

To add the binary path `_jll.jl` packages, you need to patch the files under `src/wrappers/`, replacing the call to the macro `JLLWrappers.@generate_wrapper_header`, adding as a second argument containing the store path the binary.

As an example, in the MbedTLS Julia package, we add a build phase (see Section 9.6 [Build Phases], page 131) to insert the absolute file name of the wrapped MbedTLS package:

```
(add-after 'unpack 'override-binary-path
  (lambda* (#:key inputs #:allow-other-keys)
    (for-each (lambda (wrapper)
                (substitute* wrapper
                  (("generate_wrapper_header.*")
                   (string-append
                    "generate_wrapper_header(\"MbedTLS\", \""
                    (assoc-ref inputs "mbedtls-apache") "\")\n"))))
              ;; There's a Julia file for each platform, override them all.
              (find-files "src/wrappers/" "\\.jl$"))))
```

Some older packages that aren't using `Project.toml` yet, will require this file to be created, too. It is internally done if the arguments `#:julia-package-name` and `#:julia-package-uuid` are provided.

`maven-build-system` [Scheme Variable]

This variable is exported by `(guix build-system maven)`. It implements a build procedure for Maven (`https://maven.apache.org`) packages. Maven is a dependency and lifecycle management tool for Java. A user of Maven specifies dependencies and plugins in a `pom.xml` file that Maven reads. When Maven does not have one of the dependencies or plugins in its repository, it will download them and use them to build the package.

The maven build system ensures that maven will not try to download any dependency by running in offline mode. Maven will fail if a dependency is missing. Before running Maven, the `pom.xml` (and subprojects) are modified to specify the version of dependencies and plugins that match the versions available in the guix build environment. Dependencies and plugins must be installed in the fake maven repository at `lib/m2`, and are symlinked into a proper repository before maven is run. Maven is instructed to use that repository for the build and installs built artifacts there. Changed files are copied to the `lib/m2` directory of the package output.

You can specify a `pom.xml` file with the `#:pom-file` argument, or let the build system use the default `pom.xml` file in the sources.

In case you need to specify a dependency's version manually, you can use the `#:local-packages` argument. It takes an association list where the key is the groupId of the package and its value is an association list where the key is the artifactId of the package and its value is the version you want to override in the `pom.xml`.

Some packages use dependencies or plugins that are not useful at runtime nor at build time in Guix. You can alter the `pom.xml` file to remove them using the `#:exclude` argument. Its value is an association list where the key is the groupId of the plugin or dependency you want to remove, and the value is a list of artifactId you want to remove.

You can override the default `jdk` and `maven` packages with the corresponding argument, `#:jdk` and `#:maven`.

The `#:maven-plugins` argument is a list of maven plugins used during the build, with the same format as the `inputs` fields of the package declaration. Its default value is `(default-maven-plugins)` which is also exported.

`minetest-mod-build-system` [Scheme Variable]

This variable is exported by `(guix build-system minetest)`. It implements a build procedure for Minetest (`https://www.minetest.net`) mods, which consists of copying Lua code, images and other resources to the location Minetest searches for mods. The build system also minimises PNG images and verifies that Minetest can load the mod without errors.

`minify-build-system` [Scheme Variable]

This variable is exported by `(guix build-system minify)`. It implements a minification procedure for simple JavaScript packages.

It adds `uglify-js` to the set of inputs and uses it to compress all JavaScript files in the `src` directory. A different minifier package can be specified with the `#:uglify-js` parameter, but it is expected that the package writes the minified code to the standard output.

When the input JavaScript files are not all located in the `src` directory, the parameter `#:javascript-files` can be used to specify a list of file names to feed to the minifier.

`ocaml-build-system` [Scheme Variable]

This variable is exported by `(guix build-system ocaml)`. It implements a build procedure for OCaml (`https://ocaml.org`) packages, which consists of choosing the correct set of commands to run for each package. OCaml packages can expect many different commands to be run. This build system will try some of them.

When the package has a `setup.ml` file present at the top-level, it will run `ocaml setup.ml -configure`, `ocaml setup.ml -build` and `ocaml setup.ml -install`. The build system will assume that this file was generated by OASIS (`http://oasis.forge.ocamlcore.org/`) and will take care of setting the prefix and enabling tests if they are not disabled. You can pass configure and build flags with the `#:configure-flags` and `#:build-flags`. The `#:test-flags` key can be passed to change the set of flags used to enable tests. The `#:use-make?` key can be used to bypass this system in the build and install phases.

When the package has a `configure` file, it is assumed that it is a hand-made configure script that requires a different argument format than in the `gnu-build-system`. You can add more flags with the `#:configure-flags` key.

When the package has a `Makefile` file (or `#:use-make?` is `#t`), it will be used and more flags can be passed to the build and install phases with the `#:make-flags` key.

Finally, some packages do not have these files and use a somewhat standard location for its build system. In that case, the build system will run `ocaml pkg/pkg.ml` or `ocaml pkg/build.ml` and take care of providing the path to the required findlib module. Additional flags can be passed via the `#:build-flags` key. Install is taken care of by `opam-installer`. In this case, the `opam` package must be added to the `native-inputs` field of the package definition.

Note that most OCaml packages assume they will be installed in the same directory as OCaml, which is not what we want in guix. In particular, they will install `.so` files in their module's directory, which is usually fine because it is in the OCaml compiler directory. In guix though, these libraries cannot be found and we use `CAML_LD_LIBRARY_PATH`. This variable points to `lib/ocaml/site-lib/stubslibs` and this is where `.so` libraries should be installed.

`python-build-system` [Scheme Variable]

This variable is exported by `(guix build-system python)`. It implements the more or less standard build procedure used by Python packages, which consists in running `python setup.py build` and then `python setup.py install --prefix=/gnu/store/...`.

For packages that install stand-alone Python programs under `bin/`, it takes care of wrapping these programs so that their `GUIX_PYTHONPATH` environment variable points to all the Python libraries they depend on.

Which Python package is used to perform the build can be specified with the `#:python` parameter. This is a useful way to force a package to be built for a specific version of the Python interpreter, which might be necessary if the package is only compatible with a single interpreter version.

By default guix calls `setup.py` under control of `setuptools`, much like `pip` does. Some packages are not compatible with setuptools (and pip), thus you can disable this by setting the `#:use-setuptools?` parameter to `#f`.

If a `"python"` output is available, the package is installed into it instead of the default `"out"` output. This is useful for packages that include a Python package as only a part of the software, and thus want to combine the phases of `python-build-system` with another build system. Python bindings are a common usecase.

`pyproject-build-system` [Scheme Variable]

This is a variable exported by `guix build-system pyproject`. It is based on *python-build-system*, and adds support for `pyproject.toml` and PEP 517 (`https://peps.python.org/pep-0517/`). It also supports a variety of build backends and test frameworks.

The API is slightly different from *python-build-system*:

- `#:use-setuptools?` and `#:test-target` is removed.

- `#:build-backend` is added. It defaults to `#false` and will try to guess the appropriate backend based on `pyproject.toml`.
- `#:test-backend` is added. It defaults to `#false` and will guess an appropriate test backend based on what is available in package inputs.
- `#:test-flags` is added. The default is `'()`. These flags are passed as arguments to the test command. Note that flags for verbose output is always enabled on supported backends.

It is considered "experimental" in that the implementation details are not set in stone yet, however users are encouraged to try it for new Python projects (even those using `setup.py`). The API is subject to change, but any breaking changes in the Guix channel will be dealt with.

Eventually this build system will be deprecated and merged back into *python-build-system*, probably some time in 2024.

`perl-build-system` [Scheme Variable]

This variable is exported by `(guix build-system perl)`. It implements the standard build procedure for Perl packages, which either consists in running `perl Build.PL --prefix=/gnu/store/...`, followed by `Build` and `Build install`; or in running `perl Makefile.PL PREFIX=/gnu/store/...`, followed by `make` and `make install`, depending on which of `Build.PL` or `Makefile.PL` is present in the package distribution. Preference is given to the former if both `Build.PL` and `Makefile.PL` exist in the package distribution. This preference can be reversed by specifying `#t` for the `#:make-maker?` parameter.

The initial `perl Makefile.PL` or `perl Build.PL` invocation passes flags specified by the `#:make-maker-flags` or `#:module-build-flags` parameter, respectively.

Which Perl package is used can be specified with `#:perl`.

`renpy-build-system` [Scheme Variable]

This variable is exported by `(guix build-system renpy)`. It implements the more or less standard build procedure used by Ren'py games, which consists of loading `#:game` once, thereby creating bytecode for it.

It further creates a wrapper script in `bin/` and a desktop entry in `share/applications`, both of which can be used to launch the game.

Which Ren'py package is used can be specified with `#:renpy`. Games can also be installed in outputs other than "out" by using `#:output`.

`qt-build-system` [Scheme Variable]

This variable is exported by `(guix build-system qt)`. It is intended for use with applications using Qt or KDE.

This build system adds the following two phases to the ones defined by `cmake-build-system`:

`check-setup`

The phase `check-setup` prepares the environment for running the checks as commonly used by Qt test programs. For now this only sets some environment variables: `QT_QPA_PLATFORM=offscreen`, `DBUS_FATAL_WARNINGS=0` and `CTEST_OUTPUT_ON_FAILURE=1`.

This phase is added before the `check` phase. It's a separate phase to ease adjusting if necessary.

`qt-wrap` The phase `qt-wrap` searches for Qt5 plugin paths, QML paths and some XDG in the inputs and output. In case some path is found, all programs in the output's `bin/`, `sbin/`, `libexec/` and `lib/libexec/` directories are wrapped in scripts defining the necessary environment variables.

It is possible to exclude specific package outputs from that wrapping process by listing their names in the `#:qt-wrap-excluded-outputs` parameter. This is useful when an output is known not to contain any Qt binaries, and where wrapping would gratuitously add a dependency of that output on Qt, KDE, or such.

This phase is added after the `install` phase.

`r-build-system` [Scheme Variable]

This variable is exported by `(guix build-system r)`. It implements the build procedure used by R (`https://r-project.org`) packages, which essentially is little more than running '`R CMD INSTALL --library=/gnu/store/...`' in an environment where `R_LIBS_SITE` contains the paths to all R package inputs. Tests are run after installation using the R function `tools::testInstalledPackage`.

`rakudo-build-system` [Scheme Variable]

This variable is exported by `(guix build-system rakudo)`. It implements the build procedure used by Rakudo (`https://rakudo.org/`) for Perl6 (`https://perl6.org/`) packages. It installs the package to `/gnu/store/.../NAME-VERSION/share/perl6` and installs the binaries, library files and the resources, as well as wrap the files under the `bin/` directory. Tests can be skipped by passing `#f` to the `tests?` parameter.

Which rakudo package is used can be specified with `rakudo`. Which perl6-tap-harness package used for the tests can be specified with `#:prove6` or removed by passing `#f` to the `with-prove6?` parameter. Which perl6-zef package used for tests and installing can be specified with `#:zef` or removed by passing `#f` to the `with-zef?` parameter.

`rebar-build-system` [Scheme Variable]

This variable is exported by `(guix build-system rebar)`. It implements a build procedure around rebar3 (`https://rebar3.org`), a build system for programs written in the Erlang language.

It adds both `rebar3` and the `erlang` to the set of inputs. Different packages can be specified with the `#:rebar` and `#:erlang` parameters, respectively.

This build system is based on `gnu-build-system`, but with the following phases changed:

`unpack` This phase, after unpacking the source like the `gnu-build-system` does, checks for a file `contents.tar.gz` at the top-level of the source. If this file exists, it will be unpacked, too. This eases handling of package hosted at `https://hex.pm/`, the Erlang and Elixir package repository.

`bootstrap`
`configure`
: There are no `bootstrap` and `configure` phase because erlang packages typically don't need to be configured.

`build`
: This phase runs `rebar3 compile` with the flags listed in `#:rebar-flags`.

`check`
: Unless `#:tests? #f` is passed, this phase runs `rebar3 eunit`, or some other target specified with `#:test-target`, with the flags listed in `#:rebar-flags`,

`install`
: This installs the files created in the *default* profile, or some other profile specified with `#:install-profile`.

`texlive-build-system` [Scheme Variable]

This variable is exported by `(guix build-system texlive)`. It is used to build TeX packages in batch mode with a specified engine. The build system sets the `TEXINPUTS` variable to find all TeX source files in the inputs.

By default it runs `luatex` on all files ending on `ins`. A different engine and format can be specified with the `#:tex-format` argument. Different build targets can be specified with the `#:build-targets` argument, which expects a list of file names. The build system adds only `texlive-bin` and `texlive-latex-base` (both from `(gnu packages tex`) to the inputs. Both can be overridden with the arguments `#:texlive-bin` and `#:texlive-latex-base`, respectively.

The `#:tex-directory` parameter tells the build system where to install the built files under the texmf tree.

`ruby-build-system` [Scheme Variable]

This variable is exported by `(guix build-system ruby)`. It implements the RubyGems build procedure used by Ruby packages, which involves running `gem build` followed by `gem install`.

The `source` field of a package that uses this build system typically references a gem archive, since this is the format that Ruby developers use when releasing their software. The build system unpacks the gem archive, potentially patches the source, runs the test suite, repackages the gem, and installs it. Additionally, directories and tarballs may be referenced to allow building unreleased gems from Git or a traditional source release tarball.

Which Ruby package is used can be specified with the `#:ruby` parameter. A list of additional flags to be passed to the `gem` command can be specified with the `#:gem-flags` parameter.

`waf-build-system` [Scheme Variable]

This variable is exported by `(guix build-system waf)`. It implements a build procedure around the `waf` script. The common phases—`configure`, `build`, and `install`—are implemented by passing their names as arguments to the `waf` script.

The `waf` script is executed by the Python interpreter. Which Python package is used to run the script can be specified with the `#:python` parameter.

`scons-build-system` [Scheme Variable]

This variable is exported by `(guix build-system scons)`. It implements the build procedure used by the SCons software construction tool. This build system runs `scons` to build the package, `scons test` to run tests, and then `scons install` to install the package.

Additional flags to be passed to `scons` can be specified with the `#:scons-flags` parameter. The default build and install targets can be overridden with `#:build-targets` and `#:install-targets` respectively. The version of Python used to run SCons can be specified by selecting the appropriate SCons package with the `#:scons` parameter.

`haskell-build-system` [Scheme Variable]

This variable is exported by `(guix build-system haskell)`. It implements the Cabal build procedure used by Haskell packages, which involves running `runhaskell Setup.hs configure --prefix=/gnu/store/...` and `runhaskell Setup.hs build`. Instead of installing the package by running `runhaskell Setup.hs install`, to avoid trying to register libraries in the read-only compiler store directory, the build system uses `runhaskell Setup.hs copy`, followed by `runhaskell Setup.hs register`. In addition, the build system generates the package documentation by running `runhaskell Setup.hs haddock`, unless `#:haddock? #f` is passed. Optional Haddock parameters can be passed with the help of the `#:haddock-flags` parameter. If the file `Setup.hs` is not found, the build system looks for `Setup.lhs` instead.

Which Haskell compiler is used can be specified with the `#:haskell` parameter which defaults to `ghc`.

`dub-build-system` [Scheme Variable]

This variable is exported by `(guix build-system dub)`. It implements the Dub build procedure used by D packages, which involves running `dub build` and `dub run`. Installation is done by copying the files manually.

Which D compiler is used can be specified with the `#:ldc` parameter which defaults to `ldc`.

`emacs-build-system` [Scheme Variable]

This variable is exported by `(guix build-system emacs)`. It implements an installation procedure similar to the packaging system of Emacs itself (see Section “Packages” in *The GNU Emacs Manual*).

It first creates the `package-autoloads.el` file, then it byte compiles all Emacs Lisp files. Differently from the Emacs packaging system, the Info documentation files are moved to the standard documentation directory and the `dir` file is deleted. The Elisp package files are installed directly under `share/emacs/site-lisp`.

`font-build-system` [Scheme Variable]

This variable is exported by `(guix build-system font)`. It implements an installation procedure for font packages where upstream provides pre-compiled TrueType, OpenType, etc. font files that merely need to be copied into place. It copies font files to standard locations in the output directory.

`meson-build-system` [Scheme Variable]

This variable is exported by `(guix build-system meson)`. It implements the build procedure for packages that use Meson (`https://mesonbuild.com`) as their build system.

It adds both Meson and Ninja (`https://ninja-build.org/`) to the set of inputs, and they can be changed with the parameters `#:meson` and `#:ninja` if needed.

This build system is an extension of `gnu-build-system`, but with the following phases changed to some specific for Meson:

`configure`
: The phase runs `meson` with the flags specified in `#:configure-flags`. The flag `--buildtype` is always set to `debugoptimized` unless something else is specified in `#:build-type`.

`build`
: The phase runs `ninja` to build the package in parallel by default, but this can be changed with `#:parallel-build?`.

`check`
: The phase runs '`meson test`' with a base set of options that cannot be overridden. This base set of options can be extended via the `#:test-options` argument, for example to select or skip a specific test suite.

`install`
: The phase runs `ninja install` and can not be changed.

Apart from that, the build system also adds the following phases:

`fix-runpath`
: This phase ensures that all binaries can find the libraries they need. It searches for required libraries in subdirectories of the package being built, and adds those to `RUNPATH` where needed. It also removes references to libraries left over from the build phase by `meson`, such as test dependencies, that aren't actually required for the program to run.

`glib-or-gtk-wrap`
: This phase is the phase provided by `glib-or-gtk-build-system`, and it is not enabled by default. It can be enabled with `#:glib-or-gtk?`.

`glib-or-gtk-compile-schemas`
: This phase is the phase provided by `glib-or-gtk-build-system`, and it is not enabled by default. It can be enabled with `#:glib-or-gtk?`.

`linux-module-build-system` [Scheme Variable]

`linux-module-build-system` allows building Linux kernel modules.

This build system is an extension of `gnu-build-system`, but with the following phases changed:

`configure`
: This phase configures the environment so that the Linux kernel's Makefile can be used to build the external kernel module.

`build`
: This phase uses the Linux kernel's Makefile in order to build the external kernel module.

`install` This phase uses the Linux kernel's Makefile in order to install the external kernel module.

It is possible and useful to specify the Linux kernel to use for building the module (in the `arguments` form of a package using the `linux-module-build-system`, use the key `#:linux` to specify it).

`node-build-system` [Scheme Variable]

This variable is exported by `(guix build-system node)`. It implements the build procedure used by Node.js (`https://nodejs.org`), which implements an approximation of the `npm install` command, followed by an `npm test` command.

Which Node.js package is used to interpret the `npm` commands can be specified with the `#:node` parameter which defaults to `node`.

Lastly, for packages that do not need anything as sophisticated, a "trivial" build system is provided. It is trivial in the sense that it provides basically no support: it does not pull any implicit inputs, and does not have a notion of build phases.

`trivial-build-system` [Scheme Variable]

This variable is exported by `(guix build-system trivial)`.

This build system requires a `#:builder` argument. This argument must be a Scheme expression that builds the package output(s)—as with `build-expression->derivation` (see Section 9.10 [Derivations], page 146).

`channel-build-system` [Scheme Variable]

This variable is exported by `(guix build-system channel)`.

This build system is meant primarily for internal use. A package using this build system must have a channel specification as its `source` field (see Chapter 7 [Channels], page 68); alternatively, its source can be a directory name, in which case an additional `#:commit` argument must be supplied to specify the commit being built (a hexadecimal string).

The resulting package is a Guix instance of the given channel, similar to how `guix time-machine` would build it.

9.6 Build Phases

Almost all package build systems implement a notion *build phases*: a sequence of actions that the build system executes, when you build the package, leading to the installed byproducts in the store. A notable exception is the "bare-bones" `trivial-build-system` (see Section 9.5 [Build Systems], page 114).

As discussed in the previous section, those build systems provide a standard list of phases. For `gnu-build-system`, the main build phases are the following:

`set-paths`
Define search path environment variables for all the input packages, including `PATH` (see Section 9.8 [Search Paths], page 141).

`unpack` Unpack the source tarball, and change the current directory to the extracted source tree. If the source is actually a directory, copy it to the build tree, and enter that directory.

`patch-source-shebangs`
: Patch shebangs encountered in source files so they refer to the right store file names. For instance, this changes `#!/bin/sh` to `#!/gnu/store/...-bash-4.3/bin/sh`.

`configure`
: Run the `configure` script with a number of default options, such as `--prefix=/gnu/store/...`, as well as the options specified by the `#:configure-flags` argument.

`build`
: Run `make` with the list of flags specified with `#:make-flags`. If the `#:parallel-build?` argument is true (the default), build with `make -j`.

`check`
: Run `make check`, or some other target specified with `#:test-target`, unless `#:tests? #f` is passed. If the `#:parallel-tests?` argument is true (the default), run `make check -j`.

`install`
: Run `make install` with the flags listed in `#:make-flags`.

`patch-shebangs`
: Patch shebangs on the installed executable files.

`strip`
: Strip debugging symbols from ELF files (unless `#:strip-binaries?` is false), copying them to the `debug` output when available (see Chapter 17 [Installing Debugging Files], page 611).

`validate-runpath`
: Validate the `RUNPATH` of ELF binaries, unless `#:validate-runpath?` is false (see Section 9.5 [Build Systems], page 114).

  This validation step consists in making sure that all the shared libraries needed by an ELF binary, which are listed as `DT_NEEDED` entries in its `PT_DYNAMIC` segment, appear in the `DT_RUNPATH` entry of that binary. In other words, it ensures that running or using those binaries will not result in a “file not found” error at run time. See Section “Options” in *The GNU Linker*, for more information on `RUNPATH`.

Other build systems have similar phases, with some variations. For example, `cmake-build-system` has same-named phases but its `configure` phases runs `cmake` instead of `./configure`. Others, such as `python-build-system`, have a wholly different list of standard phases. All this code runs on the *build side*: it is evaluated when you actually build the package, in a dedicated build process spawned by the build daemon (see Section 2.5 [Invoking guix-daemon], page 15).

Build phases are represented as association lists or “alists” (see Section “Association Lists” in *GNU Guile Reference Manual*) where each key is a symbol for the name of the phase and the associated value is a procedure that accepts an arbitrary number of arguments. By convention, those procedures receive information about the build in the form of *keyword parameters*, which they can use or ignore.

For example, here is how `(guix build gnu-build-system)` defines `%standard-phases`, the variable holding its alist of build phases[3]:

[3] We present a simplified view of those build phases, but do take a look at `(guix build gnu-build-system)` to see all the details!

```
;; The build phases of 'gnu-build-system'.

(define* (unpack #:key source #:allow-other-keys)
  ;; Extract the source tarball.
  (invoke "tar" "xvf" source))

(define* (configure #:key outputs #:allow-other-keys)
  ;; Run the 'configure' script.  Install to output "out".
  (let ((out (assoc-ref outputs "out")))
    (invoke "./configure"
            (string-append "--prefix=" out))))

(define* (build #:allow-other-keys)
  ;; Compile.
  (invoke "make"))

(define* (check #:key (test-target "check") (tests? #true)
                #:allow-other-keys)
  ;; Run the test suite.
  (if tests?
      (invoke "make" test-target)
      (display "test suite not run\n")))

(define* (install #:allow-other-keys)
  ;; Install files to the prefix 'configure' specified.
  (invoke "make" "install"))

(define %standard-phases
  ;; The list of standard phases (quite a few are omitted
  ;; for brevity).  Each element is a symbol/procedure pair.
  (list (cons 'unpack unpack)
        (cons 'configure configure)
        (cons 'build build)
        (cons 'check check)
        (cons 'install install)))
```

This shows how `%standard-phases` is defined as a list of symbol/procedure pairs (see Section "Pairs" in *GNU Guile Reference Manual*). The first pair associates the `unpack` procedure with the `unpack` symbol—a name; the second pair defines the `configure` phase similarly, and so on. When building a package that uses `gnu-build-system` with its default list of phases, those phases are executed sequentially. You can see the name of each phase started and completed in the build log of packages that you build.

Let's now look at the procedures themselves. Each one is defined with `define*`: `#:key` lists keyword parameters the procedure accepts, possibly with a default value, and `#:allow-other-keys` specifies that other keyword parameters are ignored (see Section "Optional Arguments" in *GNU Guile Reference Manual*).

The `unpack` procedure honors the `source` parameter, which the build system uses to pass the file name of the source tarball (or version control checkout), and it ignores other parameters. The `configure` phase only cares about the `outputs` parameter, an alist mapping package output names to their store file name (see Section 6.4 [Packages with Multiple Outputs], page 53). It extracts the file name of for `out`, the default output, and passes it to `./configure` as the installation prefix, meaning that `make install` will eventually copy all the files in that directory (see Section "Configuration" in *GNU Coding Standards*). `build` and `install` ignore all their arguments. `check` honors the `test-target` argument, which specifies the name of the Makefile target to run tests; it prints a message and skips tests when `tests?` is false.

The list of phases used for a particular package can be changed with the `#:phases` parameter of the build system. Changing the set of build phases boils down to building a new alist of phases based on the `%standard-phases` alist described above. This can be done with standard alist procedures such as `alist-delete` (see Section "SRFI-1 Association Lists" in *GNU Guile Reference Manual*); however, it is more convenient to do so with `modify-phases` (see Section 9.7 [Build Utilities], page 135).

Here is an example of a package definition that removes the `configure` phase of `%standard-phases` and inserts a new phase before the `build` phase, called `set-prefix-in-makefile`:

```
(define-public example
  (package
    (name "example")
    ;; other fields omitted
    (build-system gnu-build-system)
    (arguments
     '(#:phases (modify-phases %standard-phases
                  (delete 'configure)
                  (add-before 'build 'set-prefix-in-makefile
                    (lambda* (#:key outputs #:allow-other-keys)
                      ;; Modify the makefile so that its
                      ;; 'PREFIX' variable points to "out".
                      (let ((out (assoc-ref outputs "out")))
                        (substitute* "Makefile"
                          (("PREFIX =.*")
                           (string-append "PREFIX = "
                                          out "\n")))))))))))
```

The new phase that is inserted is written as an anonymous procedure, introduced with `lambda*`; it honors the `outputs` parameter we have seen before. See Section 9.7 [Build Utilities], page 135, for more about the helpers used by this phase, and for more examples of `modify-phases`.

Keep in mind that build phases are code evaluated at the time the package is actually built. This explains why the whole `modify-phases` expression above is quoted (it comes after the `'` or apostrophe): it is *staged* for later execution. See Section 9.12 [G-Expressions], page 154, for an explanation of code staging and the *code strata* involved.

9.7 Build Utilities

As soon as you start writing non-trivial package definitions (see Section 9.2 [Defining Packages], page 96) or other build actions (see Section 9.12 [G-Expressions], page 154), you will likely start looking for helpers for "shell-like" actions—creating directories, copying and deleting files recursively, manipulating build phases, and so on. The `(guix build utils)` module provides such utility procedures.

Most build systems load `(guix build utils)` (see Section 9.5 [Build Systems], page 114). Thus, when writing custom build phases for your package definitions, you can usually assume those procedures are in scope.

When writing G-expressions, you can import `(guix build utils)` on the "build side" using `with-imported-modules` and then put it in scope with the `use-modules` form (see Section "Using Guile Modules" in *GNU Guile Reference Manual*):

```
(with-imported-modules '((guix build utils))  ;import it
  (computed-file "empty-tree"
                 #~(begin
                     ;; Put it in scope.
                     (use-modules (guix build utils))

                     ;; Happily use its 'mkdir-p' procedure.
                     (mkdir-p (string-append #$output "/a/b/c")))))
```

The remainder of this section is the reference for most of the utility procedures provided by `(guix build utils)`.

9.7.1 Dealing with Store File Names

This section documents procedures that deal with store file names.

`%store-directory` [Scheme Procedure]
: Return the directory name of the store.

`store-file-name?` *file* [Scheme Procedure]
: Return true if *file* is in the store.

`strip-store-file-name` *file* [Scheme Procedure]
: Strip the `/gnu/store` and hash from *file*, a store file name. The result is typically a `"`*package-version*`"` string.

`package-name->name+version` *name* [Scheme Procedure]
: Given *name*, a package name like `"foo-0.9.1b"`, return two values: `"foo"` and `"0.9.1b"`. When the version part is unavailable, *name* and `#f` are returned. The first hyphen followed by a digit is considered to introduce the version part.

9.7.2 File Types

The procedures below deal with files and file types.

`directory-exists?` *dir* [Scheme Procedure]
: Return `#t` if *dir* exists and is a directory.

`executable-file?` *file* [Scheme Procedure]

Return `#t` if *file* exists and is executable.

`symbolic-link?` *file* [Scheme Procedure]

Return `#t` if *file* is a symbolic link (aka. a "symlink").

`elf-file?` *file* [Scheme Procedure]
`ar-file?` *file* [Scheme Procedure]
`gzip-file?` *file* [Scheme Procedure]

Return `#t` if *file* is, respectively, an ELF file, an `ar` archive (such as a `.a` static library), or a gzip file.

`reset-gzip-timestamp` *file* [*#:keep-mtime? #t*] [Scheme Procedure]

If *file* is a gzip file, reset its embedded timestamp (as with `gzip --no-name`) and return true. Otherwise return `#f`. When *keep-mtime?* is true, preserve *file*'s modification time.

9.7.3 File Manipulation

The following procedures and macros help create, modify, and delete files. They provide functionality comparable to common shell utilities such as `mkdir -p`, `cp -r`, `rm -r`, and `sed`. They complement Guile's extensive, but low-level, file system interface (see Section "POSIX" in *GNU Guile Reference Manual*).

`with-directory-excursion` *directory body...* [Scheme Syntax]

Run *body* with *directory* as the process's current directory.

Essentially, this macro changes the current directory to *directory* before evaluating *body*, using `chdir` (see Section "Processes" in *GNU Guile Reference Manual*). It changes back to the initial directory when the dynamic extent of *body* is left, be it *via* normal procedure return or *via* a non-local exit such as an exception.

`mkdir-p` *dir* [Scheme Procedure]

Create directory *dir* and all its ancestors.

`install-file` *file directory* [Scheme Procedure]

Create *directory* if it does not exist and copy *file* in there under the same name.

`make-file-writable` *file* [Scheme Procedure]

Make *file* writable for its owner.

`copy-recursively` *source destination* [*#:log (current-output-port)*] [*#:follow-symlinks? #f*] [*#:copy-file copy-file*] [*#:keep-mtime? #f*] [*#:keep-permissions? #t*] [Scheme Procedure]

Copy *source* directory to *destination*. Follow symlinks if *follow-symlinks?* is true; otherwise, just preserve them. Call *copy-file* to copy regular files. When *keep-mtime?* is true, keep the modification time of the files in *source* on those of *destination*. When *keep-permissions?* is true, preserve file permissions. Write verbose output to the *log* port.

`delete-file-recursively` *dir* [*#:follow-mounts? #f*] [Scheme Procedure]

Delete *dir* recursively, like `rm -rf`, without following symlinks. Don't follow mount points either, unless *follow-mounts?* is true. Report but ignore errors.

`substitute*` *file* ((*regexp match-var*. . .) *body*. . .) . . . [Scheme Syntax]

Substitute *regexp* in *file* by the string returned by *body*. *body* is evaluated with each *match-var* bound to the corresponding positional regexp sub-expression. For example:

```
(substitute* file
  (("hello")
   "good morning\n")
  (("foo([a-z]+)bar(.*)$" all letters end)
   (string-append "baz" letters end)))
```

Here, anytime a line of *file* contains `hello`, it is replaced by `good morning`. Anytime a line of *file* matches the second regexp, `all` is bound to the complete match, `letters` is bound to the first sub-expression, and `end` is bound to the last one.

When one of the *match-var* is `_`, no variable is bound to the corresponding match substring.

Alternatively, *file* may be a list of file names, in which case they are all subject to the substitutions.

Be careful about using `$` to match the end of a line; by itself it won't match the terminating newline of a line.

9.7.4 File Search

This section documents procedures to search and filter files.

`file-name-predicate` *regexp* [Scheme Procedure]

Return a predicate that returns true when passed a file name whose base name matches *regexp*.

`find-files` *dir* [*pred*] [*#:stat lstat*] [*#:directories? #f*] [*#:fail-on-error? #f*] [Scheme Procedure]

Return the lexicographically sorted list of files under *dir* for which *pred* returns true. *pred* is passed two arguments: the absolute file name, and its stat buffer; the default predicate always returns true. *pred* can also be a regular expression, in which case it is equivalent to `(file-name-predicate` *pred*`)`. *stat* is used to obtain file information; using `lstat` means that symlinks are not followed. If *directories?* is true, then directories will also be included. If *fail-on-error?* is true, raise an exception upon error.

Here are a few examples where we assume that the current directory is the root of the Guix source tree:

```
;; List all the regular files in the current directory.
(find-files ".")
⇒ ("./.dir-locals.el" "./.gitignore" ...)

;; List all the .scm files under gnu/services.
(find-files "gnu/services" "\\.scm$")
⇒ ("gnu/services/admin.scm" "gnu/services/audio.scm" ...)
```

```
;; List ar files in the current directory.
(find-files "." (lambda (file stat) (ar-file? file)))
⇒ ("./libformat.a" "./libstore.a" ...)
```

`which` *program* [Scheme Procedure]

Return the complete file name for *program* as found in `$PATH`, or `#f` if *program* could not be found.

`search-input-file` *inputs name* [Scheme Procedure]
`search-input-directory` *inputs name* [Scheme Procedure]

Return the complete file name for *name* as found in *inputs*; `search-input-file` searches for a regular file and `search-input-directory` searches for a directory. If *name* could not be found, an exception is raised.

Here, *inputs* must be an association list like `inputs` and `native-inputs` as available to build phases (see Section 9.6 [Build Phases], page 131).

Here is a (simplified) example of how `search-input-file` is used in a build phase of the `wireguard-tools` package:

```
(add-after 'install 'wrap-wg-quick
  (lambda* (#:key inputs outputs #:allow-other-keys)
    (let ((coreutils (string-append (assoc-ref inputs "coreutils")
                                    "/bin")))
      (wrap-program (search-input-file outputs "bin/wg-quick")
        #:sh (search-input-file inputs "bin/bash")
        `("PATH" ":" prefix ,(list coreutils))))))
```

9.7.5 Program Invocation

You'll find handy procedures to spawn processes in this module, essentially convenient wrappers around Guile's `system*` (see Section "Processes" in *GNU Guile Reference Manual*).

`invoke` *program args...* [Scheme Procedure]

Invoke *program* with the given *args*. Raise an `&invoke-error` exception if the exit code is non-zero; otherwise return `#t`.

The advantage compared to `system*` is that you do not need to check the return value. This reduces boilerplate in shell-script-like snippets for instance in package build phases.

`invoke-error?` *c* [Scheme Procedure]

Return true if *c* is an `&invoke-error` condition.

`invoke-error-program` *c* [Scheme Procedure]
`invoke-error-arguments` *c* [Scheme Procedure]
`invoke-error-exit-status` *c* [Scheme Procedure]
`invoke-error-term-signal` *c* [Scheme Procedure]
`invoke-error-stop-signal` *c* [Scheme Procedure]

Access specific fields of *c*, an `&invoke-error` condition.

`report-invoke-error` *c* [*port*] [Scheme Procedure]

Report to *port* (by default the current error port) about *c*, an `&invoke-error` condition, in a human-friendly way.

Typical usage would look like this:

```
(use-modules (srfi srfi-34) ;for 'guard'
             (guix build utils))

(guard (c ((invoke-error? c)
           (report-invoke-error c)))
  (invoke "date" "--imaginary-option"))

⊣ command "date" "--imaginary-option" failed with status 1
```

`invoke/quiet` *program args...* [Scheme Procedure]

Invoke *program* with *args* and capture *program*'s standard output and standard error. If *program* succeeds, print nothing and return the unspecified value; otherwise, raise a `&message` error condition that includes the status code and the output of *program*.

Here's an example:

```
(use-modules (srfi srfi-34) ;for 'guard'
             (srfi srfi-35) ;for 'message-condition?'
             (guix build utils))

(guard (c ((message-condition? c)
           (display (condition-message c))))
  (invoke/quiet "date")  ;all is fine
  (invoke/quiet "date" "--imaginary-option"))

⊣ 'date --imaginary-option' exited with status 1; output follows:

    date: unrecognized option '--imaginary-option'
    Try 'date --help' for more information.
```

9.7.6 Build Phases

The `(guix build utils)` also contains tools to manipulate build phases as used by build systems (see Section 9.5 [Build Systems], page 114). Build phases are represented as association lists or "alists" (see Section "Association Lists" in *GNU Guile Reference Manual*) where each key is a symbol naming the phase and the associated value is a procedure (see Section 9.6 [Build Phases], page 131).

Guile core and the `(srfi srfi-1)` module both provide tools to manipulate alists. The `(guix build utils)` module complements those with tools written with build phases in mind.

`modify-phases` *phases clause...* [Scheme Syntax]

Modify *phases* sequentially as per each *clause*, which may have one of the following forms:

```
(delete old-phase-name)
```

```
(replace old-phase-name new-phase)
(add-before old-phase-name new-phase-name new-phase)
(add-after old-phase-name new-phase-name new-phase)
```

Where every *phase-name* above is an expression evaluating to a symbol, and *new-phase* an expression evaluating to a procedure.

The example below is taken from the definition of the `grep` package. It adds a phase to run after the `install` phase, called `fix-egrep-and-fgrep`. That phase is a procedure (`lambda*` is for anonymous procedures) that takes a `#:outputs` keyword argument and ignores extra keyword arguments (see Section "Optional Arguments" in *GNU Guile Reference Manual*, for more on `lambda*` and optional and keyword arguments.) The phase uses `substitute*` to modify the installed `egrep` and `fgrep` scripts so that they refer to `grep` by its absolute file name:

```
(modify-phases %standard-phases
  (add-after 'install 'fix-egrep-and-fgrep
    ;; Patch 'egrep' and 'fgrep' to execute 'grep' via its
    ;; absolute file name instead of searching for it in $PATH.
    (lambda* (#:key outputs #:allow-other-keys)
      (let* ((out (assoc-ref outputs "out"))
             (bin (string-append out "/bin")))
        (substitute* (list (string-append bin "/egrep")
                           (string-append bin "/fgrep"))
          (("^exec grep")
           (string-append "exec " bin "/grep")))))))
```

In the example below, phases are modified in two ways: the standard `configure` phase is deleted, presumably because the package does not have a `configure` script or anything similar, and the default `install` phase is replaced by one that manually copies the executable files to be installed:

```
(modify-phases %standard-phases
  (delete 'configure)      ;no 'configure' script
  (replace 'install
    (lambda* (#:key outputs #:allow-other-keys)
      ;; The package's Makefile doesn't provide an "install"
      ;; rule so do it by ourselves.
      (let ((bin (string-append (assoc-ref outputs "out")
                                "/bin")))
        (install-file "footswitch" bin)
        (install-file "scythe" bin)))))
```

9.7.7 Wrappers

It is not unusual for a command to require certain environment variables to be set for proper functioning, typically search paths (see Section 9.8 [Search Paths], page 141). Failing to do that, the command might fail to find files or other commands it relies on, or it might pick the "wrong" ones—depending on the environment in which it runs. Examples include:

- a shell script that assumes all the commands it uses are in `PATH`;

- a Guile program that assumes all its modules are in `GUILE_LOAD_PATH` and `GUILE_LOAD_COMPILED_PATH`;
- a Qt application that expects to find certain plugins in `QT_PLUGIN_PATH`.

For a package writer, the goal is to make sure commands always work the same rather than depend on some external settings. One way to achieve that is to *wrap* commands in a thin script that sets those environment variables, thereby ensuring that those run-time dependencies are always found. The wrapper would be used to set `PATH`, `GUILE_LOAD_PATH`, or `QT_PLUGIN_PATH` in the examples above.

To ease that task, the `(guix build utils)` module provides a couple of helpers to wrap commands.

`wrap-program` *program* [#:sh *sh*] [#:rest *variables*] [Scheme Procedure]

Make a wrapper for *program*. *variables* should look like this:

```
'(variable delimiter position list-of-directories)
```

where *delimiter* is optional. `:` will be used if *delimiter* is not given.

For example, this call:

```
(wrap-program "foo"
              '("PATH" ":" = ("/gnu/.../bar/bin"))
              '("CERT_PATH" suffix ("/gnu/.../baz/certs"
                                    "/qux/certs")))
```

will copy `foo` to `.foo-real` and create the file `foo` with the following contents:

```
#!location/of/bin/bash
export PATH="/gnu/.../bar/bin"
export CERT_PATH="$CERT_PATH${CERT_PATH:+:}/gnu/.../baz/certs:/qux/certs"
exec -a $0 location/of/.foo-real "$@"
```

If *program* has previously been wrapped by `wrap-program`, the wrapper is extended with definitions for *variables*. If it is not, *sh* will be used as the interpreter.

`wrap-script` *program* [#:guile *guile*] [#:rest *variables*] [Scheme Procedure]

Wrap the script *program* such that *variables* are set first. The format of *variables* is the same as in the `wrap-program` procedure. This procedure differs from `wrap-program` in that it does not create a separate shell script. Instead, *program* is modified directly by prepending a Guile script, which is interpreted as a comment in the script's language.

Special encoding comments as supported by Python are recreated on the second line.

Note that this procedure can only be used once per file as Guile scripts are not supported.

9.8 Search Paths

Many programs and libraries look for input data in a *search path*, a list of directories: shells like Bash look for executables in the command search path, a C compiler looks for `.h` files in its header search path, the Python interpreter looks for `.py` files in its search path, the spell checker has a search path for dictionaries, and so on.

Search paths can usually be defined or overridden *via* environment variables (see Section "Environment Variables" in *The GNU C Library Reference Manual*). For example, the search paths mentioned above can be changed by defining the `PATH`, `C_INCLUDE_PATH`, `PYTHONPATH` (or `GUIX_PYTHONPATH`), and `DICPATH` environment variables—you know, all these something-PATH variables that you need to get right or things "won't be found".

You may have noticed from the command line that Guix "knows" which search path environment variables should be defined, and how. When you install packages in your default profile, the file `~/.guix-profile/etc/profile` is created, which you can "source" from the shell to set those variables. Likewise, if you ask `guix shell` to create an environment containing Python and NumPy, a Python library, and if you pass it the `--search-paths` option, it will tell you about `PATH` and `GUIX_PYTHONPATH` (see Section 8.1 [Invoking guix shell], page 76):

```
$ guix shell python python-numpy --pure --search-paths
export PATH="/gnu/store/...-profile/bin"
export GUIX_PYTHONPATH="/gnu/store/...-profile/lib/python3.9/site-packages"
```

When you omit `--search-paths`, it defines these environment variables right away, such that Python can readily find NumPy:

```
$ guix shell python python-numpy -- python3
Python 3.9.6 (default, Jan  1 1970, 00:00:01)
[GCC 10.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import numpy
>>> numpy.version.version
'1.20.3'
```

For this to work, the definition of the `python` package *declares* the search path it cares about and its associated environment variable, `GUIX_PYTHONPATH`. It looks like this:

```
(package
  (name "python")
  (version "3.9.9")
  ;; some fields omitted...
  (native-search-paths
   (list (search-path-specification
          (variable "GUIX_PYTHONPATH")
          (files (list "lib/python/3.9/site-packages"))))))
```

What this `native-search-paths` field says is that, when the `python` package is used, the `GUIX_PYTHONPATH` environment variable must be defined to include all the `lib/python/3.9/site-packages` sub-directories encountered in its environment. (The `native-` bit means that, if we are in a cross-compilation environment, only native inputs may be added to the search path; see Section 9.2.1 [package Reference], page 99.) In the NumPy example above, the profile where `python` appears contains exactly one such sub-directory, and `GUIX_PYTHONPATH` is set to that. When there are several `lib/python/3.9/site-packages`—this is the case in package build environments—they are all added to `GUIX_PYTHONPATH`, separated by colons (`:`).

> **Note:** Notice that `GUIX_PYTHONPATH` is specified as part of the definition of the `python` package, and *not* as part of that of `python-numpy`. This is because this

environment variable "belongs" to Python, not NumPy: Python actually reads the value of that variable and honors it.

Corollary: if you create a profile that does not contain `python`, `GUIX_PYTHONPATH` will *not* be defined, even if it contains packages that provide `.py` files:

```
$ guix shell python-numpy --search-paths --pure
export PATH="/gnu/store/...-profile/bin"
```

This makes a lot of sense if we look at this profile in isolation: no software in this profile would read `GUIX_PYTHONPATH`.

Of course, there are many variations on that theme: some packages honor more than one search path, some use separators other than colon, some accumulate several directories in their search path, and so on. A more complex example is the search path of libxml2: the value of the `XML_CATALOG_FILES` environment variable is space-separated, it must contain a list of `catalog.xml` files (not directories), which are to be found in `xml` sub-directories—nothing less. The search path specification looks like this:

```
(package
  (name "libxml2")
  ;; some fields omitted
  (native-search-paths
   (list (search-path-specification
          (variable "XML_CATALOG_FILES")
          (separator " ")
          (files '("xml"))
          (file-pattern "^catalog\\.xml$")
          (file-type 'regular)))))
```

Worry not, search path specifications are usually not this tricky.

The `(guix search-paths)` module defines the data type of search path specifications and a number of helper procedures. Below is the reference of search path specifications.

`search-path-specification` [Data Type]

The data type for search path specifications.

`variable` The name of the environment variable for this search path (a string).

`files` The list of sub-directories (strings) that should be added to the search path.

`separator` (default: `":"`)

The string used to separate search path components.

As a special case, a `separator` value of `#f` specifies a "single-component search path"—in other words, a search path that cannot contain more than one element. This is useful in some cases, such as the `SSL_CERT_DIR` variable (honored by OpenSSL, cURL, and a few other packages) or the `ASPELL_DICT_DIR` variable (honored by the GNU Aspell spell checker), both of which must point to a single directory.

`file-type` (default: `'directory`)
: The type of file being matched—`'directory` or `'regular`, though it can be any symbol returned by `stat:type` (see Section “File System” in *GNU Guile Reference Manual*).

  In the libxml2 example above, we would match regular files; in the Python example, we would match directories.

`file-pattern` (default: `#f`)
: This must be either `#f` or a regular expression specifying files to be matched *within* the sub-directories specified by the `files` field.

  Again, the libxml2 example shows a situation where this is needed.

Some search paths are not tied by a single package but to many packages. To reduce duplications, some of them are pre-defined in `(guix search-paths)`.

`$SSL_CERT_DIR` [Scheme Variable]
`$SSL_CERT_FILE` [Scheme Variable]
: These two search paths indicate where X.509 certificates can be found (see Section 12.11 [X.509 Certificates], page 535).

These pre-defined search paths can be used as in the following example:

```
(package
  (name "curl")
  ;; some fields omitted ...
  (native-search-paths (list $SSL_CERT_DIR $SSL_CERT_FILE)))
```

How do you turn search path specifications on one hand and a bunch of directories on the other hand in a set of environment variable definitions? That’s the job of `evaluate-search-paths`.

`evaluate-search-paths` *search-paths directories* [Scheme Procedure]
[*getenv*]
: Evaluate *search-paths*, a list of search-path specifications, for *directories*, a list of directory names, and return a list of specification/value pairs. Use *getenv* to determine the current settings and report only settings not already effective.

The `(guix profiles)` provides a higher-level helper procedure, `load-profile`, that sets the environment variables of a profile.

9.9 The Store

Conceptually, the *store* is the place where derivations that have been built successfully are stored—by default, `/gnu/store`. Sub-directories in the store are referred to as *store items* or sometimes *store paths*. The store has an associated database that contains information such as the store paths referred to by each store path, and the list of *valid* store items—results of successful builds. This database resides in *`localstatedir`*`/guix/db`, where *localstatedir* is the state directory specified *via* `--localstatedir` at configure time, usually `/var`.

The store is *always* accessed by the daemon on behalf of its clients (see Section 2.5 [Invoking guix-daemon], page 15). To manipulate the store, clients connect to the daemon over a Unix-domain socket, send requests to it, and read the result—these are remote procedure calls, or RPCs.

> **Note:** Users must *never* modify files under `/gnu/store` directly. This would lead to inconsistencies and break the immutability assumptions of Guix's functional model (see Chapter 1 [Introduction], page 1).
>
> See Section 6.5 [Invoking guix gc], page 53, for information on how to check the integrity of the store and attempt recovery from accidental modifications.

The `(guix store)` module provides procedures to connect to the daemon, and to perform RPCs. These are described below. By default, `open-connection`, and thus all the `guix` commands, connect to the local daemon or to the URI specified by the `GUIX_DAEMON_SOCKET` environment variable.

`GUIX_DAEMON_SOCKET` [Environment Variable]

When set, the value of this variable should be a file name or a URI designating the daemon endpoint. When it is a file name, it denotes a Unix-domain socket to connect to. In addition to file names, the supported URI schemes are:

`file`
`unix`
: These are for Unix-domain sockets. `file:///var/guix/daemon-socket/socket` is equivalent to `/var/guix/daemon-socket/socket`.

`guix`
: These URIs denote connections over TCP/IP, without encryption nor authentication of the remote host. The URI must specify the host name and optionally a port number (by default port 44146 is used):

```
guix://master.guix.example.org:1234
```

This setup is suitable on local networks, such as clusters, where only trusted nodes may connect to the build daemon at `master.guix.example.org`.

The `--listen` option of `guix-daemon` can be used to instruct it to listen for TCP connections (see Section 2.5 [Invoking guix-daemon], page 15).

`ssh`
: These URIs allow you to connect to a remote daemon over SSH. This feature requires Guile-SSH (see Section 2.2 [Requirements], page 7) and a working `guile` binary in `PATH` on the destination machine. It supports public key and GSSAPI authentication. A typical URL might look like this:

```
ssh://charlie@guix.example.org:22
```

As for `guix copy`, the usual OpenSSH client configuration files are honored (see Section 10.13 [Invoking guix copy], page 212).

Additional URI schemes may be supported in the future.

> **Note:** The ability to connect to remote build daemons is considered experimental as of 1.4.0. Please get in touch with us to share any problems or suggestions you may have (see Chapter 22 [Contributing], page 625).

`open-connection` [*uri*] [*#:reserve-space? #t*] [Scheme Procedure]

Connect to the daemon over the Unix-domain socket at *uri* (a string). When *reserve-space?* is true, instruct it to reserve a little bit of extra space on the file system so that the garbage collector can still operate should the disk become full. Return a server object.

file defaults to `%default-socket-path`, which is the normal location given the options that were passed to `configure`.

`close-connection` *server* [Scheme Procedure]
Close the connection to *server*.

`current-build-output-port` [Scheme Variable]
This variable is bound to a SRFI-39 parameter, which refers to the port where build and error logs sent by the daemon should be written.

Procedures that make RPCs all take a server object as their first argument.

`valid-path?` *server path* [Scheme Procedure]
Return `#t` when *path* designates a valid store item and `#f` otherwise (an invalid item may exist on disk but still be invalid, for instance because it is the result of an aborted or failed build).

A `&store-protocol-error` condition is raised if *path* is not prefixed by the store directory (`/gnu/store`).

`add-text-to-store` *server name text* [*references*] [Scheme Procedure]
Add *text* under file *name* in the store, and return its store path. *references* is the list of store paths referred to by the resulting store path.

`build-derivations` *store derivations* [*mode*] [Scheme Procedure]
Build *derivations*, a list of `<derivation>` objects, `.drv` file names, or derivation/output pairs, using the specified *mode*—`(build-mode normal)` by default.

Note that the `(guix monads)` module provides a monad as well as monadic versions of the above procedures, with the goal of making it more convenient to work with code that accesses the store (see Section 9.11 [The Store Monad], page 149).

This section is currently incomplete.

9.10 Derivations

Low-level build actions and the environment in which they are performed are represented by *derivations*. A derivation contains the following pieces of information:

- The outputs of the derivation—derivations produce at least one file or directory in the store, but may produce more.
- The inputs of the derivations—i.e., its build-time dependencies—which may be other derivations or plain files in the store (patches, build scripts, etc.).
- The system type targeted by the derivation—e.g., `x86_64-linux`.
- The file name of a build script in the store, along with the arguments to be passed.
- A list of environment variables to be defined.

Derivations allow clients of the daemon to communicate build actions to the store. They exist in two forms: as an in-memory representation, both on the client- and daemon-side, and as files in the store whose name end in `.drv`—these files are referred to as *derivation paths*. Derivations paths can be passed to the `build-derivations` procedure to perform the build actions they prescribe (see Section 9.9 [The Store], page 144).

Operations such as file downloads and version-control checkouts for which the expected content hash is known in advance are modeled as *fixed-output derivations*. Unlike regular derivations, the outputs of a fixed-output derivation are independent of its inputs—e.g., a source code download produces the same result regardless of the download method and tools being used.

The outputs of derivations—i.e., the build results—have a set of *references*, as reported by the `references` RPC or the `guix gc --references` command (see Section 6.5 [Invoking guix gc], page 53). References are the set of run-time dependencies of the build results. References are a subset of the inputs of the derivation; this subset is automatically computed by the build daemon by scanning all the files in the outputs.

The `(guix derivations)` module provides a representation of derivations as Scheme objects, along with procedures to create and otherwise manipulate derivations. The lowest-level primitive to create a derivation is the `derivation` procedure:

`derivation` *store name builder args* [*#:outputs '("out")*] [*#:hash #f*] [*#:hash-algo #f*] [*#:recursive? #f*] [*#:inputs '()*] [*#:env-vars '()*] [*#:system (%current-system)*] [*#:references-graphs #f*] [*#:allowed-references #f*] [*#:disallowed-references #f*] [*#:leaked-env-vars #f*] [*#:local-build? #f*] [*#:substitutable? #t*] [*#:properties '()*] [Scheme Procedure]

Build a derivation with the given arguments, and return the resulting `<derivation>` object.

When *hash* and *hash-algo* are given, a *fixed-output derivation* is created—i.e., one whose result is known in advance, such as a file download. If, in addition, *recursive?* is true, then that fixed output may be an executable file or a directory and *hash* must be the hash of an archive containing this output.

When *references-graphs* is true, it must be a list of file name/store path pairs. In that case, the reference graph of each store path is exported in the build environment in the corresponding file, in a simple text format.

When *allowed-references* is true, it must be a list of store items or outputs that the derivation's output may refer to. Likewise, *disallowed-references*, if true, must be a list of things the outputs may *not* refer to.

When *leaked-env-vars* is true, it must be a list of strings denoting environment variables that are allowed to "leak" from the daemon's environment to the build environment. This is only applicable to fixed-output derivations—i.e., when *hash* is true. The main use is to allow variables such as `http_proxy` to be passed to derivations that download files.

When *local-build?* is true, declare that the derivation is not a good candidate for offloading and should rather be built locally (see Section 2.4.2 [Daemon Offload Setup], page 11). This is the case for small derivations where the costs of data transfers would outweigh the benefits.

When *substitutable?* is false, declare that substitutes of the derivation's output should not be used (see Section 6.3 [Substitutes], page 48). This is useful, for instance, when building packages that capture details of the host CPU instruction set.

properties must be an association list describing "properties" of the derivation. It is kept as-is, uninterpreted, in the derivation.

Here's an example with a shell script as its builder, assuming *store* is an open connection to the daemon, and *bash* points to a Bash executable in the store:

```
(use-modules (guix utils)
             (guix store)
             (guix derivations))

(let ((builder   ; add the Bash script to the store
        (add-text-to-store store "my-builder.sh"
                           "echo hello world > $out\n" '())))
  (derivation store "foo"
              bash `("-e" ,builder)
              #:inputs `((,bash) (,builder))
              #:env-vars '(("HOME" . "/homeless"))))
⇒ #<derivation /gnu/store/...-foo.drv => /gnu/store/...-foo>
```

As can be guessed, this primitive is cumbersome to use directly. A better approach is to write build scripts in Scheme, of course! The best course of action for that is to write the build code as a "G-expression", and to pass it to `gexp->derivation`. For more information, see Section 9.12 [G-Expressions], page 154.

Once upon a time, `gexp->derivation` did not exist and constructing derivations with build code written in Scheme was achieved with `build-expression->derivation`, documented below. This procedure is now deprecated in favor of the much nicer `gexp->derivation`.

`build-expression->derivation` *store name exp* [*#:system (%current-system)*] [*#:inputs '()*] [*#:outputs '("out")*] [*#:hash #f*] [*#:hash-algo #f*] [*#:recursive? #f*] [*#:env-vars '()*] [*#:modules '()*] [*#:references-graphs #f*] [*#:allowed-references #f*] [*#:disallowed-references #f*] [*#:local-build? #f*] [*#:substitutable? #t*] [*#:guile-for-build #f*] [Scheme Procedure]

Return a derivation that executes Scheme expression *exp* as a builder for derivation *name*. *inputs* must be a list of `(name drv-path sub-drv)` tuples; when *sub-drv* is omitted, `"out"` is assumed. *modules* is a list of names of Guile modules from the current search path to be copied in the store, compiled, and made available in the load path during the execution of *exp*—e.g., `((guix build utils) (guix build gnu-build-system))`.

exp is evaluated in an environment where `%outputs` is bound to a list of output/path pairs, and where `%build-inputs` is bound to a list of string/output-path pairs made from *inputs*. Optionally, *env-vars* is a list of string pairs specifying the name and value of environment variables visible to the builder. The builder terminates by passing the result of *exp* to `exit`; thus, when *exp* returns `#f`, the build is considered to have failed.

exp is built using *guile-for-build* (a derivation). When *guile-for-build* is omitted or is `#f`, the value of the `%guile-for-build` fluid is used instead.

See the `derivation` procedure for the meaning of *references-graphs*, *allowed-references*, *disallowed-references*, *local-build?*, and *substitutable?*.

Here's an example of a single-output derivation that creates a directory containing one file:

```
(let ((builder '(let ((out (assoc-ref %outputs "out")))
                  (mkdir out)    ; create /gnu/store/...-goo
                  (call-with-output-file (string-append out "/test")
                    (lambda (p)
                      (display '(hello guix) p))))))
  (build-expression->derivation store "goo" builder))

⇒ #<derivation /gnu/store/...-goo.drv => ...>
```

9.11 The Store Monad

The procedures that operate on the store described in the previous sections all take an open connection to the build daemon as their first argument. Although the underlying model is functional, they either have side effects or depend on the current state of the store.

The former is inconvenient: the connection to the build daemon has to be carried around in all those functions, making it impossible to compose functions that do not take that parameter with functions that do. The latter can be problematic: since store operations have side effects and/or depend on external state, they have to be properly sequenced.

This is where the `(guix monads)` module comes in. This module provides a framework for working with *monads*, and a particularly useful monad for our uses, the *store monad*. Monads are a construct that allows two things: associating "context" with values (in our case, the context is the store), and building sequences of computations (here computations include accesses to the store). Values in a monad—values that carry this additional context—are called *monadic values*; procedures that return such values are called *monadic procedures*.

Consider this "normal" procedure:

```
(define (sh-symlink store)
  ;; Return a derivation that symlinks the 'bash' executable.
  (let* ((drv (package-derivation store bash))
         (out (derivation->output-path drv))
         (sh  (string-append out "/bin/bash")))
    (build-expression->derivation store "sh"
                                  `(symlink ,sh %output))))
```

Using `(guix monads)` and `(guix gexp)`, it may be rewritten as a monadic function:

```
(define (sh-symlink)
  ;; Same, but return a monadic value.
  (mlet %store-monad ((drv (package->derivation bash)))
    (gexp->derivation "sh"
                      #~(symlink (string-append #$drv "/bin/bash")
                                 #$output))))
```

There are several things to note in the second version: the `store` parameter is now implicit and is "threaded" in the calls to the `package->derivation` and `gexp->derivation` monadic procedures, and the monadic value returned by `package->derivation` is *bound* using `mlet` instead of plain `let`.

As it turns out, the call to `package->derivation` can even be omitted since it will take place implicitly, as we will see later (see Section 9.12 [G-Expressions], page 154):

```
(define (sh-symlink)
  (gexp->derivation "sh"
                    #~(symlink (string-append #$bash "/bin/bash")
                               #$output)))
```

Calling the monadic `sh-symlink` has no effect. As someone once said, "you exit a monad like you exit a building on fire: by running". So, to exit the monad and get the desired effect, one must use `run-with-store`:

```
(run-with-store (open-connection) (sh-symlink))
⇒ /gnu/store/...-sh-symlink
```

Note that the `(guix monad-repl)` module extends the Guile REPL with new "commands" to make it easier to deal with monadic procedures: `run-in-store`, and `enter-store-monad` (see Section 9.14 [Using Guix Interactively], page 164). The former is used to "run" a single monadic value through the store:

```
scheme@(guile-user)> ,run-in-store (package->derivation hello)
$1 = #<derivation /gnu/store/...-hello-2.9.drv => ...>
```

The latter enters a recursive REPL, where all the return values are automatically run through the store:

```
scheme@(guile-user)> ,enter-store-monad
store-monad@(guile-user) [1]> (package->derivation hello)
$2 = #<derivation /gnu/store/...-hello-2.9.drv => ...>
store-monad@(guile-user) [1]> (text-file "foo" "Hello!")
$3 = "/gnu/store/...-foo"
store-monad@(guile-user) [1]> ,q
scheme@(guile-user)>
```

Note that non-monadic values cannot be returned in the `store-monad` REPL.

Other meta-commands are available at the REPL, such as `,build` to build a file-like object (see Section 9.14 [Using Guix Interactively], page 164).

The main syntactic forms to deal with monads in general are provided by the `(guix monads)` module and are described below.

`with-monad` *monad body* ... [Scheme Syntax]

Evaluate any `>>=` or `return` forms in *body* as being in *monad*.

`return` *val* [Scheme Syntax]

Return a monadic value that encapsulates *val*.

`>>=` *mval mproc ...* [Scheme Syntax]

Bind monadic value *mval*, passing its “contents” to monadic procedures *mproc*...[4]. There can be one *mproc* or several of them, as in this example:

```
(run-with-state
    (with-monad %state-monad
      (>>= (return 1)
           (lambda (x) (return (+ 1 x)))
           (lambda (x) (return (* 2 x)))))
  'some-state)

⇒ 4
⇒ some-state
```

`mlet` *monad ((var mval) ...) body ...* [Scheme Syntax]
`mlet*` *monad ((var mval) ...) body ...* [Scheme Syntax]

Bind the variables *var* to the monadic values *mval* in *body*, which is a sequence of expressions. As with the bind operator, this can be thought of as “unpacking” the raw, non-monadic value “contained” in *mval* and making *var* refer to that raw, non-monadic value within the scope of the *body*. The form (*var* `->` *val*) binds *var* to the “normal” value *val*, as per `let`. The binding operations occur in sequence from left to right. The last expression of *body* must be a monadic expression, and its result will become the result of the `mlet` or `mlet*` when run in the *monad*.

`mlet*` is to `mlet` what `let*` is to `let` (see Section “Local Bindings” in *GNU Guile Reference Manual*).

`mbegin` *monad mexp ...* [Scheme System]

Bind *mexp* and the following monadic expressions in sequence, returning the result of the last expression. Every expression in the sequence must be a monadic expression.

This is akin to `mlet`, except that the return values of the monadic expressions are ignored. In that sense, it is analogous to `begin`, but applied to monadic expressions.

`mwhen` *condition mexp0 mexp* ...* [Scheme System]

When *condition* is true, evaluate the sequence of monadic expressions *mexp0..mexp** as in an `mbegin`. When *condition* is false, return `*unspecified*` in the current monad. Every expression in the sequence must be a monadic expression.

`munless` *condition mexp0 mexp* ...* [Scheme System]

When *condition* is false, evaluate the sequence of monadic expressions *mexp0..mexp** as in an `mbegin`. When *condition* is true, return `*unspecified*` in the current monad. Every expression in the sequence must be a monadic expression.

The `(guix monads)` module provides the *state monad*, which allows an additional value—the state—to be *threaded* through monadic procedure calls.

[4] This operation is commonly referred to as “bind”, but that name denotes an unrelated procedure in Guile. Thus we use this somewhat cryptic symbol inherited from the Haskell language.

`%state-monad` [Scheme Variable]

The state monad. Procedures in the state monad can access and change the state that is threaded.

Consider the example below. The `square` procedure returns a value in the state monad. It returns the square of its argument, but also increments the current state value:

```
(define (square x)
  (mlet %state-monad ((count (current-state)))
    (mbegin %state-monad
      (set-current-state (+ 1 count))
      (return (* x x)))))

(run-with-state (sequence %state-monad (map square (iota 3))) 0)
⇒ (0 1 4)
⇒ 3
```

When "run" through `%state-monad`, we obtain that additional state value, which is the number of `square` calls.

`current-state` [Monadic Procedure]

Return the current state as a monadic value.

`set-current-state` *value* [Monadic Procedure]

Set the current state to *value* and return the previous state as a monadic value.

`state-push` *value* [Monadic Procedure]

Push *value* to the current state, which is assumed to be a list, and return the previous state as a monadic value.

`state-pop` [Monadic Procedure]

Pop a value from the current state and return it as a monadic value. The state is assumed to be a list.

`run-with-state` *mval* [*state*] [Scheme Procedure]

Run monadic value *mval* starting with *state* as the initial state. Return two values: the resulting value, and the resulting state.

The main interface to the store monad, provided by the `(guix store)` module, is as follows.

`%store-monad` [Scheme Variable]

The store monad—an alias for `%state-monad`.

Values in the store monad encapsulate accesses to the store. When its effect is needed, a value of the store monad must be "evaluated" by passing it to the `run-with-store` procedure (see below).

`run-with-store` *store mval* [*#:guile-for-build*] [*#:system (%current-system)*] [Scheme Procedure]

Run *mval*, a monadic value in the store monad, in *store*, an open store connection.

`text-file` *name text* [*references*] [Monadic Procedure]

Return as a monadic value the absolute file name in the store of the file containing *text*, a string. *references* is a list of store items that the resulting text file refers to; it defaults to the empty list.

`binary-file` *name data* [*references*] [Monadic Procedure]

Return as a monadic value the absolute file name in the store of the file containing *data*, a bytevector. *references* is a list of store items that the resulting binary file refers to; it defaults to the empty list.

`interned-file` *file* [*name*] [*#:recursive? #t*] [*#:select? (const #t)*] [Monadic Procedure]

Return the name of *file* once interned in the store. Use *name* as its store name, or the basename of *file* if *name* is omitted.

When *recursive?* is true, the contents of *file* are added recursively; if *file* designates a flat file and *recursive?* is true, its contents are added, and its permission bits are kept.

When *recursive?* is true, call `(`*select? file stat*`)` for each directory entry, where *file* is the entry's absolute file name and *stat* is the result of `lstat`; exclude entries for which *select?* does not return true.

The example below adds a file to the store, under two different names:

```
(run-with-store (open-connection)
  (mlet %store-monad ((a (interned-file "README"))
                      (b (interned-file "README" "LEGU-MIN")))
    (return (list a b))))

⇒ ("/gnu/store/rwm...-README" "/gnu/store/44i...-LEGU-MIN")
```

The `(guix packages)` module exports the following package-related monadic procedures:

`package-file` *package* [*file*] [*#:system (%current-system)*] [*#:target #f*] [*#:output "out"*] [Monadic Procedure]

Return as a monadic value in the absolute file name of *file* within the *output* directory of *package*. When *file* is omitted, return the name of the *output* directory of *package*. When *target* is true, use it as a cross-compilation target triplet.

Note that this procedure does *not* build *package*. Thus, the result might or might not designate an existing file. We recommend not using this procedure unless you know what you are doing.

`package->derivation` *package* [*system*] [Monadic Procedure]
`package->cross-derivation` *package target* [*system*] [Monadic Procedure]

Monadic version of `package-derivation` and `package-cross-derivation` (see Section 9.2 [Defining Packages], page 96).

9.12 G-Expressions

So we have "derivations", which represent a sequence of build actions to be performed to produce an item in the store (see Section 9.10 [Derivations], page 146). These build actions are performed when asking the daemon to actually build the derivations; they are run by the daemon in a container (see Section 2.5 [Invoking guix-daemon], page 15).

It should come as no surprise that we like to write these build actions in Scheme. When we do that, we end up with two *strata* of Scheme code[5]: the "host code"—code that defines packages, talks to the daemon, etc.—and the "build code"—code that actually performs build actions, such as making directories, invoking `make`, and so on (see Section 9.6 [Build Phases], page 131).

To describe a derivation and its build actions, one typically needs to embed build code inside host code. It boils down to manipulating build code as data, and the homoiconicity of Scheme—code has a direct representation as data—comes in handy for that. But we need more than the normal `quasiquote` mechanism in Scheme to construct build expressions.

The `(guix gexp)` module implements *G-expressions*, a form of S-expressions adapted to build expressions. G-expressions, or *gexps*, consist essentially of three syntactic forms: `gexp`, `ungexp`, and `ungexp-splicing` (or simply: `#~`, `#$`, and `#$@`), which are comparable to `quasiquote`, `unquote`, and `unquote-splicing`, respectively (see Section "Expression Syntax" in *GNU Guile Reference Manual*). However, there are major differences:

- Gexps are meant to be written to a file and run or manipulated by other processes.
- When a high-level object such as a package or derivation is unquoted inside a gexp, the result is as if its output file name had been introduced.
- Gexps carry information about the packages or derivations they refer to, and these dependencies are automatically added as inputs to the build processes that use them.

This mechanism is not limited to package and derivation objects: *compilers* able to "lower" other high-level objects to derivations or files in the store can be defined, such that these objects can also be inserted into gexps. For example, a useful type of high-level objects that can be inserted in a gexp is "file-like objects", which make it easy to add files to the store and to refer to them in derivations and such (see `local-file` and `plain-file` below).

To illustrate the idea, here is an example of a gexp:

```
(define build-exp
  #~(begin
      (mkdir #$output)
      (chdir #$output)
      (symlink (string-append #$coreutils "/bin/ls")
               "list-files")))
```

This gexp can be passed to `gexp->derivation`; we obtain a derivation that builds a directory containing exactly one symlink to `/gnu/store/...-coreutils-8.22/bin/ls`:

```
(gexp->derivation "the-thing" build-exp)
```

[5] The term *stratum* in this context was coined by Manuel Serrano et al. in the context of their work on Hop. Oleg Kiselyov, who has written insightful essays and code on this topic (`http://okmij.org/ftp/meta-programming/#meta-scheme`), refers to this kind of code generation as *staging*.

As one would expect, the `"/gnu/store/...-coreutils-8.22"` string is substituted to the reference to the *coreutils* package in the actual build code, and *coreutils* is automatically made an input to the derivation. Likewise, `#$output` (equivalent to `(ungexp output)`) is replaced by a string containing the directory name of the output of the derivation.

In a cross-compilation context, it is useful to distinguish between references to the *native* build of a package—that can run on the host—versus references to cross builds of a package. To that end, the `#+` plays the same role as `#$`, but is a reference to a native package build:

```
(gexp->derivation "vi"
   #~(begin
       (mkdir #$output)
       (mkdir (string-append #$output "/bin"))
       (system* (string-append #+coreutils "/bin/ln")
                "-s"
                (string-append #$emacs "/bin/emacs")
                (string-append #$output "/bin/vi")))
   #:target "aarch64-linux-gnu")
```

In the example above, the native build of *coreutils* is used, so that `ln` can actually run on the host; but then the cross-compiled build of *emacs* is referenced.

Another gexp feature is *imported modules*: sometimes you want to be able to use certain Guile modules from the "host environment" in the gexp, so those modules should be imported in the "build environment". The `with-imported-modules` form allows you to express that:

```
(let ((build (with-imported-modules '((guix build utils))
               #~(begin
                   (use-modules (guix build utils))
                   (mkdir-p (string-append #$output "/bin"))))))
  (gexp->derivation "empty-dir"
                    #~(begin
                        #$build
                        (display "success!\n")
                        #t)))
```

In this example, the `(guix build utils)` module is automatically pulled into the isolated build environment of our gexp, such that `(use-modules (guix build utils))` works as expected.

Usually you want the *closure* of the module to be imported—i.e., the module itself and all the modules it depends on—rather than just the module; failing to do that, attempts to use the module will fail because of missing dependent modules. The `source-module-closure` procedure computes the closure of a module by looking at its source file headers, which comes in handy in this case:

```
(use-modules (guix modules))   ;for 'source-module-closure'

(with-imported-modules (source-module-closure
                         '((guix build utils)
                           (gnu build image)))
  (gexp->derivation "something-with-vms"
                    #~(begin
                        (use-modules (guix build utils)
                                     (gnu build image))
                        ...)))
```

In the same vein, sometimes you want to import not just pure-Scheme modules, but also "extensions" such as Guile bindings to C libraries or other "full-blown" packages. Say you need the `guile-json` package available on the build side, here's how you would do it:

```
(use-modules (gnu packages guile))  ;for 'guile-json'

(with-extensions (list guile-json)
  (gexp->derivation "something-with-json"
                    #~(begin
                        (use-modules (json))
                        ...)))
```

The syntactic form to construct gexps is summarized below.

`#~exp` [Scheme Syntax]
`(gexp exp)` [Scheme Syntax]

Return a G-expression containing *exp*. *exp* may contain one or more of the following forms:

`#$obj`
`(ungexp obj)`
: Introduce a reference to *obj*. *obj* may have one of the supported types, for example a package or a derivation, in which case the `ungexp` form is replaced by its output file name—e.g., `"/gnu/store/...-coreutils-8.22`.

  If *obj* is a list, it is traversed and references to supported objects are substituted similarly.

  If *obj* is another gexp, its contents are inserted and its dependencies are added to those of the containing gexp.

  If *obj* is another kind of object, it is inserted as is.

`#$obj:output`
`(ungexp obj output)`
: This is like the form above, but referring explicitly to the *output* of *obj*—this is useful when *obj* produces multiple outputs (see Section 6.4 [Packages with Multiple Outputs], page 53).

`#+obj`
`#+obj:output`
`(ungexp-native obj)`
`(ungexp-native obj output)`
: Same as `ungexp`, but produces a reference to the *native* build of *obj* when used in a cross compilation context.

`#$output[:`*`output`*`]`
`(ungexp output [`*`output`*`])`
: Insert a reference to derivation output *output*, or to the main output when *output* is omitted.

  This only makes sense for gexps passed to `gexp->derivation`.

`#$@`*`lst`*
`(ungexp-splicing `*`lst`*`)`
: Like the above, but splices the contents of *lst* inside the containing list.

`#+@`*`lst`*
`(ungexp-native-splicing `*`lst`*`)`
: Like the above, but refers to native builds of the objects listed in *lst*.

G-expressions created by `gexp` or `#~` are run-time objects of the `gexp?` type (see below).

`with-imported-modules` *`modules body...`* [Scheme Syntax]

Mark the gexps defined in *body*... as requiring *modules* in their execution environment.

Each item in *modules* can be the name of a module, such as `(guix build utils)`, or it can be a module name, followed by an arrow, followed by a file-like object:

```
`((guix build utils)
  (guix gcrypt)
  ((guix config) => ,(scheme-file "config.scm"
                                  #~(define-module ...))))
```

In the example above, the first two modules are taken from the search path, and the last one is created from the given file-like object.

This form has *lexical* scope: it has an effect on the gexps directly defined in *body*..., but not on those defined, say, in procedures called from *body*....

`with-extensions` *`extensions body...`* [Scheme Syntax]

Mark the gexps defined in *body*... as requiring *extensions* in their build and execution environment. *extensions* is typically a list of package objects such as those defined in the `(gnu packages guile)` module.

Concretely, the packages listed in *extensions* are added to the load path while compiling imported modules in *body*...; they are also added to the load path of the gexp returned by *body*....

`gexp?` *`obj`* [Scheme Procedure]

Return `#t` if *obj* is a G-expression.

G-expressions are meant to be written to disk, either as code building some derivation, or as plain files in the store. The monadic procedures below allow you to do that (see Section 9.11 [The Store Monad], page 149, for more information about monads).

`gexp->derivation` *name exp* [*#:system* (*%current-system*)] [*#:target #f*] [*#:graft? #t*] [*#:hash #f*] [*#:hash-algo #f*] [*#:recursive? #f*] [*#:env-vars* '()] [*#:modules* '()] [*#:module-path* `%load-path`] [*#:effective-version* "*2.2*"] [*#:references-graphs #f*] [*#:allowed-references #f*] [*#:disallowed-references #f*] [*#:leaked-env-vars #f*] [*#:script-name* (*string-append* `name` "*-builder*")] [*#:deprecation-warnings #f*] [*#:local-build? #f*] [*#:substitutable? #t*] [*#:properties* '()] [*#:guile-for-build #f*] [Monadic Procedure]

Return a derivation *name* that runs *exp* (a gexp) with *guile-for-build* (a derivation) on *system*; *exp* is stored in a file called *script-name*. When *target* is true, it is used as the cross-compilation target triplet for packages referred to by *exp*.

modules is deprecated in favor of `with-imported-modules`. Its meaning is to make *modules* available in the evaluation context of *exp*; *modules* is a list of names of Guile modules searched in *module-path* to be copied in the store, compiled, and made available in the load path during the execution of *exp*—e.g., `((guix build utils) (guix build gnu-build-system))`.

effective-version determines the string to use when adding extensions of *exp* (see `with-extensions`) to the search path—e.g., `"2.2"`.

graft? determines whether packages referred to by *exp* should be grafted when applicable.

When *references-graphs* is true, it must be a list of tuples of one of the following forms:

```
(file-name package)
(file-name package output)
(file-name derivation)
(file-name derivation output)
(file-name store-item)
```

The right-hand-side of each element of *references-graphs* is automatically made an input of the build process of *exp*. In the build environment, each *file-name* contains the reference graph of the corresponding item, in a simple text format.

allowed-references must be either `#f` or a list of output names and packages. In the latter case, the list denotes store items that the result is allowed to refer to. Any reference to another store item will lead to a build error. Similarly for *disallowed-references*, which can list items that must not be referenced by the outputs.

deprecation-warnings determines whether to show deprecation warnings while compiling modules. It can be `#f`, `#t`, or `'detailed`.

The other arguments are as for `derivation` (see Section 9.10 [Derivations], page 146).

The `local-file`, `plain-file`, `computed-file`, `program-file`, and `scheme-file` procedures below return *file-like objects*. That is, when unquoted in a G-expression, these objects lead to a file in the store. Consider this G-expression:

```
#~(system* #$(file-append glibc "/sbin/nscd") "-f"
           #$(local-file "/tmp/my-nscd.conf"))
```

The effect here is to "intern" `/tmp/my-nscd.conf` by copying it to the store. Once expanded, for instance *via* `gexp->derivation`, the G-expression refers to that copy under

`/gnu/store`; thus, modifying or removing the file in `/tmp` does not have any effect on what the G-expression does. `plain-file` can be used similarly; it differs in that the file content is directly passed as a string.

`local-file` ***file*** [*name*] [*#:recursive? #f*] [*#:select? (const #t)*] [Scheme Procedure]

Return an object representing local file *file* to add to the store; this object can be used in a gexp. If *file* is a literal string denoting a relative file name, it is looked up relative to the source file where it appears; if *file* is not a literal string, it is looked up relative to the current working directory at run time. *file* will be added to the store under *name*–by default the base name of *file*.

When *recursive?* is true, the contents of *file* are added recursively; if *file* designates a flat file and *recursive?* is true, its contents are added, and its permission bits are kept.

When *recursive?* is true, call `(select? file stat)` for each directory entry, where *file* is the entry's absolute file name and *stat* is the result of `lstat`; exclude entries for which *select?* does not return true.

This is the declarative counterpart of the `interned-file` monadic procedure (see Section 9.11 [The Store Monad], page 149).

`plain-file` ***name content*** [Scheme Procedure]

Return an object representing a text file called *name* with the given *content* (a string or a bytevector) to be added to the store.

This is the declarative counterpart of `text-file`.

`computed-file` ***name gexp*** [*#:local-build? #t*] [*#:options '()*] [Scheme Procedure]

Return an object representing the store item *name*, a file or directory computed by *gexp*. When *local-build?* is true (the default), the derivation is built locally. *options* is a list of additional arguments to pass to `gexp->derivation`.

This is the declarative counterpart of `gexp->derivation`.

`gexp->script` ***name exp*** [*#:guile (default-guile)*] [*#:module-path %load-path*] [*#:system (%current-system)*] [*#:target #f*] [Monadic Procedure]

Return an executable script *name* that runs *exp* using *guile*, with *exp*'s imported modules in its search path. Look up *exp*'s modules in *module-path*.

The example below builds a script that simply invokes the `ls` command:

```
(use-modules (guix gexp) (gnu packages base))

(gexp->script "list-files"
              #~(execl #$(file-append coreutils "/bin/ls")
                       "ls"))
```

When "running" it through the store (see Section 9.11 [The Store Monad], page 149), we obtain a derivation that produces an executable file `/gnu/store/...-list-files` along these lines:

```
#!/gnu/store/...-guile-2.0.11/bin/guile -ds
!#
(execl "/gnu/store/...-coreutils-8.22"/bin/ls" "ls")
```

`program-file` *name exp* [*#:guile #f*] [*#:module-path %load-path*] [Scheme Procedure]

Return an object representing the executable store item *name* that runs *gexp*. *guile* is the Guile package used to execute that script. Imported modules of *gexp* are looked up in *module-path*.

This is the declarative counterpart of `gexp->script`.

`gexp->file` *name exp* [*#:set-load-path? #t*] [*#:module-path %load-path*] [*#:splice? #f*] [*#:guile (default-guile)*] [Monadic Procedure]

Return a derivation that builds a file *name* containing *exp*. When *splice?* is true, *exp* is considered to be a list of expressions that will be spliced in the resulting file.

When *set-load-path?* is true, emit code in the resulting file to set `%load-path` and `%load-compiled-path` to honor *exp*'s imported modules. Look up *exp*'s modules in *module-path*.

The resulting file holds references to all the dependencies of *exp* or a subset thereof.

`scheme-file` *name exp* [*#:splice? #f*] [*#:set-load-path? #t*] [Scheme Procedure]

Return an object representing the Scheme file *name* that contains *exp*.

This is the declarative counterpart of `gexp->file`.

`text-file*` *name text ...* [Monadic Procedure]

Return as a monadic value a derivation that builds a text file containing all of *text*. *text* may list, in addition to strings, objects of any type that can be used in a gexp: packages, derivations, local file objects, etc. The resulting store file holds references to all these.

This variant should be preferred over `text-file` anytime the file to create will reference items from the store. This is typically the case when building a configuration file that embeds store file names, like this:

```
(define (profile.sh)
  ;; Return the name of a shell script in the store that
  ;; initializes the 'PATH' environment variable.
  (text-file* "profile.sh"
              "export PATH=" coreutils "/bin:"
              grep "/bin:" sed "/bin\n"))
```

In this example, the resulting `/gnu/store/...-profile.sh` file will reference *coreutils*, *grep*, and *sed*, thereby preventing them from being garbage-collected during its lifetime.

`mixed-text-file` *name text ...* [Scheme Procedure]

Return an object representing store file *name* containing *text*. *text* is a sequence of strings and file-like objects, as in:

```
(mixed-text-file "profile"
                 "export PATH=" coreutils "/bin:" grep "/bin")
```

This is the declarative counterpart of `text-file*`.

`file-union` *name files* [Scheme Procedure]

Return a `<computed-file>` that builds a directory containing all of *files*. Each item in *files* must be a two-element list where the first element is the file name to use in the new directory, and the second element is a gexp denoting the target file. Here's an example:

```
(file-union "etc"
            `(("hosts" ,(plain-file "hosts"
                                    "127.0.0.1 localhost"))
              ("bashrc" ,(plain-file "bashrc"
                                     "alias ls='ls --color=auto'"))))
```

This yields an `etc` directory containing these two files.

`directory-union` *name things* [Scheme Procedure]

Return a directory that is the union of *things*, where *things* is a list of file-like objects denoting directories. For example:

```
(directory-union "guile+emacs" (list guile emacs))
```

yields a directory that is the union of the `guile` and `emacs` packages.

`file-append` *obj suffix* . . . [Scheme Procedure]

Return a file-like object that expands to the concatenation of *obj* and *suffix*, where *obj* is a lowerable object and each *suffix* is a string.

As an example, consider this gexp:

```
(gexp->script "run-uname"
              #~(system* #$(file-append coreutils
                                         "/bin/uname")))
```

The same effect could be achieved with:

```
(gexp->script "run-uname"
              #~(system* (string-append #$coreutils
                                         "/bin/uname")))
```

There is one difference though: in the `file-append` case, the resulting script contains the absolute file name as a string, whereas in the second case, the resulting script contains a `(string-append ...)` expression to construct the file name *at run time*.

`let-system` *system body*. . . [Scheme Syntax]
`let-system` (*system target*) *body*. . . [Scheme Syntax]

Bind *system* to the currently targeted system—e.g., `"x86_64-linux"`—within *body*.

In the second case, additionally bind *target* to the current cross-compilation target—a GNU triplet such as `"arm-linux-gnueabihf"`—or `#f` if we are not cross-compiling.

`let-system` is useful in the occasional case where the object spliced into the gexp depends on the target system, as in this example:

```
#~(system*
   #+(let-system system
       (cond ((string-prefix? "armhf-" system)
              (file-append qemu "/bin/qemu-system-arm"))
             ((string-prefix? "x86_64-" system)
              (file-append qemu "/bin/qemu-system-x86_64"))
             (else
              (error "dunno!"))))
   "-net" "user" #$image)
```

`with-parameters` ((*parameter value*) ...) *exp* [Scheme Syntax]

This macro is similar to the `parameterize` form for dynamically-bound *parameters* (see Section "Parameters" in *GNU Guile Reference Manual*). The key difference is that it takes effect when the file-like object returned by *exp* is lowered to a derivation or store item.

A typical use of `with-parameters` is to force the system in effect for a given object:

```
(with-parameters ((%current-system "i686-linux"))
  coreutils)
```

The example above returns an object that corresponds to the i686 build of Coreutils, regardless of the current value of `%current-system`.

Of course, in addition to gexps embedded in "host" code, there are also modules containing build tools. To make it clear that they are meant to be used in the build stratum, these modules are kept in the `(guix build ...)` name space.

Internally, high-level objects are *lowered*, using their compiler, to either derivations or store items. For instance, lowering a package yields a derivation, and lowering a `plain-file` yields a store item. This is achieved using the `lower-object` monadic procedure.

`lower-object` *obj* [*system*] [*#:target #f*] [Monadic Procedure]

Return as a value in `%store-monad` the derivation or store item corresponding to *obj* for *system*, cross-compiling for *target* if *target* is true. *obj* must be an object that has an associated gexp compiler, such as a `<package>`.

`gexp->approximate-sexp` *gexp* [Procedure]

Sometimes, it may be useful to convert a G-exp into a S-exp. For example, some linters (see Section 10.8 [Invoking guix lint], page 196) peek into the build phases of a package to detect potential problems. This conversion can be achieved with this procedure. However, some information can be lost in the process. More specifically, lowerable objects will be silently replaced with some arbitrary object – currently the list `(*approximate*)`, but this may change.

9.13 Invoking `guix repl`

The `guix repl` command makes it easier to program Guix in Guile by launching a Guile *read-eval-print loop* (REPL) for interactive programming (see Section "Using Guile Interactively" in *GNU Guile Reference Manual*), or by running Guile scripts (see Section "Running Guile Scripts" in *GNU Guile Reference Manual*). Compared to just launching the `guile` command, `guix repl` guarantees that all the Guix modules and all its dependencies are available in the search path.

The general syntax is:

```
guix repl options [file args]
```

When a *file* argument is provided, *file* is executed as a Guile scripts:

```
guix repl my-script.scm
```

To pass arguments to the script, use `--` to prevent them from being interpreted as arguments to `guix repl` itself:

```
guix repl -- my-script.scm --input=foo.txt
```

To make a script executable directly from the shell, using the guix executable that is on the user's search path, add the following two lines at the top of the script:

```
#!/usr/bin/env -S guix repl --
!#
```

Without a file name argument, a Guile REPL is started, allowing for interactive use (see Section 9.14 [Using Guix Interactively], page 164):

```
$ guix repl
scheme@(guile-user)> ,use (gnu packages base)
scheme@(guile-user)> coreutils
$1 = #<package coreutils@8.29 gnu/packages/base.scm:327 3e28300>
```

In addition, `guix repl` implements a simple machine-readable REPL protocol for use by `(guix inferior)`, a facility to interact with *inferiors*, separate processes running a potentially different revision of Guix.

The available options are as follows:

`--type=`*`type`*
`-t` *`type`*
: Start a REPL of the given *TYPE*, which can be one of the following:

  `guile` This is default, and it spawns a standard full-featured Guile REPL.

  `machine` Spawn a REPL that uses the machine-readable protocol. This is the protocol that the `(guix inferior)` module speaks.

`--listen=`*`endpoint`*
: By default, `guix repl` reads from standard input and writes to standard output. When this option is passed, it will instead listen for connections on *endpoint*. Here are examples of valid options:

  `--listen=tcp:37146`
  : Accept connections on localhost on port 37146.

  `--listen=unix:/tmp/socket`
  : Accept connections on the Unix-domain socket `/tmp/socket`.

`--load-path=`*`directory`*
`-L` *`directory`*
: Add *directory* to the front of the package module search path (see Section 9.1 [Package Modules], page 95).

  This allows users to define their own packages and make them visible to the script or REPL.

`-q` Inhibit loading of the `~/.guile` file. By default, that configuration file is loaded when spawning a `guile` REPL.

9.14 Using Guix Interactively

The `guix repl` command gives you access to a warm and friendly *read-eval-print loop* (REPL) (see Section 9.13 [Invoking guix repl], page 162). If you're getting into Guix programming—defining your own packages, writing manifests, defining services for Guix System or Guix Home, etc.—you will surely find it convenient to toy with ideas at the REPL.

If you use Emacs, the most convenient way to do that is with Geiser (see Section 22.3 [The Perfect Setup], page 628), but you do not have to use Emacs to enjoy the REPL. When using `guix repl` or `guile` in the terminal, we recommend using Readline for completion and Colorized to get colorful output. To do that, you can run:

```
guix install guile guile-readline guile-colorized
```

... and then create a `.guile` file in your home directory containing this:

```
(use-modules (ice-9 readline) (ice-9 colorized))

(activate-readline)
(activate-colorized)
```

The REPL lets you evaluate Scheme code; you type a Scheme expression at the prompt, and the REPL prints what it evaluates to:

```
$ guix repl
scheme@(guix-user)> (+ 2 3)
$1 = 5
scheme@(guix-user)> (string-append "a" "b")
$2 = "ab"
```

It becomes interesting when you start fiddling with Guix at the REPL. The first thing you'll want to do is to "import" the `(guix)` module, which gives access to the main part of the programming interface, and perhaps a bunch of useful Guix modules. You could type `(use-modules (guix))`, which is valid Scheme code to import a module (see Section "Using Guile Modules" in *GNU Guile Reference Manual*), but the REPL provides the `use` *command* as a shorthand notation (see Section "REPL Commands" in *GNU Guile Reference Manual*):

```
scheme@(guix-user)> ,use (guix)
scheme@(guix-user)> ,use (gnu packages base)
```

Notice that REPL commands are introduced by a leading comma. A REPL command like `use` is not valid Scheme code; it's interpreted specially by the REPL.

Guix extends the Guile REPL with additional commands for convenience. Among those, the `build` command comes in handy: it ensures that the given file-like object is built, building it if needed, and returns its output file name(s). In the example below, we build the `coreutils` and `grep` packages, as well as a "computed file" (see Section 9.12 [G-Expressions], page 154), and we use the `scandir` procedure to list the files in Grep's `/bin` directory:

```
scheme@(guix-user)> ,build coreutils
$1 = "/gnu/store/...-coreutils-8.32-debug"
$2 = "/gnu/store/...-coreutils-8.32"
scheme@(guix-user)> ,build grep
```

```
$3 = "/gnu/store/...-grep-3.6"
scheme@(guix-user)> ,build (computed-file "x" #~(mkdir #$output))
building /gnu/store/...-x.drv...
$4 = "/gnu/store/...-x"
scheme@(guix-user)> ,use(ice-9 ftw)
scheme@(guix-user)> (scandir (string-append $3 "/bin"))
$5 = ("." ".." "egrep" "fgrep" "grep")
```

At a lower-level, a useful command is `lower`: it takes a file-like object and "lowers" it into a derivation (see Section 9.10 [Derivations], page 146) or a store file:

```
scheme@(guix-user)> ,lower grep
$6 = #<derivation /gnu/store/...-grep-3.6.drv => /gnu/store/...-grep-3.6 7f0e639115f0>
scheme@(guix-user)> ,lower (plain-file "x" "Hello!")
$7 = "/gnu/store/...-x"
```

The full list of REPL commands can be seen by typing `,help guix` and is given below for reference.

`build` *`object`* [REPL command]
: Lower *object* and build it if it's not already built, returning its output file name(s).

`lower` *`object`* [REPL command]
: Lower *object* into a derivation or store file name and return it.

`verbosity` *`level`* [REPL command]
: Change build verbosity to *level*.

  This is similar to the `--verbosity` command-line option (see Section 10.1.1 [Common Build Options], page 166): level 0 means total silence, level 1 shows build events only, and higher levels print build logs.

`run-in-store` *`exp`* [REPL command]
: Run *exp*, a monadic expresssion, through the store monad. See Section 9.11 [The Store Monad], page 149, for more information.

`enter-store-monad` [REPL command]
: Enter a new REPL to evaluate monadic expressions (see Section 9.11 [The Store Monad], page 149). You can quit this "inner" REPL by typing `,q`.

10 Utilities

This section describes Guix command-line utilities. Some of them are primarily targeted at developers and users who write new package definitions, while others are more generally useful. They complement the Scheme programming interface of Guix in a convenient way.

10.1 Invoking `guix build`

The `guix build` command builds packages or derivations and their dependencies, and prints the resulting store paths. Note that it does not modify the user's profile—this is the job of the `guix package` command (see Section 6.2 [Invoking guix package], page 39). Thus, it is mainly useful for distribution developers.

The general syntax is:

```
guix build options package-or-derivation...
```

As an example, the following command builds the latest versions of Emacs and of Guile, displays their build logs, and finally displays the resulting directories:

```
guix build emacs guile
```

Similarly, the following command builds all the available packages:

```
guix build --quiet --keep-going \
  $(guix package -A | awk '{ print $1 "@" $2 }')
```

package-or-derivation may be either the name of a package found in the software distribution such as `coreutils` or `coreutils@8.20`, or a derivation such as `/gnu/store/...-coreutils-8.19.drv`. In the former case, a package with the corresponding name (and optionally version) is searched for among the GNU distribution modules (see Section 9.1 [Package Modules], page 95).

Alternatively, the `--expression` option may be used to specify a Scheme expression that evaluates to a package; this is useful when disambiguating among several same-named packages or package variants is needed.

There may be zero or more *options*. The available options are described in the subsections below.

10.1.1 Common Build Options

A number of options that control the build process are common to `guix build` and other commands that can spawn builds, such as `guix package` or `guix archive`. These are the following:

`--load-path=`*`directory`*
`-L` *`directory`*
: Add *directory* to the front of the package module search path (see Section 9.1 [Package Modules], page 95).

  This allows users to define their own packages and make them visible to the command-line tools.

`--keep-failed`
`-K`
: Keep the build tree of failed builds. Thus, if a build fails, its build tree is kept under `/tmp`, in a directory whose name is shown at the end of the build log.

This is useful when debugging build issues. See Section 10.1.4 [Debugging Build Failures], page 178, for tips and tricks on how to debug build issues.

This option implies `--no-offload`, and it has no effect when connecting to a remote daemon with a `guix://` URI (see Section 9.9 [The Store], page 144).

`--keep-going`
`-k` Keep going when some of the derivations fail to build; return only once all the builds have either completed or failed.

The default behavior is to stop as soon as one of the specified derivations has failed.

`--dry-run`
`-n` Do not build the derivations.

`--fallback`
When substituting a pre-built binary fails, fall back to building packages locally (see Section 6.3.6 [Substitution Failure], page 52).

`--substitute-urls=`*`urls`*
Consider *urls* the whitespace-separated list of substitute source URLs, overriding the default list of URLs of `guix-daemon` (see [`guix-daemon` URLs], page 16).

This means that substitutes may be downloaded from *urls*, provided they are signed by a key authorized by the system administrator (see Section 6.3 [Substitutes], page 48).

When *urls* is the empty string, substitutes are effectively disabled.

`--no-substitutes`
Do not use substitutes for build products. That is, always build things locally instead of allowing downloads of pre-built binaries (see Section 6.3 [Substitutes], page 48).

`--no-grafts`
Do not "graft" packages. In practice, this means that package updates available as grafts are not applied. See Chapter 19 [Security Updates], page 616, for more information on grafts.

`--rounds=`*`n`*
Build each derivation *n* times in a row, and raise an error if consecutive build results are not bit-for-bit identical.

This is a useful way to detect non-deterministic builds processes. Non-deterministic build processes are a problem because they make it practically impossible for users to *verify* whether third-party binaries are genuine. See Section 10.12 [Invoking guix challenge], page 209, for more.

When used in conjunction with `--keep-failed`, the differing output is kept in the store, under `/gnu/store/...-check`. This makes it easy to look for differences between the two results.

`--no-offload`
Do not use offload builds to other machines (see Section 2.4.2 [Daemon Offload Setup], page 11). That is, always build things locally instead of offloading builds to remote machines.

`--max-silent-time=`*`seconds`*
: When the build or substitution process remains silent for more than *seconds*, terminate it and report a build failure.

  By default, the daemon's setting is honored (see Section 2.5 [Invoking guix-daemon], page 15).

`--timeout=`*`seconds`*
: Likewise, when the build or substitution process lasts for more than *seconds*, terminate it and report a build failure.

  By default, the daemon's setting is honored (see Section 2.5 [Invoking guix-daemon], page 15).

`-v` *`level`*
`--verbosity=`*`level`*
: Use the given verbosity *level*, an integer. Choosing 0 means that no output is produced, 1 is for quiet output; 2 is similar to 1 but it additionally displays download URLs; 3 shows all the build log output on standard error.

`--cores=`*`n`*
`-c` *`n`*
: Allow the use of up to *n* CPU cores for the build. The special value `0` means to use as many CPU cores as available.

`--max-jobs=`*`n`*
`-M` *`n`*
: Allow at most *n* build jobs in parallel. See Section 2.5 [Invoking guix-daemon], page 15, for details about this option and the equivalent `guix-daemon` option.

`--debug=`*`level`*
: Produce debugging output coming from the build daemon. *level* must be an integer between 0 and 5; higher means more verbose output. Setting a level of 4 or more may be helpful when debugging setup issues with the build daemon.

Behind the scenes, `guix build` is essentially an interface to the `package-derivation` procedure of the `(guix packages)` module, and to the `build-derivations` procedure of the `(guix derivations)` module.

In addition to options explicitly passed on the command line, `guix build` and other `guix` commands that support building honor the `GUIX_BUILD_OPTIONS` environment variable.

`GUIX_BUILD_OPTIONS` [Environment Variable]
: Users can define this variable to a list of command line options that will automatically be used by `guix build` and other `guix` commands that can perform builds, as in the example below:

```
$ export GUIX_BUILD_OPTIONS="--no-substitutes -c 2 -L /foo/bar"
```

  These options are parsed independently, and the result is appended to the parsed command-line options.

10.1.2 Package Transformation Options

Another set of command-line options supported by `guix build` and also `guix package` are *package transformation options*. These are options that make it possible to define *package variants*—for instance, packages built from different source code. This is a convenient way to create customized packages on the fly without having to type in the definitions of package variants (see Section 9.2 [Defining Packages], page 96).

Package transformation options are preserved across upgrades: `guix upgrade` attempts to apply transformation options initially used when creating the profile to the upgraded packages.

The available options are listed below. Most commands support them and also support a `--help-transform` option that lists all the available options and a synopsis (these options are not shown in the `--help` output for brevity).

`--tune[=cpu]`

Use versions of the packages marked as "tunable" optimized for *cpu*. When *cpu* is `native`, or when it is omitted, tune for the CPU on which the `guix` command is running.

Valid *cpu* names are those recognized by the underlying compiler, by default the GNU Compiler Collection. On x86_64 processors, this includes CPU names such as `nehalem`, `haswell`, and `skylake` (see Section "x86 Options" in *Using the GNU Compiler Collection (GCC)*).

As new generations of CPUs come out, they augment the standard instruction set architecture (ISA) with additional instructions, in particular instructions for single-instruction/multiple-data (SIMD) parallel processing. For example, while Core2 and Skylake CPUs both implement the x86_64 ISA, only the latter supports AVX2 SIMD instructions.

The primary gain one can expect from `--tune` is for programs that can make use of those SIMD capabilities *and* that do not already have a mechanism to select the right optimized code at run time. Packages that have the `tunable?` property set are considered *tunable packages* by the `--tune` option; a package definition with the property set looks like this:

```
(package
  (name "hello-simd")
  ;; ...

  ;; This package may benefit from SIMD extensions so
  ;; mark it as "tunable".
  (properties '((tunable? . #t))))
```

Other packages are not considered tunable. This allows Guix to use generic binaries in the cases where tuning for a specific CPU is unlikely to provide any gain.

Tuned packages are built with `-march=CPU`; under the hood, the `-march` option is passed to the actual wrapper by a compiler wrapper. Since the build machine may not be able to run code for the target CPU micro-architecture, the test suite is not run when building a tuned package.

To reduce rebuilds to the minimum, tuned packages are *grafted* onto packages that depend on them (see Chapter 19 [Security Updates], page 616). Thus, using `--no-grafts` cancels the effect of `--tune`.

We call this technique *package multi-versioning*: several variants of tunable packages may be built, one for each CPU variant. It is the coarse-grain counterpart of *function multi-versioning* as implemented by the GNU tool chain (see Section "Function Multiversioning" in *Using the GNU Compiler Collection (GCC)*).

`--with-source=`*`source`*
`--with-source=`*`package`*`=`*`source`*
`--with-source=`*`package`*`@`*`version`*`=`*`source`*

Use *source* as the source of *package*, and *version* as its version number. *source* must be a file name or a URL, as for `guix download` (see Section 10.3 [Invoking guix download], page 179).

When *package* is omitted, it is taken to be the package name specified on the command line that matches the base of *source*—e.g., if *source* is `/src/guile-2.0.10.tar.gz`, the corresponding package is `guile`.

Likewise, when *version* is omitted, the version string is inferred from *source*; in the previous example, it is `2.0.10`.

This option allows users to try out versions of packages other than the one provided by the distribution. The example below downloads `ed-1.7.tar.gz` from a GNU mirror and uses that as the source for the `ed` package:

```
guix build ed --with-source=mirror://gnu/ed/ed-1.4.tar.gz
```

As a developer, `--with-source` makes it easy to test release candidates, and even to test their impact on packages that depend on them:

```
guix build elogind --with-source=.../shepherd-0.9.0rc1.tar.gz
```

... or to build from a checkout in a pristine environment:

```
$ git clone git://git.sv.gnu.org/guix.git
$ guix build guix --with-source=guix@1.0=./guix
```

`--with-input=`*`package`*`=`*`replacement`*

Replace dependency on *package* by a dependency on *replacement*. *package* must be a package name, and *replacement* must be a package specification such as `guile` or `guile@1.8`.

For instance, the following command builds Guix, but replaces its dependency on the current stable version of Guile with a dependency on the legacy version of Guile, `guile@2.0`:

```
guix build --with-input=guile=guile@2.0 guix
```

This is a recursive, deep replacement. So in this example, both `guix` and its dependency `guile-json` (which also depends on `guile`) get rebuilt against `guile@2.0`.

This is implemented using the `package-input-rewriting` Scheme procedure (see Section 9.2 [Defining Packages], page 96).

`--with-graft=`*`package`*`=`*`replacement`*

This is similar to `--with-input` but with an important difference: instead of rebuilding the whole dependency chain, *replacement* is built and then *grafted* onto the binaries that were initially referring to *package*. See Chapter 19 [Security Updates], page 616, for more information on grafts.

For example, the command below grafts version 3.5.4 of GnuTLS onto Wget and all its dependencies, replacing references to the version of GnuTLS they currently refer to:

```
guix build --with-graft=gnutls=gnutls@3.5.4 wget
```

This has the advantage of being much faster than rebuilding everything. But there is a caveat: it works if and only if *package* and *replacement* are strictly compatible—for example, if they provide a library, the application binary interface (ABI) of those libraries must be compatible. If *replacement* is somehow incompatible with *package*, then the resulting package may be unusable. Use with care!

`--with-debug-info=`*`package`*

Build *package* in a way that preserves its debugging info and graft it onto packages that depend on it. This is useful if *package* does not already provide debugging info as a `debug` output (see Chapter 17 [Installing Debugging Files], page 611).

For example, suppose you're experiencing a crash in Inkscape and would like to see what's up in GLib, a library deep down in Inkscape's dependency graph. GLib lacks a `debug` output, so debugging is tough. Fortunately, you rebuild GLib with debugging info and tack it on Inkscape:

```
guix install inkscape --with-debug-info=glib
```

Only GLib needs to be recompiled so this takes a reasonable amount of time. See Chapter 17 [Installing Debugging Files], page 611, for more info.

> **Note:** Under the hood, this option works by passing the '`#:strip-binaries? #f`' to the build system of the package of interest (see Section 9.5 [Build Systems], page 114). Most build systems support that option but some do not. In that case, an error is raised.
>
> Likewise, if a C/C++ package is built without `-g` (which is rarely the case), debugging info will remain unavailable even when `#:strip-binaries?` is false.

`--with-c-toolchain=`*`package`*`=`*`toolchain`*

This option changes the compilation of *package* and everything that depends on it so that they get built with *toolchain* instead of the default GNU tool chain for C/C++.

Consider this example:

```
guix build octave-cli \
  --with-c-toolchain=fftw=gcc-toolchain@10 \
  --with-c-toolchain=fftwf=gcc-toolchain@10
```

The command above builds a variant of the `fftw` and `fftwf` packages using version 10 of `gcc-toolchain` instead of the default tool chain, and then builds a variant of the GNU Octave command-line interface using them. GNU Octave itself is also built with `gcc-toolchain@10`.

This other example builds the Hardware Locality (`hwloc`) library and its dependents up to `intel-mpi-benchmarks` with the Clang C compiler:

```
guix build --with-c-toolchain=hwloc=clang-toolchain \
           intel-mpi-benchmarks
```

Note: There can be application binary interface (ABI) incompatibilities among tool chains. This is particularly true of the C++ standard library and run-time support libraries such as that of OpenMP. By rebuilding all dependents with the same tool chain, `--with-c-toolchain` minimizes the risks of incompatibility but cannot entirely eliminate them. Choose *package* wisely.

`--with-git-url=`*`package`*`=`*`url`*

Build *package* from the latest commit of the `master` branch of the Git repository at *url*. Git sub-modules of the repository are fetched, recursively.

For example, the following command builds the NumPy Python library against the latest commit of the master branch of Python itself:

```
guix build python-numpy \
  --with-git-url=python=https://github.com/python/cpython
```

This option can also be combined with `--with-branch` or `--with-commit` (see below).

Obviously, since it uses the latest commit of the given branch, the result of such a command varies over time. Nevertheless it is a convenient way to rebuild entire software stacks against the latest commit of one or more packages. This is particularly useful in the context of continuous integration (CI).

Checkouts are kept in a cache under `~/.cache/guix/checkouts` to speed up consecutive accesses to the same repository. You may want to clean it up once in a while to save disk space.

`--with-branch=`*`package`*`=`*`branch`*

Build *package* from the latest commit of *branch*. If the `source` field of *package* is an origin with the `git-fetch` method (see Section 9.2.2 [origin Reference], page 103) or a `git-checkout` object, the repository URL is taken from that `source`. Otherwise you have to use `--with-git-url` to specify the URL of the Git repository.

For instance, the following command builds `guile-sqlite3` from the latest commit of its `master` branch, and then builds `guix` (which depends on it) and `cuirass` (which depends on `guix`) against this specific `guile-sqlite3` build:

```
guix build --with-branch=guile-sqlite3=master cuirass
```

`--with-commit=`*`package`*`=`*`commit`*

This is similar to `--with-branch`, except that it builds from *commit* rather than the tip of a branch. *commit* must be a valid Git commit SHA1 identifier, a tag, or a `git describe` style identifier such as `1.0-3-gabc123`.

`--with-patch=`*`package`*`=`*`file`*

Add *file* to the list of patches applied to *package*, where *package* is a spec such as `python@3.8` or `glibc`. *file* must contain a patch; it is applied with the flags specified in the `origin` of *package* (see Section 9.2.2 [origin Reference], page 103), which by default includes `-p1` (see Section "patch Directories" in *Comparing and Merging Files*).

As an example, the command below rebuilds Coreutils with the GNU C Library (glibc) patched with the given patch:

```
guix build coreutils --with-patch=glibc=./glibc-frob.patch
```

In this example, glibc itself as well as everything that leads to Coreutils in the dependency graph is rebuilt.

`--with-latest=`*package*

So you like living on the bleeding edge? This option is for you! It replaces occurrences of *package* in the dependency graph with its latest upstream version, as reported by `guix refresh` (see Section 10.6 [Invoking guix refresh], page 189).

It does so by determining the latest upstream release of *package* (if possible), downloading it, and authenticating it *if* it comes with an OpenPGP signature.

As an example, the command below builds Guix against the latest version of Guile-JSON:

```
guix build guix --with-latest=guile-json
```

There are limitations. First, in cases where the tool cannot or does not know how to authenticate source code, you are at risk of running malicious code; a warning is emitted in this case. Second, this option simply changes the source used in the existing package definitions, which is not always sufficient: there might be additional dependencies that need to be added, patches to apply, and more generally the quality assurance work that Guix developers normally do will be missing.

You've been warned! In all the other cases, it's a snappy way to stay on top. We encourage you to submit patches updating the actual package definitions once you have successfully tested an upgrade (see Chapter 22 [Contributing], page 625).

`--without-tests=`*package*

Build *package* without running its tests. This can be useful in situations where you want to skip the lengthy test suite of a intermediate package, or if a package's test suite fails in a non-deterministic fashion. It should be used with care because running the test suite is a good way to ensure a package is working as intended.

Turning off tests leads to a different store item. Consequently, when using this option, anything that depends on *package* must be rebuilt, as in this example:

```
guix install --without-tests=python python-notebook
```

The command above installs `python-notebook` on top of `python` built without running its test suite. To do so, it also rebuilds everything that depends on `python`, including `python-notebook` itself.

Internally, `--without-tests` relies on changing the `#:tests?` option of a package's `check` phase (see Section 9.5 [Build Systems], page 114). Note that some packages use a customized `check` phase that does not respect a `#:tests? #f` setting. Therefore, `--without-tests` has no effect on these packages.

Wondering how to achieve the same effect using Scheme code, for example in your manifest, or how to write your own package transformation? See Section 9.3 [Defining Package Variants], page 106, for an overview of the programming interfaces available.

10.1.3 Additional Build Options

The command-line options presented below are specific to `guix build`.

`--quiet`
`-q`
: Build quietly, without displaying the build log; this is equivalent to `--verbosity=0`. Upon completion, the build log is kept in `/var` (or similar) and can always be retrieved using the `--log-file` option.

`--file=`*`file`*
`-f` *`file`*
: Build the package, derivation, or other file-like object that the code within *file* evaluates to (see Section 9.12 [G-Expressions], page 154).

As an example, *file* might contain a package definition like this (see Section 9.2 [Defining Packages], page 96):

```
(use-modules (guix)
             (guix build-system gnu)
             (guix licenses))

(package
  (name "hello")
  (version "2.10")
  (source (origin
            (method url-fetch)
            (uri (string-append "mirror://gnu/hello/hello-" version
                                ".tar.gz"))
            (sha256
             (base32
              "0ssi1wpaf7plaswqqjwigppsg5fyh99vdlb9kzl7c9lng89ndq1i"))))
  (build-system gnu-build-system)
  (synopsis "Hello, GNU world: An example GNU package")
  (description "Guess what GNU Hello prints!")
  (home-page "http://www.gnu.org/software/hello/")
  (license gpl3+))
```

The *file* may also contain a JSON representation of one or more package definitions. Running `guix build -f` on `hello.json` with the following contents would result in building the packages `myhello` and `greeter`:

```
[
  {
    "name": "myhello",
    "version": "2.10",
    "source": "mirror://gnu/hello/hello-2.10.tar.gz",
    "build-system": "gnu",
    "arguments": {
      "tests?": false
    }
    "home-page": "https://www.gnu.org/software/hello/",
    "synopsis": "Hello, GNU world: An example GNU package",
    "description": "GNU Hello prints a greeting.",
    "license": "GPL-3.0+",
    "native-inputs": ["gettext"]
  },
  {
    "name": "greeter",
    "version": "1.0",
    "source": "https://example.com/greeter-1.0.tar.gz",
    "build-system": "gnu",
    "arguments": {
      "test-target": "foo",
      "parallel-build?": false,
    },
    "home-page": "https://example.com/",
    "synopsis": "Greeter using GNU Hello",
    "description": "This is a wrapper around GNU Hello.",
    "license": "GPL-3.0+",
    "inputs": ["myhello", "hello"]
  }
]
```

`--manifest=`*`manifest`*
`-m` *`manifest`*
Build all packages listed in the given *manifest* (see [profile-manifest], page 43).

`--expression=`*`expr`*
`-e` *`expr`* Build the package or derivation *expr* evaluates to.

For example, *expr* may be `(@ (gnu packages guile) guile-1.8)`, which unambiguously designates this specific variant of version 1.8 of Guile.

Alternatively, *expr* may be a G-expression, in which case it is used as a build program passed to `gexp->derivation` (see Section 9.12 [G-Expressions], page 154).

Lastly, *expr* may refer to a zero-argument monadic procedure (see Section 9.11 [The Store Monad], page 149). The procedure must return a derivation as a monadic value, which is then passed through `run-with-store`.

`--source`
`-S` Build the source derivations of the packages, rather than the packages themselves.

For instance, `guix build -S gcc` returns something like `/gnu/store/...-gcc-4.7.2.tar.bz2`, which is the GCC source tarball.

The returned source tarball is the result of applying any patches and code snippets specified in the package `origin` (see Section 9.2 [Defining Packages], page 96).

As with other derivations, the result of building a source derivation can be verified using the `--check` option (see [build-check], page 177). This is useful to validate that a (potentially already built or substituted, thus cached) package source matches against its declared hash.

Note that `guix build -S` compiles the sources only of the specified packages. They do not include the sources of statically linked dependencies and by themselves are insufficient for reproducing the packages.

`--sources`

Fetch and return the source of *package-or-derivation* and all their dependencies, recursively. This is a handy way to obtain a local copy of all the source code needed to build *packages*, allowing you to eventually build them even without network access. It is an extension of the `--source` option and can accept one of the following optional argument values:

`package` This value causes the `--sources` option to behave in the same way as the `--source` option.

`all` Build the source derivations of all packages, including any source that might be listed as `inputs`. This is the default value.

```
$ guix build --sources tzdata
The following derivations will be built:
   /gnu/store/...-tzdata2015b.tar.gz.drv
   /gnu/store/...-tzcode2015b.tar.gz.drv
```

`transitive`

Build the source derivations of all packages, as well of all transitive inputs to the packages. This can be used e.g. to prefetch package source for later offline building.

```
$ guix build --sources=transitive tzdata
The following derivations will be built:
   /gnu/store/...-tzcode2015b.tar.gz.drv
   /gnu/store/...-findutils-4.4.2.tar.xz.drv
   /gnu/store/...-grep-2.21.tar.xz.drv
   /gnu/store/...-coreutils-8.23.tar.xz.drv
   /gnu/store/...-make-4.1.tar.xz.drv
   /gnu/store/...-bash-4.3.tar.xz.drv
...
```

`--system=`*`system`*
`-s` *`system`* Attempt to build for *system*—e.g., `i686-linux`—instead of the system type of the build host. The `guix build` command allows you to repeat this option several times, in which case it builds for all the specified systems; other commands ignore extraneous `-s` options.

> **Note:** The `--system` flag is for *native* compilation and must not be confused with cross-compilation. See `--target` below for information on cross-compilation.

An example use of this is on Linux-based systems, which can emulate different personalities. For instance, passing `--system=i686-linux` on an `x86_64-`

`linux` system or `--system=armhf-linux` on an `aarch64-linux` system allows you to build packages in a complete 32-bit environment.

> **Note:** Building for an `armhf-linux` system is unconditionally enabled on `aarch64-linux` machines, although certain aarch64 chipsets do not allow for this functionality, notably the ThunderX.

Similarly, when transparent emulation with QEMU and `binfmt_misc` is enabled (see Section 12.9.29 [Virtualization Services], page 471), you can build for any system for which a QEMU `binfmt_misc` handler is installed.

Builds for a system other than that of the machine you are using can also be offloaded to a remote machine of the right architecture. See Section 2.4.2 [Daemon Offload Setup], page 11, for more information on offloading.

`--target=`*`triplet`*
: Cross-build for *triplet*, which must be a valid GNU triplet, such as `"aarch64-linux-gnu"` (see Section “Specifying Target Triplets” in *Autoconf*).

`--list-systems`
: List all the supported systems, that can be passed as an argument to `--system`.

`--list-targets`
: List all the supported targets, that can be passed as an argument to `--target`.

`--check`
: Rebuild *package-or-derivation*, which are already available in the store, and raise an error if the build results are not bit-for-bit identical.

This mechanism allows you to check whether previously installed substitutes are genuine (see Section 6.3 [Substitutes], page 48), or whether the build result of a package is deterministic. See Section 10.12 [Invoking guix challenge], page 209, for more background information and tools.

When used in conjunction with `--keep-failed`, the differing output is kept in the store, under `/gnu/store/...-check`. This makes it easy to look for differences between the two results.

`--repair`
: Attempt to repair the specified store items, if they are corrupt, by re-downloading or rebuilding them.

This operation is not atomic and thus restricted to `root`.

`--derivations`
`-d`
: Return the derivation paths, not the output paths, of the given packages.

`--root=`*`file`*
`-r `*`file`*
: Make *file* a symlink to the result, and register it as a garbage collector root.

Consequently, the results of this `guix build` invocation are protected from garbage collection until *file* is removed. When that option is omitted, build results are eligible for garbage collection as soon as the build completes. See Section 6.5 [Invoking guix gc], page 53, for more on GC roots.

`--log-file`
: Return the build log file names or URLs for the given *package-or-derivation*, or raise an error if build logs are missing.

This works regardless of how packages or derivations are specified. For instance, the following invocations are equivalent:

```
guix build --log-file $(guix build -d guile)
guix build --log-file $(guix build guile)
guix build --log-file guile
guix build --log-file -e '(@ (gnu packages guile) guile-2.0)'
```

If a log is unavailable locally, and unless `--no-substitutes` is passed, the command looks for a corresponding log on one of the substitute servers (as specified with `--substitute-urls`).

So for instance, imagine you want to see the build log of GDB on `aarch64`, but you are actually on an `x86_64` machine:

```
$ guix build --log-file gdb -s aarch64-linux
https://ci.guix.gnu.org/log/...-gdb-7.10
```

You can freely access a huge library of build logs!

10.1.4 Debugging Build Failures

When defining a new package (see Section 9.2 [Defining Packages], page 96), you will probably find yourself spending some time debugging and tweaking the build until it succeeds. To do that, you need to operate the build commands yourself in an environment as close as possible to the one the build daemon uses.

To that end, the first thing to do is to use the `--keep-failed` or `-K` option of `guix build`, which will keep the failed build tree in `/tmp` or whatever directory you specified as `TMPDIR` (see Section 10.1.1 [Common Build Options], page 166).

From there on, you can `cd` to the failed build tree and source the `environment-variables` file, which contains all the environment variable definitions that were in place when the build failed. So let's say you're debugging a build failure in package `foo`; a typical session would look like this:

```
$ guix build foo -K
... build fails
$ cd /tmp/guix-build-foo.drv-0
$ source ./environment-variables
$ cd foo-1.2
```

Now, you can invoke commands as if you were the daemon (almost) and troubleshoot your build process.

Sometimes it happens that, for example, a package's tests pass when you run them manually but they fail when the daemon runs them. This can happen because the daemon runs builds in containers where, unlike in our environment above, network access is missing, `/bin/sh` does not exist, etc. (see Section 2.4.1 [Build Environment Setup], page 9).

In such cases, you may need to run inspect the build process from within a container similar to the one the build daemon creates:

```
$ guix build -K foo
...
$ cd /tmp/guix-build-foo.drv-0
$ guix shell --no-grafts -C -D foo strace gdb
```

```
[env]# source ./environment-variables
[env]# cd foo-1.2
```

Here, `guix shell -C` creates a container and spawns a new shell in it (see Section 8.1 [Invoking guix shell], page 76). The `strace gdb` part adds the `strace` and `gdb` commands to the container, which you may find handy while debugging. The `--no-grafts` option makes sure we get the exact same environment, with ungrafted packages (see Chapter 19 [Security Updates], page 616, for more info on grafts).

To get closer to a container like that used by the build daemon, we can remove `/bin/sh`:

```
[env]# rm /bin/sh
```

(Don't worry, this is harmless: this is all happening in the throw-away container created by `guix shell`.)

The `strace` command is probably not in the search path, but we can run:

```
[env]# $GUIX_ENVIRONMENT/bin/strace -f -o log make check
```

In this way, not only you will have reproduced the environment variables the daemon uses, you will also be running the build process in a container similar to the one the daemon uses.

10.2 Invoking `guix edit`

So many packages, so many source files! The `guix edit` command facilitates the life of users and packagers by pointing their editor at the source file containing the definition of the specified packages. For instance:

```
guix edit gcc@4.9 vim
```

launches the program specified in the `VISUAL` or in the `EDITOR` environment variable to view the recipe of GCC 4.9.3 and that of Vim.

If you are using a Guix Git checkout (see Section 22.1 [Building from Git], page 625), or have created your own packages on `GUIX_PACKAGE_PATH` (see Section 9.1 [Package Modules], page 95), you will be able to edit the package recipes. In other cases, you will be able to examine the read-only recipes for packages currently in the store.

Instead of `GUIX_PACKAGE_PATH`, the command-line option `--load-path=`*`directory`* (or in short `-L` *`directory`*) allows you to add *directory* to the front of the package module search path and so make your own packages visible.

10.3 Invoking `guix download`

When writing a package definition, developers typically need to download a source tarball, compute its SHA256 hash, and write that hash in the package definition (see Section 9.2 [Defining Packages], page 96). The `guix download` tool helps with this task: it downloads a file from the given URI, adds it to the store, and prints both its file name in the store and its SHA256 hash.

The fact that the downloaded file is added to the store saves bandwidth: when the developer eventually tries to build the newly defined package with `guix build`, the source tarball will not have to be downloaded again because it is already in the store. It is also a convenient way to temporarily stash files, which may be deleted eventually (see Section 6.5 [Invoking guix gc], page 53).

The `guix download` command supports the same URIs as used in package definitions. In particular, it supports `mirror://` URIs. `https` URIs (HTTP over TLS) are supported *provided* the Guile bindings for GnuTLS are available in the user's environment; when they are not available, an error is raised. See Section "Guile Preparations" in *GnuTLS-Guile*, for more information.

`guix download` verifies HTTPS server certificates by loading the certificates of X.509 authorities from the directory pointed to by the `SSL_CERT_DIR` environment variable (see Section 12.11 [X.509 Certificates], page 535), unless `--no-check-certificate` is used.

The following options are available:

`--hash=`*`algorithm`*
`-H `*`algorithm`*
: Compute a hash using the specified *algorithm*. See Section 10.4 [Invoking guix hash], page 180, for more information.

`--format=`*`fmt`*
`-f `*`fmt`*
: Write the hash in the format specified by *fmt*. For more information on the valid values for *fmt*, see Section 10.4 [Invoking guix hash], page 180.

`--no-check-certificate`
: Do not validate the X.509 certificates of HTTPS servers.

  When using this option, you have *absolutely no guarantee* that you are communicating with the authentic server responsible for the given URL, which makes you vulnerable to "man-in-the-middle" attacks.

`--output=`*`file`*
`-o `*`file`*
: Save the downloaded file to *file* instead of adding it to the store.

10.4 Invoking `guix hash`

The `guix hash` command computes the hash of a file. It is primarily a convenience tool for anyone contributing to the distribution: it computes the cryptographic hash of one or more files, which can be used in the definition of a package (see Section 9.2 [Defining Packages], page 96).

The general syntax is:

```
guix hash option file ...
```

When *file* is `-` (a hyphen), `guix hash` computes the hash of data read from standard input. `guix hash` has the following options:

`--hash=`*`algorithm`*
`-H `*`algorithm`*
: Compute a hash using the specified *algorithm*, `sha256` by default.

  algorithm must be the name of a cryptographic hash algorithm supported by Libgcrypt *via* Guile-Gcrypt—e.g., `sha512` or `sha3-256` (see Section "Hash Functions" in *Guile-Gcrypt Reference Manual*).

`--format=`*`fmt`*
`-f `*`fmt`*
: Write the hash in the format specified by *fmt*.

Supported formats: `base64`, `nix-base32`, `base32`, `base16` (`hex` and `hexadecimal` can be used as well).

If the `--format` option is not specified, `guix hash` will output the hash in `nix-base32`. This representation is used in the definitions of packages.

`--recursive`
`-r` The `--recursive` option is deprecated in favor of `--serializer=nar` (see below); `-r` remains accepted as a convenient shorthand.

`--serializer=`*type*
`-S` *type* Compute the hash on *file* using *type* serialization.

type may be one of the following:

`none` This is the default: it computes the hash of a file's contents.

`nar` Compute the hash of a "normalized archive" (or "nar") containing *file*, including its children if it is a directory. Some of the metadata of *file* is part of the archive; for instance, when *file* is a regular file, the hash is different depending on whether *file* is executable or not. Metadata such as time stamps have no impact on the hash (see Section 6.10 [Invoking guix archive], page 64, for more info on the nar format).

`git` Compute the hash of the file or directory as a Git "tree", following the same method as the Git version control system.

`--exclude-vcs`
`-x` When combined with `--recursive`, exclude version control system directories (`.bzr`, `.git`, `.hg`, etc.).

As an example, here is how you would compute the hash of a Git checkout, which is useful when using the `git-fetch` method (see Section 9.2.2 [origin Reference], page 103):

```
$ git clone http://example.org/foo.git
$ cd foo
$ guix hash -x --serializer=nar .
```

10.5 Invoking `guix import`

The `guix import` command is useful for people who would like to add a package to the distribution with as little work as possible—a legitimate demand. The command knows of a few repositories from which it can "import" package metadata. The result is a package definition, or a template thereof, in the format we know (see Section 9.2 [Defining Packages], page 96).

The general syntax is:

```
guix import importer options...
```

importer specifies the source from which to import package metadata, and *options* specifies a package identifier and other options specific to *importer*.

Some of the importers rely on the ability to run the `gpgv` command. For these, GnuPG must be installed and in `$PATH`; run `guix install gnupg` if needed.

Currently, the available "importers" are:

`gnu`
: Import metadata for the given GNU package. This provides a template for the latest version of that GNU package, including the hash of its source tarball, and its canonical synopsis and description.

  Additional information such as the package dependencies and its license needs to be figured out manually.

  For example, the following command returns a package definition for GNU Hello:

  ```
  guix import gnu hello
  ```

  Specific command-line options are:

  `--key-download=`*`policy`*
  : As for `guix refresh`, specify the policy to handle missing OpenPGP keys when verifying the package signature. See Section 10.6 [Invoking guix refresh], page 189.

`pypi`
: Import metadata from the Python Package Index (`https://pypi.python.org/`). Information is taken from the JSON-formatted description available at `pypi.python.org` and usually includes all the relevant information, including package dependencies. For maximum efficiency, it is recommended to install the `unzip` utility, so that the importer can unzip Python wheels and gather data from them.

  The command below imports metadata for the latest version of the `itsdangerous` Python package:

  ```
  guix import pypi itsdangerous
  ```

  You can also ask for a specific version:

  ```
  guix import pypi itsdangerous@1.1.0
  ```

  `--recursive`
  `-r`
  : Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`gem`
: Import metadata from RubyGems (`https://rubygems.org/`). Information is taken from the JSON-formatted description available at `rubygems.org` and includes most relevant information, including runtime dependencies. There are some caveats, however. The metadata doesn't distinguish between synopses and descriptions, so the same string is used for both fields. Additionally, the details of non-Ruby dependencies required to build native extensions is unavailable and left as an exercise to the packager.

  The command below imports metadata for the `rails` Ruby package:

  ```
  guix import gem rails
  ```

  You can also ask for a specific version:

  ```
  guix import gem rails@7.0.4
  ```

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`minetest` Import metadata from ContentDB (`https://content.minetest.net`). Information is taken from the JSON-formatted metadata provided through ContentDB's API (`https://content.minetest.net/help/api/`) and includes most relevant information, including dependencies. There are some caveats, however. The license information is often incomplete. The commit hash is sometimes missing. The descriptions are in the Markdown format, but Guix uses Texinfo instead. Texture packs and subgames are unsupported.

The command below imports metadata for the Mesecons mod by Jeija:

```
guix import minetest Jeija/mesecons
```

The author name can also be left out:

```
guix import minetest mesecons
```

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`cpan` Import metadata from MetaCPAN (`https://www.metacpan.org/`). Information is taken from the JSON-formatted metadata provided through MetaCPAN's API (`https://fastapi.metacpan.org/`) and includes most relevant information, such as module dependencies. License information should be checked closely. If Perl is available in the store, then the `corelist` utility will be used to filter core modules out of the list of dependencies.

The command command below imports metadata for the Acme::Boolean Perl module:

```
guix import cpan Acme::Boolean
```

`cran` Import metadata from CRAN (`https://cran.r-project.org/`), the central repository for the GNU R statistical and graphical environment (`https://r-project.org`).

Information is extracted from the `DESCRIPTION` file of the package.

The command command below imports metadata for the Cairo R package:

```
guix import cran Cairo
```

You can also ask for a specific version:

```
guix import cran rasterVis@0.50.3
```

When `--recursive` is added, the importer will traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

When `--style=specification` is added, the importer will generate package definitions whose inputs are package specifications instead of references to package variables. This is useful when generated package definitions are to be appended to existing user modules, as the list of used package modules need not be changed. The default is `--style=variable`.

When `--archive=bioconductor` is added, metadata is imported from Bioconductor (`https://www.bioconductor.org/`), a repository of R packages for the analysis and comprehension of high-throughput genomic data in bioinformatics.

Information is extracted from the `DESCRIPTION` file contained in the package archive.

The command below imports metadata for the GenomicRanges R package:

```
guix import cran --archive=bioconductor GenomicRanges
```

Finally, you can also import R packages that have not yet been published on CRAN or Bioconductor as long as they are in a git repository. Use `--archive=git` followed by the URL of the git repository:

```
guix import cran --archive=git https://github.com/immunogenomics/harmony
```

`texlive` Import TeX package information from the TeX Live package database for TeX packages that are part of the TeX Live distribution (`https://www.tug.org/texlive/`).

Information about the package is obtained from the TeX Live package database, a plain text file that is included in the `texlive-bin` package. The source code is downloaded from possibly multiple locations in the SVN repository of the Tex Live project.

The command command below imports metadata for the `fontspec` TeX package:

```
guix import texlive fontspec
```

`json` Import package metadata from a local JSON file. Consider the following example package definition in JSON format:

```
{
  "name": "hello",
  "version": "2.10",
  "source": "mirror://gnu/hello/hello-2.10.tar.gz",
  "build-system": "gnu",
  "home-page": "https://www.gnu.org/software/hello/",
  "synopsis": "Hello, GNU world: An example GNU package",
  "description": "GNU Hello prints a greeting.",
  "license": "GPL-3.0+",
  "native-inputs": ["gettext"]
}
```

The field names are the same as for the `<package>` record (See Section 9.2 [Defining Packages], page 96). References to other packages are provided as JSON lists of quoted package specification strings such as `guile` or `guile@2.0`.

The importer also supports a more explicit source definition using the common fields for `<origin>` records:

```
{
  ...
  "source": {
    "method": "url-fetch",
    "uri": "mirror://gnu/hello/hello-2.10.tar.gz",
    "sha256": {
      "base32": "0ssi1wpaf7plaswqqjwigppsg5fyh99vdlb9kzl7c9lng89ndq1i"
    }
  }
  ...
}
```

The command below reads metadata from the JSON file `hello.json` and outputs a package expression:

```
guix import json hello.json
```

`hackage` Import metadata from the Haskell community's central package archive Hackage (`https://hackage.haskell.org/`). Information is taken from Cabal files and includes all the relevant information, including package dependencies.

Specific command-line options are:

`--stdin`
`-s` Read a Cabal file from standard input.

`--no-test-dependencies`
`-t` Do not include dependencies required only by the test suites.

`--cabal-environment=`*`alist`*
`-e` *`alist`* *alist* is a Scheme alist defining the environment in which the Cabal conditionals are evaluated. The accepted keys are: `os`, `arch`, `impl` and a string representing the name of a flag. The value associated with a flag has to be either the symbol `true` or `false`. The value associated with other keys has to conform to the Cabal file format definition. The default value associated with the keys `os`, `arch` and `impl` is '`linux`', '`x86_64`' and '`ghc`', respectively.

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

The command below imports metadata for the latest version of the HTTP Haskell package without including test dependencies and specifying the value of the flag '`network-uri`' as `false`:

```
guix import hackage -t -e "'((\"network-uri\" . false))" HTTP
```

A specific package version may optionally be specified by following the package name by an at-sign and a version number as in the following example:

```
guix import hackage mtl@2.1.3.1
```

`stackage` The `stackage` importer is a wrapper around the `hackage` one. It takes a package name, looks up the package version included in a long-term support (LTS)

Stackage (`https://www.stackage.org`) release and uses the `hackage` importer to retrieve its metadata. Note that it is up to you to select an LTS release compatible with the GHC compiler used by Guix.

Specific command-line options are:

`--no-test-dependencies`
`-t` Do not include dependencies required only by the test suites.

`--lts-version=`*`version`*
`-l` *`version`*
version is the desired LTS release version. If omitted the latest release is used.

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

The command below imports metadata for the HTTP Haskell package included in the LTS Stackage release version 7.18:

```
guix import stackage --lts-version=7.18 HTTP
```

`elpa` Import metadata from an Emacs Lisp Package Archive (ELPA) package repository (see Section "Packages" in *The GNU Emacs Manual*).

Specific command-line options are:

`--archive=`*`repo`*
`-a` *`repo`* *repo* identifies the archive repository from which to retrieve the information. Currently the supported repositories and their identifiers are:

- GNU (`https://elpa.gnu.org/packages`), selected by the `gnu` identifier. This is the default.

  Packages from `elpa.gnu.org` are signed with one of the keys contained in the GnuPG keyring at `share/emacs/25.1/etc/package-keyring.gpg` (or similar) in the `emacs` package (see Section "Package Installation" in *The GNU Emacs Manual*).
- NonGNU (`https://elpa.nongnu.org/nongnu/`), selected by the `nongnu` identifier.
- MELPA-Stable (`https://stable.melpa.org/packages`), selected by the `melpa-stable` identifier.
- MELPA (`https://melpa.org/packages`), selected by the `melpa` identifier.

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`crate` Import metadata from the crates.io Rust package repository crates.io (`https://crates.io`), as in this example:

```
guix import crate blake2-rfc
```

The crate importer also allows you to specify a version string:

```
guix import crate constant-time-eq@0.1.0
```

Additional options include:

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`elm` Import metadata from the Elm package repository package.elm-lang.org (`https://package.elm-lang.org`), as in this example:

```
guix import elm elm-explorations/webgl
```

The Elm importer also allows you to specify a version string:

```
guix import elm elm-explorations/webgl@1.1.3
```

Additional options include:

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`opam` Import metadata from the OPAM (`https://opam.ocaml.org/`) package repository used by the OCaml community.

Additional options include:

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`--repo` By default, packages are searched in the official OPAM repository. This option, which can be used more than once, lets you add other repositories which will be searched for packages. It accepts as valid arguments:

- the name of a known repository - can be one of `opam`, `coq` (equivalent to `coq-released`), `coq-core-dev`, `coq-extra-dev` or `grew`.
- the URL of a repository as expected by the `opam repository add` command (for instance, the URL equivalent of the above `opam` name would be `https://opam.ocaml.org`).
- the path to a local copy of a repository (a directory containing a `packages/` sub-directory).

Repositories are assumed to be passed to this option by order of preference. The additional repositories will not replace the default `opam` repository, which is always kept as a fallback.

Also, please note that versions are not compared across repositories. The first repository (from left to right) that has at least one version of a given package will prevail over any others, and the version imported will be the latest one found *in this repository only*.

`go` Import metadata for a Go module using proxy.golang.org (`https://proxy.golang.org`).

```
guix import go gopkg.in/yaml.v2
```

It is possible to use a package specification with a `@VERSION` suffix to import a specific version.

Additional options include:

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`--pin-versions`
When using this option, the importer preserves the exact versions of the Go modules dependencies instead of using their latest available versions. This can be useful when attempting to import packages that recursively depend on former versions of themselves to build. When using this mode, the symbol of the package is made by appending the version to its name, so that multiple versions of the same package can coexist.

`egg` Import metadata for CHICKEN eggs (`https://wiki.call-cc.org/eggs`). The information is taken from `PACKAGE.egg` files found in the eggs-5-all (`git://code.call-cc.org/eggs-5-all`) Git repository. However, it does not provide all the information that we need, there is no “description” field, and the licenses used are not always precise (BSD is often used instead of BSD-N).

```
guix import egg sourcehut
```

You can also ask for a specific version:

```
guix import egg arrays@1.0
```

Additional options include:

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

`hexpm` Import metadata from the hex.pm Erlang and Elixir package repository hex.pm (`https://hex.pm`), as in this example:

```
guix import hexpm stun
```

The importer tries to determine the build system used by the package.

The hexpm importer also allows you to specify a version string:

```
guix import hexpm cf@0.3.0
```

Additional options include:

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

The structure of the `guix import` code is modular. It would be useful to have more importers for other package formats, and your help is welcome here (see Chapter 22 [Contributing], page 625).

10.6 Invoking `guix refresh`

The primary audience of the `guix refresh` command is packagers. As a user, you may be interested in the `--with-latest` option, which can bring you package update superpowers built upon `guix refresh` (see Section 10.1.2 [Package Transformation Options], page 168). By default, `guix refresh` reports any packages provided by the distribution that are outdated compared to the latest upstream version, like this:

```
$ guix refresh
gnu/packages/gettext.scm:29:13: gettext would be upgraded from 0.18.1.1 to 0.18.2.1
gnu/packages/glib.scm:77:12: glib would be upgraded from 2.34.3 to 2.37.0
```

Alternatively, one can specify packages to consider, in which case a warning is emitted for packages that lack an updater:

```
$ guix refresh coreutils guile guile-ssh
gnu/packages/ssh.scm:205:2: warning: no updater for guile-ssh
gnu/packages/guile.scm:136:12: guile would be upgraded from 2.0.12 to 2.0.13
```

`guix refresh` browses the upstream repository of each package and determines the highest version number of the releases therein. The command knows how to update specific types of packages: GNU packages, ELPA packages, etc.—see the documentation for `--type` below. There are many packages, though, for which it lacks a method to determine whether a new upstream release is available. However, the mechanism is extensible, so feel free to get in touch with us to add a new method!

`--recursive`
Consider the packages specified, and all the packages upon which they depend.

```
$ guix refresh --recursive coreutils
gnu/packages/acl.scm:40:13: acl would be upgraded from 2.2.53 to 2.3.1
gnu/packages/m4.scm:30:12: 1.4.18 is already the latest version of m4
gnu/packages/xml.scm:68:2: warning: no updater for expat
gnu/packages/multiprecision.scm:40:12: 6.1.2 is already the latest version o
...
```

Sometimes the upstream name differs from the package name used in Guix, and `guix refresh` needs a little help. Most updaters honor the `upstream-name` property in package definitions, which can be used to that effect:

```
(define-public network-manager
  (package
    (name "network-manager")
```

```
        ;; ...
        (properties '((upstream-name . "NetworkManager")))))
```

When passed `--update`, it modifies distribution source files to update the version numbers and source tarball hashes of those package recipes (see Section 9.2 [Defining Packages], page 96). This is achieved by downloading each package's latest source tarball and its associated OpenPGP signature, authenticating the downloaded tarball against its signature using `gpgv`, and finally computing its hash—note that GnuPG must be installed and in `$PATH`; run `guix install gnupg` if needed.

When the public key used to sign the tarball is missing from the user's keyring, an attempt is made to automatically retrieve it from a public key server; when this is successful, the key is added to the user's keyring; otherwise, `guix refresh` reports an error.

The following options are supported:

`--expression=`*`expr`*
`-e `*`expr`*
: Consider the package *expr* evaluates to.

  This is useful to precisely refer to a package, as in this example:

  ```
  guix refresh -l -e '(@@ (gnu packages commencement) glibc-final)'
  ```

  This command lists the dependents of the "final" libc (essentially all the packages).

`--update`
`-u`
: Update distribution source files (package recipes) in place. This is usually run from a checkout of the Guix source tree (see Section 22.2 [Running Guix Before It Is Installed], page 627):

  ```
  $ ./pre-inst-env guix refresh -s non-core -u
  ```

  See Section 9.2 [Defining Packages], page 96, for more information on package definitions.

`--select=[`*`subset`*`]`
`-s `*`subset`*
: Select all the packages in *subset*, one of `core` or `non-core`.

  The `core` subset refers to all the packages at the core of the distribution—i.e., packages that are used to build "everything else". This includes GCC, libc, Binutils, Bash, etc. Usually, changing one of these packages in the distribution entails a rebuild of all the others. Thus, such updates are an inconvenience to users in terms of build time or bandwidth used to achieve the upgrade.

  The `non-core` subset refers to the remaining packages. It is typically useful in cases where an update of the core packages would be inconvenient.

`--manifest=`*`file`*
`-m `*`file`*
: Select all the packages from the manifest in *file*. This is useful to check if any packages of the user manifest can be updated.

`--type=`*`updater`*
`-t `*`updater`*
: Select only packages handled by *updater* (may be a comma-separated list of updaters). Currently, *updater* may be one of:

  `gnu` the updater for GNU packages;

`savannah` the updater for packages hosted at Savannah (`https://savannah.gnu.org`);

`sourceforge`
the updater for packages hosted at SourceForge (`https://sourceforge.net`);

`gnome` the updater for GNOME packages;

`kde` the updater for KDE packages;

`xorg` the updater for X.org packages;

`kernel.org`
the updater for packages hosted on kernel.org;

`egg` the updater for Egg (`https://wiki.call-cc.org/eggs/`) packages;

`elpa` the updater for ELPA (`https://elpa.gnu.org/`) packages;

`cran` the updater for CRAN (`https://cran.r-project.org/`) packages;

`bioconductor`
the updater for Bioconductor (`https://www.bioconductor.org/`) R packages;

`cpan` the updater for CPAN (`https://www.cpan.org/`) packages;

`pypi` the updater for PyPI (`https://pypi.python.org`) packages.

`gem` the updater for RubyGems (`https://rubygems.org`) packages.

`github` the updater for GitHub (`https://github.com`) packages.

`hackage` the updater for Hackage (`https://hackage.haskell.org`) packages.

`stackage` the updater for Stackage (`https://www.stackage.org`) packages.

`crate` the updater for Crates (`https://crates.io`) packages.

`launchpad`
the updater for Launchpad (`https://launchpad.net`) packages.

`generic-html`
a generic updater that crawls the HTML page where the source tarball of the package is hosted, when applicable.

`generic-git`
a generic updater for packages hosted on Git repositories. It tries to be smart about parsing Git tag names, but if it is not able to parse the tag name and compare tags correctly, users can define the following properties for a package.

- `release-tag-prefix`: a regular expression for matching a prefix of the tag name.

- `release-tag-suffix`: a regular expression for matching a suffix of the tag name.
- `release-tag-version-delimiter`: a string used as the delimiter in the tag name for separating the numbers of the version.
- `accept-pre-releases`: by default, the updater will ignore pre-releases; to make it also look for pre-releases, set the this property to `#t`.

```
(package
  (name "foo")
  ;; ...
  (properties
    '((release-tag-prefix . "^release0-")
      (release-tag-suffix . "[a-z]?$")
      (release-tag-version-delimiter . ":"))))
```

For instance, the following command only checks for updates of Emacs packages hosted at `elpa.gnu.org` and for updates of CRAN packages:

```
$ guix refresh --type=elpa,cran
gnu/packages/statistics.scm:819:13: r-testthat would be upgraded from 0.10.0
gnu/packages/emacs.scm:856:13: emacs-auctex would be upgraded from 11.88.6 t
```

`--list-updaters`
: List available updaters and exit (see `--type` above).

  For each updater, display the fraction of packages it covers; at the end, display the fraction of packages covered by all these updaters.

In addition, `guix refresh` can be passed one or more package names, as in this example:

```
$ ./pre-inst-env guix refresh -u emacs idutils gcc@4.8
```

The command above specifically updates the `emacs` and `idutils` packages. The `--select` option would have no effect in this case. You might also want to update definitions that correspond to the packages installed in your profile:

```
$ ./pre-inst-env guix refresh -u \
       $(guix package --list-installed | cut -f1)
```

When considering whether to upgrade a package, it is sometimes convenient to know which packages would be affected by the upgrade and should be checked for compatibility. For this the following option may be used when passing `guix refresh` one or more package names:

`--list-dependent`
`-l`
: List top-level dependent packages that would need to be rebuilt as a result of upgrading one or more packages.

  See Section 10.10 [Invoking guix graph], page 201, for information on how to visualize the list of dependents of a package.

Be aware that the `--list-dependent` option only *approximates* the rebuilds that would be required as a result of an upgrade. More rebuilds might be required under some circumstances.

```
$ guix refresh --list-dependent flex
```

```
Building the following 120 packages would ensure 213 dependent packages are rebuilt:█
hop@2.4.0 emacs-geiser@0.13 notmuch@0.18 mu@0.9.9.5 cflow@1.4 idutils@4.6 ...█
```

The command above lists a set of packages that could be built to check for compatibility with an upgraded `flex` package.

`--list-transitive`
: List all the packages which one or more packages depend upon.

```
$ guix refresh --list-transitive flex
flex@2.6.4 depends on the following 25 packages: perl@5.28.0 help2man@1.47.6
bison@3.0.5 indent@2.2.10 tar@1.30 gzip@1.9 bzip2@1.0.6 xz@5.2.4 file@5.33 .
```

The command above lists a set of packages which, when changed, would cause `flex` to be rebuilt.

The following options can be used to customize GnuPG operation:

`--gpg=`*`command`*
: Use *command* as the GnuPG 2.x command. *command* is searched for in `$PATH`.

`--keyring=`*`file`*
: Use *file* as the keyring for upstream keys. *file* must be in the *keybox format*. Keybox files usually have a name ending in `.kbx` and the GNU Privacy Guard (GPG) can manipulate these files (see Section "kbxutil" in *Using the GNU Privacy Guard*, for information on a tool to manipulate keybox files).

When this option is omitted, `guix refresh` uses `~/.config/guix/upstream/trustedkeys.kbx`█ as the keyring for upstream signing keys. OpenPGP signatures are checked against keys from this keyring; missing keys are downloaded to this keyring as well (see `--key-download` below).

You can export keys from your default GPG keyring into a keybox file using commands like this one:

```
gpg --export rms@gnu.org | kbxutil --import-openpgp >> mykeyring.kbx█
```

Likewise, you can fetch keys to a specific keybox file like this:

```
gpg --no-default-keyring --keyring mykeyring.kbx \
  --recv-keys 3CE464558A84FDC69DB40CFB090B11993D9AEBB5
```

See Section "GPG Configuration Options" in *Using the GNU Privacy Guard*, for more information on GPG's `--keyring` option.

`--key-download=`*`policy`*
: Handle missing OpenPGP keys according to *policy*, which may be one of:

`always`	Always download missing OpenPGP keys from the key server, and add them to the user's GnuPG keyring.
`never`	Never try to download missing OpenPGP keys. Instead just bail out.
`interactive`	When a package signed with an unknown OpenPGP key is encountered, ask the user whether to download it or not. This is the default behavior.

`--key-server=host`
: Use *host* as the OpenPGP key server when importing a public key.

`--load-path=directory`
`-L directory`
: Add *directory* to the front of the package module search path (see Section 9.1 [Package Modules], page 95).

  This allows users to define their own packages and make them visible to the command-line tools.

The `github` updater uses the GitHub API (`https://developer.github.com/v3/`) to query for new releases. When used repeatedly e.g. when refreshing all packages, GitHub will eventually refuse to answer any further API requests. By default 60 API requests per hour are allowed, and a full refresh on all GitHub packages in Guix requires more than this. Authentication with GitHub through the use of an API token alleviates these limits. To use an API token, set the environment variable `GUIX_GITHUB_TOKEN` to a token procured from `https://github.com/settings/tokens` or otherwise.

10.7 Invoking `guix style`

The `guix style` command helps users and packagers alike style their package definitions and configuration files according to the latest fashionable trends. It can either reformat whole files, with the `--whole-file` option, or apply specific *styling rules* to individual package definitions. The command currently provides the following styling rules:

- formatting package definitions according to the project's conventions (see Section 22.5.4 [Formatting Code], page 639);
- rewriting package inputs to the "new style", as explained below.

The way package inputs are written is going through a transition (see Section 9.2.1 [package Reference], page 99, for more on package inputs). Until version 1.3.0, package inputs were written using the "old style", where each input was given an explicit label, most of the time the package name:

```
(package
  ;; ...
  ;; The "old style" (deprecated).
  (inputs `(("libunistring" ,libunistring)
            ("libffi" ,libffi))))
```

Today, the old style is deprecated and the preferred style looks like this:

```
(package
  ;; ...
  ;; The "new style".
  (inputs (list libunistring libffi)))
```

Likewise, uses of `alist-delete` and friends to manipulate inputs is now deprecated in favor of `modify-inputs` (see Section 9.3 [Defining Package Variants], page 106, for more info on `modify-inputs`).

In the vast majority of cases, this is a purely mechanical change on the surface syntax that does not even incur a package rebuild. Running `guix style -S inputs` can do that for you, whether you're working on packages in Guix proper or in an external channel.

The general syntax is:

```
guix style [options] package...
```

This causes `guix style` to analyze and rewrite the definition of *package*... or, when *package* is omitted, of *all* the packages. The `--styling` or `-S` option allows you to select the style rule, the default rule being `format`—see below.

To reformat entire source files, the syntax is:

```
guix style --whole-file file...
```

The available options are listed below.

`--dry-run`
`-n` Show source file locations that would be edited but do not modify them.

`--whole-file`
`-f` Reformat the given files in their entirety. In that case, subsequent arguments are interpreted as file names (rather than package names), and the `--styling` option has no effect.

As an example, here is how you might reformat your operating system configuration (you need write permissions for the file):

```
guix style -f /etc/config.scm
```

`--styling=`*rule*
`-S` *rule* Apply *rule*, one of the following styling rules:

`format` Format the given package definition(s)—this is the default styling rule. For example, a packager running Guix on a checkout (see Section 22.2 [Running Guix Before It Is Installed], page 627) might want to reformat the definition of the Coreutils package like so:

```
./pre-inst-env guix style coreutils
```

`inputs` Rewrite package inputs to the “new style”, as described above. This is how you would rewrite inputs of package `whatnot` in your own channel:

```
guix style -L ~/my/channel -S inputs whatnot
```

Rewriting is done in a conservative way: preserving comments and bailing out if it cannot make sense of the code that appears in an inputs field. The `--input-simplification` option described below provides fine-grain control over when inputs should be simplified.

`--list-stylings`
`-l` List and describe the available styling rules and exit.

`--load-path=`*directory*
`-L` *directory*
Add *directory* to the front of the package module search path (see Section 9.1 [Package Modules], page 95).

`--expression=`*expr*
`-e` *expr* Style the package *expr* evaluates to.

For example, running:

```
guix style -e '(@ (gnu packages gcc) gcc-5)'
```

styles the `gcc-5` package definition.

`--input-simplification=`*`policy`*
: When using the `inputs` styling rule, with '`-S inputs`', this option specifies the package input simplification policy for cases where an input label does not match the corresponding package name. *policy* may be one of the following:

`silent`	Simplify inputs only when the change is "silent", meaning that the package does not need to be rebuilt (its derivation is unchanged).
`safe`	Simplify inputs only when that is "safe" to do: the package might need to be rebuilt, but the change is known to have no observable effect.
`always`	Simplify inputs even when input labels do not match package names, and even if that might have an observable effect.

The default is `silent`, meaning that input simplifications do not trigger any package rebuild.

10.8 Invoking `guix lint`

The `guix lint` command is meant to help package developers avoid common errors and use a consistent style. It runs a number of checks on a given set of packages in order to find common mistakes in their definitions. Available *checkers* include (see `--list-checkers` for a complete list):

`synopsis`
`description`
: Validate certain typographical and stylistic rules about package descriptions and synopses.

`inputs-should-be-native`
: Identify inputs that should most likely be native inputs.

`source`
`home-page`
`mirror-url`
`github-url`
`source-file-name`
: Probe `home-page` and `source` URLs and report those that are invalid. Suggest a `mirror://` URL when applicable. If the `source` URL redirects to a GitHub URL, recommend usage of the GitHub URL. Check that the source file name is meaningful, e.g. is not just a version number or "git-checkout", without a declared `file-name` (see Section 9.2.2 [origin Reference], page 103).

`source-unstable-tarball`
: Parse the `source` URL to determine if a tarball from GitHub is autogenerated or if it is a release tarball. Unfortunately GitHub's autogenerated tarballs are sometimes regenerated.

`derivation`
: Check that the derivation of the given packages can be successfully computed for all the supported systems (see Section 9.10 [Derivations], page 146).

`profile-collisions`
: Check whether installing the given packages in a profile would lead to collisions. Collisions occur when several packages with the same name but a different version or a different store file name are propagated. See Section 9.2.1 [package Reference], page 99, for more information on propagated inputs.

`archival`
: Checks whether the package's source code is archived at Software Heritage (`https://www.softwareheritage.org`).

When the source code that is not archived comes from a version-control system (VCS)—e.g., it's obtained with `git-fetch`, send Software Heritage a "save" request so that it eventually archives it. This ensures that the source will remain available in the long term, and that Guix can fall back to Software Heritage should the source code disappear from its original host. The status of recent "save" requests can be viewed on-line (`https://archive.softwareheritage.org/save/#requests`).

When source code is a tarball obtained with `url-fetch`, simply print a message when it is not archived. As of this writing, Software Heritage does not allow requests to save arbitrary tarballs; we are working on ways to ensure that non-VCS source code is also archived.

Software Heritage limits the request rate per IP address (`https://archive.softwareheritage.org/api/#rate-limiting`). When the limit is reached, `guix lint` prints a message and the `archival` checker stops doing anything until that limit has been reset.

`cve`
: Report known vulnerabilities found in the Common Vulnerabilities and Exposures (CVE) databases of the current and past year published by the US NIST (`https://nvd.nist.gov/vuln/data-feeds`).

To view information about a particular vulnerability, visit pages such as:

- '`https://web.nvd.nist.gov/view/vuln/detail?vulnId=CVE-YYYY-ABCD`'
- '`https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-YYYY-ABCD`'

where `CVE-YYYY-ABCD` is the CVE identifier—e.g., `CVE-2015-7554`.

Package developers can specify in package recipes the Common Platform Enumeration (CPE) (`https://nvd.nist.gov/products/cpe`) name and version of the package when they differ from the name or version that Guix uses, as in this example:

```
(package
  (name "grub")
  ;; ...
  ;; CPE calls this package "grub2".
  (properties '((cpe-name . "grub2")
                (cpe-version . "2.3"))))
```

Some entries in the CVE database do not specify which version of a package they apply to, and would thus "stick around" forever. Package developers who found CVE alerts and verified they can be ignored can declare them as in this example:

```
(package
  (name "t1lib")
  ;; ...
  ;; These CVEs no longer apply and can be safely ignored.
  (properties `((lint-hidden-cve . ("CVE-2011-0433"
                                    "CVE-2011-1553"
                                    "CVE-2011-1554"
                                    "CVE-2011-5244")))))
```

`formatting`
: Warn about obvious source code formatting issues: trailing white space, use of tabulations, etc.

`input-labels`
: Report old-style input labels that do not match the name of the corresponding package. This aims to help migrate from the "old input style". See Section 9.2.1 [package Reference], page 99, for more information on package inputs and input styles. See Section 10.7 [Invoking guix style], page 194, on how to migrate to the new style.

The general syntax is:

```
guix lint options package...
```

If no package is given on the command line, then all packages are checked. The *options* may be zero or more of the following:

`--list-checkers`
`-l`
: List and describe all the available checkers that will be run on packages and exit.

`--checkers`
`-c`
: Only enable the checkers specified in a comma-separated list using the names returned by `--list-checkers`.

`--exclude`
`-x`
: Only disable the checkers specified in a comma-separated list using the names returned by `--list-checkers`.

`--expression=`*`expr`*
`-e` *`expr`*
: Consider the package *expr* evaluates to.

  This is useful to unambiguously designate packages, as in this example:

```
guix lint -c archival -e '(@ (gnu packages guile) guile-3.0)'
```

`--no-network`
`-n`
: Only enable the checkers that do not depend on Internet access.

`--load-path=`*`directory`*
`-L` *`directory`*
: Add *directory* to the front of the package module search path (see Section 9.1 [Package Modules], page 95).

This allows users to define their own packages and make them visible to the command-line tools.

10.9 Invoking `guix size`

The `guix size` command helps package developers profile the disk usage of packages. It is easy to overlook the impact of an additional dependency added to a package, or the impact of using a single output for a package that could easily be split (see Section 6.4 [Packages with Multiple Outputs], page 53). Such are the typical issues that `guix size` can highlight.

The command can be passed one or more package specifications such as `gcc@4.8` or `guile:debug`, or a file name in the store. Consider this example:

```
$ guix size coreutils
store item                                   total    self
/gnu/store/...-gcc-5.5.0-lib                60.4    30.1  38.1%
/gnu/store/...-glibc-2.27                   30.3    28.8  36.6%
/gnu/store/...-coreutils-8.28               78.9    15.0  19.0%
/gnu/store/...-gmp-6.1.2                    63.1     2.7   3.4%
/gnu/store/...-bash-static-4.4.12            1.5     1.5   1.9%
/gnu/store/...-acl-2.2.52                   61.1     0.4   0.5%
/gnu/store/...-attr-2.4.47                  60.6     0.2   0.3%
/gnu/store/...-libcap-2.25                  60.5     0.2   0.2%
total: 78.9 MiB
```

The store items listed here constitute the *transitive closure* of Coreutils—i.e., Coreutils and all its dependencies, recursively—as would be returned by:

```
$ guix gc -R /gnu/store/...-coreutils-8.23
```

Here the output shows three columns next to store items. The first column, labeled "total", shows the size in mebibytes (MiB) of the closure of the store item—that is, its own size plus the size of all its dependencies. The next column, labeled "self", shows the size of the item itself. The last column shows the ratio of the size of the item itself to the space occupied by all the items listed here.

In this example, we see that the closure of Coreutils weighs in at 79 MiB, most of which is taken by libc and GCC's run-time support libraries. (That libc and GCC's libraries represent a large fraction of the closure is not a problem *per se* because they are always available on the system anyway.)

Since the command also accepts store file names, assessing the size of a build result is straightforward:

```
guix size $(guix system build config.scm)
```

When the package(s) passed to `guix size` are available in the store[1], `guix size` queries the daemon to determine its dependencies, and measures its size in the store, similar to `du -ms --apparent-size` (see Section "du invocation" in *GNU Coreutils*).

When the given packages are *not* in the store, `guix size` reports information based on the available substitutes (see Section 6.3 [Substitutes], page 48). This makes it possible it to profile disk usage of store items that are not even on disk, only available remotely.

[1] More precisely, `guix size` looks for the *ungrafted* variant of the given package(s), as returned by `guix build` *`package`* `--no-grafts`. See Chapter 19 [Security Updates], page 616, for information on grafts.

You can also specify several package names:

```
$ guix size coreutils grep sed bash
store item                               total    self
/gnu/store/...-coreutils-8.24           77.8    13.8  13.4%
/gnu/store/...-grep-2.22                73.1     0.8   0.8%
/gnu/store/...-bash-4.3.42              72.3     4.7   4.6%
/gnu/store/...-readline-6.3             67.6     1.2   1.2%
...
total: 102.3 MiB
```

In this example we see that the combination of the four packages takes 102.3 MiB in total, which is much less than the sum of each closure since they have a lot of dependencies in common.

When looking at the profile returned by `guix size`, you may find yourself wondering why a given package shows up in the profile at all. To understand it, you can use `guix graph --path -t references` to display the shortest path between the two packages (see Section 10.10 [Invoking guix graph], page 201).

The available options are:

`--substitute-urls=`*`urls`*

Use substitute information from *urls*. See [client-substitute-urls], page 167.

`--sort=`*`key`*

Sort lines according to *key*, one of the following options:

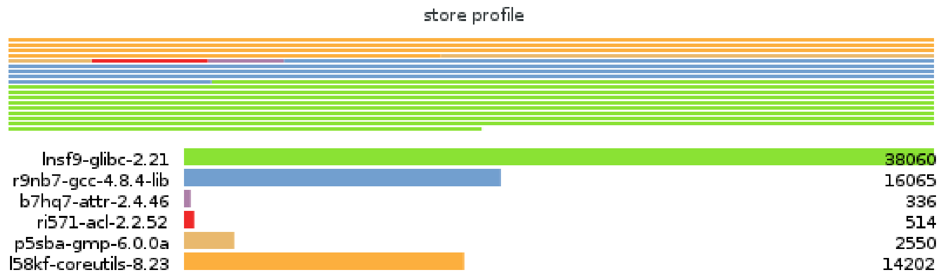
`self` the size of each item (the default);

`closure` the total size of the item's closure.

`--map-file=`*`file`*

Write a graphical map of disk usage in PNG format to *file*.

For the example above, the map looks like this:



This option requires that Guile-Charting (`https://wingolog.org/software/guile-charting/`) be installed and visible in Guile's module search path. When that is not the case, `guix size` fails as it tries to load it.

`--system=`*`system`*
`-s `*`system`* Consider packages for *system*—e.g., `x86_64-linux`.

`--load-path=`*`directory`*
`-L` *`directory`*

Add *directory* to the front of the package module search path (see Section 9.1 [Package Modules], page 95).

This allows users to define their own packages and make them visible to the command-line tools.

10.10 Invoking `guix graph`

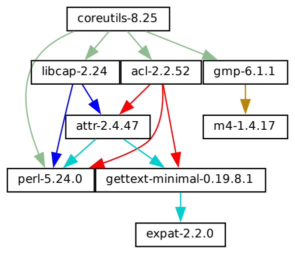
Packages and their dependencies form a *graph*, specifically a directed acyclic graph (DAG). It can quickly become difficult to have a mental model of the package DAG, so the `guix graph` command provides a visual representation of the DAG. By default, `guix graph` emits a DAG representation in the input format of Graphviz (`https://www.graphviz.org/`), so its output can be passed directly to the `dot` command of Graphviz. It can also emit an HTML page with embedded JavaScript code to display a "chord diagram" in a Web browser, using the d3.js (`https://d3js.org/`) library, or emit Cypher queries to construct a graph in a graph database supporting the openCypher (`https://www.opencypher.org/`) query language. With `--path`, it simply displays the shortest path between two packages. The general syntax is:

```
guix graph options package...
```

For example, the following command generates a PDF file representing the package DAG for the GNU Core Utilities, showing its build-time dependencies:

```
guix graph coreutils | dot -Tpdf > dag.pdf
```

The output looks like this:



Nice little graph, no?

You may find it more pleasant to navigate the graph interactively with `xdot` (from the `xdot` package):

```
guix graph coreutils | xdot -
```

But there is more than one graph! The one above is concise: it is the graph of package objects, omitting implicit inputs such as GCC, libc, grep, etc. It is often useful to have such a concise graph, but sometimes one may want to see more details. `guix graph` supports several types of graphs, allowing you to choose the level of detail:

`package` This is the default type used in the example above. It shows the DAG of package objects, excluding implicit dependencies. It is concise, but filters out many details.

`reverse-package`
This shows the *reverse* DAG of packages. For example:

```
guix graph --type=reverse-package ocaml
```

... yields the graph of packages that *explicitly* depend on OCaml (if you are also interested in cases where OCaml is an implicit dependency, see `reverse-bag` below).

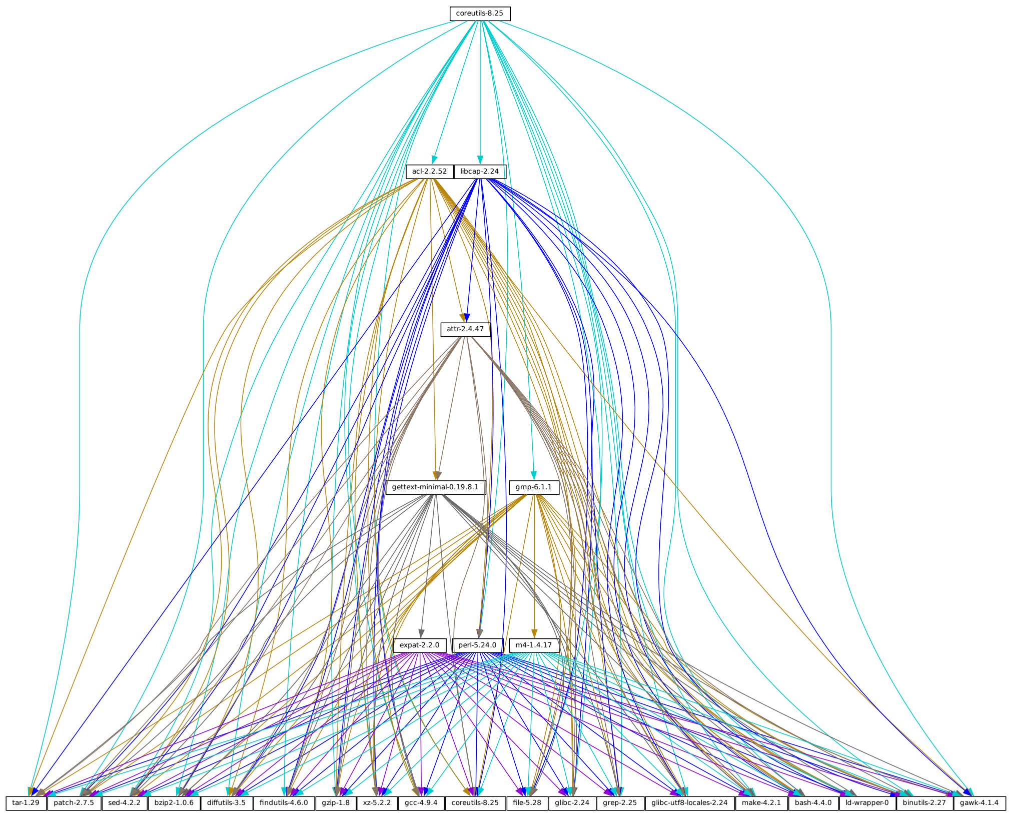
Note that for core packages this can yield huge graphs. If all you want is to know the number of packages that depend on a given package, use `guix refresh --list-dependent` (see Section 10.6 [Invoking guix refresh], page 189).

`bag-emerged`
This is the package DAG, *including* implicit inputs.

For instance, the following command:

```
guix graph --type=bag-emerged coreutils
```

... yields this bigger graph:



At the bottom of the graph, we see all the implicit inputs of *gnu-build-system* (see Section 9.5 [Build Systems], page 114).

Now, note that the dependencies of these implicit inputs—that is, the *bootstrap dependencies* (see Chapter 20 [Bootstrapping], page 618)—are not shown here, for conciseness.

`bag` Similar to `bag-emerged`, but this time including all the bootstrap dependencies.

`bag-with-origins`
Similar to `bag`, but also showing origins and their dependencies.

`reverse-bag`
This shows the *reverse* DAG of packages. Unlike `reverse-package`, it also takes implicit dependencies into account. For example:

```
guix graph -t reverse-bag dune
```

... yields the graph of all packages that depend on Dune, directly or indirectly. Since Dune is an *implicit* dependency of many packages *via* `dune-build-system`, this shows a large number of packages, whereas `reverse-package` would show very few if any.

`derivation`
This is the most detailed representation: It shows the DAG of derivations (see Section 9.10 [Derivations], page 146) and plain store items. Compared to the above representation, many additional nodes are visible, including build scripts, patches, Guile modules, etc.

For this type of graph, it is also possible to pass a `.drv` file name instead of a package name, as in:

```
guix graph -t derivation $(guix system build -d my-config.scm)
```

`module` This is the graph of *package modules* (see Section 9.1 [Package Modules], page 95). For example, the following command shows the graph for the package module that defines the `guile` package:

```
guix graph -t module guile | xdot -
```

All the types above correspond to *build-time dependencies*. The following graph type represents the *run-time dependencies*:

`references`
This is the graph of *references* of a package output, as returned by `guix gc --references` (see Section 6.5 [Invoking guix gc], page 53).

If the given package output is not available in the store, `guix graph` attempts to obtain dependency information from substitutes.

Here you can also pass a store file name instead of a package name. For example, the command below produces the reference graph of your profile (which can be big!):

```
guix graph -t references $(readlink -f ~/.guix-profile)
```

`referrers`
This is the graph of the *referrers* of a store item, as returned by `guix gc --referrers` (see Section 6.5 [Invoking guix gc], page 53).

This relies exclusively on local information from your store. For instance, let us suppose that the current Inkscape is available in 10 profiles on your machine; `guix graph -t referrers inkscape` will show a graph rooted at Inkscape and with those 10 profiles linked to it.

It can help determine what is preventing a store item from being garbage collected.

Often, the graph of the package you are interested in does not fit on your screen, and anyway all you want to know is *why* that package actually depends on some seemingly unrelated package. The `--path` option instructs `guix graph` to display the shortest path between two packages (or derivations, or store items, etc.):

```
$ guix graph --path emacs libunistring
emacs@26.3
mailutils@3.9
libunistring@0.9.10
$ guix graph --path -t derivation emacs libunistring
/gnu/store/...-emacs-26.3.drv
/gnu/store/...-mailutils-3.9.drv
/gnu/store/...-libunistring-0.9.10.drv
$ guix graph --path -t references emacs libunistring
/gnu/store/...-emacs-26.3
/gnu/store/...-libidn2-2.2.0
/gnu/store/...-libunistring-0.9.10
```

Sometimes you still want to visualize the graph but would like to trim it so it can actually be displayed. One way to do it is via the `--max-depth` (or `-M`) option, which lets you specify the maximum depth of the graph. In the example below, we visualize only `libreoffice` and the nodes whose distance to `libreoffice` is at most 2:

```
guix graph -M 2 libreoffice | xdot -f fdp -
```

Mind you, that's still a big ball of spaghetti, but at least `dot` can render it quickly and it can be browsed somewhat.

The available options are the following:

`--type=`*`type`*
`-t` *`type`*
: Produce a graph output of *type*, where *type* must be one of the values listed above.

`--list-types`
: List the supported graph types.

`--backend=`*`backend`*
`-b` *`backend`*
: Produce a graph using the selected *backend*.

`--list-backends`
: List the supported graph backends.

Currently, the available backends are Graphviz and d3.js.

`--path` Display the shortest path between two nodes of the type specified by `--type`. The example below shows the shortest path between `libreoffice` and `llvm` according to the references of `libreoffice`:

```
$ guix graph --path -t references libreoffice llvm
/gnu/store/...-libreoffice-6.4.2.2
/gnu/store/...-libepoxy-1.5.4
/gnu/store/...-mesa-19.3.4
/gnu/store/...-llvm-9.0.1
```

`--expression=`*`expr`*
`-e` *`expr`* Consider the package *expr* evaluates to.

This is useful to precisely refer to a package, as in this example:

```
guix graph -e '(@@ (gnu packages commencement) gnu-make-final)'
```

`--system=`*`system`*
`-s` *`system`* Display the graph for *system*—e.g., `i686-linux`.

The package dependency graph is largely architecture-independent, but there are some architecture-dependent bits that this option allows you to visualize.

`--load-path=`*`directory`*
`-L` *`directory`*
Add *directory* to the front of the package module search path (see Section 9.1 [Package Modules], page 95).

This allows users to define their own packages and make them visible to the command-line tools.

On top of that, `guix graph` supports all the usual package transformation options (see Section 10.1.2 [Package Transformation Options], page 168). This makes it easy to view the effect of a graph-rewriting transformation such as `--with-input`. For example, the command below outputs the graph of `git` once `openssl` has been replaced by `libressl` everywhere in the graph:

```
guix graph git --with-input=openssl=libressl
```

So many possibilities, so much fun!

10.11 Invoking `guix publish`

The purpose of `guix publish` is to enable users to easily share their store with others, who can then use it as a substitute server (see Section 6.3 [Substitutes], page 48).

When `guix publish` runs, it spawns an HTTP server which allows anyone with network access to obtain substitutes from it. This means that any machine running Guix can also act as if it were a build farm, since the HTTP interface is compatible with Cuirass, the software behind the `ci.guix.gnu.org` build farm.

For security, each substitute is signed, allowing recipients to check their authenticity and integrity (see Section 6.3 [Substitutes], page 48). Because `guix publish` uses the signing key of the system, which is only readable by the system administrator, it must be started as root; the `--user` option makes it drop root privileges early on.

The signing key pair must be generated before `guix publish` is launched, using `guix archive --generate-key` (see Section 6.10 [Invoking guix archive], page 64).

When the `--advertise` option is passed, the server advertises its availability on the local network using multicast DNS (mDNS) and DNS service discovery (DNS-SD), currently *via* Guile-Avahi (see *Using Avahi in Guile Scheme Programs*).

The general syntax is:

```
guix publish options...
```

Running `guix publish` without any additional arguments will spawn an HTTP server on port 8080:

```
guix publish
```

`guix publish` can also be started following the systemd "socket activation" protocol (see Section "Service De- and Constructors" in *The GNU Shepherd Manual*).

Once a publishing server has been authorized, the daemon may download substitutes from it. See Section 6.3.3 [Getting Substitutes from Other Servers], page 50.

By default, `guix publish` compresses archives on the fly as it serves them. This "on-the-fly" mode is convenient in that it requires no setup and is immediately available. However, when serving lots of clients, we recommend using the `--cache` option, which enables caching of the archives before they are sent to clients—see below for details. The `guix weather` command provides a handy way to check what a server provides (see Section 10.15 [Invoking guix weather], page 213).

As a bonus, `guix publish` also serves as a content-addressed mirror for source files referenced in `origin` records (see Section 9.2.2 [origin Reference], page 103). For instance, assuming `guix publish` is running on `example.org`, the following URL returns the raw `hello-2.10.tar.gz` file with the given SHA256 hash (represented in `nix-base32` format, see Section 10.4 [Invoking guix hash], page 180):

```
http://example.org/file/hello-2.10.tar.gz/sha256/0ssi1...ndq1i
```

Obviously, these URLs only work for files that are in the store; in other cases, they return 404 ("Not Found").

Build logs are available from `/log` URLs like:

```
http://example.org/log/gwspk...-guile-2.2.3
```

When `guix-daemon` is configured to save compressed build logs, as is the case by default (see Section 2.5 [Invoking guix-daemon], page 15), `/log` URLs return the compressed log as-is, with an appropriate `Content-Type` and/or `Content-Encoding` header. We recommend running `guix-daemon` with `--log-compression=gzip` since Web browsers can automatically decompress it, which is not the case with Bzip2 compression.

The following options are available:

`--port=`*`port`*
`-p `*`port`* Listen for HTTP requests on *port*.

`--listen=`*`host`*
Listen on the network interface for *host*. The default is to accept connections from any interface.

`--user=`*`user`*
`-u `*`user`* Change privileges to *user* as soon as possible—i.e., once the server socket is open and the signing key has been read.

`--compression[=`*`method`*`[:`*`level`*`]]`
`-C [`*`method`*`[:`*`level`*`]]`

Compress data using the given *method* and *level*. *method* is one of `lzip`, `zstd`, and `gzip`; when *method* is omitted, `gzip` is used.

When *level* is zero, disable compression. The range 1 to 9 corresponds to different compression levels: 1 is the fastest, and 9 is the best (CPU-intensive). The default is 3.

Usually, `lzip` compresses noticeably better than `gzip` for a small increase in CPU usage; see benchmarks on the lzip Web page (`https://nongnu.org/lzip/lzip_benchmark.html`). However, `lzip` achieves low decompression throughput (on the order of 50 MiB/s on modern hardware), which can be a bottleneck for someone who downloads over a fast network connection.

The compression ratio of `zstd` is between that of `lzip` and that of `gzip`; its main advantage is a high decompression speed (`https://facebook.github.io/zstd/`).

Unless `--cache` is used, compression occurs on the fly and the compressed streams are not cached. Thus, to reduce load on the machine that runs `guix publish`, it may be a good idea to choose a low compression level, to run `guix publish` behind a caching proxy, or to use `--cache`. Using `--cache` has the advantage that it allows `guix publish` to add `Content-Length` HTTP header to its responses.

This option can be repeated, in which case every substitute gets compressed using all the selected methods, and all of them are advertised. This is useful when users may not support all the compression methods: they can select the one they support.

`--cache=`*`directory`*
`-c `*`directory`*

Cache archives and meta-data (`.narinfo` URLs) to *directory* and only serve archives that are in cache.

When this option is omitted, archives and meta-data are created on-the-fly. This can reduce the available bandwidth, especially when compression is enabled, since this may become CPU-bound. Another drawback of the default mode is that the length of archives is not known in advance, so `guix publish` does not add a `Content-Length` HTTP header to its responses, which in turn prevents clients from knowing the amount of data being downloaded.

Conversely, when `--cache` is used, the first request for a store item (*via* a `.narinfo` URL) triggers a background process to *bake* the archive—computing its `.narinfo` and compressing the archive, if needed. Once the archive is cached in *directory*, subsequent requests succeed and are served directly from the cache, which guarantees that clients get the best possible bandwidth.

That first `.narinfo` request nonetheless returns 200, provided the requested store item is "small enough", below the cache bypass threshold—see `--cache-bypass-threshold` below. That way, clients do not have to wait until the archive is baked. For larger store items, the first `.narinfo` request returns 404, meaning that clients have to wait until the archive is baked.

The "baking" process is performed by worker threads. By default, one thread per CPU core is created, but this can be customized. See `--workers` below.

When `--ttl` is used, cached entries are automatically deleted when they have expired.

`--workers=`*N*
: When `--cache` is used, request the allocation of *N* worker threads to "bake" archives.

`--ttl=`*ttl*
: Produce `Cache-Control` HTTP headers that advertise a time-to-live (TTL) of *ttl*. *ttl* must denote a duration: `5d` means 5 days, `1m` means 1 month, and so on.

This allows the user's Guix to keep substitute information in cache for *ttl*. However, note that `guix publish` does not itself guarantee that the store items it provides will indeed remain available for as long as *ttl*.

Additionally, when `--cache` is used, cached entries that have not been accessed for *ttl* and that no longer have a corresponding item in the store, may be deleted.

`--negative-ttl=`*ttl*
: Similarly produce `Cache-Control` HTTP headers to advertise the time-to-live (TTL) of *negative* lookups—missing store items, for which the HTTP 404 code is returned. By default, no negative TTL is advertised.

This parameter can help adjust server load and substitute latency by instructing cooperating clients to be more or less patient when a store item is missing.

`--cache-bypass-threshold=`*size*
: When used in conjunction with `--cache`, store items smaller than *size* are immediately available, even when they are not yet in cache. *size* is a size in bytes, or it can be suffixed by `M` for megabytes and so on. The default is `10M`.

"Cache bypass" allows you to reduce the publication delay for clients at the expense of possibly additional I/O and CPU use on the server side: depending on the client access patterns, those store items can end up being baked several times until a copy is available in cache.

Increasing the threshold may be useful for sites that have few users, or to guarantee that users get substitutes even for store items that are not popular.

`--nar-path=`*path*
: Use *path* as the prefix for the URLs of "nar" files (see Section 6.10 [Invoking guix archive], page 64).

By default, nars are served at a URL such as `/nar/gzip/...-coreutils-8.25`. This option allows you to change the `/nar` part to *path*.

`--public-key=`*file*
`--private-key=`*file*
: Use the specific *file*s as the public/private key pair used to sign the store items being published.

The files must correspond to the same key pair (the private key is used for signing and the public key is merely advertised in the signature metadata). They must contain keys in the canonical s-expression format as produced by `guix archive --generate-key` (see Section 6.10 [Invoking guix archive], page 64). By default, `/etc/guix/signing-key.pub` and `/etc/guix/signing-key.sec` are used.

`--repl[=`*port*`]`
`-r [`*port*`]` Spawn a Guile REPL server (see Section "REPL Servers" in *GNU Guile Reference Manual*) on *port* (37146 by default). This is used primarily for debugging a running `guix publish` server.

Enabling `guix publish` on Guix System is a one-liner: just instantiate a `guix-publish-service-type` service in the `services` field of the `operating-system` declaration (see [guix-publish-service-type], page 260).

If you are instead running Guix on a "foreign distro", follow these instructions:

- If your host distro uses the systemd init system:

  ```
  # ln -s ~root/.guix-profile/lib/systemd/system/guix-publish.service \
          /etc/systemd/system/
  # systemctl start guix-publish && systemctl enable guix-publish
  ```

- If your host distro uses the Upstart init system:

  ```
  # ln -s ~root/.guix-profile/lib/upstart/system/guix-publish.conf /etc/init/
  # start guix-publish
  ```

- Otherwise, proceed similarly with your distro's init system.

10.12 Invoking `guix challenge`

Do the binaries provided by this server really correspond to the source code it claims to build? Is a package build process deterministic? These are the questions the `guix challenge` command attempts to answer.

The former is obviously an important question: Before using a substitute server (see Section 6.3 [Substitutes], page 48), one had better *verify* that it provides the right binaries, and thus *challenge* it. The latter is what enables the former: If package builds are deterministic, then independent builds of the package should yield the exact same result, bit for bit; if a server provides a binary different from the one obtained locally, it may be either corrupt or malicious.

We know that the hash that shows up in `/gnu/store` file names is the hash of all the inputs of the process that built the file or directory—compilers, libraries, build scripts, etc. (see Chapter 1 [Introduction], page 1). Assuming deterministic build processes, one store file name should map to exactly one build output. `guix challenge` checks whether there is, indeed, a single mapping by comparing the build outputs of several independent builds of any given store item.

The command output looks like this:

```
$ guix challenge \
  --substitute-urls="https://ci.guix.gnu.org https://guix.example.org" \
  openssl git pius coreutils grep
updating substitutes from 'https://ci.guix.gnu.org'... 100.0%
updating substitutes from 'https://guix.example.org'... 100.0%
/gnu/store/...-openssl-1.0.2d contents differ:
```

```
    local hash: 0725l22r5jnzazaacncwsvp9kgf42266ayyp814v7djxs7nk963q
    https://ci.guix.gnu.org/nar/...-openssl-1.0.2d: 0725l22r5jnzazaacncwsvp9kgf42266ayyp814v7djxs7nk963q
    https://guix.example.org/nar/...-openssl-1.0.2d: 1zy4fmaaqcnjrzzajkdn3f5gmjk754b43qkq47llbyak9z0qjyim
    differing files:
      /lib/libcrypto.so.1.1
      /lib/libssl.so.1.1

  /gnu/store/...-git-2.5.0 contents differ:
    local hash: 00p3bmryhjxrhpn2gxs2fy0a15lnip05l97205pgbk5ra395hyha
    https://ci.guix.gnu.org/nar/...-git-2.5.0: 069nb85bv4d4a6slrwjdy8v1cn4cwspm3kdbmyb81d6zckj3nq9f
    https://guix.example.org/nar/...-git-2.5.0: 0mdqa9w1p6cmli6976v4wi0sw9r4p5prkj7lzfd1877wk11c9c73
    differing file:
      /libexec/git-core/git-fsck

  /gnu/store/...-pius-2.1.1 contents differ:
    local hash: 0k4v3m9z1zp8xzzizb7d8kjj72f9172xv078sq4wl73vnq9ig3ax
    https://ci.guix.gnu.org/nar/...-pius-2.1.1: 0k4v3m9z1zp8xzzizb7d8kjj72f9172xv078sq4wl73vnq9ig3ax
    https://guix.example.org/nar/...-pius-2.1.1: 1cy25x1a4fzq5rk0pmvc8xhwyffnqz95h2bpvqsz2mpvlbccy0gs
    differing file:
      /share/man/man1/pius.1.gz

  ...

  5 store items were analyzed:
    - 2 (40.0%) were identical
    - 3 (60.0%) differed
    - 0 (0.0%) were inconclusive
```

In this example, `guix challenge` queries all the substitute servers for each of the fives packages specified on the command line. It then reports those store items for which the servers obtained a result different from the local build (if it exists) and/or different from one another; here, the '`local hash`' lines indicate that a local build result was available for each of these packages and shows its hash.

As an example, `guix.example.org` always gets a different answer. Conversely, `ci.guix.gnu.org` agrees with local builds, except in the case of Git. This might indicate that the build process of Git is non-deterministic, meaning that its output varies as a function of various things that Guix does not fully control, in spite of building packages in isolated environments (see Section 6.1 [Features], page 38). Most common sources of non-determinism include the addition of timestamps in build results, the inclusion of random numbers, and directory listings sorted by inode number. See `https://reproducible-builds.org/docs/`, for more information.

To find out what is wrong with this Git binary, the easiest approach is to run:

```
guix challenge git \
  --diff=diffoscope \
  --substitute-urls="https://ci.guix.gnu.org https://guix.example.org"
```

This automatically invokes `diffoscope`, which displays detailed information about files that differ.

Alternatively, we can do something along these lines (see Section 6.10 [Invoking guix archive], page 64):

```
$ wget -q -O - https://ci.guix.gnu.org/nar/lzip/...-git-2.5.0 \
   | lzip -d | guix archive -x /tmp/git
$ diff -ur --no-dereference /gnu/store/...-git.2.5.0 /tmp/git
```

This command shows the difference between the files resulting from the local build, and the files resulting from the build on `ci.guix.gnu.org` (see Section "Overview" in *Comparing and Merging Files*). The `diff` command works great for text files. When binary files differ, a better option is Diffoscope (`https://diffoscope.org/`), a tool that helps visualize differences for all kinds of files.

Once you have done that work, you can tell whether the differences are due to a non-deterministic build process or to a malicious server. We try hard to remove sources of non-determinism in packages to make it easier to verify substitutes, but of course, this is a process that involves not just Guix, but a large part of the free software community. In the meantime, `guix challenge` is one tool to help address the problem.

If you are writing packages for Guix, you are encouraged to check whether `ci.guix.gnu.org` and other substitute servers obtain the same build result as you did with:

```
guix challenge package
```

The general syntax is:

```
guix challenge options argument...
```

where *argument* is a package specification such as `guile@2.0` or `glibc:debug` or, alternatively, a store file name as returned, for example, by `guix build` or `guix gc --list-live`.

When a difference is found between the hash of a locally-built item and that of a server-provided substitute, or among substitutes provided by different servers, the command displays it as in the example above and its exit code is 2 (other non-zero exit codes denote other kinds of errors).

The one option that matters is:

`--substitute-urls=`*urls*
: Consider *urls* the whitespace-separated list of substitute source URLs to compare to.

`--diff=`*mode*
: Upon mismatches, show differences according to *mode*, one of:

  `simple` (the default)
  : Show the list of files that differ.

  `diffoscope`
  command
  : Invoke Diffoscope (`https://diffoscope.org/`), passing it two directories whose contents do not match.

    When *command* is an absolute file name, run *command* instead of Diffoscope.

  `none`
  : Do not show further details about the differences.

  Thus, unless `--diff=none` is passed, `guix challenge` downloads the store items from the given substitute servers so that it can compare them.

`--verbose`
`-v`
: Show details about matches (identical contents) in addition to information about mismatches.

10.13 Invoking `guix copy`

The `guix copy` command copies items from the store of one machine to that of another machine over a secure shell (SSH) connection[2]. For example, the following command copies the `coreutils` package, the user's profile, and all their dependencies over to *host*, logged in as *user*:

```
guix copy --to=user@host \
          coreutils $(readlink -f ~/.guix-profile)
```

If some of the items to be copied are already present on *host*, they are not actually sent.

The command below retrieves `libreoffice` and `gimp` from *host*, assuming they are available there:

```
guix copy --from=host libreoffice gimp
```

The SSH connection is established using the Guile-SSH client, which is compatible with OpenSSH: it honors `~/.ssh/known_hosts` and `~/.ssh/config`, and uses the SSH agent for authentication.

The key used to sign items that are sent must be accepted by the remote machine. Likewise, the key used by the remote machine to sign items you are retrieving must be in `/etc/guix/acl` so it is accepted by your own daemon. See Section 6.10 [Invoking guix archive], page 64, for more information about store item authentication.

The general syntax is:

```
guix copy [--to=spec|--from=spec] items...
```

You must always specify one of the following options:

`--to=spec`
`--from=spec`
: Specify the host to send to or receive from. *spec* must be an SSH spec such as `example.org`, `charlie@example.org`, or `charlie@example.org:2222`.

The *items* can be either package names, such as `gimp`, or store items, such as `/gnu/store/...-idutils-4.6`.

When specifying the name of a package to send, it is first built if needed, unless `--dry-run` was specified. Common build options are supported (see Section 10.1.1 [Common Build Options], page 166).

10.14 Invoking `guix container`

> **Note:** As of version 1.4.0, this tool is experimental. The interface is subject to radical change in the future.

The purpose of `guix container` is to manipulate processes running within an isolated environment, commonly known as a "container", typically created by the `guix shell` (see Section 8.1 [Invoking guix shell], page 76) and `guix system container` (see Section 12.15 [Invoking guix system], page 545) commands.

The general syntax is:

```
guix container action options...
```

[2] This command is available only when Guile-SSH was found. See Section 2.2 [Requirements], page 7, for details.

action specifies the operation to perform with a container, and *options* specifies the context-specific arguments for the action.

The following actions are available:

`exec` Execute a command within the context of a running container.

The syntax is:

```
guix container exec pid program arguments...
```

pid specifies the process ID of the running container. *program* specifies an executable file name within the root file system of the container. *arguments* are the additional options that will be passed to *program*.

The following command launches an interactive login shell inside a Guix system container, started by `guix system container`, and whose process ID is 9001:

```
guix container exec 9001 /run/current-system/profile/bin/bash --login
```

Note that the *pid* cannot be the parent process of a container. It must be PID 1 of the container or one of its child processes.

10.15 Invoking `guix weather`

Occasionally you're grumpy because substitutes are lacking and you end up building packages by yourself (see Section 6.3 [Substitutes], page 48). The `guix weather` command reports on substitute availability on the specified servers so you can have an idea of whether you'll be grumpy today. It can sometimes be useful info as a user, but it is primarily useful to people running `guix publish` (see Section 10.11 [Invoking guix publish], page 205).

Here's a sample run:

```
$ guix weather --substitute-urls=https://guix.example.org
computing 5,872 package derivations for x86_64-linux...
looking for 6,128 store items on https://guix.example.org..
updating substitutes from 'https://guix.example.org'... 100.0%
https://guix.example.org
  43.4% substitutes available (2,658 out of 6,128)
  7,032.5 MiB of nars (compressed)
  19,824.2 MiB on disk (uncompressed)
  0.030 seconds per request (182.9 seconds in total)
  33.5 requests per second

  9.8% (342 out of 3,470) of the missing items are queued
  867 queued builds
      x86_64-linux: 518 (59.7%)
      i686-linux: 221 (25.5%)
      aarch64-linux: 128 (14.8%)
  build rate: 23.41 builds per hour
      x86_64-linux: 11.16 builds per hour
      i686-linux: 6.03 builds per hour
      aarch64-linux: 6.41 builds per hour
```

As you can see, it reports the fraction of all the packages for which substitutes are available on the server—regardless of whether substitutes are enabled, and regardless of whether this server's signing key is authorized. It also reports the size of the compressed archives ("nars") provided by the server, the size the corresponding store items occupy in the store (assuming deduplication is turned off), and the server's throughput. The second part gives continuous integration (CI) statistics, if the server supports it. In addition, using the `--coverage` option, `guix weather` can list "important" package substitutes missing on the server (see below).

To achieve that, `guix weather` queries over HTTP(S) meta-data (*narinfos*) for all the relevant store items. Like `guix challenge`, it ignores signatures on those substitutes, which is innocuous since the command only gathers statistics and cannot install those substitutes.

The general syntax is:

```
guix weather options... [packages...]
```

When *packages* is omitted, `guix weather` checks the availability of substitutes for *all* the packages, or for those specified with `--manifest`; otherwise it only considers the specified packages. It is also possible to query specific system types with `--system`. `guix weather` exits with a non-zero code when the fraction of available substitutes is below 100%.

The available options are listed below.

`--substitute-urls=urls`
: *urls* is the space-separated list of substitute server URLs to query. When this option is omitted, the default set of substitute servers is queried.

`--system=system`
`-s system`
: Query substitutes for *system*—e.g., `aarch64-linux`. This option can be repeated, in which case `guix weather` will query substitutes for several system types.

`--manifest=file`
: Instead of querying substitutes for all the packages, only ask for those specified in *file*. *file* must contain a *manifest*, as with the `-m` option of `guix package` (see Section 6.2 [Invoking guix package], page 39).

  This option can be repeated several times, in which case the manifests are concatenated.

`--coverage[=count]`
`-c [count]`
: Report on substitute coverage for packages: list packages with at least *count* dependents (zero by default) for which substitutes are unavailable. Dependent packages themselves are not listed: if *b* depends on *a* and *a* has no substitutes, only *a* is listed, even though *b* usually lacks substitutes as well. The result looks like this:

```
$ guix weather --substitute-urls=https://ci.guix.gnu.org https://bordeaux.gu
computing 8,983 package derivations for x86_64-linux...
looking for 9,343 store items on https://ci.guix.gnu.org https://bordeaux.gu
updating substitutes from 'https://ci.guix.gnu.org https://bordeaux.guix.gnu
https://ci.guix.gnu.org https://bordeaux.guix.gnu.org
  64.7% substitutes available (6,047 out of 9,343)
...
2502 packages are missing from 'https://ci.guix.gnu.org https://bordeaux.gui
```

```
58  kcoreaddons@5.49.0      /gnu/store/...-kcoreaddons-5.49.0
46  qgpgme@1.11.1           /gnu/store/...-qgpgme-1.11.1
37  perl-http-cookiejar@0.008  /gnu/store/...-perl-http-cookiejar-0.008
...
```

What this example shows is that `kcoreaddons` and presumably the 58 packages that depend on it have no substitutes at `ci.guix.gnu.org`; likewise for `qgpgme` and the 46 packages that depend on it.

If you are a Guix developer, or if you are taking care of this build farm, you'll probably want to have a closer look at these packages: they may simply fail to build.

`--display-missing`
Display the list of store items for which substitutes are missing.

10.16 Invoking guix processes

The `guix processes` command can be useful to developers and system administrators, especially on multi-user machines and on build farms: it lists the current sessions (connections to the daemon), as well as information about the processes involved[3]. Here's an example of the information it returns:

```
$ sudo guix processes
SessionPID: 19002
ClientPID: 19090
ClientCommand: guix shell python

SessionPID: 19402
ClientPID: 19367
ClientCommand: guix publish -u guix-publish -p 3000 -C 9 ...

SessionPID: 19444
ClientPID: 19419
ClientCommand: cuirass --cache-directory /var/cache/cuirass ...
LockHeld: /gnu/store/...-perl-ipc-cmd-0.96.lock
LockHeld: /gnu/store/...-python-six-bootstrap-1.11.0.lock
LockHeld: /gnu/store/...-libjpeg-turbo-2.0.0.lock
ChildPID: 20495
ChildCommand: guix offload x86_64-linux 7200 1 28800
ChildPID: 27733
ChildCommand: guix offload x86_64-linux 7200 1 28800
ChildPID: 27793
ChildCommand: guix offload x86_64-linux 7200 1 28800
```

In this example we see that `guix-daemon` has three clients: `guix environment`, `guix publish`, and the Cuirass continuous integration tool; their process identifier (PID) is given by the `ClientPID` field. The `SessionPID` field gives the PID of the `guix-daemon` sub-process of this particular session.

[3] Remote sessions, when `guix-daemon` is started with `--listen` specifying a TCP endpoint, are *not* listed.

The `LockHeld` fields show which store items are currently locked by this session, which corresponds to store items being built or substituted (the `LockHeld` field is not displayed when `guix processes` is not running as root). Last, by looking at the `ChildPID` and `ChildCommand` fields, we understand that these three builds are being offloaded (see Section 2.4.2 [Daemon Offload Setup], page 11).

The output is in Recutils format so we can use the handy `recsel` command to select sessions of interest (see Section "Selection Expressions" in *GNU recutils manual*). As an example, the command shows the command line and PID of the client that triggered the build of a Perl package:

```
$ sudo guix processes | \
    recsel -p ClientPID,ClientCommand -e 'LockHeld ~ "perl"'
ClientPID: 19419
ClientCommand: cuirass --cache-directory /var/cache/cuirass ...
```

Additional options are listed below.

`--format=`*format*
`-f` *format* Produce output in the specified *format*, one of:

`recutils` The default option. It outputs a set of Session recutils records that include each `ChildProcess` as a field.

`normalized`
Normalize the output records into record sets (see Section "Record Sets" in *GNU recutils manual*). Normalizing into record sets allows joins across record types. The example below lists the PID of each `ChildProcess` and the associated PID for `Session` that spawned the `ChildProcess` where the `Session` was started using `guix build`.

```
$ guix processes --format=normalized | \
    recsel \
    -j Session \
    -t ChildProcess \
    -p Session.PID,PID \
    -e 'Session.ClientCommand ~ "guix build"'
PID: 4435
Session_PID: 4278

PID: 4554
Session_PID: 4278

PID: 4646
Session_PID: 4278
```

11 Foreign Architectures

You can target computers of different CPU architectures when producing packages (see Section 6.2 [Invoking guix package], page 39), packs (see Section 8.3 [Invoking guix pack], page 87) or full systems (see Section 12.15 [Invoking guix system], page 545).

GNU Guix supports two distinct mechanisms to target foreign architectures:

1. The traditional cross-compilation (`https://en.wikipedia.org/wiki/Cross_compiler`) mechanism.
2. The native building mechanism which consists in building using the CPU instruction set of the foreign system you are targeting. It often requires emulation, using the QEMU program for instance.

11.1 Cross-Compilation

The commands supporting cross-compilation are proposing the `--list-targets` and `--target` options.

The `--list-targets` option lists all the supported targets that can be passed as an argument to `--target`.

```
$ guix build --list-targets
The available targets are:

   - aarch64-linux-gnu
   - arm-linux-gnueabihf
   - i586-pc-gnu
   - i686-linux-gnu
   - i686-w64-mingw32
   - mips64el-linux-gnu
   - powerpc-linux-gnu
   - powerpc64le-linux-gnu
   - riscv64-linux-gnu
   - x86_64-linux-gnu
   - x86_64-w64-mingw32
```

Targets are specified as GNU triplets (see Section "Specifying Target Triplets" in *Autoconf*).

Those triplets are passed to GCC and the other underlying compilers possibly involved when building a package, a system image or any other GNU Guix output.

```
$ guix build --target=aarch64-linux-gnu hello
/gnu/store/9926by9qrxa91ijkhw9ndgwp4bn24g9h-hello-2.12

$ file /gnu/store/9926by9qrxa91ijkhw9ndgwp4bn24g9h-hello-2.12/bin/hello
/gnu/store/9926by9qrxa91ijkhw9ndgwp4bn24g9h-hello-2.12/bin/hello: ELF
64-bit LSB executable, ARM aarch64 ...
```

The major benefit of cross-compilation is that there are no performance penaly compared to emulation using QEMU. There are however higher risks that some packages fail to cross-compile because few users are using this mechanism extensively.

11.2 Native Builds

The commands that support impersonating a specific system have the `--list-systems` and `--system` options.

The `--list-systems` option lists all the supported systems that can be passed as an argument to `--system`.

```
$ guix build --list-systems
The available systems are:

   - x86_64-linux [current]
   - aarch64-linux
   - armhf-linux
   - i586-gnu
   - i686-linux
   - mips64el-linux
   - powerpc-linux
   - powerpc64le-linux
   - riscv64-linux

$ guix build --system=i686-linux hello
/gnu/store/cc0km35s8x2z4pmwkrqqjx46i8b1i3gm-hello-2.12

$ file /gnu/store/cc0km35s8x2z4pmwkrqqjx46i8b1i3gm-hello-2.12/bin/hello
/gnu/store/cc0km35s8x2z4pmwkrqqjx46i8b1i3gm-hello-2.12/bin/hello: ELF
32-bit LSB executable, Intel 80386 ...
```

In the above example, the current system is *x86_64-linux*. The *hello* package is however built for the *i686-linux* system.

This is possible because the *i686* CPU instruction set is a subset of the *x86_64*, hence *i686* targeting binaries can be run on *x86_64*.

Still in the context of the previous example, if picking the *aarch64-linux* system and the `guix build --system=aarch64-linux hello` has to build some derivations, an extra step might be needed.

The *aarch64-linux* targeting binaries cannot directly be run on a *x86_64-linux* system. An emulation layer is requested. The GNU Guix daemon can take advantage of the Linux kernel binfmt_misc (`https://en.wikipedia.org/wiki/Binfmt_misc`) mechanism for that. In short, the Linux kernel can defer the execution of a binary targeting a foreign platform, here *aarch64-linux*, to a userspace program, usually an emulator.

There is a service that registers QEMU as a backend for the `binfmt_misc` mechanism (see Section 12.9.29 [Virtualization Services], page 471). On Debian based foreign distributions, the alternative would be the `qemu-user-static` package.

If the `binfmt_misc` mechanism is not setup correctly, the building will fail this way:

```
$ guix build --system=armhf-linux hello --check
...
 unsupported-platform /gnu/store/jjn969pijv7hff62025yxpfmc8zy0aq0-hello-2.12.drv aarch
while setting up the build environment: a `aarch64-linux' is required to
```

```
build `/gnu/store/jjn969pijv7hff62025yxpfmc8zy0aq0-hello-2.12.drv', but
I am a `x86_64-linux'...
```

whereas, with the `binfmt_misc` mechanism correctly linked with QEMU, one can expect to see:

```
$ guix build --system=armhf-linux hello --check
/gnu/store/13xz4nghg39wpymivlwghy08yzj97hlj-hello-2.12
```

The main advantage of native building compared to cross-compiling, is that more packages are likely to build correctly. However it comes at a price: compilation backed by QEMU is *way slower* than cross-compilation, because every instruction needs to be emulated.

The availability of substitutes for the architecture targeted by the `--system` option can mitigate this problem. An other way to work around it is to install GNU Guix on a machine whose CPU supports the targeted instruction set, and set it up as an offload machine (see Section 2.4.2 [Daemon Offload Setup], page 11).

12 System Configuration

Guix System supports a consistent whole-system configuration mechanism. By that we mean that all aspects of the global system configuration—such as the available system services, timezone and locale settings, user accounts—are declared in a single place. Such a *system configuration* can be *instantiated*—i.e., effected.

One of the advantages of putting all the system configuration under the control of Guix is that it supports transactional system upgrades, and makes it possible to roll back to a previous system instantiation, should something go wrong with the new one (see Section 6.1 [Features], page 38). Another advantage is that it makes it easy to replicate the exact same configuration across different machines, or at different points in time, without having to resort to additional administration tools layered on top of the own tools of the system.

This section describes this mechanism. First we focus on the system administrator's viewpoint—explaining how the system is configured and instantiated. Then we show how this mechanism can be extended, for instance to support new system services.

12.1 Using the Configuration System

The operating system is configured by providing an `operating-system` declaration in a file that can then be passed to the `guix system` command (see Section 12.15 [Invoking guix system], page 545). A simple setup, with the default system services, the default Linux-Libre kernel, initial RAM disk, and boot loader looks like this:

```
;; This is an operating system configuration template
;; for a "bare bones" setup, with no X11 display server.

(use-modules (gnu))
(use-service-modules networking ssh)
(use-package-modules screen ssh)

(operating-system
  (host-name "komputilo")
  (timezone "Europe/Berlin")
  (locale "en_US.utf8")

  ;; Boot in "legacy" BIOS mode, assuming /dev/sdX is the
  ;; target hard disk, and "my-root" is the label of the target
  ;; root file system.
  (bootloader (bootloader-configuration
                (bootloader grub-bootloader)
                (targets '("/dev/sdX"))))
  ;; It's fitting to support the equally bare bones ‘-nographic’
  ;; QEMU option, which also nicely sidesteps forcing QWERTY.
  (kernel-arguments (list "console=ttyS0,115200"))
  (file-systems (cons (file-system
                        (device (file-system-label "my-root"))
                        (mount-point "/")
```

```
                          (type "ext4"))
                        %base-file-systems))

  ;; This is where user accounts are specified.  The "root"
  ;; account is implicit, and is initially created with the
  ;; empty password.
  (users (cons (user-account
                (name "alice")
                (comment "Bob's sister")
                (group "users")

                ;; Adding the account to the "wheel" group
                ;; makes it a sudoer.  Adding it to "audio"
                ;; and "video" allows the user to play sound
                ;; and access the webcam.
                (supplementary-groups '("wheel"
                                        "audio" "video")))
               %base-user-accounts))

  ;; Globally-installed packages.
  (packages (cons screen %base-packages))

  ;; Add services to the baseline: a DHCP client and
  ;; an SSH server.
  (services (append (list (service dhcp-client-service-type)
                          (service openssh-service-type
                                   (openssh-configuration
                                    (openssh openssh-sans-x)
                                    (port-number 2222))))
                    %base-services)))
```

This example should be self-describing. Some of the fields defined above, such as `host-name` and `bootloader`, are mandatory. Others, such as `packages` and `services`, can be omitted, in which case they get a default value.

Below we discuss the effect of some of the most important fields (see Section 12.2 [operating-system Reference], page 228, for details about all the available fields), and how to *instantiate* the operating system using `guix system`.

Bootloader

The `bootloader` field describes the method that will be used to boot your system. Machines based on Intel processors can boot in “legacy” BIOS mode, as in the example above. However, more recent machines rely instead on the *Unified Extensible Firmware Interface* (UEFI) to boot. In that case, the `bootloader` field should contain something along these lines:

```
(bootloader-configuration
  (bootloader grub-efi-bootloader)
  (targets '("/boot/efi")))
```

See Section 12.14 [Bootloader Configuration], page 540, for more information on the available configuration options.

Globally-Visible Packages

The `packages` field lists packages that will be globally visible on the system, for all user accounts—i.e., in every user's `PATH` environment variable—in addition to the per-user profiles (see Section 6.2 [Invoking guix package], page 39). The `%base-packages` variable provides all the tools one would expect for basic user and administrator tasks—including the GNU Core Utilities, the GNU Networking Utilities, the `mg` lightweight text editor, `find`, `grep`, etc. The example above adds GNU Screen to those, taken from the `(gnu packages screen)` module (see Section 9.1 [Package Modules], page 95). The `(list package output)` syntax can be used to add a specific output of a package:

```
(use-modules (gnu packages))
(use-modules (gnu packages dns))

(operating-system
  ;; ...
  (packages (cons (list isc-bind "utils")
                  %base-packages)))
```

Referring to packages by variable name, like `isc-bind` above, has the advantage of being unambiguous; it also allows typos and such to be diagnosed right away as "unbound variables". The downside is that one needs to know which module defines which package, and to augment the `use-package-modules` line accordingly. To avoid that, one can use the `specification->package` procedure of the `(gnu packages)` module, which returns the best package for a given name or name and version:

```
(use-modules (gnu packages))

(operating-system
  ;; ...
  (packages (append (map specification->package
                         '("tcpdump" "htop" "gnupg@2.0"))
                    %base-packages)))
```

System Services

The `services` field lists *system services* to be made available when the system starts (see Section 12.9 [Services], page 247). The `operating-system` declaration above specifies that, in addition to the basic services, we want the OpenSSH secure shell daemon listening on port 2222 (see Section 12.9.5 [Networking Services], page 277). Under the hood, `openssh-service-type` arranges so that `sshd` is started with the right command-line options, possibly with supporting configuration files generated as needed (see Section 12.18 [Defining Services], page 560).

Occasionally, instead of using the base services as is, you will want to customize them. To do this, use `modify-services` (see Section 12.18.3 [Service Reference], page 563) to modify the list.

For example, suppose you want to modify `guix-daemon` and Mingetty (the console log-in) in the `%base-services` list (see Section 12.9.1 [Base Services], page 248). To do that, you can write the following in your operating system declaration:

```
(define %my-services
  ;; My very own list of services.
  (modify-services %base-services
    (guix-service-type config =>
                       (guix-configuration
                        (inherit config)
                        ;; Fetch substitutes from example.org.
                        (substitute-urls
                          (list "https://example.org/guix"
                                "https://ci.guix.gnu.org"))))
    (mingetty-service-type config =>
                           (mingetty-configuration
                            (inherit config)
                            ;; Automatically log in as "guest".
                            (auto-login "guest")))))

(operating-system
  ;; ...
  (services %my-services))
```

This changes the configuration—i.e., the service parameters—of the `guix-service-type` instance, and that of all the `mingetty-service-type` instances in the `%base-services` list (see Section "Auto-Login to a Specific TTY" in *GNU Guix Cookbook*)). Observe how this is accomplished: first, we arrange for the original configuration to be bound to the identifier `config` in the *body*, and then we write the *body* so that it evaluates to the desired configuration. In particular, notice how we use `inherit` to create a new configuration which has the same values as the old configuration, but with a few modifications.

The configuration for a typical "desktop" usage, with an encrypted root partition, a swap file on the root partition, the X11 display server, GNOME and Xfce (users can choose which of these desktop environments to use at the log-in screen by pressing `F1`), network management, power management, and more, would look like this:

```
;; This is an operating system configuration template
;; for a "desktop" setup with GNOME and Xfce where the
;; root partition is encrypted with LUKS, and a swap file.

(use-modules (gnu) (gnu system nss) (guix utils))
(use-service-modules desktop sddm xorg)
(use-package-modules certs gnome)

(operating-system
  (host-name "antelope")
  (timezone "Europe/Paris")
  (locale "en_US.utf8")
```

```
;; Choose US English keyboard layout.  The "altgr-intl"
;; variant provides dead keys for accented characters.
(keyboard-layout (keyboard-layout "us" "altgr-intl"))

;; Use the UEFI variant of GRUB with the EFI System
;; Partition mounted on /boot/efi.
(bootloader (bootloader-configuration
              (bootloader grub-efi-bootloader)
              (targets '("/boot/efi"))
              (keyboard-layout keyboard-layout)))

;; Specify a mapped device for the encrypted root partition.
;; The UUID is that returned by 'cryptsetup luksUUID'.
(mapped-devices
 (list (mapped-device
        (source (uuid "12345678-1234-1234-1234-123456789abc"))
        (target "my-root")
        (type luks-device-mapping))))

(file-systems (append
               (list (file-system
                       (device (file-system-label "my-root"))
                       (mount-point "/")
                       (type "ext4")
                       (dependencies mapped-devices))
                     (file-system
                       (device (uuid "1234-ABCD" 'fat))
                       (mount-point "/boot/efi")
                       (type "vfat")))
               %base-file-systems))

;; Specify a swap file for the system, which resides on the
;; root file system.
(swap-devices (list (swap-space
                     (target "/swapfile"))))

;; Create user `bob' with `alice' as its initial password.
(users (cons (user-account
              (name "bob")
              (comment "Alice's brother")
              (password (crypt "alice" "$6$abc"))
              (group "students")
              (supplementary-groups '("wheel" "netdev"
                                      "audio" "video")))
             %base-user-accounts))

;; Add the `students' group
```

```
  (groups (cons* (user-group
                  (name "students"))
                 %base-groups))

  ;; This is where we specify system-wide packages.
  (packages (append (list
                     ;; for HTTPS access
                     nss-certs
                     ;; for user mounts
                     gvfs)
                    %base-packages))

  ;; Add GNOME and Xfce---we can choose at the log-in screen
  ;; by clicking the gear.  Use the "desktop" services, which
  ;; include the X11 log-in service, networking with
  ;; NetworkManager, and more.
  (services (if (target-x86-64?)
                (append (list (service gnome-desktop-service-type)
                              (service xfce-desktop-service-type)
                              (set-xorg-configuration
                               (xorg-configuration
                                (keyboard-layout keyboard-layout))))
                        %desktop-services)

                ;; FIXME: Since GDM depends on Rust (gdm -> gnome-shell -> gjs
                ;; -> mozjs -> rust) and Rust is currently unavailable on
                ;; non-x86_64 platforms, we use SDDM and Mate here instead of
                ;; GNOME and GDM.
                (append (list (service mate-desktop-service-type)
                              (service xfce-desktop-service-type)
                              (set-xorg-configuration
                               (xorg-configuration
                                (keyboard-layout keyboard-layout))
                               sddm-service-type))
                        %desktop-services)))

  ;; Allow resolution of '.local' host names with mDNS.
  (name-service-switch %mdns-host-lookup-nss))
```

A graphical system with a choice of lightweight window managers instead of full-blown desktop environments would look like this:

```
;; This is an operating system configuration template
;; for a "desktop" setup without full-blown desktop
;; environments.

(use-modules (gnu) (gnu system nss))
(use-service-modules desktop)
```

```
(use-package-modules bootloaders certs emacs emacs-xyz ratpoison suckless wm
                     xorg)

(operating-system
  (host-name "antelope")
  (timezone "Europe/Paris")
  (locale "en_US.utf8")

  ;; Use the UEFI variant of GRUB with the EFI System
  ;; Partition mounted on /boot/efi.
  (bootloader (bootloader-configuration
                (bootloader grub-efi-bootloader)
                (targets '("/boot/efi"))))

  ;; Assume the target root file system is labelled "my-root",
  ;; and the EFI System Partition has UUID 1234-ABCD.
  (file-systems (append
                 (list (file-system
                         (device (file-system-label "my-root"))
                         (mount-point "/")
                         (type "ext4"))
                       (file-system
                         (device (uuid "1234-ABCD" 'fat))
                         (mount-point "/boot/efi")
                         (type "vfat")))
                 %base-file-systems))

  (users (cons (user-account
                (name "alice")
                (comment "Bob's sister")
                (group "users")
                (supplementary-groups '("wheel" "netdev"
                                        "audio" "video")))
               %base-user-accounts))

  ;; Add a bunch of window managers; we can choose one at
  ;; the log-in screen with F1.
  (packages (append (list
                     ;; window managers
                     ratpoison i3-wm i3status dmenu
                     emacs emacs-exwm emacs-desktop-environment
                     ;; terminal emulator
                     xterm
                     ;; for HTTPS access
                     nss-certs)
                    %base-packages))
```

```
    ;; Use the "desktop" services, which include the X11
    ;; log-in service, networking with NetworkManager, and more.
    (services %desktop-services)

    ;; Allow resolution of '.local' host names with mDNS.
    (name-service-switch %mdns-host-lookup-nss))
```

This example refers to the `/boot/efi` file system by its UUID, `1234-ABCD`. Replace this UUID with the right UUID on your system, as returned by the `blkid` command.

See Section 12.9.9 [Desktop Services], page 322, for the exact list of services provided by `%desktop-services`. See Section 12.11 [X.509 Certificates], page 535, for background information about the `nss-certs` package that is used here.

Again, `%desktop-services` is just a list of service objects. If you want to remove services from there, you can do so using the procedures for list filtering (see Section "SRFI-1 Filtering and Partitioning" in *GNU Guile Reference Manual*). For instance, the following expression returns a list that contains all the services in `%desktop-services` minus the Avahi service:

```
(remove (lambda (service)
          (eq? (service-kind service) avahi-service-type))
        %desktop-services)
```

Alternatively, the `modify-services` macro can be used:

```
(modify-services %desktop-services
  (delete avahi-service-type))
```

Instantiating the System

Assuming the `operating-system` declaration is stored in the `my-system-config.scm` file, the `guix system reconfigure my-system-config.scm` command instantiates that configuration, and makes it the default GRUB boot entry (see Section 12.15 [Invoking guix system], page 545).

> **Note:** We recommend that you keep this `my-system-config.scm` file safe and under version control to easily track changes to your configuration.

The normal way to change the system configuration is by updating this file and re-running `guix system reconfigure`. One should never have to touch files in `/etc` or to run commands that modify the system state such as `useradd` or `grub-install`. In fact, you must avoid that since that would not only void your warranty but also prevent you from rolling back to previous versions of your system, should you ever need to.

Speaking of roll-back, each time you run `guix system reconfigure`, a new *generation* of the system is created—without modifying or deleting previous generations. Old system generations get an entry in the bootloader boot menu, allowing you to boot them in case something went wrong with the latest generation. Reassuring, no? The `guix system list-generations` command lists the system generations available on disk. It is also possible to roll back the system via the commands `guix system roll-back` and `guix system switch-generation`.

Although the `guix system reconfigure` command will not modify previous generations, you must take care when the current generation is not the latest (e.g., after invoking `guix system roll-back`), since the operation might overwrite a later generation (see Section 12.15 [Invoking guix system], page 545).

The Programming Interface

At the Scheme level, the bulk of an `operating-system` declaration is instantiated with the following monadic procedure (see Section 9.11 [The Store Monad], page 149):

`operating-system-derivation` *os* [Monadic Procedure]

Return a derivation that builds *os*, an `operating-system` object (see Section 9.10 [Derivations], page 146).

The output of the derivation is a single directory that refers to all the packages, configuration files, and other supporting files needed to instantiate *os*.

This procedure is provided by the `(gnu system)` module. Along with `(gnu services)` (see Section 12.9 [Services], page 247), this module contains the guts of Guix System. Make sure to visit it!

12.2 `operating-system` Reference

This section summarizes all the options available in `operating-system` declarations (see Section 12.1 [Using the Configuration System], page 220).

`operating-system` [Data Type]

This is the data type representing an operating system configuration. By that, we mean all the global system configuration, not per-user configuration (see Section 12.1 [Using the Configuration System], page 220).

`kernel` (default: `linux-libre`)
: The package object of the operating system kernel to use[1].

`hurd` (default: `#f`)
: The package object of the Hurd to be started by the kernel. When this field is set, produce a GNU/Hurd operating system. In that case, `kernel` must also be set to the `gnumach` package—the microkernel the Hurd runs on.

> **Warning:** This feature is experimental and only supported for disk images.

`kernel-loadable-modules` (default: '())
: A list of objects (usually packages) to collect loadable kernel modules from–e.g. `(list ddcci-driver-linux)`.

`kernel-arguments` (default: `%default-kernel-arguments`)
: List of strings or gexps representing additional arguments to pass on the command-line of the kernel—e.g., `("console=ttyS0")`.

`bootloader`
: The system bootloader configuration object. See Section 12.14 [Bootloader Configuration], page 540.

`label`
: This is the label (a string) as it appears in the bootloader's menu entry. The default label includes the kernel name and version.

[1] Currently only the Linux-libre kernel is fully supported. Using GNU mach with the GNU Hurd is experimental and only available when building a virtual machine disk image.

`keyboard-layout` (default: `#f`)
: This field specifies the keyboard layout to use in the console. It can be either `#f`, in which case the default keyboard layout is used (usually US English), or a `<keyboard-layout>` record. See Section 12.7 [Keyboard Layout], page 243, for more information.

  This keyboard layout is in effect as soon as the kernel has booted. For instance, it is the keyboard layout in effect when you type a passphrase if your root file system is on a `luks-device-mapping` mapped device (see Section 12.4 [Mapped Devices], page 237).

  > **Note:** This does *not* specify the keyboard layout used by the bootloader, nor that used by the graphical display server. See Section 12.14 [Bootloader Configuration], page 540, for information on how to specify the bootloader's keyboard layout. See Section 12.9.7 [X Window], page 301, for information on how to specify the keyboard layout used by the X Window System.

`initrd-modules` (default: `%base-initrd-modules`)
: The list of Linux kernel modules that need to be available in the initial RAM disk. See Section 12.13 [Initial RAM Disk], page 537.

`initrd` (default: `base-initrd`)
: A procedure that returns an initial RAM disk for the Linux kernel. This field is provided to support low-level customization and should rarely be needed for casual use. See Section 12.13 [Initial RAM Disk], page 537.

`firmware` (default: `%base-firmware`)
: List of firmware packages loadable by the operating system kernel.

  The default includes firmware needed for Atheros- and Broadcom-based WiFi devices (Linux-libre modules `ath9k` and `b43-open`, respectively). See Section 3.2 [Hardware Considerations], page 23, for more info on supported hardware.

`host-name`
: The host name.

`hosts-file`
: A file-like object (see Section 9.12 [G-Expressions], page 154) for use as `/etc/hosts` (see Section "Host Names" in *The GNU C Library Reference Manual*). The default is a file with entries for `localhost` and *host-name*.

`mapped-devices` (default: `'()`)
: A list of mapped devices. See Section 12.4 [Mapped Devices], page 237.

`file-systems`
: A list of file systems. See Section 12.3 [File Systems], page 232.

`swap-devices` (default: `'()`)
: A list of swap spaces. See Section 12.5 [Swap Space], page 239.

`users` (default: `%base-user-accounts`)
`groups` (default: `%base-groups`)
: List of user accounts and groups. See Section 12.6 [User Accounts], page 241.

  If the `users` list lacks a user account with UID 0, a “root” account with UID 0 is automatically added.

`skeletons` (default: `(default-skeletons)`)
: A list of target file name/file-like object tuples (see Section 9.12 [G-Expressions], page 154). These are the skeleton files that will be added to the home directory of newly-created user accounts.

  For instance, a valid value may look like this:

```
`((".bashrc" ,(plain-file "bashrc" "echo Hello\n"))
  (".guile" ,(plain-file "guile"
                         "(use-modules (ice-9 readline))
                          (activate-readline)")))
```

`issue` (default: `%default-issue`)
: A string denoting the contents of the `/etc/issue` file, which is displayed when users log in on a text console.

`packages` (default: `%base-packages`)
: A list of packages to be installed in the global profile, which is accessible at `/run/current-system/profile`. Each element is either a package variable or a package/output tuple. Here’s a simple example of both:

```
(cons* git                     ; the default "out" output
       (list git "send-email") ; another output of git
       %base-packages)         ; the default set
```

  The default set includes core utilities and it is good practice to install non-core utilities in user profiles (see Section 6.2 [Invoking guix package], page 39).

`timezone` (default: `"Etc/UTC"`)
: A timezone identifying string—e.g., `"Europe/Paris"`.

  You can run the `tzselect` command to find out which timezone string corresponds to your region. Choosing an invalid timezone name causes `guix system` to fail.

`locale` (default: `"en_US.utf8"`)
: The name of the default locale (see Section “Locale Names” in *The GNU C Library Reference Manual*). See Section 12.8 [Locales], page 245, for more information.

`locale-definitions` (default: `%default-locale-definitions`)
: The list of locale definitions to be compiled and that may be used at run time. See Section 12.8 [Locales], page 245.

`locale-libcs` (default: `(list` *`glibc`*`)`)
: The list of GNU libc packages whose locale data and tools are used to build the locale definitions. See Section 12.8 [Locales], page 245, for compatibility considerations that justify this option.

`name-service-switch` (default: `%default-nss`)
: Configuration of the libc name service switch (NSS)—a `<name-service-switch>` object. See Section 12.12 [Name Service Switch], page 535, for details.

`services` (default: `%base-services`)
: A list of service objects denoting system services. See Section 12.9 [Services], page 247.

`essential-services` (default: ...)
: The list of "essential services"—i.e., things like instances of `system-service-type` and `host-name-service-type` (see Section 12.18.3 [Service Reference], page 563), which are derived from the operating system definition itself. As a user you should *never* need to touch this field.

`pam-services` (default: `(base-pam-services)`)
: Linux *pluggable authentication module* (PAM) services.

`setuid-programs` (default: `%setuid-programs`)
: List of `<setuid-program>`. See Section 12.10 [Setuid Programs], page 533, for more information.

`sudoers-file` (default: `%sudoers-specification`)
: The contents of the `/etc/sudoers` file as a file-like object (see Section 9.12 [G-Expressions], page 154).

  This file specifies which users can use the `sudo` command, what they are allowed to do, and what privileges they may gain. The default is that only `root` and members of the `wheel` group may use `sudo`.

`this-operating-system` [Scheme Syntax]

When used in the *lexical scope* of an operating system field definition, this identifier resolves to the operating system being defined.

The example below shows how to refer to the operating system being defined in the definition of the `label` field:

```
(use-modules (gnu) (guix))

(operating-system
  ;; ...
  (label (package-full-name
          (operating-system-kernel this-operating-system))))
```

It is an error to refer to `this-operating-system` outside an operating system definition.

12.3 File Systems

The list of file systems to be mounted is specified in the `file-systems` field of the operating system declaration (see Section 12.1 [Using the Configuration System], page 220). Each file system is declared using the `file-system` form, like this:

```
(file-system
  (mount-point "/home")
  (device "/dev/sda3")
  (type "ext4"))
```

As usual, some of the fields are mandatory—those shown in the example above—while others can be omitted. These are described below.

`file-system` [Data Type]

Objects of this type represent file systems to be mounted. They contain the following members:

`type` This is a string specifying the type of the file system—e.g., `"ext4"`.

`mount-point`
This designates the place where the file system is to be mounted.

`device` This names the “source” of the file system. It can be one of three things: a file system label, a file system UUID, or the name of a `/dev` node. Labels and UUIDs offer a way to refer to file systems without having to hard-code their actual device name[2].

File system labels are created using the `file-system-label` procedure, UUIDs are created using `uuid`, and `/dev` node are plain strings. Here’s an example of a file system referred to by its label, as shown by the `e2label` command:

```
(file-system
  (mount-point "/home")
  (type "ext4")
  (device (file-system-label "my-home")))
```

UUIDs are converted from their string representation (as shown by the `tune2fs -l` command) using the `uuid` form[3], like this:

```
(file-system
  (mount-point "/home")
  (type "ext4")
  (device (uuid "4dab5feb-d176-45de-b287-9b0a6e4c01cb")))
```

When the source of a file system is a mapped device (see Section 12.4 [Mapped Devices], page 237), its `device` field *must* refer to the mapped device name—e.g., `"/dev/mapper/root-partition"`. This is required so

[2] Note that, while it is tempting to use `/dev/disk/by-uuid` and similar device names to achieve the same result, this is not recommended: These special device nodes are created by the udev daemon and may be unavailable at the time the device is mounted.

[3] The `uuid` form expects 16-byte UUIDs as defined in RFC 4122 (`https://tools.ietf.org/html/rfc4122`). This is the form of UUID used by the ext2 family of file systems and others, but it is different from “UUIDs” found in FAT file systems, for instance.

that the system knows that mounting the file system depends on having the corresponding device mapping established.

`flags` (default: `'()`)
: This is a list of symbols denoting mount flags. Recognized flags include `read-only`, `bind-mount`, `no-dev` (disallow access to special files), `no-suid` (ignore setuid and setgid bits), `no-atime` (do not update file access times), `no-diratime` (likewise for directories only), `strict-atime` (update file access time), `lazy-time` (only update time on the in-memory version of the file inode), `no-exec` (disallow program execution), and `shared` (make the mount shared). See Section “Mount-Unmount-Remount” in *The GNU C Library Reference Manual*, for more information on these flags.

`options` (default: `#f`)
: This is either `#f`, or a string denoting mount options passed to the file system driver. See Section “Mount-Unmount-Remount” in *The GNU C Library Reference Manual*, for details.

  Run `man 8 mount` for options for various file systems, but beware that what it lists as file-system-independent “mount options” are in fact flags, and belong in the `flags` field described above.

  The `file-system-options->alist` and `alist->file-system-options` procedures from `(gnu system file-systems)` can be used to convert file system options given as an association list to the string representation, and vice-versa.

`mount?` (default: `#t`)
: This value indicates whether to automatically mount the file system when the system is brought up. When set to `#f`, the file system gets an entry in `/etc/fstab` (read by the `mount` command) but is not automatically mounted.

`needed-for-boot?` (default: `#f`)
: This Boolean value indicates whether the file system is needed when booting. If that is true, then the file system is mounted when the initial RAM disk (initrd) is loaded. This is always the case, for instance, for the root file system.

`check?` (default: `#t`)
: This Boolean indicates whether the file system should be checked for errors before being mounted. How and when this happens can be further adjusted with the following options.

`skip-check-if-clean?` (default: `#t`)
: When true, this Boolean indicates that a file system check triggered by `check?` may exit early if the file system is marked as “clean”, meaning that it was previously correctly unmounted and should not contain errors.

  Setting this to false will always force a full consistency check when `check?` is true. This may take a very long time and is not recommended on healthy systems—in fact, it may reduce reliability!

Conversely, some primitive file systems like `fat` do not keep track of clean shutdowns and will perform a full scan regardless of the value of this option.

`repair` (default: `'preen`)
: When `check?` finds errors, it can (try to) repair them and continue booting. This option controls when and how to do so.

  If false, try not to modify the file system at all. Checking certain file systems like `jfs` may still write to the device to replay the journal. No repairs will be attempted.

  If `#t`, try to repair any errors found and assume "yes" to all questions. This will fix the most errors, but may be risky.

  If `'preen`, repair only errors that are safe to fix without human interaction. What that means is left up to the developers of each file system and may be equivalent to "none" or "all".

`create-mount-point?` (default: `#f`)
: When true, the mount point is created if it does not exist yet.

`mount-may-fail?` (default: `#f`)
: When true, this indicates that mounting this file system can fail but that should not be considered an error. This is useful in unusual cases; an example of this is `efivarfs`, a file system that can only be mounted on EFI/UEFI systems.

`dependencies` (default: `'()`)
: This is a list of `<file-system>` or `<mapped-device>` objects representing file systems that must be mounted or mapped devices that must be opened before (and unmounted or closed after) this one.

  As an example, consider a hierarchy of mounts: `/sys/fs/cgroup` is a dependency of `/sys/fs/cgroup/cpu` and `/sys/fs/cgroup/memory`.

  Another example is a file system that depends on a mapped device, for example for an encrypted partition (see Section 12.4 [Mapped Devices], page 237).

`file-system-label` *`str`* [Scheme Procedure]

This procedure returns an opaque file system label from *str*, a string:

```
(file-system-label "home")
⇒ #<file-system-label "home">
```

File system labels are used to refer to file systems by label rather than by device name. See above for examples.

The `(gnu system file-systems)` exports the following useful variables.

`%base-file-systems` [Scheme Variable]

These are essential file systems that are required on normal systems, such as `%pseudo-terminal-file-system` and `%immutable-store` (see below). Operating system declarations should always contain at least these.

`%pseudo-terminal-file-system` [Scheme Variable]

This is the file system to be mounted as `/dev/pts`. It supports *pseudo-terminals* created *via* `openpty` and similar functions (see Section "Pseudo-Terminals" in *The GNU C Library Reference Manual*). Pseudo-terminals are used by terminal emulators such as `xterm`.

`%shared-memory-file-system` [Scheme Variable]

This file system is mounted as `/dev/shm` and is used to support memory sharing across processes (see Section "Memory-mapped I/O" in *The GNU C Library Reference Manual*).

`%immutable-store` [Scheme Variable]

This file system performs a read-only "bind mount" of `/gnu/store`, making it read-only for all the users including `root`. This prevents against accidental modification by software running as `root` or by system administrators.

The daemon itself is still able to write to the store: it remounts it read-write in its own "name space."

`%binary-format-file-system` [Scheme Variable]

The `binfmt_misc` file system, which allows handling of arbitrary executable file types to be delegated to user space. This requires the `binfmt.ko` kernel module to be loaded.

`%fuse-control-file-system` [Scheme Variable]

The `fusectl` file system, which allows unprivileged users to mount and unmount user-space FUSE file systems. This requires the `fuse.ko` kernel module to be loaded.

The `(gnu system uuid)` module provides tools to deal with file system "unique identifiers" (UUIDs).

`uuid` *`str`* [*`type`*] [Scheme Procedure]

Return an opaque UUID (unique identifier) object of the given *type* (a symbol) by parsing *str* (a string):

```
(uuid "4dab5feb-d176-45de-b287-9b0a6e4c01cb")
⇒ #<<uuid> type: dce bv: ...>

(uuid "1234-ABCD" 'fat)
⇒ #<<uuid> type: fat bv: ...>
```

type may be one of `dce`, `iso9660`, `fat`, `ntfs`, or one of the commonly found synonyms for these.

UUIDs are another way to unambiguously refer to file systems in operating system configuration. See the examples above.

12.3.1 Btrfs file system

The Btrfs has special features, such as subvolumes, that merit being explained in more details. The following section attempts to cover basic as well as complex uses of a Btrfs file system with the Guix System.

In its simplest usage, a Btrfs file system can be described, for example, by:

```
(file-system
  (mount-point "/home")
  (type "btrfs")
  (device (file-system-label "my-home")))
```

The example below is more complex, as it makes use of a Btrfs subvolume, named `rootfs`. The parent Btrfs file system is labeled `my-btrfs-pool`, and is located on an encrypted device (hence the dependency on `mapped-devices`):

```
(file-system
  (device (file-system-label "my-btrfs-pool"))
  (mount-point "/")
  (type "btrfs")
  (options "subvol=rootfs")
  (dependencies mapped-devices))
```

Some bootloaders, for example GRUB, only mount a Btrfs partition at its top level during the early boot, and rely on their configuration to refer to the correct subvolume path within that top level. The bootloaders operating in this way typically produce their configuration on a running system where the Btrfs partitions are already mounted and where the subvolume information is readily available. As an example, `grub-mkconfig`, the configuration generator command shipped with GRUB, reads `/proc/self/mountinfo` to determine the top-level path of a subvolume.

The Guix System produces a bootloader configuration using the operating system configuration as its sole input; it is therefore necessary to extract the subvolume name on which `/gnu/store` lives (if any) from that operating system configuration. To better illustrate, consider a subvolume named 'rootfs' which contains the root file system data. In such situation, the GRUB bootloader would only see the top level of the root Btrfs partition, e.g.:

```
/                    (top level)
 rootfs           (subvolume directory)
     gnu          (normal directory)
         store    (normal directory)
[...]
```

Thus, the subvolume name must be prepended to the `/gnu/store` path of the kernel, initrd binaries and any other files referred to in the GRUB configuration that must be found during the early boot.

The next example shows a nested hierarchy of subvolumes and directories:

```
/                    (top level)
 rootfs           (subvolume)
     gnu          (normal directory)
         store    (subvolume)
[...]
```

This scenario would work without mounting the 'store' subvolume. Mounting 'rootfs' is sufficient, since the subvolume name matches its intended mount point in the file system hierarchy. Alternatively, the 'store' subvolume could be referred to by setting the `subvol` option to either `/rootfs/gnu/store` or `rootfs/gnu/store`.

Finally, a more contrived example of nested subvolumes:

```
/                           (top level)
 root-snapshots          (subvolume)
     root-current        (subvolume)
         guix-store      (subvolume)
[...]
```

Here, the 'guix-store' subvolume doesn't match its intended mount point, so it is necessary to mount it. The subvolume must be fully specified, by passing its file name to the `subvol` option. To illustrate, the 'guix-store' subvolume could be mounted on `/gnu/store` by using a file system declaration such as:

```
(file-system
  (device (file-system-label "btrfs-pool-1"))
  (mount-point "/gnu/store")
  (type "btrfs")
  (options "subvol=root-snapshots/root-current/guix-store,\
compress-force=zstd,space_cache=v2"))
```

12.4 Mapped Devices

The Linux kernel has a notion of *device mapping*: a block device, such as a hard disk partition, can be *mapped* into another device, usually in `/dev/mapper/`, with additional processing over the data that flows through it[4]. A typical example is encryption device mapping: all writes to the mapped device are encrypted, and all reads are deciphered, transparently. Guix extends this notion by considering any device or set of devices that are *transformed* in some way to create a new device; for instance, RAID devices are obtained by *assembling* several other devices, such as hard disks or partitions, into a new one that behaves as one partition.

Mapped devices are declared using the `mapped-device` form, defined as follows; for examples, see below.

`mapped-device` [Data Type]

Objects of this type represent device mappings that will be made when the system boots up.

`source` This is either a string specifying the name of the block device to be mapped, such as `"/dev/sda3"`, or a list of such strings when several devices need to be assembled for creating a new one. In case of LVM this is a string specifying name of the volume group to be mapped.

`target` This string specifies the name of the resulting mapped device. For kernel mappers such as encrypted devices of type `luks-device-mapping`, specifying `"my-partition"` leads to the creation of the `"/dev/mapper/my-partition"` device. For RAID devices of type `raid-device-mapping`, the full device name such as `"/dev/md0"` needs to be given. LVM logical

[4] Note that the GNU Hurd makes no difference between the concept of a "mapped device" and that of a file system: both boil down to *translating* input/output operations made on a file to operations on its backing store. Thus, the Hurd implements mapped devices, like file systems, using the generic *translator* mechanism (see Section "Translators" in *The GNU Hurd Reference Manual*).

volumes of type `lvm-device-mapping` need to be specified as `"VGNAME-LVNAME"`.

`targets` This list of strings specifies names of the resulting mapped devices in case there are several. The format is identical to *target*.

`type` This must be a `mapped-device-kind` object, which specifies how *source* is mapped to *target*.

`luks-device-mapping` [Scheme Variable]

This defines LUKS block device encryption using the `cryptsetup` command from the package with the same name. It relies on the `dm-crypt` Linux kernel module.

`raid-device-mapping` [Scheme Variable]

This defines a RAID device, which is assembled using the `mdadm` command from the package with the same name. It requires a Linux kernel module for the appropriate RAID level to be loaded, such as `raid456` for RAID-4, RAID-5 or RAID-6, or `raid10` for RAID-10.

`lvm-device-mapping` [Scheme Variable]

This defines one or more logical volumes for the Linux Logical Volume Manager (LVM) (`https://www.sourceware.org/lvm2/`). The volume group is activated by the `vgchange` command from the `lvm2` package.

The following example specifies a mapping from `/dev/sda3` to `/dev/mapper/home` using LUKS—the Linux Unified Key Setup (`https://gitlab.com/cryptsetup/cryptsetup`), a standard mechanism for disk encryption. The `/dev/mapper/home` device can then be used as the `device` of a `file-system` declaration (see Section 12.3 [File Systems], page 232).

```
(mapped-device
  (source "/dev/sda3")
  (target "home")
  (type luks-device-mapping))
```

Alternatively, to become independent of device numbering, one may obtain the LUKS UUID (*unique identifier*) of the source device by a command like:

```
cryptsetup luksUUID /dev/sda3
```

and use it as follows:

```
(mapped-device
  (source (uuid "cb67fc72-0d54-4c88-9d4b-b225f30b0f44"))
  (target "home")
  (type luks-device-mapping))
```

It is also desirable to encrypt swap space, since swap space may contain sensitive data. One way to accomplish that is to use a swap file in a file system on a device mapped via LUKS encryption. In this way, the swap file is encrypted because the entire device is encrypted. See Section 12.5 [Swap Space], page 239, or See Section 3.4 [Disk Partitioning], page 25, for an example.

A RAID device formed of the partitions `/dev/sda1` and `/dev/sdb1` may be declared as follows:

```
(mapped-device
     (source (list "/dev/sda1" "/dev/sdb1"))
     (target "/dev/md0")
     (type raid-device-mapping))
```

The `/dev/md0` device can then be used as the `device` of a `file-system` declaration (see Section 12.3 [File Systems], page 232). Note that the RAID level need not be given; it is chosen during the initial creation and formatting of the RAID device and is determined automatically later.

LVM logical volumes “alpha” and “beta” from volume group “vg0” can be declared as follows:

```
   (mapped-device
     (source "vg0")
     (targets (list "vg0-alpha" "vg0-beta"))
     (type lvm-device-mapping))
```

Devices `/dev/mapper/vg0-alpha` and `/dev/mapper/vg0-beta` can then be used as the `device` of a `file-system` declaration (see Section 12.3 [File Systems], page 232).

12.5 Swap Space

Swap space, as it is commonly called, is a disk area specifically designated for paging: the process in charge of memory management (the Linux kernel or Hurd’s default pager) can decide that some memory pages stored in RAM which belong to a running program but are unused should be stored on disk instead. It unloads those from the RAM, freeing up precious fast memory, and writes them to the swap space. If the program tries to access that very page, the memory management process loads it back into memory for the program to use.

A common misconception about swap is that it is only useful when small amounts of RAM are available to the system. However, it should be noted that kernels often use all available RAM for disk access caching to make I/O faster, and thus paging out unused portions of program memory will expand the RAM available for such caching.

For a more detailed description of how memory is managed from the viewpoint of a monolithic kernel, See Section “Memory Concepts” in *The GNU C Library Reference Manual*.

The Linux kernel has support for swap partitions and swap files: the former uses a whole disk partition for paging, whereas the second uses a file on a file system for that (the file system driver needs to support it). On a comparable setup, both have the same performance, so one should consider ease of use when deciding between them. Partitions are “simpler” and do not need file system support, but need to be allocated at disk formatting time (logical volumes notwithstanding), whereas files can be allocated and deallocated at any time.

Note that swap space is not zeroed on shutdown, so sensitive data (such as passwords) may linger on it if it was paged out. As such, you should consider having your swap reside on an encrypted device (see Section 12.4 [Mapped Devices], page 237).

`swap-space` [Data Type]

Objects of this type represent swap spaces. They contain the following members:

`target` The device or file to use, either a UUID, a `file-system-label` or a string, as in the definition of a `file-system` (see Section 12.3 [File Systems], page 232).

`dependencies` (default: `'()`)
A list of `file-system` or `mapped-device` objects, upon which the availability of the space depends. Note that just like for `file-system` objects, dependencies which are needed for boot and mounted in early userspace are not managed by the Shepherd, and so automatically filtered out for you.

`priority` (default: `#f`)
Only supported by the Linux kernel. Either `#f` to disable swap priority, or an integer between 0 and 32767. The kernel will first use swap spaces of higher priority when paging, and use same priority spaces on a round-robin basis. The kernel will use swap spaces without a set priority after prioritized spaces, and in the order that they appeared in (not round-robin).

`discard?` (default: `#f`)
Only supported by the Linux kernel. When true, the kernel will notify the disk controller of discarded pages, for example with the TRIM operation on Solid State Drives.

Here are some examples:

```
(swap-space (target (uuid "4dab5feb-d176-45de-b287-9b0a6e4c01cb")))
```

Use the swap partition with the given UUID. You can learn the UUID of a Linux swap partition by running `swaplabel` *`device`*, where *device* is the `/dev` file name of that partition.

```
(swap-space
  (target (file-system-label "swap"))
  (dependencies mapped-devices))
```

Use the partition with label `swap`, which can be found after all the *mapped-devices* mapped devices have been opened. Again, the `swaplabel` command allows you to view and change the label of a Linux swap partition.

Here's a more involved example with the corresponding `file-systems` part of an `operating-system` declaration.

```
(file-systems
  (list (file-system
          (device (file-system-label "root"))
          (mount-point "/")
          (type "ext4"))
        (file-system
          (device (file-system-label "btrfs"))
          (mount-point "/btrfs")
          (type "btrfs"))))
```

```
(swap-devices
  (list
    (swap-space
      (target "/btrfs/swapfile")
      (dependencies (filter (file-system-mount-point-predicate "/btrfs")
                            file-systems)))))
```

Use the file `/btrfs/swapfile` as swap space, which depends on the file system mounted at `/btrfs`. Note how we use Guile's filter to select the file system in an elegant fashion!

12.6 User Accounts

User accounts and groups are entirely managed through the `operating-system` declaration. They are specified with the `user-account` and `user-group` forms:

```
(user-account
  (name "alice")
  (group "users")
  (supplementary-groups '("wheel"   ;allow use of sudo, etc.
                          "audio"   ;sound card
                          "video"   ;video devices such as webcams
                          "cdrom")) ;the good ol' CD-ROM
  (comment "Bob's sister"))
```

Here's a user account that uses a different shell and a custom home directory (the default would be `"/home/bob"`):

```
(user-account
  (name "bob")
  (group "users")
  (comment "Alice's bro")
  (shell (file-append zsh "/bin/zsh"))
  (home-directory "/home/robert"))
```

When booting or upon completion of `guix system reconfigure`, the system ensures that only the user accounts and groups specified in the `operating-system` declaration exist, and with the specified properties. Thus, account or group creations or modifications made by directly invoking commands such as `useradd` are lost upon reconfiguration or reboot. This ensures that the system remains exactly as declared.

`user-account` [Data Type]

Objects of this type represent user accounts. The following members may be specified:

`name` The name of the user account.

`group` This is the name (a string) or identifier (a number) of the user group this account belongs to.

`supplementary-groups` (default: `'()`)
Optionally, this can be defined as a list of group names that this account belongs to.

`uid` (default: `#f`)
: This is the user ID for this account (a number), or `#f`. In the latter case, a number is automatically chosen by the system when the account is created.

`comment` (default: `""`)
: A comment about the account, such as the account owner's full name.

  Note that, for non-system accounts, users are free to change their real name as it appears in `/etc/passwd` using the `chfn` command. When they do, their choice prevails over the system administrator's choice; reconfiguring does *not* change their name.

`home-directory`
: This is the name of the home directory for the account.

`create-home-directory?` (default: `#t`)
: Indicates whether the home directory of this account should be created if it does not exist yet.

`shell` (default: Bash)
: This is a G-expression denoting the file name of a program to be used as the shell (see Section 9.12 [G-Expressions], page 154). For example, you would refer to the Bash executable like this:

```
(file-append bash "/bin/bash")
```

... and to the Zsh executable like that:

```
(file-append zsh "/bin/zsh")
```

`system?` (default: `#f`)
: This Boolean value indicates whether the account is a "system" account. System accounts are sometimes treated specially; for instance, graphical login managers do not list them.

`password` (default: `#f`)
: You would normally leave this field to `#f`, initialize user passwords as `root` with the `passwd` command, and then let users change it with `passwd`. Passwords set with `passwd` are of course preserved across reboot and reconfiguration.

  If you *do* want to set an initial password for an account, then this field must contain the encrypted password, as a string. You can use the `crypt` procedure for this purpose:

```
(user-account
  (name "charlie")
  (group "users")

  ;; Specify a SHA-512-hashed initial password.
  (password (crypt "InitialPassword!" "$6$abc")))
```

> **Note:** The hash of this initial password will be available in a file in `/gnu/store`, readable by all the users, so this method must be used with care.

See Section "Passphrase Storage" in *The GNU C Library Reference Manual*, for more information on password encryption, and Section "Encryption" in *GNU Guile Reference Manual*, for information on Guile's `crypt` procedure.

User group declarations are even simpler:

```
(user-group (name "students"))
```

`user-group` [Data Type]

This type is for, well, user groups. There are just a few fields:

`name` The name of the group.

`id` (default: `#f`)
: The group identifier (a number). If `#f`, a new number is automatically allocated when the group is created.

`system?` (default: `#f`)
: This Boolean value indicates whether the group is a "system" group. System groups have low numerical IDs.

`password` (default: `#f`)
: What, user groups can have a password? Well, apparently yes. Unless `#f`, this field specifies the password of the group.

For convenience, a variable lists all the basic user groups one may expect:

`%base-groups` [Scheme Variable]

This is the list of basic user groups that users and/or packages expect to be present on the system. This includes groups such as "root", "wheel", and "users", as well as groups used to control access to specific devices such as "audio", "disk", and "cdrom".

`%base-user-accounts` [Scheme Variable]

This is the list of basic system accounts that programs may expect to find on a GNU/Linux system, such as the "nobody" account.

Note that the "root" account is not included here. It is a special-case and is automatically added whether or not it is specified.

12.7 Keyboard Layout

To specify what each key of your keyboard does, you need to tell the operating system what *keyboard layout* you want to use. The default, when nothing is specified, is the US English QWERTY layout for 105-key PC keyboards. However, German speakers will usually prefer the German QWERTZ layout, French speakers will want the AZERTY layout, and so on; hackers might prefer Dvorak or bépo, and they might even want to further customize the effect of some of the keys. This section explains how to get that done.

There are three components that will want to know about your keyboard layout:

- The *bootloader* may want to know what keyboard layout you want to use (see Section 12.14 [Bootloader Configuration], page 540). This is useful if you want, for instance, to make sure that you can type the passphrase of your encrypted root partition using the right layout.

- The *operating system kernel*, Linux, will need that so that the console is properly configured (see Section 12.2 [operating-system Reference], page 228).
- The *graphical display server*, usually Xorg, also has its own idea of the keyboard layout (see Section 12.9.7 [X Window], page 301).

Guix allows you to configure all three separately but, fortunately, it allows you to share the same keyboard layout for all three components.

Keyboard layouts are represented by records created by the `keyboard-layout` procedure of `(gnu system keyboard)`. Following the X Keyboard extension (XKB), each layout has four attributes: a name (often a language code such as "fi" for Finnish or "jp" for Japanese), an optional variant name, an optional keyboard model name, and a possibly empty list of additional options. In most cases the layout name is all you care about.

`keyboard-layout` *name* [*variant*] [*#:model*] [*#:options '()*] [Scheme Procedure]

Return a new keyboard layout with the given *name* and *variant*.

name must be a string such as `"fr"`; *variant* must be a string such as `"bepo"` or `"nodeadkeys"`. See the `xkeyboard-config` package for valid options.

Here are a few examples:

```
;; The German QWERTZ layout.  Here we assume a standard
;; "pc105" keyboard model.
(keyboard-layout "de")

;; The bépo variant of the French layout.
(keyboard-layout "fr" "bepo")

;; The Catalan layout.
(keyboard-layout "es" "cat")

;; Arabic layout with "Alt-Shift" to switch to US layout.
(keyboard-layout "ar,us" #:options '("grp:alt_shift_toggle"))

;; The Latin American Spanish layout.  In addition, the
;; "Caps Lock" key is used as an additional "Ctrl" key,
;; and the "Menu" key is used as a "Compose" key to enter
;; accented letters.
(keyboard-layout "latam"
                 #:options '("ctrl:nocaps" "compose:menu"))

;; The Russian layout for a ThinkPad keyboard.
(keyboard-layout "ru" #:model "thinkpad")

;; The "US international" layout, which is the US layout plus
;; dead keys to enter accented characters.  This is for an
;; Apple MacBook keyboard.
(keyboard-layout "us" "intl" #:model "macbook78")
```

See the `share/X11/xkb` directory of the `xkeyboard-config` package for a complete list of supported layouts, variants, and models.

Let's say you want your system to use the Turkish keyboard layout throughout your system—bootloader, console, and Xorg. Here's what your system configuration would look like:

```
;; Using the Turkish layout for the bootloader, the console,
;; and for Xorg.

(operating-system
  ;; ...
  (keyboard-layout (keyboard-layout "tr"))  ;for the console
  (bootloader (bootloader-configuration
                (bootloader grub-efi-bootloader)
                (targets '("/boot/efi"))
                (keyboard-layout keyboard-layout))) ;for GRUB
  (services (cons (set-xorg-configuration
                    (xorg-configuration             ;for Xorg
                      (keyboard-layout keyboard-layout)))
                  %desktop-services)))
```

In the example above, for GRUB and for Xorg, we just refer to the `keyboard-layout` field defined above, but we could just as well refer to a different layout. The `set-xorg-configuration` procedure communicates the desired Xorg configuration to the graphical log-in manager, by default GDM.

We've discussed how to specify the *default* keyboard layout of your system when it starts, but you can also adjust it at run time:

- If you're using GNOME, its settings panel has a "Region & Language" entry where you can select one or more keyboard layouts.
- Under Xorg, the `setxkbmap` command (from the same-named package) allows you to change the current layout. For example, this is how you would change the layout to US Dvorak:

  ```
  setxkbmap us dvorak
  ```
- The `loadkeys` command changes the keyboard layout in effect in the Linux console. However, note that `loadkeys` does *not* use the XKB keyboard layout categorization described above. The command below loads the French bépo layout:

  ```
  loadkeys fr-bepo
  ```

12.8 Locales

A *locale* defines cultural conventions for a particular language and region of the world (see Section "Locales" in *The GNU C Library Reference Manual*). Each locale has a name that typically has the form `language_territory.codeset`—e.g., `fr_LU.utf8` designates the locale for the French language, with cultural conventions from Luxembourg, and using the UTF-8 encoding.

Usually, you will want to specify the default locale for the machine using the `locale` field of the `operating-system` declaration (see Section 12.2 [operating-system Reference], page 228).

The selected locale is automatically added to the *locale definitions* known to the system if needed, with its codeset inferred from its name—e.g., `bo_CN.utf8` will be assumed to use the `UTF-8` codeset. Additional locale definitions can be specified in the `locale-definitions` slot of `operating-system`—this is useful, for instance, if the codeset could not be inferred from the locale name. The default set of locale definitions includes some widely used locales, but not all the available locales, in order to save space.

For instance, to add the North Frisian locale for Germany, the value of that field may be:

```
(cons (locale-definition
        (name "fy_DE.utf8") (source "fy_DE"))
      %default-locale-definitions)
```

Likewise, to save space, one might want `locale-definitions` to list only the locales that are actually used, as in:

```
(list (locale-definition
        (name "ja_JP.eucjp") (source "ja_JP")
        (charset "EUC-JP")))
```

The compiled locale definitions are available at `/run/current-system/locale/X.Y`, where `X.Y` is the libc version, which is the default location where the GNU libc provided by Guix looks for locale data. This can be overridden using the `LOCPATH` environment variable (see [locales-and-locpath], page 19).

The `locale-definition` form is provided by the `(gnu system locale)` module. Details are given below.

`locale-definition` [Data Type]

This is the data type of a locale definition.

`name` The name of the locale. See Section "Locale Names" in *The GNU C Library Reference Manual*, for more information on locale names.

`source` The name of the source for that locale. This is typically the *`language_territory`* part of the locale name.

`charset` (default: `"UTF-8"`)
The "character set" or "code set" for that locale, as defined by IANA (`https://www.iana.org/assignments/character-sets`).

`%default-locale-definitions` [Scheme Variable]

A list of commonly used UTF-8 locales, used as the default value of the `locale-definitions` field of `operating-system` declarations.

These locale definitions use the *normalized codeset* for the part that follows the dot in the name (see Section "Using gettextized software" in *The GNU C Library Reference Manual*). So for instance it has `uk_UA.utf8` but *not*, say, `uk_UA.UTF-8`.

12.8.1 Locale Data Compatibility Considerations

`operating-system` declarations provide a `locale-libcs` field to specify the GNU libc packages that are used to compile locale declarations (see Section 12.2 [operating-system Reference], page 228). "Why would I care?", you may ask. Well, it turns out that the binary format of locale data is occasionally incompatible from one libc version to another.

For instance, a program linked against libc version 2.21 is unable to read locale data produced with libc 2.22; worse, that program *aborts* instead of simply ignoring the incompatible locale data[5]. Similarly, a program linked against libc 2.22 can read most, but not all, of the locale data from libc 2.21 (specifically, `LC_COLLATE` data is incompatible); thus calls to `setlocale` may fail, but programs will not abort.

The "problem" with Guix is that users have a lot of freedom: They can choose whether and when to upgrade software in their profiles, and might be using a libc version different from the one the system administrator used to build the system-wide locale data.

Fortunately, unprivileged users can also install their own locale data and define `GUIX_LOCPATH` accordingly (see [locales-and-locpath], page 19).

Still, it is best if the system-wide locale data at `/run/current-system/locale` is built for all the libc versions actually in use on the system, so that all the programs can access it—this is especially crucial on a multi-user system. To do that, the administrator can specify several libc packages in the `locale-libcs` field of `operating-system`:

```
(use-package-modules base)

(operating-system
  ;; ...
  (locale-libcs (list glibc-2.21 (canonical-package glibc))))
```

This example would lead to a system containing locale definitions for both libc 2.21 and the current version of libc in `/run/current-system/locale`.

12.9 Services

An important part of preparing an `operating-system` declaration is listing *system services* and their configuration (see Section 12.1 [Using the Configuration System], page 220). System services are typically daemons launched when the system boots, or other actions needed at that time—e.g., configuring network access.

Guix has a broad definition of "service" (see Section 12.18.1 [Service Composition], page 560), but many services are managed by the GNU Shepherd (see Section 12.18.4 [Shepherd Services], page 568). On a running system, the `herd` command allows you to list the available services, show their status, start and stop them, or do other specific operations (see Section "Jump Start" in *The GNU Shepherd Manual*). For example:

```
# herd status
```

The above command, run as `root`, lists the currently defined services. The `herd doc` command shows a synopsis of the given service and its associated actions:

```
# herd doc nscd
```

[5] Versions 2.23 and later of GNU libc will simply skip the incompatible locale data, which is already an improvement.

```
Run libc's name service cache daemon (nscd).

# herd doc nscd action invalidate
invalidate: Invalidate the given cache--e.g., 'hosts' for host name lookups.
```

The `start`, `stop`, and `restart` sub-commands have the effect you would expect. For instance, the commands below stop the nscd service and restart the Xorg display server:

```
# herd stop nscd
Service nscd has been stopped.
# herd restart xorg-server
Service xorg-server has been stopped.
Service xorg-server has been started.
```

For some services, `herd configuration` returns the name of the service's configuration file, which can be handy to inspect its configuration:

```
# herd configuration sshd
/gnu/store/...-sshd_config
```

The following sections document the available services, starting with the core services, that may be used in an `operating-system` declaration.

12.9.1 Base Services

The `(gnu services base)` module provides definitions for the basic services that one expects from the system. The services exported by this module are listed below.

`%base-services` [Scheme Variable]

This variable contains a list of basic services (see Section 12.18.2 [Service Types and Services], page 561, for more information on service objects) one would expect from the system: a login service (mingetty) on each tty, syslogd, the libc name service cache daemon (nscd), the udev device manager, and more.

This is the default value of the `services` field of `operating-system` declarations. Usually, when customizing a system, you will want to append services to `%base-services`, like this:

```
(append (list (service avahi-service-type)
              (service openssh-service-type))
        %base-services)
```

`special-files-service-type` [Scheme Variable]

This is the service that sets up "special files" such as `/bin/sh`; an instance of it is part of `%base-services`.

The value associated with `special-files-service-type` services must be a list of tuples where the first element is the "special file" and the second element is its target. By default it is:

```
`(("/bin/sh" ,(file-append bash "/bin/sh"))
  ("/usr/bin/env" ,(file-append coreutils "/bin/env")))
```

If you want to add, say, `/bin/bash` to your system, you can change it to:

```
`(("/bin/sh" ,(file-append bash "/bin/sh"))
  ("/usr/bin/env" ,(file-append coreutils "/bin/env"))
```

```
        ("/bin/bash" ,(file-append bash "/bin/bash")))
```

Since this is part of `%base-services`, you can use `modify-services` to customize the set of special files (see Section 12.18.3 [Service Reference], page 563). But the simple way to add a special file is *via* the `extra-special-file` procedure (see below).

`extra-special-file` ***file target*** [Scheme Procedure]

Use *target* as the "special file" *file*.

For example, adding the following lines to the `services` field of your operating system declaration leads to a `/usr/bin/env` symlink:

```
(extra-special-file "/usr/bin/env"
                    (file-append coreutils "/bin/env"))
```

`host-name-service` ***name*** [Scheme Procedure]

Return a service that sets the host name to *name*.

`console-font-service-type` [Scheme Variable]

Install the given fonts on the specified ttys (fonts are per virtual console on the kernel Linux). The value of this service is a list of tty/font pairs. The font can be the name of a font provided by the `kbd` package or any valid argument to `setfont`, as in this example:

```
`(("tty1" . "LatGrkCyr-8x16")
  ("tty2" . ,(file-append
                font-tamzen
                "/share/kbd/consolefonts/TamzenForPowerline10x20.psf"))
  ("tty3" . ,(file-append
                font-terminus
                "/share/consolefonts/ter-132n"))) ; for HDPI
```

`login-service` ***config*** [Scheme Procedure]

Return a service to run login according to *config*, a `<login-configuration>` object, which specifies the message of the day, among other things.

`login-configuration` [Data Type]

This is the data type representing the configuration of login.

`motd` A file-like object containing the "message of the day".

`allow-empty-passwords?` (default: `#t`)
Allow empty passwords by default so that first-time users can log in when the 'root' account has just been created.

`mingetty-service` ***config*** [Scheme Procedure]

Return a service to run mingetty according to *config*, a `<mingetty-configuration>` object, which specifies the tty to run, among other things.

`mingetty-configuration` [Data Type]

This is the data type representing the configuration of Mingetty, which provides the default implementation of virtual console log-in.

`tty` The name of the console this Mingetty runs on—e.g., `"tty1"`.

`auto-login` (default: `#f`)
: When true, this field must be a string denoting the user name under which the system automatically logs in. When it is `#f`, a user name and password must be entered to log in.

`login-program` (default: `#f`)
: This must be either `#f`, in which case the default log-in program is used (`login` from the Shadow tool suite), or a gexp denoting the name of the log-in program.

`login-pause?` (default: `#f`)
: When set to `#t` in conjunction with *auto-login*, the user will have to press a key before the log-in shell is launched.

`clear-on-logout?` (default: `#t`)
: When set to `#t`, the screen will be cleared after logout.

`mingetty` (default: *mingetty*)
: The Mingetty package to use.

`agetty-service` *`config`* [Scheme Procedure]

Return a service to run agetty according to *config*, an `<agetty-configuration>` object, which specifies the tty to run, among other things.

`agetty-configuration` [Data Type]

This is the data type representing the configuration of agetty, which implements virtual and serial console log-in. See the `agetty(8)` man page for more information.

`tty`
: The name of the console this agetty runs on, as a string—e.g., `"ttyS0"`. This argument is optional, it will default to a reasonable default serial port used by the kernel Linux.

  For this, if there is a value for an option `agetty.tty` in the kernel command line, agetty will extract the device name of the serial port from it and use that.

  If not and if there is a value for an option `console` with a tty in the Linux command line, agetty will extract the device name of the serial port from it and use that.

  In both cases, agetty will leave the other serial device settings (baud rate etc.) alone—in the hope that Linux pinned them to the correct values.

`baud-rate` (default: `#f`)
: A string containing a comma-separated list of one or more baud rates, in descending order.

`term` (default: `#f`)
: A string containing the value used for the `TERM` environment variable.

`eight-bits?` (default: `#f`)
: When `#t`, the tty is assumed to be 8-bit clean, and parity detection is disabled.

`auto-login` (default: `#f`)
: When passed a login name, as a string, the specified user will be logged in automatically without prompting for their login name or password.

`no-reset?` (default: `#f`)
: When `#t`, don't reset terminal cflags (control modes).

`host` (default: `#f`)
: This accepts a string containing the "login_host", which will be written into the `/var/run/utmpx` file.

`remote?` (default: `#f`)
: When set to `#t` in conjunction with *host*, this will add an `-r` fakehost option to the command line of the login program specified in *login-program*.

`flow-control?` (default: `#f`)
: When set to `#t`, enable hardware (RTS/CTS) flow control.

`no-issue?` (default: `#f`)
: When set to `#t`, the contents of the `/etc/issue` file will not be displayed before presenting the login prompt.

`init-string` (default: `#f`)
: This accepts a string that will be sent to the tty or modem before sending anything else. It can be used to initialize a modem.

`no-clear?` (default: `#f`)
: When set to `#t`, agetty will not clear the screen before showing the login prompt.

`login-program` (default: (file-append shadow "/bin/login"))
: This must be either a gexp denoting the name of a log-in program, or unset, in which case the default value is the `login` from the Shadow tool suite.

`local-line` (default: `#f`)
: Control the CLOCAL line flag. This accepts one of three symbols as arguments, `'auto`, `'always`, or `'never`. If `#f`, the default value chosen by agetty is `'auto`.

`extract-baud?` (default: `#f`)
: When set to `#t`, instruct agetty to try to extract the baud rate from the status messages produced by certain types of modems.

`skip-login?` (default: `#f`)
: When set to `#t`, do not prompt the user for a login name. This can be used with *login-program* field to use non-standard login systems.

`no-newline?` (default: `#f`)
: When set to `#t`, do not print a newline before printing the `/etc/issue` file.

`login-options` (default: `#f`)
: This option accepts a string containing options that are passed to the login program. When used with the *login-program*, be aware that a malicious

user could try to enter a login name containing embedded options that could be parsed by the login program.

`login-pause` (default: `#f`)
: When set to `#t`, wait for any key before showing the login prompt. This can be used in conjunction with *auto-login* to save memory by lazily spawning shells.

`chroot` (default: `#f`)
: Change root to the specified directory. This option accepts a directory path as a string.

`hangup?` (default: `#f`)
: Use the Linux system call `vhangup` to do a virtual hangup of the specified terminal.

`keep-baud?` (default: `#f`)
: When set to `#t`, try to keep the existing baud rate. The baud rates from *baud-rate* are used when agetty receives a `BREAK` character.

`timeout` (default: `#f`)
: When set to an integer value, terminate if no user name could be read within *timeout* seconds.

`detect-case?` (default: `#f`)
: When set to `#t`, turn on support for detecting an uppercase-only terminal. This setting will detect a login name containing only uppercase letters as indicating an uppercase-only terminal and turn on some upper-to-lower case conversions. Note that this will not support Unicode characters.

`wait-cr?` (default: `#f`)
: When set to `#t`, wait for the user or modem to send a carriage-return or linefeed character before displaying `/etc/issue` or login prompt. This is typically used with the *init-string* option.

`no-hints?` (default: `#f`)
: When set to `#t`, do not print hints about Num, Caps, and Scroll locks.

`no-hostname?` (default: `#f`)
: By default, the hostname is printed. When this option is set to `#t`, no hostname will be shown at all.

`long-hostname?` (default: `#f`)
: By default, the hostname is only printed until the first dot. When this option is set to `#t`, the fully qualified hostname by `gethostname` or `getaddrinfo` is shown.

`erase-characters` (default: `#f`)
: This option accepts a string of additional characters that should be interpreted as backspace when the user types their login name.

`kill-characters` (default: `#f`)
: This option accepts a string that should be interpreted to mean "ignore all previous characters" (also called a "kill" character) when the user types their login name.

`chdir` (default: `#f`)
: This option accepts, as a string, a directory path that will be changed to before login.

`delay` (default: `#f`)
: This options accepts, as an integer, the number of seconds to sleep before opening the tty and displaying the login prompt.

`nice` (default: `#f`)
: This option accepts, as an integer, the nice value with which to run the `login` program.

`extra-options` (default: `'()`)
: This option provides an "escape hatch" for the user to provide arbitrary command-line arguments to `agetty` as a list of strings.

`shepherd-requirement` (default: `'()`)
: The option can be used to provides extra shepherd requirements (for example `'syslogd`) to the respective `'term-*` shepherd service.

`kmscon-service-type` *config* [Scheme Procedure]

Return a service to run kmscon (`https://www.freedesktop.org/wiki/Software/kmscon`) according to *config*, a `<kmscon-configuration>` object, which specifies the tty to run, among other things.

`kmscon-configuration` [Data Type]

This is the data type representing the configuration of Kmscon, which implements virtual console log-in.

`virtual-terminal`
: The name of the console this Kmscon runs on—e.g., `"tty1"`.

`login-program` (default: `#~(string-append #$shadow "/bin/login")`)
: A gexp denoting the name of the log-in program. The default log-in program is `login` from the Shadow tool suite.

`login-arguments` (default: `'("-p")`)
: A list of arguments to pass to `login`.

`auto-login` (default: `#f`)
: When passed a login name, as a string, the specified user will be logged in automatically without prompting for their login name or password.

`hardware-acceleration?` (default: #f)
: Whether to use hardware acceleration.

`font-engine` (default: `"pango"`)
: Font engine used in Kmscon.

`font-size` (default: `12`)
: Font size used in Kmscon.

`keyboard-layout` (default: `#f`)
: If this is `#f`, Kmscon uses the default keyboard layout—usually US English ("qwerty") for a 105-key PC keyboard.

Otherwise this must be a `keyboard-layout` object specifying the keyboard layout. See Section 12.7 [Keyboard Layout], page 243, for more information on how to specify the keyboard layout.

`kmscon` (default: *kmscon*)
: The Kmscon package to use.

`nscd-service` [*config*] [*#:glibc glibc*] [*#:name-services '()*] [Scheme Procedure]

Return a service that runs the libc name service cache daemon (nscd) with the given *config*—an `<nscd-configuration>` object. See Section 12.12 [Name Service Switch], page 535, for an example.

For convenience, the Shepherd service for nscd provides the following actions:

`invalidate`
: This invalidate the given cache. For instance, running:

```
herd invalidate nscd hosts
```

invalidates the host name lookup cache of nscd.

`statistics`
: Running `herd statistics nscd` displays information about nscd usage and caches.

`%nscd-default-configuration` [Scheme Variable]

This is the default `<nscd-configuration>` value (see below) used by `nscd-service`. It uses the caches defined by `%nscd-default-caches`; see below.

`nscd-configuration` [Data Type]

This is the data type representing the name service cache daemon (nscd) configuration.

`name-services` (default: `'()`)
: List of packages denoting *name services* that must be visible to the nscd—e.g., `(list` *`nss-mdns`*`)`.

`glibc` (default: *glibc*)
: Package object denoting the GNU C Library providing the `nscd` command.

`log-file` (default: `"/var/log/nscd.log"`)
: Name of the nscd log file. This is where debugging output goes when `debug-level` is strictly positive.

`debug-level` (default: `0`)
: Integer denoting the debugging levels. Higher numbers mean that more debugging output is logged.

`caches` (default: `%nscd-default-caches`)
: List of `<nscd-cache>` objects denoting things to be cached; see below.

`nscd-cache` [Data Type]

Data type representing a cache database of nscd and its parameters.

`database` This is a symbol representing the name of the database to be cached. Valid values are `passwd`, `group`, `hosts`, and `services`, which designate the corresponding NSS database (see Section "NSS Basics" in *The GNU C Library Reference Manual*).

`positive-time-to-live`
`negative-time-to-live` (default: `20`)
: A number representing the number of seconds during which a positive or negative lookup result remains in cache.

`check-files?` (default: `#t`)
: Whether to check for updates of the files corresponding to *database*.

  For instance, when *database* is `hosts`, setting this flag instructs nscd to check for updates in `/etc/hosts` and to take them into account.

`persistent?` (default: `#t`)
: Whether the cache should be stored persistently on disk.

`shared?` (default: `#t`)
: Whether the cache should be shared among users.

`max-database-size` (default: 32 MiB)
: Maximum size in bytes of the database cache.

`%nscd-default-caches` [Scheme Variable]

List of `<nscd-cache>` objects used by default by `nscd-configuration` (see above).

It enables persistent and aggressive caching of service and host name lookups. The latter provides better host name lookup performance, resilience in the face of unreliable name servers, and also better privacy—often the result of host name lookups is in local cache, so external name servers do not even need to be queried.

`syslog-configuration` [Data Type]

This data type represents the configuration of the syslog daemon.

`syslogd` (default: `#~(string-append #$inetutils "/libexec/syslogd")`)
: The syslog daemon to use.

`config-file` (default: `%default-syslog.conf`)
: The syslog configuration file to use.

`syslog-service` *`config`* [Scheme Procedure]

Return a service that runs a syslog daemon according to *config*.

See Section "syslogd invocation" in *GNU Inetutils*, for more information on the configuration file syntax.

`guix-service-type` [Scheme Variable]

This is the type of the service that runs the build daemon, `guix-daemon` (see Section 2.5 [Invoking guix-daemon], page 15). Its value must be a `guix-configuration` record as described below.

`guix-configuration` [Data Type]

This data type represents the configuration of the Guix build daemon. See Section 2.5 [Invoking guix-daemon], page 15, for more information.

`guix` (default: *guix*)
: The Guix package to use.

`build-group` (default: `"guixbuild"`)
: Name of the group for build user accounts.

`build-accounts` (default: `10`)
: Number of build user accounts to create.

`authorize-key?` (default: `#t`)
: Whether to authorize the substitute keys listed in `authorized-keys`—by default that of `ci.guix.gnu.org` and `bordeaux.guix.gnu.org` (see Section 6.3 [Substitutes], page 48).

  When `authorize-key?` is true, `/etc/guix/acl` cannot be changed by invoking `guix archive --authorize`. You must instead adjust `guix-configuration` as you wish and reconfigure the system. This ensures that your operating system configuration file is self-contained.

  > **Note:** When booting or reconfiguring to a system where `authorize-key?` is true, the existing `/etc/guix/acl` file is backed up as `/etc/guix/acl.bak` if it was determined to be a manually modified file. This is to facilitate migration from earlier versions, which allowed for in-place modifications to `/etc/guix/acl`.

`authorized-keys` (default: `%default-authorized-guix-keys`)
: The list of authorized key files for archive imports, as a list of string-valued gexps (see Section 6.10 [Invoking guix archive], page 64). By default, it contains that of `ci.guix.gnu.org` and `bordeaux.guix.gnu.org` (see Section 6.3 [Substitutes], page 48). See `substitute-urls` below for an example on how to change it.

`use-substitutes?` (default: `#t`)
: Whether to use substitutes.

`substitute-urls` (default: `%default-substitute-urls`)
: The list of URLs where to look for substitutes by default.

  Suppose you would like to fetch substitutes from `guix.example.org` in addition to `ci.guix.gnu.org`. You will need to do two things: (1) add `guix.example.org` to `substitute-urls`, and (2) authorize its signing key, having done appropriate checks (see Section 6.3.2 [Substitute Server Authorization], page 49). The configuration below does exactly that:

```
(guix-configuration
  (substitute-urls
   (append (list "https://guix.example.org")
           %default-substitute-urls))
  (authorized-keys
   (append (list (local-file "./guix.example.org-key.pub"))
           %default-authorized-guix-keys)))
```

  This example assumes that the file `./guix.example.org-key.pub` contains the public key that `guix.example.org` uses to sign substitutes.

`generate-substitute-key?` (default: `#t`)
: Whether to generate a *substitute key pair* under `/etc/guix/signing-key.pub` and `/etc/guix/signing-key.sec` if there is not already one.

  This key pair is used when exporting store items, for instance with `guix publish` (see Section 10.11 [Invoking guix publish], page 205) or `guix archive` (see Section 6.10 [Invoking guix archive], page 64). Generating a key pair takes a few seconds when enough entropy is available and is only done once; you might want to turn it off for instance in a virtual machine that does not need it and where the extra boot time is a problem.

`max-silent-time` (default: `0`)
`timeout` (default: `0`)
: The number of seconds of silence and the number of seconds of activity, respectively, after which a build process times out. A value of zero disables the timeout.

`log-compression` (default: `'gzip`)
: The type of compression used for build logs—one of `gzip`, `bzip2`, or `none`.

`discover?` (default: `#f`)
: Whether to discover substitute servers on the local network using mDNS and DNS-SD.

`extra-options` (default: `'()`)
: List of extra command-line options for `guix-daemon`.

`log-file` (default: `"/var/log/guix-daemon.log"`)
: File where `guix-daemon`'s standard output and standard error are written.

`http-proxy` (default: `#f`)
: The URL of the HTTP and HTTPS proxy used for downloading fixed-output derivations and substitutes.

  It is also possible to change the daemon's proxy at run time through the `set-http-proxy` action, which restarts it:

```
herd set-http-proxy guix-daemon http://localhost:8118
```

  To clear the proxy settings, run:

```
herd set-http-proxy guix-daemon
```

`tmpdir` (default: `#f`)
: A directory path where the `guix-daemon` will perform builds.

`guix-extension` [Data Type]

This data type represents the parameters of the Guix build daemon that are extendable. This is the type of the object that must be used within a guix service extension. See Section 12.18.1 [Service Composition], page 560, for more information.

`authorized-keys` (default: `'()`)
: A list of file-like objects where each element contains a public key.

`substitute-urls` (default: `'()`)
: A list of strings where each element is a substitute URL.

`chroot-directories` (default: `'()`)
: A list of file-like objects or strings pointing to additional directories the build daemon can use.

`udev-service` [*#:udev* `eudev` *#:rules* `'()`] [Scheme Procedure]

Run *udev*, which populates the `/dev` directory dynamically. udev rules can be provided as a list of files through the *rules* variable. The procedures `udev-rule`, `udev-rules-service` and `file->udev-rule` from `(gnu services base)` simplify the creation of such rule files.

The `herd rules udev` command, as root, returns the name of the directory containing all the active udev rules.

`udev-rule` [*file-name contents*] [Scheme Procedure]

Return a udev-rule file named *file-name* containing the rules defined by the *contents* literal.

In the following example, a rule for a USB device is defined to be stored in the file `90-usb-thing.rules`. The rule runs a script upon detecting a USB device with a given product identifier.

```
(define %example-udev-rule
  (udev-rule
    "90-usb-thing.rules"
    (string-append "ACTION==\"add\", SUBSYSTEM==\"usb\", "
                   "ATTR{product}==\"Example\", "
                   "RUN+=\"/path/to/script\"")))
```

`udev-rules-service` [*name rules*] [*#:groups groups*] [Scheme Procedure]

Return a service that extends `udev-service-type` with *rules* and `account-service-type` with *groups* as system groups. This works by creating a singleton service type *name*`-udev-rules`, of which the returned service is an instance.

Here we show how it can be used to extend `udev-service-type` with the previously defined rule `%example-udev-rule`.

```
(operating-system
 ;; ...
 (services
   (cons (udev-rules-service 'usb-thing %example-udev-rule)
         %desktop-services)))
```

`file->udev-rule` [*file-name file*] [Scheme Procedure]

Return a udev file named *file-name* containing the rules defined within *file*, a file-like object.

The following example showcases how we can use an existing rule file.

```
(use-modules (guix download)     ;for url-fetch
             (guix packages)     ;for origin
             ...)

(define %android-udev-rules
  (file->udev-rule
    "51-android-udev.rules"
    (let ((version "20170910"))
      (origin
       (method url-fetch)
       (uri (string-append "https://raw.githubusercontent.com/M0Rf30/"
                           "android-udev-rules/" version "/51-android.rules"))
       (sha256
        (base32 "0lmmagpyb6xsq6zcr2w1cyx9qmjqmajkvrdbhjx32gqf1d9is003"))))))
```

Additionally, Guix package definitions can be included in *rules* in order to extend the udev rules with the definitions found under their `lib/udev/rules.d` sub-directory. In lieu of the previous *file->udev-rule* example, we could have used the *android-udev-rules* package which exists in Guix in the `(gnu packages android)` module.

The following example shows how to use the *android-udev-rules* package so that the Android tool `adb` can detect devices without root privileges. It also details how to create the `adbusers` group, which is required for the proper functioning of the rules defined within the `android-udev-rules` package. To create such a group, we must define it both as part of the `supplementary-groups` of our `user-account` declaration, as well as in the *groups* of the `udev-rules-service` procedure.

```
(use-modules (gnu packages android)  ;for android-udev-rules
             (gnu system shadow)     ;for user-group
             ...)

(operating-system
  ;; ...
  (users (cons (user-account
                ;; ...
                (supplementary-groups
                 '("adbusers"   ;for adb
                   "wheel" "netdev" "audio" "video")))))
  ;; ...
  (services
    (cons (udev-rules-service 'android android-udev-rules
                              #:groups '("adbusers"))
          %desktop-services)))
```

`urandom-seed-service-type` [Scheme Variable]

Save some entropy in `%random-seed-file` to seed `/dev/urandom` when rebooting. It also tries to seed `/dev/urandom` from `/dev/hwrng` while booting, if `/dev/hwrng` exists and is readable.

`%random-seed-file` [Scheme Variable]

This is the name of the file where some random bytes are saved by *urandom-seed-service* to seed `/dev/urandom` when rebooting. It defaults to `/var/lib/random-seed`.

`gpm-service-type` [Scheme Variable]

This is the type of the service that runs GPM, the *general-purpose mouse daemon*, which provides mouse support to the Linux console. GPM allows users to use the mouse in the console, notably to select, copy, and paste text.

The value for services of this type must be a `gpm-configuration` (see below). This service is not part of `%base-services`.

`gpm-configuration` [Data Type]

Data type representing the configuration of GPM.

`options` (default: `%default-gpm-options`)
: Command-line options passed to `gpm`. The default set of options instruct `gpm` to listen to mouse events on `/dev/input/mice`. See Section "Command Line" in *gpm manual*, for more information.

`gpm` (default: `gpm`)
: The GPM package to use.

`guix-publish-service-type` [Scheme Variable]

This is the service type for `guix publish` (see Section 10.11 [Invoking guix publish], page 205). Its value must be a `guix-publish-configuration` object, as described below.

This assumes that `/etc/guix` already contains a signing key pair as created by `guix archive --generate-key` (see Section 6.10 [Invoking guix archive], page 64). If that is not the case, the service will fail to start.

`guix-publish-configuration` [Data Type]

Data type representing the configuration of the `guix publish` service.

`guix` (default: `guix`)
: The Guix package to use.

`port` (default: `80`)
: The TCP port to listen for connections.

`host` (default: `"localhost"`)
: The host (and thus, network interface) to listen to. Use `"0.0.0.0"` to listen on all the network interfaces.

`advertise?` (default: `#f`)
: When true, advertise the service on the local network *via* the DNS-SD protocol, using Avahi.

  This allows neighboring Guix devices with discovery on (see `guix-configuration` above) to discover this `guix publish` instance and to automatically download substitutes from it.

`compression` (default: `'(("gzip" 3) ("zstd" 3))`)
: This is a list of compression method/level tuple used when compressing substitutes. For example, to compress all substitutes with *both* lzip at level 7 and gzip at level 9, write:

```
'(("lzip" 7) ("gzip" 9))
```

Level 9 achieves the best compression ratio at the expense of increased CPU usage, whereas level 1 achieves fast compression. See Section 10.11 [Invoking guix publish], page 205, for more information on the available compression methods and the tradeoffs involved.

An empty list disables compression altogether.

`nar-path` (default: `"nar"`)
: The URL path at which "nars" can be fetched. See Section 10.11 [Invoking guix publish], page 205, for details.

`cache` (default: `#f`)
: When it is `#f`, disable caching and instead generate archives on demand. Otherwise, this should be the name of a directory—e.g., `"/var/cache/guix/publish"`—where `guix publish` caches archives and meta-data ready to be sent. See Section 10.11 [Invoking guix publish], page 205, for more information on the tradeoffs involved.

`workers` (default: `#f`)
: When it is an integer, this is the number of worker threads used for caching; when `#f`, the number of processors is used. See Section 10.11 [Invoking guix publish], page 205, for more information.

`cache-bypass-threshold` (default: 10 MiB)
: When `cache` is true, this is the maximum size in bytes of a store item for which `guix publish` may bypass its cache in case of a cache miss. See Section 10.11 [Invoking guix publish], page 205, for more information.

`ttl` (default: `#f`)
: When it is an integer, this denotes the *time-to-live* in seconds of the published archives. See Section 10.11 [Invoking guix publish], page 205, for more information.

`negative-ttl` (default: `#f`)
: When it is an integer, this denotes the *time-to-live* in seconds for the negative lookups. See Section 10.11 [Invoking guix publish], page 205, for more information.

`rngd-service` [*#:rng-tools* `rng-tools`] [*#:device* `"`*/dev/hwrng*`"`] [Scheme Procedure]

Return a service that runs the `rngd` program from *rng-tools* to add *device* to the kernel's entropy pool. The service will fail if *device* does not exist.

`pam-limits-service` [*#:limits* `'()`] [Scheme Procedure]

Return a service that installs a configuration file for the `pam_limits` module (`http://linux-pam.org/Linux-PAM-html/sag-pam_limits.html`). The procedure optionally takes a list of `pam-limits-entry` values, which can be used to specify `ulimit` limits and `nice` priority limits to user sessions.

The following limits definition sets two hard and soft limits for all login sessions of users in the `realtime` group:

```
(pam-limits-service
(list
 (pam-limits-entry "@realtime" 'both 'rtprio 99)
 (pam-limits-entry "@realtime" 'both 'memlock 'unlimited)))
```

The first entry increases the maximum realtime priority for non-privileged processes; the second entry lifts any restriction of the maximum address space that can be locked in memory. These settings are commonly used for real-time audio systems.

Another useful example is raising the maximum number of open file descriptors that can be used:

```
(pam-limits-service
 (list
  (pam-limits-entry "*" 'both 'nofile 100000)))
```

In the above example, the asterisk means the limit should apply to any user. It is important to ensure the chosen value doesn't exceed the maximum system value visible in the `/proc/sys/fs/file-max` file, else the users would be prevented from login in. For more information about the Pluggable Authentication Module (PAM) limits, refer to the 'pam_limits' man page from the `linux-pam` package.

`greetd-service-type` [Scheme Variable]

`greetd` (`https://git.sr.ht/~kennylevinsen/greetd`) is a minimal and flexible login manager daemon, that makes no assumptions about what you want to launch.

If you can run it from your shell in a TTY, greetd can start it. If it can be taught to speak a simple JSON-based IPC protocol, then it can be a geeter.

`greetd-service-type` provides necessary infrastructure for logging in users, including:

- `greetd` PAM service
- Special variation of `pam-mount` to mount `XDG_RUNTIME_DIR`

Here is example of switching from `mingetty-service-type` to `greetd-service-type`, and how different terminals could be:

```
(append
 (modify-services %base-services
   ;; greetd-service-type provides "greetd" PAM service
   (delete login-service-type)
   ;; and can be used in place of mingetty-service-type
   (delete mingetty-service-type))
 (list
  (service greetd-service-type
           (greetd-configuration
            (terminals
             (list
              ;; we can make any terminal active by default
              (greetd-terminal-configuration (terminal-vt "1") (terminal-switch
              ;; we can make environment without XDG_RUNTIME_DIR set█
              ;; even provide our own environment variables
              (greetd-terminal-configuration
               (terminal-vt "2")
```

```
                      (default-session-command
                        (greetd-agreety-session
                         (extra-env '(("MY_VAR" . "1")))
                         (xdg-env? #f))))
                     ;; we can use different shell instead of default bash
                     (greetd-terminal-configuration
                      (terminal-vt "3")
                      (default-session-command
                        (greetd-agreety-session (command (file-append zsh "/bin/zsh"))
                     ;; we can use any other executable command as greeter
                     (greetd-terminal-configuration
                      (terminal-vt "4")
                      (default-session-command (program-file "my-noop-greeter" #~(exit
                     (greetd-terminal-configuration (terminal-vt "5"))
                     (greetd-terminal-configuration (terminal-vt "6"))))))
         ;; mingetty-service-type can be used in parallel
         ;; if needed to do so, do not (delete login-service-type)
         ;; as illustrated above
         #| (service mingetty-service-type (mingetty-configuration (tty "tty8"))) |#))
```

`greetd-configuration` [Data Type]

Configuration record for the `greetd-service-type`.

`motd` A file-like object containing the “message of the day”.

`allow-empty-passwords?` (default: `#t`)
: Allow empty passwords by default so that first-time users can log in when the ’root’ account has just been created.

`terminals` (default: `'()`)
: List of `greetd-terminal-configuration` per terminal for which `greetd` should be started.

`greeter-supplementary-groups` (default: `'()`)
: List of groups which should be added to `greeter` user. For instance:

```
(greeter-supplementary-groups '("seat" "video"))
```

Note that this example will fail if `seat` group does not exist.

`greetd-terminal-configuration` [Data Type]

Configuration record for per terminal greetd daemon service.

`greetd` (default: `greetd`)
: The greetd package to use.

`config-file-name`
: Configuration file name to use for greetd daemon. Generally, autogenerated derivation based on `terminal-vt` value.

`log-file-name`
: Log file name to use for greetd daemon. Generally, autogenerated name based on `terminal-vt` value.

`terminal-vt` (default: ‘"7"’)
: The VT to run on. Use of a specific VT with appropriate conflict avoidance is recommended.

`terminal-switch` (default: `#f`)
: Make this terminal active on start of `greetd`.

`default-session-user` (default: ‘"greeter"’)
: The user to use for running the greeter.

`default-session-command` (default: `(greetd-agreety-session)`)
: Can be either instance of `greetd-agreety-session` configuration or `gexp->script` like object to use as greeter.

`greetd-agreety-session` [Data Type]

Configuration record for the agreety greetd greeter.

`agreety` (default: `greetd`)
: The package with `/bin/agreety` command.

`command` (default: `(file-append bash "/bin/bash")`)
: Command to be started by `/bin/agreety` on successful login.

`command-args` (default: `'("-l")`)
: Command arguments to pass to command.

`extra-env` (default: `'()`)
: Extra environment variables to set on login.

`xdg-env?` (default: `#t`)
: If true `XDG_RUNTIME_DIR` and `XDG_SESSION_TYPE` will be set before starting command. One should note that, `extra-env` variables are set right after mentioned variables, so that they can be overriden.

`greetd-wlgreet-session` [Data Type]

Generic configuration record for the wlgreet greetd greeter.

`wlgreet` (default: `wlgreet`)
: The package with the `/bin/wlgreet` command.

`command` (default: `(file-append sway "/bin/sway")`)
: Command to be started by `/bin/wlgreet` on successful login.

`command-args` (default: `'()`)
: Command arguments to pass to command.

`output-mode` (default: `"all"`)
: Option to use for `outputMode` in the TOML configuration file.

`scale` (default: `1`)
: Option to use for `scale` in the TOML configuration file.

`background` (default: `'(0 0 0 0.9)`)
: RGBA list to use as the background colour of the login prompt.

`headline` (default: `'(1 1 1 1)`)
: RGBA list to use as the headline colour of the UI popup.

`prompt` (default: `'(1 1 1 1)`)
: RGBA list to use as the prompt colour of the UI popup.

`prompt-error` (default: `'(1 1 1 1)`)
: RGBA list to use as the error colour of the UI popup.

`border` (default: `'(1 1 1 1)`)
: RGBA list to use as the border colour of the UI popup.

`extra-env` (default: `'()`)
: Extra environment variables to set on login.

`greetd-wlgreet-sway-session` [Data Type]

Sway-specific configuration record for the wlgreet greetd greeter.

`wlgreet-session` (default: `(greetd-wlgreet-session)`)
: A `greetd-wlgreet-session` record for generic wlgreet configuration, on top of the Sway-specific `greetd-wlgreet-sway-session`.

`sway` (default: `sway`)
: The package providing the `/bin/sway` command.

`sway-configuration` (default: #f)
: File-like object providing an additional Sway configuration file to be prepended to the mandatory part of the configuration.

Here is an example of a greetd configuration that uses wlgreet and Sway:

```
(greetd-configuration
 ;; We need to give the greeter user these permissions, otherwise
 ;; Sway will crash on launch.
 (greeter-supplementary-groups (list "video" "input" "seat"))
 (terminals
  (list (greetd-terminal-configuration
         (terminal-vt "1")
         (terminal-switch #t)
         (default-session-command
          (greetd-wlgreet-sway-session
           (sway-configuration
            (local-file "sway-greetd.conf"))))))))
```

12.9.2 Scheduled Job Execution

The `(gnu services mcron)` module provides an interface to GNU mcron, a daemon to run jobs at scheduled times (see *GNU mcron*). GNU mcron is similar to the traditional Unix `cron` daemon; the main difference is that it is implemented in Guile Scheme, which provides a lot of flexibility when specifying the scheduling of jobs and their actions.

The example below defines an operating system that runs the `updatedb` (see Section "Invoking updatedb" in *Finding Files*) and the `guix gc` commands (see Section 6.5 [Invoking guix gc], page 53) daily, as well as the `mkid` command on behalf of an unprivileged user (see Section "mkid invocation" in *ID Database Utilities*). It uses gexps to introduce job definitions that are passed to mcron (see Section 9.12 [G-Expressions], page 154).

```
(use-modules (guix) (gnu) (gnu services mcron))
```

```
(use-package-modules base idutils)

(define updatedb-job
  ;; Run 'updatedb' at 3AM every day.  Here we write the
  ;; job's action as a Scheme procedure.
  #~(job '(next-hour '(3))
         (lambda ()
           (execl (string-append #$findutils "/bin/updatedb")
                  "updatedb"
                  "--prunepaths=/tmp /var/tmp /gnu/store"))
         "updatedb"))

(define garbage-collector-job
  ;; Collect garbage 5 minutes after midnight every day.
  ;; The job's action is a shell command.
  #~(job "5 0 * * *"            ;Vixie cron syntax
         "guix gc -F 1G"))

(define idutils-job
  ;; Update the index database as user "charlie" at 12:15PM
  ;; and 19:15PM.  This runs from the user's home directory.
  #~(job '(next-minute-from (next-hour '(12 19)) '(15))
         (string-append #$idutils "/bin/mkid src")
         #:user "charlie"))

(operating-system
  ;; ...

  ;; %BASE-SERVICES already includes an instance of
  ;; 'mcron-service-type', which we extend with additional
  ;; jobs using 'simple-service'.
  (services (cons (simple-service 'my-cron-jobs
                                  mcron-service-type
                                  (list garbage-collector-job
                                        updatedb-job
                                        idutils-job))
                  %base-services)))
```

Tip: When providing the action of a job specification as a procedure, you should provide an explicit name for the job via the optional 3rd argument as done in the `updatedb-job` example above. Otherwise, the job would appear as "Lambda function" in the output of `herd schedule mcron`, which is not nearly descriptive enough!

For more complex jobs defined in Scheme where you need control over the top level, for instance to introduce a `use-modules` form, you can move your code to a separate program using the `program-file` procedure of the `(guix gexp)` module (see Section 9.12 [G-Expressions], page 154). The example below illustrates that.

```
(define %battery-alert-job
  ;; Beep when the battery percentage falls below %MIN-LEVEL.
  #~(job
     '(next-minute (range 0 60 1))
     #$(program-file
        "battery-alert.scm"
        (with-imported-modules (source-module-closure
                                '((guix build utils)))
          #~(begin
              (use-modules (guix build utils)
                           (ice-9 popen)
                           (ice-9 regex)
                           (ice-9 textual-ports)
                           (srfi srfi-2))

              (define %min-level 20)

              (setenv "LC_ALL" "C")     ;ensure English output
              (and-let* ((input-pipe (open-pipe*
                                      OPEN_READ
                                      #$(file-append acpi "/bin/acpi")))
                         (output (get-string-all input-pipe))
                         (m (string-match "Discharging, ([0-9]+)%" output))
                         (level (string->number (match:substring m 1)))
                         ((< level %min-level)))
                (format #t "warning: Battery level is low (~a%)~%" level)
                (invoke #$(file-append beep "/bin/beep") "-r5")))))))
```

See Section “Guile Syntax” in *GNU mcron*, for more information on mcron job specifications. Below is the reference of the mcron service.

On a running system, you can use the `schedule` action of the service to visualize the mcron jobs that will be executed next:

```
# herd schedule mcron
```

The example above lists the next five tasks that will be executed, but you can also specify the number of tasks to display:

```
# herd schedule mcron 10
```

`mcron-service-type` [Scheme Variable]

This is the type of the `mcron` service, whose value is an `mcron-configuration` object.

This service type can be the target of a service extension that provides additional job specifications (see Section 12.18.1 [Service Composition], page 560). In other words, it is possible to define services that provide additional mcron jobs to run.

`mcron-configuration` [Data Type]

Available `mcron-configuration` fields are:

`mcron` (default: `mcron`) (type: file-like)
: The mcron package to use.

`jobs` (default: `()`) (type: list-of-gexps)
: This is a list of gexps (see Section 9.12 [G-Expressions], page 154), where each gexp corresponds to an mcron job specification (see Section “Syntax” in *GNU mcron*).

`log?` (default: `#t`) (type: boolean)
: Log messages to standard output.

`log-format` (default: `"~1@*~a ~a: ~a~%"`) (type: string)
: `(ice-9 format)` format string for log messages. The default value produces messages like "‘*pid name*: *message*"’ (see Section “Invoking mcron” in *GNU mcron*). Each message is also prefixed by a timestamp by GNU Shepherd.

12.9.3 Log Rotation

Log files such as those found in `/var/log` tend to grow endlessly, so it’s a good idea to *rotate* them once in a while—i.e., archive their contents in separate files, possibly compressed. The `(gnu services admin)` module provides an interface to GNU Rot[t]log, a log rotation tool (see *GNU Rot[t]log Manual*).

This service is part of `%base-services`, and thus enabled by default, with the default settings, for commonly encountered log files. The example below shows how to extend it with an additional *rotation*, should you need to do that (usually, services that produce log files already take care of that):

```
(use-modules (guix) (gnu))
(use-service-modules admin)

(define my-log-files
  ;; Log files that I want to rotate.
  '("/var/log/something.log" "/var/log/another.log"))

(operating-system
  ;; ...
  (services (cons (simple-service 'rotate-my-stuff
                                  rottlog-service-type
                                  (list (log-rotation
                                         (frequency 'daily)
                                         (files my-log-files))))
                  %base-services)))
```

`rottlog-service-type` [Scheme Variable]
: This is the type of the Rottlog service, whose value is a `rottlog-configuration` object.

  Other services can extend this one with new `log-rotation` objects (see below), thereby augmenting the set of files to be rotated.

  This service type can define mcron jobs (see Section 12.9.2 [Scheduled Job Execution], page 265) to run the rottlog service.

`rottlog-configuration` [Data Type]

Data type representing the configuration of rottlog.

`rottlog` (default: `rottlog`)
: The Rottlog package to use.

`rc-file` (default: `(file-append rottlog "/etc/rc")`)
: The Rottlog configuration file to use (see Section "Mandatory RC Variables" in *GNU Rot[t]log Manual*).

`rotations` (default: `%default-rotations`)
: A list of `log-rotation` objects as defined below.

`jobs`
: This is a list of gexps where each gexp corresponds to an mcron job specification (see Section 12.9.2 [Scheduled Job Execution], page 265).

`log-rotation` [Data Type]

Data type representing the rotation of a group of log files.

Taking an example from the Rottlog manual (see Section "Period Related File Examples" in *GNU Rot[t]log Manual*), a log rotation might be defined like this:

```
(log-rotation
  (frequency 'daily)
  (files '("/var/log/apache/*"))
  (options '("storedir apache-archives"
             "rotate 6"
             "notifempty"
             "nocompress")))
```

The list of fields is as follows:

`frequency` (default: `'weekly`)
: The log rotation frequency, a symbol.

`files`
: The list of files or file glob patterns to rotate.

`options` (default: `%default-log-rotation-options`)
: The list of rottlog options for this rotation (see Section "Configuration parameters" in *GNU Rot[t]log Manual*).

`post-rotate` (default: `#f`)
: Either `#f` or a gexp to execute once the rotation has completed.

`%default-rotations` [Scheme Variable]

Specifies weekly rotation of `%rotated-files` and of `/var/log/guix-daemon.log`.

`%rotated-files` [Scheme Variable]

The list of syslog-controlled files to be rotated. By default it is: `'("/var/log/messages" "/var/log/secure" "/var/log/debug" \ "/var/log/maillog")`.

Some log files just need to be deleted periodically once they are old, without any other criterion and without any archival step. This is the case of build logs stored by `guix-daemon` under /var/log/guix/drvs (see Section 2.5 [Invoking guix-daemon], page 15). The log-cleanup service addresses this use case. For example, %base-services (see Section 12.9.1 [Base Services], page 248) includes the following:

```
;; Periodically delete old build logs.
(service log-cleanup-service-type
         (log-cleanup-configuration
          (directory "/var/log/guix/drvs")))
```

That ensures build logs do not accumulate endlessly.

log-cleanup-service-type [Scheme Variable]

This is the type of the service to delete old logs. Its value must be a log-cleanup-configuration record as described below.

log-cleanup-configuration [Data Type]

Data type representing the log cleanup configuration

directory
: Name of the directory containing log files.

expiry (default: (* 6 30 24 3600))
: Age in seconds after which a file is subject to deletion (six months by default).

schedule (default: "30 12 01,08,15,22 * *")
: String or gexp denoting the corresponding mcron job schedule (see Section 12.9.2 [Scheduled Job Execution], page 265).

Anonip Service

Anonip is a privacy filter that removes IP address from web server logs. This service creates a FIFO and filters any written lines with anonip before writing the filtered log to a target file.

The following example sets up the FIFO /var/run/anonip/https.access.log and writes the filtered log file /var/log/anonip/https.access.log.

```
(service anonip-service-type
         (anonip-configuration
           (input  "/var/run/anonip/https.access.log")
           (output "/var/log/anonip/https.access.log")))
```

Configure your web server to write its logs to the FIFO at /var/run/anonip/https.access.log and collect the anonymized log file at /var/web-logs/https.access.log.

anonip-configuration [Data Type]

This data type represents the configuration of anonip. It has the following parameters:

anonip (default: anonip)
: The anonip package to use.

input
: The file name of the input log file to process. The service creates a FIFO of this name. The web server should write its logs to this FIFO.

output
: The file name of the processed log file.

The following optional settings may be provided:

`skip-private?`
: When `#true` do not mask addresses in private ranges.

`column`
: A 1-based indexed column number. Assume IP address is in the specified column (default is 1).

`replacement`
: Replacement string in case address parsing fails, e.g. `"0.0.0.0"`.

`ipv4mask`
: Number of bits to mask in IPv4 addresses.

`ipv6mask`
: Number of bits to mask in IPv6 addresses.

`increment`
: Increment the IP address by the given number. By default this is zero.

`delimiter`
: Log delimiter string.

`regex`
: Regular expression for detecting IP addresses. Use this instead of `column`.

12.9.4 Networking Setup

The `(gnu services networking)` module provides services to configure network interfaces and set up networking on your machine. Those services provide different ways for you to set up your machine: by declaring a static network configuration, by running a Dynamic Host Configuration Protocol (DHCP) client, or by running daemons such as NetworkManager and Connman that automate the whole process, automatically adapt to connectivity changes, and provide a high-level user interface.

On a laptop, NetworkManager and Connman are by far the most convenient options, which is why the default desktop services include NetworkManager (see Section 12.9.9 [Desktop Services], page 322). For a server, or for a virtual machine or a container, static network configuration or a simple DHCP client are often more appropriate.

This section describes the various network setup services available, starting with static network configuration.

`static-networking-service-type` [Scheme Variable]

This is the type for statically-configured network interfaces. Its value must be a list of `static-networking` records. Each of them declares a set of *addresses*, *routes*, and *links*, as shown below.

Here is the simplest configuration, with only one network interface controller (NIC) and only IPv4 connectivity:

```
;; Static networking for one NIC, IPv4-only.
(service static-networking-service-type
         (list (static-networking
                (addresses
                 (list (network-address
                        (device "eno1")
                        (value "10.0.2.15/24"))))
                (routes
                 (list (network-route
                        (destination "default")
                        (gateway "10.0.2.2"))))
                (name-servers '("10.0.2.3")))))
```

The snippet above can be added to the `services` field of your operating system configuration (see Section 12.1 [Using the Configuration System], page 220). It will configure your machine to have 10.0.2.15 as its IP address, with a 24-bit netmask for the local network—meaning that any 10.0.2.x address is on the local area network (LAN). Traffic to addresses outside the local network is routed *via* 10.0.2.2. Host names are resolved by sending domain name system (DNS) queries to 10.0.2.3.

`static-networking` [Data Type]

This is the data type representing a static network configuration.

As an example, here is how you would declare the configuration of a machine with a single network interface controller (NIC) available as `eno1`, and with one IPv4 and one IPv6 address:

```
;; Network configuration for one NIC, IPv4 + IPv6.
(static-networking
 (addresses (list (network-address
                   (device "eno1")
                   (value "10.0.2.15/24"))
                  (network-address
                   (device "eno1")
                   (value "2001:123:4567:101::1/64"))))
 (routes (list (network-route
                (destination "default")
                (gateway "10.0.2.2"))
               (network-route
                (destination "default")
                (gateway "2020:321:4567:42::1"))))
 (name-servers '("10.0.2.3")))
```

If you are familiar with the `ip` command of the `iproute2` package (`https://wiki.linuxfoundation.org/networking/iproute2`) found on Linux-based systems, the declaration above is equivalent to typing:

```
ip address add 10.0.2.15/24 dev eno1
ip address add 2001:123:4567:101::1/64 dev eno1
ip route add default via inet 10.0.2.2
ip route add default via inet6 2020:321:4567:42::1
```

Run `man 8 ip` for more info. Venerable GNU/Linux users will certainly know how to do it with `ifconfig` and `route`, but we'll spare you that.

The available fields of this data type are as follows:

`addresses`
`links` (default: `'()`)
`routes` (default: `'()`)

The list of `network-address`, `network-link`, and `network-route` records for this network (see below).

`name-servers` (default: `'()`)
: The list of IP addresses (strings) of domain name servers. These IP addresses go to `/etc/resolv.conf`.

`provision` (default: `'(networking)`)
: If true, this should be a list of symbols for the Shepherd service corresponding to this network configuration.

`requirement` (default `'()`)
: The list of Shepherd services depended on.

`network-address` [Data Type]

This is the data type representing the IP address of a network interface.

`device` The name of the network interface for this address—e.g., `"eno1"`.

`value` The actual IP address and network mask, in CIDR (Classless Inter-Domain Routing) notation (`https://en.wikipedia.org/wiki/CIDR#CIDR_notation`), as a string.

For example, `"10.0.2.15/24"` denotes IPv4 address 10.0.2.15 on a 24-bit sub-network—all 10.0.2.*x* addresses are on the same local network.

`ipv6?` Whether `value` denotes an IPv6 address. By default this is automatically determined.

`network-route` [Data Type]

This is the data type representing a network route.

`destination`
: The route destination (a string), either an IP address and network mask or `"default"` to denote the default route.

`source` (default: `#f`)
: The route source.

`device` (default: `#f`)
: The device used for this route—e.g., `"eno2"`.

`ipv6?` (default: auto)
: Whether this is an IPv6 route. By default this is automatically determined based on `destination` or `gateway`.

`gateway` (default: `#f`)
: IP address (a string) through which traffic is routed.

`network-link` [Data Type]

Data type for a network link (see Section “Link” in *Guile-Netlink Manual*).

`name` The name of the link—e.g., `"v0p0"`.

`type` A symbol denoting the type of the link—e.g., `'veth`.

`arguments`
: List of arguments for this type of link.

`%loopback-static-networking` [Scheme Variable]

This is the `static-networking` record representing the “loopback device”, `lo`, for IP addresses 127.0.0.1 and ::1, and providing the `loopback` Shepherd service.

`%qemu-static-networking` [Scheme Variable]

This is the `static-networking` record representing network setup when using QEMU’s user-mode network stack on `eth0` (see Section “Using the user mode network stack” in *QEMU Documentation*).

`dhcp-client-service-type` [Scheme Variable]

This is the type of services that run *dhcp*, a Dynamic Host Configuration Protocol (DHCP) client.

`dhcp-client-configuration` [Data Type]

Data type representing the configuration of the DHCP client service.

`package` (default: `isc-dhcp`)
: DHCP client package to use.

`interfaces` (default: `'all`)
: Either `'all` or the list of interface names that the DHCP client should listen on—e.g., `'("eno1")`.

  When set to `'all`, the DHCP client listens on all the available non-loopback interfaces that can be activated. Otherwise the DHCP client listens only on the specified interfaces.

`network-manager-service-type` [Scheme Variable]

This is the service type for the NetworkManager (`https://wiki.gnome.org/Projects/NetworkManager`) service. The value for this service type is a `network-manager-configuration` record.

This service is part of `%desktop-services` (see Section 12.9.9 [Desktop Services], page 322).

`network-manager-configuration` [Data Type]

Data type representing the configuration of NetworkManager.

`network-manager` (default: `network-manager`)
: The NetworkManager package to use.

`dns` (default: `"default"`)
: Processing mode for DNS, which affects how NetworkManager uses the `resolv.conf` configuration file.

  ‘`default`’ NetworkManager will update `resolv.conf` to reflect the nameservers provided by currently active connections.

  ‘`dnsmasq`’ NetworkManager will run `dnsmasq` as a local caching nameserver, using a *conditional forwarding* configuration if you are connected to a VPN, and then update `resolv.conf` to point to the local nameserver.

  With this setting, you can share your network connection. For example when you want to share your network connection to another laptop *via* an Ethernet cable, you can open `nm-connection-editor` and configure the Wired connection's method for IPv4 and IPv6 to be "Shared to other computers" and reestablish the connection (or reboot).

You can also set up a *host-to-guest connection* to QEMU VMs (see Section 3.8 [Installing Guix in a VM], page 31). With a host-to-guest connection, you can e.g. access a Web server running on the VM (see Section 12.9.19 [Web Services], page 411) from a Web browser on your host system, or connect to the VM *via* SSH (see Section 12.9.5 [Networking Services], page 277). To set up a host-to-guest connection, run this command once:

```
nmcli connection add type tun \
 connection.interface-name tap0 \
 tun.mode tap tun.owner $(id -u) \
 ipv4.method shared \
 ipv4.addresses 172.28.112.1/24
```

Then each time you launch your QEMU VM (see Section 12.17 [Running Guix in a VM], page 558), pass `-nic tap,ifname=tap0,script=no,downscript=no` to `qemu-system-...`.

'`none`' NetworkManager will not modify `resolv.conf`.

`vpn-plugins` (default: `'()`)
This is the list of available plugins for virtual private networks (VPNs). An example of this is the `network-manager-openvpn` package, which allows NetworkManager to manage VPNs *via* OpenVPN.

`connman-service-type` [Scheme Variable]
This is the service type to run Connman (`https://01.org/connman`), a network connection manager.

Its value must be an `connman-configuration` record as in this example:

```
(service connman-service-type
         (connman-configuration
           (disable-vpn? #t)))
```

See below for details about `connman-configuration`.

`connman-configuration` [Data Type]
Data Type representing the configuration of connman.

`connman` (default: *connman*)
The connman package to use.

`disable-vpn?` (default: `#f`)
When true, disable connman's vpn plugin.

`wpa-supplicant-service-type` [Scheme Variable]

This is the service type to run WPA supplicant (`https://w1.fi/wpa_supplicant/`), an authentication daemon required to authenticate against encrypted WiFi or ethernet networks.

`wpa-supplicant-configuration` [Data Type]

Data type representing the configuration of WPA Supplicant.

It takes the following parameters:

`wpa-supplicant` (default: `wpa-supplicant`)
: The WPA Supplicant package to use.

`requirement` (default: `'(user-processes loopback syslogd)`
: List of services that should be started before WPA Supplicant starts.

`dbus?` (default: `#t`)
: Whether to listen for requests on D-Bus.

`pid-file` (default: `"/var/run/wpa_supplicant.pid"`)
: Where to store the PID file.

`interface` (default: `#f`)
: If this is set, it must specify the name of a network interface that WPA supplicant will control.

`config-file` (default: `#f`)
: Optional configuration file to use.

`extra-options` (default: `'()`)
: List of additional command-line arguments to pass to the daemon.

Some networking devices such as modems require special care, and this is what the services below focus on.

`modem-manager-service-type` [Scheme Variable]

This is the service type for the ModemManager (`https://wiki.gnome.org/Projects/ModemManager`) service. The value for this service type is a `modem-manager-configuration` record.

This service is part of `%desktop-services` (see Section 12.9.9 [Desktop Services], page 322).

`modem-manager-configuration` [Data Type]

Data type representing the configuration of ModemManager.

`modem-manager` (default: `modem-manager`)
: The ModemManager package to use.

`usb-modeswitch-service-type` [Scheme Variable]

This is the service type for the USB_ModeSwitch (`https://www.draisberghof.de/usb_modeswitch/`) service. The value for this service type is a `usb-modeswitch-configuration` record.

When plugged in, some USB modems (and other USB devices) initially present themselves as a read-only storage medium and not as a modem. They need to be *modeswitched* before they are usable. The USB_ModeSwitch service type installs udev rules to automatically modeswitch these devices when they are plugged in.

This service is part of `%desktop-services` (see Section 12.9.9 [Desktop Services], page 322).

`usb-modeswitch-configuration` [Data Type]

Data type representing the configuration of USB_ModeSwitch.

`usb-modeswitch` (default: `usb-modeswitch`)
: The USB_ModeSwitch package providing the binaries for modeswitching.

`usb-modeswitch-data` (default: `usb-modeswitch-data`)
: The package providing the device data and udev rules file used by USB_ModeSwitch.

`config-file` (default: `#~(string-append #$usb-modeswitch:dispatcher "/etc/usb_modeswitch.conf")`)
: Which config file to use for the USB_ModeSwitch dispatcher. By default the config file shipped with USB_ModeSwitch is used which disables logging to `/var/log` among other default settings. If set to `#f`, no config file is used.

12.9.5 Networking Services

The `(gnu services networking)` module discussed in the previous section provides services for more advanced setups: providing a DHCP service for others to use, filtering packets with iptables or nftables, running a WiFi access point with `hostapd`, running the `inetd` "superdaemon", and more. This section describes those.

`dhcpd-service-type` [Scheme Procedure]

This type defines a service that runs a DHCP daemon. To create a service of this type, you must supply a `<dhcpd-configuration>`. For example:

```
(service dhcpd-service-type
         (dhcpd-configuration
          (config-file (local-file "my-dhcpd.conf"))
          (interfaces '("enp0s25"))))
```

`dhcpd-configuration` [Data Type]

`package` (default: `isc-dhcp`)
: The package that provides the DHCP daemon. This package is expected to provide the daemon at `sbin/dhcpd` relative to its output directory. The default package is the ISC's DHCP server (`https://www.isc.org/dhcp/`).

`config-file` (default: `#f`)
: The configuration file to use. This is required. It will be passed to `dhcpd` via its `-cf` option. This may be any "file-like" object (see Section 9.12 [G-Expressions], page 154). See `man dhcpd.conf` for details on the configuration file syntax.

`version` (default: `"4"`)
: The DHCP version to use. The ISC DHCP server supports the values “4”, “6”, and “4o6”. These correspond to the `dhcpd` program options `-4`, `-6`, and `-4o6`. See `man dhcpd` for details.

`run-directory` (default: `"/run/dhcpd"`)
: The run directory to use. At service activation time, this directory will be created if it does not exist.

`pid-file` (default: `"/run/dhcpd/dhcpd.pid"`)
: The PID file to use. This corresponds to the `-pf` option of `dhcpd`. See `man dhcpd` for details.

`interfaces` (default: `'()`)
: The names of the network interfaces on which dhcpd should listen for broadcasts. If this list is not empty, then its elements (which must be strings) will be appended to the `dhcpd` invocation when starting the daemon. It may not be necessary to explicitly specify any interfaces here; see `man dhcpd` for details.

`hostapd-service-type` [Scheme Variable]

This is the service type to run the hostapd (`https://w1.fi/hostapd/`) daemon to set up WiFi (IEEE 802.11) access points and authentication servers. Its associated value must be a `hostapd-configuration` as shown below:

```
;; Use wlan1 to run the access point for "My Network".
(service hostapd-service-type
         (hostapd-configuration
          (interface "wlan1")
          (ssid "My Network")
          (channel 12)))
```

`hostapd-configuration` [Data Type]

This data type represents the configuration of the hostapd service, with the following fields:

`package` (default: `hostapd`)
: The hostapd package to use.

`interface` (default: `"wlan0"`)
: The network interface to run the WiFi access point.

`ssid`
: The SSID (*service set identifier*), a string that identifies this network.

`broadcast-ssid?` (default: `#t`)
: Whether to broadcast this SSID.

`channel` (default: `1`)
: The WiFi channel to use.

`driver` (default: `"nl80211"`)
: The driver interface type. `"nl80211"` is used with all Linux mac80211 drivers. Use `"none"` if building hostapd as a standalone RADIUS server that does # not control any wireless/wired driver.

`extra-settings` (default: `""`)

Extra settings to append as-is to the hostapd configuration file. See `https://w1.fi/cgit/hostap/plain/hostapd/hostapd.conf` for the configuration file reference.

`simulated-wifi-service-type` [Scheme Variable]

This is the type of a service to simulate WiFi networking, which can be useful in virtual machines for testing purposes. The service loads the Linux kernel `mac80211_hwsim` module (`https://www.kernel.org/doc/html/latest/networking/mac80211_hwsim/mac80211_hwsim.html`) and starts hostapd to create a pseudo WiFi network that can be seen on `wlan0`, by default.

The service's value is a `hostapd-configuration` record.

`iptables-service-type` [Scheme Variable]

This is the service type to set up an iptables configuration. iptables is a packet filtering framework supported by the Linux kernel. This service supports configuring iptables for both IPv4 and IPv6. A simple example configuration rejecting all incoming connections except those to the ssh port 22 is shown below.

```
(service iptables-service-type
         (iptables-configuration
          (ipv4-rules (plain-file "iptables.rules" "*filter
:INPUT ACCEPT
:FORWARD ACCEPT
:OUTPUT ACCEPT
-A INPUT -m conntrack --ctstate ESTABLISHED,RELATED -j ACCEPT
-A INPUT -p tcp --dport 22 -j ACCEPT
-A INPUT -j REJECT --reject-with icmp-port-unreachable
COMMIT
"))
          (ipv6-rules (plain-file "ip6tables.rules" "*filter
:INPUT ACCEPT
:FORWARD ACCEPT
:OUTPUT ACCEPT
-A INPUT -m conntrack --ctstate ESTABLISHED,RELATED -j ACCEPT
-A INPUT -p tcp --dport 22 -j ACCEPT
-A INPUT -j REJECT --reject-with icmp6-port-unreachable
COMMIT
"))))
```

`iptables-configuration` [Data Type]

The data type representing the configuration of iptables.

`iptables` (default: `iptables`)

The iptables package that provides `iptables-restore` and `ip6tables-restore`.

`ipv4-rules` (default: `%iptables-accept-all-rules`)

The iptables rules to use. It will be passed to `iptables-restore`. This may be any "file-like" object (see Section 9.12 [G-Expressions], page 154).

`ipv6-rules` (default: `%iptables-accept-all-rules`)
: The ip6tables rules to use. It will be passed to `ip6tables-restore`. This may be any "file-like" object (see Section 9.12 [G-Expressions], page 154).

`nftables-service-type` [Scheme Variable]

This is the service type to set up a nftables configuration. nftables is a netfilter project that aims to replace the existing iptables, ip6tables, arptables and ebtables framework. It provides a new packet filtering framework, a new user-space utility `nft`, and a compatibility layer for iptables. This service comes with a default ruleset `%default-nftables-ruleset` that rejecting all incoming connections except those to the ssh port 22. To use it, simply write:

```
(service nftables-service-type)
```

`nftables-configuration` [Data Type]

The data type representing the configuration of nftables.

`package` (default: `nftables`)
: The nftables package that provides `nft`.

`ruleset` (default: `%default-nftables-ruleset`)
: The nftables ruleset to use. This may be any "file-like" object (see Section 9.12 [G-Expressions], page 154).

`ntp-service-type` [Scheme Variable]

This is the type of the service running the Network Time Protocol (NTP) (`https://www.ntp.org`) daemon, `ntpd`. The daemon will keep the system clock synchronized with that of the specified NTP servers.

The value of this service is an `ntpd-configuration` object, as described below.

`ntp-configuration` [Data Type]

This is the data type for the NTP service configuration.

`servers` (default: `%ntp-servers`)
: This is the list of servers (`<ntp-server>` records) with which `ntpd` will be synchronized. See the `ntp-server` data type definition below.

`allow-large-adjustment?` (default: `#t`)
: This determines whether `ntpd` is allowed to make an initial adjustment of more than 1,000 seconds.

`ntp` (default: `ntp`)
: The NTP package to use.

`%ntp-servers` [Scheme Variable]

List of host names used as the default NTP servers. These are servers of the NTP Pool Project (`https://www.ntppool.org/en/`).

`ntp-server` [Data Type]

The data type representing the configuration of a NTP server.

`type` (default: `'server`)
: The type of the NTP server, given as a symbol. One of `'pool`, `'server`, `'peer`, `'broadcast` or `'manycastclient`.

`address` The address of the server, as a string.

`options` NTPD options to use with that specific server, given as a list of option names and/or of option names and values tuples. The following example define a server to use with the options `iburst` and `prefer`, as well as `version` 3 and a `maxpoll` time of 16 seconds.

```
(ntp-server
 (type 'server)
 (address "some.ntp.server.org")
 (options `(iburst (version 3) (maxpoll 16) prefer))))
```

`openntpd-service-type` [Scheme Procedure]

Run the `ntpd`, the Network Time Protocol (NTP) daemon, as implemented by OpenNTPD (`http://www.openntpd.org`). The daemon will keep the system clock synchronized with that of the given servers.

```
(service
 openntpd-service-type
 (openntpd-configuration
  (listen-on '("127.0.0.1" "::1"))
  (sensor '("udcf0 correction 70000"))
  (constraint-from '("www.gnu.org"))
  (constraints-from '("https://www.google.com/"))))
```

`%openntpd-servers` [Scheme Variable]

This variable is a list of the server addresses defined in `%ntp-servers`.

`openntpd-configuration` [Data Type]

`openntpd` (default: `(file-append openntpd "/sbin/ntpd")`)
The openntpd executable to use.

`listen-on` (default: `'("127.0.0.1" "::1")`)
A list of local IP addresses or hostnames the ntpd daemon should listen on.

`query-from` (default: `'()`)
A list of local IP address the ntpd daemon should use for outgoing queries.

`sensor` (default: `'()`)
Specify a list of timedelta sensor devices ntpd should use. `ntpd` will listen to each sensor that actually exists and ignore non-existent ones. See upstream documentation (`https://man.openbsd.org/ntpd.conf`) for more information.

`server` (default: `'()`)
Specify a list of IP addresses or hostnames of NTP servers to synchronize to.

`servers` (default: `%openntp-servers`)
Specify a list of IP addresses or hostnames of NTP pools to synchronize to.

`constraint-from` (default: `'()`)

`ntpd` can be configured to query the 'Date' from trusted HTTPS servers via TLS. This time information is not used for precision but acts as an authenticated constraint, thereby reducing the impact of unauthenticated NTP man-in-the-middle attacks. Specify a list of URLs, IP addresses or hostnames of HTTPS servers to provide a constraint.

`constraints-from` (default: `'()`)

As with constraint from, specify a list of URLs, IP addresses or hostnames of HTTPS servers to provide a constraint. Should the hostname resolve to multiple IP addresses, `ntpd` will calculate a median constraint from all of them.

`inetd-service-type` [Scheme variable]

This service runs the `inetd` (see Section "inetd invocation" in *GNU Inetutils*) daemon. `inetd` listens for connections on internet sockets, and lazily starts the specified server program when a connection is made on one of these sockets.

The value of this service is an `inetd-configuration` object. The following example configures the `inetd` daemon to provide the built-in `echo` service, as well as an smtp service which forwards smtp traffic over ssh to a server `smtp-server` behind a gateway `hostname`:

```
(service
 inetd-service-type
 (inetd-configuration
  (entries (list
            (inetd-entry
             (name "echo")
             (socket-type 'stream)
             (protocol "tcp")
             (wait? #f)
             (user "root"))
            (inetd-entry
             (node "127.0.0.1")
             (name "smtp")
             (socket-type 'stream)
             (protocol "tcp")
             (wait? #f)
             (user "root")
             (program (file-append openssh "/bin/ssh"))
             (arguments
              '("ssh" "-qT" "-i" "/path/to/ssh_key"
                "-W" "smtp-server:25" "user@hostname")))))))
```

See below for more details about `inetd-configuration`.

`inetd-configuration` [Data Type]

Data type representing the configuration of `inetd`.

`program` (default: `(file-append inetutils "/libexec/inetd")`)

The `inetd` executable to use.

`entries` (default: `'()`)
: A list of `inetd` service entries. Each entry should be created by the `inetd-entry` constructor.

`inetd-entry` [Data Type]

Data type representing an entry in the `inetd` configuration. Each entry corresponds to a socket where `inetd` will listen for requests.

`node` (default: `#f`)
: Optional string, a comma-separated list of local addresses `inetd` should use when listening for this service. See Section "Configuration file" in *GNU Inetutils* for a complete description of all options.

`name`
: A string, the name must correspond to an entry in `/etc/services`.

`socket-type`
: One of `'stream`, `'dgram`, `'raw`, `'rdm` or `'seqpacket`.

`protocol`
: A string, must correspond to an entry in `/etc/protocols`.

`wait?` (default: `#t`)
: Whether `inetd` should wait for the server to exit before listening to new service requests.

`user`
: A string containing the user (and, optionally, group) name of the user as whom the server should run. The group name can be specified in a suffix, separated by a colon or period, i.e. `"user"`, `"user:group"` or `"user.group"`.

`program` (default: `"internal"`)
: The server program which will serve the requests, or `"internal"` if `inetd` should use a built-in service.

`arguments` (default: `'()`)
: A list strings or file-like objects, which are the server program's arguments, starting with the zeroth argument, i.e. the name of the program itself. For `inetd`'s internal services, this entry must be `'()` or `'("internal")`.

See Section "Configuration file" in *GNU Inetutils* for a more detailed discussion of each configuration field.

`opendht-service-type` [Scheme Variable]

This is the type of the service running a OpenDHT (`https://opendht.net`) node, `dhtnode`. The daemon can be used to host your own proxy service to the distributed hash table (DHT), for example to connect to with Jami, among other applications.

> **Important:** When using the OpenDHT proxy server, the IP addresses it "sees" from the clients should be addresses reachable from other peers. In practice this means that a publicly reachable address is best suited for a proxy server, outside of your private network. For example, hosting the proxy server on a IPv4 private local network and exposing it via port forwarding could work for external peers, but peers local to the proxy

would have their private addresses shared with the external peers, leading to connectivity problems.

The value of this service is a `opendht-configuration` object, as described below.

`opendht-configuration` [Data Type]

Available `opendht-configuration` fields are:

`opendht` (default: `opendht`) (type: file-like)
: The `opendht` package to use.

`peer-discovery?` (default: `#f`) (type: boolean)
: Whether to enable the multicast local peer discovery mechanism.

`enable-logging?` (default: `#f`) (type: boolean)
: Whether to enable logging messages to syslog. It is disabled by default as it is rather verbose.

`debug?` (default: `#f`) (type: boolean)
: Whether to enable debug-level logging messages. This has no effect if logging is disabled.

`bootstrap-host` (default: `"bootstrap.jami.net:4222"`) (type: maybe-string)
: The node host name that is used to make the first connection to the network. A specific port value can be provided by appending the `:PORT` suffix. By default, it uses the Jami bootstrap nodes, but any host can be specified here. It's also possible to disable bootstrapping by explicitly setting this field to the `%unset-value` value.

`port` (default: `4222`) (type: maybe-number)
: The UDP port to bind to. When left unspecified, an available port is automatically selected.

`proxy-server-port` (type: maybe-number)
: Spawn a proxy server listening on the specified port.

`proxy-server-port-tls` (type: maybe-number)
: Spawn a proxy server listening to TLS connections on the specified port.

`tor-service-type` [Scheme Variable]

This is the type for a service that runs the Tor (`https://torproject.org`) anonymous networking daemon. The service is configured using a `<tor-configuration>` record. By default, the Tor daemon runs as the `tor` unprivileged user, which is a member of the `tor` group.

`tor-configuration` [Data Type]

`tor` (default: `tor`)
: The package that provides the Tor daemon. This package is expected to provide the daemon at `bin/tor` relative to its output directory. The default package is the Tor Project's (`https://www.torproject.org`) implementation.

`config-file` (default: `(plain-file "empty" "")`)
: The configuration file to use. It will be appended to a default configuration file, and the final configuration file will be passed to `tor` via its `-f` option. This may be any "file-like" object (see Section 9.12 [G-Expressions], page 154). See `man tor` for details on the configuration file syntax.

`hidden-services` (default: `'()`)
: The list of `<hidden-service>` records to use. For any hidden service you include in this list, appropriate configuration to enable the hidden service will be automatically added to the default configuration file. You may conveniently create `<hidden-service>` records using the `tor-hidden-service` procedure described below.

`socks-socket-type` (default: `'tcp`)
: The default socket type that Tor should use for its SOCKS socket. This must be either `'tcp` or `'unix`. If it is `'tcp`, then by default Tor will listen on TCP port 9050 on the loopback interface (i.e., localhost). If it is `'unix`, then Tor will listen on the UNIX domain socket `/var/run/tor/socks-sock`, which will be made writable by members of the `tor` group.

  If you want to customize the SOCKS socket in more detail, leave `socks-socket-type` at its default value of `'tcp` and use `config-file` to override the default by providing your own `SocksPort` option.

`control-socket?` (default: `#f`)
: Whether or not to provide a "control socket" by which Tor can be controlled to, for instance, dynamically instantiate tor onion services. If `#t`, Tor will listen for control commands on the UNIX domain socket `/var/run/tor/control-sock`, which will be made writable by members of the `tor` group.

`tor-hidden-service` *name mapping* [Scheme Procedure]

Define a new Tor *hidden service* called *name* and implementing *mapping*. *mapping* is a list of port/host tuples, such as:

```
'((22 "127.0.0.1:22")
  (80 "127.0.0.1:8080"))
```

In this example, port 22 of the hidden service is mapped to local port 22, and port 80 is mapped to local port 8080.

This creates a `/var/lib/tor/hidden-services/`*name* directory, where the `hostname` file contains the `.onion` host name for the hidden service.

See the Tor project's documentation (`https://www.torproject.org/docs/tor-hidden-service.html.en`) for more information.

The `(gnu services rsync)` module provides the following services:

You might want an rsync daemon if you have files that you want available so anyone (or just yourself) can download existing files or upload new files.

`rsync-service-type` [Scheme Variable]

This is the service type for the rsync (`https://rsync.samba.org`) daemon, The value for this service type is a `rsync-configuration` record as in this example:

```
;; Export two directories over rsync.  By default rsync listens on
;; all the network interfaces.
(service rsync-service-type
         (rsync-configuration
           (modules (list (rsync-module
                            (name "music")
                            (file-name "/srv/zik")
                            (read-only? #f))
                          (rsync-module
                            (name "movies")
                            (file-name "/home/charlie/movies"))))))
```

See below for details about `rsync-configuration`.

`rsync-configuration` [Data Type]

Data type representing the configuration for `rsync-service`.

`package` (default: *rsync*)
: `rsync` package to use.

`address` (default: `#f`)
: IP address on which `rsync` listens for incoming connections. If unspecified, it defaults to listening on all available addresses.

`port-number` (default: `873`)
: TCP port on which `rsync` listens for incoming connections. If port is less than `1024` `rsync` needs to be started as the `root` user and group.

`pid-file` (default: `"/var/run/rsyncd/rsyncd.pid"`)
: Name of the file where `rsync` writes its PID.

`lock-file` (default: `"/var/run/rsyncd/rsyncd.lock"`)
: Name of the file where `rsync` writes its lock file.

`log-file` (default: `"/var/log/rsyncd.log"`)
: Name of the file where `rsync` writes its log file.

`user` (default: `"root"`)
: Owner of the `rsync` process.

`group` (default: `"root"`)
: Group of the `rsync` process.

`uid` (default: `"rsyncd"`)
: User name or user ID that file transfers to and from that module should take place as when the daemon was run as `root`.

`gid` (default: `"rsyncd"`)
: Group name or group ID that will be used when accessing the module.

`modules` (default: `%default-modules`)
: List of “modules”—i.e., directories exported over rsync. Each element must be a `rsync-module` record, as described below.

`rsync-module` [Data Type]

This is the data type for rsync “modules”. A module is a directory exported over the rsync protocol. The available fields are as follows:

`name` The module name. This is the name that shows up in URLs. For example, if the module is called `music`, the corresponding URL will be `rsync://host.example.org/music`.

`file-name`
: Name of the directory being exported.

`comment` (default: `""`)
: Comment associated with the module. Client user interfaces may display it when they obtain the list of available modules.

`read-only?` (default: `#t`)
: Whether or not client will be able to upload files. If this is false, the uploads will be authorized if permissions on the daemon side permit it.

`chroot?` (default: `#t`)
: When this is true, the rsync daemon changes root to the module’s directory before starting file transfers with the client. This improves security, but requires rsync to run as root.

`timeout` (default: `300`)
: Idle time in seconds after which the daemon closes a connection with the client.

The `(gnu services syncthing)` module provides the following services:

You might want a syncthing daemon if you have files between two or more computers and want to sync them in real time, safely protected from prying eyes.

`syncthing-service-type` [Scheme Variable]

This is the service type for the syncthing (`https://syncthing.net/`) daemon, The value for this service type is a `syncthing-configuration` record as in this example:

```
(service syncthing-service-type
         (syncthing-configuration (user "alice")))
```

See below for details about `syncthing-configuration`.

`syncthing-configuration` [Data Type]

Data type representing the configuration for `syncthing-service-type`.

`syncthing` (default: *syncthing*)
: `syncthing` package to use.

`arguments` (default: *’()*)
: List of command-line arguments passing to `syncthing` binary.

`logflags` (default: *0*)
: Sum of logging flags, see Syncthing documentation logflags (`https://docs.syncthing.net/users/syncthing.html#cmdoption-logflags`).

`user` (default: *#f*)
: The user as which the Syncthing service is to be run. This assumes that the specified user exists.

`group` (default: `"`*users*`"`)
: The group as which the Syncthing service is to be run. This assumes that the specified group exists.

`home` (default: *#f*)
: Common configuration and data directory. The default configuration directory is `$HOME` of the specified Syncthing `user`.

Furthermore, `(gnu services ssh)` provides the following services.

`lsh-service` [*#:host-key* `"`*/etc/lsh/host-key*`"`] [*#:daemonic? #t*] [*#:interfaces '()*] [*#:port-number 22*] [*#:allow-empty-passwords? #f*] [*#:root-login? #f*] [*#:syslog-output? #t*] [*#:x11-forwarding? #t*] [*#:tcp/ip-forwarding? #t*] [*#:password-authentication? #t*] [*#:public-key-authentication? #t*] [*#:initialize? #t*] [Scheme Procedure]

Run the `lshd` program from *lsh* to listen on port *port-number*. *host-key* must designate a file containing the host key, and readable only by root.

When *daemonic?* is true, `lshd` will detach from the controlling terminal and log its output to syslogd, unless one sets *syslog-output?* to false. Obviously, it also makes lsh-service depend on existence of syslogd service. When *pid-file?* is true, `lshd` writes its PID to the file called *pid-file*.

When *initialize?* is true, automatically create the seed and host key upon service activation if they do not exist yet. This may take long and require interaction.

When *initialize?* is false, it is up to the user to initialize the randomness generator (see Section "lsh-make-seed" in *LSH Manual*), and to create a key pair with the private key stored in file *host-key* (see Section "lshd basics" in *LSH Manual*).

When *interfaces* is empty, lshd listens for connections on all the network interfaces; otherwise, *interfaces* must be a list of host names or addresses.

allow-empty-passwords? specifies whether to accept log-ins with empty passwords, and *root-login?* specifies whether to accept log-ins as root.

The other options should be self-descriptive.

`openssh-service-type` [Scheme Variable]

This is the type for the OpenSSH (`http://www.openssh.org`) secure shell daemon, `sshd`. Its value must be an `openssh-configuration` record as in this example:

```
(service openssh-service-type
         (openssh-configuration
           (x11-forwarding? #t)
           (permit-root-login 'prohibit-password)
```

```
                  (authorized-keys
                    `(("alice" ,(local-file "alice.pub"))
                      ("bob" ,(local-file "bob.pub"))))))
```

See below for details about `openssh-configuration`.

This service can be extended with extra authorized keys, as in this example:

```
(service-extension openssh-service-type
                   (const `(("charlie"
                             ,(local-file "charlie.pub")))))
```

`openssh-configuration` [Data Type]

This is the configuration record for OpenSSH's `sshd`.

`openssh` (default *openssh*)
: The OpenSSH package to use.

`pid-file` (default: `"/var/run/sshd.pid"`)
: Name of the file where `sshd` writes its PID.

`port-number` (default: `22`)
: TCP port on which `sshd` listens for incoming connections.

`max-connections` (default: `200`)
: Hard limit on the maximum number of simultaneous client connections, enforced by the inetd-style Shepherd service (see Section "Service De- and Constructors" in *The GNU Shepherd Manual*).

`permit-root-login` (default: `#f`)
: This field determines whether and when to allow logins as root. If `#f`, root logins are disallowed; if `#t`, they are allowed. If it's the symbol `'prohibit-password`, then root logins are permitted but not with password-based authentication.

`allow-empty-passwords?` (default: `#f`)
: When true, users with empty passwords may log in. When false, they may not.

`password-authentication?` (default: `#t`)
: When true, users may log in with their password. When false, they have other authentication methods.

`public-key-authentication?` (default: `#t`)
: When true, users may log in using public key authentication. When false, users have to use other authentication method.

  Authorized public keys are stored in `~/.ssh/authorized_keys`. This is used only by protocol version 2.

`x11-forwarding?` (default: `#f`)
: When true, forwarding of X11 graphical client connections is enabled—in other words, `ssh` options `-X` and `-Y` will work.

`allow-agent-forwarding?` (default: `#t`)
: Whether to allow agent forwarding.

`allow-tcp-forwarding?` (default: `#t`)
: Whether to allow TCP forwarding.

`gateway-ports?` (default: `#f`)
: Whether to allow gateway ports.

`challenge-response-authentication?` (default: `#f`)
: Specifies whether challenge response authentication is allowed (e.g. via PAM).

`use-pam?` (default: `#t`)
: Enables the Pluggable Authentication Module interface. If set to `#t`, this will enable PAM authentication using `challenge-response-authentication?` and `password-authentication?`, in addition to PAM account and session module processing for all authentication types.

  Because PAM challenge response authentication usually serves an equivalent role to password authentication, you should disable either `challenge-response-authentication?` or `password-authentication?`.

`print-last-log?` (default: `#t`)
: Specifies whether `sshd` should print the date and time of the last user login when a user logs in interactively.

`subsystems` (default: `'(("sftp" "internal-sftp"))`)
: Configures external subsystems (e.g. file transfer daemon).

  This is a list of two-element lists, each of which containing the subsystem name and a command (with optional arguments) to execute upon subsystem request.

  The command `internal-sftp` implements an in-process SFTP server. Alternatively, one can specify the `sftp-server` command:

```
(service openssh-service-type
         (openssh-configuration
          (subsystems
           `(("sftp" ,(file-append openssh "/libexec/sftp-server"))))))
```

`accepted-environment` (default: `'()`)
: List of strings describing which environment variables may be exported.

  Each string gets on its own line. See the `AcceptEnv` option in `man sshd_config`.

  This example allows ssh-clients to export the `COLORTERM` variable. It is set by terminal emulators, which support colors. You can use it in your shell's resource file to enable colors for the prompt and commands if this variable is set.

```
(service openssh-service-type
         (openssh-configuration
           (accepted-environment '("COLORTERM"))))
```

`authorized-keys` (default: `'()`)
: This is the list of authorized keys. Each element of the list is a user name followed by one or more file-like objects that represent SSH public keys. For example:

```
(openssh-configuration
  (authorized-keys
    `(("rekado" ,(local-file "rekado.pub"))
      ("chris" ,(local-file "chris.pub"))
      ("root" ,(local-file "rekado.pub") ,(local-file "chris.pub")))))
```

registers the specified public keys for user accounts `rekado`, `chris`, and `root`.

Additional authorized keys can be specified *via* `service-extension`.

Note that this does *not* interfere with the use of `~/.ssh/authorized_keys`.

`generate-host-keys?` (default: `#t`)
: Whether to generate host key pairs with `ssh-keygen -A` under `/etc/ssh` if there are none.

Generating key pairs takes a few seconds when enough entropy is available and is only done once. You might want to turn it off for instance in a virtual machine that does not need it because host keys are provided in some other way, and where the extra boot time is a problem.

`log-level` (default: `'info`)
: This is a symbol specifying the logging level: `quiet`, `fatal`, `error`, `info`, `verbose`, `debug`, etc. See the man page for `sshd_config` for the full list of level names.

`extra-content` (default: `""`)
: This field can be used to append arbitrary text to the configuration file. It is especially useful for elaborate configurations that cannot be expressed otherwise. This configuration, for example, would generally disable root logins, but permit them from one specific IP address:

```
(openssh-configuration
  (extra-content "\
Match Address 192.168.0.1
  PermitRootLogin yes"))
```

`dropbear-service` [*config*] [Scheme Procedure]

Run the Dropbear SSH daemon (`https://matt.ucc.asn.au/dropbear/dropbear.html`) with the given *config*, a `<dropbear-configuration>` object.

For example, to specify a Dropbear service listening on port 1234, add this call to the operating system's `services` field:

```
(dropbear-service (dropbear-configuration
                    (port-number 1234)))
```

`dropbear-configuration` [Data Type]

This data type represents the configuration of a Dropbear SSH daemon.

`dropbear` (default: *dropbear*)
: The Dropbear package to use.

`port-number` (default: 22)
: The TCP port where the daemon waits for incoming connections.

`syslog-output?` (default: `#t`)
: Whether to enable syslog output.

`pid-file` (default: `"/var/run/dropbear.pid"`)
: File name of the daemon's PID file.

`root-login?` (default: `#f`)
: Whether to allow `root` logins.

`allow-empty-passwords?` (default: `#f`)
: Whether to allow empty passwords.

`password-authentication?` (default: `#t`)
: Whether to enable password-based authentication.

`autossh-service-type` [Scheme Variable]

This is the type for the AutoSSH (`https://www.harding.motd.ca/autossh`) program that runs a copy of `ssh` and monitors it, restarting it as necessary should it die or stop passing traffic. AutoSSH can be run manually from the command-line by passing arguments to the binary `autossh` from the package `autossh`, but it can also be run as a Guix service. This latter use case is documented here.

AutoSSH can be used to forward local traffic to a remote machine using an SSH tunnel, and it respects the `~/.ssh/config` of the user it is run as.

For example, to specify a service running autossh as the user `pino` and forwarding all local connections to port `8081` to `remote:8081` using an SSH tunnel, add this call to the operating system's `services` field:

```
(service autossh-service-type
         (autossh-configuration
          (user "pino")
          (ssh-options (list "-T" "-N" "-L" "8081:localhost:8081" "remote.net"))))
```

`autossh-configuration` [Data Type]

This data type represents the configuration of an AutoSSH service.

`user` (default `"autossh"`)
: The user as which the AutoSSH service is to be run. This assumes that the specified user exists.

`poll` (default `600`)
: Specifies the connection poll time in seconds.

`first-poll` (default `#f`)
: Specifies how many seconds AutoSSH waits before the first connection test. After this first test, polling is resumed at the pace defined in `poll`. When set to `#f`, the first poll is not treated specially and will also use the connection poll specified in `poll`.

`gate-time` (default `30`)
: Specifies how many seconds an SSH connection must be active before it is considered successful.

`log-level` (default `1`)
: The log level, corresponding to the levels used by syslog—so `0` is the most silent while `7` is the chattiest.

`max-start` (default `#f`)
: The maximum number of times SSH may be (re)started before AutoSSH exits. When set to `#f`, no maximum is configured and AutoSSH may restart indefinitely.

`message` (default `""`)
: The message to append to the echo message sent when testing connections.

`port` (default `"0"`)
: The ports used for monitoring the connection. When set to `"0"`, monitoring is disabled. When set to `"n"` where *n* is a positive integer, ports *n* and *n*+1 are used for monitoring the connection, such that port *n* is the base monitoring port and `n+1` is the echo port. When set to `"n:m"` where *n* and *m* are positive integers, the ports *n* and *m* are used for monitoring the connection, such that port *n* is the base monitoring port and *m* is the echo port.

`ssh-options` (default `'()`)
: The list of command-line arguments to pass to `ssh` when it is run. Options `-f` and `-M` are reserved for AutoSSH and may cause undefined behaviour.

`webssh-service-type` [Scheme Variable]

This is the type for the WebSSH (`https://webssh.huashengdun.org/`) program that runs a web SSH client. WebSSH can be run manually from the command-line by passing arguments to the binary `wssh` from the package `webssh`, but it can also be run as a Guix service. This latter use case is documented here.

For example, to specify a service running WebSSH on loopback interface on port `8888` with reject policy with a list of allowed to connection hosts, and NGINX as a reverse-proxy to this service listening for HTTPS connection, add this call to the operating system's `services` field:

```
(service webssh-service-type
  (webssh-configuration (address "127.0.0.1")
                        (port 8888)
                        (policy 'reject)
                        (known-hosts '("localhost ecdsa-sha2-nistp256 AAAA..."
                                       "127.0.0.1 ecdsa-sha2-nistp256 AAAA..."))))

(service nginx-service-type
         (nginx-configuration
          (server-blocks
           (list
            (nginx-server-configuration
             (inherit %webssh-configuration-nginx)
             (server-name '("webssh.example.com"))
             (listen '("443 ssl"))
             (ssl-certificate (letsencrypt-certificate "webssh.example.com"))
             (ssl-certificate-key (letsencrypt-key "webssh.example.com"))
             (locations
              (cons (nginx-location-configuration
                     (uri "/.well-known")
                     (body '("root /var/www;")))
                    (nginx-server-configuration-locations %webssh-configuration-n
```

`webssh-configuration` [Data Type]

Data type representing the configuration for `webssh-service`.

`package` (default: *webssh*)
: `webssh` package to use.

`user-name` (default: "*webssh*")
: User name or user ID that file transfers to and from that module should take place.

`group-name` (default: "*webssh*")
: Group name or group ID that will be used when accessing the module.

`address` (default: *#f*)
: IP address on which `webssh` listens for incoming connections.

`port` (default: *8888*)
: TCP port on which `webssh` listens for incoming connections.

`policy` (default: *#f*)
: Connection policy. *reject* policy requires to specify *known-hosts*.

`known-hosts` (default: *'()*)
: List of hosts which allowed for SSH connection from `webssh`.

`log-file` (default: "/var/log/webssh.log")
: Name of the file where `webssh` writes its log file.

`log-level` (default: *#f*)
: Logging level.

`%facebook-host-aliases` [Scheme Variable]

This variable contains a string for use in `/etc/hosts` (see Section "Host Names" in *The GNU C Library Reference Manual*). Each line contains a entry that maps a known server name of the Facebook on-line service—e.g., `www.facebook.com`—to the local host—`127.0.0.1` or its IPv6 equivalent, `::1`.

This variable is typically used in the `hosts-file` field of an `operating-system` declaration (see Section 12.2 [operating-system Reference], page 228):

```
(use-modules (gnu) (guix))
```

```
(operating-system
  (host-name "mymachine")
  ;; ...
  (hosts-file
    ;; Create a /etc/hosts file with aliases for "localhost"
    ;; and "mymachine", as well as for Facebook servers.
    (plain-file "hosts"
                (string-append (local-host-aliases host-name)
                               %facebook-host-aliases))))
```

This mechanism can prevent programs running locally, such as Web browsers, from accessing Facebook.

The `(gnu services avahi)` provides the following definition.

`avahi-service-type` [Scheme Variable]

This is the service that runs `avahi-daemon`, a system-wide mDNS/DNS-SD responder that allows for service discovery and "zero-configuration" host name lookups (see `https://avahi.org/`). Its value must be an `avahi-configuration` record—see below.

This service extends the name service cache daemon (nscd) so that it can resolve `.local` host names using nss-mdns (`https://0pointer.de/lennart/projects/nss-mdns/`). See Section 12.12 [Name Service Switch], page 535, for information on host name resolution.

Additionally, add the *avahi* package to the system profile so that commands such as `avahi-browse` are directly usable.

`avahi-configuration` [Data Type]

Data type representation the configuration for Avahi.

`host-name` (default: `#f`)
: If different from `#f`, use that as the host name to publish for this machine; otherwise, use the machine's actual host name.

`publish?` (default: `#t`)
: When true, allow host names and services to be published (broadcast) over the network.

`publish-workstation?` (default: `#t`)
: When true, `avahi-daemon` publishes the machine's host name and IP address via mDNS on the local network. To view the host names published on your local network, you can run:

```
avahi-browse _workstation._tcp
```

`wide-area?` (default: `#f`)
: When true, DNS-SD over unicast DNS is enabled.

`ipv4?` (default: `#t`)
`ipv6?` (default: `#t`)
: These fields determine whether to use IPv4/IPv6 sockets.

`domains-to-browse` (default: `'()`)
: This is a list of domains to browse.

`openvswitch-service-type` [Scheme Variable]

This is the type of the Open vSwitch (`https://www.openvswitch.org`) service, whose value should be an `openvswitch-configuration` object.

`openvswitch-configuration` [Data Type]

Data type representing the configuration of Open vSwitch, a multilayer virtual switch which is designed to enable massive network automation through programmatic extension.

`package` (default: *openvswitch*)
: Package object of the Open vSwitch.

`pagekite-service-type` [Scheme Variable]

This is the service type for the PageKite (`https://pagekite.net`) service, a tunneling solution for making localhost servers publicly visible, even from behind restrictive firewalls or NAT without forwarded ports. The value for this service type is a `pagekite-configuration` record.

Here's an example exposing the local HTTP and SSH daemons:

```
(service pagekite-service-type
         (pagekite-configuration
           (kites '("http:@kitename:localhost:80:@kitesecret"
                    "raw/22:@kitename:localhost:22:@kitesecret"))
           (extra-file "/etc/pagekite.rc")))
```

`pagekite-configuration` [Data Type]

Data type representing the configuration of PageKite.

`package` (default: *pagekite*)
: Package object of PageKite.

`kitename` (default: `#f`)
: PageKite name for authenticating to the frontend server.

`kitesecret` (default: `#f`)
: Shared secret for authenticating to the frontend server. You should probably put this inside `extra-file` instead.

`frontend` (default: `#f`)
: Connect to the named PageKite frontend server instead of the pagekite.net service.

`kites` (default: `'("http:@kitename:localhost:80:@kitesecret")`)
: List of service kites to use. Exposes HTTP on port 80 by default. The format is `proto:kitename:host:port:secret`.

`extra-file` (default: `#f`)
: Extra configuration file to read, which you are expected to create manually. Use this to add additional options and manage shared secrets out-of-band.

`yggdrasil-service-type` [Scheme Variable]

The service type for connecting to the Yggdrasil network (`https://yggdrasil-network.github.io/`), an early-stage implementation of a fully end-to-end encrypted IPv6 network.

> Yggdrasil provides name-independent routing with cryptographically generated addresses. Static addressing means you can keep the same address as long as you want, even if you move to a new location, or generate a new address (by generating new keys) whenever you want. `https://yggdrasil-network.github.io/2018/07/28/addressing.html`

Pass it a value of `yggdrasil-configuration` to connect it to public peers and/or local peers.

Here is an example using public peers and a static address. The static signing and encryption keys are defined in `/etc/yggdrasil-private.conf` (the default value for `config-file`).

```
;; part of the operating-system declaration
(service yggdrasil-service-type
              (yggdrasil-configuration
               (autoconf? #f) ;; use only the public peers
               (json-config
               ;; choose one from
               ;; https://github.com/yggdrasil-network/public-peers
                '((peers . #("tcp://1.2.3.4:1337"))))
               ;; /etc/yggdrasil-private.conf is the default value for config-fil
               ))
```

```
# sample content for /etc/yggdrasil-private.conf
{
  # Your public key. Your peers may ask you for this to put
  # into their AllowedPublicKeys configuration.
  PublicKey: 64277...

  # Your private key. DO NOT share this with anyone!
  PrivateKey: 5c750...
}
```

`yggdrasil-configuration` [Data Type]

Data type representing the configuration of Yggdrasil.

`package` (default: `yggdrasil`)
: Package object of Yggdrasil.

`json-config` (default: `'()`)
: Contents of `/etc/yggdrasil.conf`. Will be merged with `/etc/yggdrasil-private.conf`. Note that these settings are stored in the Guix store, which is readable to all users. **Do not store your private keys in it**. See the output of `yggdrasil -genconf` for a quick overview of valid keys and their default values.

`autoconf?` (default: `#f`)
: Whether to use automatic mode. Enabling it makes Yggdrasil use adynamic IP and peer with IPv6 neighbors.

`log-level` (default: `'info`)
: How much detail to include in logs. Use `'debug` for more detail.

`log-to` (default: `'stdout`)
: Where to send logs. By default, the service logs standard output to `/var/log/yggdrasil.log`. The alternative is `'syslog`, which sends output to the running syslog service.

`config-file` (default: `"/etc/yggdrasil-private.conf"`)
: What HJSON file to load sensitive data from. This is where private keys should be stored, which are necessary to specify if you don't want a randomized address after each restart. Use `#f` to disable. Options defined in this file take precedence over `json-config`. Use the output of `yggdrasil -genconf` as a starting point. To configure a static address, delete everything except these options:

- `EncryptionPublicKey`
- `EncryptionPrivateKey`
- `SigningPublicKey`
- `SigningPrivateKey`

`ipfs-service-type` [Scheme Variable]

The service type for connecting to the IPFS network (`https://ipfs.io`), a global, versioned, peer-to-peer file system. Pass it a `ipfs-configuration` to change the ports used for the gateway and API.

Here's an example configuration, using some non-standard ports:

```
(service ipfs-service-type
         (ipfs-configuration
          (gateway "/ip4/127.0.0.1/tcp/8880")
          (api "/ip4/127.0.0.1/tcp/8881")))
```

`ipfs-configuration` [Data Type]

Data type representing the configuration of IPFS.

`package` (default: `go-ipfs`)
: Package object of IPFS.

`gateway` (default: `"/ip4/127.0.0.1/tcp/8082"`)
: Address of the gateway, in 'multiaddress' format.

`api` (default: `"/ip4/127.0.0.1/tcp/5001"`)
: Address of the API endpoint, in 'multiaddress' format.

`keepalived-service-type` [Scheme Variable]

This is the type for the Keepalived (`https://www.keepalived.org/`) routing software, `keepalived`. Its value must be an `keepalived-configuration` record as in this example for master machine:

```
(service keepalived-service-type
                 (keepalived-configuration
                   (config-file (local-file "keepalived-master.conf"))))
```

where `keepalived-master.conf`:

```
vrrp_instance my-group {
  state MASTER
  interface enp9s0
  virtual_router_id 100
  priority 100
  unicast_peer { 10.0.0.2 }
  virtual_ipaddress {
    10.0.0.4/24
  }
}
```

and for backup machine:

```
(service keepalived-service-type
         (keepalived-configuration
          (config-file (local-file "keepalived-backup.conf"))))
```

where `keepalived-backup.conf`:

```
vrrp_instance my-group {
  state BACKUP
  interface enp9s0
  virtual_router_id 100
  priority 99
  unicast_peer { 10.0.0.3 }
  virtual_ipaddress {
    10.0.0.4/24
  }
}
```

12.9.6 Unattended Upgrades

Guix provides a service to perform *unattended upgrades*: periodically, the system automatically reconfigures itself from the latest Guix. Guix System has several properties that make unattended upgrades safe:

- upgrades are transactional (either the upgrade succeeds or it fails, but you cannot end up with an “in-between” system state);
- the upgrade log is kept—you can view it with `guix system list-generations`—and you can roll back to any previous generation, should the upgraded system fail to behave as intended;
- channel code is authenticated so you know you can only run genuine code (see Chapter 7 [Channels], page 68);
- `guix system reconfigure` prevents downgrades, which makes it immune to *downgrade attacks*.

To set up unattended upgrades, add an instance of `unattended-upgrade-service-type` like the one below to the list of your operating system services:

```
(service unattended-upgrade-service-type)
```

The defaults above set up weekly upgrades: every Sunday at midnight. You do not need to provide the operating system configuration file: it uses `/run/current-system/configuration.scm`, which ensures it always uses your latest configuration—see [provenance-service-type], page 567, for more information about this file.

There are several things that can be configured, in particular the periodicity and services (daemons) to be restarted upon completion. When the upgrade is successful, the service takes care of deleting system generations older that some threshold, as per `guix system delete-generations`. See the reference below for details.

To ensure that upgrades are actually happening, you can run `guix system describe`. To investigate upgrade failures, visit the unattended upgrade log file (see below).

`unattended-upgrade-service-type` [Scheme Variable]

This is the service type for unattended upgrades. It sets up an mcron job (see Section 12.9.2 [Scheduled Job Execution], page 265) that runs `guix system reconfigure` from the latest version of the specified channels.

Its value must be a `unattended-upgrade-configuration` record (see below).

`unattended-upgrade-configuration` [Data Type]

This data type represents the configuration of the unattended upgrade service. The following fields are available:

`schedule` (default: `"30 01 * * 0"`)
: This is the schedule of upgrades, expressed as a gexp containing an mcron job schedule (see Section "Guile Syntax" in *GNU mcron*).

`channels` (default: `#~%default-channels`)
: This gexp specifies the channels to use for the upgrade (see Chapter 7 [Channels], page 68). By default, the tip of the official `guix` channel is used.

`operating-system-file` (default: `"/run/current-system/configuration.scm"`)
: This field specifies the operating system configuration file to use. The default is to reuse the config file of the current configuration.

There are cases, though, where referring to `/run/current-system/configuration.scm` is not enough, for instance because that file refers to extra files (SSH public keys, extra configuration files, etc.) *via* `local-file` and similar constructs. For those cases, we recommend something along these lines:

```
(unattended-upgrade-configuration
  (operating-system-file
    (file-append (local-file "." "config-dir" #:recursive? #t)
                 "/config.scm")))
```

The effect here is to import all of the current directory into the store, and to refer to `config.scm` within that directory. Therefore, uses of `local-file` within `config.scm` will work as expected. See Section 9.12 [G-Expressions], page 154, for information about `local-file` and `file-append`.

`services-to-restart` (default: `'(mcron)`)
: This field specifies the Shepherd services to restart when the upgrade completes.

  Those services are restarted right away upon completion, as with `herd restart`, which ensures that the latest version is running—remember that by default `guix system reconfigure` only restarts services that are not currently running, which is conservative: it minimizes disruption but leaves outdated services running.

  Use `herd status` to find out candidates for restarting. See Section 12.9 [Services], page 247, for general information about services. Common services to restart would include `ntpd` and `ssh-daemon`.

  By default, the `mcron` service is restarted. This ensures that the latest version of the unattended upgrade job will be used next time.

`system-expiration` (default: `(* 3 30 24 3600)`)
: This is the expiration time in seconds for system generations. System generations older that this amount of time are deleted with `guix system delete-generations` when an upgrade completes.

  > **Note:** The unattended upgrade service does not run the garbage collector. You will probably want to set up your own mcron job to run `guix gc` periodically.

`maximum-duration` (default: `3600`)
: Maximum duration in seconds for the upgrade; past that time, the upgrade aborts.

  This is primarily useful to ensure the upgrade does not end up rebuilding or re-downloading "the world".

`log-file` (default: `"/var/log/unattended-upgrade.log"`)
: File where unattended upgrades are logged.

12.9.7 X Window

Support for the X Window graphical display system—specifically Xorg—is provided by the `(gnu services xorg)` module. Note that there is no `xorg-service` procedure. Instead, the X server is started by the *login manager*, by default the GNOME Display Manager (GDM).

GDM of course allows users to log in into window managers and desktop environments other than GNOME; for those using GNOME, GDM is required for features such as automatic screen locking.

To use X11, you must install at least one *window manager*—for example the `windowmaker` or `openbox` packages—preferably by adding it to the `packages` field of your operating system definition (see Section 12.2 [operating-system Reference], page 228).

GDM also supports Wayland: it can itself use Wayland instead of X11 for its user interface, and it can also start Wayland sessions. The former is required for the latter, to enable, set `wayland?` to `#t` in `gdm-configuration`.

`gdm-service-type` [Scheme Variable]

This is the type for the GNOME Desktop Manager (`https://wiki.gnome.org/Projects/GDM/`) (GDM), a program that manages graphical display servers and handles graphical user logins. Its value must be a `gdm-configuration` (see below).

GDM looks for *session types* described by the `.desktop` files in `/run/current-system/profile/share/xsessions` (for X11 sessions) and `/run/current-system/profile/share/wayland-sessions` (for Wayland sessions) and allows users to choose a session from the log-in screen. Packages such as `gnome`, `xfce`, `i3` and `sway` provide `.desktop` files; adding them to the system-wide set of packages automatically makes them available at the log-in screen.

In addition, `~/.xsession` files are honored. When available, `~/.xsession` must be an executable that starts a window manager and/or other X clients.

`gdm-configuration` [Data Type]

`auto-login?` (default: `#f`)
`default-user` (default: `#f`)
: When `auto-login?` is false, GDM presents a log-in screen.

When `auto-login?` is true, GDM logs in directly as `default-user`.

`auto-suspend?` (default `#t`)
: When true, GDM will automatically suspend to RAM when nobody is physically connected. When a machine is used via remote desktop or SSH, this should be set to false to avoid GDM interrupting remote sessions or rendering the machine unavailable.

`debug?` (default: `#f`)
: When true, GDM writes debug messages to its log.

`gnome-shell-assets` (default: ...)
: List of GNOME Shell assets needed by GDM: icon theme, fonts, etc.

`xorg-configuration` (default: `(xorg-configuration)`)
: Configuration of the Xorg graphical server.

`x-session` (default: `(xinitrc)`)
: Script to run before starting a X session.

`xdmcp?` (default: `#f`)
: When true, enable the X Display Manager Control Protocol (XDMCP). This should only be enabled in trusted environments, as the protocol is not secure. When enabled, GDM listens for XDMCP queries on the UDP port 177.

`dbus-daemon` (default: `dbus-daemon-wrapper`)
: File name of the `dbus-daemon` executable.

`gdm` (default: `gdm`)
: The GDM package to use.

`wayland?` (default: `#f`)
: When true, enables Wayland in GDM, necessary to use Wayland sessions.

`wayland-session` (default: `gdm-wayland-session-wrapper`)
: The Wayland session wrapper to use, needed to setup the environment.

`slim-service-type` [Scheme Variable]

This is the type for the SLiM graphical login manager for X11.

Like GDM, SLiM looks for session types described by `.desktop` files and allows users to choose a session from the log-in screen using *F1*. It also honors `~/.xsession` files.

Unlike GDM, SLiM does not spawn the user session on a different VT after logging in, which means that you can only start one graphical session. If you want to be able to run multiple graphical sessions at the same time you have to add multiple SLiM services to your system services. The following example shows how to replace the default GDM service with two SLiM services on tty7 and tty8.

```
(use-modules (gnu services)
             (gnu services desktop)
             (gnu services xorg))

(operating-system
  ;; ...
  (services (cons* (service slim-service-type (slim-configuration
                                               (display ":0")
                                               (vt "vt7")))
                   (service slim-service-type (slim-configuration
                                               (display ":1")
                                               (vt "vt8")))
                   (modify-services %desktop-services
                     (delete gdm-service-type)))))
```

`slim-configuration` [Data Type]

Data type representing the configuration of `slim-service-type`.

`allow-empty-passwords?` (default: `#t`)
: Whether to allow logins with empty passwords.

`gnupg?` (default: `#f`)
: If enabled, `pam-gnupg` will attempt to automatically unlock the user's GPG keys with the login password via `gpg-agent`. The keygrips of all keys to be unlocked should be written to `~/.pam-gnupg`, and can be queried with `gpg -K --with-keygrip`. Presetting passphrases must be enabled by adding `allow-preset-passphrase` in `~/.gnupg/gpg-agent.conf`.

`auto-login?` (default: `#f`)
`default-user` (default: `""`)
: When `auto-login?` is false, SLiM presents a log-in screen.
: When `auto-login?` is true, SLiM logs in directly as `default-user`.

`theme` (default: `%default-slim-theme`)
`theme-name` (default: `%default-slim-theme-name`)
: The graphical theme to use and its name.

`auto-login-session` (default: `#f`)
: If true, this must be the name of the executable to start as the default session—e.g., `(file-append windowmaker "/bin/windowmaker")`.

  If false, a session described by one of the available `.desktop` files in `/run/current-system/profile` and `~/.guix-profile` will be used.

  > **Note:** You must install at least one window manager in the system profile or in your user profile. Failing to do that, if `auto-login-session` is false, you will be unable to log in.

`xorg-configuration` (default `(xorg-configuration)`)
: Configuration of the Xorg graphical server.

`display` (default `":0"`)
: The display on which to start the Xorg graphical server.

`vt` (default `"vt7"`)
: The VT on which to start the Xorg graphical server.

`xauth` (default: `xauth`)
: The XAuth package to use.

`shepherd` (default: `shepherd`)
: The Shepherd package used when invoking `halt` and `reboot`.

`sessreg` (default: `sessreg`)
: The sessreg package used in order to register the session.

`slim` (default: `slim`)
: The SLiM package to use.

`%default-theme` [Scheme Variable]
`%default-theme-name` [Scheme Variable]
The default SLiM theme and its name.

`sddm-service-type` [Scheme Variable]
This is the type of the service to run the SDDM display manager (`https://github.com/sddm/sddm`). Its value must be a `sddm-configuration` record (see below).

Here's an example use:

```
(service sddm-service-type
         (sddm-configuration
           (auto-login-user "alice")
           (auto-login-session "xfce.desktop")))
```

`sddm-configuration` [Data Type]
This data type represents the configuration of the SDDM login manager. The available fields are:

`sddm` (default: `sddm`)
: The SDDM package to use.

`display-server` (default: "x11")
: Select display server to use for the greeter. Valid values are ‘`"x11"`’ or ‘`"wayland"`’.

`numlock` (default: "on")
: Valid values are '`"on"`', '`"off"`' or '`"none"`'.

`halt-command` (default `#~(string-append #$shepherd "/sbin/halt")`)
: Command to run when halting.

`reboot-command` (default `#~(string-append #$shepherd "/sbin/reboot")`)
: Command to run when rebooting.

`theme` (default "maldives")
: Theme to use. Default themes provided by SDDM are '`"elarun"`', '`"maldives"`' or '`"maya"`'.

`themes-directory` (default "/run/current-system/profile/share/sddm/themes")
: Directory to look for themes.

`faces-directory` (default "/run/current-system/profile/share/sddm/faces")
: Directory to look for faces.

`default-path` (default "/run/current-system/profile/bin")
: Default PATH to use.

`minimum-uid` (default: 1000)
: Minimum UID displayed in SDDM and allowed for log-in.

`maximum-uid` (default: 2000)
: Maximum UID to display in SDDM.

`remember-last-user?` (default #t)
: Remember last user.

`remember-last-session?` (default #t)
: Remember last session.

`hide-users` (default "")
: Usernames to hide from SDDM greeter.

`hide-shells` (default `#~(string-append #$shadow "/sbin/nologin")`)
: Users with shells listed will be hidden from the SDDM greeter.

`session-command` (default `#~(string-append #$sddm "/share/sddm/scripts/wayland-session")`)
: Script to run before starting a wayland session.

`sessions-directory` (default "/run/current-system/profile/share/wayland-sessions")
: Directory to look for desktop files starting wayland sessions.

`xorg-configuration` (default `(xorg-configuration)`)
: Configuration of the Xorg graphical server.

`xauth-path` (default `#~(string-append #$xauth "/bin/xauth")`)
: Path to xauth.

`xephyr-path` (default `#~(string-append #$xorg-server "/bin/Xephyr")`)
: Path to Xephyr.

`xdisplay-start` (default `#~(string-append #$sddm "/share/sddm/scripts/Xsetup")`)
: Script to run after starting xorg-server.

`xdisplay-stop` (default `#~(string-append #$sddm "/share/sddm/scripts/Xstop")`)
: Script to run before stopping xorg-server.

`xsession-command` (default: `xinitrc`)
: Script to run before starting a X session.

`xsessions-directory` (default: "/run/current-system/profile/share/xsessions")
: Directory to look for desktop files starting X sessions.

`minimum-vt` (default: 7)
: Minimum VT to use.

`auto-login-user` (default "")
: User account that will be automatically logged in. Setting this to the empty string disables auto-login.

`auto-login-session` (default "")
: The `.desktop` file name to use as the auto-login session, or the empty string.

`relogin?` (default #f)
: Relogin after logout.

`lightdm-service-type` [Scheme Variable]

This is the type of the service to run the LightDM display manager (`https://github.com/canonical/lightdm`). Its value must be a `lightdm-configuration` record, which is documented below. Among its distinguishing features are TigerVNC integration for easily remoting your desktop as well as support for the XDMCP protocol, which can be used by remote clients to start a session from the login manager.

In its most basic form, it can be used simply as:

```
(service lightdm-service-type)
```

A more elaborate example making use of the VNC capabilities and enabling more features and verbose logs could look like:

```
(service lightdm-service-type
         (lightdm-configuration
          (allow-empty-passwords? #t)
          (xdmcp? #t)
          (vnc-server? #t)
          (vnc-server-command
           (file-append tigervnc-server "/bin/Xvnc"
                        "  -SecurityTypes None"))
          (seats
           (list (lightdm-seat-configuration
                  (name "*")
                  (user-session "ratpoison"))))))
```

lightdm-configuration [Data Type]

Available `lightdm-configuration` fields are:

`lightdm` (default: `lightdm`) (type: file-like)
: The lightdm package to use.

`allow-empty-passwords?` (default: `#f`) (type: boolean)
: Whether users not having a password set can login.

`debug?` (default: `#f`) (type: boolean)
: Enable verbose output.

`xorg-configuration` (type: xorg-configuration)
: The default Xorg server configuration to use to generate the Xorg server start script. It can be refined per seat via the `xserver-command` of the `<lightdm-seat-configuration>` record, if desired.

`greeters` (type: list-of-greeter-configurations)
: The LightDM greeter configurations specifying the greeters to use.

`seats` (type: list-of-seat-configurations)
: The seat configurations to use. A LightDM seat is akin to a user.

`xdmcp?` (default: `#f`) (type: boolean)
: Whether a XDMCP server should listen on port UDP 177.

`xdmcp-listen-address` (type: maybe-string)
: The host or IP address the XDMCP server listens for incoming connections. When unspecified, listen on for any hosts/IP addresses.

`vnc-server?` (default: `#f`) (type: boolean)
: Whether a VNC server is started.

`vnc-server-command` (type: file-like)
: The Xvnc command to use for the VNC server, it's possible to provide extra options not otherwise exposed along the command, for example to disable security:

```
(vnc-server-command (file-append tigervnc-server "/bin/Xvnc"█
                                 " -SecurityTypes None" ))█
```

Or to set a PasswordFile for the classic (unsecure) VncAuth mecanism:

```
(vnc-server-command (file-append tigervnc-server "/bin/Xvnc"█
                                 " -PasswordFile /var/lib/lightdm/.vnc/
```

The password file should be manually created using the `vncpasswd` command. Note that LightDM will create new sessions for VNC users, which means they need to authenticate in the same way as local users would.

`vnc-server-listen-address` (type: maybe-string)
: The host or IP address the VNC server listens for incoming connections. When unspecified, listen for any hosts/IP addresses.

`vnc-server-port` (default: `5900`) (type: number)
: The TCP port the VNC server should listen to.

`extra-config` (default: `()`) (type: list-of-strings)
: Extra configuration values to append to the LightDM configuration file.

`lightdm-gtk-greeter-configuration` [Data Type]

Available `lightdm-gtk-greeter-configuration` fields are:

`lightdm-gtk-greeter` (default: `lightdm-gtk-greeter`) (type: file-like)
: The lightdm-gtk-greeter package to use.

`assets` (default: `(adwaita-icon-theme gnome-themes-extrahicolor-icon-theme)`) (type: list-of-file-likes)
: The list of packages complementing the greeter, such as package providing icon themes.

`theme-name` (default: `"Adwaita"`) (type: string)
: The name of the theme to use.

`icon-theme-name` (default: `"Adwaita"`) (type: string)
: The name of the icon theme to use.

`cursor-theme-name` (default: `"Adwaita"`) (type: string)
: The name of the cursor theme to use.

`cursor-theme-size` (default: `16`) (type: number)
: The size to use for the cursor theme.

`allow-debugging?` (type: maybe-boolean)
: Set to #t to enable debug log level.

`background` (type: file-like)
: The background image to use.

`at-spi-enabled?` (default: `#f`) (type: boolean)
: Enable accessibility support through the Assistive Technology Service Provider Interface (AT-SPI).

`a11y-states` (default: `(contrast font keyboard reader)`) (type: list-of-a11y-states)
: The accessibility features to enable, given as list of symbols.

`reader` (type: maybe-file-like)
: The command to use to launch a screen reader.

`extra-config` (default: `()`) (type: list-of-strings)
: Extra configuration values to append to the LightDM GTK Greeter configuration file.

`lightdm-seat-configuration` [Data Type]

Available `lightdm-seat-configuration` fields are:

`name` (type: seat-name)
: The name of the seat. An asterisk (*) can be used in the name to apply the seat configuration to all the seat names it matches.

`user-session` (type: maybe-string)
: The session to use by default. The session name must be provided as a lowercase string, such as `"gnome"`, `"ratpoison"`, etc.

`type` (default: `local`) (type: seat-type)
: The type of the seat, either the `local` or `xremote` symbol.

`autologin-user` (type: maybe-string)
: The username to automatically log in with by default.

`greeter-session` (default: `lightdm-gtk-greeter`) (type: greeter-session)
: The greeter session to use, specified as a symbol. Currently, only `lightdm-gtk-greeter` is supported.

`xserver-command` (type: maybe-file-like)
: The Xorg server command to run.

`session-wrapper` (type: file-like)
: The xinitrc session wrapper to use.

`extra-config` (default: `()`) (type: list-of-strings)
: Extra configuration values to append to the seat configuration section.

`xorg-configuration` [Data Type]

This data type represents the configuration of the Xorg graphical display server. Note that there is no Xorg service; instead, the X server is started by a "display manager" such as GDM, SDDM, LightDM or SLiM. Thus, the configuration of these display managers aggregates an `xorg-configuration` record.

`modules` (default: `%default-xorg-modules`)
: This is a list of *module packages* loaded by the Xorg server—e.g., `xf86-video-vesa`, `xf86-input-keyboard`, and so on.

`fonts` (default: `%default-xorg-fonts`)
: This is a list of font directories to add to the server's *font path*.

`drivers` (default: `'()`)
: This must be either the empty list, in which case Xorg chooses a graphics driver automatically, or a list of driver names that will be tried in this order—e.g., `("modesetting" "vesa")`.

`resolutions` (default: `'()`)
: When `resolutions` is the empty list, Xorg chooses an appropriate screen resolution. Otherwise, it must be a list of resolutions—e.g., `((1024 768) (640 480))`.

`keyboard-layout` (default: `#f`)
: If this is `#f`, Xorg uses the default keyboard layout—usually US English ("qwerty") for a 105-key PC keyboard.

: Otherwise this must be a `keyboard-layout` object specifying the keyboard layout in use when Xorg is running. See Section 12.7 [Keyboard Layout], page 243, for more information on how to specify the keyboard layout.

`extra-config` (default: `'()`)
: This is a list of strings or objects appended to the configuration file. It is used to pass extra text to be added verbatim to the configuration file.

`server` (default: `xorg-server`)
: This is the package providing the Xorg server.

`server-arguments` (default: `%default-xorg-server-arguments`)
: This is the list of command-line arguments to pass to the X server. The default is `-nolisten tcp`.

`set-xorg-configuration` *`config`* [*`login-manager-service-type`*] [Scheme Procedure]

Tell the log-in manager (of type *login-manager-service-type*) to use *config*, an `<xorg-configuration>` record.

Since the Xorg configuration is embedded in the log-in manager's configuration—e.g., `gdm-configuration`—this procedure provides a shorthand to set the Xorg configuration.

`xorg-start-command` [*`config`*] [Scheme Procedure]

Return a `startx` script in which the modules, fonts, etc. specified in *config*, are available. The result should be used in place of `startx`.

Usually the X server is started by a login manager.

`screen-locker-service` *`package`* [*`program`*] [Scheme Procedure]

Add *package*, a package for a screen locker or screen saver whose command is *program*, to the set of setuid programs and add a PAM entry for it. For example:

```
(screen-locker-service xlockmore "xlock")
```

makes the good ol' XlockMore usable.

12.9.8 Printing Services

The `(gnu services cups)` module provides a Guix service definition for the CUPS printing service. To add printer support to a Guix system, add a `cups-service` to the operating system definition:

`cups-service-type` [Scheme Variable]

The service type for the CUPS print server. Its value should be a valid CUPS configuration (see below). To use the default settings, simply write:

```
(service cups-service-type)
```

The CUPS configuration controls the basic things about your CUPS installation: what interfaces it listens on, what to do if a print job fails, how much logging to do, and so on. To actually add a printer, you have to visit the `http://localhost:631` URL, or use a tool such as GNOME's printer configuration services. By default, configuring a CUPS service will generate a self-signed certificate if needed, for secure connections to the print server.

Suppose you want to enable the Web interface of CUPS and also add support for Epson printers *via* the `epson-inkjet-printer-escpr` package and for HP printers *via* the `hplip-minimal` package. You can do that directly, like this (you need to use the `(gnu packages cups)` module):

```
(service cups-service-type
               (cups-configuration
                 (web-interface? #t)
                 (extensions
                   (list cups-filters epson-inkjet-printer-escpr hplip-minimal))))
```

Note: If you wish to use the Qt5 based GUI which comes with the hplip package then it is suggested that you install the `hplip` package, either in your OS configuration file or as your user.

The available configuration parameters follow. Each parameter definition is preceded by its type; for example, '`string-list foo`' indicates that the `foo` parameter should be specified as a list of strings. There is also a way to specify the configuration as a string, if you have an old `cupsd.conf` file that you want to port over from some other system; see the end for more details.

Available `cups-configuration` fields are:

`package cups` [`cups-configuration` parameter]

The CUPS package.

`package-list extensions` (*default:* `(list brlaser cups-filters epson-inkjet-printer-escpr foomatic-filters hplip-minimal splix)`) [`cups-configuration` parameter]

Drivers and other extensions to the CUPS package.

`files-configuration files-configuration` [`cups-configuration` parameter]

Configuration of where to write logs, what directories to use for print spools, and related privileged configuration parameters.

Available `files-configuration` fields are:

`log-location access-log` [`files-configuration` parameter]

Defines the access log filename. Specifying a blank filename disables access log generation. The value `stderr` causes log entries to be sent to the standard error file when the scheduler is running in the foreground, or to the system log daemon when run in the background. The value `syslog` causes log entries to be sent to the system log daemon. The server name may be included in filenames using the string `%s`, as in `/var/log/cups/%s-access_log`.

Defaults to '`"/var/log/cups/access_log"`'.

`file-name cache-dir` [`files-configuration` parameter]

Where CUPS should cache data.

Defaults to '`"/var/cache/cups"`'.

`string config-file-perm` [`files-configuration` parameter]

Specifies the permissions for all configuration files that the scheduler writes.

Note that the permissions for the printers.conf file are currently masked to only allow access from the scheduler user (typically root). This is done because printer device URIs sometimes contain sensitive authentication information that should not be generally known on the system. There is no way to disable this security feature.

Defaults to '`"0640"`'.

`log-location error-log` [`files-configuration` parameter]

Defines the error log filename. Specifying a blank filename disables error log generation. The value `stderr` causes log entries to be sent to the standard error file when the scheduler is running in the foreground, or to the system log daemon when run in the background. The value `syslog` causes log entries to be sent to the system log daemon. The server name may be included in filenames using the string `%s`, as in `/var/log/cups/%s-error_log`.

Defaults to '`"/var/log/cups/error_log"`'.

`string fatal-errors` [`files-configuration` parameter]

Specifies which errors are fatal, causing the scheduler to exit. The kind strings are:

`none`	No errors are fatal.
`all`	All of the errors below are fatal.
`browse`	Browsing initialization errors are fatal, for example failed connections to the DNS-SD daemon.
`config`	Configuration file syntax errors are fatal.
`listen`	Listen or Port errors are fatal, except for IPv6 failures on the loopback or `any` addresses.
`log`	Log file creation or write errors are fatal.
`permissions`	Bad startup file permissions are fatal, for example shared TLS certificate and key files with world-read permissions.

Defaults to '`"all -browse"`'.

`boolean file-device?` [`files-configuration` parameter]

Specifies whether the file pseudo-device can be used for new printer queues. The URI `file:///dev/null` is always allowed.

Defaults to '`#f`'.

`string group` [`files-configuration` parameter]

Specifies the group name or ID that will be used when executing external programs.

Defaults to '`"lp"`'.

`string log-file-group` [`files-configuration` parameter]

Specifies the group name or ID that will be used for log files.

Defaults to '`"lpadmin"`'.

`string log-file-perm` [`files-configuration` parameter]

Specifies the permissions for all log files that the scheduler writes.

Defaults to '`"0644"`'.

`log-location page-log` [`files-configuration` parameter]
: Defines the page log filename. Specifying a blank filename disables page log generation. The value `stderr` causes log entries to be sent to the standard error file when the scheduler is running in the foreground, or to the system log daemon when run in the background. The value `syslog` causes log entries to be sent to the system log daemon. The server name may be included in filenames using the string `%s`, as in `/var/log/cups/%s-page_log`.

  Defaults to ‘`"/var/log/cups/page_log"`’.

`string remote-root` [`files-configuration` parameter]
: Specifies the username that is associated with unauthenticated accesses by clients claiming to be the root user. The default is `remroot`.

  Defaults to ‘`"remroot"`’.

`file-name request-root` [`files-configuration` parameter]
: Specifies the directory that contains print jobs and other HTTP request data.

  Defaults to ‘`"/var/spool/cups"`’.

`sandboxing sandboxing` [`files-configuration` parameter]
: Specifies the level of security sandboxing that is applied to print filters, backends, and other child processes of the scheduler; either `relaxed` or `strict`. This directive is currently only used/supported on macOS.

  Defaults to ‘`strict`’.

`file-name server-keychain` [`files-configuration` parameter]
: Specifies the location of TLS certificates and private keys. CUPS will look for public and private keys in this directory: `.crt` files for PEM-encoded certificates and corresponding `.key` files for PEM-encoded private keys.

  Defaults to ‘`"/etc/cups/ssl"`’.

`file-name server-root` [`files-configuration` parameter]
: Specifies the directory containing the server configuration files.

  Defaults to ‘`"/etc/cups"`’.

`boolean sync-on-close?` [`files-configuration` parameter]
: Specifies whether the scheduler calls fsync(2) after writing configuration or state files.

  Defaults to ‘`#f`’.

`space-separated-string-list system-group` [`files-configuration` parameter]
: Specifies the group(s) to use for `@SYSTEM` group authentication.

`file-name temp-dir` [`files-configuration` parameter]
: Specifies the directory where temporary files are stored.

  Defaults to ‘`"/var/spool/cups/tmp"`’.

`string user` [`files-configuration` parameter]

Specifies the user name or ID that is used when running external programs.

Defaults to ‘`"lp"`’.

`string set-env` [`files-configuration` parameter]

Set the specified environment variable to be passed to child processes.

Defaults to ‘`"variable value"`’.

`access-log-level access-log-level` [`cups-configuration` parameter]

Specifies the logging level for the AccessLog file. The `config` level logs when printers and classes are added, deleted, or modified and when configuration files are accessed or updated. The `actions` level logs when print jobs are submitted, held, released, modified, or canceled, and any of the conditions for `config`. The `all` level logs all requests.

Defaults to ‘`actions`’.

`boolean auto-purge-jobs?` [`cups-configuration` parameter]

Specifies whether to purge job history data automatically when it is no longer required for quotas.

Defaults to ‘`#f`’.

`comma-separated-string-list browse-dns-sd-sub-types` [`cups-configuration` parameter]

Specifies a list of DNS-SD sub-types to advertise for each shared printer. For example, ‘`"_cups" "_print"`’ will tell network clients that both CUPS sharing and IPP Everywhere are supported.

Defaults to ‘`"_cups"`’.

`browse-local-protocols browse-local-protocols` [`cups-configuration` parameter]

Specifies which protocols to use for local printer sharing.

Defaults to ‘`dnssd`’.

`boolean browse-web-if?` [`cups-configuration` parameter]

Specifies whether the CUPS web interface is advertised.

Defaults to ‘`#f`’.

`boolean browsing?` [`cups-configuration` parameter]

Specifies whether shared printers are advertised.

Defaults to ‘`#f`’.

`string classification` [`cups-configuration` parameter]

Specifies the security classification of the server. Any valid banner name can be used, including ‘`"classified"`’, ‘`"confidential"`’, ‘`"secret"`’, ‘`"topsecret"`’, and ‘`"unclassified"`’, or the banner can be omitted to disable secure printing functions.

Defaults to ‘`""`’.

`boolean classify-override?` [`cups-configuration` parameter]

Specifies whether users may override the classification (cover page) of individual print jobs using the `job-sheets` option.

Defaults to '`#f`'.

`default-auth-type default-auth-type` [`cups-configuration` parameter]

Specifies the default type of authentication to use.

Defaults to '`Basic`'.

`default-encryption default-encryption` [`cups-configuration` parameter]

Specifies whether encryption will be used for authenticated requests.

Defaults to '`Required`'.

`string default-language` [`cups-configuration` parameter]

Specifies the default language to use for text and web content.

Defaults to '`"en"`'.

`string default-paper-size` [`cups-configuration` parameter]

Specifies the default paper size for new print queues. '`"Auto"`' uses a locale-specific default, while '`"None"`' specifies there is no default paper size. Specific size names are typically '`"Letter"`' or '`"A4"`'.

Defaults to '`"Auto"`'.

`string default-policy` [`cups-configuration` parameter]

Specifies the default access policy to use.

Defaults to '`"default"`'.

`boolean default-shared?` [`cups-configuration` parameter]

Specifies whether local printers are shared by default.

Defaults to '`#t`'.

`non-negative-integer dirty-clean-interval` [`cups-configuration` parameter]

Specifies the delay for updating of configuration and state files, in seconds. A value of 0 causes the update to happen as soon as possible, typically within a few milliseconds.

Defaults to '`30`'.

`error-policy error-policy` [`cups-configuration` parameter]

Specifies what to do when an error occurs. Possible values are `abort-job`, which will discard the failed print job; `retry-job`, which will retry the job at a later time; `retry-current-job`, which retries the failed job immediately; and `stop-printer`, which stops the printer.

Defaults to '`stop-printer`'.

`non-negative-integer filter-limit` [`cups-configuration` parameter]

Specifies the maximum cost of filters that are run concurrently, which can be used to minimize disk, memory, and CPU resource problems. A limit of 0 disables filter limiting. An average print to a non-PostScript printer needs a filter limit of about

200. A PostScript printer needs about half that (100). Setting the limit below these thresholds will effectively limit the scheduler to printing a single job at any time.

Defaults to '`0`'.

`non-negative-integer filter-nice` [`cups-configuration` parameter]
: Specifies the scheduling priority of filters that are run to print a job. The nice value ranges from 0, the highest priority, to 19, the lowest priority.

  Defaults to '`0`'.

`host-name-lookups host-name-lookups` [`cups-configuration` parameter]
: Specifies whether to do reverse lookups on connecting clients. The `double` setting causes `cupsd` to verify that the hostname resolved from the address matches one of the addresses returned for that hostname. Double lookups also prevent clients with unregistered addresses from connecting to your server. Only set this option to `#t` or `double` if absolutely required.

  Defaults to '`#f`'.

`non-negative-integer job-kill-delay` [`cups-configuration` parameter]
: Specifies the number of seconds to wait before killing the filters and backend associated with a canceled or held job.

  Defaults to '`30`'.

`non-negative-integer job-retry-interval` [`cups-configuration` parameter]
: Specifies the interval between retries of jobs in seconds. This is typically used for fax queues but can also be used with normal print queues whose error policy is `retry-job` or `retry-current-job`.

  Defaults to '`30`'.

`non-negative-integer job-retry-limit` [`cups-configuration` parameter]
: Specifies the number of retries that are done for jobs. This is typically used for fax queues but can also be used with normal print queues whose error policy is `retry-job` or `retry-current-job`.

  Defaults to '`5`'.

`boolean keep-alive?` [`cups-configuration` parameter]
: Specifies whether to support HTTP keep-alive connections.

  Defaults to '`#t`'.

`non-negative-integer limit-request-body` [`cups-configuration` parameter]
: Specifies the maximum size of print files, IPP requests, and HTML form data. A limit of 0 disables the limit check.

  Defaults to '`0`'.

`multiline-string-list listen` [`cups-configuration` parameter]
: Listens on the specified interfaces for connections. Valid values are of the form *address*:*port*, where *address* is either an IPv6 address enclosed in brackets, an IPv4 address, or `*` to indicate all addresses. Values can also be file names of local UNIX domain sockets. The Listen directive is similar to the Port directive but allows you to restrict access to specific interfaces or networks.

`non-negative-integer listen-back-log` [`cups-configuration` parameter]

Specifies the number of pending connections that will be allowed. This normally only affects very busy servers that have reached the MaxClients limit, but can also be triggered by large numbers of simultaneous connections. When the limit is reached, the operating system will refuse additional connections until the scheduler can accept the pending ones.

Defaults to '`128`'.

`location-access-control-list location-access-controls` [`cups-configuration` parameter]

Specifies a set of additional access controls.

Available `location-access-controls` fields are:

`file-name path` [`location-access-controls` parameter]

Specifies the URI path to which the access control applies.

`access-control-list access-controls` [`location-access-controls` parameter]

Access controls for all access to this path, in the same format as the `access-controls` of `operation-access-control`.

Defaults to '`()`'.

`method-access-control-list method-access-controls` [`location-access-controls` parameter]

Access controls for method-specific access to this path.

Defaults to '`()`'.

Available `method-access-controls` fields are:

`boolean reverse?` [`method-access-controls` parameter]

If `#t`, apply access controls to all methods except the listed methods. Otherwise apply to only the listed methods.

Defaults to '`#f`'.

`method-list methods` [`method-access-controls` parameter]

Methods to which this access control applies.

Defaults to '`()`'.

`access-control-list access-controls` [`method-access-controls` parameter]

Access control directives, as a list of strings. Each string should be one directive, such as '`"Order allow,deny"`'.

Defaults to '`()`'.

`non-negative-integer log-debug-history` [`cups-configuration` parameter]

Specifies the number of debugging messages that are retained for logging if an error occurs in a print job. Debug messages are logged regardless of the LogLevel setting.

Defaults to '`100`'.

`log-level` **log-level** [`cups-configuration` parameter]
: Specifies the level of logging for the ErrorLog file. The value `none` stops all logging while `debug2` logs everything.

  Defaults to '`info`'.

`log-time-format` **log-time-format** [`cups-configuration` parameter]
: Specifies the format of the date and time in the log files. The value `standard` logs whole seconds while `usecs` logs microseconds.

  Defaults to '`standard`'.

`non-negative-integer` **max-clients** [`cups-configuration` parameter]
: Specifies the maximum number of simultaneous clients that are allowed by the scheduler.

  Defaults to '`100`'.

`non-negative-integer` **max-clients-per-host** [`cups-configuration` parameter]
: Specifies the maximum number of simultaneous clients that are allowed from a single address.

  Defaults to '`100`'.

`non-negative-integer` **max-copies** [`cups-configuration` parameter]
: Specifies the maximum number of copies that a user can print of each job.

  Defaults to '`9999`'.

`non-negative-integer` **max-hold-time** [`cups-configuration` parameter]
: Specifies the maximum time a job may remain in the `indefinite` hold state before it is canceled. A value of 0 disables cancellation of held jobs.

  Defaults to '`0`'.

`non-negative-integer` **max-jobs** [`cups-configuration` parameter]
: Specifies the maximum number of simultaneous jobs that are allowed. Set to 0 to allow an unlimited number of jobs.

  Defaults to '`500`'.

`non-negative-integer` **max-jobs-per-printer** [`cups-configuration` parameter]
: Specifies the maximum number of simultaneous jobs that are allowed per printer. A value of 0 allows up to MaxJobs jobs per printer.

  Defaults to '`0`'.

`non-negative-integer` **max-jobs-per-user** [`cups-configuration` parameter]
: Specifies the maximum number of simultaneous jobs that are allowed per user. A value of 0 allows up to MaxJobs jobs per user.

  Defaults to '`0`'.

`non-negative-integer max-job-time` [`cups-configuration` parameter]

Specifies the maximum time a job may take to print before it is canceled, in seconds. Set to 0 to disable cancellation of "stuck" jobs.

Defaults to '`10800`'.

`non-negative-integer max-log-size` [`cups-configuration` parameter]

Specifies the maximum size of the log files before they are rotated, in bytes. The value 0 disables log rotation.

Defaults to '`1048576`'.

`non-negative-integer multiple-operation-timeout` [`cups-configuration` parameter]

Specifies the maximum amount of time to allow between files in a multiple file print job, in seconds.

Defaults to '`900`'.

`string page-log-format` [`cups-configuration` parameter]

Specifies the format of PageLog lines. Sequences beginning with percent ('`%`') characters are replaced with the corresponding information, while all other characters are copied literally. The following percent sequences are recognized:

'`%%`'	insert a single percent character
'`%{name}`'	insert the value of the specified IPP attribute
'`%C`'	insert the number of copies for the current page
'`%P`'	insert the current page number
'`%T`'	insert the current date and time in common log format
'`%j`'	insert the job ID
'`%p`'	insert the printer name
'`%u`'	insert the username

A value of the empty string disables page logging. The string `%p %u %j %T %P %C %{job-billing} %{job-originating-host-name} %{job-name} %{media} %{sides}` creates a page log with the standard items.

Defaults to '`""`'.

`environment-variables environment-variables` [`cups-configuration` parameter]

Passes the specified environment variable(s) to child processes; a list of strings.

Defaults to '`()`'.

`policy-configuration-list policies` [`cups-configuration` parameter]

Specifies named access control policies.

Available `policy-configuration` fields are:

`string name` [`policy-configuration` parameter]

Name of the policy.

`string job-private-access` [`policy-configuration` parameter]

Specifies an access list for a job's private values. `@ACL` maps to the printer's requesting-user-name-allowed or requesting-user-name-denied values. `@OWNER` maps to the job's owner. `@SYSTEM` maps to the groups listed for the `system-group` field of the `files-configuration`, which is reified into the `cups-files.conf(5)` file. Other possible elements of the access list include specific user names, and `@`*group* to indicate members of a specific group. The access list may also be simply `all` or `default`.

Defaults to '`"@OWNER @SYSTEM"`'.

`string job-private-values` [`policy-configuration` parameter]

Specifies the list of job values to make private, or `all`, `default`, or `none`.

Defaults to '`"job-name job-originating-host-name job-originating-user-name phone"`'.

`string subscription-private-access` [`policy-configuration` parameter]

Specifies an access list for a subscription's private values. `@ACL` maps to the printer's requesting-user-name-allowed or requesting-user-name-denied values. `@OWNER` maps to the job's owner. `@SYSTEM` maps to the groups listed for the `system-group` field of the `files-configuration`, which is reified into the `cups-files.conf(5)` file. Other possible elements of the access list include specific user names, and `@`*group* to indicate members of a specific group. The access list may also be simply `all` or `default`.

Defaults to '`"@OWNER @SYSTEM"`'.

`string subscription-private-values` [`policy-configuration` parameter]

Specifies the list of job values to make private, or `all`, `default`, or `none`.

Defaults to '`"notify-events notify-pull-method notify-recipient-uri notify-subscriber-user-name notify-user-data"`'.

`operation-access-control-list access-controls` [`policy-configuration` parameter]

Access control by IPP operation.

Defaults to '`()`'.

`boolean-or-non-negative-integer preserve-job-files` [`cups-configuration` parameter]

Specifies whether job files (documents) are preserved after a job is printed. If a numeric value is specified, job files are preserved for the indicated number of seconds after printing. Otherwise a boolean value applies indefinitely.

Defaults to '`86400`'.

`boolean-or-non-negative-integer preserve-job-history` [`cups-configuration` parameter]

Specifies whether the job history is preserved after a job is printed. If a numeric value is specified, the job history is preserved for the indicated number of seconds after printing. If `#t`, the job history is preserved until the MaxJobs limit is reached.

Defaults to '`#t`'.

`non-negative-integer reload-timeout` [`cups-configuration` parameter]
Specifies the amount of time to wait for job completion before restarting the scheduler.

Defaults to '`30`'.

`string rip-cache` [`cups-configuration` parameter]
Specifies the maximum amount of memory to use when converting documents into bitmaps for a printer.

Defaults to '`"128m"`'.

`string server-admin` [`cups-configuration` parameter]
Specifies the email address of the server administrator.

Defaults to '`"root@localhost.localdomain"`'.

`host-name-list-or-* server-alias` [`cups-configuration` parameter]
The ServerAlias directive is used for HTTP Host header validation when clients connect to the scheduler from external interfaces. Using the special name `*` can expose your system to known browser-based DNS rebinding attacks, even when accessing sites through a firewall. If the auto-discovery of alternate names does not work, we recommend listing each alternate name with a ServerAlias directive instead of using `*`.

Defaults to '`*`'.

`string server-name` [`cups-configuration` parameter]
Specifies the fully-qualified host name of the server.

Defaults to '`"localhost"`'.

`server-tokens server-tokens` [`cups-configuration` parameter]
Specifies what information is included in the Server header of HTTP responses. `None` disables the Server header. `ProductOnly` reports `CUPS`. `Major` reports `CUPS 2`. `Minor` reports `CUPS 2.0`. `Minimal` reports `CUPS 2.0.0`. `OS` reports `CUPS 2.0.0 (`*`uname`*`)` where *uname* is the output of the `uname` command. `Full` reports `CUPS 2.0.0 (`*`uname`*`) IPP/2.0`.

Defaults to '`Minimal`'.

`multiline-string-list ssl-listen` [`cups-configuration` parameter]
Listens on the specified interfaces for encrypted connections. Valid values are of the form *address*:*port*, where *address* is either an IPv6 address enclosed in brackets, an IPv4 address, or `*` to indicate all addresses.

Defaults to '`()`'.

`ssl-options ssl-options` [`cups-configuration` parameter]
Sets encryption options. By default, CUPS only supports encryption using TLS v1.0 or higher using known secure cipher suites. Security is reduced when `Allow` options are used, and enhanced when `Deny` options are used. The `AllowRC4` option enables the 128-bit RC4 cipher suites, which are required for some older clients. The `AllowSSL3` option enables SSL v3.0, which is required for some older clients that do not support

TLS v1.0. The `DenyCBC` option disables all CBC cipher suites. The `DenyTLS1.0` option disables TLS v1.0 support - this sets the minimum protocol version to TLS v1.1.

Defaults to '`()`'.

`boolean strict-conformance?` [`cups-configuration` parameter]

Specifies whether the scheduler requires clients to strictly adhere to the IPP specifications.

Defaults to '`#f`'.

`non-negative-integer timeout` [`cups-configuration` parameter]

Specifies the HTTP request timeout, in seconds.

Defaults to '`900`'.

`boolean web-interface?` [`cups-configuration` parameter]

Specifies whether the web interface is enabled.

Defaults to '`#f`'.

At this point you're probably thinking "oh dear, Guix manual, I like you but you can stop already with the configuration options". Indeed. However, one more point: it could be that you have an existing `cupsd.conf` that you want to use. In that case, you can pass an `opaque-cups-configuration` as the configuration of a `cups-service-type`.

Available `opaque-cups-configuration` fields are:

`package cups` [`opaque-cups-configuration` parameter]

The CUPS package.

`string cupsd.conf` [`opaque-cups-configuration` parameter]

The contents of the `cupsd.conf`, as a string.

`string cups-files.conf` [`opaque-cups-configuration` parameter]

The contents of the `cups-files.conf` file, as a string.

For example, if your `cupsd.conf` and `cups-files.conf` are in strings of the same name, you could instantiate a CUPS service like this:

```
(service cups-service-type
         (opaque-cups-configuration
           (cupsd.conf cupsd.conf)
           (cups-files.conf cups-files.conf)))
```

12.9.9 Desktop Services

The `(gnu services desktop)` module provides services that are usually useful in the context of a "desktop" setup—that is, on a machine running a graphical display server, possibly with graphical user interfaces, etc. It also defines services that provide specific desktop environments like GNOME, Xfce or MATE.

To simplify things, the module defines a variable containing the set of services that users typically expect on a machine with a graphical environment and networking:

`%desktop-services` [Scheme Variable]

This is a list of services that builds upon `%base-services` and adds or adjusts services for a typical "desktop" setup.

In particular, it adds a graphical login manager (see Section 12.9.7 [X Window], page 301), screen lockers, a network management tool (see Section 12.9.5 [Networking Services], page 277) with modem support (see Section 12.9.5 [Networking Services], page 277), energy and color management services, the `elogind` login and seat manager, the Polkit privilege service, the GeoClue location service, the AccountsService daemon that allows authorized users change system passwords, an NTP client (see Section 12.9.5 [Networking Services], page 277), the Avahi daemon, and has the name service switch service configured to be able to use `nss-mdns` (see Section 12.12 [Name Service Switch], page 535).

The `%desktop-services` variable can be used as the `services` field of an `operating-system` declaration (see Section 12.2 [operating-system Reference], page 228).

Additionally, the `gnome-desktop-service-type`, `xfce-desktop-service`, `mate-desktop-service-type`, `lxqt-desktop-service-type` and `enlightenment-desktop-service-type` procedures can add GNOME, Xfce, MATE and/or Enlightenment to a system. To "add GNOME" means that system-level services like the backlight adjustment helpers and the power management utilities are added to the system, extending `polkit` and `dbus` appropriately, allowing GNOME to operate with elevated privileges on a limited number of special-purpose system interfaces. Additionally, adding a service made by `gnome-desktop-service-type` adds the GNOME metapackage to the system profile. Likewise, adding the Xfce service not only adds the `xfce` metapackage to the system profile, but it also gives the Thunar file manager the ability to open a "root-mode" file management window, if the user authenticates using the administrator's password via the standard polkit graphical interface. To "add MATE" means that `polkit` and `dbus` are extended appropriately, allowing MATE to operate with elevated privileges on a limited number of special-purpose system interfaces. Additionally, adding a service of type `mate-desktop-service-type` adds the MATE metapackage to the system profile. "Adding Enlightenment" means that `dbus` is extended appropriately, and several of Enlightenment's binaries are set as setuid, allowing Enlightenment's screen locker and other functionality to work as expected.

The desktop environments in Guix use the Xorg display server by default. If you'd like to use the newer display server protocol called Wayland, you need to enable Wayland support in GDM (see [wayland-gdm], page 301). Another solution is to use the `sddm-service` instead of GDM as the graphical login manager. You should then select the "GNOME (Wayland)" session in SDDM. Alternatively you can also try starting GNOME on Wayland manually from a TTY with the command "XDG_SESSION_TYPE=wayland exec dbus-run-session gnome-session". Currently only GNOME has support for Wayland.

`gnome-desktop-service-type` [Scheme Variable]

This is the type of the service that adds the GNOME (`https://www.gnome.org`) desktop environment. Its value is a `gnome-desktop-configuration` object (see below).

This service adds the `gnome` package to the system profile, and extends polkit with the actions from `gnome-settings-daemon`.

`gnome-desktop-configuration` [Data Type]

Configuration record for the GNOME desktop environment.

`gnome` (default: `gnome`)
: The GNOME package to use.

`xfce-desktop-service-type` [Scheme Variable]

This is the type of a service to run the https://xfce.org/ (`Xfce`) desktop environment. Its value is an `xfce-desktop-configuration` object (see below).

This service adds the `xfce` package to the system profile, and extends polkit with the ability for `thunar` to manipulate the file system as root from within a user session, after the user has authenticated with the administrator's password.

Note that `xfce4-panel` and its plugin packages should be installed in the same profile to ensure compatibility. When using this service, you should add extra plugins (`xfce4-whiskermenu-plugin`, `xfce4-weather-plugin`, etc.) to the `packages` field of your `operating-system`.

`xfce-desktop-configuration` [Data Type]

Configuration record for the Xfce desktop environment.

`xfce` (default: `xfce`)
: The Xfce package to use.

`mate-desktop-service-type` [Scheme Variable]

This is the type of the service that runs the MATE desktop environment (`https://mate-desktop.org/`). Its value is a `mate-desktop-configuration` object (see below).

This service adds the `mate` package to the system profile, and extends polkit with the actions from `mate-settings-daemon`.

`mate-desktop-configuration` [Data Type]

Configuration record for the MATE desktop environment.

`mate` (default: `mate`)
: The MATE package to use.

`lxqt-desktop-service-type` [Scheme Variable]

This is the type of the service that runs the LXQt desktop environment (`https://lxqt-project.org`). Its value is a `lxqt-desktop-configuration` object (see below).

This service adds the `lxqt` package to the system profile.

`lxqt-desktop-configuration` [Data Type]

Configuration record for the LXQt desktop environment.

`lxqt` (default: `lxqt`)
: The LXQT package to use.

`enlightenment-desktop-service-type` [Scheme Variable]

Return a service that adds the `enlightenment` package to the system profile, and extends dbus with actions from `efl`.

`enlightenment-desktop-service-configuration` [Data Type]

`enlightenment` (default: `enlightenment`)
: The enlightenment package to use.

Because the GNOME, Xfce and MATE desktop services pull in so many packages, the default `%desktop-services` variable doesn't include any of them by default. To add GNOME, Xfce or MATE, just `cons` them onto `%desktop-services` in the `services` field of your `operating-system`:

```
(use-modules (gnu))
(use-service-modules desktop)
(operating-system
  ...
  ;; cons* adds items to the list given as its last argument.
  (services (cons* (service gnome-desktop-service-type)
                   (service xfce-desktop-service)
                   %desktop-services))
  ...)
```

These desktop environments will then be available as options in the graphical login window.

The actual service definitions included in `%desktop-services` and provided by `(gnu services dbus)` and `(gnu services desktop)` are described below.

`dbus-service` [#:dbus `dbus`] [#:services '()] [#:verbose?] [Scheme Procedure]

Return a service that runs the "system bus", using *dbus*, with support for *services*. When *verbose?* is true, it causes the '`DBUS_VERBOSE`' environment variable to be set to '`1`'; a verbose-enabled D-Bus package such as `dbus-verbose` should be provided as *dbus* in this scenario. The verbose output is logged to `/var/log/dbus-daemon.log`.

D-Bus (`https://dbus.freedesktop.org/`) is an inter-process communication facility. Its system bus is used to allow system services to communicate and to be notified of system-wide events.

services must be a list of packages that provide an `etc/dbus-1/system.d` directory containing additional D-Bus configuration and policy files. For example, to allow avahi-daemon to use the system bus, *services* must be equal to `(list avahi)`.

`elogind-service` [#:config `config`] [Scheme Procedure]

Return a service that runs the `elogind` login and seat management daemon. Elogind (`https://github.com/elogind/elogind`) exposes a D-Bus interface that can be used to know which users are logged in, know what kind of sessions they have open, suspend the system, inhibit system suspend, reboot the system, and other tasks.

Elogind handles most system-level power events for a computer, for example suspending the system when a lid is closed, or shutting it down when the power button is pressed.

The *config* keyword argument specifies the configuration for elogind, and should be the result of an `(elogind-configuration (`*`parameter value`*`)...)` invocation. Available parameters and their default values are:

`kill-user-processes?`
: `#f`

`kill-only-users`
: `()`

`kill-exclude-users`
: `("root")`

`inhibit-delay-max-seconds`
: `5`

`handle-power-key`
: `poweroff`

`handle-suspend-key`
: `suspend`

`handle-hibernate-key`
: `hibernate`

`handle-lid-switch`
: `suspend`

`handle-lid-switch-docked`
: `ignore`

`handle-lid-switch-external-power`
: `*unspecified*`

`power-key-ignore-inhibited?`
: `#f`

`suspend-key-ignore-inhibited?`
: `#f`

`hibernate-key-ignore-inhibited?`
: `#f`

`lid-switch-ignore-inhibited?`
: `#t`

`holdoff-timeout-seconds`
: `30`

`idle-action`
: `ignore`

`idle-action-seconds`
: `(* 30 60)`

`runtime-directory-size-percent`
: `10`

`runtime-directory-size`
: `#f`

`remove-ipc?`
: `#t`

`suspend-state`
: `("mem" "standby" "freeze")`

`suspend-mode`
: `()`

`hibernate-state`
: `("disk")`

`hibernate-mode`
: `("platform" "shutdown")`

`hybrid-sleep-state`
: `("disk")`

`hybrid-sleep-mode`
: `("suspend" "platform" "shutdown")`

`accountsservice-service` [*#:accountsservice* *`accountsservice`*] [Scheme Procedure]

Return a service that runs AccountsService, a system service that can list available accounts, change their passwords, and so on. AccountsService integrates with PolicyKit to enable unprivileged users to acquire the capability to modify their system configuration. the accountsservice web site (`https://www.freedesktop.org/wiki/Software/AccountsService/`) for more information.

The *accountsservice* keyword argument is the `accountsservice` package to expose as a service.

`polkit-service` [*#:polkit* *`polkit`*] [Scheme Procedure]

Return a service that runs the Polkit privilege management service (`https://www.freedesktop.org/wiki/Software/polkit/`), which allows system administrators to grant access to privileged operations in a structured way. By querying the Polkit service, a privileged system component can know when it should grant additional capabilities to ordinary users. For example, an ordinary user can be granted the capability to suspend the system if the user is logged in locally.

`polkit-wheel-service` [Scheme Variable]

Service that adds the `wheel` group as admins to the Polkit service. This makes it so that users in the `wheel` group are queried for their own passwords when performing administrative actions instead of `root`'s, similar to the behaviour used by `sudo`.

`upower-service-type` [Scheme Variable]

Service that runs `upowerd` (`https://upower.freedesktop.org/`), a system-wide monitor for power consumption and battery levels, with the given configuration settings.

It implements the `org.freedesktop.UPower` D-Bus interface, and is notably used by GNOME.

`upower-configuration` [Data Type]

Data type representation the configuration for UPower.

`upower` (default: *upower*)
: Package to use for `upower`.

`watts-up-pro?` (default: `#f`)
: Enable the Watts Up Pro device.

`poll-batteries?` (default: `#t`)
: Enable polling the kernel for battery level changes.

`ignore-lid?` (default: `#f`)
: Ignore the lid state, this can be useful if it's incorrect on a device.

`use-percentage-for-policy?` (default: `#t`)
: Whether to use a policy based on battery percentage rather than on estimated time left. A policy based on battery percentage is usually more reliable.

`percentage-low` (default: `20`)
: When `use-percentage-for-policy?` is `#t`, this sets the percentage at which the battery is considered low.

`percentage-critical` (default: `5`)
: When `use-percentage-for-policy?` is `#t`, this sets the percentage at which the battery is considered critical.

`percentage-action` (default: `2`)
: When `use-percentage-for-policy?` is `#t`, this sets the percentage at which action will be taken.

`time-low` (default: `1200`)
: When `use-time-for-policy?` is `#f`, this sets the time remaining in seconds at which the battery is considered low.

`time-critical` (default: `300`)
: When `use-time-for-policy?` is `#f`, this sets the time remaining in seconds at which the battery is considered critical.

`time-action` (default: `120`)
: When `use-time-for-policy?` is `#f`, this sets the time remaining in seconds at which action will be taken.

`critical-power-action` (default: `'hybrid-sleep`)
: The action taken when `percentage-action` or `time-action` is reached (depending on the configuration of `use-percentage-for-policy?`).

  Possible values are:

  - `'power-off`
  - `'hibernate`
  - `'hybrid-sleep`.

`udisks-service` [*#:udisks* `udisks`] [Scheme Procedure]

Return a service for UDisks (`https://udisks.freedesktop.org/docs/latest/`), a *disk management* daemon that provides user interfaces with notifications and ways to mount/unmount disks. Programs that talk to UDisks include the `udisksctl` command, part of UDisks, and GNOME Disks. Note that Udisks relies on the `mount` command, so it will only be able to use the file-system utilities installed in the system profile. For example if you want to be able to mount NTFS file-systems in read and write fashion, you'll need to have `ntfs-3g` installed system-wide.

`colord-service-type` [Scheme Variable]

This is the type of the service that runs `colord`, a system service with a D-Bus interface to manage the color profiles of input and output devices such as screens and scanners. It is notably used by the GNOME Color Manager graphical tool. See the colord web site (`https://www.freedesktop.org/software/colord/`) for more information.

`sane-service-type` [Scheme Variable]

This service provides access to scanners *via* SANE (`http://www.sane-project.org`) by installing the necessary udev rules. It is included in `%desktop-services` (see Section 12.9.9 [Desktop Services], page 322) and relies by default on `sane-backends-minimal` package (see below) for hardware support.

`sane-backends-minimal` [Scheme Variable]

The default package which the `sane-service-type` installs. It supports many recent scanners.

`sane-backends` [Scheme Variable]

This package includes support for all scanners that `sane-backends-minimal` supports, plus older Hewlett-Packard scanners supported by `hplip` package. In order to use this on a system which relies on `%desktop-services`, you may use `modify-services` (see Section 12.18.3 [Service Reference], page 563) as illustrated below:

```
(use-modules (gnu))
(use-service-modules
  ...
  desktop)
(use-package-modules
  ...
  scanner)

(define %my-desktop-services
  ;; List of desktop services that supports a broader range of scanners.
  (modify-services %desktop-services
    (sane-service-type _ => sane-backends)))

(operating-system
  ...
  (services %my-desktop-services))
```

`geoclue-application` *name* [*#:allowed? #t*] [*#:system? #f*] [*#:users '()*] [Scheme Procedure]

Return a configuration allowing an application to access GeoClue location data. *name* is the Desktop ID of the application, without the `.desktop` part. If *allowed?* is true, the application will have access to location information by default. The boolean *system?* value indicates whether an application is a system component or not. Finally *users* is a list of UIDs of all users for which this application is allowed location info access. An empty users list means that all users are allowed.

`%standard-geoclue-applications` [Scheme Variable]
The standard list of well-known GeoClue application configurations, granting authority to the GNOME date-and-time utility to ask for the current location in order to set the time zone, and allowing the IceCat and Epiphany web browsers to request location information. IceCat and Epiphany both query the user before allowing a web page to know the user's location.

`geoclue-service` [*#:colord* `colord`] [*#:whitelist '()*] [Scheme Procedure]
[*#:wifi-geolocation-url*
"*https://location.services.mozilla.com/v1/geolocate?key=geoclue*"]
[*#:submit-data? #f*]
[#:wifi-submission-url "https://location.services.mozilla.com/v1/submit?key=geoclue"]
[#:submission-nick "geoclue"] [#:applications %standard-geoclue-applications]
Return a service that runs the GeoClue location service. This service provides a D-Bus interface to allow applications to request access to a user's physical location, and optionally to add information to online location databases. See the GeoClue web site (`https://wiki.freedesktop.org/www/Software/GeoClue/`) for more information.

`bluetooth-service` [*#:bluez* `bluez`] [*#:auto-enable? #f*] [Scheme Procedure]
Return a service that runs the `bluetoothd` daemon, which manages all the Bluetooth devices and provides a number of D-Bus interfaces. When AUTO-ENABLE? is true, the bluetooth controller is powered automatically at boot, which can be useful when using a bluetooth keyboard or mouse.

Users need to be in the `lp` group to access the D-Bus service.

`bluetooth-service-type` [Scheme Variable]
This is the type for the Linux Bluetooth Protocol Stack (`https://bluez.org/`) (BlueZ) system, which generates the `/etc/bluetooth/main.conf` configuration file. The value for this type is a `bluetooth-configuration` record as in this example:

```
(service bluetooth-service-type)
```

See below for details about `bluetooth-configuration`.

`bluetooth-configuration` [Data Type]
Data type representing the configuration for `bluetooth-service`.

`bluez` (default: `bluez`)
`bluez` package to use.

`name` (default: `"BlueZ"`)
Default adapter name.

`class` (default: `#x000000`)
Default device class. Only the major and minor device class bits are considered.

`discoverable-timeout` (default: `180`)
: How long to stay in discoverable mode before going back to non-discoverable. The value is in seconds.

`always-pairable?` (default: `#f`)
: Always allow pairing even if there are no agents registered.

`pairable-timeout` (default: `0`)
: How long to stay in pairable mode before going back to non-discoverable. The value is in seconds.

`device-id` (default: `#f`)
: Use vendor id source (assigner), vendor, product and version information for DID profile support. The values are separated by `":"` and *assigner*, *VID*, *PID* and *version*.

  Possible values are:

  - `#f` to disable it,
  - `"assigner:1234:5678:abcd"`, where *assigner* is either `usb` (default) or `bluetooth`.

`reverse-service-discovery?` (default: `#t`)
: Do reverse service discovery for previously unknown devices that connect to us. For BR/EDR this option is really only needed for qualification since the BITE tester doesn't like us doing reverse SDP for some test cases, for LE this disables the GATT client functionally so it can be used in system which can only operate as peripheral.

`name-resolving?` (default: `#t`)
: Enable name resolving after inquiry. Set it to `#f` if you don't need remote devices name and want shorter discovery cycle.

`debug-keys?` (default: `#f`)
: Enable runtime persistency of debug link keys. Default is false which makes debug link keys valid only for the duration of the connection that they were created for.

`controller-mode` (default: `'dual`)
: Restricts all controllers to the specified transport. `'dual` means both BR/EDR and LE are enabled (if supported by the hardware).

  Possible values are:

  - `'dual`
  - `'bredr`
  - `'le`

`multi-profile` (default: `'off`)
: Enables Multi Profile Specification support. This allows to specify if system supports only Multiple Profiles Single Device (MPSD) configuration or both Multiple Profiles Single Device (MPSD) and Multiple Profiles Multiple Devices (MPMD) configurations.

Possible values are:

- `'off`
- `'single`
- `'multiple`

`fast-connectable?` (default: `#f`)
: Permanently enables the Fast Connectable setting for adapters that support it. When enabled other devices can connect faster to us, however the tradeoff is increased power consumptions. This feature will fully work only on kernel version 4.1 and newer.

`privacy` (default: `'off`)
: Default privacy settings.

- `'off`: Disable local privacy
- `'network/on`: A device will only accept advertising packets from peer devices that contain private addresses. It may not be compatible with some legacy devices since it requires the use of RPA(s) all the time
- `'device`: A device in device privacy mode is only concerned about the privacy of the device and will accept advertising packets from peer devices that contain their Identity Address as well as ones that contain a private address, even if the peer device has distributed its IRK in the past

and additionally, if *controller-mode* is set to `'dual`:

- `'limited-network`: Apply Limited Discoverable Mode to advertising, which follows the same policy as to BR/EDR that publishes the identity address when discoverable, and Network Privacy Mode for scanning
- `'limited-device`: Apply Limited Discoverable Mode to advertising, which follows the same policy as to BR/EDR that publishes the identity address when discoverable, and Device Privacy Mode for scanning.

`just-works-repairing` (default: `'never`)
: Specify the policy to the JUST-WORKS repairing initiated by peer.

Possible values:

- `'never`
- `'confirm`
- `'always`

`temporary-timeout` (default: `30`)
: How long to keep temporary devices around. The value is in seconds. `0` disables the timer completely.

`refresh-discovery?` (default: `#t`)
: Enables the device to issue an SDP request to update known services when profile is connected.

`experimental` (default: `#f`)
: Enables experimental features and interfaces, alternatively a list of UUIDs can be given.

  Possible values:

  - `#t`
  - `#f`
  - `(list (uuid <uuid-1>) (uuid <uuid-2>) ...)`.

  List of possible UUIDs:

  - `d4992530-b9ec-469f-ab01-6c481c47da1c`: BlueZ Experimental Debug,
  - `671b10b5-42c0-4696-9227-eb28d1b049d6`: BlueZ Experimental Simultaneous Central and Peripheral,
  - `"15c0a148-c273-11ea-b3de-0242ac130004`: BlueZ Experimental LL privacy,
  - `330859bc-7506-492d-9370-9a6f0614037f`: BlueZ Experimental Bluetooth Quality Report,
  - `a6695ace-ee7f-4fb9-881a-5fac66c629af`: BlueZ Experimental Offload Codecs.

`remote-name-request-retry-delay` (default: `300`)
: The duration to avoid retrying to resolve a peer's name, if the previous try failed.

`page-scan-type` (default: `#f`)
: BR/EDR Page scan activity type.

`page-scan-interval` (default: `#f`)
: BR/EDR Page scan activity interval.

`page-scan-window` (default: `#f`)
: BR/EDR Page scan activity window.

`inquiry-scan-type` (default: `#f`)
: BR/EDR Inquiry scan activity type.

`inquiry-scan-interval` (default: `#f`)
: BR/EDR Inquiry scan activity interval.

`inquiry-scan-window` (default: `#f`)
: BR/EDR Inquiry scan activity window.

`link-supervision-timeout` (default: `#f`)
: BR/EDR Link supervision timeout.

`page-timeout` (default: `#f`)
: BR/EDR Page timeout.

`min-sniff-interval` (default: `#f`)
: BR/EDR minimum sniff interval.

`max-sniff-interval` (default: `#f`)
: BR/EDR maximum sniff interval.

`min-advertisement-interval` (default: `#f`)
: LE minimum advertisement interval (used for legacy advertisement only).

`max-advertisement-interval` (default: `#f`)
: LE maximum advertisement interval (used for legacy advertisement only).

`multi-advertisement-rotation-interval` (default: `#f`)
: LE multiple advertisement rotation interval.

`scan-interval-auto-connect` (default: `#f`)
: LE scanning interval used for passive scanning supporting auto connect.

`scan-window-auto-connect` (default: `#f`)
: LE scanning window used for passive scanning supporting auto connect.

`scan-interval-suspend` (default: `#f`)
: LE scanning interval used for active scanning supporting wake from suspend.

`scan-window-suspend` (default: `#f`)
: LE scanning window used for active scanning supporting wake from suspend.

`scan-interval-discovery` (default: `#f`)
: LE scanning interval used for active scanning supporting discovery.

`scan-window-discovery` (default: `#f`)
: LE scanning window used for active scanning supporting discovery.

`scan-interval-adv-monitor` (default: `#f`)
: LE scanning interval used for passive scanning supporting the advertisement monitor APIs.

`scan-window-adv-monitor` (default: `#f`)
: LE scanning window used for passive scanning supporting the advertisement monitor APIs.

`scan-interval-connect` (default: `#f`)
: LE scanning interval used for connection establishment.

`scan-window-connect` (default: `#f`)
: LE scanning window used for connection establishment.

`min-connection-interval` (default: `#f`)
: LE default minimum connection interval. This value is superseded by any specific value provided via the Load Connection Parameters interface.

`max-connection-interval` (default: `#f`)
: LE default maximum connection interval. This value is superseded by any specific value provided via the Load Connection Parameters interface.

`connection-latency` (default: `#f`)
: LE default connection latency. This value is superseded by any specific value provided via the Load Connection Parameters interface.

`connection-supervision-timeout` (default: `#f`)
: LE default connection supervision timeout. This value is superseded by any specific value provided via the Load Connection Parameters interface.

`autoconnect-timeout` (default: `#f`)
: LE default autoconnect timeout. This value is superseded by any specific value provided via the Load Connection Parameters interface.

`adv-mon-allowlist-scan-duration` (default: `300`)
: Allowlist scan duration during interleaving scan. Only used when scanning for ADV monitors. The units are msec.

`adv-mon-no-filter-scan-duration` (default: `500`)
: No filter scan duration during interleaving scan. Only used when scanning for ADV monitors. The units are msec.

`enable-adv-mon-interleave-scan?` (default: `#t`)
: Enable/Disable Advertisement Monitor interleave scan for power saving.

`cache` (default: `'always`)
: GATT attribute cache.

  Possible values are:

  - `'always`: Always cache attributes even for devices not paired, this is recommended as it is best for interoperability, with more consistent reconnection times and enables proper tracking of notifications for all devices
  - `'yes`: Only cache attributes of paired devices
  - `'no`: Never cache attributes.

`key-size` (default: `0`)
: Minimum required Encryption Key Size for accessing secured characteristics.

  Possible values are:

  - `0`: Don't care
  - `7 <= N <= 16`

`exchange-mtu` (default: `517`)
: Exchange MTU size. Possible values are:

  - `23 <= N <= 517`

`att-channels` (default: `3`)
: Number of ATT channels. Possible values are:

  - `1`: Disables EATT
  - `2 <= N <= 5`

`session-mode` (default: `'basic`)
: AVDTP L2CAP signalling channel mode.

  Possible values are:

  - `'basic`: Use L2CAP basic mode

- `'ertm`: Use L2CAP enhanced retransmission mode.

`stream-mode` (default: `'basic`)
: AVDTP L2CAP transport channel mode.

  Possible values are:

  - `'basic`: Use L2CAP basic mode
  - `'streaming`: Use L2CAP streaming mode.

`reconnect-uuids` (default: `'()`)
: The ReconnectUUIDs defines the set of remote services that should try to be reconnected to in case of a link loss (link supervision timeout). The policy plugin should contain a sane set of values by default, but this list can be overridden here. By setting the list to empty the reconnection feature gets disabled.

  Possible values:

  - `'()`
  - `(list (uuid <uuid-1>) (uuid <uuid-2>) ...)`.

`reconnect-attempts` (default: `7`)
: Defines the number of attempts to reconnect after a link lost. Setting the value to 0 disables reconnecting feature.

`reconnect-intervals` (default: `'(1 2 4 8 16 32 64)`)
: Defines a list of intervals in seconds to use in between attempts. If the number of attempts defined in *reconnect-attempts* is bigger than the list of intervals the last interval is repeated until the last attempt.

`auto-enable?` (default: `#f`)
: Defines option to enable all controllers when they are found. This includes adapters present on start as well as adapters that are plugged in later on.

`resume-delay` (default: `2`)
: Audio devices that were disconnected due to suspend will be reconnected on resume. *resume-delay* determines the delay between when the controller resumes from suspend and a connection attempt is made. A longer delay is better for better co-existence with Wi-Fi. The value is in seconds.

`rssi-sampling-period` (default: `#xFF`)
: Default RSSI Sampling Period. This is used when a client registers an advertisement monitor and leaves the RSSISamplingPeriod unset.

  Possible values are:

  - `#x0`: Report all advertisements
  - `N = #xXX`: Report advertisements every N x 100 msec (range: #x01 to #xFE)
  - `#xFF`: Report only one advertisement per device during monitoring period.

`gnome-keyring-service-type` [Scheme Variable]

This is the type of the service that adds the GNOME Keyring (`https://wiki.gnome.org/Projects/GnomeKeyring`). Its value is a `gnome-keyring-configuration` object (see below).

This service adds the `gnome-keyring` package to the system profile and extends PAM with entries using `pam_gnome_keyring.so`, unlocking a user's login keyring when they log in or setting its password with passwd.

`gnome-keyring-configuration` [Data Type]

Configuration record for the GNOME Keyring service.

`keyring` (default: `gnome-keyring`)
: The GNOME keyring package to use.

`pam-services`
: A list of (*service* . *kind*) pairs denoting PAM services to extend, where *service* is the name of an existing service to extend and *kind* is one of `login` or `passwd`.

  If `login` is given, it adds an optional `pam_gnome_keyring.so` to the auth block without arguments and to the session block with `auto_start`. If `passwd` is given, it adds an optional `pam_gnome_keyring.so` to the password block without arguments.

  By default, this field contains "gdm-password" with the value `login` and "passwd" is with the value `passwd`.

`seatd-service-type` [Scheme Variable]

seatd (`https://sr.ht/~kennylevinsen/seatd/`) is a minimal seat management daemon.

Seat management takes care of mediating access to shared devices (graphics, input), without requiring the applications needing access to be root.

```
(append
  (list
   ;; make sure seatd is running
   (service seatd-service-type))

  ;; normally one would want %base-services
  %base-services)
```

`seatd` operates over a UNIX domain socket, with `libseat` providing the client side of the protocol. Applications that acquire access to the shared resources via `seatd` (e.g. `sway`) need to be able to talk to this socket. This can be achieved by adding the user they run under to the group owning `seatd`'s socket (usually "seat"), like so:

```
(user-account
  (name "alice")
  (group "users")
  (supplementary-groups '("wheel"   ; allow use of sudo, etc.
                          "seat"    ; seat management
```

```
                                "audio"   ; sound card
                                "video"   ; video devices such as webcams
                                "cdrom")) ; the good ol' CD-ROM
          (comment "Bob's sister"))
```

Depending on your setup, you will have to not only add regular users, but also system users to this group. For instance, some greetd greeters require graphics and therefore also need to negotiate with seatd.

`seatd-configuration` [Data Type]

Configuration record for the seatd daemon service.

`seatd` (default: `seatd`)
: The seatd package to use.

`group` (default: '`"seat"`')
: Group to own the seatd socket.

`socket` (default: '`"/run/seatd.sock"`')
: Where to create the seatd socket.

`logfile` (default: '`"/var/log/seatd.log"`')
: Log file to write to.

`loglevel` (default: '`"error"`')
: Log level to output logs. Possible values: '`"silent"`', '`"error"`', '`"info"`' and '`"debug"`'.

12.9.10 Sound Services

The `(gnu services sound)` module provides a service to configure the Advanced Linux Sound Architecture (ALSA) system, which makes PulseAudio the preferred ALSA output driver.

`alsa-service-type` [Scheme Variable]

This is the type for the Advanced Linux Sound Architecture (`https://alsa-project.org/`) (ALSA) system, which generates the `/etc/asound.conf` configuration file. The value for this type is a `alsa-configuration` record as in this example:

```
(service alsa-service-type)
```

See below for details about `alsa-configuration`.

`alsa-configuration` [Data Type]

Data type representing the configuration for `alsa-service`.

`alsa-plugins` (default: *alsa-plugins*)
: `alsa-plugins` package to use.

`pulseaudio?` (default: *#t*)
: Whether ALSA applications should transparently be made to use the PulseAudio (`https://www.pulseaudio.org/`) sound server.

: Using PulseAudio allows you to run several sound-producing applications at the same time and to individual control them *via* `pavucontrol`, among other things.

`extra-options` (default: `""`)
String to append to the `/etc/asound.conf` file.

Individual users who want to override the system configuration of ALSA can do it with the `~/.asoundrc` file:

```
# In guix, we have to specify the absolute path for plugins.
pcm_type.jack {
  lib "/home/alice/.guix-profile/lib/alsa-lib/libasound_module_pcm_jack.so"
}

# Routing ALSA to jack:
# <http://jackaudio.org/faq/routing_alsa.html>.
pcm.rawjack {
  type jack
  playback_ports {
    0 system:playback_1
    1 system:playback_2
  }

  capture_ports {
    0 system:capture_1
    1 system:capture_2
  }
}

pcm.!default {
  type plug
  slave {
    pcm "rawjack"
  }
}
```

See `https://www.alsa-project.org/main/index.php/Asoundrc` for the details.

`pulseaudio-service-type` [Scheme Variable]
This is the type for the PulseAudio (`https://www.pulseaudio.org/`) sound server. It exists to allow system overrides of the default settings via `pulseaudio-configuration`, see below.

> **Warning:** This service overrides per-user configuration files. If you want PulseAudio to honor configuration files in `~/.config/pulse` you have to unset the environment variables `PULSE_CONFIG` and `PULSE_CLIENTCONFIG` in your `~/.bash_profile`.

> **Warning:** This service on its own does not ensure, that the `pulseaudio` package exists on your machine. It merely adds configuration files for it, as detailed below. In the (admittedly unlikely) case, that you find yourself without a `pulseaudio` package, consider enabling it through the `alsa-service-type` above.

`pulseaudio-configuration` [Data Type]

Data type representing the configuration for `pulseaudio-service`.

`client-conf` (default: `'()`)
: List of settings to set in `client.conf`. Accepts a list of strings or symbol-value pairs. A string will be inserted as-is with a newline added. A pair will be formatted as "key = value", again with a newline added.

`daemon-conf` (default: `'((flat-volumes . no))`)
: List of settings to set in `daemon.conf`, formatted just like *client-conf*.

`script-file` (default: `(file-append pulseaudio "/etc/pulse/default.pa")`)
: Script file to use as `default.pa`. In case the `extra-script-files` field below is used, an `.include` directive pointing to `/etc/pulse/default.pa.d` is appended to the provided script.

`extra-script-files` (default: `'()`)
: A list of file-like objects defining extra PulseAudio scripts to run at the initialization of the `pulseaudio` daemon, after the main `script-file`. The scripts are deployed to the `/etc/pulse/default.pa.d` directory; they should have the '`.pa`' file name extension. For a reference of the available commands, refer to `man pulse-cli-syntax`.

`system-script-file` (default: `(file-append pulseaudio "/etc/pulse/system.pa")`)
: Script file to use as `system.pa`.

The example below sets the default PulseAudio card profile, the default sink and the default source to use for a old SoundBlaster Audigy sound card:

```
(pulseaudio-configuration
 (extra-script-files
  (list (plain-file "audigy.pa"
                    (string-append "\
set-card-profile alsa_card.pci-0000_01_01.0 \
  output:analog-surround-40+input:analog-mono
set-default-source alsa_input.pci-0000_01_01.0.analog-mono
set-default-sink alsa_output.pci-0000_01_01.0.analog-surround-40\n")))))
```

Note that `pulseaudio-service-type` is part of `%desktop-services`; if your operating system declaration was derived from one of the desktop templates, you'll want to adjust the above example to modify the existing `pulseaudio-service-type` via `modify-services` (see Section 12.18.3 [Service Reference], page 563), instead of defining a new one.

`ladspa-service-type` [Scheme Variable]

This service sets the *LADSPA_PATH* variable, so that programs, which respect it, e.g. PulseAudio, can load LADSPA plugins.

The following example will setup the service to enable modules from the `swh-plugins` package:

```
(service ladspa-service-type
         (ladspa-configuration (plugins (list swh-plugins))))
```

See `http://plugin.org.uk/ladspa-swh/docs/ladspa-swh.html` for the details.

12.9.11 Database Services

The `(gnu services databases)` module provides the following services.

PostgreSQL

The following example describes a PostgreSQL service with the default configuration.

```
(service postgresql-service-type
         (postgresql-configuration
          (postgresql postgresql-10)))
```

If the services fails to start, it may be due to an incompatible cluster already present in *data-directory*. Adjust it (or, if you don't need the cluster anymore, delete *data-directory*), then restart the service.

Peer authentication is used by default and the `postgres` user account has no shell, which prevents the direct execution of `psql` commands as this user. To use `psql`, you can temporarily log in as `postgres` using a shell, create a PostgreSQL superuser with the same name as one of the system users and then create the associated database.

```
sudo -u postgres -s /bin/sh
createuser --interactive
createdb $MY_USER_LOGIN      # Replace appropriately.
```

`postgresql-configuration` [Data Type]

Data type representing the configuration for the `postgresql-service-type`.

`postgresql`
: PostgreSQL package to use for the service.

`port` (default: `5432`)
: Port on which PostgreSQL should listen.

`locale` (default: `"en_US.utf8"`)
: Locale to use as the default when creating the database cluster.

`config-file` (default: `(postgresql-config-file)`)
: The configuration file to use when running PostgreSQL. The default behaviour uses the postgresql-config-file record with the default values for the fields.

`log-directory` (default: `"/var/log/postgresql"`)
: The directory where `pg_ctl` output will be written in a file named `"pg_ctl.log"`. This file can be useful to debug PostgreSQL configuration errors for instance.

`data-directory` (default: `"/var/lib/postgresql/data"`)
: Directory in which to store the data.

`extension-packages` (default: `'()`)
: Additional extensions are loaded from packages listed in *extension-packages*. Extensions are available at runtime. For instance, to create a

geographic database using the `postgis` extension, a user can configure the postgresql-service as in this example:

```
(use-package-modules databases geo)

(operating-system
  ...
  ;; postgresql is required to run `psql' but postgis is not required f
  ;; proper operation.
  (packages (cons* postgresql %base-packages))
  (services
    (cons*
      (service postgresql-service-type
               (postgresql-configuration
                (postgresql postgresql-10)
                (extension-packages (list postgis))))
      %base-services)))
```

Then the extension becomes visible and you can initialise an empty geographic database in this way:

```
psql -U postgres
> create database postgistest;
> \connect postgistest;
> create extension postgis;
> create extension postgis_topology;
```

There is no need to add this field for contrib extensions such as hstore or dblink as they are already loadable by postgresql. This field is only required to add extensions provided by other packages.

`postgresql-config-file` [Data Type]

Data type representing the PostgreSQL configuration file. As shown in the following example, this can be used to customize the configuration of PostgreSQL. Note that you can use any G-expression or filename in place of this record, if you already have a configuration file you'd like to use for example.

```
(service postgresql-service-type
         (postgresql-configuration
          (config-file
           (postgresql-config-file
            (log-destination "stderr")
            (hba-file
             (plain-file "pg_hba.conf"
                         "
local all all trust
host all all 127.0.0.1/32  md5
host all all ::1/128  md5"))
            (extra-config
             '(("session_preload_libraries"     "auto_explain")
               ("random_page_cost"              2)
```

```
                         ("auto_explain.log_min_duration" "100 ms")
                         ("work_mem"                      "500 MB")
                         ("logging_collector"             #t)
                         ("log_directory"                 "/var/log/postgresql")))))))
```

`log-destination` (default: `"syslog"`)
: The logging method to use for PostgreSQL. Multiple values are accepted, separated by commas.

`hba-file` (default: `%default-postgres-hba`)
: Filename or G-expression for the host-based authentication configuration.

`ident-file` (default: `%default-postgres-ident`)
: Filename or G-expression for the user name mapping configuration.

`socket-directory` (default: `"/var/run/postgresql"`)
: Specifies the directory of the Unix-domain socket(s) on which PostgreSQL is to listen for connections from client applications. If set to `""` PostgreSQL does not listen on any Unix-domain sockets, in which case only TCP/IP sockets can be used to connect to the server.

By default, the `#false` value means the PostgreSQL default value will be used, which is currently '`/tmp`'.

`extra-config` (default: `'()`)
: List of additional keys and values to include in the PostgreSQL config file. Each entry in the list should be a list where the first element is the key, and the remaining elements are the values.

The values can be numbers, booleans or strings and will be mapped to PostgreSQL parameters types `Boolean`, `String`, `Numeric`, `Numeric with Unit` and `Enumerated` described here (`https://www.postgresql.org/docs/current/config-setting.html`).

`postgresql-role-service-type` [Scheme Variable]

This service allows to create PostgreSQL roles and databases after PostgreSQL service start. Here is an example of its use.

```
(service postgresql-role-service-type
         (postgresql-role-configuration
          (roles
           (list (postgresql-role
                  (name "test")
                  (create-database? #t))))))
```

This service can be extended with extra roles, as in this example:

```
(service-extension postgresql-role-service-type
                   (const (postgresql-role
                           (name "alice")
                           (create-database? #t))))
```

`postgresql-role` [Data Type]

PostgreSQL manages database access permissions using the concept of roles. A role can be thought of as either a database user, or a group of database users, depending on how the role is set up. Roles can own database objects (for example, tables) and can assign privileges on those objects to other roles to control who has access to which objects.

`name` The role name.

`permissions` (default: `'(createdb login)`)
: The role permissions list. Supported permissions are `bypassrls`, `createdb`, `createrole`, `login`, `replication` and `superuser`.

`create-database?` (default: `#f`)
: Whether to create a database with the same name as the role.

`postgresql-role-configuration` [Data Type]

Data type representing the configuration of *postgresql-role-service-type*.

`host` (default: `"/var/run/postgresql"`)
: The PostgreSQL host to connect to.

`log` (default: `"/var/log/postgresql_roles.log"`)
: File name of the log file.

`roles` (default: `'()`)
: The initial PostgreSQL roles to create.

MariaDB/MySQL

`mysql-service-type` [Scheme Variable]

This is the service type for a MySQL or MariaDB database server. Its value is a `mysql-configuration` object that specifies which package to use, as well as various settings for the `mysqld` daemon.

`mysql-configuration` [Data Type]

Data type representing the configuration of *mysql-service-type*.

`mysql` (default: *mariadb*)
: Package object of the MySQL database server, can be either *mariadb* or *mysql*.

  For MySQL, a temporary root password will be displayed at activation time. For MariaDB, the root password is empty.

`bind-address` (default: `"127.0.0.1"`)
: The IP on which to listen for network connections. Use `"0.0.0.0"` to bind to all available network interfaces.

`port` (default: `3306`)
: TCP port on which the database server listens for incoming connections.

`socket` (default: `"/run/mysqld/mysqld.sock"`)
: Socket file to use for local (non-network) connections.

`extra-content` (default: `""`)
: Additional settings for the `my.cnf` configuration file.

`extra-environment` (default: `#~'()`)
: List of environment variables passed to the `mysqld` process.

`auto-upgrade?` (default: `#t`)
: Whether to automatically run `mysql_upgrade` after starting the service. This is necessary to upgrade the *system schema* after “major” updates (such as switching from MariaDB 10.4 to 10.5), but can be disabled if you would rather do that manually.

Memcached

`memcached-service-type` [Scheme Variable]

This is the service type for the Memcached (`https://memcached.org/`) service, which provides a distributed in memory cache. The value for the service type is a `memcached-configuration` object.

```
(service memcached-service-type)
```

`memcached-configuration` [Data Type]

Data type representing the configuration of memcached.

`memcached` (default: `memcached`)
: The Memcached package to use.

`interfaces` (default: `'("0.0.0.0")`)
: Network interfaces on which to listen.

`tcp-port` (default: `11211`)
: Port on which to accept connections.

`udp-port` (default: `11211`)
: Port on which to accept UDP connections on, a value of 0 will disable listening on a UDP socket.

`additional-options` (default: `'()`)
: Additional command line options to pass to `memcached`.

Redis

`redis-service-type` [Scheme Variable]

This is the service type for the Redis (`https://redis.io/`) key/value store, whose value is a `redis-configuration` object.

`redis-configuration` [Data Type]

Data type representing the configuration of redis.

`redis` (default: `redis`)
: The Redis package to use.

`bind` (default: `"127.0.0.1"`)
: Network interface on which to listen.

`port` (default: `6379`)
: Port on which to accept connections on, a value of 0 will disable listening on a TCP socket.

`working-directory` (default: `"/var/lib/redis"`)
Directory in which to store the database and related files.

12.9.12 Mail Services

The `(gnu services mail)` module provides Guix service definitions for email services: IMAP, POP3, and LMTP servers, as well as mail transport agents (MTAs). Lots of acronyms! These services are detailed in the subsections below.

Dovecot Service

`dovecot-service` [*#:config* (*dovecot-configuration*)] [Scheme Procedure]
Return a service that runs the Dovecot IMAP/POP3/LMTP mail server.

By default, Dovecot does not need much configuration; the default configuration object created by `(dovecot-configuration)` will suffice if your mail is delivered to `~/Maildir`. A self-signed certificate will be generated for TLS-protected connections, though Dovecot will also listen on cleartext ports by default. There are a number of options, though, which mail administrators might need to change, and as is the case with other services, Guix allows the system administrator to specify these parameters via a uniform Scheme interface.

For example, to specify that mail is located at `maildir~/.mail`, one would instantiate the Dovecot service like this:

```
(dovecot-service #:config
                 (dovecot-configuration
                  (mail-location "maildir:~/.mail")))
```

The available configuration parameters follow. Each parameter definition is preceded by its type; for example, '`string-list foo`' indicates that the `foo` parameter should be specified as a list of strings. There is also a way to specify the configuration as a string, if you have an old `dovecot.conf` file that you want to port over from some other system; see the end for more details.

Available `dovecot-configuration` fields are:

`package dovecot` [`dovecot-configuration` parameter]
The dovecot package.

`comma-separated-string-list listen` [`dovecot-configuration` parameter]
A list of IPs or hosts where to listen for connections. '`*`' listens on all IPv4 interfaces, '`::`' listens on all IPv6 interfaces. If you want to specify non-default ports or anything more complex, customize the address and port fields of the '`inet-listener`' of the specific services you are interested in.

`protocol-configuration-list protocols` [`dovecot-configuration` parameter]
List of protocols we want to serve. Available protocols include '`imap`', '`pop3`', and '`lmtp`'.

Available `protocol-configuration` fields are:

`string name` [`protocol-configuration` parameter]
The name of the protocol.

`string auth-socket-path` [`protocol-configuration` parameter]
UNIX socket path to the master authentication server to find users. This is used by imap (for shared users) and lda. It defaults to ‘`"/var/run/dovecot/auth-userdb"`’.

`boolean imap-metadata?` [`protocol-configuration` parameter]
Whether to enable the `IMAP METADATA` extension as defined in RFC 5464 (`https://tools.ietf.org/html/rfc5464`), which provides a means for clients to set and retrieve per-mailbox, per-user metadata and annotations over IMAP.

If this is ‘`#t`’, you must also specify a dictionary *via* the `mail-attribute-dict` setting.

Defaults to ‘`#f`’.

`space-separated-string-list managesieve-notify-capabilities` [`protocol-configuration` parameter]
Which NOTIFY capabilities to report to clients that first connect to the ManageSieve service, before authentication. These may differ from the capabilities offered to authenticated users. If this field is left empty, report what the Sieve interpreter supports by default.

Defaults to ‘`()`’.

`space-separated-string-list managesieve-sieve-capability` [`protocol-configuration` parameter]
Which SIEVE capabilities to report to clients that first connect to the ManageSieve service, before authentication. These may differ from the capabilities offered to authenticated users. If this field is left empty, report what the Sieve interpreter supports by default.

Defaults to ‘`()`’.

`space-separated-string-list mail-plugins` [`protocol-configuration` parameter]
Space separated list of plugins to load.

`non-negative-integer mail-max-userip-connections` [`protocol-configuration` parameter]
Maximum number of IMAP connections allowed for a user from each IP address. NOTE: The username is compared case-sensitively. Defaults to ‘`10`’.

`service-configuration-list services` [`dovecot-configuration` parameter]
List of services to enable. Available services include ‘`imap`’, ‘`imap-login`’, ‘`pop3`’, ‘`pop3-login`’, ‘`auth`’, and ‘`lmtp`’.

Available `service-configuration` fields are:

`string kind` [`service-configuration` parameter]
The service kind. Valid values include `director`, `imap-login`, `pop3-login`, `lmtp`, `imap`, `pop3`, `auth`, `auth-worker`, `dict`, `tcpwrap`, `quota-warning`, or anything else.

`listener-configuration-list listeners` [`service-configuration` parameter]

Listeners for the service. A listener is either a `unix-listener-configuration`, a `fifo-listener-configuration`, or an `inet-listener-configuration`. Defaults to '`()`'.

Available `unix-listener-configuration` fields are:

`string path` [`unix-listener-configuration` parameter]

Path to the file, relative to `base-dir` field. This is also used as the section name.

`string mode` [`unix-listener-configuration` parameter]

The access mode for the socket. Defaults to '`"0600"`'.

`string user` [`unix-listener-configuration` parameter]

The user to own the socket. Defaults to '`""`'.

`string group` [`unix-listener-configuration` parameter]

The group to own the socket. Defaults to '`""`'.

Available `fifo-listener-configuration` fields are:

`string path` [`fifo-listener-configuration` parameter]

Path to the file, relative to `base-dir` field. This is also used as the section name.

`string mode` [`fifo-listener-configuration` parameter]

The access mode for the socket. Defaults to '`"0600"`'.

`string user` [`fifo-listener-configuration` parameter]

The user to own the socket. Defaults to '`""`'.

`string group` [`fifo-listener-configuration` parameter]

The group to own the socket. Defaults to '`""`'.

Available `inet-listener-configuration` fields are:

`string protocol` [`inet-listener-configuration` parameter]

The protocol to listen for.

`string address` [`inet-listener-configuration` parameter]

The address on which to listen, or empty for all addresses. Defaults to '`""`'.

`non-negative-integer port` [`inet-listener-configuration` parameter]

The port on which to listen.

`boolean ssl?` [`inet-listener-configuration` parameter]

Whether to use SSL for this service; '`yes`', '`no`', or '`required`'. Defaults to '`#t`'.

`non-negative-integer client-limit` [`service-configuration` parameter]

Maximum number of simultaneous client connections per process. Once this number of connections is received, the next incoming connection will prompt Dovecot to spawn another process. If set to 0, `default-client-limit` is used instead.

Defaults to '`0`'.

`non-negative-integer service-count` [`service-configuration` parameter]

Number of connections to handle before starting a new process. Typically the only useful values are 0 (unlimited) or 1. 1 is more secure, but 0 is faster. <doc/wiki/LoginProcess.txt>. Defaults to '`1`'.

`non-negative-integer process-limit` [`service-configuration` parameter]

Maximum number of processes that can exist for this service. If set to 0, `default-process-limit` is used instead.

Defaults to '`0`'.

`non-negative-integer process-min-avail` [`service-configuration` parameter]

Number of processes to always keep waiting for more connections. Defaults to '`0`'.

`non-negative-integer vsz-limit` [`service-configuration` parameter]

If you set '`service-count 0`', you probably need to grow this. Defaults to '`256000000`'.

`dict-configuration dict` [`dovecot-configuration` parameter]

Dict configuration, as created by the `dict-configuration` constructor.

Available `dict-configuration` fields are:

`free-form-fields entries` [`dict-configuration` parameter]

A list of key-value pairs that this dict should hold. Defaults to '`()`'.

`passdb-configuration-list passdbs` [`dovecot-configuration` parameter]

A list of passdb configurations, each one created by the `passdb-configuration` constructor.

Available `passdb-configuration` fields are:

`string driver` [`passdb-configuration` parameter]

The driver that the passdb should use. Valid values include '`pam`', '`passwd`', '`shadow`', '`bsdauth`', and '`static`'. Defaults to '`"pam"`'.

`space-separated-string-list args` [`passdb-configuration` parameter]

Space separated list of arguments to the passdb driver. Defaults to '`""`'.

`userdb-configuration-list userdbs` [`dovecot-configuration` parameter]

List of userdb configurations, each one created by the `userdb-configuration` constructor.

Available `userdb-configuration` fields are:

`string driver` [`userdb-configuration` parameter]

The driver that the userdb should use. Valid values include '`passwd`' and '`static`'. Defaults to '`"passwd"`'.

`space-separated-string-list args` [`userdb-configuration` parameter]

Space separated list of arguments to the userdb driver. Defaults to '`""`'.

`free-form-args override-fields` [`userdb-configuration` parameter]

Override fields from passwd. Defaults to '`()`'.

`plugin-configuration plugin-configuration` [`dovecot-configuration` parameter]

Plug-in configuration, created by the `plugin-configuration` constructor.

`list-of-namespace-configuration namespaces` [`dovecot-configuration` parameter]

List of namespaces. Each item in the list is created by the `namespace-configuration` constructor.

Available `namespace-configuration` fields are:

`string name` [`namespace-configuration` parameter]

Name for this namespace.

`string type` [`namespace-configuration` parameter]

Namespace type: '`private`', '`shared`' or '`public`'. Defaults to '`"private"`'.

`string separator` [`namespace-configuration` parameter]

Hierarchy separator to use. You should use the same separator for all namespaces or some clients get confused. '`/`' is usually a good one. The default however depends on the underlying mail storage format. Defaults to '`""`'.

`string prefix` [`namespace-configuration` parameter]

Prefix required to access this namespace. This needs to be different for all namespaces. For example '`Public/`'. Defaults to '`""`'.

`string location` [`namespace-configuration` parameter]

Physical location of the mailbox. This is in the same format as mail_location, which is also the default for it. Defaults to '`""`'.

`boolean inbox?` [`namespace-configuration` parameter]

There can be only one INBOX, and this setting defines which namespace has it. Defaults to '`#f`'.

`boolean hidden?` [`namespace-configuration` parameter]

If namespace is hidden, it's not advertised to clients via NAMESPACE extension. You'll most likely also want to set '`list? #f`'. This is mostly useful when converting from another server with different namespaces which you want to deprecate but still keep working. For example you can create hidden namespaces with prefixes '`~/mail/`', '`~%u/mail/`' and '`mail/`'. Defaults to '`#f`'.

`boolean list?` [`namespace-configuration` parameter]

Show the mailboxes under this namespace with the LIST command. This makes the namespace visible for clients that do not support the NAMESPACE extension. The special `children` value lists child mailboxes, but hides the namespace prefix. Defaults to '`#t`'.

`boolean subscriptions?` [`namespace-configuration` parameter]

Namespace handles its own subscriptions. If set to `#f`, the parent namespace handles them. The empty prefix should always have this as `#t`). Defaults to '`#t`'.

`mailbox-configuration-list mailboxes` [`namespace-configuration` parameter]

List of predefined mailboxes in this namespace. Defaults to '`()`'.

Available `mailbox-configuration` fields are:

`string name` [`mailbox-configuration` parameter]

Name for this mailbox.

`string auto` [`mailbox-configuration` parameter]

'`create`' will automatically create this mailbox. '`subscribe`' will both create and subscribe to the mailbox. Defaults to '`"no"`'.

`space-separated-string-list special-use` [`mailbox-configuration` parameter]

List of IMAP `SPECIAL-USE` attributes as specified by RFC 6154. Valid values are `\All`, `\Archive`, `\Drafts`, `\Flagged`, `\Junk`, `\Sent`, and `\Trash`. Defaults to '`()`'.

`file-name base-dir` [`dovecot-configuration` parameter]

Base directory where to store runtime data. Defaults to '`"/var/run/dovecot/"`'.

`string login-greeting` [`dovecot-configuration` parameter]

Greeting message for clients. Defaults to '`"Dovecot ready."`'.

`space-separated-string-list login-trusted-networks` [`dovecot-configuration` parameter]

List of trusted network ranges. Connections from these IPs are allowed to override their IP addresses and ports (for logging and for authentication checks). '`disable-plaintext-auth`' is also ignored for these networks. Typically you would specify your IMAP proxy servers here. Defaults to '`()`'.

`space-separated-string-list login-access-sockets` [`dovecot-configuration` parameter]
: List of login access check sockets (e.g. tcpwrap). Defaults to '`()`'.

`boolean verbose-proctitle?` [`dovecot-configuration` parameter]
: Show more verbose process titles (in ps). Currently shows user name and IP address. Useful for seeing who is actually using the IMAP processes (e.g. shared mailboxes or if the same uid is used for multiple accounts). Defaults to '`#f`'.

`boolean shutdown-clients?` [`dovecot-configuration` parameter]
: Should all processes be killed when Dovecot master process shuts down. Setting this to `#f` means that Dovecot can be upgraded without forcing existing client connections to close (although that could also be a problem if the upgrade is e.g. due to a security fix). Defaults to '`#t`'.

`non-negative-integer doveadm-worker-count` [`dovecot-configuration` parameter]
: If non-zero, run mail commands via this many connections to doveadm server, instead of running them directly in the same process. Defaults to '`0`'.

`string doveadm-socket-path` [`dovecot-configuration` parameter]
: UNIX socket or host:port used for connecting to doveadm server. Defaults to '`"doveadm-server"`'.

`space-separated-string-list import-environment` [`dovecot-configuration` parameter]
: List of environment variables that are preserved on Dovecot startup and passed down to all of its child processes. You can also give key=value pairs to always set specific settings.

`boolean disable-plaintext-auth?` [`dovecot-configuration` parameter]
: Disable LOGIN command and all other plaintext authentications unless SSL/TLS is used (LOGINDISABLED capability). Note that if the remote IP matches the local IP (i.e. you're connecting from the same computer), the connection is considered secure and plaintext authentication is allowed. See also ssl=required setting. Defaults to '`#t`'.

`non-negative-integer auth-cache-size` [`dovecot-configuration` parameter]
: Authentication cache size (e.g. '`#e10e6`'). 0 means it's disabled. Note that bsdauth, PAM and vpopmail require '`cache-key`' to be set for caching to be used. Defaults to '`0`'.

`string auth-cache-ttl` [`dovecot-configuration` parameter]
: Time to live for cached data. After TTL expires the cached record is no longer used, *except* if the main database lookup returns internal failure. We also try to handle password changes automatically: If user's previous authentication was successful, but this one wasn't, the cache isn't used. For now this works only with plaintext authentication. Defaults to '`"1 hour"`'.

`string auth-cache-negative-ttl` [`dovecot-configuration` parameter]

TTL for negative hits (user not found, password mismatch). 0 disables caching them completely. Defaults to '`"1 hour"`'.

`space-separated-string-list auth-realms` [`dovecot-configuration` parameter]

List of realms for SASL authentication mechanisms that need them. You can leave it empty if you don't want to support multiple realms. Many clients simply use the first one listed here, so keep the default realm first. Defaults to '`()`'.

`string auth-default-realm` [`dovecot-configuration` parameter]

Default realm/domain to use if none was specified. This is used for both SASL realms and appending @domain to username in plaintext logins. Defaults to '`""`'.

`string auth-username-chars` [`dovecot-configuration` parameter]

List of allowed characters in username. If the user-given username contains a character not listed in here, the login automatically fails. This is just an extra check to make sure user can't exploit any potential quote escaping vulnerabilities with SQL/LDAP databases. If you want to allow all characters, set this value to empty. Defaults to '`"abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ01234567890.-_@"`'.

`string auth-username-translation` [`dovecot-configuration` parameter]

Username character translations before it's looked up from databases. The value contains series of from `->` to characters. For example '`#@/@`' means that '`#`' and '`/`' characters are translated to '`@`'. Defaults to '`""`'.

`string auth-username-format` [`dovecot-configuration` parameter]

Username formatting before it's looked up from databases. You can use the standard variables here, e.g. %Lu would lowercase the username, %n would drop away the domain if it was given, or '`%n-AT-%d`' would change the '`@`' into '`-AT-`'. This translation is done after '`auth-username-translation`' changes. Defaults to '`"%Lu"`'.

`string auth-master-user-separator` [`dovecot-configuration` parameter]

If you want to allow master users to log in by specifying the master username within the normal username string (i.e. not using SASL mechanism's support for it), you can specify the separator character here. The format is then <username><separator><master username>. UW-IMAP uses '`*`' as the separator, so that could be a good choice. Defaults to '`""`'.

`string auth-anonymous-username` [`dovecot-configuration` parameter]

Username to use for users logging in with ANONYMOUS SASL mechanism. Defaults to '`"anonymous"`'.

`non-negative-integer auth-worker-max-count` [`dovecot-configuration` parameter]

Maximum number of dovecot-auth worker processes. They're used to execute blocking passdb and userdb queries (e.g. MySQL and PAM). They're automatically created and destroyed as needed. Defaults to '`30`'.

`string auth-gssapi-hostname` [`dovecot-configuration` parameter]

Host name to use in GSSAPI principal names. The default is to use the name returned by gethostname(). Use '`$ALL`' (with quotes) to allow all keytab entries. Defaults to '`""`'.

`string auth-krb5-keytab` [`dovecot-configuration` parameter]

Kerberos keytab to use for the GSSAPI mechanism. Will use the system default (usually `/etc/krb5.keytab`) if not specified. You may need to change the auth service to run as root to be able to read this file. Defaults to '`""`'.

`boolean auth-use-winbind?` [`dovecot-configuration` parameter]

Do NTLM and GSS-SPNEGO authentication using Samba's winbind daemon and '`ntlm-auth`' helper. <doc/wiki/Authentication/Mechanisms/Winbind.txt>. Defaults to '`#f`'.

`file-name auth-winbind-helper-path` [`dovecot-configuration` parameter]

Path for Samba's '`ntlm-auth`' helper binary. Defaults to '`"/usr/bin/ntlm_auth"`'.

`string auth-failure-delay` [`dovecot-configuration` parameter]

Time to delay before replying to failed authentications. Defaults to '`"2 secs"`'.

`boolean auth-ssl-require-client-cert?` [`dovecot-configuration` parameter]

Require a valid SSL client certificate or the authentication fails. Defaults to '`#f`'.

`boolean auth-ssl-username-from-cert?` [`dovecot-configuration` parameter]

Take the username from client's SSL certificate, using `X509_NAME_get_text_by_NID()` which returns the subject's DN's CommonName. Defaults to '`#f`'.

`space-separated-string-list auth-mechanisms` [`dovecot-configuration` parameter]

List of wanted authentication mechanisms. Supported mechanisms are: '`plain`', '`login`', '`digest-md5`', '`cram-md5`', '`ntlm`', '`rpa`', '`apop`', '`anonymous`', '`gssapi`', '`otp`', '`skey`', and '`gss-spnego`'. NOTE: See also '`disable-plaintext-auth`' setting.

`space-separated-string-list director-servers` [`dovecot-configuration` parameter]

List of IPs or hostnames to all director servers, including ourself. Ports can be specified as ip:port. The default port is the same as what director service's '`inet-listener`' is using. Defaults to '`()`'.

`space-separated-string-list director-mail-servers` [`dovecot-configuration` parameter]

List of IPs or hostnames to all backend mail servers. Ranges are allowed too, like 10.0.0.10-10.0.0.30. Defaults to '`()`'.

`string director-user-expire` [`dovecot-configuration` parameter]

How long to redirect users to a specific server after it no longer has any connections. Defaults to '`"15 min"`'.

`string director-username-hash` [`dovecot-configuration` parameter]
How the username is translated before being hashed. Useful values include %Ln if user can log in with or without @domain, %Ld if mailboxes are shared within domain. Defaults to ‘`"%Lu"`’.

`string log-path` [`dovecot-configuration` parameter]
Log file to use for error messages. ‘`syslog`’ logs to syslog, ‘`/dev/stderr`’ logs to stderr. Defaults to ‘`"syslog"`’.

`string info-log-path` [`dovecot-configuration` parameter]
Log file to use for informational messages. Defaults to ‘`log-path`’. Defaults to ‘`""`’.

`string debug-log-path` [`dovecot-configuration` parameter]
Log file to use for debug messages. Defaults to ‘`info-log-path`’. Defaults to ‘`""`’.

`string syslog-facility` [`dovecot-configuration` parameter]
Syslog facility to use if you're logging to syslog. Usually if you don't want to use ‘`mail`’, you'll use local0..local7. Also other standard facilities are supported. Defaults to ‘`"mail"`’.

`boolean auth-verbose?` [`dovecot-configuration` parameter]
Log unsuccessful authentication attempts and the reasons why they failed. Defaults to ‘`#f`’.

`string auth-verbose-passwords` [`dovecot-configuration` parameter]
In case of password mismatches, log the attempted password. Valid values are no, plain and sha1. sha1 can be useful for detecting brute force password attempts vs. user simply trying the same password over and over again. You can also truncate the value to n chars by appending ":n" (e.g. sha1:6). Defaults to ‘`"no"`’.

`boolean auth-debug?` [`dovecot-configuration` parameter]
Even more verbose logging for debugging purposes. Shows for example SQL queries. Defaults to ‘`#f`’.

`boolean auth-debug-passwords?` [`dovecot-configuration` parameter]
In case of password mismatches, log the passwords and used scheme so the problem can be debugged. Enabling this also enables ‘`auth-debug`’. Defaults to ‘`#f`’.

`boolean mail-debug?` [`dovecot-configuration` parameter]
Enable mail process debugging. This can help you figure out why Dovecot isn't finding your mails. Defaults to ‘`#f`’.

`boolean verbose-ssl?` [`dovecot-configuration` parameter]
Show protocol level SSL errors. Defaults to ‘`#f`’.

`string log-timestamp` [`dovecot-configuration` parameter]
Prefix for each line written to log file. % codes are in strftime(3) format. Defaults to ‘`"\"%b %d %H:%M:%S \""`’.

`space-separated-string-list login-log-format-elements` [`dovecot-configuration` parameter]

List of elements we want to log. The elements which have a non-empty variable value are joined together to form a comma-separated string.

`string login-log-format` [`dovecot-configuration` parameter]

Login log format. %s contains '`login-log-format-elements`' string, %$ contains the data we want to log. Defaults to '`"%$: %s"`'.

`string mail-log-prefix` [`dovecot-configuration` parameter]

Log prefix for mail processes. See doc/wiki/Variables.txt for list of possible variables you can use. Defaults to '`"\"%s(%u)<%{pid}><%{session}>: \""`'.

`string deliver-log-format` [`dovecot-configuration` parameter]

Format to use for logging mail deliveries. You can use variables:

`%$`	Delivery status message (e.g. '`saved to INBOX`')
`%m`	Message-ID
`%s`	Subject
`%f`	From address
`%p`	Physical size
`%w`	Virtual size.

Defaults to '`"msgid=%m: %$"`'.

`string mail-location` [`dovecot-configuration` parameter]

Location for users' mailboxes. The default is empty, which means that Dovecot tries to find the mailboxes automatically. This won't work if the user doesn't yet have any mail, so you should explicitly tell Dovecot the full location.

If you're using mbox, giving a path to the INBOX file (e.g. `/var/mail/%u`) isn't enough. You'll also need to tell Dovecot where the other mailboxes are kept. This is called the *root mail directory*, and it must be the first path given in the '`mail-location`' setting.

There are a few special variables you can use, e.g.:

'%u'	username
'%n'	user part in user@domain, same as %u if there's no domain
'%d'	domain part in user@domain, empty if there's no domain
'%h'	home director

See doc/wiki/Variables.txt for full list. Some examples:

'`maildir:~/Maildir`'
'`mbox:~/mail:INBOX=/var/mail/%u`'
'`mbox:/var/mail/%d/%1n/%n:INDEX=/var/indexes/%d/%1n/%`'

Defaults to '`""`'.

string mail-uid [dovecot-configuration parameter]
System user and group used to access mails. If you use multiple, userdb can override these by returning uid or gid fields. You can use either numbers or names. <doc/wiki/UserIds.txt>. Defaults to '""'.

string mail-gid [dovecot-configuration parameter]
Defaults to '""'.

string mail-privileged-group [dovecot-configuration parameter]
Group to enable temporarily for privileged operations. Currently this is used only with INBOX when either its initial creation or dotlocking fails. Typically this is set to '"mail"' to give access to `/var/mail`. Defaults to '""'.

string mail-access-groups [dovecot-configuration parameter]
Grant access to these supplementary groups for mail processes. Typically these are used to set up access to shared mailboxes. Note that it may be dangerous to set these if users can create symlinks (e.g. if 'mail' group is set here, `ln -s /var/mail ~/mail/var` could allow a user to delete others' mailboxes, or `ln -s /secret/shared/box ~/mail/mybox` would allow reading it). Defaults to '""'.

string mail-attribute-dict [dovecot-configuration parameter]
The location of a dictionary used to store IMAP METADATA as defined by RFC 5464 (`https://tools.ietf.org/html/rfc5464`).

The IMAP METADATA commands are available only if the "imap" protocol configuration's `imap-metadata?` field is '#t'.

Defaults to '""'.

boolean mail-full-filesystem-access? [dovecot-configuration parameter]
Allow full file system access to clients. There's no access checks other than what the operating system does for the active UID/GID. It works with both maildir and mboxes, allowing you to prefix mailboxes names with e.g. `/path/` or `~user/`. Defaults to '#f'.

boolean mmap-disable? [dovecot-configuration parameter]
Don't use `mmap()` at all. This is required if you store indexes to shared file systems (NFS or clustered file system). Defaults to '#f'.

boolean dotlock-use-excl? [dovecot-configuration parameter]
Rely on 'O_EXCL' to work when creating dotlock files. NFS supports 'O_EXCL' since version 3, so this should be safe to use nowadays by default. Defaults to '#t'.

string mail-fsync [dovecot-configuration parameter]
When to use fsync() or fdatasync() calls:

`optimized`	Whenever necessary to avoid losing important data
`always`	Useful with e.g. NFS when `write()`s are delayed
`never`	Never use it (best performance, but crashes can lose data).

Defaults to '"optimized"'.

`boolean mail-nfs-storage?` [`dovecot-configuration` parameter]

Mail storage exists in NFS. Set this to yes to make Dovecot flush NFS caches whenever needed. If you're using only a single mail server this isn't needed. Defaults to '`#f`'.

`boolean mail-nfs-index?` [`dovecot-configuration` parameter]

Mail index files also exist in NFS. Setting this to yes requires '`mmap-disable? #t`' and '`fsync-disable? #f`'. Defaults to '`#f`'.

`string lock-method` [`dovecot-configuration` parameter]

Locking method for index files. Alternatives are fcntl, flock and dotlock. Dotlocking uses some tricks which may create more disk I/O than other locking methods. NFS users: flock doesn't work, remember to change '`mmap-disable`'. Defaults to '`"fcntl"`'.

`file-name mail-temp-dir` [`dovecot-configuration` parameter]

Directory in which LDA/LMTP temporarily stores incoming mails >128 kB. Defaults to '`"/tmp"`'.

`non-negative-integer first-valid-uid` [`dovecot-configuration` parameter]

Valid UID range for users. This is mostly to make sure that users can't log in as daemons or other system users. Note that denying root logins is hardcoded to dovecot binary and can't be done even if '`first-valid-uid`' is set to 0. Defaults to '`500`'.

`non-negative-integer last-valid-uid` [`dovecot-configuration` parameter]

Defaults to '`0`'.

`non-negative-integer first-valid-gid` [`dovecot-configuration` parameter]

Valid GID range for users. Users having non-valid GID as primary group ID aren't allowed to log in. If user belongs to supplementary groups with non-valid GIDs, those groups are not set. Defaults to '`1`'.

`non-negative-integer last-valid-gid` [`dovecot-configuration` parameter]

Defaults to '`0`'.

`non-negative-integer mail-max-keyword-length` [`dovecot-configuration` parameter]

Maximum allowed length for mail keyword name. It's only forced when trying to create new keywords. Defaults to '`50`'.

`colon-separated-file-name-list valid-chroot-dirs` [`dovecot-configuration` parameter]

List of directories under which chrooting is allowed for mail processes (i.e. `/var/mail` will allow chrooting to `/var/mail/foo/bar` too). This setting doesn't affect '`login-chroot`' '`mail-chroot`' or auth chroot settings. If this setting is empty, '`/./`' in home dirs are ignored. WARNING: Never add directories here which local users can modify, that may lead to root exploit. Usually this should be done only if you don't allow shell access for users. <doc/wiki/Chrooting.txt>. Defaults to '`()`'.

`string mail-chroot` [`dovecot-configuration` parameter]

Default chroot directory for mail processes. This can be overridden for specific users in user database by giving '`/./`' in user's home directory (e.g. '`/home/./user`' chroots into `/home`). Note that usually there is no real need to do chrooting, Dovecot doesn't allow users to access files outside their mail directory anyway. If your home directories are prefixed with the chroot directory, append '`/.`' to '`mail-chroot`'. <doc/wiki/Chrooting.txt>. Defaults to '`""`'.

`file-name auth-socket-path` [`dovecot-configuration` parameter]

UNIX socket path to master authentication server to find users. This is used by imap (for shared users) and lda. Defaults to '`"/var/run/dovecot/auth-userdb"`'.

`file-name mail-plugin-dir` [`dovecot-configuration` parameter]

Directory where to look up mail plugins. Defaults to '`"/usr/lib/dovecot"`'.

`space-separated-string-list mail-plugins` [`dovecot-configuration` parameter]

List of plugins to load for all services. Plugins specific to IMAP, LDA, etc. are added to this list in their own .conf files. Defaults to '`()`'.

`non-negative-integer mail-cache-min-mail-count` [`dovecot-configuration` parameter]

The minimum number of mails in a mailbox before updates are done to cache file. This allows optimizing Dovecot's behavior to do less disk writes at the cost of more disk reads. Defaults to '`0`'.

`string mailbox-idle-check-interval` [`dovecot-configuration` parameter]

When IDLE command is running, mailbox is checked once in a while to see if there are any new mails or other changes. This setting defines the minimum time to wait between those checks. Dovecot can also use dnotify, inotify and kqueue to find out immediately when changes occur. Defaults to '`"30 secs"`'.

`boolean mail-save-crlf?` [`dovecot-configuration` parameter]

Save mails with CR+LF instead of plain LF. This makes sending those mails take less CPU, especially with sendfile() syscall with Linux and FreeBSD. But it also creates a bit more disk I/O which may just make it slower. Also note that if other software reads the mboxes/maildirs, they may handle the extra CRs wrong and cause problems. Defaults to '`#f`'.

`boolean maildir-stat-dirs?` [`dovecot-configuration` parameter]

By default LIST command returns all entries in maildir beginning with a dot. Enabling this option makes Dovecot return only entries which are directories. This is done by stat()ing each entry, so it causes more disk I/O. (For systems setting struct '`dirent->d_type`' this check is free and it's done always regardless of this setting). Defaults to '`#f`'.

`boolean maildir-copy-with-hardlinks?` [`dovecot-configuration` parameter]

When copying a message, do it with hard links whenever possible. This makes the performance much better, and it's unlikely to have any side effects. Defaults to '`#t`'.

`boolean maildir-very-dirty-syncs?` [`dovecot-configuration` parameter]

Assume Dovecot is the only MUA accessing Maildir: Scan cur/ directory only when its mtime changes unexpectedly or when we can't find the mail otherwise. Defaults to '`#f`'.

`space-separated-string-list mbox-read-locks` [`dovecot-configuration` parameter]

Which locking methods to use for locking mbox. There are four available:

`dotlock`
: Create <mailbox>.lock file. This is the oldest and most NFS-safe solution. If you want to use /var/mail/ like directory, the users will need write access to that directory.

`dotlock-try`
: Same as dotlock, but if it fails because of permissions or because there isn't enough disk space, just skip it.

`fcntl`
: Use this if possible. Works with NFS too if lockd is used.

`flock`
: May not exist in all systems. Doesn't work with NFS.

`lockf`
: May not exist in all systems. Doesn't work with NFS.

You can use multiple locking methods; if you do the order they're declared in is important to avoid deadlocks if other MTAs/MUAs are using multiple locking methods as well. Some operating systems don't allow using some of them simultaneously.

`space-separated-string-list mbox-write-locks` [`dovecot-configuration` parameter]

`string mbox-lock-timeout` [`dovecot-configuration` parameter]

Maximum time to wait for lock (all of them) before aborting. Defaults to '`"5 mins"`'.

`string mbox-dotlock-change-timeout` [`dovecot-configuration` parameter]

If dotlock exists but the mailbox isn't modified in any way, override the lock file after this much time. Defaults to '`"2 mins"`'.

`boolean mbox-dirty-syncs?` [`dovecot-configuration` parameter]

When mbox changes unexpectedly we have to fully read it to find out what changed. If the mbox is large this can take a long time. Since the change is usually just a newly appended mail, it'd be faster to simply read the new mails. If this setting is enabled, Dovecot does this but still safely fallbacks to re-reading the whole mbox file whenever something in mbox isn't how it's expected to be. The only real downside to this setting is that if some other MUA changes message flags, Dovecot doesn't notice it immediately. Note that a full sync is done with SELECT, EXAMINE, EXPUNGE and CHECK commands. Defaults to '`#t`'.

`boolean mbox-very-dirty-syncs?` [`dovecot-configuration` parameter]

Like '`mbox-dirty-syncs`', but don't do full syncs even with SELECT, EXAMINE, EXPUNGE or CHECK commands. If this is set, '`mbox-dirty-syncs`' is ignored. Defaults to '`#f`'.

boolean mbox-lazy-writes? [dovecot-configuration parameter]

Delay writing mbox headers until doing a full write sync (EXPUNGE and CHECK commands and when closing the mailbox). This is especially useful for POP3 where clients often delete all mails. The downside is that our changes aren't immediately visible to other MUAs. Defaults to '`#t`'.

non-negative-integer mbox-min-index-size [dovecot-configuration parameter]

If mbox size is smaller than this (e.g. 100k), don't write index files. If an index file already exists it's still read, just not updated. Defaults to '`0`'.

non-negative-integer mdbox-rotate-size [dovecot-configuration parameter]

Maximum dbox file size until it's rotated. Defaults to '`10000000`'.

string mdbox-rotate-interval [dovecot-configuration parameter]

Maximum dbox file age until it's rotated. Typically in days. Day begins from midnight, so 1d = today, 2d = yesterday, etc. 0 = check disabled. Defaults to '`"1d"`'.

boolean mdbox-preallocate-space? [dovecot-configuration parameter]

When creating new mdbox files, immediately preallocate their size to '`mdbox-rotate-size`'. This setting currently works only in Linux with some file systems (ext4, xfs). Defaults to '`#f`'.

string mail-attachment-dir [dovecot-configuration parameter]

sdbox and mdbox support saving mail attachments to external files, which also allows single instance storage for them. Other backends don't support this for now.

WARNING: This feature hasn't been tested much yet. Use at your own risk.

Directory root where to store mail attachments. Disabled, if empty. Defaults to '`""`'.

non-negative-integer mail-attachment-min-size [dovecot-configuration parameter]

Attachments smaller than this aren't saved externally. It's also possible to write a plugin to disable saving specific attachments externally. Defaults to '`128000`'.

string mail-attachment-fs [dovecot-configuration parameter]

File system backend to use for saving attachments:

`posix` No SiS done by Dovecot (but this might help FS's own deduplication)

`sis posix` SiS with immediate byte-by-byte comparison during saving

`sis-queue posix`
SiS with delayed comparison and deduplication.

Defaults to '`"sis posix"`'.

string mail-attachment-hash [dovecot-configuration parameter]

Hash format to use in attachment filenames. You can add any text and variables: `%{md4}`, `%{md5}`, `%{sha1}`, `%{sha256}`, `%{sha512}`, `%{size}`. Variables can be truncated, e.g. `%{sha256:80}` returns only first 80 bits. Defaults to '`"%{sha1}"`'.

`non-negative-integer default-process-limit` [`dovecot-configuration` parameter]
: Defaults to '`100`'.

`non-negative-integer default-client-limit` [`dovecot-configuration` parameter]
: Defaults to '`1000`'.

`non-negative-integer default-vsz-limit` [`dovecot-configuration` parameter]
: Default VSZ (virtual memory size) limit for service processes. This is mainly intended to catch and kill processes that leak memory before they eat up everything. Defaults to '`256000000`'.

`string default-login-user` [`dovecot-configuration` parameter]
: Login user is internally used by login processes. This is the most untrusted user in Dovecot system. It shouldn't have access to anything at all. Defaults to '`"dovenull"`'.

`string default-internal-user` [`dovecot-configuration` parameter]
: Internal user is used by unprivileged processes. It should be separate from login user, so that login processes can't disturb other processes. Defaults to '`"dovecot"`'.

`string ssl?` [`dovecot-configuration` parameter]
: SSL/TLS support: yes, no, required. <doc/wiki/SSL.txt>. Defaults to '`"required"`'.

`string ssl-cert` [`dovecot-configuration` parameter]
: PEM encoded X.509 SSL/TLS certificate (public key). Defaults to '`"</etc/dovecot/default.pem"`'.

`string ssl-key` [`dovecot-configuration` parameter]
: PEM encoded SSL/TLS private key. The key is opened before dropping root privileges, so keep the key file unreadable by anyone but root. Defaults to '`"</etc/dovecot/private/default.pem"`'.

`string ssl-key-password` [`dovecot-configuration` parameter]
: If key file is password protected, give the password here. Alternatively give it when starting dovecot with -p parameter. Since this file is often world-readable, you may want to place this setting instead to a different. Defaults to '`""`'.

`string ssl-ca` [`dovecot-configuration` parameter]
: PEM encoded trusted certificate authority. Set this only if you intend to use '`ssl-verify-client-cert? #t`'. The file should contain the CA certificate(s) followed by the matching CRL(s). (e.g. '`ssl-ca </etc/ssl/certs/ca.pem`'). Defaults to '`""`'.

`boolean ssl-require-crl?` [`dovecot-configuration` parameter]
: Require that CRL check succeeds for client certificates. Defaults to '`#t`'.

`boolean ssl-verify-client-cert?` [`dovecot-configuration` parameter]
: Request client to send a certificate. If you also want to require it, set '`auth-ssl-require-client-cert? #t`' in auth section. Defaults to '`#f`'.

`string ssl-cert-username-field` [`dovecot-configuration` parameter]
: Which field from certificate to use for username. commonName and x500UniqueIdentifier are the usual choices. You'll also need to set '`auth-ssl-username-from-cert? #t`'. Defaults to '`"commonName"`'.

`string ssl-min-protocol` [`dovecot-configuration` parameter]
: Minimum SSL protocol version to accept. Defaults to '`"TLSv1"`'.

`string ssl-cipher-list` [`dovecot-configuration` parameter]
: SSL ciphers to use. Defaults to '`"ALL:!kRSA:!SRP:!kDHd:!DSS:!aNULL:!eNULL:!EXPORT:!DES:!3DES:`

`string ssl-crypto-device` [`dovecot-configuration` parameter]
: SSL crypto device to use, for valid values run "openssl engine". Defaults to '`""`'.

`string postmaster-address` [`dovecot-configuration` parameter]
: Address to use when sending rejection mails. %d expands to recipient domain. Defaults to '`"postmaster@%d"`'.

`string hostname` [`dovecot-configuration` parameter]
: Hostname to use in various parts of sent mails (e.g. in Message-Id) and in LMTP replies. Default is the system's real hostname@domain. Defaults to '`""`'.

`boolean quota-full-tempfail?` [`dovecot-configuration` parameter]
: If user is over quota, return with temporary failure instead of bouncing the mail. Defaults to '`#f`'.

`file-name sendmail-path` [`dovecot-configuration` parameter]
: Binary to use for sending mails. Defaults to '`"/usr/sbin/sendmail"`'.

`string submission-host` [`dovecot-configuration` parameter]
: If non-empty, send mails via this SMTP host[:port] instead of sendmail. Defaults to '`""`'.

`string rejection-subject` [`dovecot-configuration` parameter]
: Subject: header to use for rejection mails. You can use the same variables as for '`rejection-reason`' below. Defaults to '`"Rejected: %s"`'.

`string rejection-reason` [`dovecot-configuration` parameter]
: Human readable error message for rejection mails. You can use variables:

`%n`	CRLF
`%r`	reason
`%s`	original subject
`%t`	recipient

Defaults to '`"Your message to <%t> was automatically rejected:%n%r"`'.

`string recipient-delimiter` [`dovecot-configuration` parameter]
: Delimiter character between local-part and detail in email address. Defaults to '`"+"`'.

`string lda-original-recipient-header` [`dovecot-configuration` parameter]
Header where the original recipient address (SMTP's RCPT TO: address) is taken from if not available elsewhere. With dovecot-lda -a parameter overrides this. A commonly used header for this is X-Original-To. Defaults to '`""`'.

`boolean lda-mailbox-autocreate?` [`dovecot-configuration` parameter]
Should saving a mail to a nonexistent mailbox automatically create it?. Defaults to '`#f`'.

`boolean lda-mailbox-autosubscribe?` [`dovecot-configuration` parameter]
Should automatically created mailboxes be also automatically subscribed?. Defaults to '`#f`'.

`non-negative-integer imap-max-line-length` [`dovecot-configuration` parameter]
Maximum IMAP command line length. Some clients generate very long command lines with huge mailboxes, so you may need to raise this if you get "Too long argument" or "IMAP command line too large" errors often. Defaults to '`64000`'.

`string imap-logout-format` [`dovecot-configuration` parameter]
IMAP logout format string:

`%i` total number of bytes read from client

`%o` total number of bytes sent to client.

See `doc/wiki/Variables.txt` for a list of all the variables you can use. Defaults to '`"in=%i out=%o deleted=%{deleted} expunged=%{expunged} trashed=%{trashed} hdr_count=%{fetch_hdr_count} hdr_bytes=%{fetch_hdr_bytes} body_count=%{fetch_body_count} body_bytes=%{fetch_body_bytes}"`'.

`string imap-capability` [`dovecot-configuration` parameter]
Override the IMAP CAPABILITY response. If the value begins with '+', add the given capabilities on top of the defaults (e.g. +XFOO XBAR). Defaults to '`""`'.

`string imap-idle-notify-interval` [`dovecot-configuration` parameter]
How long to wait between "OK Still here" notifications when client is IDLEing. Defaults to '`"2 mins"`'.

`string imap-id-send` [`dovecot-configuration` parameter]
ID field names and values to send to clients. Using * as the value makes Dovecot use the default value. The following fields have default values currently: name, version, os, os-version, support-url, support-email. Defaults to '`""`'.

`string imap-id-log` [`dovecot-configuration` parameter]
ID fields sent by client to log. * means everything. Defaults to '`""`'.

`space-separated-string-list imap-client-workarounds` [`dovecot-configuration` parameter]
Workarounds for various client bugs:

`delay-newmail`
Send EXISTS/RECENT new mail notifications only when replying to NOOP and CHECK commands. Some clients ignore them otherwise, for

example OSX Mail (<v2.1). Outlook Express breaks more badly though, without this it may show user "Message no longer in server" errors. Note that OE6 still breaks even with this workaround if synchronization is set to "Headers Only".

`tb-extra-mailbox-sep`
: Thunderbird gets somehow confused with LAYOUT=fs (mbox and dbox) and adds extra '`/`' suffixes to mailbox names. This option causes Dovecot to ignore the extra '`/`' instead of treating it as invalid mailbox name.

`tb-lsub-flags`
: Show \Noselect flags for LSUB replies with LAYOUT=fs (e.g. mbox). This makes Thunderbird realize they aren't selectable and show them greyed out, instead of only later giving "not selectable" popup error.

Defaults to '`()`'.

`string imap-urlauth-host` [`dovecot-configuration` parameter]
Host allowed in URLAUTH URLs sent by client. "*" allows all. Defaults to '`""`'.

Whew! Lots of configuration options. The nice thing about it though is that Guix has a complete interface to Dovecot's configuration language. This allows not only a nice way to declare configurations, but also offers reflective capabilities as well: users can write code to inspect and transform configurations from within Scheme.

However, it could be that you just want to get a `dovecot.conf` up and running. In that case, you can pass an `opaque-dovecot-configuration` as the `#:config` parameter to `dovecot-service`. As its name indicates, an opaque configuration does not have easy reflective capabilities.

Available `opaque-dovecot-configuration` fields are:

`package dovecot` [`opaque-dovecot-configuration` parameter]
The dovecot package.

`string string` [`opaque-dovecot-configuration` parameter]
The contents of the `dovecot.conf`, as a string.

For example, if your `dovecot.conf` is just the empty string, you could instantiate a dovecot service like this:

```
(dovecot-service #:config
                 (opaque-dovecot-configuration
                  (string "")))
```

OpenSMTPD Service

`opensmtpd-service-type` [Scheme Variable]
This is the type of the OpenSMTPD (`https://www.opensmtpd.org`) service, whose value should be an `opensmtpd-configuration` object as in this example:

```
(service opensmtpd-service-type
         (opensmtpd-configuration
           (config-file (local-file "./my-smtpd.conf"))))
```

`opensmtpd-configuration` [Data Type]

Data type representing the configuration of opensmtpd.

`package` (default: *opensmtpd*)
: Package object of the OpenSMTPD SMTP server.

`config-file` (default: `%default-opensmtpd-config-file`)
: File-like object of the OpenSMTPD configuration file to use. By default it listens on the loopback network interface, and allows for mail from users and daemons on the local machine, as well as permitting email to remote servers. Run `man smtpd.conf` for more information.

`setgid-commands?` (default: `#t`)
: Make the following commands setgid to `smtpq` so they can be executed: `smtpctl`, `sendmail`, `send-mail`, `makemap`, `mailq`, and `newaliases`. See Section 12.10 [Setuid Programs], page 533, for more information on setgid programs.

Exim Service

`exim-service-type` [Scheme Variable]

This is the type of the Exim (`https://exim.org`) mail transfer agent (MTA), whose value should be an `exim-configuration` object as in this example:

```
(service exim-service-type
         (exim-configuration
           (config-file (local-file "./my-exim.conf"))))
```

In order to use an `exim-service-type` service you must also have a `mail-aliases-service-type` service present in your `operating-system` (even if it has no aliases).

`exim-configuration` [Data Type]

Data type representing the configuration of exim.

`package` (default: *exim*)
: Package object of the Exim server.

`config-file` (default: `#f`)
: File-like object of the Exim configuration file to use. If its value is `#f` then use the default configuration file from the package provided in `package`. The resulting configuration file is loaded after setting the `exim_user` and `exim_group` configuration variables.

Getmail service

`getmail-service-type` [Scheme Variable]

This is the type of the Getmail (`http://pyropus.ca/software/getmail/`) mail retriever, whose value should be an `getmail-configuration`.

Available `getmail-configuration` fields are:

`symbol name` [`getmail-configuration` parameter]

A symbol to identify the getmail service.

Defaults to ‘`"unset"`’.

`package package` [`getmail-configuration` parameter]
: The getmail package to use.

`string user` [`getmail-configuration` parameter]
: The user to run getmail as.

  Defaults to ‘`"getmail"`’.

`string group` [`getmail-configuration` parameter]
: The group to run getmail as.

  Defaults to ‘`"getmail"`’.

`string directory` [`getmail-configuration` parameter]
: The getmail directory to use.

  Defaults to ‘`"/var/lib/getmail/default"`’.

`getmail-configuration-file rcfile` [`getmail-configuration` parameter]
: The getmail configuration file to use.

  Available `getmail-configuration-file` fields are:

  `getmail-retriever-configuration retriever` [`getmail-configuration-file` parameter]
  : What mail account to retrieve mail from, and how to access that account.

    Available `getmail-retriever-configuration` fields are:

    `string type` [`getmail-retriever-configuration` parameter]
    : The type of mail retriever to use. Valid values include ‘`passwd`’ and ‘`static`’.

      Defaults to ‘`"SimpleIMAPSSLRetriever"`’.

    `string server` [`getmail-retriever-configuration` parameter]
    : Username to login to the mail server with.

      Defaults to ‘`unset`’.

    `string username` [`getmail-retriever-configuration` parameter]
    : Username to login to the mail server with.

      Defaults to ‘`unset`’.

    `non-negative-integer port` [`getmail-retriever-configuration` parameter]
    : Port number to connect to.

      Defaults to ‘`#f`’.

    `string password` [`getmail-retriever-configuration` parameter]
    : Override fields from passwd.

      Defaults to ‘`""`’.

    `list password-command` [`getmail-retriever-configuration` parameter]
    : Override fields from passwd.

      Defaults to ‘`()`’.

`string keyfile` [`getmail-retriever-configuration` parameter]

PEM-formatted key file to use for the TLS negotiation.

Defaults to ‘`""`’.

`string certfile` [`getmail-retriever-configuration` parameter]

PEM-formatted certificate file to use for the TLS negotiation.

Defaults to ‘`""`’.

`string ca-certs` [`getmail-retriever-configuration` parameter]

CA certificates to use.

Defaults to ‘`""`’.

`parameter-alist extra-parameters` [`getmail-retriever-configuration` parameter]

Extra retriever parameters.

Defaults to ‘`()`’.

`getmail-destination-configuration destination` [`getmail-configuration-file` parameter]

What to do with retrieved messages.

Available `getmail-destination-configuration` fields are:

`string type` [`getmail-destination-configuration` parameter]

The type of mail destination. Valid values include ‘`Maildir`’, ‘`Mboxrd`’ and ‘`MDA_external`’.

Defaults to ‘`unset`’.

`string-or-filelike path` [`getmail-destination-configuration` parameter]

The path option for the mail destination. The behaviour depends on the chosen type.

Defaults to ‘`""`’.

`parameter-alist extra-parameters` [`getmail-destination-configuration` parameter]

Extra destination parameters

Defaults to ‘`()`’.

`getmail-options-configuration options` [`getmail-configuration-file` parameter]

Configure getmail.

Available `getmail-options-configuration` fields are:

`non-negative-integer verbose` [`getmail-options-configuration` parameter]

If set to ‘`0`’, getmail will only print warnings and errors. A value of ‘`1`’ means that messages will be printed about retrieving and deleting messages. If set to ‘`2`’, getmail will print messages about each of its actions.

Defaults to ‘`1`’.

`boolean read-all` [`getmail-options-configuration` parameter]
: If true, getmail will retrieve all available messages. Otherwise it will only retrieve messages it hasn't seen previously.

  Defaults to '`#t`'.

`boolean delete` [`getmail-options-configuration` parameter]
: If set to true, messages will be deleted from the server after retrieving and successfully delivering them. Otherwise, messages will be left on the server.

  Defaults to '`#f`'.

`non-negative-integer delete-after` [`getmail-options-configuration` parameter]
: Getmail will delete messages this number of days after seeing them, if they have been delivered. This means messages will be left on the server this number of days after delivering them. A value of '`0`' disabled this feature.

  Defaults to '`0`'.

`non-negative-integer delete-bigger-than` [`getmail-options-configuration` parameter]
: Delete messages larger than this of bytes after retrieving them, even if the delete and delete-after options are disabled. A value of '`0`' disables this feature.

  Defaults to '`0`'.

`non-negative-integer max-bytes-per-session` [`getmail-options-configuration` parameter]
: Retrieve messages totalling up to this number of bytes before closing the session with the server. A value of '`0`' disables this feature.

  Defaults to '`0`'.

`non-negative-integer max-message-size` [`getmail-options-configuration` parameter]
: Don't retrieve messages larger than this number of bytes. A value of '`0`' disables this feature.

  Defaults to '`0`'.

`boolean delivered-to` [`getmail-options-configuration` parameter]
: If true, getmail will add a Delivered-To header to messages.

  Defaults to '`#t`'.

`boolean received` [`getmail-options-configuration` parameter]
: If set, getmail adds a Received header to the messages.

  Defaults to '`#t`'.

`string message-log` [`getmail-options-configuration` parameter]
: Getmail will record a log of its actions to the named file. A value of '`""`' disables this feature.

  Defaults to '`""`'.

`boolean message-log-syslog` [`getmail-options-configuration` parameter]
: If true, getmail will record a log of its actions using the system logger.

  Defaults to '`#f`'.

`boolean message-log-verbose` [`getmail-options-configuration` parameter]
: If true, getmail will log information about messages not retrieved and the reason for not retrieving them, as well as starting and ending information lines.

  Defaults to '`#f`'.

`parameter-alist extra-parameters` [`getmail-options-configuration` parameter]
: Extra options to include.

  Defaults to '`()`'.

`list idle` [`getmail-configuration` parameter]
: A list of mailboxes that getmail should wait on the server for new mail notifications. This depends on the server supporting the IDLE extension.

  Defaults to '`()`'.

`list environment-variables` [`getmail-configuration` parameter]
: Environment variables to set for getmail.

  Defaults to '`()`'.

Mail Aliases Service

`mail-aliases-service-type` [Scheme Variable]
: This is the type of the service which provides `/etc/aliases`, specifying how to deliver mail to users on this system.

```
(service mail-aliases-service-type
         '(("postmaster" "bob")
           ("bob" "bob@example.com" "bob@example2.com")))
```

The configuration for a `mail-aliases-service-type` service is an association list denoting how to deliver mail that comes to this system. Each entry is of the form `(alias addresses ...)`, with `alias` specifying the local alias and `addresses` specifying where to deliver this user's mail.

The aliases aren't required to exist as users on the local system. In the above example, there doesn't need to be a `postmaster` entry in the `operating-system`'s `user-accounts` in order to deliver the `postmaster` mail to `bob` (which subsequently would deliver mail to `bob@example.com` and `bob@example2.com`).

GNU Mailutils IMAP4 Daemon

`imap4d-service-type` [Scheme Variable]

This is the type of the GNU Mailutils IMAP4 Daemon (see Section "imap4d" in *GNU Mailutils Manual*), whose value should be an `imap4d-configuration` object as in this example:

```
(service imap4d-service-type
         (imap4d-configuration
           (config-file (local-file "imap4d.conf"))))
```

`imap4d-configuration` [Data Type]

Data type representing the configuration of `imap4d`.

`package` (default: `mailutils`)
: The package that provides `imap4d`.

`config-file` (default: `%default-imap4d-config-file`)
: File-like object of the configuration file to use, by default it will listen on TCP port 143 of `localhost`. See Section "Conf-imap4d" in *GNU Mailutils Manual*, for details.

Radicale Service

`radicale-service-type` [Scheme Variable]

This is the type of the Radicale (`https://radicale.org`) CalDAV/CardDAV server whose value should be a `radicale-configuration`.

`radicale-configuration` [Data Type]

Data type representing the configuration of `radicale`.

`package` (default: `radicale`)
: The package that provides `radicale`.

`config-file` (default: `%default-radicale-config-file`)
: File-like object of the configuration file to use, by default it will listen on TCP port 5232 of `localhost` and use the `htpasswd` file at `/var/lib/radicale/users` with no (`plain`) encryption.

12.9.13 Messaging Services

The `(gnu services messaging)` module provides Guix service definitions for messaging services. Currently it provides the following services:

Prosody Service

`prosody-service-type` [Scheme Variable]

This is the type for the Prosody XMPP communication server (`https://prosody.im`). Its value must be a `prosody-configuration` record as in this example:

```
(service prosody-service-type
         (prosody-configuration
          (modules-enabled (cons* "groups" "mam" %default-modules-enabled))
```

```
                    (int-components
                     (list
                      (int-component-configuration
                       (hostname "conference.example.net")
                       (plugin "muc")
                       (mod-muc (mod-muc-configuration)))))
                    (virtualhosts
                     (list
                      (virtualhost-configuration
                       (domain "example.net"))))))
```

See below for details about `prosody-configuration`.

By default, Prosody does not need much configuration. Only one `virtualhosts` field is needed: it specifies the domain you wish Prosody to serve.

You can perform various sanity checks on the generated configuration with the `prosodyctl check` command.

Prosodyctl will also help you to import certificates from the `letsencrypt` directory so that the `prosody` user can access them. See `https://prosody.im/doc/letsencrypt`.

```
prosodyctl --root cert import /etc/letsencrypt/live
```

The available configuration parameters follow. Each parameter definition is preceded by its type; for example, '`string-list foo`' indicates that the `foo` parameter should be specified as a list of strings. Types starting with `maybe-` denote parameters that won't show up in `prosody.cfg.lua` when their value is left unspecified.

There is also a way to specify the configuration as a string, if you have an old `prosody.cfg.lua` file that you want to port over from some other system; see the end for more details.

The `file-object` type designates either a file-like object (see Section 9.12 [G-Expressions], page 154) or a file name.

Available `prosody-configuration` fields are:

`package prosody` [`prosody-configuration` parameter]

The Prosody package.

`file-name data-path` [`prosody-configuration` parameter]

Location of the Prosody data storage directory. See `https://prosody.im/doc/configure`. Defaults to '`"/var/lib/prosody"`'.

`file-object-list plugin-paths` [`prosody-configuration` parameter]

Additional plugin directories. They are searched in all the specified paths in order. See `https://prosody.im/doc/plugins_directory`. Defaults to '`()`'.

`file-name certificates` [`prosody-configuration` parameter]

Every virtual host and component needs a certificate so that clients and servers can securely verify its identity. Prosody will automatically load certificates/keys from the directory specified here. Defaults to '`"/etc/prosody/certs"`'.

`string-list admins` [`prosody-configuration` parameter]
: This is a list of accounts that are admins for the server. Note that you must create the accounts separately. See `https://prosody.im/doc/admins` and `https://prosody.im/doc/creating_accounts`. Example: `(admins '("user1@example.com" "user2@example.net"))` Defaults to '`()`'.

`boolean use-libevent?` [`prosody-configuration` parameter]
: Enable use of libevent for better performance under high load. See `https://prosody.im/doc/libevent`. Defaults to '`#f`'.

`module-list modules-enabled` [`prosody-configuration` parameter]
: This is the list of modules Prosody will load on startup. It looks for `mod_modulename.lua` in the plugins folder, so make sure that exists too. Documentation on modules can be found at: `https://prosody.im/doc/modules`. Defaults to '`("roster" "saslauth" "tls" "dialback" "disco" "carbons" "private" "blocklist" "vcard" "version" "uptime" "time" "ping" "pep" "register" "admin_adhoc")`'.

`string-list modules-disabled` [`prosody-configuration` parameter]
: '`"offline"`', '`"c2s"`' and '`"s2s"`' are auto-loaded, but should you want to disable them then add them to this list. Defaults to '`()`'.

`file-object groups-file` [`prosody-configuration` parameter]
: Path to a text file where the shared groups are defined. If this path is empty then '`mod_groups`' does nothing. See `https://prosody.im/doc/modules/mod_groups`. Defaults to '`"/var/lib/prosody/sharedgroups.txt"`'.

`boolean allow-registration?` [`prosody-configuration` parameter]
: Disable account creation by default, for security. See `https://prosody.im/doc/creating_accounts`. Defaults to '`#f`'.

`maybe-ssl-configuration ssl` [`prosody-configuration` parameter]
: These are the SSL/TLS-related settings. Most of them are disabled so to use Prosody's defaults. If you do not completely understand these options, do not add them to your config, it is easy to lower the security of your server using them. See `https://prosody.im/doc/advanced_ssl_config`.

  Available `ssl-configuration` fields are:

  `maybe-string protocol` [`ssl-configuration` parameter]
  : This determines what handshake to use.

  `maybe-file-name key` [`ssl-configuration` parameter]
  : Path to your private key file.

  `maybe-file-name certificate` [`ssl-configuration` parameter]
  : Path to your certificate file.

  `file-object capath` [`ssl-configuration` parameter]
  : Path to directory containing root certificates that you wish Prosody to trust when verifying the certificates of remote servers. Defaults to '`"/etc/ssl/certs"`'.

`maybe-file-object cafile` [`ssl-configuration` parameter]
: Path to a file containing root certificates that you wish Prosody to trust. Similar to `capath` but with all certificates concatenated together.

`maybe-string-list verify` [`ssl-configuration` parameter]
: A list of verification options (these mostly map to OpenSSL's `set_verify()` flags).

`maybe-string-list options` [`ssl-configuration` parameter]
: A list of general options relating to SSL/TLS. These map to OpenSSL's `set_options()`. For a full list of options available in LuaSec, see the LuaSec source.

`maybe-non-negative-integer depth` [`ssl-configuration` parameter]
: How long a chain of certificate authorities to check when looking for a trusted root certificate.

`maybe-string ciphers` [`ssl-configuration` parameter]
: An OpenSSL cipher string. This selects what ciphers Prosody will offer to clients, and in what order.

`maybe-file-name dhparam` [`ssl-configuration` parameter]
: A path to a file containing parameters for Diffie-Hellman key exchange. You can create such a file with: `openssl dhparam -out /etc/prosody/certs/dh-2048.pem 2048`

`maybe-string curve` [`ssl-configuration` parameter]
: Curve for Elliptic curve Diffie-Hellman. Prosody's default is '`"secp384r1"`'.

`maybe-string-list verifyext` [`ssl-configuration` parameter]
: A list of "extra" verification options.

`maybe-string password` [`ssl-configuration` parameter]
: Password for encrypted private keys.

`boolean c2s-require-encryption?` [`prosody-configuration` parameter]
: Whether to force all client-to-server connections to be encrypted or not. See `https://prosody.im/doc/modules/mod_tls`. Defaults to '`#f`'.

`string-list disable-sasl-mechanisms` [`prosody-configuration` parameter]
: Set of mechanisms that will never be offered. See `https://prosody.im/doc/modules/mod_saslauth`. Defaults to '`("DIGEST-MD5")`'.

`boolean s2s-require-encryption?` [`prosody-configuration` parameter]
: Whether to force all server-to-server connections to be encrypted or not. See `https://prosody.im/doc/modules/mod_tls`. Defaults to '`#f`'.

`boolean s2s-secure-auth?` [`prosody-configuration` parameter]
: Whether to require encryption and certificate authentication. This provides ideal security, but requires servers you communicate with to support encryption AND present valid, trusted certificates. See `https://prosody.im/doc/s2s#security`. Defaults to '`#f`'.

`string-list s2s-insecure-domains` [`prosody-configuration` parameter]
: Many servers don't support encryption or have invalid or self-signed certificates. You can list domains here that will not be required to authenticate using certificates. They will be authenticated using DNS. See `https://prosody.im/doc/s2s#security`. Defaults to '`()`'.

`string-list s2s-secure-domains` [`prosody-configuration` parameter]
: Even if you leave `s2s-secure-auth?` disabled, you can still require valid certificates for some domains by specifying a list here. See `https://prosody.im/doc/s2s#security`. Defaults to '`()`'.

`string authentication` [`prosody-configuration` parameter]
: Select the authentication backend to use. The default provider stores passwords in plaintext and uses Prosody's configured data storage to store the authentication data. If you do not trust your server please see `https://prosody.im/doc/modules/mod_auth_internal_hashed` for information about using the hashed backend. See also `https://prosody.im/doc/authentication` Defaults to '`"internal_plain"`'.

`maybe-string log` [`prosody-configuration` parameter]
: Set logging options. Advanced logging configuration is not yet supported by the Prosody service. See `https://prosody.im/doc/logging`. Defaults to '`"*syslog"`'.

`file-name pidfile` [`prosody-configuration` parameter]
: File to write pid in. See `https://prosody.im/doc/modules/mod_posix`. Defaults to '`"/var/run/prosody/prosody.pid"`'.

`maybe-non-negative-integer http-max-content-size` [`prosody-configuration` parameter]
: Maximum allowed size of the HTTP body (in bytes).

`maybe-string http-external-url` [`prosody-configuration` parameter]
: Some modules expose their own URL in various ways. This URL is built from the protocol, host and port used. If Prosody sits behind a proxy, the public URL will be `http-external-url` instead. See `https://prosody.im/doc/http#external_url`.

`virtualhost-configuration-list virtualhosts` [`prosody-configuration` parameter]
: A host in Prosody is a domain on which user accounts can be created. For example if you want your users to have addresses like '`"john.smith@example.com"`' then you need to add a host '`"example.com"`'. All options in this list will apply only to this host.

> **Note:** The name *virtual* host is used in configuration to avoid confusion with the actual physical host that Prosody is installed on. A single Prosody instance can serve many domains, each one defined as a VirtualHost entry in Prosody's configuration. Conversely a server that hosts a single domain would have just one VirtualHost entry.
>
> See `https://prosody.im/doc/configure#virtual_host_settings`.

Available `virtualhost-configuration` fields are:

all these `prosody-configuration` fields: `admins`, `use-libevent?`, `modules-enabled`, `modules-disabled`, `groups-file`, `allow-registration?`, `ssl`, `c2s-require-encryption?`, `disable-sasl-mechanisms`, `s2s-require-encryption?`, `s2s-secure-auth?`, `s2s-insecure-domains`, `s2s-secure-domains`, `authentication`, `log`, `http-max-content-size`, `http-external-url`, `raw-content`, plus:

`string domain` [`virtualhost-configuration` parameter]

Domain you wish Prosody to serve.

`int-component-configuration-list int-components` [`prosody-configuration` parameter]

Components are extra services on a server which are available to clients, usually on a subdomain of the main server (such as '`"mycomponent.example.com"`'). Example components might be chatroom servers, user directories, or gateways to other protocols.

Internal components are implemented with Prosody-specific plugins. To add an internal component, you simply fill the hostname field, and the plugin you wish to use for the component.

See `https://prosody.im/doc/components`. Defaults to '`()`'.

Available `int-component-configuration` fields are:

all these `prosody-configuration` fields: `admins`, `use-libevent?`, `modules-enabled`, `modules-disabled`, `groups-file`, `allow-registration?`, `ssl`, `c2s-require-encryption?`, `disable-sasl-mechanisms`, `s2s-require-encryption?`, `s2s-secure-auth?`, `s2s-insecure-domains`, `s2s-secure-domains`, `authentication`, `log`, `http-max-content-size`, `http-external-url`, `raw-content`, plus:

`string hostname` [`int-component-configuration` parameter]

Hostname of the component.

`string plugin` [`int-component-configuration` parameter]

Plugin you wish to use for the component.

`maybe-mod-muc-configuration mod-muc` [`int-component-configuration` parameter]

Multi-user chat (MUC) is Prosody's module for allowing you to create hosted chatrooms/conferences for XMPP users.

General information on setting up and using multi-user chatrooms can be found in the "Chatrooms" documentation (`https://prosody.im/doc/chatrooms`), which you should read if you are new to XMPP chatrooms.

See also `https://prosody.im/doc/modules/mod_muc`.

Available `mod-muc-configuration` fields are:

`string name` [`mod-muc-configuration` parameter]

The name to return in service discovery responses. Defaults to '`"Prosody Chatrooms"`'.

`string-or-boolean restrict-room-creation` [`mod-muc-configuration` parameter]
If '`#t`', this will only allow admins to create new chatrooms. Otherwise anyone can create a room. The value '`"local"`' restricts room creation to users on the service's parent domain. E.g. '`user@example.com`' can create rooms on '`rooms.example.com`'. The value '`"admin"`' restricts to service administrators only. Defaults to '`#f`'.

`non-negative-integer max-history-messages` [`mod-muc-configuration` parameter]
Maximum number of history messages that will be sent to the member that has just joined the room. Defaults to '`20`'.

`ext-component-configuration-list ext-components` [`prosody-configuration` parameter]
External components use XEP-0114, which most standalone components support. To add an external component, you simply fill the hostname field. See `https://prosody.im/doc/components`. Defaults to '`()`'.

Available `ext-component-configuration` fields are:

all these `prosody-configuration` fields: `admins`, `use-libevent?`, `modules-enabled`, `modules-disabled`, `groups-file`, `allow-registration?`, `ssl`, `c2s-require-encryption?`, `disable-sasl-mechanisms`, `s2s-require-encryption?`, `s2s-secure-auth?`, `s2s-insecure-domains`, `s2s-secure-domains`, `authentication`, `log`, `http-max-content-size`, `http-external-url`, `raw-content`, plus:

`string component-secret` [`ext-component-configuration` parameter]
Password which the component will use to log in.

`string hostname` [`ext-component-configuration` parameter]
Hostname of the component.

`non-negative-integer-list component-ports` [`prosody-configuration` parameter]
Port(s) Prosody listens on for component connections. Defaults to '`(5347)`'.

`string component-interface` [`prosody-configuration` parameter]
Interface Prosody listens on for component connections. Defaults to '`"127.0.0.1"`'.

`maybe-raw-content raw-content` [`prosody-configuration` parameter]
Raw content that will be added to the configuration file.

It could be that you just want to get a `prosody.cfg.lua` up and running. In that case, you can pass an `opaque-prosody-configuration` record as the value of `prosody-service-type`. As its name indicates, an opaque configuration does not have easy reflective capabilities. Available `opaque-prosody-configuration` fields are:

`package prosody` [`opaque-prosody-configuration` parameter]
The prosody package.

`string prosody.cfg.lua` [`opaque-prosody-configuration` parameter]
: The contents of the `prosody.cfg.lua` to use.

For example, if your `prosody.cfg.lua` is just the empty string, you could instantiate a prosody service like this:

```
(service prosody-service-type
         (opaque-prosody-configuration
          (prosody.cfg.lua "")))
```

BitlBee Service

BitlBee (`https://bitlbee.org`) is a gateway that provides an IRC interface to a variety of messaging protocols such as XMPP.

`bitlbee-service-type` [Scheme Variable]
: This is the service type for the BitlBee (`https://bitlbee.org`) IRC gateway daemon. Its value is a `bitlbee-configuration` (see below).

  To have BitlBee listen on port 6667 on localhost, add this line to your services:

  ```
  (service bitlbee-service-type)
  ```

`bitlbee-configuration` [Data Type]
: This is the configuration for BitlBee, with the following fields:

  `interface` (default: `"127.0.0.1"`)
  `port` (default: `6667`)
  : Listen on the network interface corresponding to the IP address specified in *interface*, on *port*.

    When *interface* is `127.0.0.1`, only local clients can connect; when it is `0.0.0.0`, connections can come from any networking interface.

  `bitlbee` (default: `bitlbee`)
  : The BitlBee package to use.

  `plugins` (default: `'()`)
  : List of plugin packages to use—e.g., `bitlbee-discord`.

  `extra-settings` (default: `""`)
  : Configuration snippet added as-is to the BitlBee configuration file.

Quassel Service

Quassel (`https://quassel-irc.org/`) is a distributed IRC client, meaning that one or more clients can attach to and detach from the central core.

`quassel-service-type` [Scheme Variable]
: This is the service type for the Quassel (`https://quassel-irc.org/`) IRC backend daemon. Its value is a `quassel-configuration` (see below).

`quassel-configuration` [Data Type]
: This is the configuration for Quassel, with the following fields:

  `quassel` (default: `quassel`)
  : The Quassel package to use.

`interface` (default: `"::,0.0.0.0"`)
`port` (default: `4242`)
: Listen on the network interface(s) corresponding to the IPv4 or IPv6 interfaces specified in the comma delimited *interface*, on *port*.

`loglevel` (default: `"Info"`)
: The level of logging desired. Accepted values are Debug, Info, Warning and Error.

12.9.14 Telephony Services

The `(gnu services telephony)` module contains Guix service definitions for telephony services. Currently it provides the following services:

Jami

This section describes how to configure a Jami server that can be used to host video (or audio) conferences, among other uses. The following example demonstrates how to specify Jami account archives (backups) to be provisioned automatically:

```
(service jami-service-type
         (jami-configuration
          (accounts
           (list (jami-account
                  (archive "/etc/jami/unencrypted-account-1.gz"))
                 (jami-account
                  (archive "/etc/jami/unencrypted-account-2.gz"))))))
```

When the accounts field is specified, the Jami account files of the service found under `/var/lib/jami` are recreated every time the service starts.

Jami accounts and their corresponding backup archives can be generated using the `jami` or `jami-gnome` Jami clients. The accounts should not be password-protected, but it is wise to ensure their files are only readable by '`root`'.

The next example shows how to declare that only some contacts should be allowed to communicate with a given account:

```
(service jami-service-type
         (jami-configuration
          (accounts
           (list (jami-account
                  (archive "/etc/jami/unencrypted-account-1.gz")
                  (peer-discovery? #t)
                  (rendezvous-point? #t)
                  (allowed-contacts
                   '("1dbcb0f5f37324228235564b79f2b9737e9a008f"
                     "2dbcb0f5f37324228235564b79f2b9737e9a008f"))))))))
```

In this mode, only the declared `allowed-contacts` can initiate communication with the Jami account. This can be used, for example, with rendezvous point accounts to create a private video conferencing space.

To put the system administrator in full control of the conferences hosted on their system, the Jami service supports the following actions:

```
# herd doc jami list-actions
(list-accounts
 list-account-details
 list-banned-contacts
 list-contacts
 list-moderators
 add-moderator
 ban-contact
 enable-account
 disable-account)
```

The above actions aim to provide the most valuable actions for moderation purposes, not to cover the whole Jami API. Users wanting to interact with the Jami daemon from Guile may be interested in experimenting with the `(gnu build jami-service)` module, which powers the above Shepherd actions.

The `add-moderator` and `ban-contact` actions accept a contact *fingerprint* (40 characters long hash) as first argument and an account fingerprint or username as second argument:

```
# herd add-moderator jami 1dbcb0f5f37324228235564b79f2b9737e9a008f \
  f3345f2775ddfe07a4b0d95daea111d15fbc1199

# herd list-moderators jami
Moderators for account f3345f2775ddfe07a4b0d95daea111d15fbc1199:
  - 1dbcb0f5f37324228235564b79f2b9737e9a008f
```

In the case of `ban-contact`, the second username argument is optional; when omitted, the account is banned from all Jami accounts:

```
# herd ban-contact jami 1dbcb0f5f37324228235564b79f2b9737e9a008f

# herd list-banned-contacts jami
Banned contacts for account f3345f2775ddfe07a4b0d95daea111d15fbc1199:
  - 1dbcb0f5f37324228235564b79f2b9737e9a008f
```

Banned contacts are also stripped from their moderation privileges.

The `disable-account` action allows to completely disconnect an account from the network, making it unreachable, while `enable-account` does the inverse. They accept a single account username or fingerprint as first argument:

```
# herd disable-account jami f3345f2775ddfe07a4b0d95daea111d15fbc1199

# herd list-accounts jami
The following Jami accounts are available:
  - f3345f2775ddfe07a4b0d95daea111d15fbc1199 (dummy) [disabled]
```

The `list-account-details` action prints the detailed parameters of each accounts in the Recutils format, which means the `recsel` command can be used to select accounts of interest (see Section “Selection Expressions” in *GNU recutils manual*). Note that period characters (‘`.`’) found in the account parameter keys are mapped to underscores (‘`_`’) in the output, to meet the requirements of the Recutils format. The following example shows how to print the account fingerprints for all accounts operating in the rendezvous point mode:

```
# herd list-account-details jami | \
  recsel -p Account.username -e 'Account.rendezVous ~ "true"'
Account_username: f3345f2775ddfe07a4b0d95daea111d15fbc1199
```

The remaining actions should be self-explanatory.

The complete set of available configuration options is detailed below.

`jami-configuration` [Data Type]

Available `jami-configuration` fields are:

`libjami` (default: `libjami`) (type: package)
: The Jami daemon package to use.

`dbus` (default: `dbus-for-jami`) (type: package)
: The D-Bus package to use to start the required D-Bus session.

`nss-certs` (default: `nss-certs`) (type: package)
: The nss-certs package to use to provide TLS certificates.

`enable-logging?` (default: `#t`) (type: boolean)
: Whether to enable logging to syslog.

`debug?` (default: `#f`) (type: boolean)
: Whether to enable debug level messages.

`auto-answer?` (default: `#f`) (type: boolean)
: Whether to force automatic answer to incoming calls.

`accounts` (type: maybe-jami-account-list)
: A list of Jami accounts to be (re-)provisioned every time the Jami daemon service starts. When providing this field, the account directories under `/var/lib/jami/` are recreated every time the service starts, ensuring a consistent state.

`jami-account` [Data Type]

Available `jami-account` fields are:

`archive` (type: string-or-computed-file)
: The account archive (backup) file name of the account. This is used to provision the account when the service starts. The account archive should *not* be encrypted. It is highly recommended to make it readable only to the '`root`' user (i.e., not in the store), to guard against leaking the secret key material of the Jami account it contains.

`allowed-contacts` (type: maybe-account-fingerprint-list)
: The list of allowed contacts for the account, entered as their 40 characters long fingerprint. Messages or calls from accounts not in that list will be rejected. When left specified, the configuration of the account archive is used as-is with respect to contacts and public inbound calls/messaging allowance, which typically defaults to allow any contact to communicate with the account.

`moderators` (type: maybe-account-fingerprint-list)
: The list of contacts that should have moderation privileges (to ban, mute, etc. other users) in rendezvous conferences, entered as their 40 characters long fingerprint. When left unspecified, the configuration of the account archive is used as-is with respect to moderation, which typically defaults to allow anyone to moderate.

`rendezvous-point?` (type: maybe-boolean)
: Whether the account should operate in the rendezvous mode. In this mode, all the incoming audio/video calls are mixed into a conference. When left unspecified, the value from the account archive prevails.

`peer-discovery?` (type: maybe-boolean)
: Whether peer discovery should be enabled. Peer discovery is used to discover other OpenDHT nodes on the local network, which can be useful to maintain communication between devices on such network even when the connection to the Internet has been lost. When left unspecified, the value from the account archive prevails.

`bootstrap-hostnames` (type: maybe-string-list)
: A list of hostnames or IPs pointing to OpenDHT nodes, that should be used to initially join the OpenDHT network. When left unspecified, the value from the account archive prevails.

`name-server-uri` (type: maybe-string)
: The URI of the name server to use, that can be used to retrieve the account fingerprint for a registered username.

Mumble server

This section describes how to set up and run a Mumble (`https://mumble.info`) server (formerly known as Murmur).

`mumble-server-configuration` [Data Type]

The service type for the Mumble server. An example configuration can look like this:

```
(service mumble-server-service-type
         (mumble-server-configuration
          (welcome-text
            "Welcome to this Mumble server running on Guix!")
          (cert-required? #t) ;disallow text password logins
          (ssl-cert "/etc/letsencrypt/live/mumble.example.com/fullchain.pem")
          (ssl-key "/etc/letsencrypt/live/mumble.example.com/privkey.pem")))
```

After reconfiguring your system, you can manually set the mumble-server `SuperUser` password with the command that is printed during the activation phase.

It is recommended to register a normal Mumble user account and grant it admin or moderator rights. You can use the `mumble` client to login as new normal user, register yourself, and log out. For the next step login with the name `SuperUser` use the `SuperUser` password that you set previously, and grant your newly registered mumble user administrator or moderator rights and create some channels.

Available `mumble-server-configuration` fields are:

`package` (default: `mumble`)
: Package that contains `bin/mumble-server`.

`user` (default: `"mumble-server"`)
: User who will run the Mumble-Server server.

`group` (default: `"mumble-server"`)
: Group of the user who will run the mumble-server server.

`port` (default: `64738`)
: Port on which the server will listen.

`welcome-text` (default: `""`)
: Welcome text sent to clients when they connect.

`server-password` (default: `""`)
: Password the clients have to enter in order to connect.

`max-users` (default: `100`)
: Maximum of users that can be connected to the server at once.

`max-user-bandwidth` (default: `#f`)
: Maximum voice traffic a user can send per second.

`database-file` (default: `"/var/lib/mumble-server/db.sqlite"`)
: File name of the sqlite database. The service's user will become the owner of the directory.

`log-file` (default: `"/var/log/mumble-server/mumble-server.log"`)
: File name of the log file. The service's user will become the owner of the directory.

`autoban-attempts` (default: `10`)
: Maximum number of logins a user can make in `autoban-timeframe` without getting auto banned for `autoban-time`.

`autoban-timeframe` (default: `120`)
: Timeframe for autoban in seconds.

`autoban-time` (default: `300`)
: Amount of time in seconds for which a client gets banned when violating the autoban limits.

`opus-threshold` (default: `100`)
: Percentage of clients that need to support opus before switching over to opus audio codec.

`channel-nesting-limit` (default: `10`)
: How deep channels can be nested at maximum.

`channelname-regex` (default: `#f`)
: A string in form of a Qt regular expression that channel names must conform to.

`username-regex` (default: `#f`)
: A string in form of a Qt regular expression that user names must conform to.

`text-message-length` (default: `5000`)
: Maximum size in bytes that a user can send in one text chat message.

`image-message-length` (default: `(* 128 1024)`)
: Maximum size in bytes that a user can send in one image message.

`cert-required?` (default: `#f`)
: If it is set to `#t` clients that use weak password authentication will not be accepted. Users must have completed the certificate wizard to join.

`remember-channel?` (default: `#f`)
: Should mumble-server remember the last channel each user was in when they disconnected and put them into the remembered channel when they rejoin.

`allow-html?` (default: `#f`)
: Should html be allowed in text messages, user comments, and channel descriptions.

`allow-ping?` (default: `#f`)
: Setting to true exposes the current user count, the maximum user count, and the server's maximum bandwidth per client to unauthenticated users. In the Mumble client, this information is shown in the Connect dialog.

  Disabling this setting will prevent public listing of the server.

`bonjour?` (default: `#f`)
: Should the server advertise itself in the local network through the bonjour protocol.

`send-version?` (default: `#f`)
: Should the mumble-server server version be exposed in ping requests.

`log-days` (default: `31`)
: Mumble also stores logs in the database, which are accessible via RPC. The default is 31 days of months, but you can set this setting to 0 to keep logs forever, or -1 to disable logging to the database.

`obfuscate-ips?` (default: `#t`)
: Should logged ips be obfuscated to protect the privacy of users.

`ssl-cert` (default: `#f`)
: File name of the SSL/TLS certificate used for encrypted connections.

```
(ssl-cert "/etc/letsencrypt/live/example.com/fullchain.pem")
```

`ssl-key` (default: `#f`)
: Filepath to the ssl private key used for encrypted connections.

```
(ssl-key "/etc/letsencrypt/live/example.com/privkey.pem")
```

`ssl-dh-params` (default: `#f`)
: File name of a PEM-encoded file with Diffie-Hellman parameters for the SSL/TLS encryption. Alternatively you set it to `"@ffdhe2048"`, `"@ffdhe3072"`, `"@ffdhe4096"`, `"@ffdhe6144"` or `"@ffdhe8192"` to use bundled parameters from RFC 7919.

`ssl-ciphers` (default: `#f`)
: The `ssl-ciphers` option chooses the cipher suites to make available for use in SSL/TLS.

  This option is specified using OpenSSL cipher list notation (`https://www.openssl.org/docs/apps/ciphers.html#CIPHER-LIST-FORMAT`).

  It is recommended that you try your cipher string using 'openssl ciphers <string>' before setting it here, to get a feel for which cipher suites you will get. After setting this option, it is recommend that you inspect your Mumble server log to ensure that Mumble is using the cipher suites that you expected it to.

  > **Note:** Changing this option may impact the backwards compatibility of your Mumble-Server server, and can remove the ability for older Mumble clients to be able to connect to it.

`public-registration` (default: `#f`)
: Must be a `<mumble-server-public-registration-configuration>` record or `#f`.

  You can optionally register your server in the public server list that the `mumble` client shows on startup. You cannot register your server if you have set a `server-password`, or set `allow-ping` to `#f`.

  It might take a few hours until it shows up in the public list.

`file` (default: `#f`)
: Optional alternative override for this configuration.

`mumble-server-public-registration-configuration` [Data Type]
: Configuration for public registration of a mumble-server service.

  `name` This is a display name for your server. Not to be confused with the hostname.

  `password` A password to identify your registration. Subsequent updates will need the same password. Don't lose your password.

  `url` This should be a `http://` or `https://` link to your web site.

  `hostname` (default: `#f`)
  : By default your server will be listed by its IP address. If it is set your server will be linked by this host name instead.

Deprecation notice: Due to historical reasons, all of the above `mumble-server-` procedures are also exported with the `murmur-` prefix. It is recommended that you switch to using `mumble-server-` going forward.

12.9.15 File-Sharing Services

The `(gnu services file-sharing)` module provides services that assist with transferring files over peer-to-peer file-sharing networks.

Transmission Daemon Service

Transmission (`https://transmissionbt.com/`) is a flexible BitTorrent client that offers a variety of graphical and command-line interfaces. A `transmission-daemon-service-type` service provides Transmission's headless variant, `transmission-daemon`, as a system service, allowing users to share files via BitTorrent even when they are not logged in.

`transmission-daemon-service-type` [Scheme Variable]

The service type for the Transmission Daemon BitTorrent client. Its value must be a `transmission-daemon-configuration` object as in this example:

```
(service transmission-daemon-service-type
         (transmission-daemon-configuration
          ;; Restrict access to the RPC ("control") interface
          (rpc-authentication-required? #t)
          (rpc-username "transmission")
          (rpc-password
           (transmission-password-hash
            "transmission" ; desired password
            "uKd1uMs9"))   ; arbitrary salt value

          ;; Accept requests from this and other hosts on the
          ;; local network
          (rpc-whitelist-enabled? #t)
          (rpc-whitelist '("::1" "127.0.0.1" "192.168.0.*"))

          ;; Limit bandwidth use during work hours
          (alt-speed-down (* 1024 2)) ;   2 MB/s
          (alt-speed-up 512)          ; 512 kB/s

          (alt-speed-time-enabled? #t)
          (alt-speed-time-day 'weekdays)
          (alt-speed-time-begin
           (+ (* 60 8) 30))           ; 8:30 am
          (alt-speed-time-end
           (+ (* 60 (+ 12 5)) 30))))  ; 5:30 pm
```

Once the service is started, users can interact with the daemon through its Web interface (at `http://localhost:9091/`) or by using the `transmission-remote` command-line tool, available in the `transmission` package. (Emacs users may want to also consider the `emacs-transmission` package.) Both communicate with the daemon through its remote procedure call (RPC) interface, which by default is available to all users on the system; you may wish to change this by assigning values to the `rpc-authentication-required?`, `rpc-username` and `rpc-password` settings, as shown in the example above and documented further below.

The value for `rpc-password` must be a password hash of the type generated and used by Transmission clients. This can be copied verbatim from an existing `settings.json` file, if another Transmission client is already being used. Otherwise, the `transmission-password-hash` and `transmission-random-salt` procedures provided by this module can be used to obtain a suitable hash value.

`transmission-password-hash` *`password salt`* [Scheme Procedure]

> Returns a string containing the result of hashing *password* together with *salt*, in the format recognized by Transmission clients for their `rpc-password` configuration setting.
>
> *salt* must be an eight-character string. The `transmission-random-salt` procedure can be used to generate a suitable salt value at random.

`transmission-random-salt` [Scheme Procedure]

> Returns a string containing a random, eight-character salt value of the type generated and used by Transmission clients, suitable for passing to the `transmission-password-hash` procedure.

These procedures are accessible from within a Guile REPL started with the `guix repl` command (see Section 9.13 [Invoking guix repl], page 162). This is useful for obtaining a random salt value to provide as the second parameter to ‘transmission-password-hash‘, as in this example session:

```
$ guix repl
scheme@(guix-user)> ,use (gnu services file-sharing)
scheme@(guix-user)> (transmission-random-salt)
$1 = "uKd1uMs9"
```

Alternatively, a complete password hash can generated in a single step:

```
scheme@(guix-user)> (transmission-password-hash "transmission"
(transmission-random-salt))
$2 = "{c8bbc6d1740cd8dc819a6e25563b67812c1c19c9VtFPfdsX"
```

The resulting string can be used as-is for the value of `rpc-password`, allowing the password to be kept hidden even in the operating-system configuration.

Torrent files downloaded by the daemon are directly accessible only to users in the “transmission” user group, who receive read-only access to the directory specified by the `download-dir` configuration setting (and also the directory specified by `incomplete-dir`, if `incomplete-dir-enabled?` is `#t`). Downloaded files can be moved to another directory or deleted altogether using `transmission-remote` with its `--move` and `--remove-and-delete` options.

If the `watch-dir-enabled?` setting is set to `#t`, users in the “transmission” group are able also to place `.torrent` files in the directory specified by `watch-dir` to have the corresponding torrents added by the daemon. (The `trash-original-torrent-files?` setting controls whether the daemon deletes these files after processing them.)

Some of the daemon’s configuration settings can be changed temporarily by `transmission-remote` and similar tools. To undo these changes, use the service’s `reload` action to have the daemon reload its settings from disk:

```
# herd reload transmission-daemon
```

The full set of available configuration settings is defined by the `transmission-daemon-configuration` data type.

`transmission-daemon-configuration` [Data Type]

The data type representing configuration settings for Transmission Daemon. These correspond directly to the settings recognized by Transmission clients in their `settings.json` file.

Available `transmission-daemon-configuration` fields are:

`package transmission` [`transmission-daemon-configuration` parameter]

The Transmission package to use.

`non-negative-integer stop-wait-period` [`transmission-daemon-configuration` parameter]

The period, in seconds, to wait when stopping the service for `transmission-daemon` to exit before killing its process. This allows the daemon time to complete its housekeeping and send a final update to trackers as it shuts down. On slow hosts, or hosts with a slow network connection, this value may need to be increased.

Defaults to '`10`'.

`string download-dir` [`transmission-daemon-configuration` parameter]

The directory to which torrent files are downloaded.

Defaults to '`"/var/lib/transmission-daemon/downloads"`'.

`boolean incomplete-dir-enabled?` [`transmission-daemon-configuration` parameter]

If `#t`, files will be held in `incomplete-dir` while their torrent is being downloaded, then moved to `download-dir` once the torrent is complete. Otherwise, files for all torrents (including those still being downloaded) will be placed in `download-dir`.

Defaults to '`#f`'.

`maybe-string incomplete-dir` [`transmission-daemon-configuration` parameter]

The directory in which files from incompletely downloaded torrents will be held when `incomplete-dir-enabled?` is `#t`.

Defaults to '`disabled`'.

`umask umask` [`transmission-daemon-configuration` parameter]

The file mode creation mask used for downloaded files. (See the `umask` man page for more information.)

Defaults to '`18`'.

`boolean rename-partial-files?` [`transmission-daemon-configuration` parameter]

When `#t`, ".part" is appended to the name of partially downloaded files.

Defaults to '`#t`'.

`preallocation-mode preallocation` [`transmission-daemon-configuration` parameter]

The mode by which space should be preallocated for downloaded files, one of `none`, `fast` (or `sparse`) and `full`. Specifying `full` will minimize disk fragmentation at a cost to file-creation speed.

Defaults to '`fast`'.

`boolean watch-dir-enabled?` [`transmission-daemon-configuration` parameter]

If `#t`, the directory specified by `watch-dir` will be watched for new `.torrent` files and the torrents they describe added automatically (and the original files removed, if `trash-original-torrent-files?` is `#t`).

Defaults to '`#f`'.

`maybe-string watch-dir` [`transmission-daemon-configuration` parameter]

The directory to be watched for `.torrent` files indicating new torrents to be added, when `watch-dir-enabled` is `#t`.

Defaults to '`disabled`'.

`boolean trash-original-torrent-files?` [`transmission-daemon-configuration` parameter]

When `#t`, `.torrent` files will be deleted from the watch directory once their torrent has been added (see `watch-directory-enabled?`).

Defaults to '`#f`'.

`boolean speed-limit-down-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, the daemon's download speed will be limited to the rate specified by `speed-limit-down`.

Defaults to '`#f`'.

`non-negative-integer speed-limit-down` [`transmission-daemon-configuration` parameter]

The default global-maximum download speed, in kilobytes per second.

Defaults to '`100`'.

`boolean speed-limit-up-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, the daemon's upload speed will be limited to the rate specified by `speed-limit-up`.

Defaults to '`#f`'.

`non-negative-integer speed-limit-up` [`transmission-daemon-configuration` parameter]

The default global-maximum upload speed, in kilobytes per second.

Defaults to '`100`'.

`boolean alt-speed-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, the alternate speed limits `alt-speed-down` and `alt-speed-up` are used (in place of `speed-limit-down` and `speed-limit-up`, if they are enabled) to constrain the daemon's bandwidth usage. This can be scheduled to occur automatically at certain times during the week; see `alt-speed-time-enabled?`.

Defaults to '`#f`'.

`non-negative-integer alt-speed-down` [`transmission-daemon-configuration` parameter]

The alternate global-maximum download speed, in kilobytes per second.

Defaults to '`50`'.

`non-negative-integer alt-speed-up` [`transmission-daemon-configuration` parameter]

The alternate global-maximum upload speed, in kilobytes per second.

Defaults to '`50`'.

`boolean alt-speed-time-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, the alternate speed limits `alt-speed-down` and `alt-speed-up` will be enabled automatically during the periods specified by `alt-speed-time-day`, `alt-speed-time-begin` and `alt-time-speed-end`.

Defaults to '`#f`'.

`day-list alt-speed-time-day` [`transmission-daemon-configuration` parameter]

The days of the week on which the alternate-speed schedule should be used, specified either as a list of days (`sunday`, `monday`, and so on) or using one of the symbols `weekdays`, `weekends` or `all`.

Defaults to '`all`'.

`non-negative-integer alt-speed-time-begin` [`transmission-daemon-configuration` parameter]

The time of day at which to enable the alternate speed limits, expressed as a number of minutes since midnight.

Defaults to '`540`'.

`non-negative-integer alt-speed-time-end` [`transmission-daemon-configuration` parameter]

The time of day at which to disable the alternate speed limits, expressed as a number of minutes since midnight.

Defaults to '`1020`'.

`string bind-address-ipv4` [`transmission-daemon-configuration` parameter]

The IP address at which to listen for peer connections, or "0.0.0.0" to listen at all available IP addresses.

Defaults to '`"0.0.0.0"`'.

`string bind-address-ipv6` [`transmission-daemon-configuration` parameter]

The IPv6 address at which to listen for peer connections, or "::" to listen at all available IPv6 addresses.

Defaults to '`"::"`'.

`boolean peer-port-random-on-start?` [`transmission-daemon-configuration` parameter]

If `#t`, when the daemon starts it will select a port at random on which to listen for peer connections, from the range specified (inclusively) by `peer-port-random-low` and `peer-port-random-high`. Otherwise, it listens on the port specified by `peer-port`.

Defaults to '`#f`'.

`port-number peer-port-random-low` [`transmission-daemon-configuration` parameter]

The lowest selectable port number when `peer-port-random-on-start?` is `#t`.

Defaults to '`49152`'.

`port-number peer-port-random-high` [`transmission-daemon-configuration` parameter]

The highest selectable port number when `peer-port-random-on-start` is `#t`.

Defaults to '`65535`'.

`port-number peer-port` [`transmission-daemon-configuration` parameter]

The port on which to listen for peer connections when `peer-port-random-on-start?` is `#f`.

Defaults to '`51413`'.

`boolean port-forwarding-enabled?` [`transmission-daemon-configuration` parameter]

If `#t`, the daemon will attempt to configure port-forwarding on an upstream gateway automatically using UPnP and NAT-PMP.

Defaults to '`#t`'.

`encryption-mode encryption` [`transmission-daemon-configuration` parameter]

The encryption preference for peer connections, one of `prefer-unencrypted-connections`, `prefer-encrypted-connections` or `require-encrypted-connections`.

Defaults to '`prefer-encrypted-connections`'.

`maybe-string peer-congestion-algorithm` [`transmission-daemon-configuration` parameter]

The TCP congestion-control algorithm to use for peer connections, specified using a string recognized by the operating system in calls to `setsockopt`. When left unspecified, the operating-system default is used.

Note that on GNU/Linux systems, the kernel must be configured to allow processes to use a congestion-control algorithm not in the default set; otherwise, it will deny these requests with "Operation not permitted". To see which algorithms are available on your system and which are currently permitted for use, look at the contents of the files `tcp_available_congestion_control` and `tcp_allowed_congestion_control` in the `/proc/sys/net/ipv4` directory.

As an example, to have Transmission Daemon use the TCP Low Priority congestion-control algorithm (`http://www-ece.rice.edu/networks/TCP-LP/`), you'll need to modify your kernel configuration to build in support for the algorithm, then update your operating-system configuration to allow its use by adding a `sysctl-service-type` service (or updating the existing one's configuration) with lines like the following:

```
(service sysctl-service-type
         (sysctl-configuration
          (settings
           ("net.ipv4.tcp_allowed_congestion_control" .
            "reno cubic lp"))))
```

The Transmission Daemon configuration can then be updated with

```
(peer-congestion-algorithm "lp")
```

and the system reconfigured to have the changes take effect.

Defaults to '`disabled`'.

`tcp-type-of-service` `peer-socket-tos` [`transmission-daemon-configuration` parameter]

The type of service to request in outgoing TCP packets, one of `default`, `low-cost`, `throughput`, `low-delay` and `reliability`.

Defaults to '`default`'.

`non-negative-integer` `peer-limit-global` [`transmission-daemon-configuration` parameter]

The global limit on the number of connected peers.

Defaults to '`200`'.

`non-negative-integer` `peer-limit-per-torrent` [`transmission-daemon-configuration` parameter]

The per-torrent limit on the number of connected peers.

Defaults to '`50`'.

`non-negative-integer` `upload-slots-per-torrent` [`transmission-daemon-configuration` parameter]

The maximum number of peers to which the daemon will upload data simultaneously for each torrent.

Defaults to '`14`'.

`non-negative-integer` `peer-id-ttl-hours` [`transmission-daemon-configuration` parameter]

The maximum lifespan, in hours, of the peer ID associated with each public torrent before it is regenerated.

Defaults to '`6`'.

`boolean blocklist-enabled?` [`transmission-daemon-configuration` parameter]
: When `#t`, the daemon will ignore peers mentioned in the blocklist it has most recently downloaded from `blocklist-url`.

  Defaults to '`#f`'.

`maybe-string blocklist-url` [`transmission-daemon-configuration` parameter]
: The URL of a peer blocklist (in P2P-plaintext or eMule `.dat` format) to be periodically downloaded and applied when `blocklist-enabled?` is `#t`.

  Defaults to '`disabled`'.

`boolean download-queue-enabled?` [`transmission-daemon-configuration` parameter]
: If `#t`, the daemon will be limited to downloading at most `download-queue-size` non-stalled torrents simultaneously.

  Defaults to '`#t`'.

`non-negative-integer download-queue-size` [`transmission-daemon-configuration` parameter]
: The size of the daemon's download queue, which limits the number of non-stalled torrents it will download at any one time when `download-queue-enabled?` is `#t`.

  Defaults to '`5`'.

`boolean seed-queue-enabled?` [`transmission-daemon-configuration` parameter]
: If `#t`, the daemon will be limited to seeding at most `seed-queue-size` non-stalled torrents simultaneously.

  Defaults to '`#f`'.

`non-negative-integer seed-queue-size` [`transmission-daemon-configuration` parameter]
: The size of the daemon's seed queue, which limits the number of non-stalled torrents it will seed at any one time when `seed-queue-enabled?` is `#t`.

  Defaults to '`10`'.

`boolean queue-stalled-enabled?` [`transmission-daemon-configuration` parameter]
: When `#t`, the daemon will consider torrents for which it has not shared data in the past `queue-stalled-minutes` minutes to be stalled and not count them against its `download-queue-size` and `seed-queue-size` limits.

  Defaults to '`#t`'.

`non-negative-integer queue-stalled-minutes` [`transmission-daemon-configuration` parameter]
: The maximum period, in minutes, a torrent may be idle before it is considered to be stalled, when `queue-stalled-enabled?` is `#t`.

  Defaults to '`30`'.

`boolean ratio-limit-enabled?` [`transmission-daemon-configuration` parameter]
: When `#t`, a torrent being seeded will automatically be paused once it reaches the ratio specified by `ratio-limit`.

  Defaults to '`#f`'.

`non-negative-rational ratio-limit` [`transmission-daemon-configuration` parameter]
: The ratio at which a torrent being seeded will be paused, when `ratio-limit-enabled?` is `#t`.

  Defaults to '`2.0`'.

`boolean idle-seeding-limit-enabled?` [`transmission-daemon-configuration` parameter]
: When `#t`, a torrent being seeded will automatically be paused once it has been idle for `idle-seeding-limit` minutes.

  Defaults to '`#f`'.

`non-negative-integer idle-seeding-limit` [`transmission-daemon-configuration` parameter]
: The maximum period, in minutes, a torrent being seeded may be idle before it is paused, when `idle-seeding-limit-enabled?` is `#t`.

  Defaults to '`30`'.

`boolean dht-enabled?` [`transmission-daemon-configuration` parameter]
: Enable the distributed hash table (DHT) protocol (`http://bittorrent.org/beps/bep_0005.html`), which supports the use of trackerless torrents.

  Defaults to '`#t`'.

`boolean lpd-enabled?` [`transmission-daemon-configuration` parameter]
: Enable local peer discovery (`https://en.wikipedia.org/wiki/Local_Peer_Discovery`) (LPD), which allows the discovery of peers on the local network and may reduce the amount of data sent over the public Internet.

  Defaults to '`#f`'.

`boolean pex-enabled?` [`transmission-daemon-configuration` parameter]
: Enable peer exchange (`https://en.wikipedia.org/wiki/Peer_exchange`) (PEX), which reduces the daemon's reliance on external trackers and may improve its performance.

  Defaults to '`#t`'.

`boolean utp-enabled?` [`transmission-daemon-configuration` parameter]
: Enable the micro transport protocol (`http://bittorrent.org/beps/bep_0029.html`) (uTP), which aims to reduce the impact of BitTorrent traffic on other users of the local network while maintaining full utilization of the available bandwidth.

  Defaults to '`#t`'.

`boolean rpc-enabled?` [`transmission-daemon-configuration` parameter]

If `#t`, enable the remote procedure call (RPC) interface, which allows remote control of the daemon via its Web interface, the `transmission-remote` command-line client, and similar tools.

Defaults to '`#t`'.

`string rpc-bind-address` [`transmission-daemon-configuration` parameter]

The IP address at which to listen for RPC connections, or "0.0.0.0" to listen at all available IP addresses.

Defaults to '`"0.0.0.0"`'.

`port-number rpc-port` [`transmission-daemon-configuration` parameter]

The port on which to listen for RPC connections.

Defaults to '`9091`'.

`string rpc-url` [`transmission-daemon-configuration` parameter]

The path prefix to use in the RPC-endpoint URL.

Defaults to '`"/transmission/"`'.

`boolean rpc-authentication-required?` [`transmission-daemon-configuration` parameter]

When `#t`, clients must authenticate (see `rpc-username` and `rpc-password`) when using the RPC interface. Note this has the side effect of disabling host-name whitelisting (see `rpc-host-whitelist-enabled?`.

Defaults to '`#f`'.

`maybe-string rpc-username` [`transmission-daemon-configuration` parameter]

The username required by clients to access the RPC interface when `rpc-authentication-required?` is `#t`.

Defaults to '`disabled`'.

`maybe-transmission-password-hash rpc-password` [`transmission-daemon-configuration` parameter]

The password required by clients to access the RPC interface when `rpc-authentication-required?` is `#t`. This must be specified using a password hash in the format recognized by Transmission clients, either copied from an existing `settings.json` file or generated using the `transmission-password-hash` procedure.

Defaults to '`disabled`'.

`boolean rpc-whitelist-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, RPC requests will be accepted only when they originate from an address specified in `rpc-whitelist`.

Defaults to '`#t`'.

`string-list rpc-whitelist` [`transmission-daemon-configuration` parameter]

The list of IP and IPv6 addresses from which RPC requests will be accepted when `rpc-whitelist-enabled?` is `#t`. Wildcards may be specified using '`*`'.

Defaults to '`("127.0.0.1" "::1")`'.

`boolean rpc-host-whitelist-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, RPC requests will be accepted only when they are addressed to a host named in `rpc-host-whitelist`. Note that requests to "localhost" or "localhost.", or to a numeric address, are always accepted regardless of these settings.

Note also this functionality is disabled when `rpc-authentication-required?` is `#t`.

Defaults to '`#t`'.

`string-list rpc-host-whitelist` [`transmission-daemon-configuration` parameter]

The list of host names recognized by the RPC server when `rpc-host-whitelist-enabled?` is `#t`.

Defaults to '`()`'.

`message-level message-level` [`transmission-daemon-configuration` parameter]

The minimum severity level of messages to be logged (to `/var/log/transmission.log`) by the daemon, one of `none` (no logging), `error`, `info` and `debug`.

Defaults to '`info`'.

`boolean start-added-torrents?` [`transmission-daemon-configuration` parameter]

When `#t`, torrents are started as soon as they are added; otherwise, they are added in "paused" state.

Defaults to '`#t`'.

`boolean script-torrent-done-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, the script specified by `script-torrent-done-filename` will be invoked each time a torrent completes.

Defaults to '`#f`'.

`maybe-file-object script-torrent-done-filename` [`transmission-daemon-configuration` parameter]

A file name or file-like object specifying a script to run each time a torrent completes, when `script-torrent-done-enabled?` is `#t`.

Defaults to '`disabled`'.

`boolean scrape-paused-torrents-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, the daemon will scrape trackers for a torrent even when the torrent is paused.

Defaults to '`#t`'.

`non-negative-integer cache-size-mb` [`transmission-daemon-configuration` parameter]

The amount of memory, in megabytes, to allocate for the daemon's in-memory cache. A larger value may increase performance by reducing the frequency of disk I/O.

Defaults to '`4`'.

`boolean prefetch-enabled?` [`transmission-daemon-configuration` parameter]

When `#t`, the daemon will try to improve I/O performance by hinting to the operating system which data is likely to be read next from disk to satisfy requests from peers.

Defaults to '`#t`'.

12.9.16 Monitoring Services

Tailon Service

Tailon (`https://tailon.readthedocs.io/`) is a web application for viewing and searching log files.

The following example will configure the service with default values. By default, Tailon can be accessed on port 8080 (`http://localhost:8080`).

```
(service tailon-service-type)
```

The following example customises more of the Tailon configuration, adding `sed` to the list of allowed commands.

```
(service tailon-service-type
         (tailon-configuration
           (config-file
             (tailon-configuration-file
               (allowed-commands '("tail" "grep" "awk" "sed"))))))
```

`tailon-configuration` [Data Type]

Data type representing the configuration of Tailon. This type has the following parameters:

`config-file` (default: `(tailon-configuration-file)`)

The configuration file to use for Tailon. This can be set to a *tailon-configuration-file* record value, or any gexp (see Section 9.12 [G-Expressions], page 154).

For example, to instead use a local file, the `local-file` function can be used:

```
(service tailon-service-type
         (tailon-configuration
           (config-file (local-file "./my-tailon.conf"))))
```

`package` (default: `tailon`)

The tailon package to use.

`tailon-configuration-file` [Data Type]

Data type representing the configuration options for Tailon. This type has the following parameters:

`files` (default: `(list "/var/log")`)
: List of files to display. The list can include strings for a single file or directory, or a list, where the first item is the name of a subsection, and the remaining items are the files or directories in that subsection.

`bind` (default: `"localhost:8080"`)
: Address and port to which Tailon should bind on.

`relative-root` (default: `#f`)
: URL path to use for Tailon, set to `#f` to not use a path.

`allow-transfers?` (default: `#t`)
: Allow downloading the log files in the web interface.

`follow-names?` (default: `#t`)
: Allow tailing of not-yet existent files.

`tail-lines` (default: `200`)
: Number of lines to read initially from each file.

`allowed-commands` (default: `(list "tail" "grep" "awk")`)
: Commands to allow running. By default, `sed` is disabled.

`debug?` (default: `#f`)
: Set `debug?` to `#t` to show debug messages.

`wrap-lines` (default: `#t`)
: Initial line wrapping state in the web interface. Set to `#t` to initially wrap lines (the default), or to `#f` to initially not wrap lines.

`http-auth` (default: `#f`)
: HTTP authentication type to use. Set to `#f` to disable authentication (the default). Supported values are `"digest"` or `"basic"`.

`users` (default: `#f`)
: If HTTP authentication is enabled (see `http-auth`), access will be restricted to the credentials provided here. To configure users, use a list of pairs, where the first element of the pair is the username, and the 2nd element of the pair is the password.

```
(tailon-configuration-file
  (http-auth "basic")
  (users     '(("user1" . "password1")
               ("user2" . "password2"))))
```

Darkstat Service

Darkstat is a packet sniffer that captures network traffic, calculates statistics about usage, and serves reports over HTTP.

`Scheme Variable` *darkstat-service-type* [Variable]

This is the service type for the darkstat (`https://unix4lyfe.org/darkstat/`) service, its value must be a `darkstat-configuration` record as in this example:

```
(service darkstat-service-type
         (darkstat-configuration
           (interface "eno1")))
```

`darkstat-configuration` [Data Type]

Data type representing the configuration of `darkstat`.

`package` (default: `darkstat`)
: The darkstat package to use.

`interface`
: Capture traffic on the specified network interface.

`port` (default: `"667"`)
: Bind the web interface to the specified port.

`bind-address` (default: `"127.0.0.1"`)
: Bind the web interface to the specified address.

`base` (default: `"/"`)
: Specify the path of the base URL. This can be useful if `darkstat` is accessed via a reverse proxy.

Prometheus Node Exporter Service

The Prometheus "node exporter" makes hardware and operating system statistics provided by the Linux kernel available for the Prometheus monitoring system. This service should be deployed on all physical nodes and virtual machines, where monitoring these statistics is desirable.

`Scheme variable` *prometheus-node-exporter-service-type* [Variable]

This is the service type for the prometheus-node-exporter (`https://github.com/prometheus/node_exporter/`) service, its value must be a `prometheus-node-exporter-configuration`.

```
(service prometheus-node-exporter-service-type)
```

`prometheus-node-exporter-configuration` [Data Type]

Data type representing the configuration of `node_exporter`.

`package` (default: `go-github-com-prometheus-node-exporter`)
: The prometheus-node-exporter package to use.

`web-listen-address` (default: `":9100"`)
: Bind the web interface to the specified address.

`textfile-directory` (default: `"/var/lib/prometheus/node-exporter"`)
: This directory can be used to export metrics specific to this machine. Files containing metrics in the text format, with the filename ending in `.prom` should be placed in this directory.

`extra-options` (default: `'()`)
: Extra options to pass to the Prometheus node exporter.

Zabbix server

Zabbix is a high performance monitoring system that can collect data from a variety of sources and provide the results in a web-based interface. Alerting and reporting is built-in, as well as *templates* for common operating system metrics such as network utilization, CPU load, and disk space consumption.

This service provides the central Zabbix monitoring service; you also need [zabbix-front-end], page 402, to configure Zabbix and display results, and optionally [zabbix-agent], page 401, on machines that should be monitored (other data sources are supported, such as [prometheus-node-exporter], page 399).

`Scheme variable` *zabbix-server-service-type* [Variable]

This is the service type for the Zabbix server service. Its value must be a `zabbix-server-configuration` record, shown below.

`zabbix-server-configuration` [Data Type]

Available `zabbix-server-configuration` fields are:

`zabbix-server` (default: `zabbix-server`) (type: file-like)
: The zabbix-server package.

`user` (default: `"zabbix"`) (type: string)
: User who will run the Zabbix server.

`group` (default: `"zabbix"`) (type: group)
: Group who will run the Zabbix server.

`db-host` (default: `"127.0.0.1"`) (type: string)
: Database host name.

`db-name` (default: `"zabbix"`) (type: string)
: Database name.

`db-user` (default: `"zabbix"`) (type: string)
: Database user.

`db-password` (default: `""`) (type: string)
: Database password. Please, use `include-files` with `DBPassword=SECRET` inside a specified file instead.

`db-port` (default: `5432`) (type: number)
: Database port.

`log-type` (default: `""`) (type: string)
: Specifies where log messages are written to:

- `system` - syslog.
- `file` - file specified with `log-file` parameter.
- `console` - standard output.

`log-file` (default: `"/var/log/zabbix/server.log"`) (type: string)
: Log file name for `log-type` `file` parameter.

`pid-file` (default: `"/var/run/zabbix/zabbix_server.pid"`) (type: string)
: Name of PID file.

`ssl-ca-location` (default: `"/etc/ssl/certs/ca-certificates.crt"`) (type: string)
: The location of certificate authority (CA) files for SSL server certificate verification.

`ssl-cert-location` (default: `"/etc/ssl/certs"`) (type: string)
: Location of SSL client certificates.

`extra-options` (default: `""`) (type: extra-options)
: Extra options will be appended to Zabbix server configuration file.

`include-files` (default: `()`) (type: include-files)
: You may include individual files or all files in a directory in the configuration file.

Zabbix agent

The Zabbix agent gathers information about the running system for the Zabbix monitoring server. It has a variety of built-in checks, and can be extended with custom *user parameters* (`https://www.zabbix.com/documentation/current/en/manual/config/items/userparameters`).

`Scheme variable` *zabbix-agent-service-type* [Variable]
: This is the service type for the Zabbix agent service. Its value must be a `zabbix-agent-configuration` record, shown below.

`zabbix-agent-configuration` [Data Type]
: Available `zabbix-agent-configuration` fields are:

`zabbix-agent` (default: `zabbix-agentd`) (type: file-like)
: The zabbix-agent package.

`user` (default: `"zabbix"`) (type: string)
: User who will run the Zabbix agent.

`group` (default: `"zabbix"`) (type: group)
: Group who will run the Zabbix agent.

`hostname` (default: `""`) (type: string)
: Unique, case sensitive hostname which is required for active checks and must match hostname as configured on the server.

`log-type` (default: `""`) (type: string)
: Specifies where log messages are written to:

- `system` - syslog.
- `file` - file specified with `log-file` parameter.
- `console` - standard output.

`log-file` (default: `"/var/log/zabbix/agent.log"`) (type: string)
: Log file name for `log-type` `file` parameter.

`pid-file` (default: `"/var/run/zabbix/zabbix_agent.pid"`) (type: string)
: Name of PID file.

`server` (default: `("127.0.0.1")`) (type: list)
: List of IP addresses, optionally in CIDR notation, or hostnames of Zabbix servers and Zabbix proxies. Incoming connections will be accepted only from the hosts listed here.

`server-active` (default: `("127.0.0.1")`) (type: list)
: List of IP:port (or hostname:port) pairs of Zabbix servers and Zabbix proxies for active checks. If port is not specified, default port is used. If this parameter is not specified, active checks are disabled.

`extra-options` (default: `""`) (type: extra-options)
: Extra options will be appended to Zabbix server configuration file.

`include-files` (default: `()`) (type: include-files)
: You may include individual files or all files in a directory in the configuration file.

Zabbix front-end

The Zabbix front-end provides a web interface to Zabbix. It does not need to run on the same machine as the Zabbix server. This service works by extending the [PHP-FPM], page 423, and [NGINX], page 413, services with the configuration necessary for loading the Zabbix user interface.

`Scheme variable` *zabbix-front-end-service-type* [Variable]
: This is the service type for the Zabbix web frontend. Its value must be a `zabbix-front-end-configuration` record, shown below.

`zabbix-front-end-configuration` [Data Type]
: Available `zabbix-front-end-configuration` fields are:

`zabbix-server` (default: `zabbix-server`) (type: file-like)
: The Zabbix server package to use.

`nginx` (default: `()`) (type: list)
: List of [nginx-server-configuration], page 416, blocks for the Zabbix front-end. When empty, a default that listens on port 80 is used.

`db-host` (default: `"localhost"`) (type: string)
: Database host name.

`db-port` (default: `5432`) (type: number)
: Database port.

`db-name` (default: `"zabbix"`) (type: string)
: Database name.

`db-user` (default: `"zabbix"`) (type: string)
: Database user.

`db-password` (default: `""`) (type: string)
: Database password. Please, use `db-secret-file` instead.

`db-secret-file` (default: `""`) (type: string)
: Secret file which will be appended to `zabbix.conf.php` file. This file contains credentials for use by Zabbix front-end. You are expected to create it manually.

`zabbix-host` (default: `"localhost"`) (type: string)
: Zabbix server hostname.

`zabbix-port` (default: `10051`) (type: number)
  Zabbix server port.

12.9.17 Kerberos Services

The `(gnu services kerberos)` module provides services relating to the authentication protocol *Kerberos*.

Krb5 Service

Programs using a Kerberos client library normally expect a configuration file in `/etc/krb5.conf`. This service generates such a file from a definition provided in the operating system declaration. It does not cause any daemon to be started.

No "keytab" files are provided by this service—you must explicitly create them. This service is known to work with the MIT client library, `mit-krb5`. Other implementations have not been tested.

`krb5-service-type` [Scheme Variable]
  A service type for Kerberos 5 clients.

Here is an example of its use:

```
(service krb5-service-type
         (krb5-configuration
          (default-realm "EXAMPLE.COM")
          (allow-weak-crypto? #t)
          (realms (list
                   (krb5-realm
                    (name "EXAMPLE.COM")
                    (admin-server "groucho.example.com")
                    (kdc "karl.example.com"))
                   (krb5-realm
                    (name "ARGRX.EDU")
                    (admin-server "kerb-admin.argrx.edu")
                    (kdc "keys.argrx.edu"))))))
```

This example provides a Kerberos 5 client configuration which:

- Recognizes two realms, *viz:* "EXAMPLE.COM" and "ARGRX.EDU", both of which have distinct administration servers and key distribution centers;
- Will default to the realm "EXAMPLE.COM" if the realm is not explicitly specified by clients;
- Accepts services which only support encryption types known to be weak.

The `krb5-realm` and `krb5-configuration` types have many fields. Only the most commonly used ones are described here. For a full list, and more detailed explanation of each, see the MIT krb5.conf documentation.

`krb5-realm` [Data Type]

`name` This field is a string identifying the name of the realm. A common convention is to use the fully qualified DNS name of your organization, converted to upper case.

`admin-server`
: This field is a string identifying the host where the administration server is running.

`kdc`
: This field is a string identifying the key distribution center for the realm.

`krb5-configuration` [Data Type]

`allow-weak-crypto?` (default: `#f`)
: If this flag is `#t` then services which only offer encryption algorithms known to be weak will be accepted.

`default-realm` (default: `#f`)
: This field should be a string identifying the default Kerberos realm for the client. You should set this field to the name of your Kerberos realm. If this value is `#f` then a realm must be specified with every Kerberos principal when invoking programs such as `kinit`.

`realms`
: This should be a non-empty list of `krb5-realm` objects, which clients may access. Normally, one of them will have a `name` field matching the `default-realm` field.

PAM krb5 Service

The `pam-krb5` service allows for login authentication and password management via Kerberos. You will need this service if you want PAM enabled applications to authenticate users using Kerberos.

`pam-krb5-service-type` [Scheme Variable]
: A service type for the Kerberos 5 PAM module.

`pam-krb5-configuration` [Data Type]
: Data type representing the configuration of the Kerberos 5 PAM module. This type has the following parameters:

`pam-krb5` (default: `pam-krb5`)
: The pam-krb5 package to use.

`minimum-uid` (default: `1000`)
: The smallest user ID for which Kerberos authentications should be attempted. Local accounts with lower values will silently fail to authenticate.

12.9.18 LDAP Services

The `(gnu services authentication)` module provides the `nslcd-service-type`, which can be used to authenticate against an LDAP server. In addition to configuring the service itself, you may want to add `ldap` as a name service to the Name Service Switch. See Section 12.12 [Name Service Switch], page 535, for detailed information.

Here is a simple operating system declaration with a default configuration of the `nslcd-service-type` and a Name Service Switch configuration that consults the `ldap` name service last:

```
(use-service-modules authentication)
```

```
(use-modules (gnu system nss))
...
(operating-system
  ...
  (services
    (cons*
      (service nslcd-service-type)
      (service dhcp-client-service-type)
      %base-services))
  (name-service-switch
   (let ((services (list (name-service (name "db"))
                         (name-service (name "files"))
                         (name-service (name "ldap")))))
     (name-service-switch
      (inherit %mdns-host-lookup-nss)
      (password services)
      (shadow   services)
      (group    services)
      (netgroup services)
      (gshadow  services)))))
```

Available `nslcd-configuration` fields are:

`package` **nss-pam-ldapd** [`nslcd-configuration` parameter]

The `nss-pam-ldapd` package to use.

`maybe-number` **threads** [`nslcd-configuration` parameter]

The number of threads to start that can handle requests and perform LDAP queries. Each thread opens a separate connection to the LDAP server. The default is to start 5 threads.

Defaults to '`disabled`'.

`string` **uid** [`nslcd-configuration` parameter]

This specifies the user id with which the daemon should be run.

Defaults to '`"nslcd"`'.

`string` **gid** [`nslcd-configuration` parameter]

This specifies the group id with which the daemon should be run.

Defaults to '`"nslcd"`'.

`log-option` **log** [`nslcd-configuration` parameter]

This option controls the way logging is done via a list containing SCHEME and LEVEL. The SCHEME argument may either be the symbols '`none`' or '`syslog`', or an absolute file name. The LEVEL argument is optional and specifies the log level. The log level may be one of the following symbols: '`crit`', '`error`', '`warning`', '`notice`', '`info`' or '`debug`'. All messages with the specified log level or higher are logged.

Defaults to '`("/var/log/nslcd" info)`'.

`list uri` [`nslcd-configuration` parameter]
: The list of LDAP server URIs. Normally, only the first server will be used with the following servers as fall-back.

  Defaults to '`("ldap://localhost:389/")`'.

`maybe-string ldap-version` [`nslcd-configuration` parameter]
: The version of the LDAP protocol to use. The default is to use the maximum version supported by the LDAP library.

  Defaults to '`disabled`'.

`maybe-string binddn` [`nslcd-configuration` parameter]
: Specifies the distinguished name with which to bind to the directory server for lookups. The default is to bind anonymously.

  Defaults to '`disabled`'.

`maybe-string bindpw` [`nslcd-configuration` parameter]
: Specifies the credentials with which to bind. This option is only applicable when used with binddn.

  Defaults to '`disabled`'.

`maybe-string rootpwmoddn` [`nslcd-configuration` parameter]
: Specifies the distinguished name to use when the root user tries to modify a user's password using the PAM module.

  Defaults to '`disabled`'.

`maybe-string rootpwmodpw` [`nslcd-configuration` parameter]
: Specifies the credentials with which to bind if the root user tries to change a user's password. This option is only applicable when used with rootpwmoddn

  Defaults to '`disabled`'.

`maybe-string sasl-mech` [`nslcd-configuration` parameter]
: Specifies the SASL mechanism to be used when performing SASL authentication.

  Defaults to '`disabled`'.

`maybe-string sasl-realm` [`nslcd-configuration` parameter]
: Specifies the SASL realm to be used when performing SASL authentication.

  Defaults to '`disabled`'.

`maybe-string sasl-authcid` [`nslcd-configuration` parameter]
: Specifies the authentication identity to be used when performing SASL authentication.

  Defaults to '`disabled`'.

`maybe-string sasl-authzid` [`nslcd-configuration` parameter]
: Specifies the authorization identity to be used when performing SASL authentication.

  Defaults to '`disabled`'.

`maybe-boolean sasl-canonicalize?` [`nslcd-configuration` parameter]
: Determines whether the LDAP server host name should be canonicalised. If this is enabled the LDAP library will do a reverse host name lookup. By default, it is left up to the LDAP library whether this check is performed or not.

  Defaults to '`disabled`'.

`maybe-string krb5-ccname` [`nslcd-configuration` parameter]
: Set the name for the GSS-API Kerberos credentials cache.

  Defaults to '`disabled`'.

`string base` [`nslcd-configuration` parameter]
: The directory search base.

  Defaults to '`"dc=example,dc=com"`'.

`scope-option scope` [`nslcd-configuration` parameter]
: Specifies the search scope (subtree, onelevel, base or children). The default scope is subtree; base scope is almost never useful for name service lookups; children scope is not supported on all servers.

  Defaults to '`(subtree)`'.

`maybe-deref-option deref` [`nslcd-configuration` parameter]
: Specifies the policy for dereferencing aliases. The default policy is to never dereference aliases.

  Defaults to '`disabled`'.

`maybe-boolean referrals` [`nslcd-configuration` parameter]
: Specifies whether automatic referral chasing should be enabled. The default behaviour is to chase referrals.

  Defaults to '`disabled`'.

`list-of-map-entries maps` [`nslcd-configuration` parameter]
: This option allows for custom attributes to be looked up instead of the default RFC 2307 attributes. It is a list of maps, each consisting of the name of a map, the RFC 2307 attribute to match and the query expression for the attribute as it is available in the directory.

  Defaults to '`()`'.

`list-of-filter-entries filters` [`nslcd-configuration` parameter]
: A list of filters consisting of the name of a map to which the filter applies and an LDAP search filter expression.

  Defaults to '`()`'.

`maybe-number bind-timelimit` [`nslcd-configuration` parameter]
: Specifies the time limit in seconds to use when connecting to the directory server. The default value is 10 seconds.

  Defaults to '`disabled`'.

`maybe-number timelimit` [`nslcd-configuration` parameter]

Specifies the time limit (in seconds) to wait for a response from the LDAP server. A value of zero, which is the default, is to wait indefinitely for searches to be completed.

Defaults to '`disabled`'.

`maybe-number idle-timelimit` [`nslcd-configuration` parameter]

Specifies the period if inactivity (in seconds) after which the con nection to the LDAP server will be closed. The default is not to time out connections.

Defaults to '`disabled`'.

`maybe-number reconnect-sleeptime` [`nslcd-configuration` parameter]

Specifies the number of seconds to sleep when connecting to all LDAP servers fails. By default one second is waited between the first failure and the first retry.

Defaults to '`disabled`'.

`maybe-number reconnect-retrytime` [`nslcd-configuration` parameter]

Specifies the time after which the LDAP server is considered to be permanently unavailable. Once this time is reached retries will be done only once per this time period. The default value is 10 seconds.

Defaults to '`disabled`'.

`maybe-ssl-option ssl` [`nslcd-configuration` parameter]

Specifies whether to use SSL/TLS or not (the default is not to). If 'start-tls is specified then StartTLS is used rather than raw LDAP over SSL.

Defaults to '`disabled`'.

`maybe-tls-reqcert-option tls-reqcert` [`nslcd-configuration` parameter]

Specifies what checks to perform on a server-supplied certificate. The meaning of the values is described in the ldap.conf(5) manual page.

Defaults to '`disabled`'.

`maybe-string tls-cacertdir` [`nslcd-configuration` parameter]

Specifies the directory containing X.509 certificates for peer authen tication. This parameter is ignored when using GnuTLS.

Defaults to '`disabled`'.

`maybe-string tls-cacertfile` [`nslcd-configuration` parameter]

Specifies the path to the X.509 certificate for peer authentication.

Defaults to '`disabled`'.

`maybe-string tls-randfile` [`nslcd-configuration` parameter]

Specifies the path to an entropy source. This parameter is ignored when using GnuTLS.

Defaults to '`disabled`'.

`maybe-string tls-ciphers` [`nslcd-configuration` parameter]

Specifies the ciphers to use for TLS as a string.

Defaults to '`disabled`'.

`maybe-string tls-cert` [`nslcd-configuration` parameter]

Specifies the path to the file containing the local certificate for client TLS authentication.

Defaults to '`disabled`'.

`maybe-string tls-key` [`nslcd-configuration` parameter]

Specifies the path to the file containing the private key for client TLS authentication.

Defaults to '`disabled`'.

`maybe-number pagesize` [`nslcd-configuration` parameter]

Set this to a number greater than 0 to request paged results from the LDAP server in accordance with RFC2696. The default (0) is to not request paged results.

Defaults to '`disabled`'.

`maybe-ignore-users-option nss-initgroups-ignoreusers` [`nslcd-configuration` parameter]

This option prevents group membership lookups through LDAP for the specified users. Alternatively, the value 'all-local may be used. With that value nslcd builds a full list of non-LDAP users on startup.

Defaults to '`disabled`'.

`maybe-number nss-min-uid` [`nslcd-configuration` parameter]

This option ensures that LDAP users with a numeric user id lower than the specified value are ignored.

Defaults to '`disabled`'.

`maybe-number nss-uid-offset` [`nslcd-configuration` parameter]

This option specifies an offset that is added to all LDAP numeric user ids. This can be used to avoid user id collisions with local users.

Defaults to '`disabled`'.

`maybe-number nss-gid-offset` [`nslcd-configuration` parameter]

This option specifies an offset that is added to all LDAP numeric group ids. This can be used to avoid user id collisions with local groups.

Defaults to '`disabled`'.

`maybe-boolean nss-nested-groups` [`nslcd-configuration` parameter]

If this option is set, the member attribute of a group may point to another group. Members of nested groups are also returned in the higher level group and parent groups are returned when finding groups for a specific user. The default is not to perform extra searches for nested groups.

Defaults to '`disabled`'.

`maybe-boolean nss-getgrent-skipmembers` [`nslcd-configuration` parameter]

If this option is set, the group member list is not retrieved when looking up groups. Lookups for finding which groups a user belongs to will remain functional so the user will likely still get the correct groups assigned on login.

Defaults to '`disabled`'.

`maybe-boolean nss-disable-enumeration` [`nslcd-configuration` parameter]
: If this option is set, functions which cause all user/group entries to be loaded from the directory will not succeed in doing so. This can dramatically reduce LDAP server load in situations where there are a great number of users and/or groups. This option is not recommended for most configurations.

  Defaults to '`disabled`'.

`maybe-string validnames` [`nslcd-configuration` parameter]
: This option can be used to specify how user and group names are verified within the system. This pattern is used to check all user and group names that are requested and returned from LDAP.

  Defaults to '`disabled`'.

`maybe-boolean ignorecase` [`nslcd-configuration` parameter]
: This specifies whether or not to perform searches using case-insensitive matching. Enabling this could open up the system to authorization bypass vulnerabilities and introduce nscd cache poisoning vulnerabilities which allow denial of service.

  Defaults to '`disabled`'.

`maybe-boolean pam-authc-ppolicy` [`nslcd-configuration` parameter]
: This option specifies whether password policy controls are requested and handled from the LDAP server when performing user authentication.

  Defaults to '`disabled`'.

`maybe-string pam-authc-search` [`nslcd-configuration` parameter]
: By default nslcd performs an LDAP search with the user's credentials after BIND (authentication) to ensure that the BIND operation was successful. The default search is a simple check to see if the user's DN exists. A search filter can be specified that will be used instead. It should return at least one entry.

  Defaults to '`disabled`'.

`maybe-string pam-authz-search` [`nslcd-configuration` parameter]
: This option allows flexible fine tuning of the authorisation check that should be performed. The search filter specified is executed and if any entries match, access is granted, otherwise access is denied.

  Defaults to '`disabled`'.

`maybe-string pam-password-prohibit-message` [`nslcd-configuration` parameter]
: If this option is set password modification using pam_ldap will be denied and the specified message will be presented to the user instead. The message can be used to direct the user to an alternative means of changing their password.

  Defaults to '`disabled`'.

`list pam-services` [`nslcd-configuration` parameter]
: List of pam service names for which LDAP authentication should suffice.

  Defaults to '`()`'.

12.9.19 Web Services

The `(gnu services web)` module provides the Apache HTTP Server, the nginx web server, and also a fastcgi wrapper daemon.

Apache HTTP Server

`httpd-service-type` [Scheme Variable]

Service type for the Apache HTTP (`https://httpd.apache.org/`) server (*httpd*). The value for this service type is a `httpd-configuration` record.

A simple example configuration is given below.

```
(service httpd-service-type
         (httpd-configuration
           (config
             (httpd-config-file
               (server-name "www.example.com")
               (document-root "/srv/http/www.example.com")))))
```

Other services can also extend the `httpd-service-type` to add to the configuration.

```
(simple-service 'www.example.com-server httpd-service-type
                (list
                  (httpd-virtualhost
                    "*:80"
                    (list (string-join '("ServerName www.example.com"
                                          "DocumentRoot /srv/http/www.example.com
                                       "\n")))))
```

The details for the `httpd-configuration`, `httpd-module`, `httpd-config-file` and `httpd-virtualhost` record types are given below.

`httpd-configuration` [Data Type]

This data type represents the configuration for the httpd service.

`package` (default: `httpd`)
: The httpd package to use.

`pid-file` (default: `"/var/run/httpd"`)
: The pid file used by the shepherd-service.

`config` (default: `(httpd-config-file)`)
: The configuration file to use with the httpd service. The default value is a `httpd-config-file` record, but this can also be a different G-expression that generates a file, for example a `plain-file`. A file outside of the store can also be specified through a string.

`httpd-module` [Data Type]

This data type represents a module for the httpd service.

`name` The name of the module.

`file` The file for the module. This can be relative to the httpd package being used, the absolute location of a file, or a G-expression for a file within the store, for example `(file-append mod-wsgi "/modules/mod_wsgi.so")`.

`%default-httpd-modules` [Scheme Variable]

A default list of `httpd-module` objects.

`httpd-config-file` [Data Type]

This data type represents a configuration file for the httpd service.

`modules` (default: `%default-httpd-modules`)

The modules to load. Additional modules can be added here, or loaded by additional configuration.

For example, in order to handle requests for PHP files, you can use Apache's `mod_proxy_fcgi` module along with `php-fpm-service-type`:

```
(service httpd-service-type
         (httpd-configuration
          (config
           (httpd-config-file
            (modules (cons*
                      (httpd-module
                       (name "proxy_module")
                       (file "modules/mod_proxy.so"))
                      (httpd-module
                       (name "proxy_fcgi_module")
                       (file "modules/mod_proxy_fcgi.so"))
                      %default-httpd-modules))
            (extra-config (list "\
<FilesMatch \\.php$>
    SetHandler \"proxy:unix:/var/run/php-fpm.sock|fcgi://localhost/\"
</FilesMatch>"))))))
(service php-fpm-service-type
         (php-fpm-configuration
          (socket "/var/run/php-fpm.sock")
          (socket-group "httpd")))
```

`server-root` (default: `httpd`)

The `ServerRoot` in the configuration file, defaults to the httpd package. Directives including `Include` and `LoadModule` are taken as relative to the server root.

`server-name` (default: `#f`)

The `ServerName` in the configuration file, used to specify the request scheme, hostname and port that the server uses to identify itself.

This doesn't need to be set in the server config, and can be specified in virtual hosts. The default is `#f` to not specify a `ServerName`.

`document-root` (default: `"/srv/http"`)

The `DocumentRoot` from which files will be served.

`listen` (default: `'("80")`)

The list of values for the `Listen` directives in the config file. The value should be a list of strings, when each string can specify the port number to listen on, and optionally the IP address and protocol to use.

`pid-file` (default: `"/var/run/httpd"`)
: The `PidFile` to use. This should match the `pid-file` set in the `httpd-configuration` so that the Shepherd service is configured correctly.

`error-log` (default: `"/var/log/httpd/error_log"`)
: The `ErrorLog` to which the server will log errors.

`user` (default: `"httpd"`)
: The `User` which the server will answer requests as.

`group` (default: `"httpd"`)
: The `Group` which the server will answer requests as.

`extra-config` (default: `(list "TypesConfig etc/httpd/mime.types")`)
: A flat list of strings and G-expressions which will be added to the end of the configuration file.

  Any values which the service is extended with will be appended to this list.

`httpd-virtualhost` [Data Type]

This data type represents a virtualhost configuration block for the httpd service.

These should be added to the extra-config for the httpd-service.

```
(simple-service 'www.example.com-server httpd-service-type
                (list
                  (httpd-virtualhost
                    "*:80"
                    (list (string-join '("ServerName www.example.com"
                                          "DocumentRoot /srv/http/www.example.com
                                        "\n")))))
```

`addresses-and-ports`
: The addresses and ports for the `VirtualHost` directive.

`contents`
: The contents of the `VirtualHost` directive, this should be a list of strings and G-expressions.

NGINX

`nginx-service-type` [Scheme Variable]

Service type for the NGinx (`https://nginx.org/`) web server. The value for this service type is a `<nginx-configuration>` record.

A simple example configuration is given below.

```
(service nginx-service-type
         (nginx-configuration
           (server-blocks
             (list (nginx-server-configuration
                     (server-name '("www.example.com"))
                     (root "/srv/http/www.example.com"))))))
```

In addition to adding server blocks to the service configuration directly, this service can be extended by other services to add server blocks, as in this example:

```
(simple-service 'my-extra-server nginx-service-type
                (list (nginx-server-configuration
                        (root "/srv/http/extra-website")
                        (try-files (list "$uri" "$uri/index.html")))))
```

At startup, `nginx` has not yet read its configuration file, so it uses a default file to log error messages. If it fails to load its configuration file, that is where error messages are logged. After the configuration file is loaded, the default error log file changes as per configuration. In our case, startup error messages can be found in `/var/run/nginx/logs/error.log`, and after configuration in `/var/log/nginx/error.log`. The second location can be changed with the *log-directory* configuration option.

`nginx-configuration` [Data Type]

This data type represents the configuration for NGinx. Some configuration can be done through this and the other provided record types, or alternatively, a config file can be provided.

`nginx` (default: `nginx`)
: The nginx package to use.

`shepherd-requirement` (default: `'()`)
: This is a list of symbols naming Shepherd services the nginx service will depend on.

  This is useful if you would like `nginx` to be started after a back-end web server or a logging service such as Anonip has been started.

`log-directory` (default: `"/var/log/nginx"`)
: The directory to which NGinx will write log files.

`run-directory` (default: `"/var/run/nginx"`)
: The directory in which NGinx will create a pid file, and write temporary files.

`server-blocks` (default: `'()`)
: A list of *server blocks* to create in the generated configuration file, the elements should be of type `<nginx-server-configuration>`.

  The following example would setup NGinx to serve `www.example.com` from the `/srv/http/www.example.com` directory, without using HTTPS.

```
(service nginx-service-type
         (nginx-configuration
           (server-blocks
             (list (nginx-server-configuration
                     (server-name '("www.example.com"))
                     (root "/srv/http/www.example.com"))))))
```

`upstream-blocks` (default: `'()`)
: A list of *upstream blocks* to create in the generated configuration file, the elements should be of type `<nginx-upstream-configuration>`.

Configuring upstreams through the `upstream-blocks` can be useful when combined with `locations` in the `<nginx-server-configuration>` records. The following example creates a server configuration with one location configuration, that will proxy requests to a upstream configuration, which will handle requests with two servers.

```
(service
  nginx-service-type
  (nginx-configuration
    (server-blocks
      (list (nginx-server-configuration
              (server-name '("www.example.com"))
              (root "/srv/http/www.example.com")
              (locations
                (list
                  (nginx-location-configuration
                  (uri "/path1")
                  (body '("proxy_pass http://server-proxy;"))))))))
    (upstream-blocks
      (list (nginx-upstream-configuration
              (name "server-proxy")
              (servers (list "server1.example.com"
                             "server2.example.com")))))))
```

`file` (default: `#f`)
: If a configuration *file* is provided, this will be used, rather than generating a configuration file from the provided `log-directory`, `run-directory`, `server-blocks` and `upstream-blocks`. For proper operation, these arguments should match what is in *file* to ensure that the directories are created when the service is activated.

  This can be useful if you have an existing configuration file, or it's not possible to do what is required through the other parts of the nginx-configuration record.

`server-names-hash-bucket-size` (default: `#f`)
: Bucket size for the server names hash tables, defaults to `#f` to use the size of the processors cache line.

`server-names-hash-bucket-max-size` (default: `#f`)
: Maximum bucket size for the server names hash tables.

`modules` (default: `'()`)
: List of nginx dynamic modules to load. This should be a list of file names of loadable modules, as in this example:

```
(modules
 (list
  (file-append nginx-accept-language-module "\
/etc/nginx/modules/ngx_http_accept_language_module.so")
  (file-append nginx-lua-module "\
/etc/nginx/modules/ngx_http_lua_module.so")))
```

`lua-package-path` (default: `'()`)
: List of nginx lua packages to load. This should be a list of package names of loadable lua modules, as in this example:

```
(lua-package-path (list lua-resty-core
                        lua-resty-lrucache
                        lua-resty-signal
                        lua-tablepool
                        lua-resty-shell))
```

`lua-package-cpath` (default: `'()`)
: List of nginx lua C packages to load. This should be a list of package names of loadable lua C modules, as in this example:

```
(lua-package-cpath (list lua-resty-signal))
```

`global-directives` (default: `'((events . ()))`)
: Association list of global directives for the top level of the nginx configuration. Values may themselves be association lists.

```
(global-directives
 `((worker_processes . 16)
   (pcre_jit . on)
   (events . ((worker_connections . 1024)))))
```

`extra-content` (default: `""`)
: Extra content for the `http` block. Should be string or a string valued G-expression.

`nginx-server-configuration` [Data Type]

Data type representing the configuration of an nginx server block. This type has the following parameters:

`listen` (default: `'("80" "443 ssl")`)
: Each `listen` directive sets the address and port for IP, or the path for a UNIX-domain socket on which the server will accept requests. Both address and port, or only address or only port can be specified. An address may also be a hostname, for example:

```
'("127.0.0.1:8000" "127.0.0.1" "8000" "*:8000" "localhost:8000")
```

`server-name` (default: `(list 'default)`)
: A list of server names this server represents. `'default` represents the default server for connections matching no other server.

`root` (default: `"/srv/http"`)
: Root of the website nginx will serve.

`locations` (default: `'()`)
: A list of *nginx-location-configuration* or *nginx-named-location-configuration* records to use within this server block.

`index` (default: `(list "index.html")`)
: Index files to look for when clients ask for a directory. If it cannot be found, Nginx will send the list of files in the directory.

`try-files` (default: `'()`)
: A list of files whose existence is checked in the specified order. `nginx` will use the first file it finds to process the request.

`ssl-certificate` (default: `#f`)
: Where to find the certificate for secure connections. Set it to `#f` if you don't have a certificate or you don't want to use HTTPS.

`ssl-certificate-key` (default: `#f`)
: Where to find the private key for secure connections. Set it to `#f` if you don't have a key or you don't want to use HTTPS.

`server-tokens?` (default: `#f`)
: Whether the server should add its configuration to response.

`raw-content` (default: `'()`)
: A list of raw lines added to the server block.

`nginx-upstream-configuration` [Data Type]

Data type representing the configuration of an nginx `upstream` block. This type has the following parameters:

`name` Name for this group of servers.

`servers` Specify the addresses of the servers in the group. The address can be specified as a IP address (e.g. '`127.0.0.1`'), domain name (e.g. '`backend1.example.com`') or a path to a UNIX socket using the prefix '`unix:`'. For addresses using an IP address or domain name, the default port is 80, and a different port can be specified explicitly.

`extra-content`
: A string or list of strings to add to the upstream block.

`nginx-location-configuration` [Data Type]

Data type representing the configuration of an nginx `location` block. This type has the following parameters:

`uri` URI which this location block matches.

`body` Body of the location block, specified as a list of strings. This can contain many configuration directives. For example, to pass requests to a upstream server group defined using an `nginx-upstream-configuration` block, the following directive would be specified in the body '`(list "proxy_pass http://upstream-name;")`'.

`nginx-named-location-configuration` [Data Type]

Data type representing the configuration of an nginx named location block. Named location blocks are used for request redirection, and not used for regular request processing. This type has the following parameters:

`name` Name to identify this location block.

`body` See [nginx-location-configuration body], page 417, as the body for named location blocks can be used in a similar way to the `nginx-location-configuration body`. One restriction is that the body of a named location block cannot contain location blocks.

Varnish Cache

Varnish is a fast cache server that sits in between web applications and end users. It proxies requests from clients and caches the accessed URLs such that multiple requests for the same resource only creates one request to the back-end.

`varnish-service-type` [Scheme Variable]

Service type for the Varnish daemon.

`varnish-configuration` [Data Type]

Data type representing the `varnish` service configuration. This type has the following parameters:

`package` (default: `varnish`)
: The Varnish package to use.

`name` (default: `"default"`)
: A name for this Varnish instance. Varnish will create a directory in `/var/varnish/` with this name and keep temporary files there. If the name starts with a forward slash, it is interpreted as an absolute directory name.

  Pass the `-n` argument to other Varnish programs to connect to the named instance, e.g. `varnishncsa -n default`.

`backend` (default: `"localhost:8080"`)
: The backend to use. This option has no effect if `vcl` is set.

`vcl` (default: #f)
: The *VCL* (Varnish Configuration Language) program to run. If this is `#f`, Varnish will proxy `backend` using the default configuration. Otherwise this must be a file-like object with valid VCL syntax.

  For example, to mirror www.gnu.org (`https://www.gnu.org`) with VCL you can do something along these lines:

```
(define %gnu-mirror
  (plain-file "gnu.vcl"
              "vcl 4.1;
backend gnu { .host = \"www.gnu.org\"; }"))

(operating-system
  ;; ...
  (services (cons (service varnish-service-type
                           (varnish-configuration
                            (listen '(":80"))
                            (vcl %gnu-mirror)))
                  %base-services)))
```

  The configuration of an already running Varnish instance can be inspected and changed using the `varnishadm` program.

  Consult the Varnish User Guide (`https://varnish-cache.org/docs/`) and Varnish Book (`https://book.varnish-software.com/4.0/`) for comprehensive documentation on Varnish and its configuration language.

`listen` (default: `'("localhost:80")`)
: List of addresses Varnish will listen on.

`storage` (default: `'("malloc,128m")`)
: List of storage backends that will be available in VCL.

`parameters` (default: `'()`)
: List of run-time parameters in the form `'(("parameter" . "value"))`.

`extra-options` (default: `'()`)
: Additional arguments to pass to the `varnishd` process.

Patchwork

Patchwork is a patch tracking system. It can collect patches sent to a mailing list, and display them in a web interface.

`patchwork-service-type` [Scheme Variable]
: Service type for Patchwork.

The following example is an example of a minimal service for Patchwork, for the `patchwork.example.com` domain.

```
(service patchwork-service-type
         (patchwork-configuration
          (domain "patchwork.example.com")
          (settings-module
           (patchwork-settings-module
            (allowed-hosts (list domain))
            (default-from-email "patchwork@patchwork.example.com")))
          (getmail-retriever-config
           (getmail-retriever-configuration
            (type "SimpleIMAPSSLRetriever")
            (server "imap.example.com")
            (port 993)
            (username "patchwork")
            (password-command
             (list (file-append coreutils "/bin/cat")
                   "/etc/getmail-patchwork-imap-password"))
            (extra-parameters
            '((mailboxes . ("Patches"))))))))
```

There are three records for configuring the Patchwork service. The `<patchwork-configuration>` relates to the configuration for Patchwork within the HTTPD service.

The `settings-module` field within the `<patchwork-configuration>` record can be populated with the `<patchwork-settings-module>` record, which describes a settings module that is generated within the Guix store.

For the `database-configuration` field within the `<patchwork-settings-module>`, the `<patchwork-database-configuration>` must be used.

`patchwork-configuration` [Data Type]

Data type representing the Patchwork service configuration. This type has the following parameters:

`patchwork` (default: `patchwork`)
: The Patchwork package to use.

`domain`
: The domain to use for Patchwork, this is used in the HTTPD service virtual host.

`settings-module`
: The settings module to use for Patchwork. As a Django application, Patchwork is configured with a Python module containing the settings. This can either be an instance of the `<patchwork-settings-module>` record, any other record that represents the settings in the store, or a directory outside of the store.

`static-path` (default: `"/static/"`)
: The path under which the HTTPD service should serve the static files.

`getmail-retriever-config`
: The getmail-retriever-configuration record value to use with Patchwork. Getmail will be configured with this value, the messages will be delivered to Patchwork.

`patchwork-settings-module` [Data Type]

Data type representing a settings module for Patchwork. Some of these settings relate directly to Patchwork, but others relate to Django, the web framework used by Patchwork, or the Django Rest Framework library. This type has the following parameters:

`database-configuration` (default: `(patchwork-database-configuration)`)
: The database connection settings used for Patchwork. See the `<patchwork-database-configuration>` record type for more information.

`secret-key-file` (default: `"/etc/patchwork/django-secret-key"`)
: Patchwork, as a Django web application uses a secret key for cryptographically signing values. This file should contain a unique unpredictable value.

  If this file does not exist, it will be created and populated with a random value by the patchwork-setup shepherd service.

  This setting relates to Django.

`allowed-hosts`
: A list of valid hosts for this Patchwork service. This should at least include the domain specified in the `<patchwork-configuration>` record.

  This is a Django setting.

`default-from-email`
: The email address from which Patchwork should send email by default.

  This is a Patchwork setting.

`static-url` (default: `#f`)
: The URL to use when serving static assets. It can be part of a URL, or a full URL, but must end in a `/`.

  If the default value is used, the `static-path` value from the `<patchwork-configuration>` record will be used.

  This is a Django setting.

`admins` (default: `'()`)
: Email addresses to send the details of errors that occur. Each value should be a list containing two elements, the name and then the email address.

  This is a Django setting.

`debug?` (default: `#f`)
: Whether to run Patchwork in debug mode. If set to `#t`, detailed error messages will be shown.

  This is a Django setting.

`enable-rest-api?` (default: `#t`)
: Whether to enable the Patchwork REST API.

  This is a Patchwork setting.

`enable-xmlrpc?` (default: `#t`)
: Whether to enable the XML RPC API.

  This is a Patchwork setting.

`force-https-links?` (default: `#t`)
: Whether to use HTTPS links on Patchwork pages.

  This is a Patchwork setting.

`extra-settings` (default: `""`)
: Extra code to place at the end of the Patchwork settings module.

`patchwork-database-configuration` [Data Type]

Data type representing the database configuration for Patchwork.

`engine` (default: `"django.db.backends.postgresql_psycopg2"`)
: The database engine to use.

`name` (default: `"patchwork"`)
: The name of the database to use.

`user` (default: `"httpd"`)
: The user to connect to the database as.

`password` (default: `""`)
: The password to use when connecting to the database.

`host` (default: `""`)
: The host to make the database connection to.

`port` (default: `""`)
: The port on which to connect to the database.

Mumi

Mumi (`https://git.elephly.net/gitweb.cgi?p=software/mumi.git`) is a Web interface to the Debbugs bug tracker, by default for the GNU instance (`https://bugs.gnu.org`). Mumi is a Web server, but it also fetches and indexes mail retrieved from Debbugs.

`mumi-service-type` [Scheme Variable]

This is the service type for Mumi.

`mumi-configuration` [Data Type]

Data type representing the Mumi service configuration. This type has the following fields:

`mumi` (default: `mumi`)
: The Mumi package to use.

`mailer?` (default: `#true`)
: Whether to enable or disable the mailer component.

`mumi-configuration-sender`
: The email address used as the sender for comments.

`mumi-configuration-smtp`
: A URI to configure the SMTP settings for Mailutils. This could be something like `sendmail:///path/to/bin/msmtp` or any other URI supported by Mailutils. See Section “SMTP Mailboxes” in *GNU Mailutils*.

FastCGI

FastCGI is an interface between the front-end and the back-end of a web service. It is a somewhat legacy facility; new web services should generally just talk HTTP between the front-end and the back-end. However there are a number of back-end services such as PHP or the optimized HTTP Git repository access that use FastCGI, so we have support for it in Guix.

To use FastCGI, you configure the front-end web server (e.g., nginx) to dispatch some subset of its requests to the fastcgi backend, which listens on a local TCP or UNIX socket. There is an intermediary `fcgiwrap` program that sits between the actual backend process and the web server. The front-end indicates which backend program to run, passing that information to the `fcgiwrap` process.

`fcgiwrap-service-type` [Scheme Variable]

A service type for the `fcgiwrap` FastCGI proxy.

`fcgiwrap-configuration` [Data Type]

Data type representing the configuration of the `fcgiwrap` service. This type has the following parameters:

`package` (default: `fcgiwrap`)
: The fcgiwrap package to use.

`socket` (default: `tcp:127.0.0.1:9000`)
: The socket on which the `fcgiwrap` process should listen, as a string. Valid *socket* values include `unix:`*`/path/to/unix/socket`*, `tcp:`*`dot.ted.qu.ad`*`:`*`port`* and `tcp6:[`*`ipv6_addr`*`]:port`.

`user` (default: `fcgiwrap`)
`group` (default: `fcgiwrap`)
: The user and group names, as strings, under which to run the `fcgiwrap` process. The `fastcgi` service will ensure that if the user asks for the specific user or group names `fcgiwrap` that the corresponding user and/or group is present on the system.

  It is possible to configure a FastCGI-backed web service to pass HTTP authentication information from the front-end to the back-end, and to allow `fcgiwrap` to run the back-end process as a corresponding local user. To enable this capability on the back-end, run `fcgiwrap` as the `root` user and group. Note that this capability also has to be configured on the front-end as well.

PHP-FPM

PHP-FPM (FastCGI Process Manager) is an alternative PHP FastCGI implementation with some additional features useful for sites of any size.

These features include:

- Adaptive process spawning
- Basic statistics (similar to Apache's mod_status)
- Advanced process management with graceful stop/start
- Ability to start workers with different uid/gid/chroot/environment and different php.ini (replaces safe_mode)
- Stdout & stderr logging
- Emergency restart in case of accidental opcode cache destruction
- Accelerated upload support
- Support for a "slowlog"
- Enhancements to FastCGI, such as fastcgi_finish_request() - a special function to finish request & flush all data while continuing to do something time-consuming (video converting, stats processing, etc.)

... and much more.

`php-fpm-service-type` [Scheme Variable]
: A Service type for `php-fpm`.

`php-fpm-configuration` [Data Type]
: Data Type for php-fpm service configuration.

  `php` (default: `php`)
  : The php package to use.

  `socket` (default: `(string-append "/var/run/php" (version-major (package-version php)) "-fpm.sock")`)
  : The address on which to accept FastCGI requests. Valid syntaxes are:

    `"ip.add.re.ss:port"`
    : Listen on a TCP socket to a specific address on a specific port.

`"port"` Listen on a TCP socket to all addresses on a specific port.

`"/path/to/unix/socket"`
Listen on a unix socket.

`user` (default: `php-fpm`)
User who will own the php worker processes.

`group` (default: `php-fpm`)
Group of the worker processes.

`socket-user` (default: `php-fpm`)
User who can speak to the php-fpm socket.

`socket-group` (default: `nginx`)
Group that can speak to the php-fpm socket.

`pid-file` (default: `(string-append "/var/run/php" (version-major (package-version php)) "-fpm.pid")`)
The process id of the php-fpm process is written to this file once the service has started.

`log-file` (default: `(string-append "/var/log/php" (version-major (package-version php)) "-fpm.log")`)
Log for the php-fpm master process.

`process-manager` (default: `(php-fpm-dynamic-process-manager-configuration)`)
Detailed settings for the php-fpm process manager. Must be one of:

```
<php-fpm-dynamic-process-manager-configuration>
<php-fpm-static-process-manager-configuration>
<php-fpm-on-demand-process-manager-configuration>
```

`display-errors` (default `#f`)
Determines whether php errors and warning should be sent to clients and displayed in their browsers. This is useful for local php development, but a security risk for public sites, as error messages can reveal passwords and personal data.

`timezone` (default `#f`)
Specifies `php_admin_value[date.timezone]` parameter.

`workers-logfile` (default `(string-append "/var/log/php" (version-major (package-version php)) "-fpm.www.log")`)
This file will log the `stderr` outputs of php worker processes. Can be set to `#f` to disable logging.

`file` (default `#f`)
An optional override of the whole configuration. You can use the `mixed-text-file` function or an absolute filepath for it.

`php-ini-file` (default `#f`)
An optional override of the default php settings. It may be any "file-like" object (see Section 9.12 [G-Expressions], page 154). You can use the `mixed-text-file` function or an absolute filepath for it.

For local development it is useful to set a higher timeout and memory limit for spawned php processes. This be accomplished with the following operating system configuration snippet:

```
(define %local-php-ini
  (plain-file "php.ini"
              "memory_limit = 2G
max_execution_time = 1800"))

(operating-system
  ;; ...
  (services (cons (service php-fpm-service-type
                           (php-fpm-configuration
                            (php-ini-file %local-php-ini)))
                  %base-services)))
```

Consult the core php.ini directives (`https://www.php.net/manual/en/ini.core.php`) for comprehensive documentation on the acceptable `php.ini` directives.

`php-fpm-dynamic-process-manager-configuration` [Data type]

Data Type for the `dynamic` php-fpm process manager. With the `dynamic` process manager, spare worker processes are kept around based on its configured limits.

`max-children` (default: `5`)
: Maximum of worker processes.

`start-servers` (default: `2`)
: How many worker processes should be started on start-up.

`min-spare-servers` (default: `1`)
: How many spare worker processes should be kept around at minimum.

`max-spare-servers` (default: `3`)
: How many spare worker processes should be kept around at maximum.

`php-fpm-static-process-manager-configuration` [Data type]

Data Type for the `static` php-fpm process manager. With the `static` process manager, an unchanging number of worker processes are created.

`max-children` (default: `5`)
: Maximum of worker processes.

`php-fpm-on-demand-process-manager-configuration` [Data type]

Data Type for the `on-demand` php-fpm process manager. With the `on-demand` process manager, worker processes are only created as requests arrive.

`max-children` (default: `5`)
: Maximum of worker processes.

`process-idle-timeout` (default: `10`)
: The time in seconds after which a process with no requests is killed.

`nginx-php-location` [*#:nginx-package nginx*] [*socket (string-append "/var/run/php" (version-major (package-version php)) "-fpm.sock")*] [Scheme Procedure]

A helper function to quickly add php to an `nginx-server-configuration`.

A simple services setup for nginx with php can look like this:

```
(services (cons* (service dhcp-client-service-type)
                 (service php-fpm-service-type)
                 (service nginx-service-type
                          (nginx-server-configuration
                           (server-name '("example.com"))
                           (root "/srv/http/")
                           (locations
                            (list (nginx-php-location)))
                           (listen '("80"))
                           (ssl-certificate #f)
                           (ssl-certificate-key #f)))
                 %base-services))
```

The cat avatar generator is a simple service to demonstrate the use of php-fpm in `Nginx`. It is used to generate cat avatar from a seed, for instance the hash of a user's email address.

`cat-avatar-generator-service` [*#:cache-dir "/var/cache/cat-avatar-generator"*] [*#:package cat-avatar-generator*] [*#:configuration (nginx-server-configuration)*] [Scheme Procedure]

Returns an nginx-server-configuration that inherits `configuration`. It extends the nginx configuration to add a server block that serves `package`, a version of cat-avatar-generator. During execution, cat-avatar-generator will be able to use `cache-dir` as its cache directory.

A simple setup for cat-avatar-generator can look like this:

```
(services (cons* (cat-avatar-generator-service
                  #:configuration
                  (nginx-server-configuration
                    (server-name '("example.com"))))
                 ...
                 %base-services))
```

Hpcguix-web

The hpcguix-web (`https://github.com/UMCUGenetics/hpcguix-web/`) program is a customizable web interface to browse Guix packages, initially designed for users of high-performance computing (HPC) clusters.

`hpcguix-web-service-type` [Scheme Variable]

The service type for `hpcguix-web`.

`hpcguix-web-configuration` [Data Type]

Data type for the hpcguix-web service configuration.

`specs` A gexp (see Section 9.12 [G-Expressions], page 154) specifying the hpcguix-web service configuration. The main items available in this spec are:

`title-prefix` (default: `"hpcguix | "`)
: The page title prefix.

`guix-command` (default: `"guix"`)
: The `guix` command.

`package-filter-proc` (default: `(const #t)`)
: A procedure specifying how to filter packages that are displayed.

`package-page-extension-proc` (default: `(const '())`)
: Extension package for `hpcguix-web`.

`menu` (default: `'()`)
: Additional entry in page `menu`.

`channels` (default: `%default-channels`)
: List of channels from which the package list is built (see Chapter 7 [Channels], page 68).

`package-list-expiration` (default: `(* 12 3600)`)
: The expiration time, in seconds, after which the package list is rebuilt from the latest instances of the given channels.

See the hpcguix-web repository for a complete example (`https://github.com/UMCUGenetics/hpcguix-web/blob/master/hpcweb-configuration.scm`).

`package` (default: `hpcguix-web`)
: The hpcguix-web package to use.

`address` (default: `"127.0.0.1"`)
: The IP address to listen to.

`port` (default: `5000`)
: The port number to listen to.

A typical hpcguix-web service declaration looks like this:

```
(service hpcguix-web-service-type
         (hpcguix-web-configuration
          (specs
           #~(define site-config
               (hpcweb-configuration
                (title-prefix "Guix-HPC - ")
                (menu '(("/about" "ABOUT"))))))))
```

Note: The hpcguix-web service periodically updates the package list it publishes by pulling channels from Git. To that end, it needs to access X.509 certificates so that it can authenticate Git servers when communicating over HTTPS, and it assumes that `/etc/ssl/certs` contains those certificates.

Thus, make sure to add `nss-certs` or another certificate package to the `packages` field of your configuration. Section 12.11 [X.509 Certificates], page 535, for more information on X.509 certificates.

gmnisrv

The gmnisrv (`https://git.sr.ht/~sircmpwn/gmnisrv`) program is a simple Gemini (`https://gemini.circumlunar.space/`) protocol server.

`gmnisrv-service-type` [Scheme Variable]

This is the type of the gmnisrv service, whose value should be a `gmnisrv-configuration` object, as in this example:

```
(service gmnisrv-service-type
         (gmnisrv-configuration
           (config-file (local-file "./my-gmnisrv.ini"))))
```

`gmnisrv-configuration` [Data Type]

Data type representing the configuration of gmnisrv.

`package` (default: *gmnisrv*)
: Package object of the gmnisrv server.

`config-file` (default: `%default-gmnisrv-config-file`)
: File-like object of the gmnisrv configuration file to use. The default configuration listens on port 1965 and serves files from `/srv/gemini`. Certificates are stored in `/var/lib/gemini/certs`. For more information, run `man gmnisrv` and `man gmnisrv.ini`.

Agate

The Agate (`gemini://qwertqwefsday.eu/agate.gmi`) (GitHub page over HTTPS (`https://github.com/mbrubeck/agate`)) program is a simple Gemini (`https://gemini.circumlunar.space/`) protocol server written in Rust.

`agate-service-type` [Scheme Variable]

This is the type of the agate service, whose value should be an `agate-service-type` object, as in this example:

```
(service agate-service-type
 (agate-configuration
   (content "/srv/gemini")
   (cert "/srv/cert.pem")
   (key "/srv/key.rsa")))
```

The example above represents the minimal tweaking necessary to get Agate up and running. Specifying the path to the certificate and key is always necessary, as the Gemini protocol requires TLS by default.

To obtain a certificate and a key, you could, for example, use OpenSSL, running a command similar to the following example:

```
openssl req -x509 -newkey rsa:4096 -keyout key.rsa -out cert.pem \
    -days 3650 -nodes -subj "/CN=example.com"
```

Of course, you'll have to replace *example.com* with your own domain name, and then point the Agate configuration towards the path of the generated key and certificate.

`agate-configuration` [Data Type]

Data type representing the configuration of Agate.

`package` (default: `agate`)
: The package object of the Agate server.

`content` (default: `"/srv/gemini"`)
: The directory from which Agate will serve files.

`cert` (default: `#f`)
: The path to the TLS certificate PEM file to be used for encrypted connections. Must be filled in with a value from the user.

`key` (default: `#f`)
: The path to the PKCS8 private key file to be used for encrypted connections. Must be filled in with a value from the user.

`addr` (default: `'("0.0.0.0:1965" "[::]:1965")`)
: A list of the addresses to listen on.

`hostname` (default: `#f`)
: The domain name of this Gemini server. Optional.

`lang` (default: `#f`)
: RFC 4646 language code(s) for text/gemini documents. Optional.

`silent?` (default: `#f`)
: Set to `#t` to disable logging output.

`serve-secret?` (default: `#f`)
: Set to `#t` to serve secret files (files/directories starting with a dot).

`log-ip?` (default: `#t`)
: Whether or not to output IP addresses when logging.

`user` (default: `"agate"`)
: Owner of the `agate` process.

`group` (default: `"agate"`)
: Owner's group of the `agate` process.

`log-file` (default: `"/var/log/agate.log"`)
: The file which should store the logging output of Agate.

12.9.20 Certificate Services

The `(gnu services certbot)` module provides a service to automatically obtain a valid TLS certificate from the Let's Encrypt certificate authority. These certificates can then be used to serve content securely over HTTPS or other TLS-based protocols, with the knowledge that the client will be able to verify the server's authenticity.

Let's Encrypt (`https://letsencrypt.org/`) provides the `certbot` tool to automate the certification process. This tool first securely generates a key on the server. It then makes a request to the Let's Encrypt certificate authority (CA) to sign the key. The CA checks that the request originates from the host in question by using a challenge-response protocol, requiring the server to provide its response over HTTP. If that protocol completes successfully, the CA signs the key, resulting in a certificate. That certificate is valid for a limited period of time, and therefore to continue to provide TLS services, the server needs to periodically ask the CA to renew its signature.

The certbot service automates this process: the initial key generation, the initial certification request to the Let's Encrypt service, the web server challenge/response integration, writing the certificate to disk, the automated periodic renewals, and the deployment tasks associated with the renewal (e.g. reloading services, copying keys with different permissions).

Certbot is run twice a day, at a random minute within the hour. It won't do anything until your certificates are due for renewal or revoked, but running it regularly would give your service a chance of staying online in case a Let's Encrypt-initiated revocation happened for some reason.

By using this service, you agree to the ACME Subscriber Agreement, which can be found there: `https://acme-v01.api.letsencrypt.org/directory`.

`certbot-service-type` [Scheme Variable]

A service type for the `certbot` Let's Encrypt client. Its value must be a `certbot-configuration` record as in this example:

```
(define %nginx-deploy-hook
  (program-file
   "nginx-deploy-hook"
   #~(let ((pid (call-with-input-file "/var/run/nginx/pid" read)))
       (kill pid SIGHUP))))

(service certbot-service-type
         (certbot-configuration
          (email "foo@example.net")
          (certificates
           (list
            (certificate-configuration
             (domains '("example.net" "www.example.net"))
             (deploy-hook %nginx-deploy-hook))
            (certificate-configuration
             (domains '("bar.example.net")))))))
```

See below for details about `certbot-configuration`.

`certbot-configuration` [Data Type]

Data type representing the configuration of the `certbot` service. This type has the following parameters:

`package` (default: `certbot`)
: The certbot package to use.

`webroot` (default: `/var/www`)
: The directory from which to serve the Let's Encrypt challenge/response files.

`certificates` (default: `()`)
: A list of `certificates-configurations` for which to generate certificates and request signatures. Each certificate has a `name` and several `domains`.

`email` (default: `#f`)
: Optional email address used for registration and recovery contact. Setting this is encouraged as it allows you to receive important notifications about the account and issued certificates.

`server` (default: `#f`)
: Optional URL of ACME server. Setting this overrides certbot's default, which is the Let's Encrypt server.

`rsa-key-size` (default: `2048`)
: Size of the RSA key.

`default-location` (default: *see below*)
: The default `nginx-location-configuration`. Because `certbot` needs to be able to serve challenges and responses, it needs to be able to run a web server. It does so by extending the `nginx` web service with an `nginx-server-configuration` listening on the *domains* on port 80, and which has a `nginx-location-configuration` for the `/.well-known/` URI path subspace used by Let's Encrypt. See Section 12.9.19 [Web Services], page 411, for more on these nginx configuration data types.

  Requests to other URL paths will be matched by the `default-location`, which if present is added to all `nginx-server-configuration`s.

  By default, the `default-location` will issue a redirect from `http://`*`domain`*`/...` to `https://`*`domain`*`/...`, leaving you to define what to serve on your site via `https`.

  Pass `#f` to not issue a default location.

`certificate-configuration` [Data Type]
: Data type representing the configuration of a certificate. This type has the following parameters:

`name` (default: *see below*)
: This name is used by Certbot for housekeeping and in file paths; it doesn't affect the content of the certificate itself. To see certificate names, run `certbot certificates`.

  Its default is the first provided domain.

`domains` (default: `()`)
: The first domain provided will be the subject CN of the certificate, and all domains will be Subject Alternative Names on the certificate.

`challenge` (default: `#f`)
: The challenge type that has to be run by certbot. If `#f` is specified, default to the HTTP challenge. If a value is specified, defaults to the manual plugin (see `authentication-hook`, `cleanup-hook` and the documentation at `https://certbot.eff.org/docs/using.html#hooks`), and gives Let's Encrypt permission to log the public IP address of the requesting machine.

`csr` (default: `#f`)
: File name of Certificate Signing Request (CSR) in DER or PEM format. If `#f` is specified, this argument will not be passed to certbot. If a value is specified, certbot will use it to obtain a certificate, instead of using a self-generated CSR. The domain-name(s) mentioned in `domains`, must be consistent with the domain-name(s) mentioned in CSR file.

`authentication-hook` (default: `#f`)
: Command to be run in a shell once for each certificate challenge to be answered. For this command, the shell variable `$CERTBOT_DOMAIN` will contain the domain being authenticated, `$CERTBOT_VALIDATION` contains the validation string and `$CERTBOT_TOKEN` contains the file name of the resource requested when performing an HTTP-01 challenge.

`cleanup-hook` (default: `#f`)
: Command to be run in a shell once for each certificate challenge that have been answered by the `auth-hook`. For this command, the shell variables available in the `auth-hook` script are still available, and additionally `$CERTBOT_AUTH_OUTPUT` will contain the standard output of the `auth-hook` script.

`deploy-hook` (default: `#f`)
: Command to be run in a shell once for each successfully issued certificate. For this command, the shell variable `$RENEWED_LINEAGE` will point to the config live subdirectory (for example, ‘`"/etc/letsencrypt/live/example.com"`’) containing the new certificates and keys; the shell variable `$RENEWED_DOMAINS` will contain a space-delimited list of renewed certificate domains (for example, ‘`"example.com www.example.com"`’.

For each `certificate-configuration`, the certificate is saved to `/etc/letsencrypt/live/`*`name`*`/fullchai` and the key is saved to `/etc/letsencrypt/live/`*`name`*`/privkey.pem`.

12.9.21 DNS Services

The `(gnu services dns)` module provides services related to the *domain name system* (DNS). It provides a server service for hosting an *authoritative* DNS server for multiple zones, slave or master. This service uses Knot DNS (`https://www.knot-dns.cz/`). And also a caching and forwarding DNS server for the LAN, which uses dnsmasq (`http://www.thekelleys.org.uk/dnsmasq/doc.html`).

Knot Service

An example configuration of an authoritative server for two zones, one master and one slave, is:

```
(define-zone-entries example.org.zone
;; Name TTL Class Type Data
  ("@"  ""  "IN"  "A"  "127.0.0.1")
  ("@"  ""  "IN"  "NS" "ns")
  ("ns" ""  "IN"  "A"  "127.0.0.1"))
```

```
(define master-zone
  (knot-zone-configuration
    (domain "example.org")
    (zone (zone-file
            (origin "example.org")
            (entries example.org.zone)))))

(define slave-zone
  (knot-zone-configuration
    (domain "plop.org")
    (dnssec-policy "default")
    (master (list "plop-master"))))

(define plop-master
  (knot-remote-configuration
    (id "plop-master")
    (address (list "208.76.58.171"))))

(operating-system
  ;; ...
  (services (cons* (service knot-service-type
                     (knot-configuration
                       (remotes (list plop-master))
                       (zones (list master-zone slave-zone))))
                   ;; ...
                   %base-services)))
```

`knot-service-type` [Scheme Variable]

This is the type for the Knot DNS server.

Knot DNS is an authoritative DNS server, meaning that it can serve multiple zones, that is to say domain names you would buy from a registrar. This server is not a resolver, meaning that it can only resolve names for which it is authoritative. This server can be configured to serve zones as a master server or a slave server as a per-zone basis. Slave zones will get their data from masters, and will serve it as an authoritative server. From the point of view of a resolver, there is no difference between master and slave.

The following data types are used to configure the Knot DNS server:

`knot-key-configuration` [Data Type]

Data type representing a key. This type has the following parameters:

`id` (default: `""`)
: An identifier for other configuration fields to refer to this key. IDs must be unique and must not be empty.

`algorithm` (default: `#f`)
: The algorithm to use. Choose between `#f`, `'hmac-md5`, `'hmac-sha1`, `'hmac-sha224`, `'hmac-sha256`, `'hmac-sha384` and `'hmac-sha512`.

`secret` (default: `""`)
: The secret key itself.

`knot-acl-configuration` [Data Type]

Data type representing an Access Control List (ACL) configuration. This type has the following parameters:

`id` (default: `""`)
: An identifier for other configuration fields to refer to this key. IDs must be unique and must not be empty.

`address` (default: `'()`)
: An ordered list of IP addresses, network subnets, or network ranges represented with strings. The query must match one of them. Empty value means that address match is not required.

`key` (default: `'()`)
: An ordered list of references to keys represented with strings. The string must match a key ID defined in a `knot-key-configuration`. No key means that a key is not require to match that ACL.

`action` (default: `'()`)
: An ordered list of actions that are permitted or forbidden by this ACL. Possible values are lists of zero or more elements from `'transfer`, `'notify` and `'update`.

`deny?` (default: `#f`)
: When true, the ACL defines restrictions. Listed actions are forbidden. When false, listed actions are allowed.

`zone-entry` [Data Type]

Data type representing a record entry in a zone file. This type has the following parameters:

`name` (default: `"@"`)
: The name of the record. `"@"` refers to the origin of the zone. Names are relative to the origin of the zone. For example, in the `example.org` zone, `"ns.example.org"` actually refers to `ns.example.org.example.org`. Names ending with a dot are absolute, which means that `"ns.example.org."` refers to `ns.example.org`.

`ttl` (default: `""`)
: The Time-To-Live (TTL) of this record. If not set, the default TTL is used.

`class` (default: `"IN"`)
: The class of the record. Knot currently supports only `"IN"` and partially `"CH"`.

`type` (default: `"A"`)
: The type of the record. Common types include A (IPv4 address), AAAA (IPv6 address), NS (Name Server) and MX (Mail eXchange). Many other types are defined.

`data` (default: `""`)
: The data contained in the record. For instance an IP address associated with an A record, or a domain name associated with an NS record. Remember that domain names are relative to the origin unless they end with a dot.

`zone-file` [Data Type]

Data type representing the content of a zone file. This type has the following parameters:

`entries` (default: `'()`)
: The list of entries. The SOA record is taken care of, so you don't need to put it in the list of entries. This list should probably contain an entry for your primary authoritative DNS server. Other than using a list of entries directly, you can use `define-zone-entries` to define a object containing the list of entries more easily, that you can later pass to the `entries` field of the `zone-file`.

`origin` (default: `""`)
: The name of your zone. This parameter cannot be empty.

`ns` (default: `"ns"`)
: The domain of your primary authoritative DNS server. The name is relative to the origin, unless it ends with a dot. It is mandatory that this primary DNS server corresponds to an NS record in the zone and that it is associated to an IP address in the list of entries.

`mail` (default: `"hostmaster"`)
: An email address people can contact you at, as the owner of the zone. This is translated as `<mail>@<origin>`.

`serial` (default: `1`)
: The serial number of the zone. As this is used to keep track of changes by both slaves and resolvers, it is mandatory that it *never* decreases. Always increment it when you make a change in your zone.

`refresh` (default: `(* 2 24 3600)`)
: The frequency at which slaves will do a zone transfer. This value is a number of seconds. It can be computed by multiplications or with `(string->duration)`.

`retry` (default: `(* 15 60)`)
: The period after which a slave will retry to contact its master when it fails to do so a first time.

`expiry` (default: `(* 14 24 3600)`)
: Default TTL of records. Existing records are considered correct for at most this amount of time. After this period, resolvers will invalidate their cache and check again that it still exists.

`nx` (default: `3600`)
: Default TTL of inexistent records. This delay is usually short because you want your new domains to reach everyone quickly.

`knot-remote-configuration` [Data Type]

Data type representing a remote configuration. This type has the following parameters:

`id` (default: `""`)
: An identifier for other configuration fields to refer to this remote. IDs must be unique and must not be empty.

`address` (default: `'()`)
: An ordered list of destination IP addresses. Addresses are tried in sequence. An optional port can be given with the @ separator. For instance: `(list "1.2.3.4" "2.3.4.5@53")`. Default port is 53.

`via` (default: `'()`)
: An ordered list of source IP addresses. An empty list will have Knot choose an appropriate source IP. An optional port can be given with the @ separator. The default is to choose at random.

`key` (default: `#f`)
: A reference to a key, that is a string containing the identifier of a key defined in a `knot-key-configuration` field.

`knot-keystore-configuration` [Data Type]

Data type representing a keystore to hold dnssec keys. This type has the following parameters:

`id` (default: `""`)
: The id of the keystore. It must not be empty.

`backend` (default: `'pem`)
: The backend to store the keys in. Can be `'pem` or `'pkcs11`.

`config` (default: `"/var/lib/knot/keys/keys"`)
: The configuration string of the backend. An example for the PKCS#11 is: `"pkcs11:token=knot;pin-value=1234 /gnu/store/.../lib/pkcs11/libsofthsm2.so"`. For the pem backend, the string represents a path in the file system.

`knot-policy-configuration` [Data Type]

Data type representing a dnssec policy. Knot DNS is able to automatically sign your zones. It can either generate and manage your keys automatically or use keys that you generate.

Dnssec is usually implemented using two keys: a Key Signing Key (KSK) that is used to sign the second, and a Zone Signing Key (ZSK) that is used to sign the zone. In order to be trusted, the KSK needs to be present in the parent zone (usually a top-level domain). If your registrar supports dnssec, you will have to send them your KSK's hash so they can add a DS record in their zone. This is not automated and need to be done each time you change your KSK.

The policy also defines the lifetime of keys. Usually, ZSK can be changed easily and use weaker cryptographic functions (they use lower parameters) in order to sign records quickly, so they are changed often. The KSK however requires manual interaction with the registrar, so they are changed less often and use stronger parameters because they sign only one record.

This type has the following parameters:

`id` (default: `""`)
: The id of the policy. It must not be empty.

`keystore` (default: `"default"`)
: A reference to a keystore, that is a string containing the identifier of a keystore defined in a `knot-keystore-configuration` field. The `"default"` identifier means the default keystore (a kasp database that was setup by this service).

`manual?` (default: `#f`)
: Whether the key management is manual or automatic.

`single-type-signing?` (default: `#f`)
: When `#t`, use the Single-Type Signing Scheme.

`algorithm` (default: `"ecdsap256sha256"`)
: An algorithm of signing keys and issued signatures.

`ksk-size` (default: `256`)
: The length of the KSK. Note that this value is correct for the default algorithm, but would be unsecure for other algorithms.

`zsk-size` (default: `256`)
: The length of the ZSK. Note that this value is correct for the default algorithm, but would be unsecure for other algorithms.

`dnskey-ttl` (default: `'default`)
: The TTL value for DNSKEY records added into zone apex. The special `'default` value means same as the zone SOA TTL.

`zsk-lifetime` (default: `(* 30 24 3600)`)
: The period between ZSK publication and the next rollover initiation.

`propagation-delay` (default: `(* 24 3600)`)
: An extra delay added for each key rollover step. This value should be high enough to cover propagation of data from the master server to all slaves.

`rrsig-lifetime` (default: `(* 14 24 3600)`)
: A validity period of newly issued signatures.

`rrsig-refresh` (default: `(* 7 24 3600)`)
: A period how long before a signature expiration the signature will be refreshed.

`nsec3?` (default: `#f`)
: When `#t`, NSEC3 will be used instead of NSEC.

`nsec3-iterations` (default: `5`)
: The number of additional times the hashing is performed.

`nsec3-salt-length` (default: `8`)
: The length of a salt field in octets, which is appended to the original owner name before hashing.

`nsec3-salt-lifetime` (default: `(* 30 24 3600)`)
: The validity period of newly issued salt field.

`knot-zone-configuration` [Data Type]

Data type representing a zone served by Knot. This type has the following parameters:

`domain` (default: `""`)
: The domain served by this configuration. It must not be empty.

`file` (default: `""`)
: The file where this zone is saved. This parameter is ignored by master zones. Empty means default location that depends on the domain name.

`zone` (default: `(zone-file)`)
: The content of the zone file. This parameter is ignored by slave zones. It must contain a zone-file record.

`master` (default: `'()`)
: A list of master remotes. When empty, this zone is a master. When set, this zone is a slave. This is a list of remotes identifiers.

`ddns-master` (default: `#f`)
: The main master. When empty, it defaults to the first master in the list of masters.

`notify` (default: `'()`)
: A list of slave remote identifiers.

`acl` (default: `'()`)
: A list of acl identifiers.

`semantic-checks?` (default: `#f`)
: When set, this adds more semantic checks to the zone.

`zonefile-sync` (default: `0`)
: The delay between a modification in memory and on disk. 0 means immediate synchronization.

`zonefile-load` (default: `#f`)
: The way the zone file contents are applied during zone load. Possible values are:

  - `#f` for using the default value from Knot,
  - `'none` for not using the zone file at all,
  - `'difference` for computing the difference between already available contents and zone contents and applying it to the current zone contents,
  - `'difference-no-serial` for the same as `'difference`, but ignoring the SOA serial in the zone file, while the server takes care of it automatically.

- 'whole for loading zone contents from the zone file.

journal-content (default: #f)
: The way the journal is used to store zone and its changes. Possible values are 'none to not use it at all, 'changes to store changes and 'all to store contents. #f does not set this option, so the default value from Knot is used.

max-journal-usage (default: #f)
: The maximum size for the journal on disk. #f does not set this option, so the default value from Knot is used.

max-journal-depth (default: #f)
: The maximum size of the history. #f does not set this option, so the default value from Knot is used.

max-zone-size (default: #f)
: The maximum size of the zone file. This limit is enforced for incoming transfer and updates. #f does not set this option, so the default value from Knot is used.

dnssec-policy (default: #f)
: A reference to a knot-policy-configuration record, or the special name "default". If the value is #f, there is no dnssec signing on this zone.

serial-policy (default: 'increment)
: A policy between 'increment and 'unixtime.

knot-configuration [Data Type]

Data type representing the Knot configuration. This type has the following parameters:

knot (default: knot)
: The Knot package.

run-directory (default: "/var/run/knot")
: The run directory. This directory will be used for pid file and sockets.

includes (default: '())
: A list of strings or file-like objects denoting other files that must be included at the top of the configuration file.

: This can be used to manage secrets out-of-band. For example, secret keys may be stored in an out-of-band file not managed by Guix, and thus not visible in /gnu/store—e.g., you could store secret key configuration in /etc/knot/secrets.conf and add this file to the includes list.

: One can generate a secret tsig key (for nsupdate and zone transfers with the keymgr command from the knot package. Note that the package is not automatically installed by the service. The following example shows how to generate a new tsig key:

```
keymgr -t mysecret > /etc/knot/secrets.conf
chmod 600 /etc/knot/secrets.conf
```

Also note that the generated key will be named *mysecret*, so it is the name that needs to be used in the *key* field of the `knot-acl-configuration` record and in other places that need to refer to that key.

It can also be used to add configuration not supported by this interface.

`listen-v4` (default: `"0.0.0.0"`)
: An ip address on which to listen.

`listen-v6` (default: `"::"`)
: An ip address on which to listen.

`listen-port` (default: `53`)
: A port on which to listen.

`keys` (default: `'()`)
: The list of knot-key-configuration used by this configuration.

`acls` (default: `'()`)
: The list of knot-acl-configuration used by this configuration.

`remotes` (default: `'()`)
: The list of knot-remote-configuration used by this configuration.

`zones` (default: `'()`)
: The list of knot-zone-configuration used by this configuration.

Knot Resolver Service

`knot-resolver-service-type` [Scheme Variable]

This is the type of the knot resolver service, whose value should be an `knot-resolver-configuration` object as in this example:

```
(service knot-resolver-service-type
         (knot-resolver-configuration
           (kresd-config-file (plain-file "kresd.conf" "
net.listen('192.168.0.1', 5353)
user('knot-resolver', 'knot-resolver')
modules = { 'hints > iterate', 'stats', 'predict' }
cache.size = 100 * MB
"))))
```

For more information, refer its manual (`https://knot-resolver.readthedocs.org/en/stable/daemon.html#configuration`).

`knot-resolver-configuration` [Data Type]

Data type representing the configuration of knot-resolver.

`package` (default: *knot-resolver*)
: Package object of the knot DNS resolver.

`kresd-config-file` (default: %kresd.conf)
: File-like object of the kresd configuration file to use, by default it will listen on `127.0.0.1` and `::1`.

`garbage-collection-interval` (default: 1000)
: Number of milliseconds for `kres-cache-gc` to periodically trim the cache.

Dnsmasq Service

`dnsmasq-service-type` [Scheme Variable]

This is the type of the dnsmasq service, whose value should be an `dnsmasq-configuration` object as in this example:

```
(service dnsmasq-service-type
         (dnsmasq-configuration
           (no-resolv? #t)
           (servers '("192.168.1.1"))))
```

`dnsmasq-configuration` [Data Type]

Data type representing the configuration of dnsmasq.

`package` (default: *dnsmasq*)
Package object of the dnsmasq server.

`no-hosts?` (default: `#f`)
When true, don't read the hostnames in /etc/hosts.

`port` (default: `53`)
The port to listen on. Setting this to zero completely disables DNS responses, leaving only DHCP and/or TFTP functions.

`local-service?` (default: `#t`)
Accept DNS queries only from hosts whose address is on a local subnet, ie a subnet for which an interface exists on the server.

`listen-addresses` (default: `'()`)
Listen on the given IP addresses.

`resolv-file` (default: `"/etc/resolv.conf"`)
The file to read the IP address of the upstream nameservers from.

`no-resolv?` (default: `#f`)
When true, don't read *resolv-file*.

`forward-private-reverse-lookup?` (default: `#t`)
When false, all reverse lookups for private IP ranges are answered with "no such domain" rather than being forwarded upstream.

`query-servers-in-order?` (default: `#f`)
When true, dnsmasq queries the servers in the same order as they appear in *servers*.

`servers` (default: `'()`)
Specify IP address of upstream servers directly.

`addresses` (default: `'()`)
For each entry, specify an IP address to return for any host in the given domains. Queries in the domains are never forwarded and always replied to with the specified IP address.

This is useful for redirecting hosts locally, for example:

```
(service dnsmasq-service-type
(dnsmasq-configuration
  (addresses
    '(; Redirect to a local web-server.
      "/example.org/127.0.0.1"
      ; Redirect subdomain to a specific IP.
      "/subdomain.example.org/192.168.1.42"))))
```

Note that rules in `/etc/hosts` take precedence over this.

`cache-size` (default: `150`)
: Set the size of dnsmasq's cache. Setting the cache size to zero disables caching.

`negative-cache?` (default: `#t`)
: When false, disable negative caching.

`cpe-id` (default: `#f`)
: If set, add a CPE (Customer-Premises Equipment) identifier to DNS queries which are forwarded upstream.

`tftp-enable?` (default: `#f`)
: Whether to enable the built-in TFTP server.

`tftp-no-fail?` (default: `#f`)
: If true, does not fail dnsmasq if the TFTP server could not start up.

`tftp-single-port?` (default: `#f`)
: Whether to use only one single port for TFTP.

`tftp-secure?` (default: `#f`)
: If true, only files owned by the user running the dnsmasq process are accessible.

  If dnsmasq is being run as root, different rules apply: `tftp-secure?` has no effect, but only files which have the world-readable bit set are accessible.

`tftp-max` (default: `#f`)
: If set, sets the maximal number of concurrent connections allowed.

`tftp-mtu` (default: `#f`)
: If set, sets the MTU for TFTP packets to that value.

`tftp-no-blocksize?` (default: `#f`)
: If true, stops the TFTP server from negotiating the blocksize with a client.

`tftp-lowercase?` (default: `#f`)
: Whether to convert all filenames in TFTP requests to lowercase.

`tftp-port-range` (default: `#f`)
: If set, fixes the dynamical ports (one per client) to the given range (`"<start>,<end>"`).

`tftp-root` (default: `/var/empty,lo`)
: Look for files to transfer using TFTP relative to the given directory. When this is set, TFTP paths which include '`..`' are rejected, to stop

clients getting outside the specified root. Absolute paths (starting with '`/`') are allowed, but they must be within the TFTP-root. If the optional interface argument is given, the directory is only used for TFTP requests via that interface.

`tftp-unique-root` (default: `#f`)
: If set, add the IP or hardware address of the TFTP client as a path component on the end of the TFTP-root. Only valid if a TFTP root is set and the directory exists. Defaults to adding IP address (in standard dotted-quad format).

  For instance, if `--tftp-root` is '`/tftp`' and client '`1.2.3.4`' requests file `myfile` then the effective path will be `/tftp/1.2.3.4/myfile` if `/tftp/1.2.3.4` exists or `/tftp/myfile` otherwise. When '`=mac`' is specified it will append the MAC address instead, using lowercase zero padded digits separated by dashes, e.g.: '`01-02-03-04-aa-bb`'. Note that resolving MAC addresses is only possible if the client is in the local network or obtained a DHCP lease from dnsmasq.

ddclient Service

The ddclient service described below runs the ddclient daemon, which takes care of automatically updating DNS entries for service providers such as Dyn (`https://dyn.com/dns/`).

The following example show instantiates the service with its default configuration:

```
(service ddclient-service-type)
```

Note that ddclient needs to access credentials that are stored in a *secret file*, by default `/etc/ddclient/secrets` (see `secret-file` below). You are expected to create this file manually, in an "out-of-band" fashion (you *could* make this file part of the service configuration, for instance by using `plain-file`, but it will be world-readable *via* `/gnu/store`). See the examples in the `share/ddclient` directory of the `ddclient` package.

Available `ddclient-configuration` fields are:

`package ddclient` [`ddclient-configuration` parameter]
: The ddclient package.

`integer daemon` [`ddclient-configuration` parameter]
: The period after which ddclient will retry to check IP and domain name.

  Defaults to '`300`'.

`boolean syslog` [`ddclient-configuration` parameter]
: Use syslog for the output.

  Defaults to '`#t`'.

`string mail` [`ddclient-configuration` parameter]
: Mail to user.

  Defaults to '`"root"`'.

`string mail-failure` [`ddclient-configuration` parameter]

Mail failed update to user.

Defaults to ‘`"root"`’.

`string pid` [`ddclient-configuration` parameter]

The ddclient PID file.

Defaults to ‘`"/var/run/ddclient/ddclient.pid"`’.

`boolean ssl` [`ddclient-configuration` parameter]

Enable SSL support.

Defaults to ‘`#t`’.

`string user` [`ddclient-configuration` parameter]

Specifies the user name or ID that is used when running ddclient program.

Defaults to ‘`"ddclient"`’.

`string group` [`ddclient-configuration` parameter]

Group of the user who will run the ddclient program.

Defaults to ‘`"ddclient"`’.

`string secret-file` [`ddclient-configuration` parameter]

Secret file which will be appended to `ddclient.conf` file. This file contains credentials for use by ddclient. You are expected to create it manually.

Defaults to ‘`"/etc/ddclient/secrets.conf"`’.

`list extra-options` [`ddclient-configuration` parameter]

Extra options will be appended to `ddclient.conf` file.

Defaults to ‘`()`’.

12.9.22 VNC Services

The `(gnu services vnc)` module provides services related to *Virtual Network Computing* (VNC), which makes it possible to locally use graphical Xorg applications running on a remote machine. Combined with a graphical manager that supports the *X Display Manager Control Protocol*, such as GDM (see [gdm], page 301) or LightDM (see [lightdm], page 306), it is possible to remote an entire desktop for a multi-user environment.

Xvnc

Xvnc is a VNC server that spawns its own X window server; which means it can run on headless servers. The Xvnc implementations provided by the `tigervnc-server` and `turbovnc` aim to be fast and efficient.

`Scheme Variable` *xvnc-service-type* [Variable]

The `xvnc-server-type` service can be configured via the `xvnc-configuration` record, documented below. A second virtual display could be made available on a remote machine via the following configuration:

```
(service xvnc-service-type
         (xvnc-configuration (display-number 10)))
```

As a demonstration, the `xclock` command could then be started on the remote machine on display number 10, and it could be displayed locally via the `vncviewer` command:

```
# Start xclock on the remote machine.
ssh -L5910:localhost:5910 -- guix shell xclock -- env DISPLAY=:10 xclock
# Access it via VNC.
guix shell tigervnc-client -- vncviewer localhost:5910
```

The following configuration combines XDMCP and Inetd to allow multiple users to concurrently use the remote system, login in graphically via the GDM display manager:

```
(operating-system
  [...]
  (services (cons*
             [...]
             (service xvnc-service-type (xvnc-configuration
                                         (display-number 5)
                                         (localhost? #f)
                                         (xdmcp? #t)
                                         (inetd? #t)))
             (modify-services %desktop-services
               (gdm-service-type config => (gdm-configuration
                                            (inherit config)
                                            (auto-suspend? #f)
                                            (xdmcp? #t)))))))
```

A remote user could then connect to it by using the `vncviewer` command or a compatible VNC client and start a desktop session of their choosing:

```
vncviewer remote-host:5905
```

Warning: Unless your machine is in a controlled environment, for security reasons, the `localhost?` configuration of the `xvnc-configuration` record should be left to its default `#t` value and exposed via a secure means such as an SSH port forward. The XDMCP port, UDP 177 should also be blocked from the outside by a firewall, as it is not a secure protocol and can expose login credentials in clear.

`xvnc-configuration` [Data Type]

Available `xvnc-configuration` fields are:

`xvnc` (default: `tigervnc-server`) (type: file-like)
: The package that provides the Xvnc binary.

`display-number` (default: `0`) (type: number)
: The display number used by Xvnc. You should set this to a number not already used a Xorg server.

`geometry` (default: `"1024x768"`) (type: string)
: The size of the desktop to be created.

`depth` (default: `24`) (type: color-depth)
: The pixel depth in bits of the desktop to be created. Accepted values are 16, 24 or 32.

`port` (type: maybe-port)
: The port on which to listen for connections from viewers. When left unspecified, it defaults to 5900 plus the display number.

`ipv4?` (default: `#t`) (type: boolean)
: Use IPv4 for incoming and outgoing connections.

`ipv6?` (default: `#t`) (type: boolean)
: Use IPv6 for incoming and outgoing connections.

`password-file` (type: maybe-string)
: The password file to use, if any. Refer to vncpasswd(1) to learn how to generate such a file.

`xdmcp?` (default: `#f`) (type: boolean)
: Query the XDMCP server for a session. This enables users to log in a desktop session from the login manager screen. For a multiple users scenario, you'll want to enable the `inetd?` option as well, so that each connection to the VNC server is handled separately rather than shared.

`inetd?` (default: `#f`) (type: boolean)
: Use an Inetd-style service, which runs the Xvnc server on demand.

`frame-rate` (default: `60`) (type: number)
: The maximum number of updates per second sent to each client.

`security-types` (default: `("None")`) (type: security-types)
: The allowed security schemes to use for incoming connections. The default is "None", which is safe given that Xvnc is configured to authenticate the user via the display manager, and only for local connections. Accepted values are any of the following: ("None" "VncAuth" "Plain" "TLSNone" "TLSVnc" "TLSPlain" "X509None" "X509Vnc")

`localhost?` (default: `#t`) (type: boolean)
: Only allow connections from the same machine. It is set to #true by default for security, which means SSH or another secure means should be used to expose the remote port.

`log-level` (default: `30`) (type: log-level)
: The log level, a number between 0 and 100, 100 meaning most verbose output. The log messages are output to syslog.

`extra-options` (default: `()`) (type: strings)
: This can be used to provide extra Xvnc options not exposed via this <xvnc-configuration> record.

12.9.23 VPN Services

The `(gnu services vpn)` module provides services related to *virtual private networks* (VPNs).

Bitmask

`bitmask-service-type` [Scheme Variable]

A service type for the Bitmask (`https://bitmask.net`) VPN client. It makes the client available in the system and loads its polkit policy. Please note that the client expects an active polkit-agent, which is either run by your desktop-environment or should be run manually.

OpenVPN

It provides a *client* service for your machine to connect to a VPN, and a *server* service for your machine to host a VPN.

`openvpn-client-service` [*#:config (openvpn-client-configuration)*] [Scheme Procedure]

Return a service that runs `openvpn`, a VPN daemon, as a client.

`openvpn-server-service` [*#:config (openvpn-server-configuration)*] [Scheme Procedure]

Return a service that runs `openvpn`, a VPN daemon, as a server.

Both can be run simultaneously.

`openvpn-client-configuration` [Data Type]

Available `openvpn-client-configuration` fields are:

`openvpn` (default: `openvpn`) (type: file-like)
: The OpenVPN package.

`pid-file` (default: `"/var/run/openvpn/openvpn.pid"`) (type: string)
: The OpenVPN pid file.

`proto` (default: `udp`) (type: proto)
: The protocol (UDP or TCP) used to open a channel between clients and servers.

`dev` (default: `tun`) (type: dev)
: The device type used to represent the VPN connection.

`ca` (default: `"/etc/openvpn/ca.crt"`) (type: maybe-string)
: The certificate authority to check connections against.

`cert` (default: `"/etc/openvpn/client.crt"`) (type: maybe-string)
: The certificate of the machine the daemon is running on. It should be signed by the authority given in `ca`.

`key` (default: `"/etc/openvpn/client.key"`) (type: maybe-string)
: The key of the machine the daemon is running on. It must be the key whose certificate is `cert`.

`comp-lzo?` (default: `#t`) (type: boolean)
: Whether to use the lzo compression algorithm.

`persist-key?` (default: `#t`) (type: boolean)
: Don’t re-read key files across SIGUSR1 or –ping-restart.

`persist-tun?` (default: `#t`) (type: boolean)
: Don't close and reopen TUN/TAP device or run up/down scripts across SIGUSR1 or –ping-restart restarts.

`fast-io?` (default: `#f`) (type: boolean)
: (Experimental) Optimize TUN/TAP/UDP I/O writes by avoiding a call to poll/epoll/select prior to the write operation.

`verbosity` (default: `3`) (type: number)
: Verbosity level.

`tls-auth` (default: `#f`) (type: tls-auth-client)
: Add an additional layer of HMAC authentication on top of the TLS control channel to protect against DoS attacks.

`auth-user-pass` (type: maybe-string)
: Authenticate with server using username/password. The option is a file containing username/password on 2 lines. Do not use a file-like object as it would be added to the store and readable by any user.

`verify-key-usage?` (default: `#t`) (type: key-usage)
: Whether to check the server certificate has server usage extension.

`bind?` (default: `#f`) (type: bind)
: Bind to a specific local port number.

`resolv-retry?` (default: `#t`) (type: resolv-retry)
: Retry resolving server address.

`remote` (default: `()`) (type: openvpn-remote-list)
: A list of remote servers to connect to.

`openvpn-remote-configuration` [Data Type]
: Available `openvpn-remote-configuration` fields are:

    `name` (default: `"my-server"`) (type: string)
    : Server name.

    `port` (default: `1194`) (type: number)
    : Port number the server listens to.

`openvpn-server-configuration` [Data Type]

Available `openvpn-server-configuration` fields are:

`openvpn` (default: `openvpn`) (type: file-like)
: The OpenVPN package.

`pid-file` (default: `"/var/run/openvpn/openvpn.pid"`) (type: string)
: The OpenVPN pid file.

`proto` (default: `udp`) (type: proto)
: The protocol (UDP or TCP) used to open a channel between clients and servers.

`dev` (default: `tun`) (type: dev)
: The device type used to represent the VPN connection.

`ca` (default: `"/etc/openvpn/ca.crt"`) (type: maybe-string)
: The certificate authority to check connections against.

`cert` (default: `"/etc/openvpn/client.crt"`) (type: maybe-string)
: The certificate of the machine the daemon is running on. It should be signed by the authority given in `ca`.

`key` (default: `"/etc/openvpn/client.key"`) (type: maybe-string)
: The key of the machine the daemon is running on. It must be the key whose certificate is `cert`.

`comp-lzo?` (default: `#t`) (type: boolean)
: Whether to use the lzo compression algorithm.

`persist-key?` (default: `#t`) (type: boolean)
: Don't re-read key files across SIGUSR1 or –ping-restart.

`persist-tun?` (default: `#t`) (type: boolean)
: Don't close and reopen TUN/TAP device or run up/down scripts across SIGUSR1 or –ping-restart restarts.

`fast-io?` (default: `#f`) (type: boolean)
: (Experimental) Optimize TUN/TAP/UDP I/O writes by avoiding a call to poll/epoll/select prior to the write operation.

`verbosity` (default: `3`) (type: number)
: Verbosity level.

`tls-auth` (default: `#f`) (type: tls-auth-server)
: Add an additional layer of HMAC authentication on top of the TLS control channel to protect against DoS attacks.

`port` (default: `1194`) (type: number)
: Specifies the port number on which the server listens.

`server` (default: `"10.8.0.0 255.255.255.0"`) (type: ip-mask)
: An ip and mask specifying the subnet inside the virtual network.

`server-ipv6` (default: `#f`) (type: cidr6)
: A CIDR notation specifying the IPv6 subnet inside the virtual network.

`dh` (default: `"/etc/openvpn/dh2048.pem"`) (type: string)
: The Diffie-Hellman parameters file.

`ifconfig-pool-persist` (default: `"/etc/openvpn/ipp.txt"`) (type: string)
: The file that records client IPs.

`redirect-gateway?` (default: `#f`) (type: gateway)
: When true, the server will act as a gateway for its clients.

`client-to-client?` (default: `#f`) (type: boolean)
: When true, clients are allowed to talk to each other inside the VPN.

`keepalive` (default: `(10 120)`) (type: keepalive)
: Causes ping-like messages to be sent back and forth over the link so that each side knows when the other side has gone down. `keepalive` requires

a pair. The first element is the period of the ping sending, and the second element is the timeout before considering the other side down.

`max-clients` (default: `100`) (type: number)
: The maximum number of clients.

`status` (default: `"/var/run/openvpn/status"`) (type: string)
: The status file. This file shows a small report on current connection. It is truncated and rewritten every minute.

`client-config-dir` (default: `()`) (type: openvpn-ccd-list)
: The list of configuration for some clients.

strongSwan

Currently, the strongSwan service only provides legacy-style configuration with `ipsec.conf` and `ipsec.secrets` files.

`strongswan-service-type` [Scheme Variable]

A service type for configuring strongSwan for IPsec VPN (Virtual Private Networking). Its value must be a `strongswan-configuration` record as in this example:

```
(service strongswan-service-type
         (strongswan-configuration
          (ipsec-conf "/etc/ipsec.conf")
          (ipsec-secrets "/etc/ipsec.secrets")))
```

`strongswan-configuration` [Data Type]

Data type representing the configuration of the StrongSwan service.

`strongswan`
: The strongSwan package to use for this service.

`ipsec-conf` (default: `#f`)
: The file name of your `ipsec.conf`. If not `#f`, then this and `ipsec-secrets` must both be strings.

`ipsec-secrets` (default `#f`)
: The file name of your `ipsec.secrets`. If not `#f`, then this and `ipsec-conf` must both be strings.

Wireguard

`wireguard-service-type` [Scheme Variable]

A service type for a Wireguard tunnel interface. Its value must be a `wireguard-configuration` record as in this example:

```
(service wireguard-service-type
         (wireguard-configuration
          (peers
           (list
            (wireguard-peer
             (name "my-peer")
```

```
                        (endpoint "my.wireguard.com:51820")
                        (public-key "hzpKg9X1yqu1axN6iJp0mWf6BZGo8m1wteKwtTmDGF4=")
                        (allowed-ips '("10.0.0.2/32")))))))
```

`wireguard-configuration` [Data Type]

Data type representing the configuration of the Wireguard service.

`wireguard`
: The wireguard package to use for this service.

`interface` (default: `"wg0"`)
: The interface name for the VPN.

`addresses` (default: `'("10.0.0.1/32")`)
: The IP addresses to be assigned to the above interface.

`port` (default: `51820`)
: The port on which to listen for incoming connections.

`dns` (default: `#f`)
: The DNS server(s) to announce to VPN clients via DHCP.

`private-key` (default: `"/etc/wireguard/private.key"`)
: The private key file for the interface. It is automatically generated if the file does not exist.

`peers` (default: `'()`)
: The authorized peers on this interface. This is a list of *wireguard-peer* records.

`pre-up` (default: `'()`)
: The script commands to be run before setting up the interface.

`post-up` (default: `'()`)
: The script commands to be run after setting up the interface.

`pre-down` (default: `'()`)
: The script commands to be run before tearing down the interface.

`post-down` (default: `'()`)
: The script commands to be run after tearing down the interface.

`table` (default: `"auto"`)
: The routing table to which routes are added, as a string. There are two special values: `"off"` that disables the creation of routes altogether, and `"auto"` (the default) that adds routes to the default table and enables special handling of default routes.

`wireguard-peer` [Data Type]

Data type representing a Wireguard peer attached to a given interface.

`name`
: The peer name.

`endpoint` (default: `#f`)
: The optional endpoint for the peer, such as `"demo.wireguard.com:51820"`.

`public-key`
: The peer public-key represented as a base64 string.

`allowed-ips`
: A list of IP addresses from which incoming traffic for this peer is allowed and to which incoming traffic for this peer is directed.

`keep-alive` (default: `#f`)
: An optional time interval in seconds. A packet will be sent to the server endpoint once per time interval. This helps receiving incoming connections from this peer when you are behind a NAT or a firewall.

12.9.24 Network File System

The `(gnu services nfs)` module provides the following services, which are most commonly used in relation to mounting or exporting directory trees as *network file systems* (NFS).

While it is possible to use the individual components that together make up a Network File System service, we recommended to configure an NFS server with the `nfs-service-type`.

NFS Service

The NFS service takes care of setting up all NFS component services, kernel configuration file systems, and installs configuration files in the locations that NFS expects.

`nfs-service-type` [Scheme Variable]
: A service type for a complete NFS server.

`nfs-configuration` [Data Type]
: This data type represents the configuration of the NFS service and all of its subsystems.

It has the following parameters:

`nfs-utils` (default: `nfs-utils`)
: The nfs-utils package to use.

`nfs-versions` (default: `'("4.2" "4.1" "4.0")`)
: If a list of string values is provided, the `rpc.nfsd` daemon will be limited to supporting the given versions of the NFS protocol.

`exports` (default: `'()`)
: This is a list of directories the NFS server should export. Each entry is a list consisting of two elements: a directory name and a string containing all options. This is an example in which the directory `/export` is served to all NFS clients as a read-only share:

```
(nfs-configuration
 (exports
  '(("/export"
     "*(ro,insecure,no_subtree_check,crossmnt,fsid=0)"))))
```

`rpcmountd-port` (default: `#f`)
: The network port that the `rpc.mountd` daemon should use.

`rpcstatd-port` (default: `#f`)
: The network port that the `rpc.statd` daemon should use.

`rpcbind` (default: `rpcbind`)
: The rpcbind package to use.

`idmap-domain` (default: `"localdomain"`)
: The local NFSv4 domain name.

`nfsd-port` (default: `2049`)
: The network port that the `nfsd` daemon should use.

`nfsd-threads` (default: `8`)
: The number of threads used by the `nfsd` daemon.

`nfsd-tcp?` (default: `#t`)
: Whether the `nfsd` daemon should listen on a TCP socket.

`nfsd-udp?` (default: `#f`)
: Whether the `nfsd` daemon should listen on a UDP socket.

`pipefs-directory` (default: `"/var/lib/nfs/rpc_pipefs"`)
: The directory where the pipefs file system is mounted.

`debug` (default: `'()"`)
: A list of subsystems for which debugging output should be enabled. This is a list of symbols. Any of these symbols are valid: `nfsd`, `nfs`, `rpc`, `idmap`, `statd`, or `mountd`.

If you don't need a complete NFS service or prefer to build it yourself you can use the individual component services that are documented below.

RPC Bind Service

The RPC Bind service provides a facility to map program numbers into universal addresses. Many NFS related services use this facility. Hence it is automatically started when a dependent service starts.

`rpcbind-service-type` [Scheme Variable]
: A service type for the RPC portmapper daemon.

`rpcbind-configuration` [Data Type]
: Data type representing the configuration of the RPC Bind Service. This type has the following parameters:

`rpcbind` (default: `rpcbind`)
: The rpcbind package to use.

`warm-start?` (default: `#t`)
: If this parameter is `#t`, then the daemon will read a state file on startup thus reloading state information saved by a previous instance.

Pipefs Pseudo File System

The pipefs file system is used to transfer NFS related data between the kernel and user space programs.

`pipefs-service-type` [Scheme Variable]

A service type for the pipefs pseudo file system.

`pipefs-configuration` [Data Type]

Data type representing the configuration of the pipefs pseudo file system service. This type has the following parameters:

`mount-point` (default: `"/var/lib/nfs/rpc_pipefs"`)
: The directory to which the file system is to be attached.

GSS Daemon Service

The *global security system* (GSS) daemon provides strong security for RPC based protocols. Before exchanging RPC requests an RPC client must establish a security context. Typically this is done using the Kerberos command `kinit` or automatically at login time using PAM services (see Section 12.9.17 [Kerberos Services], page 403).

`gss-service-type` [Scheme Variable]

A service type for the Global Security System (GSS) daemon.

`gss-configuration` [Data Type]

Data type representing the configuration of the GSS daemon service. This type has the following parameters:

`nfs-utils` (default: `nfs-utils`)
: The package in which the `rpc.gssd` command is to be found.

`pipefs-directory` (default: `"/var/lib/nfs/rpc_pipefs"`)
: The directory where the pipefs file system is mounted.

IDMAP Daemon Service

The idmap daemon service provides mapping between user IDs and user names. Typically it is required in order to access file systems mounted via NFSv4.

`idmap-service-type` [Scheme Variable]

A service type for the Identity Mapper (IDMAP) daemon.

`idmap-configuration` [Data Type]

Data type representing the configuration of the IDMAP daemon service. This type has the following parameters:

`nfs-utils` (default: `nfs-utils`)
: The package in which the `rpc.idmapd` command is to be found.

`pipefs-directory` (default: `"/var/lib/nfs/rpc_pipefs"`)
: The directory where the pipefs file system is mounted.

`domain` (default: `#f`)
: The local NFSv4 domain name. This must be a string or `#f`. If it is `#f` then the daemon will use the host's fully qualified domain name.

`verbosity` (default: `0`)
: The verbosity level of the daemon.

12.9.25 Samba Services

The `(gnu services samba)` module provides service definitions for Samba as well as additional helper services. Currently it provides the following services.

Samba

Samba (`https://www.samba.org`) provides network shares for folders and printers using the SMB/CIFS protocol commonly used on Windows. It can also act as an Active Directory Domain Controller (AD DC) for other hosts in an heterougenious network with different types of Computer systems.

`Scheme variable` *samba-service-type* [Variable]

The service type to enable the samba services `samba`, `nmbd`, `smbd` and `winbindd`. By default this service type does not run any of the Samba daemons; they must be enabled individually.

Below is a basic example that configures a simple, anonymous (unauthenticated) Samba file share exposing the `/public` directory.

> **Tip:** The `/public` directory and its contents must be world readable/writable, so you'll want to run '`chmod -R 777 /public`' on it.
>
> **Caution:** Such a Samba configuration should only be used in controlled environments, and you should not share any private files using it, as anyone connecting to your network would be able to access them.

```
(service samba-service-type (samba-configuration
                             (enable-smbd? #t)
                             (config-file (plain-file "smb.conf" "\
[global]
map to guest = Bad User
logging = syslog@1

[public]
browsable = yes
path = /public
read only = no
guest ok = yes
guest only = yes\n"))))
```

`samba-service-configuration` [Data Type]

Configuration record for the Samba suite.

`package` (default: `samba`)
: The samba package to use.

`config-file` (default: `#f`)
: The config file to use. To learn about its syntax, run '`man smb.conf`'.

`enable-samba?` (default: `#f`)
: Enable the `samba` daemon.

`enable-smbd?` (default: `#f`)
: Enable the `smbd` daemon.

`enable-nmbd?` (default: `#f`)
: Enable the `nmbd` daemon.

`enable-winbindd?` (default: `#f`)
: Enable the `winbindd` daemon.

Web Service Discovery Daemon

The WSDD (Web Service Discovery daemon) implements the Web Services Dynamic Discovery (`http://docs.oasis-open.org/ws-dd/discovery/1.1/os/wsdd-discovery-1.1-spec-os.html`) protocol that enables host discovery over Multicast DNS, similar to what Avahi does. It is a drop-in replacement for SMB hosts that have had SMBv1 disabled for security reasons.

`wsdd-service-type` [Scheme Variable]

Service type for the WSD host daemon. The value for this service type is a `wsdd-configuration` record. The details for the `wsdd-configuration` record type are given below.

`wsdd-configuration` [Data Type]

This data type represents the configuration for the wsdd service.

`package` (default: `wsdd`)
: The wsdd package to use.

`ipv4only?` (default: `#f`)
: Only listen to IPv4 addresses.

`ipv6only` (default: `#f`)
: Only listen to IPv6 addresses. Please note: Activating both options is not possible, since there would be no IP versions to listen to.

`chroot` (default: `#f`)
: Chroot into a separate directory to prevent access to other directories. This is to increase security in case there is a vulnerability in `wsdd`.

`hop-limit` (default: `1`)
: Limit to the level of hops for multicast packets. The default is *1* which should prevent packets from leaving the local network.

`interface` (default: `'()`)
: Limit to the given list of interfaces to listen to. By default wsdd will listen to all interfaces. Except the loopback interface is never used.

`uuid-device` (default: `#f`)
: The WSD protocol requires a device to have a UUID. Set this to manually assign the service a UUID.

`domain` (default: `#f`)
: Notify this host is a member of an Active Directory.

`host-name` (default: `#f`)
: Manually set the hostname rather than letting `wsdd` inherit this host's hostname. Only the host name part of a possible FQDN will be used in the default case.

`preserve-case?` (default: `#f`)
: By default `wsdd` will convert the hostname in workgroup to all uppercase. The opposite is true for hostnames in domains. Setting this parameter will preserve case.

`workgroup` (default: `"`*WORKGROUP*`"`)
: Change the name of the workgroup. By default `wsdd` reports this host being member of a workgroup.

12.9.26 Continuous Integration

Cuirass (`https://guix.gnu.org/cuirass/`) is a continuous integration tool for Guix. It can be used both for development and for providing substitutes to others (see Section 6.3 [Substitutes], page 48).

The `(gnu services cuirass)` module provides the following service.

`cuirass-service-type` [Scheme Procedure]
: The type of the Cuirass service. Its value must be a `cuirass-configuration` object, as described below.

To add build jobs, you have to set the `specifications` field of the configuration. For instance, the following example will build all the packages provided by the `my-channel` channel.

```
(define %cuirass-specs
  #~(list (specification
           (name "my-channel")
           (build '(channels my-channel))
           (channels
            (cons (channel
                   (name 'my-channel)
                   (url "https://my-channel.git"))
                  %default-channels)))))

(service cuirass-service-type
         (cuirass-configuration
          (specifications %cuirass-specs)))
```

To build the `linux-libre` package defined by the default Guix channel, one can use the following configuration.

```
(define %cuirass-specs
  #~(list (specification
           (name "my-linux")
           (build '(packages "linux-libre")))))

(service cuirass-service-type
         (cuirass-configuration
          (specifications %cuirass-specs)))
```

The other configuration possibilities, as well as the specification record itself are described in the Cuirass manual (see Section "Specifications" in *Cuirass*).

While information related to build jobs is located directly in the specifications, global settings for the `cuirass` process are accessible in other `cuirass-configuration` fields.

`cuirass-configuration` [Data Type]

Data type representing the configuration of Cuirass.

`cuirass` (default: `cuirass`)
: The Cuirass package to use.

`log-file` (default: `"/var/log/cuirass.log"`)
: Location of the log file.

`web-log-file` (default: `"/var/log/cuirass-web.log"`)
: Location of the log file used by the web interface.

`cache-directory` (default: `"/var/cache/cuirass"`)
: Location of the repository cache.

`user` (default: `"cuirass"`)
: Owner of the `cuirass` process.

`group` (default: `"cuirass"`)
: Owner's group of the `cuirass` process.

`interval` (default: `60`)
: Number of seconds between the poll of the repositories followed by the Cuirass jobs.

`parameters` (default: `#f`)
: Read parameters from the given *parameters* file. The supported parameters are described here (see Section "Parameters" in *Cuirass*).

`remote-server` (default: `#f`)
: A `cuirass-remote-server-configuration` record to use the build remote mechanism or `#f` to use the default build mechanism.

`database` (default: `"dbname=cuirass host=/var/run/postgresql"`)
: Use *database* as the database containing the jobs and the past build results. Since Cuirass uses PostgreSQL as a database engine, *database* must be a string such as `"dbname=cuirass host=localhost"`.

`port` (default: `8081`)
: Port number used by the HTTP server.

`host` (default: `"localhost"`)
: Listen on the network interface for *host*. The default is to accept connections from localhost.

`specifications` (default: `#~'()`)
: A gexp (see Section 9.12 [G-Expressions], page 154) that evaluates to a list of specifications records. The specification record is described in the Cuirass manual (see Section "Specifications" in *Cuirass*).

`use-substitutes?` (default: `#f`)
: This allows using substitutes to avoid building every dependencies of a job from source.

`one-shot?` (default: `#f`)
: Only evaluate specifications and build derivations once.

`fallback?` (default: `#f`)
: When substituting a pre-built binary fails, fall back to building packages locally.

`extra-options` (default: `'()`)
: Extra options to pass when running the Cuirass processes.

Cuirass remote building

Cuirass supports two mechanisms to build derivations.

- Using the local Guix daemon. This is the default build mechanism. Once the build jobs are evaluated, they are sent to the local Guix daemon. Cuirass then listens to the Guix daemon output to detect the various build events.
- Using the remote build mechanism. The build jobs are not submitted to the local Guix daemon. Instead, a remote server dispatches build requests to the connect remote workers, according to the build priorities.

To enable this build mode a `cuirass-remote-server-configuration` record must be passed as `remote-server` argument of the `cuirass-configuration` record. The `cuirass-remote-server-configuration` record is described below.

This build mode scales way better than the default build mode. This is the build mode that is used on the GNU Guix build farm at `https://ci.guix.gnu.org`. It should be preferred when using Cuirass to build large amount of packages.

`cuirass-remote-server-configuration` [Data Type]

Data type representing the configuration of the Cuirass remote-server.

`backend-port` (default: `5555`)
: The TCP port for communicating with `remote-worker` processes using ZMQ. It defaults to `5555`.

`log-port` (default: `5556`)
: The TCP port of the log server. It defaults to `5556`.

`publish-port` (default: `5557`)
: The TCP port of the publish server. It defaults to `5557`.

`log-file` (default: `"/var/log/cuirass-remote-server.log"`)
: Location of the log file.

`cache` (default: `"/var/cache/cuirass/remote"`)
: Use *cache* directory to cache build log files.

`trigger-url` (default: `#f`)
: Once a substitute is successfully fetched, trigger substitute baking at *trigger-url*.

`publish?` (default: `#t`)
: If set to false, do not start a publish server and ignore the `publish-port` argument. This can be useful if there is already a standalone publish server standing next to the remote server.

`public-key`
`private-key`
: Use the specific *file*s as the public/private key pair used to sign the store items being published.

At least one remote worker must also be started on any machine of the local network to actually perform the builds and report their status.

`cuirass-remote-worker-configuration` [Data Type]

Data type representing the configuration of the Cuirass remote-worker.

`cuirass` (default: `cuirass`)
: The Cuirass package to use.

`workers` (default: `1`)
: Start *workers* parallel workers.

`server` (default: `#f`)
: Do not use Avahi discovery and connect to the given `server` IP address instead.

`systems` (default: `(list (%current-system))`)
: Only request builds for the given *systems*.

`log-file` (default: `"/var/log/cuirass-remote-worker.log"`)
: Location of the log file.

`publish-port` (default: `5558`)
: The TCP port of the publish server. It defaults to `5558`.

`substitute-urls` (default: `%default-substitute-urls`)
: The list of URLs where to look for substitutes by default.

`public-key`
`private-key`
: Use the specific *file*s as the public/private key pair used to sign the store items being published.

Laminar

Laminar (`https://laminar.ohwg.net/`) is a lightweight and modular Continuous Integration service. It doesn't have a configuration web UI instead uses version-controllable configuration files and scripts.

Laminar encourages the use of existing tools such as bash and cron instead of reinventing them.

`laminar-service-type` [Scheme Procedure]

The type of the Laminar service. Its value must be a `laminar-configuration` object, as described below.

All configuration values have defaults, a minimal configuration to get Laminar running is shown below. By default, the web interface is available on port 8080.

```
(service laminar-service-type)
```

`laminar-configuration` [Data Type]

Data type representing the configuration of Laminar.

`laminar` (default: `laminar`)
: The Laminar package to use.

`home-directory` (default: `"/var/lib/laminar"`)
: The directory for job configurations and run directories.

`bind-http` (default: `"*:8080"`)
: The interface/port or unix socket on which laminard should listen for incoming connections to the web frontend.

`bind-rpc` (default: `"unix-abstract:laminar"`)
: The interface/port or unix socket on which laminard should listen for incoming commands such as build triggers.

`title` (default: `"Laminar"`)
: The page title to show in the web frontend.

`keep-rundirs` (default: `0`)
: Set to an integer defining how many rundirs to keep per job. The lowest-numbered ones will be deleted. The default is 0, meaning all run dirs will be immediately deleted.

`archive-url` (default: `#f`)
: The web frontend served by laminard will use this URL to form links to artefacts archived jobs.

`base-url` (default: `#f`)
: Base URL to use for links to laminar itself.

12.9.27 Power Management Services

TLP daemon

The `(gnu services pm)` module provides a Guix service definition for the Linux power management tool TLP.

TLP enables various powersaving modes in userspace and kernel. Contrary to `upower-service`, it is not a passive, monitoring tool, as it will apply custom settings each time a new power source is detected. More information can be found at TLP home page (`https://linrunner.de/en/tlp/tlp.html`).

`tlp-service-type` [Scheme Variable]

The service type for the TLP tool. The default settings are optimised for battery life on most systems, but you can tweak them to your heart's content by adding a valid `tlp-configuration`:

```
(service tlp-service-type
(tlp-configuration
 (cpu-scaling-governor-on-ac (list "performance"))
 (sched-powersave-on-bat? #t)))
```

Each parameter definition is preceded by its type; for example, '`boolean foo`' indicates that the `foo` parameter should be specified as a boolean. Types starting with `maybe-` denote parameters that won't show up in TLP config file when their value is left unset, or is explicitly set to the `%unset-value` value.

Available `tlp-configuration` fields are:

`package tlp` [`tlp-configuration` parameter]

The TLP package.

`boolean tlp-enable?` [`tlp-configuration` parameter]

Set to true if you wish to enable TLP.

Defaults to '`#t`'.

`string tlp-default-mode` [`tlp-configuration` parameter]

Default mode when no power supply can be detected. Alternatives are AC and BAT.

Defaults to '`"AC"`'.

`non-negative-integer disk-idle-secs-on-ac` [`tlp-configuration` parameter]

Number of seconds Linux kernel has to wait after the disk goes idle, before syncing on AC.

Defaults to '`0`'.

`non-negative-integer disk-idle-secs-on-bat` [`tlp-configuration` parameter]

Same as `disk-idle-ac` but on BAT mode.

Defaults to '`2`'.

`non-negative-integer max-lost-work-secs-on-ac` [`tlp-configuration` parameter]

Dirty pages flushing periodicity, expressed in seconds.

Defaults to '`15`'.

`non-negative-integer max-lost-work-secs-on-bat` [`tlp-configuration` parameter]

Same as `max-lost-work-secs-on-ac` but on BAT mode.

Defaults to '`60`'.

`maybe-space-separated-string-list cpu-scaling-governor-on-ac` [`tlp-configuration` parameter]

CPU frequency scaling governor on AC mode. With intel_pstate driver, alternatives are powersave and performance. With acpi-cpufreq driver, alternatives are ondemand, powersave, performance and conservative.

Defaults to '`disabled`'.

`maybe-space-separated-string-list` `cpu-scaling-governor-on-bat` [`tlp-configuration` parameter]

Same as `cpu-scaling-governor-on-ac` but on BAT mode.

Defaults to '`disabled`'.

`maybe-non-negative-integer` `cpu-scaling-min-freq-on-ac` [`tlp-configuration` parameter]

Set the min available frequency for the scaling governor on AC.

Defaults to '`disabled`'.

`maybe-non-negative-integer` `cpu-scaling-max-freq-on-ac` [`tlp-configuration` parameter]

Set the max available frequency for the scaling governor on AC.

Defaults to '`disabled`'.

`maybe-non-negative-integer` `cpu-scaling-min-freq-on-bat` [`tlp-configuration` parameter]

Set the min available frequency for the scaling governor on BAT.

Defaults to '`disabled`'.

`maybe-non-negative-integer` `cpu-scaling-max-freq-on-bat` [`tlp-configuration` parameter]

Set the max available frequency for the scaling governor on BAT.

Defaults to '`disabled`'.

`maybe-non-negative-integer` `cpu-min-perf-on-ac` [`tlp-configuration` parameter]

Limit the min P-state to control the power dissipation of the CPU, in AC mode. Values are stated as a percentage of the available performance.

Defaults to '`disabled`'.

`maybe-non-negative-integer` `cpu-max-perf-on-ac` [`tlp-configuration` parameter]

Limit the max P-state to control the power dissipation of the CPU, in AC mode. Values are stated as a percentage of the available performance.

Defaults to '`disabled`'.

`maybe-non-negative-integer` `cpu-min-perf-on-bat` [`tlp-configuration` parameter]

Same as `cpu-min-perf-on-ac` on BAT mode.

Defaults to '`disabled`'.

`maybe-non-negative-integer` `cpu-max-perf-on-bat` [`tlp-configuration` parameter]

Same as `cpu-max-perf-on-ac` on BAT mode.

Defaults to '`disabled`'.

`maybe-boolean cpu-boost-on-ac?` [`tlp-configuration` parameter]

Enable CPU turbo boost feature on AC mode.

Defaults to '`disabled`'.

`maybe-boolean cpu-boost-on-bat?` [`tlp-configuration` parameter]

Same as `cpu-boost-on-ac?` on BAT mode.

Defaults to '`disabled`'.

`boolean sched-powersave-on-ac?` [`tlp-configuration` parameter]

Allow Linux kernel to minimize the number of CPU cores/hyper-threads used under light load conditions.

Defaults to '`#f`'.

`boolean sched-powersave-on-bat?` [`tlp-configuration` parameter]

Same as `sched-powersave-on-ac?` but on BAT mode.

Defaults to '`#t`'.

`boolean nmi-watchdog?` [`tlp-configuration` parameter]

Enable Linux kernel NMI watchdog.

Defaults to '`#f`'.

`maybe-string phc-controls` [`tlp-configuration` parameter]

For Linux kernels with PHC patch applied, change CPU voltages. An example value would be '`"F:V F:V F:V F:V"`'.

Defaults to '`disabled`'.

`string energy-perf-policy-on-ac` [`tlp-configuration` parameter]

Set CPU performance versus energy saving policy on AC. Alternatives are performance, normal, powersave.

Defaults to '`"performance"`'.

`string energy-perf-policy-on-bat` [`tlp-configuration` parameter]

Same as `energy-perf-policy-ac` but on BAT mode.

Defaults to '`"powersave"`'.

`space-separated-string-list disks-devices` [`tlp-configuration` parameter]

Hard disk devices.

`space-separated-string-list disk-apm-level-on-ac` [`tlp-configuration` parameter]

Hard disk advanced power management level.

`space-separated-string-list disk-apm-level-on-bat` [`tlp-configuration` parameter]

Same as `disk-apm-bat` but on BAT mode.

`maybe-space-separated-string-list disk-spindown-timeout-on-ac` [`tlp-configuration` parameter]

Hard disk spin down timeout. One value has to be specified for each declared hard disk.

Defaults to '`disabled`'.

`maybe-space-separated-string-list disk-spindown-timeout-on-bat` [`tlp-configuration` parameter]

Same as `disk-spindown-timeout-on-ac` but on BAT mode.

Defaults to '`disabled`'.

`maybe-space-separated-string-list disk-iosched` [`tlp-configuration` parameter]

Select IO scheduler for disk devices. One value has to be specified for each declared hard disk. Example alternatives are cfq, deadline and noop.

Defaults to '`disabled`'.

`string sata-linkpwr-on-ac` [`tlp-configuration` parameter]

SATA aggressive link power management (ALPM) level. Alternatives are min_power, medium_power, max_performance.

Defaults to '`"max_performance"`'.

`string sata-linkpwr-on-bat` [`tlp-configuration` parameter]

Same as `sata-linkpwr-ac` but on BAT mode.

Defaults to '`"min_power"`'.

`maybe-string sata-linkpwr-blacklist` [`tlp-configuration` parameter]

Exclude specified SATA host devices for link power management.

Defaults to '`disabled`'.

`maybe-on-off-boolean ahci-runtime-pm-on-ac?` [`tlp-configuration` parameter]

Enable Runtime Power Management for AHCI controller and disks on AC mode.

Defaults to '`disabled`'.

`maybe-on-off-boolean ahci-runtime-pm-on-bat?` [`tlp-configuration` parameter]

Same as `ahci-runtime-pm-on-ac` on BAT mode.

Defaults to '`disabled`'.

`non-negative-integer ahci-runtime-pm-timeout` [`tlp-configuration` parameter]

Seconds of inactivity before disk is suspended.

Defaults to '`15`'.

`string pcie-aspm-on-ac` [`tlp-configuration` parameter]

PCI Express Active State Power Management level. Alternatives are default, performance, powersave.

Defaults to '`"performance"`'.

`string pcie-aspm-on-bat` [`tlp-configuration` parameter]

Same as `pcie-aspm-ac` but on BAT mode.

Defaults to ‘`"powersave"`’.

`maybe-non-negative-integer start-charge-thresh-bat0` [`tlp-configuration` parameter]

Percentage when battery 0 should begin charging. Only supported on some laptops.

Defaults to ‘`disabled`’.

`maybe-non-negative-integer stop-charge-thresh-bat0` [`tlp-configuration` parameter]

Percentage when battery 0 should stop charging. Only supported on some laptops.

Defaults to ‘`disabled`’.

`maybe-non-negative-integer start-charge-thresh-bat1` [`tlp-configuration` parameter]

Percentage when battery 1 should begin charging. Only supported on some laptops.

Defaults to ‘`disabled`’.

`maybe-non-negative-integer stop-charge-thresh-bat1` [`tlp-configuration` parameter]

Percentage when battery 1 should stop charging. Only supported on some laptops.

Defaults to ‘`disabled`’.

`string radeon-power-profile-on-ac` [`tlp-configuration` parameter]

Radeon graphics clock speed level. Alternatives are low, mid, high, auto, default.

Defaults to ‘`"high"`’.

`string radeon-power-profile-on-bat` [`tlp-configuration` parameter]

Same as `radeon-power-ac` but on BAT mode.

Defaults to ‘`"low"`’.

`string radeon-dpm-state-on-ac` [`tlp-configuration` parameter]

Radeon dynamic power management method (DPM). Alternatives are battery, performance.

Defaults to ‘`"performance"`’.

`string radeon-dpm-state-on-bat` [`tlp-configuration` parameter]

Same as `radeon-dpm-state-ac` but on BAT mode.

Defaults to ‘`"battery"`’.

`string radeon-dpm-perf-level-on-ac` [`tlp-configuration` parameter]

Radeon DPM performance level. Alternatives are auto, low, high.

Defaults to ‘`"auto"`’.

`string radeon-dpm-perf-level-on-bat` [`tlp-configuration` parameter]

Same as `radeon-dpm-perf-ac` but on BAT mode.

Defaults to ‘`"auto"`’.

`on-off-boolean wifi-pwr-on-ac?` [`tlp-configuration` parameter]

Wifi power saving mode.

Defaults to '`#f`'.

`on-off-boolean wifi-pwr-on-bat?` [`tlp-configuration` parameter]

Same as `wifi-power-ac?` but on BAT mode.

Defaults to '`#t`'.

`y-n-boolean wol-disable?` [`tlp-configuration` parameter]

Disable wake on LAN.

Defaults to '`#t`'.

`non-negative-integer sound-power-save-on-ac` [`tlp-configuration` parameter]

Timeout duration in seconds before activating audio power saving on Intel HDA and AC97 devices. A value of 0 disables power saving.

Defaults to '`0`'.

`non-negative-integer sound-power-save-on-bat` [`tlp-configuration` parameter]

Same as `sound-powersave-ac` but on BAT mode.

Defaults to '`1`'.

`y-n-boolean sound-power-save-controller?` [`tlp-configuration` parameter]

Disable controller in powersaving mode on Intel HDA devices.

Defaults to '`#t`'.

`boolean bay-poweroff-on-bat?` [`tlp-configuration` parameter]

Enable optical drive in UltraBay/MediaBay on BAT mode. Drive can be powered on again by releasing (and reinserting) the eject lever or by pressing the disc eject button on newer models.

Defaults to '`#f`'.

`string bay-device` [`tlp-configuration` parameter]

Name of the optical drive device to power off.

Defaults to '`"sr0"`'.

`string runtime-pm-on-ac` [`tlp-configuration` parameter]

Runtime Power Management for PCI(e) bus devices. Alternatives are on and auto.

Defaults to '`"on"`'.

`string runtime-pm-on-bat` [`tlp-configuration` parameter]

Same as `runtime-pm-ac` but on BAT mode.

Defaults to '`"auto"`'.

`boolean runtime-pm-all?` [`tlp-configuration` parameter]

Runtime Power Management for all PCI(e) bus devices, except blacklisted ones.

Defaults to '`#t`'.

`maybe-space-separated-string-list runtime-pm-blacklist` [`tlp-configuration` parameter]

Exclude specified PCI(e) device addresses from Runtime Power Management.

Defaults to '`disabled`'.

`space-separated-string-list runtime-pm-driver-blacklist` [`tlp-configuration` parameter]

Exclude PCI(e) devices assigned to the specified drivers from Runtime Power Management.

`boolean usb-autosuspend?` [`tlp-configuration` parameter]

Enable USB autosuspend feature.

Defaults to '`#t`'.

`maybe-string usb-blacklist` [`tlp-configuration` parameter]

Exclude specified devices from USB autosuspend.

Defaults to '`disabled`'.

`boolean usb-blacklist-wwan?` [`tlp-configuration` parameter]

Exclude WWAN devices from USB autosuspend.

Defaults to '`#t`'.

`maybe-string usb-whitelist` [`tlp-configuration` parameter]

Include specified devices into USB autosuspend, even if they are already excluded by the driver or via `usb-blacklist-wwan?`.

Defaults to '`disabled`'.

`maybe-boolean usb-autosuspend-disable-on-shutdown?` [`tlp-configuration` parameter]

Enable USB autosuspend before shutdown.

Defaults to '`disabled`'.

`boolean restore-device-state-on-startup?` [`tlp-configuration` parameter]

Restore radio device state (bluetooth, wifi, wwan) from previous shutdown on system startup.

Defaults to '`#f`'.

Thermald daemon

The `(gnu services pm)` module provides an interface to thermald, a CPU frequency scaling service which helps prevent overheating.

`thermald-service-type` [Scheme Variable]

This is the service type for thermald (`https://01.org/linux-thermal-daemon/`), the Linux Thermal Daemon, which is responsible for controlling the thermal state of processors and preventing overheating.

`thermald-configuration` [Data Type]

Data type representing the configuration of `thermald-service-type`.

`adaptive?` (default: `#f`)
: Use DPTF (Dynamic Power and Thermal Framework) adaptive tables when present.

`ignore-cpuid-check?` (default: `#f`)
: Ignore cpuid check for supported CPU models.

`thermald` (default: *thermald*)
: Package object of thermald.

12.9.28 Audio Services

The `(gnu services audio)` module provides a service to start MPD (the Music Player Daemon).

Music Player Daemon

The Music Player Daemon (MPD) is a service that can play music while being controlled from the local machine or over the network by a variety of clients.

The following example shows how one might run `mpd` as user `"bob"` on port `6666`. It uses pulseaudio for output.

```
(service mpd-service-type
         (mpd-configuration
          (user "bob")
          (port "6666")))
```

`mpd-service-type` [Scheme Variable]

The service type for `mpd`

`mpd-configuration` [Data Type]

Data type representing the configuration of `mpd`.

`user` (default: `"mpd"`)
: The user to run mpd as.

`music-dir` (default: `"~/Music"`)
: The directory to scan for music files.

`playlist-dir` (default: `"~/.mpd/playlists"`)
: The directory to store playlists.

`db-file` (default: `"~/.mpd/tag_cache"`)
: The location of the music database.

`state-file` (default: `"~/.mpd/state"`)
: The location of the file that stores current MPD's state.

`sticker-file` (default: `"~/.mpd/sticker.sql"`)
: The location of the sticker database.

`port` (default: `"6600"`)
: The port to run mpd on.

`address` (default: `"any"`)
: The address that mpd will bind to. To use a Unix domain socket, an absolute path can be specified here.

`outputs` (default: `"(list (mpd-output))"`)
: The audio outputs that MPD can use. By default this is a single output using pulseaudio.

`mpd-output` [Data Type]

Data type representing an `mpd` audio output.

`name` (default: `"MPD"`)
: The name of the audio output.

`type` (default: `"pulse"`)
: The type of audio output.

`enabled?` (default: `#t`)
: Specifies whether this audio output is enabled when MPD is started. By default, all audio outputs are enabled. This is just the default setting when there is no state file; with a state file, the previous state is restored.

`tags?` (default: `#t`)
: If set to `#f`, then MPD will not send tags to this output. This is only useful for output plugins that can receive tags, for example the `httpd` output plugin.

`always-on?` (default: `#f`)
: If set to `#t`, then MPD attempts to keep this audio output always open. This may be useful for streaming servers, when you don't want to disconnect all listeners even when playback is accidentally stopped.

`mixer-type`
: This field accepts a symbol that specifies which mixer should be used for this audio output: the `hardware` mixer, the `software` mixer, the `null` mixer (allows setting the volume, but with no effect; this can be used as a trick to implement an external mixer External Mixer) or no mixer (`none`).

`extra-options` (default: `'()`)
: An association list of option symbols to string values to be appended to the audio output configuration.

The following example shows a configuration of `mpd` that provides an HTTP audio streaming output.

```
(service mpd-service-type
         (mpd-configuration
           (outputs
             (list (mpd-output
                     (name "streaming")
                     (type "httpd")
                     (mixer-type 'null)
```

```
                          (extra-options
                           `((encoder . "vorbis")
                             (port    . "8080"))))))))
```

12.9.29 Virtualization Services

The `(gnu services virtualization)` module provides services for the libvirt and virtlog daemons, as well as other virtualization-related services.

Libvirt daemon

`libvirtd` is the server side daemon component of the libvirt virtualization management system. This daemon runs on host servers and performs required management tasks for virtualized guests.

`libvirt-service-type` [Scheme Variable]

This is the type of the libvirt daemon (`https://libvirt.org`). Its value must be a `libvirt-configuration`.

```
(service libvirt-service-type
         (libvirt-configuration
          (unix-sock-group "libvirt")
          (tls-port "16555")))
```

Available `libvirt-configuration` fields are:

`package libvirt` [`libvirt-configuration` parameter]

Libvirt package.

`boolean listen-tls?` [`libvirt-configuration` parameter]

Flag listening for secure TLS connections on the public TCP/IP port. You must set `listen` for this to have any effect.

It is necessary to setup a CA and issue server certificates before using this capability.

Defaults to '`#t`'.

`boolean listen-tcp?` [`libvirt-configuration` parameter]

Listen for unencrypted TCP connections on the public TCP/IP port. You must set `listen` for this to have any effect.

Using the TCP socket requires SASL authentication by default. Only SASL mechanisms which support data encryption are allowed. This is DIGEST_MD5 and GSSAPI (Kerberos5).

Defaults to '`#f`'.

`string tls-port` [`libvirt-configuration` parameter]

Port for accepting secure TLS connections. This can be a port number, or service name.

Defaults to '`"16514"`'.

`string tcp-port` [`libvirt-configuration` parameter]

Port for accepting insecure TCP connections. This can be a port number, or service name.

Defaults to '`"16509"`'.

`string listen-addr` [`libvirt-configuration` parameter]

IP address or hostname used for client connections.

Defaults to ‘`"0.0.0.0"`’.

`boolean mdns-adv?` [`libvirt-configuration` parameter]

Flag toggling mDNS advertisement of the libvirt service.

Alternatively can disable for all services on a host by stopping the Avahi daemon.

Defaults to ‘`#f`’.

`string mdns-name` [`libvirt-configuration` parameter]

Default mDNS advertisement name. This must be unique on the immediate broadcast network.

Defaults to ‘`"Virtualization Host <hostname>"`’.

`string unix-sock-group` [`libvirt-configuration` parameter]

UNIX domain socket group ownership. This can be used to allow a ’trusted’ set of users access to management capabilities without becoming root.

Defaults to ‘`"root"`’.

`string unix-sock-ro-perms` [`libvirt-configuration` parameter]

UNIX socket permissions for the R/O socket. This is used for monitoring VM status only.

Defaults to ‘`"0777"`’.

`string unix-sock-rw-perms` [`libvirt-configuration` parameter]

UNIX socket permissions for the R/W socket. Default allows only root. If PolicyKit is enabled on the socket, the default will change to allow everyone (eg, 0777)

Defaults to ‘`"0770"`’.

`string unix-sock-admin-perms` [`libvirt-configuration` parameter]

UNIX socket permissions for the admin socket. Default allows only owner (root), do not change it unless you are sure to whom you are exposing the access to.

Defaults to ‘`"0777"`’.

`string unix-sock-dir` [`libvirt-configuration` parameter]

The directory in which sockets will be found/created.

Defaults to ‘`"/var/run/libvirt"`’.

`string auth-unix-ro` [`libvirt-configuration` parameter]

Authentication scheme for UNIX read-only sockets. By default socket permissions allow anyone to connect

Defaults to ‘`"polkit"`’.

`string auth-unix-rw` [`libvirt-configuration` parameter]

Authentication scheme for UNIX read-write sockets. By default socket permissions only allow root. If PolicyKit support was compiled into libvirt, the default will be to use ’polkit’ auth.

Defaults to ‘`"polkit"`’.

`string auth-tcp` [`libvirt-configuration` parameter]

Authentication scheme for TCP sockets. If you don't enable SASL, then all TCP traffic is cleartext. Don't do this outside of a dev/test scenario.

Defaults to '`"sasl"`'.

`string auth-tls` [`libvirt-configuration` parameter]

Authentication scheme for TLS sockets. TLS sockets already have encryption provided by the TLS layer, and limited authentication is done by certificates.

It is possible to make use of any SASL authentication mechanism as well, by using 'sasl' for this option

Defaults to '`"none"`'.

`optional-list access-drivers` [`libvirt-configuration` parameter]

API access control scheme.

By default an authenticated user is allowed access to all APIs. Access drivers can place restrictions on this.

Defaults to '`()`'.

`string key-file` [`libvirt-configuration` parameter]

Server key file path. If set to an empty string, then no private key is loaded.

Defaults to '`""`'.

`string cert-file` [`libvirt-configuration` parameter]

Server key file path. If set to an empty string, then no certificate is loaded.

Defaults to '`""`'.

`string ca-file` [`libvirt-configuration` parameter]

Server key file path. If set to an empty string, then no CA certificate is loaded.

Defaults to '`""`'.

`string crl-file` [`libvirt-configuration` parameter]

Certificate revocation list path. If set to an empty string, then no CRL is loaded.

Defaults to '`""`'.

`boolean tls-no-sanity-cert` [`libvirt-configuration` parameter]

Disable verification of our own server certificates.

When libvirtd starts it performs some sanity checks against its own certificates.

Defaults to '`#f`'.

`boolean tls-no-verify-cert` [`libvirt-configuration` parameter]

Disable verification of client certificates.

Client certificate verification is the primary authentication mechanism. Any client which does not present a certificate signed by the CA will be rejected.

Defaults to '`#f`'.

`optional-list tls-allowed-dn-list` [`libvirt-configuration` parameter]

Whitelist of allowed x509 Distinguished Name.

Defaults to '`()`'.

`optional-list sasl-allowed-usernames` [`libvirt-configuration` parameter]

Whitelist of allowed SASL usernames. The format for username depends on the SASL authentication mechanism.

Defaults to '`()`'.

`string tls-priority` [`libvirt-configuration` parameter]

Override the compile time default TLS priority string. The default is usually '`"NORMAL"`' unless overridden at build time. Only set this is it is desired for libvirt to deviate from the global default settings.

Defaults to '`"NORMAL"`'.

`integer max-clients` [`libvirt-configuration` parameter]

Maximum number of concurrent client connections to allow over all sockets combined.

Defaults to '`5000`'.

`integer max-queued-clients` [`libvirt-configuration` parameter]

Maximum length of queue of connections waiting to be accepted by the daemon. Note, that some protocols supporting retransmission may obey this so that a later reattempt at connection succeeds.

Defaults to '`1000`'.

`integer max-anonymous-clients` [`libvirt-configuration` parameter]

Maximum length of queue of accepted but not yet authenticated clients. Set this to zero to turn this feature off

Defaults to '`20`'.

`integer min-workers` [`libvirt-configuration` parameter]

Number of workers to start up initially.

Defaults to '`5`'.

`integer max-workers` [`libvirt-configuration` parameter]

Maximum number of worker threads.

If the number of active clients exceeds `min-workers`, then more threads are spawned, up to max_workers limit. Typically you'd want max_workers to equal maximum number of clients allowed.

Defaults to '`20`'.

`integer prio-workers` [`libvirt-configuration` parameter]

Number of priority workers. If all workers from above pool are stuck, some calls marked as high priority (notably domainDestroy) can be executed in this pool.

Defaults to '`5`'.

`integer max-requests` [`libvirt-configuration` parameter]

Total global limit on concurrent RPC calls.

Defaults to '`20`'.

`integer max-client-requests` [`libvirt-configuration` parameter]

Limit on concurrent requests from a single client connection. To avoid one client monopolizing the server this should be a small fraction of the global max_requests and max_workers parameter.

Defaults to '`5`'.

`integer admin-min-workers` [`libvirt-configuration` parameter]

Same as `min-workers` but for the admin interface.

Defaults to '`1`'.

`integer admin-max-workers` [`libvirt-configuration` parameter]

Same as `max-workers` but for the admin interface.

Defaults to '`5`'.

`integer admin-max-clients` [`libvirt-configuration` parameter]

Same as `max-clients` but for the admin interface.

Defaults to '`5`'.

`integer admin-max-queued-clients` [`libvirt-configuration` parameter]

Same as `max-queued-clients` but for the admin interface.

Defaults to '`5`'.

`integer admin-max-client-requests` [`libvirt-configuration` parameter]

Same as `max-client-requests` but for the admin interface.

Defaults to '`5`'.

`integer log-level` [`libvirt-configuration` parameter]

Logging level. 4 errors, 3 warnings, 2 information, 1 debug.

Defaults to '`3`'.

`string log-filters` [`libvirt-configuration` parameter]

Logging filters.

A filter allows to select a different logging level for a given category of logs. The format for a filter is one of:

- x:name
- x:+name

where `name` is a string which is matched against the category given in the `VIR_LOG_INIT()` at the top of each libvirt source file, e.g., '`"remote"`', '`"qemu"`', or '`"util.json"`' (the name in the filter can be a substring of the full category name, in order to match multiple similar categories), the optional '`"+"`' prefix tells libvirt to log stack trace for each message matching name, and `x` is the minimal level where matching messages should be logged:

- 1: DEBUG
- 2: INFO
- 3: WARNING
- 4: ERROR

Multiple filters can be defined in a single filters statement, they just need to be separated by spaces.

Defaults to ‘`"3:remote 4:event"`’.

`string log-outputs` [`libvirt-configuration` parameter]

Logging outputs.

An output is one of the places to save logging information. The format for an output can be:

`x:stderr` output goes to stderr

`x:syslog:name`
use syslog for the output and use the given name as the ident

`x:file:file_path`
output to a file, with the given filepath

`x:journald`
output to journald logging system

In all case the x prefix is the minimal level, acting as a filter

- 1: DEBUG
- 2: INFO
- 3: WARNING
- 4: ERROR

Multiple outputs can be defined, they just need to be separated by spaces.

Defaults to ‘`"3:stderr"`’.

`integer audit-level` [`libvirt-configuration` parameter]

Allows usage of the auditing subsystem to be altered

- 0: disable all auditing
- 1: enable auditing, only if enabled on host
- 2: enable auditing, and exit if disabled on host.

Defaults to ‘`1`’.

`boolean audit-logging` [`libvirt-configuration` parameter]

Send audit messages via libvirt logging infrastructure.

Defaults to ‘`#f`’.

`optional-string host-uuid` [`libvirt-configuration` parameter]

Host UUID. UUID must not have all digits be the same.

Defaults to ‘`""`’.

`string host-uuid-source` [`libvirt-configuration` parameter]

Source to read host UUID.

- `smbios`: fetch the UUID from `dmidecode -s system-uuid`
- `machine-id`: fetch the UUID from `/etc/machine-id`

If `dmidecode` does not provide a valid UUID a temporary UUID will be generated.

Defaults to ‘`"smbios"`’.

`integer keepalive-interval` [`libvirt-configuration` parameter]

A keepalive message is sent to a client after `keepalive_interval` seconds of inactivity to check if the client is still responding. If set to -1, libvirtd will never send keepalive requests; however clients can still send them and the daemon will send responses.

Defaults to '`5`'.

`integer keepalive-count` [`libvirt-configuration` parameter]

Maximum number of keepalive messages that are allowed to be sent to the client without getting any response before the connection is considered broken.

In other words, the connection is automatically closed approximately after `keepalive_interval * (keepalive_count + 1)` seconds since the last message received from the client. When `keepalive-count` is set to 0, connections will be automatically closed after `keepalive-interval` seconds of inactivity without sending any keepalive messages.

Defaults to '`5`'.

`integer admin-keepalive-interval` [`libvirt-configuration` parameter]

Same as above but for admin interface.

Defaults to '`5`'.

`integer admin-keepalive-count` [`libvirt-configuration` parameter]

Same as above but for admin interface.

Defaults to '`5`'.

`integer ovs-timeout` [`libvirt-configuration` parameter]

Timeout for Open vSwitch calls.

The `ovs-vsctl` utility is used for the configuration and its timeout option is set by default to 5 seconds to avoid potential infinite waits blocking libvirt.

Defaults to '`5`'.

Virtlog daemon

The virtlogd service is a server side daemon component of libvirt that is used to manage logs from virtual machine consoles.

This daemon is not used directly by libvirt client applications, rather it is called on their behalf by `libvirtd`. By maintaining the logs in a standalone daemon, the main `libvirtd` daemon can be restarted without risk of losing logs. The `virtlogd` daemon has the ability to re-exec() itself upon receiving `SIGUSR1`, to allow live upgrades without downtime.

`virtlog-service-type` [Scheme Variable]

This is the type of the virtlog daemon. Its value must be a `virtlog-configuration`.

```
(service virtlog-service-type
         (virtlog-configuration
          (max-clients 1000)))
```

`libvirt parameter package` *libvirt* [Variable]

Libvirt package.

`integer log-level` [`virtlog-configuration` parameter]

Logging level. 4 errors, 3 warnings, 2 information, 1 debug.

Defaults to '`3`'.

`string log-filters` [`virtlog-configuration` parameter]

Logging filters.

A filter allows to select a different logging level for a given category of logs The format for a filter is one of:

- x:name
- x:+name

where `name` is a string which is matched against the category given in the `VIR_LOG_INIT()` at the top of each libvirt source file, e.g., "remote", "qemu", or "util.json" (the name in the filter can be a substring of the full category name, in order to match multiple similar categories), the optional `"+"` prefix tells libvirt to log stack trace for each message matching name, and `x` is the minimal level where matching messages should be logged:

- 1: DEBUG
- 2: INFO
- 3: WARNING
- 4: ERROR

Multiple filters can be defined in a single filters statement, they just need to be separated by spaces.

Defaults to '`"3:remote 4:event"`'.

`string log-outputs` [`virtlog-configuration` parameter]

Logging outputs.

An output is one of the places to save logging information The format for an output can be:

`x:stderr` output goes to stderr

`x:syslog:name`
: use syslog for the output and use the given name as the ident

`x:file:file_path`
: output to a file, with the given filepath

`x:journald`
: output to journald logging system

In all case the x prefix is the minimal level, acting as a filter

- 1: DEBUG
- 2: INFO
- 3: WARNING
- 4: ERROR

Multiple outputs can be defined, they just need to be separated by spaces.

Defaults to '`"3:stderr"`'.

`integer max-clients` [`virtlog-configuration` parameter]

Maximum number of concurrent client connections to allow over all sockets combined.

Defaults to '`1024`'.

`integer max-size` [`virtlog-configuration` parameter]

Maximum file size before rolling over.

Defaults to '`2MB`'

`integer max-backups` [`virtlog-configuration` parameter]

Maximum number of backup files to keep.

Defaults to '`3`'

Transparent Emulation with QEMU

`qemu-binfmt-service-type` provides support for transparent emulation of program binaries built for different architectures—e.g., it allows you to transparently execute an ARMv7 program on an x86_64 machine. It achieves this by combining the QEMU (`https://www.qemu.org`) emulator and the `binfmt_misc` feature of the kernel Linux. This feature only allows you to emulate GNU/Linux on a different architecture, but see below for GNU/Hurd support.

`qemu-binfmt-service-type` [Scheme Variable]

This is the type of the QEMU/binfmt service for transparent emulation. Its value must be a `qemu-binfmt-configuration` object, which specifies the QEMU package to use as well as the architecture we want to emulated:

```
(service qemu-binfmt-service-type
         (qemu-binfmt-configuration
           (platforms (lookup-qemu-platforms "arm" "aarch64"))))
```

In this example, we enable transparent emulation for the ARM and aarch64 platforms. Running `herd stop qemu-binfmt` turns it off, and running `herd start qemu-binfmt` turns it back on (see Section "Invoking herd" in *The GNU Shepherd Manual*).

`qemu-binfmt-configuration` [Data Type]

This is the configuration for the `qemu-binfmt` service.

`platforms` (default: `'()`)

The list of emulated QEMU platforms. Each item must be a *platform object* as returned by `lookup-qemu-platforms` (see below).

For example, let's suppose you're on an x86_64 machine and you have this service:

```
(service qemu-binfmt-service-type
         (qemu-binfmt-configuration
           (platforms (lookup-qemu-platforms "arm"))))
```

You can run:

```
guix build -s armhf-linux inkscape
```

and it will build Inkscape for ARMv7 *as if it were a native build*, transparently using QEMU to emulate the ARMv7 CPU. Pretty handy if you'd like to test a package build for an architecture you don't have access to!

`qemu` (default: `qemu`)
The QEMU package to use.

`lookup-qemu-platforms` *`platforms...`* [Scheme Procedure]
Return the list of QEMU platform objects corresponding to *platforms*.... *platforms* must be a list of strings corresponding to platform names, such as `"arm"`, `"sparc"`, `"mips64el"`, and so on.

`qemu-platform?` *`obj`* [Scheme Procedure]
Return true if *obj* is a platform object.

`qemu-platform-name` *`platform`* [Scheme Procedure]
Return the name of *platform*—a string such as `"arm"`.

QEMU Guest Agent

The QEMU guest agent provides control over the emulated system to the host. The `qemu-guest-agent` service runs the agent on Guix guests. To control the agent from the host, open a socket by invoking QEMU with the following arguments:

```
qemu-system-x86_64 \
-chardev socket,path=/tmp/qga.sock,server=on,wait=off,id=qga0 \
-device virtio-serial \
-device virtserialport,chardev=qga0,name=org.qemu.guest_agent.0 \
...
```

This creates a socket at `/tmp/qga.sock` on the host. Once the guest agent is running, you can issue commands with `socat`:

```
$ guix shell socat -- socat unix-connect:/tmp/qga.sock stdio
{"execute": "guest-get-host-name"}
{"return": {"host-name": "guix"}}
```

See QEMU guest agent documentation (`https://wiki.qemu.org/Features/GuestAgent`) for more options and commands.

`qemu-guest-agent-service-type` [Scheme Variable]
Service type for the QEMU guest agent service.

`qemu-guest-agent-configuration` [Data Type]
Configuration for the `qemu-guest-agent` service.

`qemu` (default: `qemu-minimal`)
The QEMU package to use.

`device` (default: `""`)
File name of the device or socket the agent uses to communicate with the host. If empty, QEMU uses a default file name.

The Hurd in a Virtual Machine

Service `hurd-vm` provides support for running GNU/Hurd in a virtual machine (VM), a so-called *childhurd*. This service is meant to be used on GNU/Linux and the given GNU/Hurd operating system configuration is cross-compiled. The virtual machine is a Shepherd service that can be referred to by the names `hurd-vm` and `childhurd` and be controlled with commands such as:

```
herd start hurd-vm
herd stop childhurd
```

When the service is running, you can view its console by connecting to it with a VNC client, for example with:

```
guix shell tigervnc-client -- vncviewer localhost:5900
```

The default configuration (see `hurd-vm-configuration` below) spawns a secure shell (SSH) server in your GNU/Hurd system, which QEMU (the virtual machine emulator) redirects to port 10222 on the host. Thus, you can connect over SSH to the childhurd with:

```
ssh root@localhost -p 10022
```

The childhurd is volatile and stateless: it starts with a fresh root file system every time you restart it. By default though, all the files under `/etc/childhurd` on the host are copied as is to the root file system of the childhurd when it boots. This allows you to initialize "secrets" inside the VM: SSH host keys, authorized substitute keys, and so on—see the explanation of `secret-root` below.

`hurd-vm-service-type` [Scheme Variable]

This is the type of the Hurd in a Virtual Machine service. Its value must be a `hurd-vm-configuration` object, which specifies the operating system (see Section 12.2 [operating-system Reference], page 228) and the disk size for the Hurd Virtual Machine, the QEMU package to use as well as the options for running it.

For example:

```
(service hurd-vm-service-type
         (hurd-vm-configuration
          (disk-size (* 5000 (expt 2 20))) ;5G
          (memory-size 1024)))             ;1024MiB
```

would create a disk image big enough to build GNU Hello, with some extra memory.

`hurd-vm-configuration` [Data Type]

The data type representing the configuration for `hurd-vm-service-type`.

`os` (default: *%hurd-vm-operating-system*)
: The operating system to instantiate. This default is bare-bones with a permissive OpenSSH secure shell daemon listening on port 2222 (see Section 12.9.5 [Networking Services], page 277).

`qemu` (default: `qemu-minimal`)
: The QEMU package to use.

`image` (default: *hurd-vm-disk-image*)
: The procedure used to build the disk-image built from this configuration.

`disk-size` (default: `'guess`)
: The size of the disk image.

`memory-size` (default: `512`)
: The memory size of the Virtual Machine in mebibytes.

`options` (default: `'("--snapshot")`)
: The extra options for running QEMU.

`id` (default: `#f`)
: If set, a non-zero positive integer used to parameterize Childhurd instances. It is appended to the service's name, e.g. `childhurd1`.

`net-options` (default: *hurd-vm-net-options*)
: The procedure used to produce the list of QEMU networking options.

By default, it produces

```
'("--device" "rtl8139,netdev=net0"
  "--netdev" (string-append
              "user,id=net0,"
              "hostfwd=tcp:127.0.0.1:secrets-port-:1004,"
              "hostfwd=tcp:127.0.0.1:ssh-port-:2222,"
              "hostfwd=tcp:127.0.0.1:vnc-port-:5900"))
```

with forwarded ports:

```
secrets-port: (+ 11004 (* 1000 ID))
ssh-port: (+ 10022 (* 1000 ID))
vnc-port: (+ 15900 (* 1000 ID))
```

`secret-root` (default: `/etc/childhurd`)
: The root directory with out-of-band secrets to be installed into the childhurd once it runs. Childhurds are volatile which means that on every startup, secrets such as the SSH host keys and Guix signing key are recreated.

If the `/etc/childhurd` directory does not exist, the `secret-service` running in the Childhurd will be sent an empty list of secrets.

By default, the service automatically populates `/etc/childhurd` with the following non-volatile secrets, unless they already exist:

```
/etc/childhurd/etc/guix/acl
/etc/childhurd/etc/guix/signing-key.pub
/etc/childhurd/etc/guix/signing-key.sec
/etc/childhurd/etc/ssh/ssh_host_ed25519_key
/etc/childhurd/etc/ssh/ssh_host_ecdsa_key
/etc/childhurd/etc/ssh/ssh_host_ed25519_key.pub
/etc/childhurd/etc/ssh/ssh_host_ecdsa_key.pub
```

These files are automatically sent to the guest Hurd VM when it boots, including permissions.

Having these files in place means that only a couple of things are missing to allow the host to offload `i586-gnu` builds to the childhurd:

1. Authorizing the childhurd's key on the host so that the host accepts build results coming from the childhurd, which can be done like so:

   ```
   guix archive --authorize < \
     /etc/childhurd/etc/guix/signing-key.pub
   ```

2. Adding the childhurd to `/etc/guix/machines.scm` (see Section 2.4.2 [Daemon Offload Setup], page 11).

> We're working towards making that happen automatically—get in touch with us at `guix-devel@gnu.org` to discuss it!

Note that by default the VM image is volatile, i.e., once stopped the contents are lost. If you want a stateful image instead, override the configuration's `image` and `options` without the `--snapshot` flag using something along these lines:

```
(service hurd-vm-service-type
         (hurd-vm-configuration
          (image   (const "/out/of/store/writable/hurd.img"))
          (options '())))
```

Ganeti

> **Note:** This service is considered experimental. Configuration options may be changed in a backwards-incompatible manner, and not all features have been thorougly tested. Users of this service are encouraged to share their experience at `guix-devel@gnu.org`.

Ganeti is a virtual machine management system. It is designed to keep virtual machines running on a cluster of servers even in the event of hardware failures, and to make maintenance and recovery tasks easy. It consists of multiple services which are described later in this section. In addition to the Ganeti service, you will need the OpenSSH service (see Section 12.9.5 [Networking Services], page 277), and update the `/etc/hosts` file (see Section 12.2 [operating-system Reference], page 228) with the cluster name and address (or use a DNS server).

All nodes participating in a Ganeti cluster should have the same Ganeti and `/etc/hosts` configuration. Here is an example configuration for a Ganeti cluster node that supports multiple storage backends, and installs the `debootstrap` and `guix` *OS providers*:

```
(use-package-modules virtualization)
(use-service-modules base ganeti networking ssh)
(operating-system
  ;; ...
  (host-name "node1")
  (hosts-file (plain-file "hosts" (format #f "
127.0.0.1       localhost
::1             localhost

192.168.1.200   ganeti.example.com
192.168.1.201   node1.example.com node1
192.168.1.202   node2.example.com node2
")))

  ;; Install QEMU so we can use KVM-based instances, and LVM, DRBD and Ceph
  ;; in order to use the "plain", "drbd" and "rbd" storage backends.
  (packages (append (map specification->package
                         '("qemu" "lvm2" "drbd-utils" "ceph"
                           ;; Add the debootstrap and guix OS providers.
                           "ganeti-instance-guix" "ganeti-instance-debootstrap"))
```

```
                    %base-packages))
  (services
   (append (list (service static-networking-service-type
                          (list (static-networking
                                 (addresses
                                  (list (network-address
                                         (device "eth0")
                                         (value "192.168.1.201/24"))))
                                 (routes
                                  (list (network-route
                                         (destination "default")
                                         (gateway "192.168.1.254"))))
                                 (name-servers '("192.168.1.252"
                                                 "192.168.1.253")))))

                 ;; Ganeti uses SSH to communicate between nodes.
                 (service openssh-service-type
                          (openssh-configuration
                           (permit-root-login 'prohibit-password)))

                 (service ganeti-service-type
                          (ganeti-configuration
                           ;; This list specifies allowed file system paths
                           ;; for storing virtual machine images.
                           (file-storage-paths '("/srv/ganeti/file-storage"))
                           ;; This variable configures a single "variant" for
                           ;; both Debootstrap and Guix that works with KVM.
                           (os %default-ganeti-os))))
           %base-services)))
```

Users are advised to read the Ganeti administrators guide (`https://docs.ganeti.org/docs/ganeti/3.0/html/admin.html`) to learn about the various cluster options and day-to-day operations. There is also a blog post (`https://guix.gnu.org/blog/2020/running-a-ganeti-cluster-on-guix/`) describing how to configure and initialize a small cluster.

`ganeti-service-type` [Scheme Variable]

This is a service type that includes all the various services that Ganeti nodes should run.

Its value is a `ganeti-configuration` object that defines the package to use for CLI operations, as well as configuration for the various daemons. Allowed file storage paths and available guest operating systems are also configured through this data type.

`ganeti-configuration` [Data Type]

The `ganeti` service takes the following configuration options:

`ganeti` (default: `ganeti`)
: The `ganeti` package to use. It will be installed to the system profile and make `gnt-cluster`, `gnt-instance`, etc available. Note that the value specified here does not affect the other services as each refer to a specific `ganeti` package (see below).

`noded-configuration` (default: `(ganeti-noded-configuration)`)
`confd-configuration` (default: `(ganeti-confd-configuration)`)
`wconfd-configuration` (default: `(ganeti-wconfd-configuration)`)
`luxid-configuration` (default: `(ganeti-luxid-configuration)`)
`rapi-configuration` (default: `(ganeti-rapi-configuration)`)
`kvmd-configuration` (default: `(ganeti-kvmd-configuration)`)
`mond-configuration` (default: `(ganeti-mond-configuration)`)
`metad-configuration` (default: `(ganeti-metad-configuration)`)
`watcher-configuration` (default: `(ganeti-watcher-configuration)`)
`cleaner-configuration` (default: `(ganeti-cleaner-configuration)`)
: These options control the various daemons and cron jobs that are distributed with Ganeti. The possible values for these are described in detail below. To override a setting, you must use the configuration type for that service:

```
(service ganeti-service-type
         (ganeti-configuration
          (rapi-configuration
           (ganeti-rapi-configuration
            (interface "eth1"))))
          (watcher-configuration
           (ganeti-watcher-configuration
            (rapi-ip "10.0.0.1"))))
```

`file-storage-paths` (default: `'()`)
: List of allowed directories for file storage backend.

`os` (default: `%default-ganeti-os`)
: List of `<ganeti-os>` records.

In essence `ganeti-service-type` is shorthand for declaring each service individually:

```
(service ganeti-noded-service-type)
(service ganeti-confd-service-type)
(service ganeti-wconfd-service-type)
(service ganeti-luxid-service-type)
(service ganeti-kvmd-service-type)
(service ganeti-mond-service-type)
(service ganeti-metad-service-type)
(service ganeti-watcher-service-type)
(service ganeti-cleaner-service-type)
```

Plus a service extension for `etc-service-type` that configures the file storage backend and OS variants.

`ganeti-os` [Data Type]

This data type is suitable for passing to the `os` parameter of `ganeti-configuration`. It takes the following parameters:

`name` The name for this OS provider. It is only used to specify where the configuration ends up. Setting it to "debootstrap" will create `/etc/ganeti/instance-debootstrap`.

`extension` (default: `#f`)
The file extension for variants of this OS type. For example `.conf` or `.scm`. It will be appended to the variant file name if set.

`variants` (default: `'()`)
This must be either a list of `ganeti-os-variant` objects for this OS, or a "file-like" object (see Section 9.12 [G-Expressions], page 154) representing the variants directory.

To use the Guix OS provider with variant definitions residing in a local directory instead of declaring individual variants (see *guix-variants* below), you can do:

```
(ganeti-os
 (name "guix")
 (variants (local-file "ganeti-guix-variants"
                       #:recursive? #true)))
```

Note that you will need to maintain the `variants.list` file (see `ganeti-os-interface(7)` (`https://docs.ganeti.org/docs/ganeti/3.0/man/ganeti-os-interface.html`)) manually in this case.

`ganeti-os-variant` [Data Type]

This is the data type for a Ganeti OS variant. It takes the following parameters:

`name` The name of this variant.

`configuration`
A configuration file for this variant.

`%default-debootstrap-hooks` [Scheme Variable]

This variable contains hooks to configure networking and the GRUB bootloader.

`%default-debootstrap-extra-pkgs` [Scheme Variable]

This variable contains a list of packages suitable for a fully-virtualized guest.

`debootstrap-configuration` [Data Type]

This data type creates configuration files suitable for the debootstrap OS provider.

`hooks` (default: `%default-debootstrap-hooks`)
When not `#f`, this must be a G-expression that specifies a directory with scripts that will run when the OS is installed. It can also be a list of `(name . file-like)` pairs. For example:

```
`((99-hello-world . ,(plain-file "#!/bin/sh\necho Hello, World")))
```

That will create a directory with one executable named `99-hello-world` and run it every time this variant is installed. If set to `#f`, hooks in `/etc/ganeti/instance-debootstrap/hooks` will be used, if any.

`proxy` (default: `#f`)
: Optional HTTP proxy to use.

`mirror` (default: `#f`)
: The Debian mirror. Typically something like `http://ftp.no.debian.org/debian`. The default varies depending on the distribution.

`arch` (default: `#f`)
: The dpkg architecture. Set to `armhf` to debootstrap an ARMv7 instance on an AArch64 host. Default is to use the current system architecture.

`suite` (default: `"stable"`)
: When set, this must be a Debian distribution "suite" such as `buster` or `focal`. If set to `#f`, the default for the OS provider is used.

`extra-pkgs` (default: `%default-debootstrap-extra-pkgs`)
: List of extra packages that will get installed by dpkg in addition to the minimal system.

`components` (default: `#f`)
: When set, must be a list of Debian repository "components". For example `'("main" "contrib")`.

`generate-cache?` (default: `#t`)
: Whether to automatically cache the generated debootstrap archive.

`clean-cache` (default: `14`)
: Discard the cache after this amount of days. Use `#f` to never clear the cache.

`partition-style` (default: `'msdos`)
: The type of partition to create. When set, it must be one of `'msdos`, `'none` or a string.

`partition-alignment` (default: `2048`)
: Alignment of the partition in sectors.

`debootstrap-variant` *`name configuration`* [Scheme Procedure]
: This is a helper procedure that creates a `ganeti-os-variant` record. It takes two parameters: a name and a `debootstrap-configuration` object.

`debootstrap-os` *`variants...`* [Scheme Procedure]
: This is a helper procedure that creates a `ganeti-os` record. It takes a list of variants created with `debootstrap-variant`.

`guix-variant` *`name configuration`* [Scheme Procedure]
: This is a helper procedure that creates a `ganeti-os-variant` record for use with the Guix OS provider. It takes a name and a G-expression that returns a "file-like" (see Section 9.12 [G-Expressions], page 154) object containing a Guix System configuration.

`guix-os` *`variants...`* [Scheme Procedure]
: This is a helper procedure that creates a `ganeti-os` record. It takes a list of variants produced by `guix-variant`.

`%default-debootstrap-variants` [Scheme Variable]

This is a convenience variable to make the debootstrap provider work "out of the box" without users having to declare variants manually. It contains a single debootstrap variant with the default configuration:

```
(list (debootstrap-variant
       "default"
       (debootstrap-configuration)))
```

`%default-guix-variants` [Scheme Variable]

This is a convenience variable to make the Guix OS provider work without additional configuration. It creates a virtual machine that has an SSH server, a serial console, and authorizes the Ganeti hosts SSH keys.

```
(list (guix-variant
       "default"
       (file-append ganeti-instance-guix
                    "/share/doc/ganeti-instance-guix/examples/dynamic.scm")))
```

Users can implement support for OS providers unbeknownst to Guix by extending the `ganeti-os` and `ganeti-os-variant` records appropriately. For example:

```
(ganeti-os
 (name "custom")
 (extension ".conf")
 (variants
  (list (ganeti-os-variant
         (name "foo")
         (configuration (plain-file "bar" "this is fine"))))))
```

That creates `/etc/ganeti/instance-custom/variants/foo.conf` which points to a file in the store with contents `this is fine`. It also creates `/etc/ganeti/instance-custom/variants/variants.list` with contents `foo`.

Obviously this may not work for all OS providers out there. If you find the interface limiting, please reach out to `guix-devel@gnu.org`.

The rest of this section documents the various services that are included by `ganeti-service-type`.

`ganeti-noded-service-type` [Scheme Variable]

`ganeti-noded` is the daemon responsible for node-specific functions within the Ganeti system. The value of this service must be a `ganeti-noded-configuration` object.

`ganeti-noded-configuration` [Data Type]

This is the configuration for the `ganeti-noded` service.

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`port` (default: `1811`)
: The TCP port on which the node daemon listens for network requests.

`address` (default: `"0.0.0.0"`)
: The network address that the daemon will bind to. The default address means bind to all available addresses.

`interface` (default: `#f`)
: When this is set, it must be a specific network interface (e.g. `eth0`) that the daemon will bind to.

`max-clients` (default: `20`)
: This sets a limit on the maximum number of simultaneous client connections that the daemon will handle. Connections above this count are accepted, but no responses will be sent until enough connections have closed.

`ssl?` (default: `#t`)
: Whether to use SSL/TLS to encrypt network communications. The certificate is automatically provisioned by the cluster and can be rotated with `gnt-cluster renew-crypto`.

`ssl-key` (default: `"/var/lib/ganeti/server.pem"`)
: This can be used to provide a specific encryption key for TLS communications.

`ssl-cert` (default: `"/var/lib/ganeti/server.pem"`)
: This can be used to provide a specific certificate for TLS communications.

`debug?` (default: `#f`)
: When true, the daemon performs additional logging for debugging purposes. Note that this will leak encryption details to the log files, use with caution.

`ganeti-confd-service-type` [Scheme Variable]

`ganeti-confd` answers queries related to the configuration of a Ganeti cluster. The purpose of this daemon is to have a highly available and fast way to query cluster configuration values. It is automatically active on all *master candidates*. The value of this service must be a `ganeti-confd-configuration` object.

`ganeti-confd-configuration` [Data Type]

This is the configuration for the `ganeti-confd` service.

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`port` (default: `1814`)
: The UDP port on which to listen for network requests.

`address` (default: `"0.0.0.0"`)
: Network address that the daemon will bind to.

`debug?` (default: `#f`)
: When true, the daemon performs additional logging for debugging purposes.

`ganeti-wconfd-service-type` [Scheme Variable]

`ganeti-wconfd` is the daemon that has authoritative knowledge about the cluster configuration and is the only entity that can accept changes to it. All jobs that need to modify the configuration will do so by sending appropriate requests to this daemon. It only runs on the *master node* and will automatically disable itself on other nodes.

The value of this service must be a `ganeti-wconfd-configuration` object.

`ganeti-wconfd-configuration` [Data Type]

This is the configuration for the `ganeti-wconfd` service.

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`no-voting?` (default: `#f`)
: The daemon will refuse to start if the majority of cluster nodes does not agree that it is running on the master node. Set to `#t` to start even if a quorum can not be reached (dangerous, use with caution).

`debug?` (default: `#f`)
: When true, the daemon performs additional logging for debugging purposes.

`ganeti-luxid-service-type` [Scheme Variable]

`ganeti-luxid` is a daemon used to answer queries related to the configuration and the current live state of a Ganeti cluster. Additionally, it is the authoritative daemon for the Ganeti job queue. Jobs can be submitted via this daemon and it schedules and starts them.

It takes a `ganeti-luxid-configuration` object.

`ganeti-luxid-configuration` [Data Type]

This is the configuration for the `ganeti-luxid` service.

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`no-voting?` (default: `#f`)
: The daemon will refuse to start if it cannot verify that the majority of cluster nodes believes that it is running on the master node. Set to `#t` to ignore such checks and start anyway (this can be dangerous).

`debug?` (default: `#f`)
: When true, the daemon performs additional logging for debugging purposes.

`ganeti-rapi-service-type` [Scheme Variable]

`ganeti-rapi` provides a remote API for Ganeti clusters. It runs on the master node and can be used to perform cluster actions programmatically via a JSON-based RPC protocol.

Most query operations are allowed without authentication (unless *require-authentication?* is set), whereas write operations require explicit authorization via the `/var/lib/ganeti/rapi/users` file. See the Ganeti Remote API documentation (`https://docs.ganeti.org/docs/ganeti/3.0/html/rapi.html`) for more information.

The value of this service must be a `ganeti-rapi-configuration` object.

`ganeti-rapi-configuration` [Data Type]

This is the configuration for the `ganeti-rapi` service.

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`require-authentication?` (default: `#f`)
: Whether to require authentication even for read-only operations.

`port` (default: `5080`)
: The TCP port on which to listen to API requests.

`address` (default: `"0.0.0.0"`)
: The network address that the service will bind to. By default it listens on all configured addresses.

`interface` (default: `#f`)
: When set, it must specify a specific network interface such as `eth0` that the daemon will bind to.

`max-clients` (default: `20`)
: The maximum number of simultaneous client requests to handle. Further connections are allowed, but no responses are sent until enough connections have closed.

`ssl?` (default: `#t`)
: Whether to use SSL/TLS encryption on the RAPI port.

`ssl-key` (default: `"/var/lib/ganeti/server.pem"`)
: This can be used to provide a specific encryption key for TLS communications.

`ssl-cert` (default: `"/var/lib/ganeti/server.pem"`)
: This can be used to provide a specific certificate for TLS communications.

`debug?` (default: `#f`)
: When true, the daemon performs additional logging for debugging purposes. Note that this will leak encryption details to the log files, use with caution.

`ganeti-kvmd-service-type` [Scheme Variable]

`ganeti-kvmd` is responsible for determining whether a given KVM instance was shut down by an administrator or a user. Normally Ganeti will restart an instance that was not stopped through Ganeti itself. If the cluster option `user_shutdown` is true, this daemon monitors the `QMP` socket provided by QEMU and listens for shutdown events, and marks the instance as *USER_down* instead of *ERROR_down* when it shuts down gracefully by itself.

It takes a `ganeti-kvmd-configuration` object.

`ganeti-kvmd-configuration` [Data Type]

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`debug?` (default: `#f`)
: When true, the daemon performs additional logging for debugging purposes.

`ganeti-mond-service-type` [Scheme Variable]

`ganeti-mond` is an optional daemon that provides Ganeti monitoring functionality. It is responsible for running data collectors and publish the collected information through a HTTP interface.

It takes a `ganeti-mond-configuration` object.

`ganeti-mond-configuration` [Data Type]

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`port` (default: `1815`)
: The port on which the daemon will listen.

`address` (default: `"0.0.0.0"`)
: The network address that the daemon will bind to. By default it binds to all available interfaces.

`debug?` (default: `#f`)
: When true, the daemon performs additional logging for debugging purposes.

`ganeti-metad-service-type` [Scheme Variable]

`ganeti-metad` is an optional daemon that can be used to provide information about the cluster to instances or OS install scripts.

It takes a `ganeti-metad-configuration` object.

`ganeti-metad-configuration` [Data Type]

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`port` (default: `80`)
: The port on which the daemon will listen.

`address` (default: `#f`)
: If set, the daemon will bind to this address only. If left unset, the behavior depends on the cluster configuration.

`debug?` (default: `#f`)
: When true, the daemon performs additional logging for debugging purposes.

`ganeti-watcher-service-type` [Scheme Variable]

`ganeti-watcher` is a script designed to run periodically and ensure the health of a cluster. It will automatically restart instances that have stopped without Ganeti's consent, and repairs DRBD links in case a node has rebooted. It also archives old cluster jobs and restarts Ganeti daemons that are not running. If the cluster parameter `ensure_node_health` is set, the watcher will also shutdown instances and DRBD devices if the node it is running on is declared offline by known master candidates.

It can be paused on all nodes with `gnt-cluster watcher pause`.

The service takes a `ganeti-watcher-configuration` object.

`ganeti-watcher-configuration` [Data Type]

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for this service.

`schedule` (default: `'(next-second-from (next-minute (range 0 60 5)))`)
: How often to run the script. The default is every five minutes.

`rapi-ip` (default: `#f`)
: This option needs to be specified only if the RAPI daemon is configured to use a particular interface or address. By default the cluster address is used.

`job-age` (default: `(* 6 3600)`)
: Archive cluster jobs older than this age, specified in seconds. The default is 6 hours. This keeps `gnt-job list` manageable.

`verify-disks?` (default: `#t`)
: If this is `#f`, the watcher will not try to repair broken DRBD links automatically. Administrators will need to use `gnt-cluster verify-disks` manually instead.

`debug?` (default: `#f`)
: When `#t`, the script performs additional logging for debugging purposes.

`ganeti-cleaner-service-type` [Scheme Variable]

`ganeti-cleaner` is a script designed to run periodically and remove old files from the cluster. This service type controls two *cron jobs*: one intended for the master node that permanently purges old cluster jobs, and one intended for every node that removes expired X509 certificates, keys, and outdated `ganeti-watcher` information. Like all Ganeti services, it is safe to include even on non-master nodes as it will disable itself as necessary.

It takes a `ganeti-cleaner-configuration` object.

`ganeti-cleaner-configuration` [Data Type]

`ganeti` (default: `ganeti`)
: The `ganeti` package to use for the `gnt-cleaner` command.

`master-schedule` (default: `"45 1 * * *"`)
: How often to run the master cleaning job. The default is once per day, at 01:45:00.

`node-schedule` (default: `"45 2 * * *"`)
: How often to run the node cleaning job. The default is once per day, at 02:45:00.

12.9.30 Version Control Services

The `(gnu services version-control)` module provides a service to allow remote access to local Git repositories. There are three options: the `git-daemon-service`, which provides access to repositories via the `git://` unsecured TCP-based protocol, extending the `nginx` web server to proxy some requests to `git-http-backend`, or providing a web interface with `cgit-service-type`.

`git-daemon-service` [*#:config* (*git-daemon-configuration*)] [Scheme Procedure]

Return a service that runs `git daemon`, a simple TCP server to expose repositories over the Git protocol for anonymous access.

The optional *config* argument should be a `<git-daemon-configuration>` object, by default it allows read-only access to exported[6] repositories under `/srv/git`.

`git-daemon-configuration` [Data Type]

Data type representing the configuration for `git-daemon-service`.

`package` (default: `git`)
: Package object of the Git distributed version control system.

`export-all?` (default: `#f`)
: Whether to allow access for all Git repositories, even if they do not have the `git-daemon-export-ok` file.

`base-path` (default: `/srv/git`)
: Whether to remap all the path requests as relative to the given path. If you run `git daemon` with `(base-path "/srv/git")` on '`example.com`', then if you later try to pull '`git://example.com/hello.git`', git daemon will interpret the path as `/srv/git/hello.git`.

`user-path` (default: `#f`)
: Whether to allow `~user` notation to be used in requests. When specified with empty string, requests to '`git://host/~alice/foo`' is taken as a request to access `foo` repository in the home directory of user `alice`. If `(user-path "`*`path`*`")` is specified, the same request is taken as a request to access *`path`*`/foo` repository in the home directory of user `alice`.

`listen` (default: `'()`)
: Whether to listen on specific IP addresses or hostnames, defaults to all.

`port` (default: `#f`)
: Whether to listen on an alternative port, which defaults to 9418.

`whitelist` (default: `'()`)
: If not empty, only allow access to this list of directories.

`extra-options` (default: `'()`)
: Extra options will be passed to `git daemon`, please run `man git-daemon` for more information.

[6] By creating the magic file `git-daemon-export-ok` in the repository directory.

The `git://` protocol lacks authentication. When you pull from a repository fetched via `git://`, you don't know whether the data you receive was modified or is even coming from the specified host, and your connection is subject to eavesdropping. It's better to use an authenticated and encrypted transport, such as `https`. Although Git allows you to serve repositories using unsophisticated file-based web servers, there is a faster protocol implemented by the `git-http-backend` program. This program is the back-end of a proper Git web service. It is designed to sit behind a FastCGI proxy. See Section 12.9.19 [Web Services], page 411, for more on running the necessary `fcgiwrap` daemon.

Guix has a separate configuration data type for serving Git repositories over HTTP.

`git-http-configuration` [Data Type]

Data type representing the configuration for a future `git-http-service-type`; can currently be used to configure Nginx through `git-http-nginx-location-configuration`.

`package` (default: *git*)
: Package object of the Git distributed version control system.

`git-root` (default: `/srv/git`)
: Directory containing the Git repositories to expose to the world.

`export-all?` (default: `#f`)
: Whether to expose access for all Git repositories in *git-root*, even if they do not have the `git-daemon-export-ok` file.

`uri-path` (default: '`/git/`')
: Path prefix for Git access. With the default '`/git/`' prefix, this will map '`http://`*server*`/git/`*repo*`.git`' to `/srv/git/`*repo*`.git`. Requests whose URI paths do not begin with this prefix are not passed on to this Git instance.

`fcgiwrap-socket` (default: `127.0.0.1:9000`)
: The socket on which the `fcgiwrap` daemon is listening. See Section 12.9.19 [Web Services], page 411.

There is no `git-http-service-type`, currently; instead you can create an `nginx-location-configuration` from a `git-http-configuration` and then add that location to a web server.

`git-http-nginx-location-configuration` [Scheme Procedure]
[*config=*(*git-http-configuration*)]

Compute an `nginx-location-configuration` that corresponds to the given Git http configuration. An example nginx service definition to serve the default `/srv/git` over HTTPS might be:

```
(service nginx-service-type
         (nginx-configuration
          (server-blocks
           (list
            (nginx-server-configuration
             (listen '("443 ssl"))
```

```
                      (server-name "git.my-host.org")
                      (ssl-certificate
                       "/etc/letsencrypt/live/git.my-host.org/fullchain.pem")
                      (ssl-certificate-key
                       "/etc/letsencrypt/live/git.my-host.org/privkey.pem")
                      (locations
                       (list
                        (git-http-nginx-location-configuration
                         (git-http-configuration (uri-path "/"))))))))))
```

This example assumes that you are using Let's Encrypt to get your TLS certificate. See Section 12.9.20 [Certificate Services], page 429. The default `certbot` service will redirect all HTTP traffic on `git.my-host.org` to HTTPS. You will also need to add an `fcgiwrap` proxy to your system services. See Section 12.9.19 [Web Services], page 411.

Cgit Service

Cgit (`https://git.zx2c4.com/cgit/`) is a web frontend for Git repositories written in C.

The following example will configure the service with default values. By default, Cgit can be accessed on port 80 (`http://localhost:80`).

```
(service cgit-service-type)
```

The `file-object` type designates either a file-like object (see Section 9.12 [G-Expressions], page 154) or a string.

Available `cgit-configuration` fields are:

`package package` [`cgit-configuration` parameter]

The CGIT package.

`nginx-server-configuration-list nginx` [`cgit-configuration` parameter]

NGINX configuration.

`file-object about-filter` [`cgit-configuration` parameter]

Specifies a command which will be invoked to format the content of about pages (both top-level and for each repository).

Defaults to '`""`'.

`string agefile` [`cgit-configuration` parameter]

Specifies a path, relative to each repository path, which can be used to specify the date and time of the youngest commit in the repository.

Defaults to '`""`'.

`file-object auth-filter` [`cgit-configuration` parameter]

Specifies a command that will be invoked for authenticating repository access.

Defaults to '`""`'.

`string branch-sort` [`cgit-configuration` parameter]

Flag which, when set to '`age`', enables date ordering in the branch ref list, and when set '`name`' enables ordering by branch name.

Defaults to '`"name"`'.

`string cache-root` [`cgit-configuration` parameter]

Path used to store the cgit cache entries.

Defaults to ‘`"/var/cache/cgit"`’.

`integer cache-static-ttl` [`cgit-configuration` parameter]

Number which specifies the time-to-live, in minutes, for the cached version of repository pages accessed with a fixed SHA1.

Defaults to ‘`-1`’.

`integer cache-dynamic-ttl` [`cgit-configuration` parameter]

Number which specifies the time-to-live, in minutes, for the cached version of repository pages accessed without a fixed SHA1.

Defaults to ‘`5`’.

`integer cache-repo-ttl` [`cgit-configuration` parameter]

Number which specifies the time-to-live, in minutes, for the cached version of the repository summary page.

Defaults to ‘`5`’.

`integer cache-root-ttl` [`cgit-configuration` parameter]

Number which specifies the time-to-live, in minutes, for the cached version of the repository index page.

Defaults to ‘`5`’.

`integer cache-scanrc-ttl` [`cgit-configuration` parameter]

Number which specifies the time-to-live, in minutes, for the result of scanning a path for Git repositories.

Defaults to ‘`15`’.

`integer cache-about-ttl` [`cgit-configuration` parameter]

Number which specifies the time-to-live, in minutes, for the cached version of the repository about page.

Defaults to ‘`15`’.

`integer cache-snapshot-ttl` [`cgit-configuration` parameter]

Number which specifies the time-to-live, in minutes, for the cached version of snapshots.

Defaults to ‘`5`’.

`integer cache-size` [`cgit-configuration` parameter]

The maximum number of entries in the cgit cache. When set to ‘`0`’, caching is disabled.

Defaults to ‘`0`’.

`boolean case-sensitive-sort?` [`cgit-configuration` parameter]

Sort items in the repo list case sensitively.

Defaults to ‘`#t`’.

`list clone-prefix` [`cgit-configuration` parameter]

List of common prefixes which, when combined with a repository URL, generates valid clone URLs for the repository.

Defaults to '`()`'.

`list clone-url` [`cgit-configuration` parameter]

List of `clone-url` templates.

Defaults to '`()`'.

`file-object commit-filter` [`cgit-configuration` parameter]

Command which will be invoked to format commit messages.

Defaults to '`""`'.

`string commit-sort` [`cgit-configuration` parameter]

Flag which, when set to '`date`', enables strict date ordering in the commit log, and when set to '`topo`' enables strict topological ordering.

Defaults to '`"git log"`'.

`file-object css` [`cgit-configuration` parameter]

URL which specifies the css document to include in all cgit pages.

Defaults to '`"/share/cgit/cgit.css"`'.

`file-object email-filter` [`cgit-configuration` parameter]

Specifies a command which will be invoked to format names and email address of committers, authors, and taggers, as represented in various places throughout the cgit interface.

Defaults to '`""`'.

`boolean embedded?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit generate a HTML fragment suitable for embedding in other HTML pages.

Defaults to '`#f`'.

`boolean enable-commit-graph?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit print an ASCII-art commit history graph to the left of the commit messages in the repository log page.

Defaults to '`#f`'.

`boolean enable-filter-overrides?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', allows all filter settings to be overridden in repository-specific cgitrc files.

Defaults to '`#f`'.

`boolean enable-follow-links?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', allows users to follow a file in the log view.

Defaults to '`#f`'.

`boolean enable-http-clone?` [`cgit-configuration` parameter]

If set to '`#t`', cgit will act as an dumb HTTP endpoint for Git clones.

Defaults to '`#t`'.

`boolean enable-index-links?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit generate extra links "summary", "commit", "tree" for each repo in the repository index.

Defaults to '`#f`'.

`boolean enable-index-owner?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit display the owner of each repo in the repository index.

Defaults to '`#t`'.

`boolean enable-log-filecount?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit print the number of modified files for each commit on the repository log page.

Defaults to '`#f`'.

`boolean enable-log-linecount?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit print the number of added and removed lines for each commit on the repository log page.

Defaults to '`#f`'.

`boolean enable-remote-branches?` [`cgit-configuration` parameter]

Flag which, when set to `#t`, will make cgit display remote branches in the summary and refs views.

Defaults to '`#f`'.

`boolean enable-subject-links?` [`cgit-configuration` parameter]

Flag which, when set to `1`, will make cgit use the subject of the parent commit as link text when generating links to parent commits in commit view.

Defaults to '`#f`'.

`boolean enable-html-serving?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit use the subject of the parent commit as link text when generating links to parent commits in commit view.

Defaults to '`#f`'.

`boolean enable-tree-linenumbers?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit generate linenumber links for plaintext blobs printed in the tree view.

Defaults to '`#t`'.

`boolean enable-git-config?` [`cgit-configuration` parameter]

Flag which, when set to '`#f`', will allow cgit to use Git config to set any repo specific settings.

Defaults to '`#f`'.

`file-object favicon` [`cgit-configuration` parameter]

URL used as link to a shortcut icon for cgit.

Defaults to ‘`"/favicon.ico"`’.

`string footer` [`cgit-configuration` parameter]

The content of the file specified with this option will be included verbatim at the bottom of all pages (i.e. it replaces the standard "generated by..." message).

Defaults to ‘`""`’.

`string head-include` [`cgit-configuration` parameter]

The content of the file specified with this option will be included verbatim in the HTML HEAD section on all pages.

Defaults to ‘`""`’.

`string header` [`cgit-configuration` parameter]

The content of the file specified with this option will be included verbatim at the top of all pages.

Defaults to ‘`""`’.

`file-object include` [`cgit-configuration` parameter]

Name of a configfile to include before the rest of the current config- file is parsed.

Defaults to ‘`""`’.

`string index-header` [`cgit-configuration` parameter]

The content of the file specified with this option will be included verbatim above the repository index.

Defaults to ‘`""`’.

`string index-info` [`cgit-configuration` parameter]

The content of the file specified with this option will be included verbatim below the heading on the repository index page.

Defaults to ‘`""`’.

`boolean local-time?` [`cgit-configuration` parameter]

Flag which, if set to ‘`#t`’, makes cgit print commit and tag times in the servers timezone.

Defaults to ‘`#f`’.

`file-object logo` [`cgit-configuration` parameter]

URL which specifies the source of an image which will be used as a logo on all cgit pages.

Defaults to ‘`"/share/cgit/cgit.png"`’.

`string logo-link` [`cgit-configuration` parameter]

URL loaded when clicking on the cgit logo image.

Defaults to ‘`""`’.

`file-object owner-filter` [`cgit-configuration` parameter]

Command which will be invoked to format the Owner column of the main page.

Defaults to ‘`""`’.

`integer max-atom-items` [`cgit-configuration` parameter]

Number of items to display in atom feeds view.

Defaults to ‘`10`’.

`integer max-commit-count` [`cgit-configuration` parameter]

Number of entries to list per page in "log" view.

Defaults to ‘`50`’.

`integer max-message-length` [`cgit-configuration` parameter]

Number of commit message characters to display in "log" view.

Defaults to ‘`80`’.

`integer max-repo-count` [`cgit-configuration` parameter]

Specifies the number of entries to list per page on the repository index page.

Defaults to ‘`50`’.

`integer max-repodesc-length` [`cgit-configuration` parameter]

Specifies the maximum number of repo description characters to display on the repository index page.

Defaults to ‘`80`’.

`integer max-blob-size` [`cgit-configuration` parameter]

Specifies the maximum size of a blob to display HTML for in KBytes.

Defaults to ‘`0`’.

`string max-stats` [`cgit-configuration` parameter]

Maximum statistics period. Valid values are ‘`week`’,‘`month`’, ‘`quarter`’ and ‘`year`’.

Defaults to ‘`""`’.

`mimetype-alist mimetype` [`cgit-configuration` parameter]

Mimetype for the specified filename extension.

Defaults to ‘`((gif "image/gif") (html "text/html") (jpg "image/jpeg") (jpeg "image/jpeg") (pdf "application/pdf") (png "image/png") (svg "image/svg+xml"))`’.

`file-object mimetype-file` [`cgit-configuration` parameter]

Specifies the file to use for automatic mimetype lookup.

Defaults to ‘`""`’.

`string module-link` [`cgit-configuration` parameter]

Text which will be used as the formatstring for a hyperlink when a submodule is printed in a directory listing.

Defaults to ‘`""`’.

`boolean nocache?` [`cgit-configuration` parameter]

If set to the value '`#t`' caching will be disabled.

Defaults to '`#f`'.

`boolean noplainemail?` [`cgit-configuration` parameter]

If set to '`#t`' showing full author email addresses will be disabled.

Defaults to '`#f`'.

`boolean noheader?` [`cgit-configuration` parameter]

Flag which, when set to '`#t`', will make cgit omit the standard header on all pages.

Defaults to '`#f`'.

`project-list project-list` [`cgit-configuration` parameter]

A list of subdirectories inside of `repository-directory`, relative to it, that should loaded as Git repositories. An empty list means that all subdirectories will be loaded.

Defaults to '`()`'.

`file-object readme` [`cgit-configuration` parameter]

Text which will be used as default value for `cgit-repo-readme`.

Defaults to '`""`'.

`boolean remove-suffix?` [`cgit-configuration` parameter]

If set to `#t` and `repository-directory` is enabled, if any repositories are found with a suffix of `.git`, this suffix will be removed for the URL and name.

Defaults to '`#f`'.

`integer renamelimit` [`cgit-configuration` parameter]

Maximum number of files to consider when detecting renames.

Defaults to '`-1`'.

`string repository-sort` [`cgit-configuration` parameter]

The way in which repositories in each section are sorted.

Defaults to '`""`'.

`robots-list robots` [`cgit-configuration` parameter]

Text used as content for the `robots` meta-tag.

Defaults to '`("noindex" "nofollow")`'.

`string root-desc` [`cgit-configuration` parameter]

Text printed below the heading on the repository index page.

Defaults to '`"a fast webinterface for the git dscm"`'.

`string root-readme` [`cgit-configuration` parameter]

The content of the file specified with this option will be included verbatim below the "about" link on the repository index page.

Defaults to '`""`'.

`string root-title` [`cgit-configuration` parameter]
: Text printed as heading on the repository index page.

  Defaults to ‘`""`’.

`boolean scan-hidden-path` [`cgit-configuration` parameter]
: If set to ‘`#t`’ and repository-directory is enabled, repository-directory will recurse into directories whose name starts with a period. Otherwise, repository-directory will stay away from such directories, considered as “hidden”. Note that this does not apply to the `.git` directory in non-bare repos.

  Defaults to ‘`#f`’.

`list snapshots` [`cgit-configuration` parameter]
: Text which specifies the default set of snapshot formats that cgit generates links for.

  Defaults to ‘`()`’.

`repository-directory` [`cgit-configuration` parameter]
`repository-directory`
: Name of the directory to scan for repositories (represents `scan-path`).

  Defaults to ‘`"/srv/git"`’.

`string section` [`cgit-configuration` parameter]
: The name of the current repository section - all repositories defined after this option will inherit the current section name.

  Defaults to ‘`""`’.

`string section-sort` [`cgit-configuration` parameter]
: Flag which, when set to ‘`1`’, will sort the sections on the repository listing by name.

  Defaults to ‘`""`’.

`integer section-from-path` [`cgit-configuration` parameter]
: A number which, if defined prior to repository-directory, specifies how many path elements from each repo path to use as a default section name.

  Defaults to ‘`0`’.

`boolean side-by-side-diffs?` [`cgit-configuration` parameter]
: If set to ‘`#t`’ shows side-by-side diffs instead of unidiffs per default.

  Defaults to ‘`#f`’.

`file-object source-filter` [`cgit-configuration` parameter]
: Specifies a command which will be invoked to format plaintext blobs in the tree view.

  Defaults to ‘`""`’.

`integer summary-branches` [`cgit-configuration` parameter]
: Specifies the number of branches to display in the repository “summary” view.

  Defaults to ‘`10`’.

`integer summary-log` [`cgit-configuration` parameter]
: Specifies the number of log entries to display in the repository “summary” view.

  Defaults to ‘`10`’.

`integer summary-tags` [`cgit-configuration` parameter]

Specifies the number of tags to display in the repository “summary” view.

Defaults to ‘`10`’.

`string strict-export` [`cgit-configuration` parameter]

Filename which, if specified, needs to be present within the repository for cgit to allow access to that repository.

Defaults to ‘`""`’.

`string virtual-root` [`cgit-configuration` parameter]

URL which, if specified, will be used as root for all cgit links.

Defaults to ‘`"/"`’.

`repository-cgit-configuration-list repositories` [`cgit-configuration` parameter]

A list of *cgit-repo* records to use with config.

Defaults to ‘`()`’.

Available `repository-cgit-configuration` fields are:

`repo-list snapshots` [`repository-cgit-configuration` parameter]

A mask of snapshot formats for this repo that cgit generates links for, restricted by the global `snapshots` setting.

Defaults to ‘`()`’.

`repo-file-object source-filter` [`repository-cgit-configuration` parameter]

Override the default `source-filter`.

Defaults to ‘`""`’.

`repo-string url` [`repository-cgit-configuration` parameter]

The relative URL used to access the repository.

Defaults to ‘`""`’.

`repo-file-object about-filter` [`repository-cgit-configuration` parameter]

Override the default `about-filter`.

Defaults to ‘`""`’.

`repo-string branch-sort` [`repository-cgit-configuration` parameter]

Flag which, when set to ‘`age`’, enables date ordering in the branch ref list, and when set to ‘`name`’ enables ordering by branch name.

Defaults to ‘`""`’.

`repo-list clone-url` [`repository-cgit-configuration` parameter]

A list of URLs which can be used to clone repo.

Defaults to ‘`()`’.

`repo-file-object commit-filter` [`repository-cgit-configuration` parameter]
: Override the default `commit-filter`.

  Defaults to ‘`""`’.

`repo-string commit-sort` [`repository-cgit-configuration` parameter]
: Flag which, when set to ‘`date`’, enables strict date ordering in the commit log, and when set to ‘`topo`’ enables strict topological ordering.

  Defaults to ‘`""`’.

`repo-string defbranch` [`repository-cgit-configuration` parameter]
: The name of the default branch for this repository. If no such branch exists in the repository, the first branch name (when sorted) is used as default instead. By default branch pointed to by HEAD, or “master” if there is no suitable HEAD.

  Defaults to ‘`""`’.

`repo-string desc` [`repository-cgit-configuration` parameter]
: The value to show as repository description.

  Defaults to ‘`""`’.

`repo-string homepage` [`repository-cgit-configuration` parameter]
: The value to show as repository homepage.

  Defaults to ‘`""`’.

`repo-file-object email-filter` [`repository-cgit-configuration` parameter]
: Override the default `email-filter`.

  Defaults to ‘`""`’.

`maybe-repo-boolean enable-commit-graph?` [`repository-cgit-configuration` parameter]
: A flag which can be used to disable the global setting `enable-commit-graph?`.

  Defaults to ‘`disabled`’.

`maybe-repo-boolean enable-log-filecount?` [`repository-cgit-configuration` parameter]
: A flag which can be used to disable the global setting `enable-log-filecount?`.

  Defaults to ‘`disabled`’.

`maybe-repo-boolean enable-log-linecount?` [`repository-cgit-configuration` parameter]
: A flag which can be used to disable the global setting `enable-log-linecount?`.

  Defaults to ‘`disabled`’.

`maybe-repo-boolean enable-remote-branches?` [`repository-cgit-configuration` parameter]
: Flag which, when set to `#t`, will make cgit display remote branches in the summary and refs views.

  Defaults to ‘`disabled`’.

`maybe-repo-boolean enable-subject-links?` [`repository-cgit-configuration` parameter]

A flag which can be used to override the global setting `enable-subject-links?`.

Defaults to '`disabled`'.

`maybe-repo-boolean enable-html-serving?` [`repository-cgit-configuration` parameter]

A flag which can be used to override the global setting `enable-html-serving?`.

Defaults to '`disabled`'.

`repo-boolean hide?` [`repository-cgit-configuration` parameter]

Flag which, when set to `#t`, hides the repository from the repository index.

Defaults to '`#f`'.

`repo-boolean ignore?` [`repository-cgit-configuration` parameter]

Flag which, when set to '`#t`', ignores the repository.

Defaults to '`#f`'.

`repo-file-object logo` [`repository-cgit-configuration` parameter]

URL which specifies the source of an image which will be used as a logo on this repo's pages.

Defaults to '`""`'.

`repo-string logo-link` [`repository-cgit-configuration` parameter]

URL loaded when clicking on the cgit logo image.

Defaults to '`""`'.

`repo-file-object owner-filter` [`repository-cgit-configuration` parameter]

Override the default `owner-filter`.

Defaults to '`""`'.

`repo-string module-link` [`repository-cgit-configuration` parameter]

Text which will be used as the formatstring for a hyperlink when a submodule is printed in a directory listing. The arguments for the formatstring are the path and SHA1 of the submodule commit.

Defaults to '`""`'.

`module-link-path module-link-path` [`repository-cgit-configuration` parameter]

Text which will be used as the formatstring for a hyperlink when a submodule with the specified subdirectory path is printed in a directory listing.

Defaults to '`()`'.

`repo-string max-stats` [`repository-cgit-configuration` parameter]

Override the default maximum statistics period.

Defaults to '`""`'.

`repo-string name` [`repository-cgit-configuration` parameter]
: The value to show as repository name.

  Defaults to ‘`""`’.

`repo-string owner` [`repository-cgit-configuration` parameter]
: A value used to identify the owner of the repository.

  Defaults to ‘`""`’.

`repo-string path` [`repository-cgit-configuration` parameter]
: An absolute path to the repository directory.

  Defaults to ‘`""`’.

`repo-string readme` [`repository-cgit-configuration` parameter]
: A path (relative to repo) which specifies a file to include verbatim as the “About” page for this repo.

  Defaults to ‘`""`’.

`repo-string section` [`repository-cgit-configuration` parameter]
: The name of the current repository section - all repositories defined after this option will inherit the current section name.

  Defaults to ‘`""`’.

`repo-list extra-options` [`repository-cgit-configuration` parameter]
: Extra options will be appended to cgitrc file.

  Defaults to ‘`()`’.

`list extra-options` [`cgit-configuration` parameter]
: Extra options will be appended to cgitrc file.

  Defaults to ‘`()`’.

However, it could be that you just want to get a `cgitrc` up and running. In that case, you can pass an `opaque-cgit-configuration` as a record to `cgit-service-type`. As its name indicates, an opaque configuration does not have easy reflective capabilities.

Available `opaque-cgit-configuration` fields are:

`package cgit` [`opaque-cgit-configuration` parameter]
: The cgit package.

`string string` [`opaque-cgit-configuration` parameter]
: The contents of the `cgitrc`, as a string.

For example, if your `cgitrc` is just the empty string, you could instantiate a cgit service like this:

```
(service cgit-service-type
         (opaque-cgit-configuration
          (cgitrc "")))
```

Gitolite Service

Gitolite (`https://gitolite.com/gitolite/`) is a tool for hosting Git repositories on a central server.

Gitolite can handle multiple repositories and users, and supports flexible configuration of the permissions for the users on the repositories.

The following example will configure Gitolite using the default `git` user, and the provided SSH public key.

```
(service gitolite-service-type
         (gitolite-configuration
           (admin-pubkey (plain-file
                           "yourname.pub"
                           "ssh-rsa AAAA... guix@example.com"))))
```

Gitolite is configured through a special admin repository which you can clone, for example, if you setup Gitolite on `example.com`, you would run the following command to clone the admin repository.

```
git clone git@example.com:gitolite-admin
```

When the Gitolite service is activated, the provided `admin-pubkey` will be inserted in to the `keydir` directory in the gitolite-admin repository. If this results in a change in the repository, it will be committed using the message "gitolite setup by GNU Guix".

`gitolite-configuration` [Data Type]

Data type representing the configuration for `gitolite-service-type`.

`package` (default: *gitolite*)

Gitolite package to use. There are optional Gitolite dependencies that are not included in the default package, such as Redis and git-annex. These features can be made available by using the `make-gitolite` procedure in the `(gnu packages version-control)` module to produce a variant of Gitolite with the desired additional dependencies.

The following code returns a package in which the Redis and git-annex programs can be invoked by Gitolite's scripts:

```
(use-modules (gnu packages databases)
             (gnu packages haskell-apps)
             (gnu packages version-control))
(make-gitolite (list redis git-annex))
```

`user` (default: *git*)

User to use for Gitolite. This will be user that you use when accessing Gitolite over SSH.

`group` (default: *git*)

Group to use for Gitolite.

`home-directory` (default: `"`*/var/lib/gitolite*`"`)

Directory in which to store the Gitolite configuration and repositories.

`rc-file` (default: *(gitolite-rc-file)*)

A "file-like" object (see Section 9.12 [G-Expressions], page 154), representing the configuration for Gitolite.

`admin-pubkey` (default: *#f*)
: A "file-like" object (see Section 9.12 [G-Expressions], page 154) used to setup Gitolite. This will be inserted in to the `keydir` directory within the gitolite-admin repository.

  To specify the SSH key as a string, use the `plain-file` function.

```
(plain-file "yourname.pub" "ssh-rsa AAAA... guix@example.com")
```

`gitolite-rc-file` [Data Type]

Data type representing the Gitolite RC file.

`umask` (default: `#o0077`)
: This controls the permissions Gitolite sets on the repositories and their contents.

  A value like `#o0027` will give read access to the group used by Gitolite (by default: `git`). This is necessary when using Gitolite with software like cgit or gitweb.

`local-code` (default: `"$rc{GL_ADMIN_BASE}/local"`)
: Allows you to add your own non-core programs, or even override the shipped ones with your own.

  Please supply the FULL path to this variable. By default, directory called "local" in your gitolite clone is used, providing the benefits of versioning them as well as making changes to them without having to log on to the server.

`unsafe-pattern` (default: `#f`)
: An optional Perl regular expression for catching unsafe configurations in the configuration file. See Gitolite's documentation (`https://gitolite.com/gitolite/git-config.html#compensating-for-unsafe_patt`) for more information.

  When the value is not `#f`, it should be a string containing a Perl regular expression, such as '`"[`~#\$\&()|;<>]"`', which is the default value used by gitolite. It rejects any special character in configuration that might be interpreted by a shell, which is useful when sharing the administration burden with other people that do not otherwise have shell access on the server.

`git-config-keys` (default: `""`)
: Gitolite allows you to set git config values using the '`config`' keyword. This setting allows control over the config keys to accept.

`roles` (default: `'(("READERS" . 1) ("WRITERS" . ))`)
: Set the role names allowed to be used by users running the perms command.

`enable` (default: `'("help" "desc" "info" "perms" "writable" "ssh-authkeys" "git-config" "daemon" "gitweb")`)
: This setting controls the commands and features to enable within Gitolite.

Gitile Service

Gitile (`https://git.lepiller.eu/gitile`) is a Git forge for viewing public git repository contents from a web browser.

Gitile works best in collaboration with Gitolite, and will serve the public repositories from Gitolite by default. The service should listen only on a local port, and a webserver should be configured to serve static resources. The gitile service provides an easy way to extend the Nginx service for that purpose (see [NGINX], page 413).

The following example will configure Gitile to serve repositories from a custom location, with some default messages for the home page and the footers.

```
(service gitile-service-type
         (gitile-configuration
           (repositories "/srv/git")
           (base-git-url "https://myweb.site/git")
           (index-title "My git repositories")
           (intro '((p "This is all my public work!")))
           (footer '((p "This is the end")))
           (nginx-server-block
             (nginx-server-configuration
               (ssl-certificate
                 "/etc/letsencrypt/live/myweb.site/fullchain.pem")
               (ssl-certificate-key
                 "/etc/letsencrypt/live/myweb.site/privkey.pem")
               (listen '("443 ssl http2" "[::]:443 ssl http2"))
               (locations
                 (list
                   ;; Allow for https anonymous fetch on /git/ urls.
                   (git-http-nginx-location-configuration
                     (git-http-configuration
                       (uri-path "/git/")
                       (git-root "/var/lib/gitolite/repositories")))))))))
```

In addition to the configuration record, you should configure your git repositories to contain some optional information. First, your public repositories need to contain the `git-daemon-export-ok` magic file that allows Git to export the repository. Gitile uses the presence of this file to detect public repositories it should make accessible. To do so with Gitolite for instance, modify your `conf/gitolite.conf` to include this in the repositories you want to make public:

```
repo foo
    R = daemon
```

In addition, Gitile can read the repository configuration to display more information on the repository. Gitile uses the gitweb namespace for its configuration. As an example, you can use the following in your `conf/gitolite.conf`:

```
repo foo
    R = daemon
    desc = A long description, optionally with <i>HTML</i>, shown on the index page
    config gitweb.name = The Foo Project
```

```
        config gitweb.synopsis = A short description, shown on the main page of the projec
```

Do not forget to commit and push these changes once you are satisfied. You may need to change your gitolite configuration to allow the previous configuration options to be set. One way to do that is to add the following service definition:

```
(service gitolite-service-type
          (gitolite-configuration
            (admin-pubkey (local-file "key.pub"))
            (rc-file
              (gitolite-rc-file
                (umask #o0027)
                ;; Allow to set any configuration key
                (git-config-keys ".*")
                ;; Allow any text as a valid configuration value
                (unsafe-patt "^$")))))
```

`gitile-configuration` [Data Type]

Data type representing the configuration for `gitile-service-type`.

`package` (default: *gitile*)
: Gitile package to use.

`host` (default: `"localhost"`)
: The host on which gitile is listening.

`port` (default: `8080`)
: The port on which gitile is listening.

`database` (default: `"/var/lib/gitile/gitile-db.sql"`)
: The location of the database.

`repositories` (default: `"/var/lib/gitolite/repositories"`)
: The location of the repositories. Note that only public repositories will be shown by Gitile. To make a repository public, add an empty `git-daemon-export-ok` file at the root of that repository.

`base-git-url`
: The base git url that will be used to show clone commands.

`index-title` (default: `"Index"`)
: The page title for the index page that lists all the available repositories.

`intro` (default: `'()`)
: The intro content, as a list of sxml expressions. This is shown above the list of repositories, on the index page.

`footer` (default: `'()`)
: The footer content, as a list of sxml expressions. This is shown on every page served by Gitile.

`nginx-server-block`
: An nginx server block that will be extended and used as a reverse proxy by Gitile to serve its pages, and as a normal web server to serve its assets.

You can use this block to add more custom URLs to your domain, such as a `/git/` URL for anonymous clones, or serving any other files you would like to serve.

12.9.31 Game Services

The Battle for Wesnoth Service

The Battle for Wesnoth (`https://wesnoth.org`) is a fantasy, turn based tactical strategy game, with several single player campaigns, and multiplayer games (both networked and local).

`Scheme Variable` *wesnothd-service-type* [Variable]

Service type for the wesnothd service. Its value must be a `wesnothd-configuration` object. To run wesnothd in the default configuration, instantiate it as:

```
(service wesnothd-service-type)
```

`wesnothd-configuration` [Data Type]

Data type representing the configuration of `wesnothd`.

`package` (default: `wesnoth-server`)
: The wesnoth server package to use.

`port` (default: `15000`)
: The port to bind the server to.

12.9.32 PAM Mount Service

The `(gnu services pam-mount)` module provides a service allowing users to mount volumes when they log in. It should be able to mount any volume format supported by the system.

`Scheme Variable` *pam-mount-service-type* [Variable]

Service type for PAM Mount support.

`pam-mount-configuration` [Data Type]

Data type representing the configuration of PAM Mount.

It takes the following parameters:

`rules`
: The configuration rules that will be used to generate `/etc/security/pam_mount.conf.xml`.

  The configuration rules are SXML elements (see Section "SXML" in *GNU Guile Reference Manual*), and the default ones don't mount anything for anyone at login:

```
`((debug (@ (enable "0")))
  (mntoptions (@ (allow ,(string-join
                           '("nosuid" "nodev" "loop"
                             "encryption" "fsck" "nonempty"
                             "allow_root" "allow_other")
                           ","))))
  (mntoptions (@ (require "nosuid,nodev")))
  (logout (@ (wait "0")
                      (hup "0")
                      (term "no")
                      (kill "no")))
           (mkmountpoint (@ (enable "1")
                            (remove "true"))))
```

Some `volume` elements must be added to automatically mount volumes at login. Here's an example allowing the user `alice` to mount her encrypted `HOME` directory and allowing the user `bob` to mount the partition where he stores his data:

```
(define pam-mount-rules
`((debug (@ (enable "0")))
            (volume (@ (user "alice")
                       (fstype "crypt")
                       (path "/dev/sda2")
                       (mountpoint "/home/alice")))
            (volume (@ (user "bob")
                       (fstype "auto")
                       (path "/dev/sdb3")
                       (mountpoint "/home/bob/data")
                       (options "defaults,autodefrag,compress")))
            (mntoptions (@ (allow ,(string-join
                                    '("nosuid" "nodev" "loop"
                                      "encryption" "fsck" "nonempty"
                                      "allow_root" "allow_other")
                                    ","))))
            (mntoptions (@ (require "nosuid,nodev")))
            (logout (@ (wait "0")
                       (hup "0")
                       (term "no")
                       (kill "no")))
            (mkmountpoint (@ (enable "1")
                             (remove "true")))))

(service pam-mount-service-type
         (pam-mount-configuration
           (rules pam-mount-rules)))
```

The complete list of possible options can be found in the man page for pam_mount.conf (`http://pam-mount.sourceforge.net/pam_mount.conf.5.html`).

12.9.33 Guix Services

Guix Build Coordinator

The Guix Build Coordinator (`https://git.cbaines.net/guix/build-coordinator/`) aids in distributing derivation builds among machines running an *agent*. The build daemon is still used to build the derivations, but the Guix Build Coordinator manages allocating builds and working with the results.

The Guix Build Coordinator consists of one *coordinator*, and one or more connected *agent* processes. The coordinator process handles clients submitting builds, and allocating builds to agents. The agent processes talk to a build daemon to actually perform the builds, then send the results back to the coordinator.

There is a script to run the coordinator component of the Guix Build Coordinator, but the Guix service uses a custom Guile script instead, to provide better integration with G-expressions used in the configuration.

`Scheme Variable` *guix-build-coordinator-service-type* [Variable]

Service type for the Guix Build Coordinator. Its value must be a `guix-build-coordinator-configuration` object.

`guix-build-coordinator-configuration` [Data Type]

Data type representing the configuration of the Guix Build Coordinator.

`package` (default: `guix-build-coordinator`)
: The Guix Build Coordinator package to use.

`user` (default: `"guix-build-coordinator"`)
: The system user to run the service as.

`group` (default: `"guix-build-coordinator"`)
: The system group to run the service as.

`database-uri-string` (default: `"sqlite:///var/lib/guix-build-coordinator/guix_build_coordinator.db"`)
: The URI to use for the database.

`agent-communication-uri` (default: `"http://0.0.0.0:8745"`)
: The URI describing how to listen to requests from agent processes.

`client-communication-uri` (default: `"http://127.0.0.1:8746"`)
: The URI describing how to listen to requests from clients. The client API allows submitting builds and currently isn't authenticated, so take care when configuring this value.

`allocation-strategy` (default: `#~basic-build-allocation-strategy`)
: A G-expression for the allocation strategy to be used. This is a procedure that takes the datastore as an argument and populates the allocation plan in the database.

`hooks` (default: *'()*)
: An association list of hooks. These provide a way to execute arbitrary code upon certain events, like a build result being processed.

`parallel-hooks` (default: *'()*)
: Hooks can be configured to run in parallel. This parameter is an association list of hooks to do in parallel, where the key is the symbol for the hook and the value is the number of threads to run.

`guile` (default: `guile-3.0-latest`)
: The Guile package with which to run the Guix Build Coordinator.

`Scheme Variable` *guix-build-coordinator-agent-service-type* [Variable]

Service type for a Guix Build Coordinator agent. Its value must be a `guix-build-coordinator-agent-configuration` object.

`guix-build-coordinator-agent-configuration` [Data Type]

Data type representing the configuration a Guix Build Coordinator agent.

`package` (default: `guix-build-coordinator/agent-only`)
: The Guix Build Coordinator package to use.

`user` (default: `"guix-build-coordinator-agent"`)
: The system user to run the service as.

`coordinator` (default: `"http://localhost:8745"`)
: The URI to use when connecting to the coordinator.

`authentication`
: Record describing how this agent should authenticate with the coordinator. Possible record types are described below.

`systems` (default: `#f`)
: The systems for which this agent should fetch builds. The agent process will use the current system it's running on as the default.

`max-parallel-builds` (default: `1`)
: The number of builds to perform in parallel.

`max-allocated-builds` (default: `#f`)
: The maximum number of builds this agent can be allocated.

`max-1min-load-average` (default: `#f`)
: Load average value to look at when considering starting new builds, if the 1 minute load average exceeds this value, the agent will wait before starting new builds.

  This will be unspecified if the value is `#f`, and the agent will use the number of cores reported by the system as the max 1 minute load average.

`derivation-substitute-urls` (default: `#f`)
: URLs from which to attempt to fetch substitutes for derivations, if the derivations aren't already available.

`non-derivation-substitute-urls` (default: `#f`)
: URLs from which to attempt to fetch substitutes for build inputs, if the input store items aren't already available.

`guix-build-coordinator-agent-password-auth` [Data Type]

Data type representing an agent authenticating with a coordinator via a UUID and password.

`uuid`
: The UUID of the agent. This should be generated by the coordinator process, stored in the coordinator database, and used by the intended agent.

`password`
: The password to use when connecting to the coordinator.

`guix-build-coordinator-agent-password-file-auth` [Data Type]

Data type representing an agent authenticating with a coordinator via a UUID and password read from a file.

`uuid` The UUID of the agent. This should be generated by the coordinator process, stored in the coordinator database, and used by the intended agent.

`password-file`
A file containing the password to use when connecting to the coordinator.

`guix-build-coordinator-agent-dynamic-auth` [Data Type]

Data type representing an agent authenticating with a coordinator via a dynamic auth token and agent name.

`agent-name`
Name of an agent, this is used to match up to an existing entry in the database if there is one. When no existing entry is found, a new entry is automatically added.

`token` Dynamic auth token, this is created and stored in the coordinator database, and is used by the agent to authenticate.

`guix-build-coordinator-agent-dynamic-auth-with-file` [Data Type]

Data type representing an agent authenticating with a coordinator via a dynamic auth token read from a file and agent name.

`agent-name`
Name of an agent, this is used to match up to an existing entry in the database if there is one. When no existing entry is found, a new entry is automatically added.

`token-file`
File containing the dynamic auth token, this is created and stored in the coordinator database, and is used by the agent to authenticate.

The Guix Build Coordinator package contains a script to query an instance of the Guix Data Service for derivations to build, and then submit builds for those derivations to the coordinator. The service type below assists in running this script. This is an additional tool that may be useful when building derivations contained within an instance of the Guix Data Service.

`Scheme Variable` *guix-build-coordinator-queue-builds-service-type* [Variable]

Service type for the guix-build-coordinator-queue-builds-from-guix-data-service script. Its value must be a `guix-build-coordinator-queue-builds-configuration` object.

`guix-build-coordinator-queue-builds-configuration` [Data Type]

Data type representing the options to the queue builds from guix data service script.

`package` (default: `guix-build-coordinator`)
The Guix Build Coordinator package to use.

`user` (default: `"guix-build-coordinator-queue-builds"`)
: The system user to run the service as.

`coordinator` (default: `"http://localhost:8746"`)
: The URI to use when connecting to the coordinator.

`systems` (default: `#f`)
: The systems for which to fetch derivations to build.

`systems-and-targets` (default: `#f`)
: An association list of system and target pairs for which to fetch derivations to build.

`guix-data-service` (default: `"https://data.guix.gnu.org"`)
: The Guix Data Service instance from which to query to find out about derivations to build.

`guix-data-service-build-server-id` (default: `#f`)
: The Guix Data Service build server ID corresponding to the builds being submitted. Providing this speeds up the submitting of builds as derivations that have already been submitted can be skipped before asking the coordinator to build them.

`processed-commits-file` (default: `"/var/cache/guix-build-coordinator-queue-builds/processed-commits"`)
: A file to record which commits have been processed, to avoid needlessly processing them again if the service is restarted.

Guix Data Service

The Guix Data Service (`http://data.guix.gnu.org`) processes, stores and provides data about GNU Guix. This includes information about packages, derivations and lint warnings.

The data is stored in a PostgreSQL database, and available through a web interface.

`Scheme Variable` *guix-data-service-type* [Variable]

Service type for the Guix Data Service. Its value must be a `guix-data-service-configuration` object. The service optionally extends the getmail service, as the guix-commits mailing list is used to find out about changes in the Guix git repository.

`guix-data-service-configuration` [Data Type]

Data type representing the configuration of the Guix Data Service.

`package` (default: `guix-data-service`)
: The Guix Data Service package to use.

`user` (default: `"guix-data-service"`)
: The system user to run the service as.

`group` (default: `"guix-data-service"`)
: The system group to run the service as.

`port` (default: `8765`)
: The port to bind the web service to.

`host` (default: `"127.0.0.1"`)
: The host to bind the web service to.

`getmail-idle-mailboxes` (default: `#f`)
: If set, this is the list of mailboxes that the getmail service will be configured to listen to.

`commits-getmail-retriever-configuration` (default: `#f`)
: If set, this is the `getmail-retriever-configuration` object with which to configure getmail to fetch mail from the guix-commits mailing list.

`extra-options` (default: *'()*)
: Extra command line options for `guix-data-service`.

`extra-process-jobs-options` (default: *'()*)
: Extra command line options for `guix-data-service-process-jobs`.

Nar Herder

The Nar Herder (`https://git.cbaines.net/guix/nar-herder/about/`) is a utility for managing a collection of nars.

`Scheme Variable` *nar-herder-type* [Variable]

Service type for the Guix Data Service. Its value must be a `nar-herder-configuration` object. The service optionally extends the getmail service, as the guix-commits mailing list is used to find out about changes in the Guix git repository.

`nar-herder-configuration` [Data Type]

Data type representing the configuration of the Guix Data Service.

`package` (default: `nar-herder`)
: The Nar Herder package to use.

`user` (default: `"nar-herder"`)
: The system user to run the service as.

`group` (default: `"nar-herder"`)
: The system group to run the service as.

`port` (default: `8734`)
: The port to bind the server to.

`host` (default: `"127.0.0.1"`)
: The host to bind the server to.

`mirror` (default: `#f`)
: Optional URL of the other Nar Herder instance which should be mirrored. This means that this Nar Herder instance will download it's database, and keep it up to date.

`database` (default: `"/var/lib/nar-herder/nar_herder.db"`)
: Location for the database. If this Nar Herder instance is mirroring another, the database will be downloaded if it doesn't exist. If this Nar Herder instance isn't mirroring another, an empty database will be created.

`database-dump` (default: `"/var/lib/nar-herder/nar_herder_dump.db"`)
: Location of the database dump. This is created and regularly updated by taking a copy of the database. This is the version of the database that is available to download.

`storage` (default: `#f`)
: Optional location in which to store nars.

`storage-limit` (default: `"none"`)
: Limit in bytes for the nars stored in the storage location. This can also be set to "none" so that there is no limit.

  When the storage location exceeds this size, nars are removed according to the nar removal criteria.

`storage-nar-removal-criteria` (default: `'()`)
: Criteria used to remove nars from the storage location. These are used in conjunction with the storage limit.

  When the storage location exceeds the storage limit size, nars will be checked against the nar removal criteria and if any of the criteria match, they will be removed. This will continue until the storage location is below the storage limit size.

  Each criteria is specified by a string, then an equals sign, then another string. Currently, only one criteria is supported, checking if a nar is stored on another Nar Herder instance.

`ttl` (default: `#f`)
: Produce `Cache-Control` HTTP headers that advertise a time-to-live (TTL) of *ttl*. *ttl* must denote a duration: `5d` means 5 days, `1m` means 1 month, and so on.

  This allows the user's Guix to keep substitute information in cache for *ttl*.

`negative-ttl` (default: `#f`)
: Similarly produce `Cache-Control` HTTP headers to advertise the time-to-live (TTL) of *negative* lookups—missing store items, for which the HTTP 404 code is returned. By default, no negative TTL is advertised.

`log-level` (default: `'DEBUG`)
: Log level to use, specify a log level like `'INFO` to stop logging individual requests.

12.9.34 Linux Services

Early OOM Service

Early OOM (`https://github.com/rfjakob/earlyoom`), also known as Earlyoom, is a minimalist out of memory (OOM) daemon that runs in user space and provides a more responsive and configurable alternative to the in-kernel OOM killer. It is useful to prevent the system from becoming unresponsive when it runs out of memory.

`earlyoom-service-type` [Scheme Variable]

The service type for running `earlyoom`, the Early OOM daemon. Its value must be a `earlyoom-configuration` object, described below. The service can be instantiated in its default configuration with:

```
(service earlyoom-service-type)
```

`earlyoom-configuration` [Data Type]

This is the configuration record for the `earlyoom-service-type`.

`earlyoom` (default: *earlyoom*)
: The Earlyoom package to use.

`minimum-available-memory` (default: `10`)
: The threshold for the minimum *available* memory, in percentages.

`minimum-free-swap` (default: `10`)
: The threshold for the minimum free swap memory, in percentages.

`prefer-regexp` (default: `#f`)
: A regular expression (as a string) to match the names of the processes that should be preferably killed.

`avoid-regexp` (default: `#f`)
: A regular expression (as a string) to match the names of the processes that should *not* be killed.

`memory-report-interval` (default: `0`)
: The interval in seconds at which a memory report is printed. It is disabled by default.

`ignore-positive-oom-score-adj?` (default: `#f`)
: A boolean indicating whether the positive adjustments set in `/proc/*/oom_score_adj` should be ignored.

`show-debug-messages?` (default: `#f`)
: A boolean indicating whether debug messages should be printed. The logs are saved at `/var/log/earlyoom.log`.

`send-notification-command` (default: `#f`)
: This can be used to provide a custom command used for sending notifications.

Kernel Module Loader Service

The kernel module loader service allows one to load loadable kernel modules at boot. This is especially useful for modules that don't autoload and need to be manually loaded, as is the case with `ddcci`.

`kernel-module-loader-service-type` [Scheme Variable]

The service type for loading loadable kernel modules at boot with `modprobe`. Its value must be a list of strings representing module names. For example loading the drivers provided by `ddcci-driver-linux`, in debugging mode by passing some module parameters, can be done as follow:

```
(use-modules (gnu) (gnu services))
```

```
(use-package-modules linux)
(use-service-modules linux)

(define ddcci-config
  (plain-file "ddcci.conf"
              "options ddcci dyndbg delay=120"))

(operating-system
  ...
  (services (cons* (service kernel-module-loader-service-type
                            '("ddcci" "ddcci_backlight"))
                   (simple-service 'ddcci-config etc-service-type
                                   (list `("modprobe.d/ddcci.conf"
                                           ,ddcci-config)))
                   %base-services))
  (kernel-loadable-modules (list ddcci-driver-linux)))
```

Rasdaemon Service

The Rasdaemon service provides a daemon which monitors platform RAS (Reliability, Availability, and Serviceability) reports from Linux kernel trace events, logging them to syslogd.

Reliability, Availability and Serviceability is a concept used on servers meant to measure their robustness.

Relability is the probability that a system will produce correct outputs:

- Generally measured as Mean Time Between Failures (MTBF), and
- Enhanced by features that help to avoid, detect and repair hardware faults

Availability is the probability that a system is operational at a given time:

- Generally measured as a percentage of downtime per a period of time, and
- Often uses mechanisms to detect and correct hardware faults in runtime.

Serviceability is the simplicity and speed with which a system can be repaired or maintained:

- Generally measured on Mean Time Between Repair (MTBR).

Among the monitoring measures, the most usual ones include:

- CPU – detect errors at instruction execution and at L1/L2/L3 caches;
- Memory – add error correction logic (ECC) to detect and correct errors;
- I/O – add CRC checksums for transferred data;
- Storage – RAID, journal file systems, checksums, Self-Monitoring, Analysis and Reporting Technology (SMART).

By monitoring the number of occurrences of error detections, it is possible to identify if the probability of hardware errors is increasing, and, on such case, do a preventive maintenance to replace a degraded component while those errors are correctable.

For detailed information about the types of error events gathered and how to make sense of them, see the kernel administrator's guide at `https://www.kernel.org/doc/html/latest/admin-guide/ras.html`.

`rasdaemon-service-type` [Scheme Variable]

Service type for the `rasdaemon` service. It accepts a `rasdaemon-configuration` object. Instantiating like

```
(service rasdaemon-service-type)
```

will load with a default configuration, which monitors all events and logs to syslogd.

`rasdaemon-configuration` [Data Type]

The data type representing the configuration of `rasdaemon`.

`record?` (default: `#f`)
: A boolean indicating whether to record the events in an SQLite database. This provides a more structured access to the information contained in the log file. The database location is hard-coded to `/var/lib/rasdaemon/ras-mc_event.db`.

Zram Device Service

The Zram device service provides a compressed swap device in system memory. The Linux Kernel documentation has more information about zram (`https://www.kernel.org/doc/html/latest/admin-guide/blockdev/zram.html`) devices.

`zram-device-service-type` [Scheme Variable]

This service creates the zram block device, formats it as swap and enables it as a swap device. The service's value is a `zram-device-configuration` record.

`zram-device-configuration` [Data Type]

This is the data type representing the configuration for the zram-device service.

`size` (default `"1G"`)
: This is the amount of space you wish to provide for the zram device. It accepts a string and can be a number of bytes or use a suffix, eg.: `"512M"` or `1024000`.

`compression-algorithm` (default `'lzo`)
: This is the compression algorithm you wish to use. It is difficult to list all the possible compression options, but common ones supported by Guix's Linux Libre Kernel include `'lzo`, `'lz4` and `'zstd`.

`memory-limit` (default `0`)
: This is the maximum amount of memory which the zram device can use. Setting it to '0' disables the limit. While it is generally expected that compression will be 2:1, it is possible that uncompressable data can be written to swap and this is a method to limit how much memory can be used. It accepts a string and can be a number of bytes or use a suffix, eg.: `"2G"`.

`priority` (default `#f`)
: This is the priority of the swap device created from the zram device. See Section 12.5 [Swap Space], page 239, for a description of swap priorities. You might want to set a specific priority for the zram device, otherwise it could end up not being used much for the reasons described there.

12.9.35 Hurd Services

`hurd-console-service-type` [Scheme Variable]

This service starts the fancy `VGA` console client on the Hurd.

The service's value is a `hurd-console-configuration` record.

`hurd-console-configuration` [Data Type]

This is the data type representing the configuration for the hurd-console-service.

`hurd` (default: *hurd*)
: The Hurd package to use.

`hurd-getty-service-type` [Scheme Variable]

This service starts a tty using the Hurd `getty` program.

The service's value is a `hurd-getty-configuration` record.

`hurd-getty-configuration` [Data Type]

This is the data type representing the configuration for the hurd-getty-service.

`hurd` (default: *hurd*)
: The Hurd package to use.

`tty` The name of the console this Getty runs on—e.g., `"tty1"`.

`baud-rate` (default: `38400`)
: An integer specifying the baud rate of the tty.

12.9.36 Miscellaneous Services

Fingerprint Service

The `(gnu services authentication)` module provides a DBus service to read and identify fingerprints via a fingerprint sensor.

`fprintd-service-type` [Scheme Variable]

The service type for `fprintd`, which provides the fingerprint reading capability.

```
(service fprintd-service-type)
```

System Control Service

The `(gnu services sysctl)` provides a service to configure kernel parameters at boot.

`sysctl-service-type` [Scheme Variable]

The service type for `sysctl`, which modifies kernel parameters under `/proc/sys/`. To enable IPv4 forwarding, it can be instantiated as:

```
(service sysctl-service-type
         (sysctl-configuration
           (settings '(("net.ipv4.ip_forward" . "1")))))
```

Since `sysctl-service-type` is used in the default lists of services, `%base-services` and `%desktop-services`, you can use `modify-services` to change its configuration and add the kernel parameters that you want (see Section 12.18.3 [Service Reference], page 563).

```
(modify-services %base-services
  (sysctl-service-type config =>
                       (sysctl-configuration
                         (settings (append '(("net.ipv4.ip_forward" . "1"))
                                           %default-sysctl-settings)))))
```

`sysctl-configuration` [Data Type]

The data type representing the configuration of `sysctl`.

`sysctl` (default: `(file-append procps "/sbin/sysctl"`)

The `sysctl` executable to use.

`settings` (default: `%default-sysctl-settings`)

An association list specifies kernel parameters and their values.

`%default-sysctl-settings` [Scheme Variable]

An association list specifying the default `sysctl` parameters on Guix System.

PC/SC Smart Card Daemon Service

The `(gnu services security-token)` module provides the following service to run `pcscd`, the PC/SC Smart Card Daemon. `pcscd` is the daemon program for pcsc-lite and the MuscleCard framework. It is a resource manager that coordinates communications with smart card readers, smart cards and cryptographic tokens that are connected to the system.

`pcscd-service-type` [Scheme Variable]

Service type for the `pcscd` service. Its value must be a `pcscd-configuration` object. To run pcscd in the default configuration, instantiate it as:

```
(service pcscd-service-type)
```

`pcscd-configuration` [Data Type]

The data type representing the configuration of `pcscd`.

`pcsc-lite` (default: `pcsc-lite`)

The pcsc-lite package that provides pcscd.

`usb-drivers` (default: `(list ccid)`)

List of packages that provide USB drivers to pcscd. Drivers are expected to be under `pcsc/drivers` in the store directory of the package.

Lirc Service

The `(gnu services lirc)` module provides the following service.

`lirc-service` [*#:lirc lirc*] [*#:device #f*] [*#:driver #f*] [*#:config-file #f*] [*#:extra-options '()*] [Scheme Procedure]

Return a service that runs LIRC (`http://www.lirc.org`), a daemon that decodes infrared signals from remote controls.

Optionally, *device*, *driver* and *config-file* (configuration file name) may be specified. See `lircd` manual for details.

Finally, *extra-options* is a list of additional command-line options passed to `lircd`.

Spice Service

The `(gnu services spice)` module provides the following service.

`spice-vdagent-service` [*#:spice-vdagent*] [Scheme Procedure]

Returns a service that runs VDAGENT (`https://www.spice-space.org`), a daemon that enables sharing the clipboard with a vm and setting the guest display resolution when the graphical console window resizes.

inputattach Service

The inputattach (`https://linuxwacom.github.io/`) service allows you to use input devices such as Wacom tablets, touchscreens, or joysticks with the Xorg display server.

`inputattach-service-type` [Scheme Variable]

Type of a service that runs `inputattach` on a device and dispatches events from it.

`inputattach-configuration` [Data Type]

`device-type` (default: `"wacom"`)
: The type of device to connect to. Run `inputattach --help`, from the `inputattach` package, to see the list of supported device types.

`device` (default: `"/dev/ttyS0"`)
: The device file to connect to the device.

`baud-rate` (default: `#f`)
: Baud rate to use for the serial connection. Should be a number or `#f`.

`log-file` (default: `#f`)
: If true, this must be the name of a file to log messages to.

Dictionary Service

The `(gnu services dict)` module provides the following service:

`dicod-service-type` [Scheme Variable]

This is the type of the service that runs the `dicod` daemon, an implementation of DICT server (see Section "Dicod" in *GNU Dico Manual*).

`dicod-service` [*#:config* (*dicod-configuration*)] [Scheme Procedure]

Return a service that runs the `dicod` daemon, an implementation of DICT server (see Section "Dicod" in *GNU Dico Manual*).

The optional *config* argument specifies the configuration for `dicod`, which should be a `<dicod-configuration>` object, by default it serves the GNU Collaborative International Dictionary of English.

You can add `open localhost` to your `~/.dico` file to make `localhost` the default server for `dico` client (see Section "Initialization File" in *GNU Dico Manual*).

`dicod-configuration` [Data Type]

Data type representing the configuration of dicod.

`dico` (default: *dico*)
: Package object of the GNU Dico dictionary server.

`interfaces` (default: *'("localhost")*)
: This is the list of IP addresses and ports and possibly socket file names to listen to (see Section “Server Settings” in *GNU Dico Manual*).

`handlers` (default: *'()*)
: List of `<dicod-handler>` objects denoting handlers (module instances).

`databases` (default: *(list %dicod-database:gcide)*)
: List of `<dicod-database>` objects denoting dictionaries to be served.

`dicod-handler` [Data Type]

Data type representing a dictionary handler (module instance).

`name` Name of the handler (module instance).

`module` (default: *#f*)
: Name of the dicod module of the handler (instance). If it is `#f`, the module has the same name as the handler. (see Section “Modules” in *GNU Dico Manual*).

`options` List of strings or gexps representing the arguments for the module handler

`dicod-database` [Data Type]

Data type representing a dictionary database.

`name` Name of the database, will be used in DICT commands.

`handler` Name of the dicod handler (module instance) used by this database (see Section “Handlers” in *GNU Dico Manual*).

`complex?` (default: *#f*)
: Whether the database configuration complex. The complex configuration will need a corresponding `<dicod-handler>` object, otherwise not.

`options` List of strings or gexps representing the arguments for the database (see Section “Databases” in *GNU Dico Manual*).

`%dicod-database:gcide` [Scheme Variable]

A `<dicod-database>` object serving the GNU Collaborative International Dictionary of English using the `gcide` package.

The following is an example `dicod-service` configuration.

```
(dicod-service #:config
  (dicod-configuration
   (handlers (list (dicod-handler
                    (name "wordnet")
                    (module "dictorg")
                    (options
                     (list #~(string-append "dbdir=" #$wordnet))))))
   (databases (list (dicod-database
                     (name "wordnet")
                     (complex? #t)
                     (handler "wordnet")
                     (options '("database=wn")))
                    %dicod-database:gcide))))
```

Docker Service

The `(gnu services docker)` module provides the following services.

`docker-service-type` [Scheme Variable]

This is the type of the service that runs Docker (`https://www.docker.com`), a daemon that can execute application bundles (sometimes referred to as "containers") in isolated environments.

`docker-configuration` [Data Type]

This is the data type representing the configuration of Docker and Containerd.

`docker` (default: `docker`)
: The Docker daemon package to use.

`docker-cli` (default: `docker-cli`)
: The Docker client package to use.

`containerd` (default: *containerd*)
: The Containerd package to use.

`proxy` (default *docker-libnetwork-cmd-proxy*)
: The Docker user-land networking proxy package to use.

`enable-proxy?` (default `#t`)
: Enable or disable the use of the Docker user-land networking proxy.

`debug?` (default `#f`)
: Enable or disable debug output.

`enable-iptables?` (default `#t`)
: Enable or disable the addition of iptables rules.

`environment-variables` (default: `()`)
: List of environment variables to set for `dockerd`.

This must be a list of strings where each string has the form '*key*=*value*' as in this example:

```
(list "LANGUAGE=eo:ca:eu"
      "TMPDIR=/tmp/dockerd")
```

`singularity-service-type` [Scheme Variable]

This is the type of the service that allows you to run Singularity (`https://www.sylabs.io/singularity/`), a Docker-style tool to create and run application bundles (aka. "containers"). The value for this service is the Singularity package to use.

The service does not install a daemon; instead, it installs helper programs as setuid-root (see Section 12.10 [Setuid Programs], page 533) such that unprivileged users can invoke `singularity run` and similar commands.

Auditd Service

The `(gnu services auditd)` module provides the following service.

`auditd-service-type` [Scheme Variable]

This is the type of the service that runs auditd (`https://people.redhat.com/sgrubb/audit/`), a daemon that tracks security-relevant information on your system.

Examples of things that can be tracked:

1. File accesses
2. System calls
3. Invoked commands
4. Failed login attempts
5. Firewall filtering
6. Network access

`auditctl` from the `audit` package can be used in order to add or remove events to be tracked (until the next reboot). In order to permanently track events, put the command line arguments of auditctl into a file called `audit.rules` in the configuration directory (see below). `aureport` from the `audit` package can be used in order to view a report of all recorded events. The audit daemon by default logs into the file `/var/log/audit.log`.

`auditd-configuration` [Data Type]

This is the data type representing the configuration of auditd.

`audit` (default: `audit`)
: The audit package to use.

`configuration-directory` (default: `%default-auditd-configuration-directory`)
: The directory containing the configuration file for the audit package, which must be named `auditd.conf`, and optionally some audit rules to instantiate on startup.

R-Shiny service

The `(gnu services science)` module provides the following service.

`rshiny-service-type` [Scheme Variable]

This is a type of service which is used to run a webapp created with `r-shiny`. This service sets the `R_LIBS_USER` environment variable and runs the provided script to call `runApp`.

`rshiny-configuration` [Data Type]

This is the data type representing the configuration of rshiny.

`package` (default: `r-shiny`)
: The package to use.

`binary` (default `"rshiny"`)
: The name of the binary or shell script located at `package/bin/` to run when the service is run.

The common way to create this file is as follows:

```
...
```

```
                          (let* ((out       (assoc-ref %outputs "out"))
                                 (targetdir (string-append out "/share/" ,name))
                                 (app       (string-append out "/bin/" ,name))
                                 (Rbin      (search-input-file %build-inputs "/bin/Rscript")
                            ;; ...
                            (mkdir-p (string-append out "/bin"))
                            (call-with-output-file app
                              (lambda (port)
                                (format port
                          "#!~a
                          library(shiny)
                          setwd(\"~a\")
                          runApp(launch.browser=0, port=4202)~%\n"
                                Rbin targetdir))))
```

Nix service

The `(gnu services nix)` module provides the following service.

`nix-service-type` [Scheme Variable]

This is the type of the service that runs build daemon of the Nix (`https://nixos.org/nix/`) package manager. Here is an example showing how to use it:

```
(use-modules (gnu))
(use-service-modules nix)
(use-package-modules package-management)

(operating-system
  ;; ...
  (packages (append (list nix)
                    %base-packages))

  (services (append (list (service nix-service-type))
                    %base-services)))
```

After `guix system reconfigure` configure Nix for your user:

- Add a Nix channel and update it. See Nix Package Manager Guide (`https://nixos.org/nix/manual/`).
- Create a symlink to your profile and activate Nix profile:

```
$ ln -s "/nix/var/nix/profiles/per-user/$USER/profile" ~/.nix-profile
$ source /run/current-system/profile/etc/profile.d/nix.sh
```

`nix-configuration` [Data Type]

This data type represents the configuration of the Nix daemon.

`nix` (default: `nix`)
: The Nix package to use.

`sandbox` (default: `#t`)
: Specifies whether builds are sandboxed by default.

`build-sandbox-items` (default: `'()`)
: This is a list of strings or objects appended to the `build-sandbox-items` field of the configuration file.

`extra-config` (default: `'()`)
: This is a list of strings or objects appended to the configuration file. It is used to pass extra text to be added verbatim to the configuration file.

`extra-options` (default: `'()`)
: Extra command line options for `nix-service-type`.

Fail2Ban service

`fail2ban` (`http://www.fail2ban.org/`) scans log files (e.g. `/var/log/apache/error_log`) and bans IP addresses that show malicious signs – repeated password failures, attempts to make use of exploits, etc.

`fail2ban-service-type` service type is provided by the `(gnu services security)` module.

This service type runs the `fail2ban` daemon. It can be configured in various ways, which are:

Basic configuration
: The basic parameters of the Fail2Ban service can be configured via its `fail2ban` configuration, which is documented below.

User-specified jail extensions
: The `fail2ban-jail-service` function can be used to add new Fail2Ban jails.

Shepherd extension mechanism
: Service developers can extend the `fail2ban-service-type` service type itself via the usual service extension mechanism.

`fail2ban-service-type` [Scheme Variable]

This is the type of the service that runs `fail2ban` daemon. Below is an example of a basic, explicit configuration:

```
(append
 (list
  (service fail2ban-service-type
           (fail2ban-configuration
            (extra-jails
             (list
              (fail2ban-jail-configuration
               (name "sshd")
               (enabled? #t))))))
  ;; There is no implicit dependency on an actual SSH
  ;; service, so you need to provide one.
  (service openssh-service-type))
 %base-services)
```

`fail2ban-jail-service` *`svc-type jail`* [Scheme Procedure]

Extend *svc-type*, a `<service-type>` object with *jail*, a `fail2ban-jail-configuration` object.

For example:

```
(append
 (list
  (service
   ;; The 'fail2ban-jail-service' procedure can extend any service type
   ;; with a fail2ban jail.  This removes the requirement to explicitly
   ;; extend services with fail2ban-service-type.
   (fail2ban-jail-service
    openssh-service-type
    (fail2ban-jail-configuration
     (name "sshd")
     (enabled? #t)))
   (openssh-configuration ...))))
```

Below is the reference for the different `jail-service-type` configuration records.

`fail2ban-configuration` [Data Type]

Available `fail2ban-configuration` fields are:

`fail2ban` (default: `fail2ban`) (type: package)
: The `fail2ban` package to use. It is used for both binaries and as base default configuration that is to be extended with `<fail2ban-jail-configuration>` objects.

`run-directory` (default: `"/var/run/fail2ban"`) (type: string)
: The state directory for the `fail2ban` daemon.

`jails` (default: `()`) (type: list-of-fail2ban-jail-configurations)
: Instances of `<fail2ban-jail-configuration>` collected from extensions.

`extra-jails` (default: `()`) (type: list-of-fail2ban-jail-configurations)
: Instances of `<fail2ban-jail-configuration>` explicitly provided.

`extra-content` (default: `()`) (type: text-config)
: Extra raw content to add to the end of the `jail.local` file, provided as a list of file-like objects.

`fail2ban-ignore-cache-configuration` [Data Type]

Available `fail2ban-ignore-cache-configuration` fields are:

`key` (type: string)
: Cache key.

`max-count` (type: integer)
: Cache size.

`max-time` (type: integer)
: Cache time.

`fail2ban-jail-action-configuration` [Data Type]

Available `fail2ban-jail-action-configuration` fields are:

`name` (type: string)
: Action name.

`arguments` (default: `()`) (type: list-of-arguments)
: Action arguments.

`fail2ban-jail-configuration` [Data Type]

Available `fail2ban-jail-configuration` fields are:

`name` (type: string)
: Required name of this jail configuration.

`enabled?` (default: `#t`) (type: boolean)
: Whether this jail is enabled.

`backend` (type: maybe-symbol)
: Backend to use to detect changes in the `log-path`. The default is 'auto. To consult the defaults of the jail configuration, refer to the `/etc/fail2ban/jail.conf` file of the `fail2ban` package.

`max-retry` (type: maybe-integer)
: The number of failures before a host get banned (e.g. `(max-retry 5)`).

`max-matches` (type: maybe-integer)
: The number of matches stored in ticket (resolvable via tag `<matches>`) in action.

`find-time` (type: maybe-string)
: The time window during which the maximum retry count must be reached for an IP address to be banned. A host is banned if it has generated `max-retry` during the last `find-time` seconds (e.g. `(find-time "10m")`). It can be provided in seconds or using Fail2Ban's "time abbreviation format", as described in `man 5 jail.conf`.

`ban-time` (type: maybe-string)
: The duration, in seconds or time abbreviated format, that a ban should last. (e.g. `(ban-time "10m")`).

`ban-time-increment?` (type: maybe-boolean)
: Whether to consider past bans to compute increases to the default ban time of a specific IP address.

`ban-time-factor` (type: maybe-string)
: The coefficient to use to compute an exponentially growing ban time.

`ban-time-formula` (type: maybe-string)
: This is the formula used to calculate the next value of a ban time.

`ban-time-multipliers` (type: maybe-string)
: Used to calculate next value of ban time instead of formula.

`ban-time-max-time` (type: maybe-string)
: The maximum number of seconds a ban should last.

`ban-time-rnd-time` (type: maybe-string)
: The maximum number of seconds a randomized ban time should last. This can be useful to stop "clever" botnets calculating the exact time an IP address can be unbanned again.

`ban-time-overall-jails?` (type: maybe-boolean)
: When true, it specifies the search of an IP address in the database should be made across all jails. Otherwise, only the current jail of the ban IP address is considered.

`ignore-self?` (type: maybe-boolean)
: Never ban the local machine's own IP address.

`ignore-ip` (default: `()`) (type: list-of-strings)
: A list of IP addresses, CIDR masks or DNS hosts to ignore. `fail2ban` will not ban a host which matches an address in this list.

`ignore-cache` (type: maybe-fail2ban-ignore-cache-configuration)
: Provide cache parameters for the ignore failure check.

`filter` (type: maybe-fail2ban-jail-filter-configuration)
: The filter to use by the jail, specified via a `<fail2ban-jail-filter-configuration>` object. By default, jails have names matching their filter name.

`log-time-zone` (type: maybe-string)
: The default time zone for log lines that do not have one.

`log-encoding` (type: maybe-symbol)
: The encoding of the log files handled by the jail. Possible values are: `'ascii`, `'utf-8` and `'auto`.

`log-path` (default: `()`) (type: list-of-strings)
: The file names of the log files to be monitored.

`action` (default: `()`) (type: list-of-fail2ban-jail-actions)
: A list of `<fail2ban-jail-action-configuration>`.

`extra-content` (default: `()`) (type: text-config)
: Extra content for the jail configuration, provided as a list of file-like objects.

`fail2ban-jail-filter-configuration` [Data Type]

Available `fail2ban-jail-filter-configuration` fields are:

`name` (type: string)
: Filter to use.

`mode` (type: maybe-string)
: Mode for filter.

12.10 Setuid Programs

Some programs need to run with elevated privileges, even when they are launched by unprivileged users. A notorious example is the `passwd` program, which users can run to change their password, and which needs to access the `/etc/passwd` and `/etc/shadow` files—something normally restricted to root, for obvious security reasons. To address that, `passwd` should be *setuid-root*, meaning that it always runs with root privileges (see Section "How

Change Persona" in *The GNU C Library Reference Manual*, for more info about the setuid mechanism).

The store itself *cannot* contain setuid programs: that would be a security issue since any user on the system can write derivations that populate the store (see Section 9.9 [The Store], page 144). Thus, a different mechanism is used: instead of changing the setuid or setgid bits directly on files that are in the store, we let the system administrator *declare* which programs should be entrusted with these additional privileges.

The `setuid-programs` field of an `operating-system` declaration contains a list of `<setuid-program>` denoting the names of programs to have a setuid or setgid bit set (see Section 12.1 [Using the Configuration System], page 220). For instance, the `mount.nfs` program, which is part of the nfs-utils package, with a setuid root can be designated like this:

```
(setuid-program
  (program (file-append nfs-utils "/sbin/mount.nfs")))
```

And then, to make `mount.nfs` setuid on your system, add the previous example to your operating system declaration by appending it to `%setuid-programs` like this:

```
(operating-system
  ;; Some fields omitted...
  (setuid-programs
    (append (list (setuid-program
                    (program (file-append nfs-utils "/sbin/mount.nfs"))))
            %setuid-programs)))
```

`setuid-program` [Data Type]

This data type represents a program with a setuid or setgid bit set.

`program` A file-like object having its setuid and/or setgid bit set.

`setuid?` (default: `#t`)
: Whether to set user setuid bit.

`setgid?` (default: `#f`)
: Whether to set group setgid bit.

`user` (default: `0`)
: UID (integer) or user name (string) for the user owner of the program, defaults to root.

`group` (default: `0`)
: GID (integer) goup name (string) for the group owner of the program, defaults to root.

A default set of setuid programs is defined by the `%setuid-programs` variable of the `(gnu system)` module.

`%setuid-programs` [Scheme Variable]

A list of `<setuid-program>` denoting common programs that are setuid-root.

The list includes commands such as `passwd`, `ping`, `su`, and `sudo`.

Under the hood, the actual setuid programs are created in the `/run/setuid-programs` directory at system activation time. The files in this directory refer to the "real" binaries, which are in the store.

12.11 X.509 Certificates

Web servers available over HTTPS (that is, HTTP over the transport-layer security mechanism, TLS) send client programs an *X.509 certificate* that the client can then use to *authenticate* the server. To do that, clients verify that the server's certificate is signed by a so-called *certificate authority* (CA). But to verify the CA's signature, clients must have first acquired the CA's certificate.

Web browsers such as GNU IceCat include their own set of CA certificates, such that they are able to verify CA signatures out-of-the-box.

However, most other programs that can talk HTTPS—`wget`, `git`, `w3m`, etc.—need to be told where CA certificates can be found.

In Guix, this is done by adding a package that provides certificates to the `packages` field of the `operating-system` declaration (see Section 12.2 [operating-system Reference], page 228). Guix includes one such package, `nss-certs`, which is a set of CA certificates provided as part of Mozilla's Network Security Services.

Note that it is *not* part of `%base-packages`, so you need to explicitly add it. The `/etc/ssl/certs` directory, which is where most applications and libraries look for certificates by default, points to the certificates installed globally.

Unprivileged users, including users of Guix on a foreign distro, can also install their own certificate package in their profile. A number of environment variables need to be defined so that applications and libraries know where to find them. Namely, the OpenSSL library honors the `SSL_CERT_DIR` and `SSL_CERT_FILE` variables. Some applications add their own environment variables; for instance, the Git version control system honors the certificate bundle pointed to by the `GIT_SSL_CAINFO` environment variable. Thus, you would typically run something like:

```
guix install nss-certs
export SSL_CERT_DIR="$HOME/.guix-profile/etc/ssl/certs"
export SSL_CERT_FILE="$HOME/.guix-profile/etc/ssl/certs/ca-certificates.crt"
export GIT_SSL_CAINFO="$SSL_CERT_FILE"
```

As another example, R requires the `CURL_CA_BUNDLE` environment variable to point to a certificate bundle, so you would have to run something like this:

```
guix install nss-certs
export CURL_CA_BUNDLE="$HOME/.guix-profile/etc/ssl/certs/ca-certificates.crt"
```

For other applications you may want to look up the required environment variable in the relevant documentation.

12.12 Name Service Switch

The `(gnu system nss)` module provides bindings to the configuration file of the libc *name service switch* or *NSS* (see Section "NSS Configuration File" in *The GNU C Library Reference Manual*). In a nutshell, the NSS is a mechanism that allows libc to be extended with new "name" lookup methods for system databases, which includes host names, service names, user accounts, and more (see Section "Name Service Switch" in *The GNU C Library Reference Manual*).

The NSS configuration specifies, for each system database, which lookup method is to be used, and how the various methods are chained together—for instance, under which circumstances NSS should try the next method in the list. The NSS configuration is given in the `name-service-switch` field of `operating-system` declarations (see Section 12.2 [operating-system Reference], page 228).

As an example, the declaration below configures the NSS to use the `nss-mdns` back-end (`https://0pointer.de/lennart/projects/nss-mdns/`), which supports host name lookups over multicast DNS (mDNS) for host names ending in `.local`:

```
(name-service-switch
   (hosts (list %files    ;first, check /etc/hosts

                ;; If the above did not succeed, try
                ;; with 'mdns_minimal'.
                (name-service
                  (name "mdns_minimal")

                  ;; 'mdns_minimal' is authoritative for
                  ;; '.local'.  When it returns "not found",
                  ;; no need to try the next methods.
                  (reaction (lookup-specification
                             (not-found => return))))

                ;; Then fall back to DNS.
                (name-service
                  (name "dns"))

                ;; Finally, try with the "full" 'mdns'.
                (name-service
                  (name "mdns")))))
```

Do not worry: the `%mdns-host-lookup-nss` variable (see below) contains this configuration, so you will not have to type it if all you want is to have `.local` host lookup working.

Note that, in this case, in addition to setting the `name-service-switch` of the `operating-system` declaration, you also need to use `avahi-service-type` (see Section 12.9.5 [Networking Services], page 277), or `%desktop-services`, which includes it (see Section 12.9.9 [Desktop Services], page 322). Doing this makes `nss-mdns` accessible to the name service cache daemon (see Section 12.9.1 [Base Services], page 248).

For convenience, the following variables provide typical NSS configurations.

`%default-nss` [Scheme Variable]

This is the default name service switch configuration, a `name-service-switch` object.

`%mdns-host-lookup-nss` [Scheme Variable]

This is the name service switch configuration with support for host name lookup over multicast DNS (mDNS) for host names ending in `.local`.

The reference for name service switch configuration is given below. It is a direct mapping of the configuration file format of the C library , so please refer to the C library manual for more information (see Section "NSS Configuration File" in *The GNU C Library Reference Manual*). Compared to the configuration file format of libc NSS, it has the advantage not only of adding this warm parenthetic feel that we like, but also static checks: you will know about syntax errors and typos as soon as you run `guix system`.

`name-service-switch` [Data Type]

This is the data type representation the configuration of libc's name service switch (NSS). Each field below represents one of the supported system databases.

`aliases`
`ethers`
`group`
`gshadow`
`hosts`
`initgroups`
`netgroup`
`networks`
`password`
`public-key`
`rpc`
`services`
`shadow`
: The system databases handled by the NSS. Each of these fields must be a list of `<name-service>` objects (see below).

`name-service` [Data Type]

This is the data type representing an actual name service and the associated lookup action.

`name`
: A string denoting the name service (see Section "Services in the NSS configuration" in *The GNU C Library Reference Manual*).

  Note that name services listed here must be visible to nscd. This is achieved by passing the `#:name-services` argument to `nscd-service` the list of packages providing the needed name services (see Section 12.9.1 [Base Services], page 248).

`reaction`
: An action specified using the `lookup-specification` macro (see Section "Actions in the NSS configuration" in *The GNU C Library Reference Manual*). For example:

```
(lookup-specification (unavailable => continue)
                      (success => return))
```

12.13 Initial RAM Disk

For bootstrapping purposes, the Linux-Libre kernel is passed an *initial RAM disk*, or *initrd*. An initrd contains a temporary root file system as well as an initialization script. The latter is responsible for mounting the real root file system, and for loading any kernel modules that may be needed to achieve that.

The initrd-modules field of an operating-system declaration allows you to specify Linux-libre kernel modules that must be available in the initrd. In particular, this is where you would list modules needed to actually drive the hard disk where your root partition is—although the default value of initrd-modules should cover most use cases. For example, assuming you need the megaraid_sas module in addition to the default modules to be able to access your root file system, you would write:

```
(operating-system
  ;; ...
  (initrd-modules (cons "megaraid_sas" %base-initrd-modules)))
```

%base-initrd-modules [Scheme Variable]

This is the list of kernel modules included in the initrd by default.

Furthermore, if you need lower-level customization, the initrd field of an operating-system declaration allows you to specify which initrd you would like to use. The (gnu system linux-initrd) module provides three ways to build an initrd: the high-level base-initrd procedure and the low-level raw-initrd and expression->initrd procedures.

The base-initrd procedure is intended to cover most common uses. For example, if you want to add a bunch of kernel modules to be loaded at boot time, you can define the initrd field of the operating system declaration like this:

```
(initrd (lambda (file-systems . rest)
          ;; Create a standard initrd but set up networking
          ;; with the parameters QEMU expects by default.
          (apply base-initrd file-systems
                 #:qemu-networking? #t
                 rest)))
```

The base-initrd procedure also handles common use cases that involves using the system as a QEMU guest, or as a "live" system with volatile root file system.

The base-initrd procedure is built from raw-initrd procedure. Unlike base-initrd, raw-initrd doesn't do anything high-level, such as trying to guess which kernel modules and packages should be included to the initrd. An example use of raw-initrd is when a user has a custom Linux kernel configuration and default kernel modules included by base-initrd are not available.

The initial RAM disk produced by base-initrd or raw-initrd honors several options passed on the Linux kernel command line (that is, arguments passed *via* the linux command of GRUB, or the -append option of QEMU), notably:

gnu.load=*boot*

Tell the initial RAM disk to load *boot*, a file containing a Scheme program, once it has mounted the root file system.

Guix uses this option to yield control to a boot program that runs the service activation programs and then spawns the GNU Shepherd, the initialization system.

root=*root*

Mount *root* as the root file system. *root* can be a device name like /dev/sda1, a file system label, or a file system UUID. When unspecified, the device name from the root file system of the operating system declaration is used.

`rootfstype=`*`type`*
: Set the type of the root file system. It overrides the `type` field of the root file system specified via the `operating-system` declaration, if any.

`rootflags=`*`options`*
: Set the mount *options* of the root file system. It overrides the `options` field of the root file system specified via the `operating-system` declaration, if any.

`fsck.mode=`*`mode`*
: Whether to check the *root* file system for errors before mounting it. *mode* is one of `skip` (never check), `force` (always check), or `auto` to respect the root `<file-system>` object's `check?` setting (see Section 12.3 [File Systems], page 232) and run a full scan only if the file system was not cleanly shut down.

  `auto` is the default if this option is not present or if *mode* is not one of the above.

`fsck.repair=`*`level`*
: The level of repairs to perform automatically if errors are found in the *root* file system. *level* is one of `no` (do not write to *root* at all if possible), `yes` (repair as much as possible), or `preen` to repair problems considered safe to repair automatically.

  `preen` is the default if this option is not present or if *level* is not one of the above.

`gnu.system=`*`system`*
: Have `/run/booted-system` and `/run/current-system` point to *system*.

`modprobe.blacklist=`*`modules`*`...`
: Instruct the initial RAM disk as well as the `modprobe` command (from the kmod package) to refuse to load *modules*. *modules* must be a comma-separated list of module names—e.g., `usbkbd,9pnet`.

`gnu.repl`
: Start a read-eval-print loop (REPL) from the initial RAM disk before it tries to load kernel modules and to mount the root file system. Our marketing team calls it *boot-to-Guile*. The Schemer in you will love it. See Section "Using Guile Interactively" in *GNU Guile Reference Manual*, for more information on Guile's REPL.

Now that you know all the features that initial RAM disks produced by `base-initrd` and `raw-initrd` provide, here is how to use it and customize it further.

`raw-initrd` *`file-systems`* [*#:linux-modules* '()] [Scheme Procedure]
[*#:pre-mount #t*] [*#:mapped-devices* '()] [*#:keyboard-layout #f*]
[*#:helper-packages* '()] [*#:qemu-networking? #f*] [*#:volatile-root? #f*]

Return a derivation that builds a raw initrd. *file-systems* is a list of file systems to be mounted by the initrd, possibly in addition to the root file system specified on the kernel command line via `root`. *linux-modules* is a list of kernel modules to be loaded at boot time. *mapped-devices* is a list of device mappings to realize before *file-systems* are mounted (see Section 12.4 [Mapped Devices], page 237). *pre-mount* is a G-expression to evaluate before realizing *mapped-devices*. *helper-packages* is a list of packages to be copied in the initrd. It may include `e2fsck/static` or other packages needed by the initrd to check the root file system.

When true, *keyboard-layout* is a `<keyboard-layout>` record denoting the desired console keyboard layout. This is done before *mapped-devices* are set up and before *file-systems* are mounted such that, should the user need to enter a passphrase or use the REPL, this happens using the intended keyboard layout.

When *qemu-networking?* is true, set up networking with the standard QEMU parameters. When *virtio?* is true, load additional modules so that the initrd can be used as a QEMU guest with para-virtualized I/O drivers.

When *volatile-root?* is true, the root file system is writable but any changes to it are lost.

`base-initrd` ***`file-systems`*** [*#:mapped-devices '()*] [*#:keyboard-layout #f*] [*#:qemu-networking? #f*] [*#:volatile-root? #f*] [*#:linux-modules '()*] [Scheme Procedure]

Return as a file-like object a generic initrd, with kernel modules taken from *linux*. *file-systems* is a list of file-systems to be mounted by the initrd, possibly in addition to the root file system specified on the kernel command line via `root`. *mapped-devices* is a list of device mappings to realize before *file-systems* are mounted.

When true, *keyboard-layout* is a `<keyboard-layout>` record denoting the desired console keyboard layout. This is done before *mapped-devices* are set up and before *file-systems* are mounted such that, should the user need to enter a passphrase or use the REPL, this happens using the intended keyboard layout.

qemu-networking? and *volatile-root?* behaves as in `raw-initrd`.

The initrd is automatically populated with all the kernel modules necessary for *file-systems* and for the given options. Additional kernel modules can be listed in *linux-modules*. They will be added to the initrd, and loaded at boot time in the order in which they appear.

Needless to say, the initrds we produce and use embed a statically-linked Guile, and the initialization program is a Guile program. That gives a lot of flexibility. The `expression->initrd` procedure builds such an initrd, given the program to run in that initrd.

`expression->initrd` ***`exp`*** [*#:guile %guile-static-stripped*] [*#:name "guile-initrd"*] [Scheme Procedure]

Return as a file-like object a Linux initrd (a gzipped cpio archive) containing *guile* and that evaluates *exp*, a G-expression, upon booting. All the derivations referenced by *exp* are automatically copied to the initrd.

12.14 Bootloader Configuration

The operating system supports multiple bootloaders. The bootloader is configured using `bootloader-configuration` declaration. All the fields of this structure are bootloader agnostic except for one field, `bootloader` that indicates the bootloader to be configured and installed.

Some of the bootloaders do not honor every field of `bootloader-configuration`. For instance, the extlinux bootloader does not support themes and thus ignores the `theme` field.

`bootloader-configuration` [Data Type]

The type of a bootloader configuration declaration.

`bootloader`

The bootloader to use, as a `bootloader` object. For now `grub-bootloader`, `grub-efi-bootloader`, `grub-efi-netboot-bootloader`, `grub-efi-removable-bootloader`, `extlinux-bootloader` and `u-boot-bootloader` are supported.

Available bootloaders are described in `(gnu bootloader ...)` modules. In particular, `(gnu bootloader u-boot)` contains definitions of bootloaders for a wide range of ARM and AArch64 systems, using the U-Boot bootloader (`https://www.denx.de/wiki/U-Boot/`).

`grub-efi-bootloader` allows to boot on modern systems using the *Unified Extensible Firmware Interface* (UEFI). This is what you should use if the installation image contains a `/sys/firmware/efi` directory when you boot it on your system.

`grub-bootloader` allows you to boot in particular Intel-based machines in "legacy" BIOS mode.

`grub-efi-netboot-bootloader` allows you to boot your system over network through TFTP. In combination with an NFS root file system this allows you to build a diskless Guix system.

The installation of the `grub-efi-netboot-bootloader` generates the content of the TFTP root directory at `targets` (see Section 12.14 [Bootloader Configuration], page 540), to be served by a TFTP server. You may want to mount your TFTP server directories onto the `targets` to move the required files to the TFTP server automatically.

If you plan to use an NFS root file system as well (actually if you mount the store from an NFS share), then the TFTP server needs to serve the file `/boot/grub/grub.cfg` and other files from the store (like GRUBs background image, the kernel (see Section 12.2 [operating-system Reference], page 228) and the initrd (see Section 12.2 [operating-system Reference], page 228)), too. All these files from the store will be accessed by GRUB through TFTP with their normal store path, for example as `tftp://tftp-server/gnu/store/...-initrd/initrd.cpio.gz`.

Two symlinks are created to make this possible. For each target in the `targets` field, the first symlink is '`target`'`/efi/Guix/boot/grub/grub.cfg` pointing to `../../../boot/grub/grub.cfg`, where '`target`' may be `/boot`. In this case the link is not leaving the served TFTP root directory, but otherwise it does. The second link is '`target`'`/gnu/store` and points to `../gnu/store`. This link is leaving the served TFTP root directory.

The assumption behind all this is that you have an NFS server exporting the root file system for your Guix system, and additionally a TFTP server exporting your `targets` directories—usually a single `/boot`—from that same root file system for your Guix system. In this constellation the symlinks will work.

For other constellations you will have to program your own bootloader installer, which then takes care to make necessary files from the store accessible through TFTP, for example by copying them into the TFTP root directory to your `targets`.

It is important to note that symlinks pointing outside the TFTP root directory may need to be allowed in the configuration of your TFTP server. Further the store link exposes the whole store through TFTP. Both points need to be considered carefully for security aspects.

Beside the `grub-efi-netboot-bootloader`, the already mentioned TFTP and NFS servers, you also need a properly configured DHCP server to make the booting over netboot possible. For all this we can currently only recommend you to look for instructions about PXE (Preboot eXecution Environment).

`grub-efi-removable-bootloader` allows you to boot your system from removable media by writing the GRUB file to the UEFI-specification location of `/EFI/BOOT/BOOTX64.efi` of the boot directory, usually `/boot/efi`. This is also useful for some UEFI firmwares that “forget” their configuration from their non-volatile storage. Like `grub-efi-bootloader`, this can only be used if the `/sys/firmware/efi` directory is available.

> **Note:** This *will* overwrite the GRUB file from any other operating systems that also place their GRUB file in the UEFI-specification location; making them unbootable.

`targets` This is a list of strings denoting the targets onto which to install the bootloader.

The interpretation of targets depends on the bootloader in question. For `grub-bootloader`, for example, they should be device names understood by the bootloader `installer` command, such as `/dev/sda` or `(hd0)` (see Section “Invoking grub-install” in *GNU GRUB Manual*). For `grub-efi-bootloader` and `grub-efi-removable-bootloader` they should be mount points of the EFI file system, usually `/boot/efi`. For `grub-efi-netboot-bootloader`, `targets` should be the mount points corresponding to TFTP root directories served by your TFTP server.

`menu-entries` (default: `()`)

A possibly empty list of `menu-entry` objects (see below), denoting entries to appear in the bootloader menu, in addition to the current system entry and the entry pointing to previous system generations.

`default-entry` (default: `0`)

The index of the default boot menu entry. Index 0 is for the entry of the current system.

`timeout` (default: `5`)

The number of seconds to wait for keyboard input before booting. Set to 0 to boot immediately, and to -1 to wait indefinitely.

`keyboard-layout` (default: `#f`)
: If this is `#f`, the bootloader's menu (if any) uses the default keyboard layout, usually US English ("qwerty").

  Otherwise, this must be a `keyboard-layout` object (see Section 12.7 [Keyboard Layout], page 243).

  > **Note:** This option is currently ignored by bootloaders other than `grub` and `grub-efi`.

`theme` (default: *#f*)
: The bootloader theme object describing the theme to use. If no theme is provided, some bootloaders might use a default theme, that's true for GRUB.

`terminal-outputs` (default: `'(gfxterm)`)
: The output terminals used for the bootloader boot menu, as a list of symbols. GRUB accepts the values: `console`, `serial`, `serial_{0-3}`, `gfxterm`, `vga_text`, `mda_text`, `morse`, and `pkmodem`. This field corresponds to the GRUB variable `GRUB_TERMINAL_OUTPUT` (see Section "Simple configuration" in *GNU GRUB manual*).

`terminal-inputs` (default: `'()`)
: The input terminals used for the bootloader boot menu, as a list of symbols. For GRUB, the default is the native platform terminal as determined at run-time. GRUB accepts the values: `console`, `serial`, `serial_{0-3}`, `at_keyboard`, and `usb_keyboard`. This field corresponds to the GRUB variable `GRUB_TERMINAL_INPUT` (see Section "Simple configuration" in *GNU GRUB manual*).

`serial-unit` (default: `#f`)
: The serial unit used by the bootloader, as an integer from 0 to 3. For GRUB, it is chosen at run-time; currently GRUB chooses 0, which corresponds to COM1 (see Section "Serial terminal" in *GNU GRUB manual*).

`serial-speed` (default: `#f`)
: The speed of the serial interface, as an integer. For GRUB, the default value is chosen at run-time; currently GRUB chooses 9600 bps (see Section "Serial terminal" in *GNU GRUB manual*).

`device-tree-support?` (default: `#t`)
: Whether to support Linux device tree (`https://en.wikipedia.org/wiki/Devicetree`) files loading.

  This option in enabled by default. In some cases involving the `u-boot` bootloader, where the device tree has already been loaded in RAM, it can be handy to disable the option by setting it to `#f`.

Should you want to list additional boot menu entries *via* the `menu-entries` field above, you will need to create them with the `menu-entry` form. For example, imagine you want to be able to boot another distro (hard to imagine!), you can define a menu entry along these lines:

```
(menu-entry
          (label "The Other Distro")
          (linux "/boot/old/vmlinux-2.6.32")
          (linux-arguments '("root=/dev/sda2"))
          (initrd "/boot/old/initrd"))
```

Details below.

`menu-entry` [Data Type]

The type of an entry in the bootloader menu.

`label` The label to show in the menu—e.g., `"GNU"`.

`linux` (default: `#f`)

The Linux kernel image to boot, for example:

```
(file-append linux-libre "/bzImage")
```

For GRUB, it is also possible to specify a device explicitly in the file path using GRUB's device naming convention (see Section "Naming convention" in *GNU GRUB manual*), for example:

```
"(hd0,msdos1)/boot/vmlinuz"
```

If the device is specified explicitly as above, then the `device` field is ignored entirely.

`linux-arguments` (default: `()`)

The list of extra Linux kernel command-line arguments—e.g., `("console=ttyS0")`.

`initrd` (default: `#f`)

A G-Expression or string denoting the file name of the initial RAM disk to use (see Section 9.12 [G-Expressions], page 154).

`device` (default: `#f`)

The device where the kernel and initrd are to be found—i.e., for GRUB, *root* for this menu entry (see Section "root" in *GNU GRUB manual*).

This may be a file system label (a string), a file system UUID (a bytevector, see Section 12.3 [File Systems], page 232), or `#f`, in which case the bootloader will search the device containing the file specified by the `linux` field (see Section "search" in *GNU GRUB manual*). It must *not* be an OS device name such as `/dev/sda1`.

`multiboot-kernel` (default: `#f`)

The kernel to boot in Multiboot-mode (see Section "multiboot" in *GNU GRUB manual*). When this field is set, a Multiboot menu-entry is generated. For example:

```
(file-append mach "/boot/gnumach")
```

`multiboot-arguments` (default: `()`)

The list of extra command-line arguments for the multiboot-kernel.

`multiboot-modules` (default: `()`)

The list of commands for loading Multiboot modules. For example:

```
(list (list (file-append hurd "/hurd/ext2fs.static") "ext2fs"
                        ...)
                 (list (file-append libc "/lib/ld.so.1") "exec"
                        ...))
```

`chain-loader` (default: `#f`)
: A string that can be accepted by `grub`'s `chainloader` directive. This has no effect if either `linux` or `multiboot-kernel` fields are specified. The following is an example of chainloading a different GNU/Linux system.

```
(bootloader
 (bootloader-configuration
  ;; ...
  (menu-entries
   (list
    (menu-entry
     (label "GNU/Linux")
     (device (uuid "1C31-A17C" 'fat))
     (chain-loader "/EFI/GNULinux/grubx64.efi"))))))
```

For now only GRUB has theme support. GRUB themes are created using the `grub-theme` form, which is not fully documented yet.

`grub-theme` [Data Type]

Data type representing the configuration of the GRUB theme.

`gfxmode` (default: `'("auto")`)
: The GRUB `gfxmode` to set (a list of screen resolution strings, see Section "gfxmode" in *GNU GRUB manual*).

`grub-theme` [Scheme Procedure]

Return the default GRUB theme used by the operating system if no `theme` field is specified in `bootloader-configuration` record.

It comes with a fancy background image displaying the GNU and Guix logos.

For example, to override the default resolution, you may use something like

```
(bootloader
 (bootloader-configuration
 ;; ...
 (theme (grub-theme
         (inherit (grub-theme))
         (gfxmode '("1024x786x32" "auto"))))))
```

12.15 Invoking `guix system`

Once you have written an operating system declaration as seen in the previous section, it can be *instantiated* using the `guix system` command. The synopsis is:

```
guix system options... action file
```

file must be the name of a file containing an `operating-system` declaration. *action* specifies how the operating system is instantiated. Currently the following values are supported:

`search` Display available service type definitions that match the given regular expressions, sorted by relevance:

```
$ guix system search console
name: console-fonts
location: gnu/services/base.scm:806:2
extends: shepherd-root
description: Install the given fonts on the specified ttys (fonts are per
+ virtual console on GNU/Linux).  The value of this service is a list of
+ tty/font pairs.  The font can be the name of a font provided by the `kbd'
+ package or any valid argument to `setfont', as in this example:
+
+      '(("tty1" . "LatGrkCyr-8x16")
+        ("tty2" . (file-append
+                      font-tamzen
+                      "/share/kbd/consolefonts/TamzenForPowerline10x20.psf"
+        ("tty3" . (file-append
+                      font-terminus
+                      "/share/consolefonts/ter-132n"))) ; for HDPI
relevance: 9

name: mingetty
location: gnu/services/base.scm:1190:2
extends: shepherd-root
description: Provide console login using the `mingetty' program.
relevance: 2

name: login
location: gnu/services/base.scm:860:2
extends: pam
description: Provide a console log-in service as specified by its
+ configuration value, a `login-configuration' object.
relevance: 2

...
```

As for `guix package --search`, the result is written in `recutils` format, which makes it easy to filter the output (see *GNU recutils manual*).

`edit` Edit or view the definition of the given service types.

For example, the command below opens your editor, as specified by the `EDITOR` environment variable, on the definition of the `openssh` service type:

```
guix system edit openssh
```

`reconfigure`

Build the operating system described in *file*, activate it, and switch to it[7].

[7] This action (and the related actions `switch-generation` and `roll-back`) are usable only on systems already running Guix System.

> **Note:** It is highly recommended to run `guix pull` once before you run `guix system reconfigure` for the first time (see Section 6.6 [Invoking guix pull], page 56). Failing to do that you would see an older version of Guix once `reconfigure` has completed.

This effects all the configuration specified in *file*: user accounts, system services, global package list, setuid programs, etc. The command starts system services specified in *file* that are not currently running; if a service is currently running this command will arrange for it to be upgraded the next time it is stopped (e.g. by `herd stop X` or `herd restart X`).

This command creates a new generation whose number is one greater than the current generation (as reported by `guix system list-generations`). If that generation already exists, it will be overwritten. This behavior mirrors that of `guix package` (see Section 6.2 [Invoking guix package], page 39).

It also adds a bootloader menu entry for the new OS configuration, —unless `--no-bootloader` is passed. For GRUB, it moves entries for older configurations to a submenu, allowing you to choose an older system generation at boot time should you need it.

Upon completion, the new system is deployed under `/run/current-system`. This directory contains *provenance meta-data*: the list of channels in use (see Chapter 7 [Channels], page 68) and *file* itself, when available. You can view it by running:

```
guix system describe
```

This information is useful should you later want to inspect how this particular generation was built. In fact, assuming *file* is self-contained, you can later rebuild generation *n* of your operating system with:

```
guix time-machine \
  -C /var/guix/profiles/system-n-link/channels.scm -- \
  system reconfigure \
  /var/guix/profiles/system-n-link/configuration.scm
```

You can think of it as some sort of built-in version control! Your system is not just a binary artifact: *it carries its own source*. See Section 12.18.3 [Service Reference], page 563, for more information on provenance tracking.

By default, `reconfigure` *prevents you from downgrading your system*, which could (re)introduce security vulnerabilities and also cause problems with "stateful" services such as database management systems. You can override that behavior by passing `--allow-downgrades`.

`switch-generation`

Switch to an existing system generation. This action atomically switches the system profile to the specified system generation. It also rearranges the system's existing bootloader menu entries. It makes the menu entry for the specified system generation the default, and it moves the entries for the other generations to a submenu, if supported by the bootloader being used. The next time the system boots, it will use the specified system generation.

The bootloader itself is not being reinstalled when using this command. Thus, the installed bootloader is used with an updated configuration file.

The target generation can be specified explicitly by its generation number. For example, the following invocation would switch to system generation 7:

```
guix system switch-generation 7
```

The target generation can also be specified relative to the current generation with the form `+N` or `-N`, where `+3` means "3 generations ahead of the current generation," and `-1` means "1 generation prior to the current generation." When specifying a negative value such as `-1`, you must precede it with `--` to prevent it from being parsed as an option. For example:

```
guix system switch-generation -- -1
```

Currently, the effect of invoking this action is *only* to switch the system profile to an existing generation and rearrange the bootloader menu entries. To actually start using the target system generation, you must reboot after running this action. In the future, it will be updated to do the same things as `reconfigure`, like activating and deactivating services.

This action will fail if the specified generation does not exist.

`roll-back`

Switch to the preceding system generation. The next time the system boots, it will use the preceding system generation. This is the inverse of `reconfigure`, and it is exactly the same as invoking `switch-generation` with an argument of `-1`.

Currently, as with `switch-generation`, you must reboot after running this action to actually start using the preceding system generation.

`delete-generations`

Delete system generations, making them candidates for garbage collection (see Section 6.5 [Invoking guix gc], page 53, for information on how to run the "garbage collector").

This works in the same way as '`guix package --delete-generations`' (see Section 6.2 [Invoking guix package], page 39). With no arguments, all system generations but the current one are deleted:

```
guix system delete-generations
```

You can also select the generations you want to delete. The example below deletes all the system generations that are more than two months old:

```
guix system delete-generations 2m
```

Running this command automatically reinstalls the bootloader with an updated list of menu entries—e.g., the "old generations" sub-menu in GRUB no longer lists the generations that have been deleted.

`build` Build the derivation of the operating system, which includes all the configuration files and programs needed to boot and run the system. This action does not actually install anything.

`init` Populate the given directory with all the files necessary to run the operating system specified in *file*. This is useful for first-time installations of Guix System. For instance:

```
guix system init my-os-config.scm /mnt
```

copies to `/mnt` all the store items required by the configuration specified in `my-os-config.scm`. This includes configuration files, packages, and so on. It also creates other essential files needed for the system to operate correctly—e.g., the `/etc`, `/var`, and `/run` directories, and the `/bin/sh` file.

This command also installs bootloader on the targets specified in `my-os-config`, unless the `--no-bootloader` option was passed.

`vm` Build a virtual machine (VM) that contains the operating system declared in *file*, and return a script to run that VM.

> **Note:** The `vm` action and others below can use KVM support in the Linux-libre kernel. Specifically, if the machine has hardware virtualization support, the corresponding KVM kernel module should be loaded, and the `/dev/kvm` device node must exist and be readable and writable by the user and by the build users of the daemon (see Section 2.4.1 [Build Environment Setup], page 9).

Arguments given to the script are passed to QEMU as in the example below, which enables networking and requests 1 GiB of RAM for the emulated machine:

```
$ /gnu/store/...-run-vm.sh -m 1024 -smp 2 -nic user,model=virtio-net-pci
```

It's possible to combine the two steps into one:

```
$ $(guix system vm my-config.scm) -m 1024 -smp 2 -nic user,model=virtio-net-
```

The VM shares its store with the host system.

By default, the root file system of the VM is mounted volatile; the `--persistent` option can be provided to make it persistent instead. In that case, the VM disk-image file will be copied from the store to the `TMPDIR` directory to make it writable.

Additional file systems can be shared between the host and the VM using the `--share` and `--expose` command-line options: the former specifies a directory to be shared with write access, while the latter provides read-only access to the shared directory.

The example below creates a VM in which the user's home directory is accessible read-only, and where the `/exchange` directory is a read-write mapping of `$HOME/tmp` on the host:

```
guix system vm my-config.scm \
   --expose=$HOME --share=$HOME/tmp=/exchange
```

On GNU/Linux, the default is to boot directly to the kernel; this has the advantage of requiring only a very tiny root disk image since the store of the host can then be mounted.

The `--full-boot` option forces a complete boot sequence, starting with the bootloader. This requires more disk space since a root image containing at least the kernel, initrd, and bootloader data files must be created.

The `--image-size` option can be used to specify the size of the image.

The `--no-graphic` option will instruct `guix system` to spawn a headless VM that will use the invoking tty for IO. Among other things, this enables copy-pasting, and scrollback. Use the *`ctrl`*`-a` prefix to issue QEMU commands; e.g.

ctrl-a h prints a help, *ctrl-a x* quits the VM, and *ctrl-a c* switches between the QEMU monitor and the VM.

`image` The `image` command can produce various image types. The image type can be selected using the `--image-type` option. It defaults to `efi-raw`. When its value is `iso9660`, the `--label` option can be used to specify a volume ID with `image`. By default, the root file system of a disk image is mounted non-volatile; the `--volatile` option can be provided to make it volatile instead. When using `image`, the bootloader installed on the generated image is taken from the provided `operating-system` definition. The following example demonstrates how to generate an image that uses the `grub-efi-bootloader` bootloader and boot it with QEMU:

```
image=$(guix system image --image-type=qcow2 \
        gnu/system/examples/lightweight-desktop.tmpl)
cp $image /tmp/my-image.qcow2
chmod +w /tmp/my-image.qcow2
qemu-system-x86_64 -enable-kvm -hda /tmp/my-image.qcow2 -m 1000 \
                   -bios $(guix build ovmf)/share/firmware/ovmf_x64.bin
```

When using the `efi-raw` image type, a raw disk image is produced; it can be copied as is to a USB stick, for instance. Assuming `/dev/sdc` is the device corresponding to a USB stick, one can copy the image to it using the following command:

```
# dd if=$(guix system image my-os.scm) of=/dev/sdc status=progress
```

The `--list-image-types` command lists all the available image types.

When using the `qcow2` image type, the returned image is in qcow2 format, which the QEMU emulator can efficiently use. See Section 12.17 [Running Guix in a VM], page 558, for more information on how to run the image in a virtual machine. The `grub-bootloader` bootloader is always used independently of what is declared in the `operating-system` file passed as argument. This is to make it easier to work with QEMU, which uses the SeaBIOS BIOS by default, expecting a bootloader to be installed in the Master Boot Record (MBR).

When using the `docker` image type, a Docker image is produced. Guix builds the image from scratch, not from a pre-existing Docker base image. As a result, it contains *exactly* what you define in the operating system configuration file. You can then load the image and launch a Docker container using commands like the following:

```
image_id="$(docker load < guix-system-docker-image.tar.gz)"
container_id="$(docker create $image_id)"
docker start $container_id
```

This command starts a new Docker container from the specified image. It will boot the Guix system in the usual manner, which means it will start any services you have defined in the operating system configuration. You can get an interactive shell running in the container using `docker exec`:

```
docker exec -ti $container_id /run/current-system/profile/bin/bash --login
```

Depending on what you run in the Docker container, it may be necessary to give the container additional permissions. For example, if you intend to build software using Guix inside of the Docker container, you may need to pass the `--privileged` option to `docker create`.

Last, the `--network` option applies to `guix system docker-image`: it produces an image where network is supposedly shared with the host, and thus without services like nscd or NetworkManager.

`container`
: Return a script to run the operating system declared in *file* within a container. Containers are a set of lightweight isolation mechanisms provided by the kernel Linux-libre. Containers are substantially less resource-demanding than full virtual machines since the kernel, shared objects, and other resources can be shared with the host system; this also means they provide thinner isolation.

  Currently, the script must be run as root in order to support more than a single user and group. The container shares its store with the host system.

  As with the `vm` action (see [guix system vm], page 549), additional file systems to be shared between the host and container can be specified using the `--share` and `--expose` options:

```
guix system container my-config.scm \
   --expose=$HOME --share=$HOME/tmp=/exchange
```

  The `--share` and `--expose` options can also be passed to the generated script to bind-mount additional directories into the container.

  Note: This option requires Linux-libre 3.19 or newer.

options can contain any of the common build options (see Section 10.1.1 [Common Build Options], page 166). In addition, *options* can contain one of the following:

`--expression=`*`expr`*
`-e` *`expr`*
: Consider the operating-system *expr* evaluates to. This is an alternative to specifying a file which evaluates to an operating system. This is used to generate the Guix system installer see Section 3.9 [Building the Installation Image], page 32).

`--system=`*`system`*
`-s` *`system`*
: Attempt to build for *system* instead of the host system type. This works as per `guix build` (see Section 10.1 [Invoking guix build], page 166).

`--target=`*`triplet`*
: Cross-build for *triplet*, which must be a valid GNU triplet, such as `"aarch64-linux-gnu"` (see Section “Specifying target triplets” in *Autoconf*).

`--derivation`
`-d`
: Return the derivation file name of the given operating system without building anything.

`--save-provenance`
: As discussed above, `guix system init` and `guix system reconfigure` always save provenance information *via* a dedicated service (see Section 12.18.3 [Service Reference], page 563). However, other commands don’t do that by default. If you wish to, say, create a virtual machine image that contains provenance information, you can run:

```
guix system image -t qcow2 --save-provenance config.scm
```

That way, the resulting image will effectively "embed its own source" in the form of meta-data in `/run/current-system`. With that information, one can rebuild the image to make sure it really contains what it pretends to contain; or they could use that to derive a variant of the image.

`--image-type=`*`type`*
`-t` *`type`*
: For the `image` action, create an image with given *type*.

  When this option is omitted, `guix system` uses the `efi-raw` image type.

  `--image-type=iso9660` produces an ISO-9660 image, suitable for burning on CDs and DVDs.

`--image-size=`*`size`*
: For the `image` action, create an image of the given *size*. *size* may be a number of bytes, or it may include a unit as a suffix (see Section "Block size" in *GNU Coreutils*).

  When this option is omitted, `guix system` computes an estimate of the image size as a function of the size of the system declared in *file*.

`--network`
`-N`
: For the `container` action, allow containers to access the host network, that is, do not create a network namespace.

`--root=`*`file`*
`-r` *`file`*
: Make *file* a symlink to the result, and register it as a garbage collector root.

`--skip-checks`
: Skip pre-installation safety checks.

  By default, `guix system init` and `guix system reconfigure` perform safety checks: they make sure the file systems that appear in the `operating-system` declaration actually exist (see Section 12.3 [File Systems], page 232), and that any Linux kernel modules that may be needed at boot time are listed in `initrd-modules` (see Section 12.13 [Initial RAM Disk], page 537). Passing this option skips these tests altogether.

`--allow-downgrades`
: Instruct `guix system reconfigure` to allow system downgrades.

  By default, `reconfigure` prevents you from downgrading your system. It achieves that by comparing the provenance info of your system (shown by `guix system describe`) with that of your `guix` command (shown by `guix describe`). If the commits for `guix` are not descendants of those used for your system, `guix system reconfigure` errors out. Passing `--allow-downgrades` allows you to bypass these checks.

  > **Note:** Make sure you understand its security implications before using `--allow-downgrades`.

`--on-error=`*`strategy`*
: Apply *strategy* when an error occurs when reading *file*. *strategy* may be one of the following:

  `nothing-special`
  : Report the error concisely and exit. This is the default strategy.

`backtrace`
: Likewise, but also display a backtrace.

`debug`
: Report the error and enter Guile's debugger. From there, you can run commands such as `,bt` to get a backtrace, `,locals` to display local variable values, and more generally inspect the state of the program. See Section "Debug Commands" in *GNU Guile Reference Manual*, for a list of available debugging commands.

Once you have built, configured, re-configured, and re-re-configured your Guix installation, you may find it useful to list the operating system generations available on disk—and that you can choose from the bootloader boot menu:

`describe`
: Describe the running system generation: its file name, the kernel and bootloader used, etc., as well as provenance information when available.

  The `--list-installed` flag is available, with the same syntax that is used in `guix package --list-installed` (see Section 6.2 [Invoking guix package], page 39). When the flag is used, the description will include a list of packages that are currently installed in the system profile, with optional filtering based on a regular expression.

  > **Note:** The *running* system generation—referred to by `/run/current-system`—is not necessarily the *current* system generation—referred to by `/var/guix/profiles/system`: it differs when, for instance, you chose from the bootloader menu to boot an older generation.
  >
  > It can also differ from the *booted* system generation—referred to by `/run/booted-system`—for instance because you reconfigured the system in the meantime.

`list-generations`
: List a summary of each generation of the operating system available on disk, in a human-readable way. This is similar to the `--list-generations` option of `guix package` (see Section 6.2 [Invoking guix package], page 39).

  Optionally, one can specify a pattern, with the same syntax that is used in `guix package --list-generations`, to restrict the list of generations displayed. For instance, the following command displays generations that are up to 10 days old:

  ```
  $ guix system list-generations 10d
  ```

  The `--list-installed` flag may also be specified, with the same syntax that is used in `guix package --list-installed`. This may be helpful if trying to determine when a package was added to the system.

The `guix system` command has even more to offer! The following sub-commands allow you to visualize how your system services relate to each other:

`extension-graph`
: Emit to standard output the *service extension graph* of the operating system defined in *file* (see Section 12.18.1 [Service Composition], page 560, for more information on service extensions). By default the output is in Dot/Graphviz

format, but you can choose a different format with `--graph-backend`, as with `guix graph` (see Section 10.10 [Invoking guix graph], page 201):

The command:

```
$ guix system extension-graph file | xdot -
```

shows the extension relations among services.

Note: The `dot` program is provided by the `graphviz` package.

`shepherd-graph`

Emit to standard output the *dependency graph* of shepherd services of the operating system defined in *file*. See Section 12.18.4 [Shepherd Services], page 568, for more information and for an example graph.

Again, the default output format is Dot/Graphviz, but you can pass `--graph-backend` to select a different one.

12.16 Invoking `guix deploy`

We've already seen `operating-system` declarations used to manage a machine's configuration locally. Suppose you need to configure multiple machines, though—perhaps you're managing a service on the web that's comprised of several servers. `guix deploy` enables you to use those same `operating-system` declarations to manage multiple remote hosts at once as a logical "deployment".

Note: The functionality described in this section is still under development and is subject to change. Get in touch with us on `guix-devel@gnu.org`!

```
guix deploy file
```

Such an invocation will deploy the machines that the code within *file* evaluates to. As an example, *file* might contain a definition like this:

```
;; This is a Guix deployment of a "bare bones" setup, with
;; no X11 display server, to a machine with an SSH daemon
;; listening on localhost:2222. A configuration such as this
;; may be appropriate for virtual machine with ports
;; forwarded to the host's loopback interface.

(use-service-modules networking ssh)
(use-package-modules bootloaders)

(define %system
  (operating-system
   (host-name "gnu-deployed")
   (timezone "Etc/UTC")
   (bootloader (bootloader-configuration
                (bootloader grub-bootloader)
                (targets '("/dev/vda"))
                (terminal-outputs '(console))))
   (file-systems (cons (file-system
                        (mount-point "/")
                        (device "/dev/vda1")
```

```
                          (type "ext4"))
                        %base-file-systems))
    (services
     (append (list (service dhcp-client-service-type)
                   (service openssh-service-type
                            (openssh-configuration
                             (permit-root-login #t)
                             (allow-empty-passwords? #t))))
             %base-services))))

(list (machine
       (operating-system %system)
       (environment managed-host-environment-type)
       (configuration (machine-ssh-configuration
                       (host-name "localhost")
                       (system "x86_64-linux")
                       (user "alice")
                       (identity "./id_rsa")
                       (port 2222)))))
```

The file should evaluate to a list of *machine* objects. This example, upon being deployed, will create a new generation on the remote system realizing the `operating-system` declaration `%system`. `environment` and `configuration` specify how the machine should be provisioned—that is, how the computing resources should be created and managed. The above example does not create any resources, as a `'managed-host` is a machine that is already running the Guix system and available over the network. This is a particularly simple case; a more complex deployment may involve, for example, starting virtual machines through a Virtual Private Server (VPS) provider. In such a case, a different *environment* type would be used.

Do note that you first need to generate a key pair on the coordinator machine to allow the daemon to export signed archives of files from the store (see Section 6.10 [Invoking guix archive], page 64), though this step is automatic on Guix System:

```
# guix archive --generate-key
```

Each target machine must authorize the key of the master machine so that it accepts store items it receives from the coordinator:

```
# guix archive --authorize < coordinator-public-key.txt
```

`user`, in this example, specifies the name of the user account to log in as to perform the deployment. Its default value is `root`, but root login over SSH may be forbidden in some cases. To work around this, `guix deploy` can log in as an unprivileged user and employ `sudo` to escalate privileges. This will only work if `sudo` is currently installed on the remote and can be invoked non-interactively as `user`. That is, the line in `sudoers` granting `user` the ability to use `sudo` must contain the `NOPASSWD` tag. This can be accomplished with the following operating system configuration snippet:

```
(use-modules ...
             (gnu system))              ;for %sudoers-specification
```

```
(define %user "username")

(operating-system
  ...
  (sudoers-file
     (plain-file "sudoers"
                 (string-append (plain-file-content %sudoers-specification)
                                (format #f "~a ALL = NOPASSWD: ALL~%"
                                        %user)))))
```

For more information regarding the format of the `sudoers` file, consult `man sudoers`.

Once you've deployed a system on a set of machines, you may find it useful to run a command on all of them. The `--execute` or `-x` option lets you do that; the example below runs `uname -a` on all the machines listed in the deployment file:

```
guix deploy file -x -- uname -a
```

One thing you may often need to do after deployment is restart specific services on all the machines, which you can do like so:

```
guix deploy file -x -- herd restart service
```

The `guix deploy -x` command returns zero if and only if the command succeeded on all the machines.

Below are the data types you need to know about when writing a deployment file.

`machine` [Data Type]

This is the data type representing a single machine in a heterogeneous Guix deployment.

`operating-system`
: The object of the operating system configuration to deploy.

`environment`
: An `environment-type` describing how the machine should be provisioned.

`configuration` (default: `#f`)
: An object describing the configuration for the machine's `environment`. If the `environment` has a default configuration, `#f` may be used. If `#f` is used for an environment with no default configuration, however, an error will be thrown.

`machine-ssh-configuration` [Data Type]

This is the data type representing the SSH client parameters for a machine with an `environment` of `managed-host-environment-type`.

`host-name`

`build-locally?` (default: `#t`)
: If false, system derivations will be built on the machine being deployed to.

`system` The system type describing the architecture of the machine being deployed to—e.g., `"x86_64-linux"`.

`authorize?` (default: `#t`)
: If true, the coordinator's signing key will be added to the remote's ACL keyring.

`port` (default: `22`)
`user` (default: `"root"`)
`identity` (default: `#f`)
: If specified, the path to the SSH private key to use to authenticate with the remote host.

`host-key` (default: `#f`)
: This should be the SSH host key of the machine, which looks like this:

```
ssh-ed25519 AAAAC3Nz... root@example.org
```

When `host-key` is `#f`, the server is authenticated against the `~/.ssh/known_hosts` file, just like the OpenSSH `ssh` client does.

`allow-downgrades?` (default: `#f`)
: Whether to allow potential downgrades.

Like `guix system reconfigure`, `guix deploy` compares the channel commits currently deployed on the remote host (as returned by `guix system describe`) to those currently in use (as returned by `guix describe`) to determine whether commits currently in use are descendants of those deployed. When this is not the case and `allow-downgrades?` is false, it raises an error. This ensures you do not accidentally downgrade remote machines.

`safety-checks?` (default: `#t`)
: Whether to perform "safety checks" before deployment. This includes verifying that devices and file systems referred to in the operating system configuration actually exist on the target machine, and making sure that Linux modules required to access storage devices at boot time are listed in the `initrd-modules` field of the operating system.

These safety checks ensure that you do not inadvertently deploy a system that would fail to boot. Be careful before turning them off!

`digital-ocean-configuration` [Data Type]

This is the data type describing the Droplet that should be created for a machine with an `environment` of `digital-ocean-environment-type`.

`ssh-key` The path to the SSH private key to use to authenticate with the remote host. In the future, this field may not exist.

`tags` A list of string "tags" that uniquely identify the machine. Must be given such that no two machines in the deployment have the same set of tags.

`region` A Digital Ocean region slug, such as `"nyc3"`.

`size` A Digital Ocean size slug, such as `"s-1vcpu-1gb"`

`enable-ipv6?`
: Whether or not the droplet should be created with IPv6 networking.

12.17 Running Guix in a Virtual Machine

To run Guix in a virtual machine (VM), one can use the pre-built Guix VM image distributed at `https://ftp.gnu.org/gnu/guix/guix-system-vm-image-1.4.0.x86_64-linux.qcow2`. This image is a compressed image in QCOW format. You can pass it to an emulator such as QEMU (`https://qemu.org/`) (see below for details).

This image boots the Xfce graphical environment and it contains some commonly used tools. You can install more software in the image by running `guix package` in a terminal (see Section 6.2 [Invoking guix package], page 39). You can also reconfigure the system based on its initial configuration file available as `/run/current-system/configuration.scm` (see Section 12.1 [Using the Configuration System], page 220).

Instead of using this pre-built image, one can also build their own image using `guix system image` (see Section 12.15 [Invoking guix system], page 545).

If you built your own image, you must copy it out of the store (see Section 9.9 [The Store], page 144) and give yourself permission to write to the copy before you can use it. When invoking QEMU, you must choose a system emulator that is suitable for your hardware platform. Here is a minimal QEMU invocation that will boot the result of `guix system image -t qcow2` on x86_64 hardware:

```
$ qemu-system-x86_64 \
   -nic user,model=virtio-net-pci \
   -enable-kvm -m 2048 \
   -device virtio-blk,drive=myhd \
   -drive if=none,file=guix-system-vm-image-1.4.0.x86_64-linux.qcow2,id=myhd
```

Here is what each of these options means:

`qemu-system-x86_64`
: This specifies the hardware platform to emulate. This should match the host.

`-nic user,model=virtio-net-pci`
: Enable the unprivileged user-mode network stack. The guest OS can access the host but not vice versa. This is the simplest way to get the guest OS online. `model` specifies which network device to emulate: `virtio-net-pci` is a special device made for virtualized operating systems and recommended for most uses. Assuming your hardware platform is x86_64, you can get a list of available NIC models by running `qemu-system-x86_64 -nic model=help`.

`-enable-kvm`
: If your system has hardware virtualization extensions, enabling the virtual machine support (KVM) of the Linux kernel will make things run faster.

`-m 2048`
: RAM available to the guest OS, in mebibytes. Defaults to 128 MiB, which may be insufficient for some operations.

`-device virtio-blk,drive=myhd`
: Create a `virtio-blk` drive called "myhd". `virtio-blk` is a "paravirtualization" mechanism for block devices that allows QEMU to achieve better per-

formance than if it were emulating a complete disk drive. See the QEMU and KVM documentation for more info.

`-drive if=none,file=/tmp/qemu-image,id=myhd`
: Use our QCOW image, the `guix-system-vm-image-1.4.0.x86_64-linux.qcow2` file, as the backing store of the "myhd" drive.

The default `run-vm.sh` script that is returned by an invocation of `guix system vm` does not add a `-nic user` flag by default. To get network access from within the vm add the `(dhcp-client-service)` to your system definition and start the VM using `$(guix system vm config.scm) -nic user`. An important caveat of using `-nic user` for networking is that `ping` will not work, because it uses the ICMP protocol. You'll have to use a different command to check for network connectivity, for example `guix download`.

12.17.1 Connecting Through SSH

To enable SSH inside a VM you need to add an SSH server like `openssh-service-type` to your VM (see Section 12.9.5 [Networking Services], page 277). In addition you need to forward the SSH port, 22 by default, to the host. You can do this with

```
$(guix system vm config.scm) -nic user,model=virtio-net-pci,hostfwd=tcp::10022-:22
```

To connect to the VM you can run

```
ssh -o UserKnownHostsFile=/dev/null -o StrictHostKeyChecking=no -p 10022 localhost
```

The `-p` tells `ssh` the port you want to connect to. `-o UserKnownHostsFile=/dev/null` prevents `ssh` from complaining every time you modify your `config.scm` file and the `-o StrictHostKeyChecking=no` prevents you from having to allow a connection to an unknown host every time you connect.

> **Note:** If you find the above '`hostfwd`' example not to be working (e.g., your SSH client hangs attempting to connect to the mapped port of your VM), make sure that your Guix System VM has networking support, such as by using the `dhcp-client-service-type` service type.

12.17.2 Using `virt-viewer` with Spice

As an alternative to the default `qemu` graphical client you can use the `remote-viewer` from the `virt-viewer` package. To connect pass the `-spice port=5930,disable-ticketing` flag to `qemu`. See previous section for further information on how to do this.

Spice also allows you to do some nice stuff like share your clipboard with your VM. To enable that you'll also have to pass the following flags to `qemu`:

```
-device virtio-serial-pci,id=virtio-serial0,max_ports=16,bus=pci.0,addr=0x5
-chardev spicevmc,name=vdagent,id=vdagent
-device virtserialport,nr=1,bus=virtio-serial0.0,chardev=vdagent,\
name=com.redhat.spice.0
```

You'll also need to add the `(spice-vdagent-service)` to your system definition (see Section 12.9.36 [Miscellaneous Services], page 523).

12.18 Defining Services

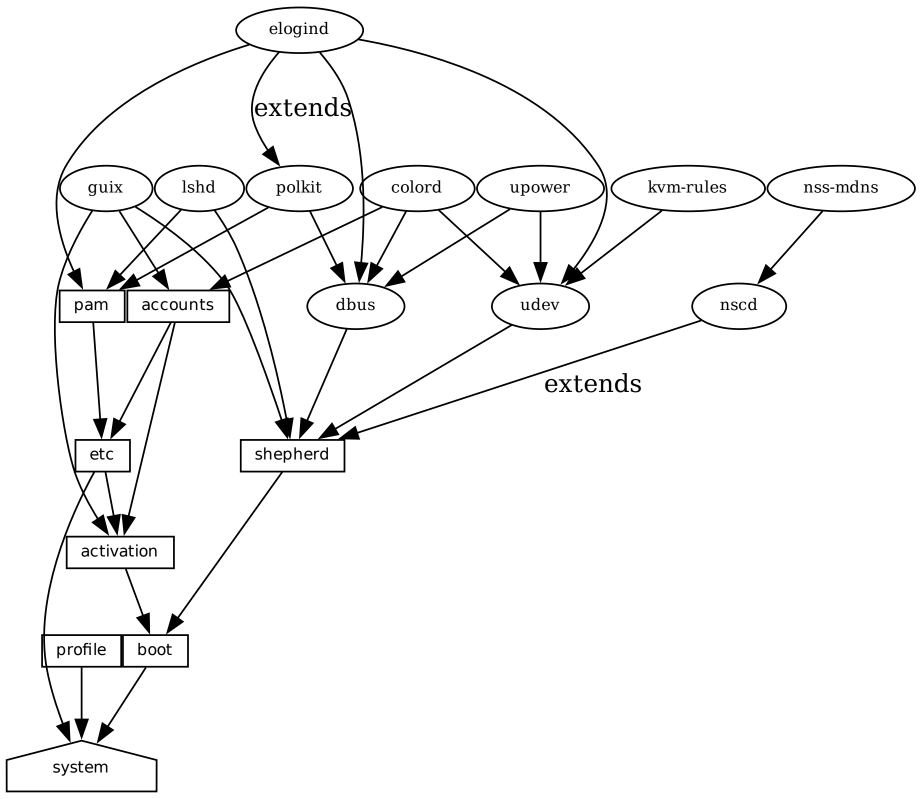
The previous sections show the available services and how one can combine them in an `operating-system` declaration. But how do we define them in the first place? And what is a service anyway?

12.18.1 Service Composition

Here we define a *service* as, broadly, something that extends the functionality of the operating system. Often a service is a process—a *daemon*—started when the system boots: a secure shell server, a Web server, the Guix build daemon, etc. Sometimes a service is a daemon whose execution can be triggered by another daemon—e.g., an FTP server started by `inetd` or a D-Bus service activated by `dbus-daemon`. Occasionally, a service does not map to a daemon. For instance, the "account" service collects user accounts and makes sure they exist when the system runs; the "udev" service collects device management rules and makes them available to the eudev daemon; the `/etc` service populates the `/etc` directory of the system.

Guix system services are connected by *extensions*. For instance, the secure shell service *extends* the Shepherd—the initialization system, running as PID 1—by giving it the command lines to start and stop the secure shell daemon (see Section 12.9.5 [Networking Services], page 277); the UPower service extends the D-Bus service by passing it its `.service` specification, and extends the udev service by passing it device management rules (see Section 12.9.9 [Desktop Services], page 322); the Guix daemon service extends the Shepherd by passing it the command lines to start and stop the daemon, and extends the account service by passing it a list of required build user accounts (see Section 12.9.1 [Base Services], page 248).

All in all, services and their "extends" relations form a directed acyclic graph (DAG). If we represent services as boxes and extensions as arrows, a typical system might provide something like this:



At the bottom, we see the *system service*, which produces the directory containing everything to run and boot the system, as returned by the `guix system build` command. See Section 12.18.3 [Service Reference], page 563, to learn about the other service types shown here. See [system-extension-graph], page 553, for information on how to generate this representation for a particular operating system definition.

Technically, developers can define *service types* to express these relations. There can be any number of services of a given type on the system—for instance, a system running two instances of the GNU secure shell server (lsh) has two instances of `lsh-service-type`, with different parameters.

The following section describes the programming interface for service types and services.

12.18.2 Service Types and Services

A *service type* is a node in the DAG described above. Let us start with a simple example, the service type for the Guix build daemon (see Section 2.5 [Invoking guix-daemon], page 15):

```
(define guix-service-type
  (service-type
   (name 'guix)
   (extensions
    (list (service-extension shepherd-root-service-type guix-shepherd-service)█
          (service-extension account-service-type guix-accounts)
          (service-extension activation-service-type guix-activation)))
   (default-value (guix-configuration))))
```

It defines three things:

1. A name, whose sole purpose is to make inspection and debugging easier.
2. A list of *service extensions*, where each extension designates the target service type and a procedure that, given the parameters of the service, returns a list of objects to extend the service of that type.

   Every service type has at least one service extension. The only exception is the *boot service type*, which is the ultimate service.
3. Optionally, a default value for instances of this type.

In this example, `guix-service-type` extends three services:

`shepherd-root-service-type`
: The `guix-shepherd-service` procedure defines how the Shepherd service is extended. Namely, it returns a `<shepherd-service>` object that defines how `guix-daemon` is started and stopped (see Section 12.18.4 [Shepherd Services], page 568).

`account-service-type`
: This extension for this service is computed by `guix-accounts`, which returns a list of `user-group` and `user-account` objects representing the build user accounts (see Section 2.5 [Invoking guix-daemon], page 15).

`activation-service-type`
: Here `guix-activation` is a procedure that returns a gexp, which is a code snippet to run at "activation time"—e.g., when the service is booted.

A service of this type is instantiated like this:

```
(service guix-service-type
         (guix-configuration
           (build-accounts 5)
           (extra-options '("--gc-keep-derivations"))))
```

The second argument to the `service` form is a value representing the parameters of this specific service instance. See [guix-configuration-type], page 255, for information about the `guix-configuration` data type. When the value is omitted, the default value specified by `guix-service-type` is used:

```
(service guix-service-type)
```

`guix-service-type` is quite simple because it extends other services but is not extensible itself.

The service type for an *extensible* service looks like this:

```
(define udev-service-type
  (service-type (name 'udev)
                (extensions
                 (list (service-extension shepherd-root-service-type
                                          udev-shepherd-service)))

                (compose concatenate)       ;concatenate the list of rules
                (extend (lambda (config rules)
                          (match config
                            (($ <udev-configuration> udev initial-rules)
                             (udev-configuration
                              (udev udev)   ;the udev package to use
                              (rules (append initial-rules rules)))))))))
```

This is the service type for the eudev device management daemon (`https://wiki.gentoo.org/wiki/Project:Eudev`). Compared to the previous example, in addition to an extension of `shepherd-root-service-type`, we see two new fields:

`compose` This is the procedure to *compose* the list of extensions to services of this type.

Services can extend the udev service by passing it lists of rules; we compose those extensions simply by concatenating them.

`extend` This procedure defines how the value of the service is *extended* with the composition of the extensions.

Udev extensions are composed into a list of rules, but the udev service value is itself a `<udev-configuration>` record. So here, we extend that record by appending the list of rules it contains to the list of contributed rules.

`description`

This is a string giving an overview of the service type. The string can contain Texinfo markup (see Section "Overview" in *GNU Texinfo*). The `guix system search` command searches these strings and displays them (see Section 12.15 [Invoking guix system], page 545).

There can be only one instance of an extensible service type such as `udev-service-type`. If there were more, the `service-extension` specifications would be ambiguous.

Still here? The next section provides a reference of the programming interface for services.

12.18.3 Service Reference

We have seen an overview of service types (see Section 12.18.2 [Service Types and Services], page 561). This section provides a reference on how to manipulate services and service types. This interface is provided by the `(gnu services)` module.

`service` *type* [*value*] [Scheme Procedure]

Return a new service of *type*, a `<service-type>` object (see below). *value* can be any object; it represents the parameters of this particular service instance.

When *value* is omitted, the default value specified by *type* is used; if *type* does not specify a default value, an error is raised.

For instance, this:

```
(service openssh-service-type)
```

is equivalent to this:

```
(service openssh-service-type
                 (openssh-configuration))
```

In both cases the result is an instance of `openssh-service-type` with the default configuration.

`service?` *obj* [Scheme Procedure]
Return true if *obj* is a service.

`service-kind` *service* [Scheme Procedure]
Return the type of *service*—i.e., a `<service-type>` object.

`service-value` *service* [Scheme Procedure]
Return the value associated with *service*. It represents its parameters.

Here is an example of how a service is created and manipulated:

```
(define s
  (service nginx-service-type
           (nginx-configuration
            (nginx nginx)
            (log-directory log-directory)
            (run-directory run-directory)
            (file config-file))))

(service? s)
⇒ #t

(eq? (service-kind s) nginx-service-type)
⇒ #t
```

The `modify-services` form provides a handy way to change the parameters of some of the services of a list such as `%base-services` (see Section 12.9.1 [Base Services], page 248). It evaluates to a list of services. Of course, you could always use standard list combinators such as `map` and `fold` to do that (see Section "SRFI-1" in *GNU Guile Reference Manual*); `modify-services` simply provides a more concise form for this common pattern.

`modify-services` *services* (*type variable* => *body*) . . . [Scheme Syntax]
Modify the services listed in *services* according to the given clauses. Each clause has the form:

```
(type variable => body)
```

where *type* is a service type—e.g., `guix-service-type`—and *variable* is an identifier that is bound within the *body* to the service parameters—e.g., a `guix-configuration` instance—of the original service of that *type*.

The *body* should evaluate to the new service parameters, which will be used to configure the new service. This new service will replace the original in the resulting list. Because a service's service parameters are created using `define-record-type*`, you can write a succinct *body* that evaluates to the new service parameters by using the `inherit` feature that `define-record-type*` provides.

Clauses can also have the following form:

```
(delete type)
```

Such a clause removes all services of the given *type* from *services*.

See Section 12.1 [Using the Configuration System], page 220, for example usage.

Next comes the programming interface for service types. This is something you want to know when writing new service definitions, but not necessarily when simply looking for ways to customize your `operating-system` declaration.

`service-type` [Data Type]

This is the representation of a *service type* (see Section 12.18.2 [Service Types and Services], page 561).

`name` This is a symbol, used only to simplify inspection and debugging.

`extensions`

A non-empty list of `<service-extension>` objects (see below).

`compose` (default: `#f`)

If this is `#f`, then the service type denotes services that cannot be extended—i.e., services that do not receive “values” from other services.

Otherwise, it must be a one-argument procedure. The procedure is called by `fold-services` and is passed a list of values collected from extensions. It may return any single value.

`extend` (default: `#f`)

If this is `#f`, services of this type cannot be extended.

Otherwise, it must be a two-argument procedure: `fold-services` calls it, passing it the initial value of the service as the first argument and the result of applying `compose` to the extension values as the second argument. It must return a value that is a valid parameter value for the service instance.

`description`

This is a string, possibly using Texinfo markup, describing in a couple of sentences what the service is about. This string allows users to find about the service through `guix system search` (see Section 12.15 [Invoking guix system], page 545).

`default-value` (default: `&no-default-value`)

The default value associated for instances of this service type. This allows users to use the `service` form without its second argument:

```
(service type)
```

The returned service in this case has the default value specified by *type*.

See Section 12.18.2 [Service Types and Services], page 561, for examples.

`service-extension` *target-type compute* [Scheme Procedure]

Return a new extension for services of type *target-type*. *compute* must be a one-argument procedure: `fold-services` calls it, passing it the value associated with the service that provides the extension; it must return a valid value for the target service.

`service-extension?` *obj* [Scheme Procedure]

Return true if *obj* is a service extension.

Occasionally, you might want to simply extend an existing service. This involves creating a new service type and specifying the extension of interest, which can be verbose; the `simple-service` procedure provides a shorthand for this.

`simple-service` *name target value* [Scheme Procedure]

Return a service that extends *target* with *value*. This works by creating a singleton service type *name*, of which the returned service is an instance.

For example, this extends mcron (see Section 12.9.2 [Scheduled Job Execution], page 265) with an additional job:

```
(simple-service 'my-mcron-job mcron-service-type
                #~(job '(next-hour (3)) "guix gc -F 2G"))
```

At the core of the service abstraction lies the `fold-services` procedure, which is responsible for "compiling" a list of services down to a single directory that contains everything needed to boot and run the system—the directory shown by the `guix system build` command (see Section 12.15 [Invoking guix system], page 545). In essence, it propagates service extensions down the service graph, updating each node parameters on the way, until it reaches the root node.

`fold-services` *services* [*#:target-type system-service-type*] [Scheme Procedure]

Fold *services* by propagating their extensions down to the root of type *target-type*; return the root service adjusted accordingly.

Lastly, the `(gnu services)` module also defines several essential service types, some of which are listed below.

`system-service-type` [Scheme Variable]

This is the root of the service graph. It produces the system directory as returned by the `guix system build` command.

`boot-service-type` [Scheme Variable]

The type of the "boot service", which produces the *boot script*. The boot script is what the initial RAM disk runs when booting.

`etc-service-type` [Scheme Variable]

The type of the `/etc` service. This service is used to create files under `/etc` and can be extended by passing it name/file tuples such as:

```
(list `("issue" ,(plain-file "issue" "Welcome!\n")))
```

In this example, the effect would be to add an `/etc/issue` file pointing to the given file.

`setuid-program-service-type` [Scheme Variable]

Type for the "setuid-program service". This service collects lists of executable file names, passed as gexps, and adds them to the set of setuid and setgid programs on the system (see Section 12.10 [Setuid Programs], page 533).

`profile-service-type` [Scheme Variable]

Type of the service that populates the *system profile*—i.e., the programs under `/run/current-system/profile`. Other services can extend it by passing it lists of packages to add to the system profile.

`provenance-service-type` [Scheme Variable]

This is the type of the service that records *provenance meta-data* in the system itself. It creates several files under `/run/current-system`:

`channels.scm`
: This is a "channel file" that can be passed to `guix pull -C` or `guix time-machine -C`, and which describes the channels used to build the system, if that information was available (see Chapter 7 [Channels], page 68).

`configuration.scm`
: This is the file that was passed as the value for this `provenance-service-type` service. By default, `guix system reconfigure` automatically passes the OS configuration file it received on the command line.

`provenance`
: This contains the same information as the two other files but in a format that is more readily processable.

In general, these two pieces of information (channels and configuration file) are enough to reproduce the operating system "from source".

> **Caveats:** This information is necessary to rebuild your operating system, but it is not always sufficient. In particular, `configuration.scm` itself is insufficient if it is not self-contained—if it refers to external Guile modules or to extra files. If you want `configuration.scm` to be self-contained, we recommend that modules or files it refers to be part of a channel.
>
> Besides, provenance meta-data is "silent" in the sense that it does not change the bits contained in your system, *except for the meta-data bits themselves.* Two different OS configurations or sets of channels can lead to the same system, bit-for-bit; when `provenance-service-type` is used, these two systems will have different meta-data and thus different store file names, which makes comparison less trivial.

This service is automatically added to your operating system configuration when you use `guix system reconfigure`, `guix system init`, or `guix deploy`.

`linux-loadable-module-service-type` [Scheme Variable]

Type of the service that collects lists of packages containing kernel-loadable modules, and adds them to the set of kernel-loadable modules.

This service type is intended to be extended by other service types, such as below:

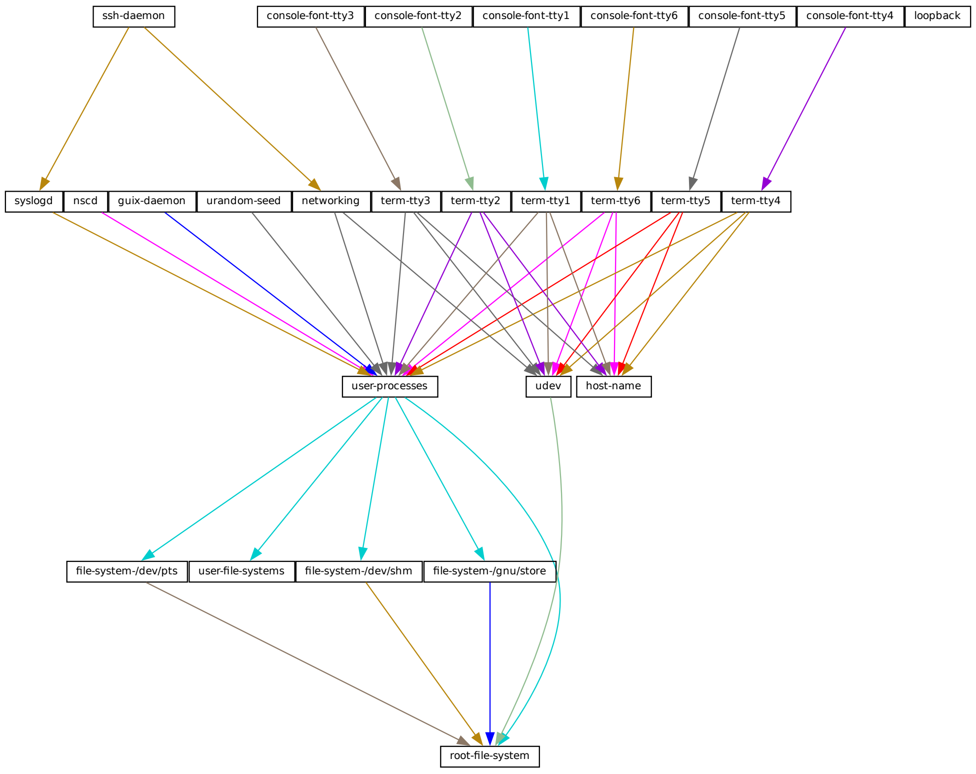
```
(simple-service 'installing-module
                linux-loadable-module-service-type
                (list module-to-install-1
                      module-to-install-2))
```

This does not actually load modules at bootup, only adds it to the kernel profile so that it *can* be loaded by other means.

12.18.4 Shepherd Services

The `(gnu services shepherd)` module provides a way to define services managed by the GNU Shepherd, which is the initialization system—the first process that is started when the system boots, also known as PID 1 (see Section “Introduction” in *The GNU Shepherd Manual*).

Services in the Shepherd can depend on each other. For instance, the SSH daemon may need to be started after the syslog daemon has been started, which in turn can only happen once all the file systems have been mounted. The simple operating system defined earlier (see Section 12.1 [Using the Configuration System], page 220) results in a service graph like this:



You can actually generate such a graph for any operating system definition using the `guix system shepherd-graph` command (see [system-shepherd-graph], page 554).

The `%shepherd-root-service` is a service object representing PID 1, of type `shepherd-root-service-type`; it can be extended by passing it lists of `<shepherd-service>` objects.

`shepherd-service` [Data Type]

The data type representing a service managed by the Shepherd.

`provision`
: This is a list of symbols denoting what the service provides.

  These are the names that may be passed to `herd start`, `herd status`, and similar commands (see Section "Invoking herd" in *The GNU Shepherd Manual*). See Section "Slots of services" in *The GNU Shepherd Manual*, for details.

`requirement` (default: `'()`)
: List of symbols denoting the Shepherd services this one depends on.

`one-shot?` (default: `#f`)
: Whether this service is *one-shot*. One-shot services stop immediately after their `start` action has completed. See Section "Slots of services" in *The GNU Shepherd Manual*, for more info.

`respawn?` (default: `#t`)
: Whether to restart the service when it stops, for instance when the underlying process dies.

`start`
`stop` (default: `#~(const #f)`)
: The `start` and `stop` fields refer to the Shepherd's facilities to start and stop processes (see Section "Service De- and Constructors" in *The GNU Shepherd Manual*). They are given as G-expressions that get expanded in the Shepherd configuration file (see Section 9.12 [G-Expressions], page 154).

`actions` (default: `'()`)
: This is a list of `shepherd-action` objects (see below) defining *actions* supported by the service, in addition to the standard `start` and `stop` actions. Actions listed here become available as `herd` sub-commands:

  ```
  herd action service [arguments...]
  ```

`auto-start?` (default: `#t`)
: Whether this service should be started automatically by the Shepherd. If it is `#f` the service has to be started manually with `herd start`.

`documentation`
: A documentation string, as shown when running:

  ```
  herd doc service-name
  ```

  where *service-name* is one of the symbols in `provision` (see Section "Invoking herd" in *The GNU Shepherd Manual*).

`modules` (default: `%default-modules`)
: This is the list of modules that must be in scope when `start` and `stop` are evaluated.

The example below defines a Shepherd service that spawns `syslogd`, the system logger from the GNU Networking Utilities (see Section "syslogd invocation" in *GNU Inetutils*):

```
(let ((config (plain-file "syslogd.conf" "...")))
  (shepherd-service
```

```
      (documentation "Run the syslog daemon (syslogd).")
      (provision '(syslogd))
      (requirement '(user-processes))
      (start #~(make-forkexec-constructor
                 (list #$(file-append inetutils "/libexec/syslogd")
                       "--rcfile" #$config)
                 #:pid-file "/var/run/syslog.pid"))
      (stop #~(make-kill-destructor))))
```

Key elements in this example are the `start` and `stop` fields: they are *staged* code snippets that use the `make-forkexec-constructor` procedure provided by the Shepherd and its dual, `make-kill-destructor` (see Section "Service De- and Constructors" in *The GNU Shepherd Manual*). The `start` field will have `shepherd` spawn `syslogd` with the given option; note that we pass `config` after `--rcfile`, which is a configuration file declared above (contents of this file are omitted). Likewise, the `stop` field tells how this service is to be stopped; in this case, it is stopped by making the `kill` system call on its PID. Code staging is achieved using G-expressions: `#~` stages code, while `#$` "escapes" back to host code (see Section 9.12 [G-Expressions], page 154).

`shepherd-action` [Data Type]

This is the data type that defines additional actions implemented by a Shepherd service (see above).

`name` Symbol naming the action.

`documentation`

This is a documentation string for the action. It can be viewed by running:

```
herd doc service action action
```

`procedure`

This should be a gexp that evaluates to a procedure of at least one argument, which is the "running value" of the service (see Section "Slots of services" in *The GNU Shepherd Manual*).

The following example defines an action called `say-hello` that kindly greets the user:

```
(shepherd-action
  (name 'say-hello)
  (documentation "Say hi!")
  (procedure #~(lambda (running . args)
                 (format #t "Hello, friend! arguments: ~s\n"
                         args)
                 #t)))
```

Assuming this action is added to the `example` service, then you can do:

```
# herd say-hello example
Hello, friend! arguments: ()
# herd say-hello example a b c
Hello, friend! arguments: ("a" "b" "c")
```

This, as you can see, is a fairly sophisticated way to say hello. See Section "Service Convenience" in *The GNU Shepherd Manual*, for more info on actions.

`shepherd-configuration-action` [Scheme Procedure]

Return a `configuration` action to display *file*, which should be the name of the service's configuration file.

It can be useful to equip services with that action. For example, the service for the Tor anonymous router (see Section 12.9.5 [Networking Services], page 277) is defined roughly like this:

```
(let ((torrc (plain-file "torrc" ...)))
  (shepherd-service
    (provision '(tor))
    (requirement '(user-processes loopback syslogd))

    (start #~(make-forkexec-constructor
              (list #$(file-append tor "/bin/tor") "-f" #$torrc)
              #:user "tor" #:group "tor"))
    (stop #~(make-kill-destructor))
    (actions (list (shepherd-configuration-action torrc)))
    (documentation "Run the Tor anonymous network overlay.")))
```

Thanks to this action, administrators can inspect the configuration file passed to `tor` with this shell command:

```
cat $(herd configuration tor)
```

This can come in as a handy debugging tool!

`shepherd-root-service-type` [Scheme Variable]

The service type for the Shepherd "root service"—i.e., PID 1.

This is the service type that extensions target when they want to create shepherd services (see Section 12.18.2 [Service Types and Services], page 561, for an example). Each extension must pass a list of `<shepherd-service>`. Its value must be a `shepherd-configuration`, as described below.

`shepherd-configuration` [Data Type]

This data type represents the Shepherd's configuration.

`shepherd (default: shepherd)`
: The Shepherd package to use.

`services (default: '())`
: A list of `<shepherd-service>` to start. You should probably use the service extension mechanism instead (see Section 12.18.4 [Shepherd Services], page 568).

The following example specifies the Shepherd package for the operating system:

```
(operating-system
  ;; ...
  (services (append (list openssh-service-type))
            ;; ...
            %desktop-services)
  ;; ...
  ;; Use own Shepherd package.
  (essential-services
   (modify-services (operating-system-default-essential-services
                     this-operating-system)
     (shepherd-root-service-type config => (shepherd-configuration
                                             (inherit config)
                                             (shepherd my-shepherd))))))
```

`%shepherd-root-service` [Scheme Variable]

This service represents PID 1.

12.18.5 Complex Configurations

Some programs might have rather complex configuration files or formats, and to make it easier to create Scheme bindings for these configuration files, you can use the utilities defined in the `(gnu services configuration)` module.

The main utility is the `define-configuration` macro, which you will use to define a Scheme record type (see Section "Record Overview" in *GNU Guile Reference Manual*). The Scheme record will be serialized to a configuration file by using *serializers*, which are procedures that take some kind of Scheme value and returns a G-expression (see Section 9.12 [G-Expressions], page 154), which should, once serialized to the disk, return a string. More details are listed below.

`define-configuration` *name clause1 clause2 ...* [Scheme Syntax]

Create a record type named *name* that contains the fields found in the clauses.

A clause can have one of the following forms:

```
(field-name
 (type default-value)
 documentation)

(field-name
 (type default-value)
 documentation
 serializer)

(field-name
 (type)
 documentation)

(field-name
 (type)
 documentation
 serializer)
```

field-name is an identifier that denotes the name of the field in the generated record.

type is the type of the value corresponding to *field-name*; since Guile is untyped, a predicate procedure—*type*?—will be called on the value corresponding to the field to ensure that the value is of the correct type. This means that if say, *type* is `package`, then a procedure named `package?` will be applied on the value to make sure that it is indeed a `<package>` object.

default-value is the default value corresponding to the field; if none is specified, the user is forced to provide a value when creating an object of the record type.

documentation is a string formatted with Texinfo syntax which should provide a description of what setting this field does.

serializer is the name of a procedure which takes two arguments, the first is the name of the field, and the second is the value corresponding to the field. The procedure should return a string or G-expression (see Section 9.12 [G-Expressions], page 154) that represents the content that will be serialized to the configuration file. If none is specified, a procedure of the name `serialize-`*`type`* will be used.

A simple serializer procedure could look like this:

```
(define (serialize-boolean field-name value)
  (let ((value (if value "true" "false")))
    #~(string-append #$field-name #$value)))
```

In some cases multiple different configuration records might be defined in the same file, but their serializers for the same type might have to be different, because they have different configuration formats. For example, the `serialize-boolean` procedure for the Getmail service would have to be different from the one for the Transmission service. To make it easier to deal with this situation, one can specify a serializer prefix by using the `prefix` literal in the `define-configuration` form. This means that one doesn't have to manually specify a custom *serializer* for every field.

```
(define (foo-serialize-string field-name value)
  ...)

(define (bar-serialize-string field-name value)
  ...)

(define-configuration foo-configuration
  (label
   (string)
   "The name of label.")
  (prefix foo-))

(define-configuration bar-configuration
  (ip-address
   (string)
   "The IPv4 address for this device.")
  (prefix bar-))
```

However, in some cases you might not want to serialize any of the values of the record, to do this, you can use the `no-serialization` literal. There is also the `define-configuration/no-serialization` macro which is a shorthand of this.

```
;; Nothing will be serialized to disk.
(define-configuration foo-configuration
  (field
    (string "test")
    "Some documentation.")
   (no-serialization))

;; The same thing as above.
(define-configuration/no-serialization bar-configuration
  (field
   (string "test")
   "Some documentation."))
```

`define-maybe` *type* [Scheme Syntax]

Sometimes a field should not be serialized if the user doesn't specify a value. To achieve this, you can use the `define-maybe` macro to define a "maybe type"; if the value of a maybe type is left unset, or is set to the `%unset-value` value, then it will not be serialized.

When defining a "maybe type", the corresponding serializer for the regular type will be used by default. For example, a field of type `maybe-string` will be serialized using the `serialize-string` procedure by default, you can of course change this by specifying a custom serializer procedure. Likewise, the type of the value would have to be a string, or left unspecified.

```
(define-maybe string)

(define (serialize-string field-name value)
  ...)

(define-configuration baz-configuration
  (name
   ;; If set to a string, the `serialize-string' procedure will be used
   ;; to serialize the string.  Otherwise this field is not serialized.
   maybe-string
   "The name of this module."))
```

Like with `define-configuration`, one can set a prefix for the serializer name by using the `prefix` literal.

```
(define-maybe integer
  (prefix baz-))

(define (baz-serialize-integer field-name value)
  ...)
```

There is also the `no-serialization` literal, which when set means that no serializer will be defined for the "maybe type", regardless of whether its value is set or not. `define-maybe/no-serialization` is a shorthand for specifying the `no-serialization` literal.

```
(define-maybe/no-serialization symbol)

(define-configuration/no-serialization test-configuration
  (mode
   maybe-symbol
   "Docstring."))
```

`Procedure)` *maybe-value-set? `value`* [(Scheme]

Predicate to check whether a user explicitly specified the value of a maybe field.

`serialize-configuration` *`configuration fields`* [Scheme Procedure]

Return a G-expression that contains the values corresponding to the *fields* of *configuration*, a record that has been generated by `define-configuration`. The G-expression can then be serialized to disk by using something like `mixed-text-file`.

`empty-serializer` *`field-name value`* [Scheme Procedure]

A serializer that just returns an empty string. The `serialize-package` procedure is an alias for this.

Once you have defined a configuration record, you will most likely also want to document it so that other people know to use it. To help with that, there are two procedures, both of which are documented below.

`generate-documentation` *`documentation documentation-name`* [Scheme Procedure]

Generate a Texinfo fragment from the docstrings in *documentation*, a list of `(`*`label fields sub-documentation`*` ...)`. *label* should be a symbol and should be the name of the configuration record. *fields* should be a list of all the fields available for the configuration record.

sub-documentation is a `(`*`field-name configuration-name`*`)` tuple. *field-name* is the name of the field which takes another configuration record as its value, and *configuration-name* is the name of that configuration record.

sub-documentation is only needed if there are nested configuration records. For example, the `getmail-configuration` record (see Section 12.9.12 [Mail Services], page 346) accepts a `getmail-configuration-file` record in one of its `rcfile` field, therefore documentation for `getmail-configuration-file` is nested in `getmail-configuration`.

```
(generate-documentation
  `((getmail-configuration ,getmail-configuration-fields
     (rcfile getmail-configuration-file))
    ...)
  'getmail-configuration)
```

documentation-name should be a symbol and should be the name of the configuration record.

`configuration->documentation` [Scheme Procedure]

configuration-symbol Take *configuration-symbol*, the symbol corresponding to the name used when defining a configuration record with `define-configuration`, and print the Texinfo documentation of its fields. This is useful if there aren't any nested configuration records since it only prints the documentation for the top-level fields.

As of right now, there is no automated way to generate documentation for configuration records and put them in the manual. Instead, every time you make a change to the docstrings of a configuration record, you have to manually call `generate-documentation` or `configuration->documentation`, and paste the output into the `doc/guix.texi` file.

Below is an example of a record type created using `define-configuration` and friends.

```
(use-modules (gnu services)
             (guix gexp)
             (gnu services configuration)
             (srfi srfi-26)
             (srfi srfi-1))

;; Turn field names, which are Scheme symbols into strings
(define (uglify-field-name field-name)
  (let ((str (symbol->string field-name)))
    ;; field? -> is-field
    (if (string-suffix? "?" str)
        (string-append "is-" (string-drop-right str 1))
        str)))

(define (serialize-string field-name value)
  #~(string-append #$(uglify-field-name field-name) " = " #$value "\n"))

(define (serialize-integer field-name value)
  (serialize-string field-name (number->string value)))

(define (serialize-boolean field-name value)
  (serialize-string field-name (if value "true" "false")))

(define (serialize-contact-name field-name value)
  #~(string-append "\n[" #$value "]\n"))

(define (list-of-contact-configurations? lst)
  (every contact-configuration? lst))

(define (serialize-list-of-contact-configurations field-name value)
  #~(string-append #$@(map (cut serialize-configuration <>
                                contact-configuration-fields)
                           value)))

(define (serialize-contacts-list-configuration configuration)
  (mixed-text-file
   "contactrc"
   #~(string-append "[Owner]\n"
                    #$(serialize-configuration
                       configuration contacts-list-configuration-fields))))
```

```
(define-maybe integer)
(define-maybe string)

(define-configuration contact-configuration
  (name
   (string)
   "The name of the contact."
   serialize-contact-name)
  (phone-number
   maybe-integer
   "The person's phone number.")
  (email
   maybe-string
   "The person's email address.")
  (married?
   (boolean)
   "Whether the person is married."))

(define-configuration contacts-list-configuration
  (name
   (string)
   "The name of the owner of this contact list.")
  (email
   (string)
   "The owner's email address.")
  (contacts
   (list-of-contact-configurations '())
   "A list of @code{contact-configuation} records which contain
information about all your contacts."))
```

A contacts list configuration could then be created like this:

```
(define my-contacts
  (contacts-list-configuration
   (name "Alice")
   (email "alice@example.org")
   (contacts
    (list (contact-configuration
           (name "Bob")
           (phone-number 1234)
           (email "bob@gnu.org")
           (married? #f))
          (contact-configuration
           (name "Charlie")
           (phone-number 0000)
           (married? #t))))))
```

After serializing the configuration to disk, the resulting file would look like this:

```
[owner]
```

```
name = Alice
email = alice@example.org

[Bob]
phone-number = 1234
email = bob@gnu.org
is-married = false

[Charlie]
phone-number = 0
is-married = true
```

13 Home Configuration

Guix supports declarative configuration of *home environments* by utilizing the configuration mechanism described in the previous chapter (see Section 12.18 [Defining Services], page 560), but for user's dotfiles and packages. It works both on Guix System and foreign distros and allows users to declare all the packages and services that should be installed and configured for the user. Once a user has written a file containing `home-environment` record, such a configuration can be *instantiated* by an unprivileged user with the `guix home` command (see Section 13.4 [Invoking guix home], page 594).

> **Note:** The functionality described in this section is still under development and is subject to change. Get in touch with us on `guix-devel@gnu.org`!

The user's home environment usually consists of three basic parts: software, configuration, and state. Software in mainstream distros are usually installed system-wide, but with GNU Guix most software packages can be installed on a per-user basis without needing root privileges, and are thus considered part of the user's *home environment*. Packages on their own are not very useful in many cases, because often they require some additional configuration, usually config files that reside in `XDG_CONFIG_HOME` (`~/.config` by default) or other directories. Everything else can be considered state, like media files, application databases, and logs.

Using Guix for managing home environments provides a number of advantages:

- All software can be configured in one language (Guile Scheme), this gives users the ability to share values between configurations of different programs.
- A well-defined home environment is self-contained and can be created in a declarative and reproducible way—there is no need to grab external binaries or manually edit some configuration file.
- After every `guix home reconfigure` invocation, a new home environment generation will be created. This means that users can rollback to a previous home environment generation so they don't have to worry about breaking their configuration.
- It is possible to manage stateful data with Guix Home, this includes the ability to automatically clone Git repositories on the initial setup of the machine, and periodically running commands like `rsync` to sync data with another host. This functionality is still in an experimental stage, though.

13.1 Declaring the Home Environment

The home environment is configured by providing a `home-environment` declaration in a file that can be passed to the `guix home` command (see Section 13.4 [Invoking guix home], page 594). The easiest way to get started is by generating an initial configuration with `guix home import`:

```
guix home import ~/src/guix-config
```

The `guix home import` command reads some of the “dot files” such as `~/.bashrc` found in your home directory and copies them to the given directory, `~/src/guix-config` in this case; it also reads the contents of your profile, `~/.guix-profile`, and, based on that, it populates `~/src/guix-config/home-configuration.scm` with a Home configuration that resembles your current configuration.

A simple setup can include Bash and a custom text configuration, like in the example below. Don't be afraid to declare home environment parts, which overlaps with your current dot files: before installing any configuration files, Guix Home will back up existing config files to a separate place in the home directory.

> **Note:** It is highly recommended that you manage your shell or shells with Guix Home, because it will make sure that all the necessary scripts are sourced by the shell configuration file. Otherwise you will need to do it manually. (see Section 13.2 [Configuring the Shell], page 581).

```
(use-modules (gnu home)
             (gnu home services)
             (gnu home services shells)
             (gnu services)
             (gnu packages admin)
             (guix gexp))


(home-environment
 (packages (list htop))
 (services
  (list
   (service home-bash-service-type
            (home-bash-configuration
             (guix-defaults? #t)
             (bash-profile (list (plain-file "bash-profile" "\
export HISTFILE=$XDG_CACHE_HOME/.bash_history")))))

   (simple-service 'test-config
                   home-xdg-configuration-files-service-type
                   (list `("test.conf"
                           ,(plain-file "tmp-file.txt"
                                        "the content of
                                          ~/.config/test.conf")))))))
```

The `packages` field should be self-explanatory, it will install the list of packages into the user's profile. The most important field is `services`, it contains a list of *home services*, which are the basic building blocks of a home environment.

There is no daemon (at least not necessarily) related to a home service, a home service is just an element that is used to declare part of home environment and extend other parts of it. The extension mechanism discussed in the previous chapter (see Section 12.18 [Defining Services], page 560) should not be confused with Shepherd services (see Section 12.18.4 [Shepherd Services], page 568). Using this extension mechanism and some Scheme code that glues things together gives the user the freedom to declare their own, very custom, home environments.

Once the configuration looks good, you can first test it in a throw-away "container":

```
guix home container config.scm
```

The command above spawns a shell where your home environment is running. The shell runs in a container, meaning it's isolated from the rest of the system, so it's a good way to try out your configuration—you can see if configuration bits are missing or misbehaving, if daemons get started, and so on. Once you exit that shell, you're back to the prompt of your original shell "in the real world".

Once you have a configuration file that suits your needs, you can reconfigure your home by running:

```
guix home reconfigure config.scm
```

This "builds" your home environment and creates `~/.guix-home` pointing to it. Voilà!

> **Note:** Make sure the operating system has elogind, systemd, or a similar mechanism to create the XDG run-time directory and has the `XDG_RUNTIME_DIR` variable set. Failing that, the `on-first-login` script will not execute anything, and processes like user Shepherd and its descendants will not start.

13.2 Configuring the Shell

This section is safe to skip if your shell or shells are managed by Guix Home. Otherwise, read it carefully.

There are a few scripts that must be evaluated by a login shell to activate the home environment. The shell startup files only read by login shells often have `profile` suffix. For more information about login shells see Section "Invoking Bash" in *The GNU Bash Reference Manual* and see Section "Bash Startup Files" in *The GNU Bash Reference Manual*.

The first script that needs to be sourced is `setup-environment`, which sets all the necessary environment variables (including variables declared by the user) and the second one is `on-first-login`, which starts Shepherd for the current user and performs actions declared by other home services that extends `home-run-on-first-login-service-type`.

Guix Home will always create `~/.profile`, which contains the following lines:

```
HOME_ENVIRONMENT=$HOME/.guix-home
. $HOME_ENVIRONMENT/setup-environment
$HOME_ENVIRONMENT/on-first-login
```

This makes POSIX compliant login shells activate the home environment. However, in most cases this file won't be read by most modern shells, because they are run in non POSIX mode by default and have their own `*profile` startup files. For example Bash will prefer `~/.bash_profile` in case it exists and only if it doesn't will it fallback to `~/.profile`. Zsh (if no additional options are specified) will ignore `~/.profile`, even if `~/.zprofile` doesn't exist.

To make your shell respect `~/.profile`, add `. ~/.profile` or `source ~/.profile` to the startup file for the login shell. In case of Bash, it is `~/.bash_profile`, and in case of Zsh, it is `~/.zprofile`.

> **Note:** This step is only required if your shell is *not* managed by Guix Home. Otherwise, everything will be done automatically.

13.3 Home Services

A *home service* is not necessarily something that has a daemon and is managed by Shepherd (see Section "Jump Start" in *The GNU Shepherd Manual*), in most cases it doesn't. It's a simple building block of the home environment, often declaring a set of packages to be installed in the home environment profile, a set of config files to be symlinked into `XDG_CONFIG_HOME` (`~/.config` by default), and environment variables to be set by a login shell.

There is a service extension mechanism (see Section 12.18.1 [Service Composition], page 560) which allows home services to extend other home services and utilize capabilities they provide; for example: declare mcron jobs (see *GNU Mcron*) by extending Section 13.3.3 [Mcron Home Service], page 588; declare daemons by extending Section 13.3.5 [Shepherd Home Service], page 590; add commands, which will be invoked on by the Bash by extending Section 13.3.2 [Shells Home Services], page 585.

A good way to discover available home services is using the `guix home search` command (see Section 13.4 [Invoking guix home], page 594). After the required home services are found, include its module with the `use-modules` form (see Section "Using Guile Modules" in *The GNU Guile Reference Manual*), or the `#:use-modules` directive (see Section "Creating Guile Modules" in *The GNU Guile Reference Manual*) and declare a home service using the `service` function, or extend a service type by declaring a new service with the `simple-service` procedure from `(gnu services)`.

13.3.1 Essential Home Services

There are a few essential home services defined in `(gnu services)`, they are mostly for internal use and are required to build a home environment, but some of them will be useful for the end user.

`home-environment-variables-service-type` [Scheme Variable]

The service of this type will be instantiated by every home environment automatically by default, there is no need to define it, but someone may want to extend it with a list of pairs to set some environment variables.

```
(list ("ENV_VAR1" . "value1")
      ("ENV_VAR2" . "value2"))
```

The easiest way to extend a service type, without defining a new service type is to use the `simple-service` helper from `(gnu services)`.

```
(simple-service 'some-useful-env-vars-service
home-environment-variables-service-type
`(("LESSHISTFILE" . "$XDG_CACHE_HOME/.lesshst")
                  ("SHELL" . ,(file-append zsh "/bin/zsh"))
                  ("USELESS_VAR" . #f)
                  ("_JAVA_AWT_WM_NONREPARENTING" . #t)))
```

If you include such a service in you home environment definition, it will add the following content to the `setup-environment` script (which is expected to be sourced by the login shell):

```
export LESSHISTFILE=$XDG_CACHE_HOME/.lesshst
export SHELL=/gnu/store/2hsg15n644f0glrcbkb1kqknmmqdar03-zsh-5.8/bin/zsh
export _JAVA_AWT_WM_NONREPARENTING
```

> **Note:** Make sure that module `(gnu packages shells)` is imported with `use-modules` or any other way, this namespace contains the definition of the `zsh` package, which is used in the example above.

The association list (see Section "Association Lists" in *The GNU Guile Reference manual*) is a data structure containing key-value pairs, for `home-environment-variables-service-type` the key is always a string, the value can be a string, string-valued gexp (see Section 9.12 [G-Expressions], page 154), file-like object (see Section 9.12 [G-Expressions], page 154) or boolean. For gexps, the variable will be set to the value of the gexp; for file-like objects, it will be set to the path of the file in the store (see Section 9.9 [The Store], page 144); for `#t`, it will export the variable without any value; and for `#f`, it will omit variable.

`home-profile-service-type` [Scheme Variable]

The service of this type will be instantiated by every home environment automatically, there is no need to define it, but you may want to extend it with a list of packages if you want to install additional packages into your profile. Other services, which need to make some programs available to the user will also extend this service type.

The extension value is just a list of packages:

```
(list htop vim emacs)
```

The same approach as `simple-service` (see Section 12.18.3 [Service Reference], page 563) for `home-environment-variables-service-type` can be used here, too. Make sure that modules containing the specified packages are imported with `use-modules`. To find a package or information about its module use `guix search` (see Section 6.2 [Invoking guix package], page 39). Alternatively, `specification->package` can be used to get the package record from string without importing related module.

There are few more essential services, but users are not expected to extend them.

`home-service-type` [Scheme Variable]

The root of home services DAG, it generates a folder, which later will be symlinked to `~/.guix-home`, it contains configurations, profile with binaries and libraries, and some necessary scripts to glue things together.

`home-run-on-first-login-service-type` [Scheme Variable]

The service of this type generates a Guile script, which is expected to be executed by the login shell. It is only executed if the special flag file inside `XDG_RUNTIME_DIR` hasn't been created, this prevents redundant executions of the script if multiple login shells are spawned.

It can be extended with a gexp. However, to autostart an application, users *should not* use this service, in most cases it's better to extend `home-shepherd-service-type` with a Shepherd service (see Section 12.18.4 [Shepherd Services], page 568), or extend the shell's startup file with the required command using the appropriate service type.

`home-files-service-type` [Scheme Variable]

The service of this type allows to specify a list of files, which will go to `~/.guix-home/files`, usually this directory contains configuration files (to be more precise it contains symlinks to files in `/gnu/store`), which should be placed in `$XDG_CONFIG_DIR` or in rare cases in `$HOME`. It accepts extension values in the following format:

```
`((".sway/config" ,sway-file-like-object)
  (".tmux.conf" ,(local-file "./tmux.conf")))
```

Each nested list contains two values: a subdirectory and file-like object. After building a home environment `~/.guix-home/files` will be populated with apropiate content and all nested directories will be created accordingly, however, those files won't go any further until some other service will do it. By default a `home-symlink-manager-service-type`, which creates necessary symlinks in home folder to files from `~/.guix-home/files` and backs up already existing, but clashing configs and other things, is a part of essential home services (enabled by default), but it's possible to use alternative services to implement more advanced use cases like read-only home. Feel free to experiment and share your results.

`home-xdg-configuration-files-service-type` [Scheme Variable]

The service is very similiar to `home-files-service-type` (and actually extends it), but used for defining files, which will go to `~/.guix-home/files/.config`, which will be symlinked to `$XDG_CONFIG_DIR` by `home-symlink-manager-service-type` (for example) during activation. It accepts extension values in the following format:

```
`(("sway/config" ,sway-file-like-object)
  ;; -> ~/.guix-home/files/.config/sway/config
  ;; -> $XDG_CONFIG_DIR/sway/config (by symlink-manager)
  ("tmux/tmux.conf" ,(local-file "./tmux.conf")))
```

`home-activation-service-type` [Scheme Variable]

The service of this type generates a guile script, which runs on every `guix home reconfigure` invocation or any other action, which leads to the activation of the home environment.

`home-symlink-manager-service-type` [Scheme Variable]

The service of this type generates a guile script, which will be executed during activation of home environment, and do a few following steps:

1. Reads the content of `files/` directory of current and pending home environments.
2. Cleans up all symlinks created by symlink-manager on previous activation. Also, sub-directories, which become empty also will be cleaned up.
3. Creates new symlinks the following way: It looks `files/` directory (usually defined with `home-files-service-type`, `home-xdg-configuration-files-service-type` and maybe some others), takes the files from `files/.config/` subdirectory and put respective links in `XDG_CONFIG_DIR`. For example symlink for `files/.config/sway/config` will end up in `$XDG_CONFIG_DIR/sway/config`. The rest files in `files/` outside of `files/.config/` subdirectory will be treated slightly different: symlink will just go to `$HOME`. `files/.some-program/config` will end up in `$HOME/.some-program/config`.
4. If some sub-directories are missing, they will be created.
5. If there is a clashing files on the way, they will be backed up.

symlink-manager is a part of essential home services and is enabled and used by default.

13.3.2 Shells

Shells play a quite important role in the environment initialization process, you can configure them manually as described in section Section 13.2 [Configuring the Shell], page 581, but the recommended way is to use home services listed below. It's both easier and more reliable.

Each home environment instantiates `home-shell-profile-service-type`, which creates a `~/.profile` startup file for all POSIX-compatible shells. This file contains all the necessary steps to properly initialize the environment, but many modern shells like Bash or Zsh prefer their own startup files, that's why the respective home services (`home-bash-service-type` and `home-zsh-service-type`) ensure that `~/.profile` is sourced by `~/.bash_profile` and `~/.zprofile`, respectively.

Shell Profile Service

`home-shell-profile-configuration` [Data Type]

Available `home-shell-profile-configuration` fields are:

`profile` (default: `()`) (type: text-config)

`home-shell-profile` is instantiated automatically by `home-environment`, DO NOT create this service manually, it can only be extended. `profile` is a list of file-like objects, which will go to `~/.profile`. By default `~/.profile` contains the initialization code which must be evaluated by the login shell to make home-environment's profile available to the user, but other commands can be added to the file if it is really necessary. In most cases shell's configuration files are preferred places for user's customizations. Extend home-shell-profile service only if you really know what you do.

Bash Home Service

`home-bash-configuration` [Data Type]

Available `home-bash-configuration` fields are:

`package` (default: `bash`) (type: package)

The Bash package to use.

`guix-defaults?` (default: `#t`) (type: boolean)

Add sane defaults like reading `/etc/bashrc` and coloring the output of `ls` to the top of the `.bashrc` file.

`environment-variables` (default: `()`) (type: alist)

Association list of environment variables to set for the Bash session. The rules for the `home-environment-variables-service-type` apply here (see Section 13.3.1 [Essential Home Services], page 582). The contents of this field will be added after the contents of the `bash-profile` field.

`aliases` (default: `()`) (type: alist)
: Association list of aliases to set for the Bash session. The aliases will be defined after the contents of the `bashrc` field has been put in the `.bashrc` file. The alias will automatically be quoted, so something like this:

```
'(("ls" . "ls -alF"))
```

turns into

```
alias ls="ls -alF"
```

`bash-profile` (default: `()`) (type: text-config)
: List of file-like objects, which will be added to `.bash_profile`. Used for executing user's commands at start of login shell (In most cases the shell started on tty just after login). `.bash_login` won't be ever read, because `.bash_profile` always present.

`bashrc` (default: `()`) (type: text-config)
: List of file-like objects, which will be added to `.bashrc`. Used for executing user's commands at start of interactive shell (The shell for interactive usage started by typing `bash` or by terminal app or any other program).

`bash-logout` (default: `()`) (type: text-config)
: List of file-like objects, which will be added to `.bash_logout`. Used for executing user's commands at the exit of login shell. It won't be read in some cases (if the shell terminates by exec'ing another process for example).

You can extend the Bash service by using the `home-bash-extension` configuration record, whose fields must mirror that of `home-bash-configuration` (see [home-bash-configuration], page 585). The contents of the extensions will be added to the end of the corresponding Bash configuration files (see Section "Bash Startup Files" in *The GNU Bash Reference Manual*.

For example, here is how you would define a service that extends the Bash service such that `~/.bash_profile` defines an additional environment variable, `PS1`:

```
(define bash-fancy-prompt-service
  (simple-service 'bash-fancy-prompt
                  home-bash-service-type
                  (home-bash-extension
                   (environment-variables
                    '(("PS1" . "\\u \\wλ "))))))
```

You would then add `bash-fancy-prompt-service` to the list in the `services` field of your `home-environment`. The reference of `home-bash-extension` follows.

`home-bash-extension` [Data Type]

Available `home-bash-extension` fields are:

`environment-variables` (default: `()`) (type: alist)
: Additional environment variables to set. These will be combined with the environment variables from other extensions and the base service to form one coherent block of environment variables.

`aliases` (default: `()`) (type: alist)
: Additional aliases to set. These will be combined with the aliases from other extensions and the base service.

`bash-profile` (default: `()`) (type: text-config)
: Additional text blocks to add to `.bash_profile`, which will be combined with text blocks from other extensions and the base service.

`bashrc` (default: `()`) (type: text-config)
: Additional text blocks to add to `.bashrc`, which will be combined with text blocks from other extensions and the base service.

`bash-logout` (default: `()`) (type: text-config)
: Additional text blocks to add to `.bash_logout`, which will be combined with text blocks from other extensions and the base service.

Zsh Home Service

`home-zsh-configuration` [Data Type]

Available `home-zsh-configuration` fields are:

`package` (default: `zsh`) (type: package)
: The Zsh package to use.

`xdg-flavor?` (default: `#t`) (type: boolean)
: Place all the configs to `$XDG_CONFIG_HOME/zsh`. Makes `~/.zshenv` to set `ZDOTDIR` to `$XDG_CONFIG_HOME/zsh`. Shell startup process will continue with `$XDG_CONFIG_HOME/zsh/.zshenv`.

`environment-variables` (default: `()`) (type: alist)
: Association list of environment variables to set for the Zsh session.

`zshenv` (default: `()`) (type: text-config)
: List of file-like objects, which will be added to `.zshenv`. Used for setting user's shell environment variables. Must not contain commands assuming the presence of tty or producing output. Will be read always. Will be read before any other file in `ZDOTDIR`.

`zprofile` (default: `()`) (type: text-config)
: List of file-like objects, which will be added to `.zprofile`. Used for executing user's commands at start of login shell (In most cases the shell started on tty just after login). Will be read before `.zlogin`.

`zshrc` (default: `()`) (type: text-config)
: List of file-like objects, which will be added to `.zshrc`. Used for executing user's commands at start of interactive shell (The shell for interactive usage started by typing `zsh` or by terminal app or any other program).

`zlogin` (default: `()`) (type: text-config)
: List of file-like objects, which will be added to `.zlogin`. Used for executing user's commands at the end of starting process of login shell.

`zlogout` (default: `()`) (type: text-config)
: List of file-like objects, which will be added to `.zlogout`. Used for executing user's commands at the exit of login shell. It won't be read in some cases (if the shell terminates by exec'ing another process for example).

13.3.3 Scheduled User's Job Execution

The `(gnu home services mcron)` module provides an interface to GNU mcron, a daemon to run jobs at scheduled times (see *GNU mcron*). The information about system's mcron is applicable here (see Section 12.9.2 [Scheduled Job Execution], page 265), the only difference for home services is that they have to be declared in a `home-environment` record instead of an `operating-system` record.

`home-mcron-service-type` [Scheme Variable]
: This is the type of the `mcron` home service, whose value is an `home-mcron-configuration` object. It allows to manage scheduled tasks.

  This service type can be the target of a service extension that provides additional job specifications (see Section 12.18.1 [Service Composition], page 560). In other words, it is possible to define services that provide additional mcron jobs to run.

`home-mcron-configuration` [Data Type]
: Available `home-mcron-configuration` fields are:

  `mcron` (default: `mcron`) (type: file-like)
  : The mcron package to use.

  `jobs` (default: `()`) (type: list-of-gexps)
  : This is a list of gexps (see Section 9.12 [G-Expressions], page 154), where each gexp corresponds to an mcron job specification (see Section "Syntax" in *GNU mcron*).

  `log?` (default: `#t`) (type: boolean)
  : Log messages to standard output.

  `log-format` (default: `"~1@*~a ~a: ~a~%"`) (type: string)
  : `(ice-9 format)` format string for log messages. The default value produces messages like "'*pid name*: *message*"' (see Section "Invoking mcron" in *GNU mcron*). Each message is also prefixed by a timestamp by GNU Shepherd.

13.3.4 Power Management Home Services

The `(gnu home services pm)` module provides home services pertaining to battery power.

`home-batsignal-service-type` [Scheme Variable]
: Service for `batsignal`, a program that monitors battery levels and warns the user through desktop notifications when their battery is getting low. You can also configure a command to be run when the battery level passes a point deemed "dangerous". This service is configured with the `home-batsignal-configuration` record.

`home-batsignal-configuration` [Data Type]
: Data type representing the configuration for batsignal.

`warning-level` (default: `15`)
: The battery level to send a warning message at.

`warning-message` (default: `#f`)
: The message to send as a notification when the battery level reaches the `warning-level`. Setting to `#f` uses the default message.

`critical-level` (default: `5`)
: The battery level to send a critical message at.

`critical-message` (default: `#f`)
: The message to send as a notification when the battery level reaches the `critical-level`. Setting to `#f` uses the default message.

`danger-level` (default: `2`)
: The battery level to run the `danger-command` at.

`danger-command` (default: `#f`)
: The command to run when the battery level reaches the `danger-level`. Setting to `#f` disables running the command entirely.

`full-level` (default: `#f`)
: The battery level to send a full message at. Setting to `#f` disables sending the full message entirely.

`full-message` (default: `#f`)
: The message to send as a notification when the battery level reaches the `full-level`. Setting to `#f` uses the default message.

`batteries` (default: `'()`)
: The batteries to monitor. Setting to `'()` tries to find batteries automatically.

`poll-delay` (default: `60`)
: The time in seconds to wait before checking the batteries again.

`icon` (default: `#f`)
: A file-like object to use as the icon for battery notifications. Setting to `#f` disables notification icons entirely.

`notifications?` (default: `#t`)
: Whether to send any notifications.

`notifications-expire?` (default: `#f`)
: Whether notifications sent expire after a time.

`notification-command` (default: `#f`)
: Command to use to send messages. Setting to `#f` sends a notification through `libnotify`.

`ignore-missing?` (default: `#f`)
: Whether to ignore missing battery errors.

13.3.5 Managing User Daemons

The `(gnu home services shepherd)` module supports the definitions of per-user Shepherd services (see Section "Introduction" in *The GNU Shepherd Manual*). You extend `home-shepherd-service-type` with new services; Guix Home then takes care of starting the `shepherd` daemon for you when you log in, which in turns starts the services you asked for.

`home-shepherd-service-type` [Scheme Variable]

The service type for the userland Shepherd, which allows one to manage long-running processes or one-shot tasks. User's Shepherd is not an init process (PID 1), but almost all other information described in (see Section 12.18.4 [Shepherd Services], page 568) is applicable here too.

This is the service type that extensions target when they want to create shepherd services (see Section 12.18.2 [Service Types and Services], page 561, for an example). Each extension must pass a list of `<shepherd-service>`. Its value must be a `home-shepherd-configuration`, as described below.

`home-shepherd-configuration` [Data Type]

This data type represents the Shepherd's configuration.

`shepherd (default: shepherd)`
: The Shepherd package to use.

`auto-start? (default: #t)`
: Whether or not to start Shepherd on first login.

`services (default: '())`
: A list of `<shepherd-service>` to start. You should probably use the service extension mechanism instead (see Section 12.18.4 [Shepherd Services], page 568).

13.3.6 Secure Shell

The OpenSSH package (`https://www.openssh.com`) includes a client, the `ssh` command, that allows you to connect to remote machines using the SSH (secure shell) protocol. With the `(gnu home services ssh)` module, you can set up OpenSSH so that it works in a predictable fashion, almost independently of state on the local machine. To do that, you instantiate `home-openssh-service-type` in your Home configuration, as explained below.

`home-openssh-service-type` [Scheme Variable]

This is the type of the service to set up the OpenSSH client. It takes care of several things:

- providing a `~/.ssh/config` file based on your configuration so that `ssh` knows about hosts you regularly connect to and their associated parameters;
- providing a `~/.ssh/authorized_keys`, which lists public keys that the local SSH server, `sshd`, may accept to connect to this user account;
- optionally providing a `~/.ssh/known_hosts` file so that `ssh` can authenticate hosts you connect to.

Here is an example of a service and its configuration that you could add to the `services` field of your `home-environment`:

```
(service home-openssh-service-type
(home-openssh-configuration
 (hosts
  (list (openssh-host (name "ci.guix.gnu.org")
                      (user "charlie"))
        (openssh-host (name "chbouib")
                      (host-name "chbouib.example.org")
                      (user "supercharlie")
                      (port 10022))))
 (authorized-keys (list (local-file "alice.pub"))))
```

The example above lists two hosts and their parameters. For instance, running `ssh chbouib` will automatically connect to `chbouib.example.org` on port 10022, logging in as user '`supercharlie`'. Further, it marks the public key in `alice.pub` as authorized for incoming connections.

The value associated with a `home-openssh-service-type` instance must be a `home-openssh-configuration` record, as describe below.

`home-openssh-configuration` [Data Type]

This is the datatype representing the OpenSSH client and server configuration in one's home environment. It contains the following fields:

`hosts` (default: `'()`)
: A list of `openssh-host` records specifying host names and associated connection parameters (see below). This host list goes into `~/.ssh/config`, which `ssh` reads at startup.

`known-hosts` (default: `*unspecified*`)
: This must be either:

  - `*unspecified*`, in which case `home-openssh-service-type` leaves it up to `ssh` and to the user to maintain the list of known hosts at `~/.ssh/known_hosts`, or
  - a list of file-like objects, in which case those are concatenated and emitted as `~/.ssh/known_hosts`.

  The `~/.ssh/known_hosts` contains a list of host name/host key pairs that allow `ssh` to authenticate hosts you connect to and to detect possible impersonation attacks. By default, `ssh` updates it in a *TOFU, trust-on-first-use* fashion, meaning that it records the host's key in that file the first time you connect to it. This behavior is preserved when `known-hosts` is set to `*unspecified*`.

  If you instead provide a list of host keys upfront in the `known-hosts` field, your configuration becomes self-contained and stateless: it can be replicated elsewhere or at another point in time. Preparing this list can be relatively tedious though, which is why `*unspecified*` is kept as a default.

`authorized-keys` (default: `'()`)
: This must be a list of file-like objects, each of which containing an SSH public key that should be authorized to connect to this machine.

Concretely, these files are concatenated and made available as `~/.ssh/authorized_keys`. If an OpenSSH server, `sshd`, is running on this machine, then it *may* take this file into account: this is what `sshd` does by default, but be aware that it can also be configured to ignore it.

`openssh-host` [Data Type]

Available `openssh-host` fields are:

`name` (type: string)
: Name of this host declaration.

`host-name` (type: maybe-string)
: Host name—e.g., `"foo.example.org"` or `"192.168.1.2"`.

`address-family` (type: address-family)
: Address family to use when connecting to this host: one of `AF_INET` (for IPv4 only), `AF_INET6` (for IPv6 only), or `*unspecified*` (allowing any address family).

`identity-file` (type: maybe-string)
: The identity file to use—e.g., `"/home/charlie/.ssh/id_ed25519"`.

`port` (type: maybe-natural-number)
: TCP port number to connect to.

`user` (type: maybe-string)
: User name on the remote host.

`forward-x11?` (default: `#f`) (type: boolean)
: Whether to forward remote client connections to the local X11 graphical display.

`forward-x11-trusted?` (default: `#f`) (type: boolean)
: Whether remote X11 clients have full access to the original X11 graphical display.

`forward-agent?` (default: `#f`) (type: boolean)
: Whether the authentication agent (if any) is forwarded to the remote machine.

`compression?` (default: `#f`) (type: boolean)
: Whether to compress data in transit.

`proxy-command` (type: maybe-string)
: The command to use to connect to the server. As an example, a command to connect via an HTTP proxy at 192.0.2.0 would be: `"nc -X connect -x 192.0.2.0:8080 %h %p"`.

`host-key-algorithms` (type: maybe-string-list)
: The list of accepted host key algorithms—e.g., `'("ssh-ed25519")`.

`accepted-key-types` (type: maybe-string-list)
: The list of accepted user public key types.

`extra-content` (default: `""`) (type: raw-configuration-string)
: Extra content appended as-is to this `Host` block in `~/.ssh/config`.

13.3.7 Desktop Home Services

The `(gnu home services desktop)` module provides services that you may find useful on "desktop" systems running a graphical user environment such as Xorg.

`home-redshift-service-type` [Scheme Variable]

This is the service type for Redshift (`https://github.com/jonls/redshift`), a program that adjusts the display color temperature according to the time of day. Its associated value must be a `home-redshift-configuration` record, as shown below.

A typical configuration, where we manually specify the latitude and longitude, might look like this:

```
(service home-redshift-service-type
         (home-redshift-configuration
          (location-provider 'manual)
          (latitude 35.81)    ;northern hemisphere
          (longitude -0.80))) ;west of Greenwich
```

`home-redshift-configuration` [Data Type]

Available `home-redshift-configuration` fields are:

`redshift` (default: `redshift`) (type: file-like)
: Redshift package to use.

`location-provider` (default: `geoclue2`) (type: symbol)
: Geolocation provider—`'manual` or `'geoclue2`. In the former case, you must also specify the `latitude` and `longitude` fields so Redshift can determine daytime at your place. In the latter case, the Geoclue system service must be running; it will be queried for location information.

`adjustment-method` (default: `randr`) (type: symbol)
: Color adjustment method.

`daytime-temperature` (default: `6500`) (type: integer)
: Daytime color temperature (kelvins).

`nighttime-temperature` (default: `4500`) (type: integer)
: Nighttime color temperature (kelvins).

`daytime-brightness` (type: maybe-inexact-number)
: Daytime screen brightness, between 0.1 and 1.0, or left unspecified.

`nighttime-brightness` (type: maybe-inexact-number)
: Nighttime screen brightness, between 0.1 and 1.0, or left unspecified.

`latitude` (type: maybe-inexact-number)
: Latitude, when `location-provider` is `'manual`.

`longitude` (type: maybe-inexact-number)
: Longitude, when `location-provider` is `'manual`.

`dawn-time` (type: maybe-string)
: Custom time for the transition from night to day in the morning—`"HH:MM"` format. When specified, solar elevation is not used to determine the daytime/nighttime period.

`dusk-time` (type: maybe-string)
: Likewise, custom time for the transition from day to night in the evening.

`extra-content` (default: `""`) (type: raw-configuration-string)
: Extra content appended as-is to the Redshift configuration file. Run `man redshift` for more information about the configuration file format.

`home-dbus-service-type` [Scheme Variable]
: This is the service type for running a session-specific D-Bus, for unprivileged applications that require D-Bus to be running.

`home-dbus-configuration` [Data Type]
: The configuration record for `home-dbus-service-type`.

`dbus` (default: `dbus`)
: The package providing the `/bin/dbus-daemon` command.

13.3.8 Guix Home Services

The `(gnu home services guix)` module provides services for user-specific Guix configuration.

`home-channels-service-type` [Scheme Variable]
: This is the service type for managing `$XDG_CONFIG_HOME/guix/channels.scm`, the file that controls the channels received on `guix pull` (see Chapter 7 [Channels], page 68). Its associated value is a list of `channel` records, defined in the `(guix channels)` module.

Generally, it is better to extend this service than to directly configure it, as its default value is the default guix channel(s) defined by `%default-channels`. If you configure this service directly, be sure to include a guix channel. See Section 7.1 [Specifying Additional Channels], page 68, and Section 7.2 [Using a Custom Guix Channel], page 68, for more details.

A typical extension for adding a channel might look like this:

```
(simple-service 'variant-packages-service
                home-channels-service-type
                (list
                 (channel
                  (name 'variant-packages)
                  (url "https://example.org/variant-packages.git"))))
```

13.4 Invoking `guix home`

Once you have written a home environment declaration (see Section 13.1 [Declaring the Home Environment], page 579, it can be *instantiated* using the `guix home` command. The synopsis is:

```
guix home options... action file
```

file must be the name of a file containing a `home-environment` declaration. *action* specifies how the home environment is instantiated, but there are few auxiliary actions which don't instantiate it. Currently the following values are supported:

`search` Display available home service type definitions that match the given regular expressions, sorted by relevance:

```
$ guix home search shell
name: home-shell-profile
location: gnu/home/services/shells.scm:100:2
extends: home-files
description: Create `~/.profile', which is used for environment initializati
+ This service type can be extended with a list of file-like objects.█
relevance: 6

name: home-fish
location: gnu/home/services/shells.scm:640:2
extends: home-files home-profile
description: Install and configure Fish, the friendly interactive shell.█
relevance: 3

name: home-zsh
location: gnu/home/services/shells.scm:290:2
extends: home-files home-profile
description: Install and configure Zsh.
relevance: 1

name: home-bash
location: gnu/home/services/shells.scm:508:2
extends: home-files home-profile
description: Install and configure GNU Bash.
relevance: 1

...
```

As for `guix search`, the result is written in `recutils` format, which makes it easy to filter the output (see *GNU recutils manual*).

`container`

Spawn a shell in an isolated environment—a *container*—containing your home as specified by *file*.

For example, this is how you would start an interactive shell in a container with your home:

```
guix home container config.scm
```

This is a throw-away container where you can lightheartedly fiddle with files; any changes made within the container, any process started—all this disappears as soon as you exit that shell.

As with `guix shell`, several options control that container:

`--network`
`-N` Enable networking within the container (it is disabled by default).

`--expose=`*source*`[=`*target*`]`
`--share=`*source*`[=`*target*`]`
: As with `guix shell`, make directory *source* of the host system available as *target* inside the container—read-only if you pass `--expose`, and writable if you pass `--share` (see Section 8.1 [Invoking guix shell], page 76).

Additionally, you can run a command in that container, instead of spawning an interactive shell. For instance, here is how you would check which Shepherd services are started in a throw-away home container:

```
guix home container config.scm -- herd status
```

The command to run in the container must come after `--` (double hyphen).

`edit` Edit or view the definition of the given Home service types.

For example, the command below opens your editor, as specified by the `EDITOR` environment variable, on the definition of the `home-mcron` service type:

```
guix home edit home-mcron
```

`reconfigure`

Build the home environment described in *file*, and switch to it. Switching means that the activation script will be evaluated and (in basic scenario) symlinks to configuration files generated from `home-environment` declaration will be created in `~`. If the file with the same path already exists in home folder it will be moved to `~/`*timestamp*`-guix-home-legacy-configs-backup`, where *timestamp* is a current UNIX epoch time.

> **Note:** It is highly recommended to run `guix pull` once before you run `guix home reconfigure` for the first time (see Section 6.6 [Invoking guix pull], page 56).

This effects all the configuration specified in *file*. The command starts Shepherd services specified in *file* that are not currently running; if a service is currently running, this command will arrange for it to be upgraded the next time it is stopped (e.g. by `herd stop` *service* or `herd restart` *service*).

This command creates a new generation whose number is one greater than the current generation (as reported by `guix home list-generations`). If that generation already exists, it will be overwritten. This behavior mirrors that of `guix package` (see Section 6.2 [Invoking guix package], page 39).

Upon completion, the new home is deployed under `~/.guix-home`. This directory contains *provenance meta-data*: the list of channels in use (see Chapter 7 [Channels], page 68) and *file* itself, when available. You can view the provenance information by running:

```
guix home describe
```

This information is useful should you later want to inspect how this particular generation was built. In fact, assuming *file* is self-contained, you can later rebuild generation *n* of your home environment with:

```
guix time-machine \
  -C /var/guix/profiles/per-user/USER/guix-home-n-link/channels.scm -- \
  home reconfigure \
  /var/guix/profiles/per-user/USER/guix-home-n-link/configuration.scm
```

You can think of it as some sort of built-in version control! Your home is not just a binary artifact: *it carries its own source.*

`switch-generation`
: Switch to an existing home generation. This action atomically switches the home profile to the specified home generation.

  The target generation can be specified explicitly by its generation number. For example, the following invocation would switch to home generation 7:

  ```
  guix home switch-generation 7
  ```

  The target generation can also be specified relative to the current generation with the form `+N` or `-N`, where `+3` means "3 generations ahead of the current generation," and `-1` means "1 generation prior to the current generation." When specifying a negative value such as `-1`, you must precede it with `--` to prevent it from being parsed as an option. For example:

  ```
  guix home switch-generation -- -1
  ```

  This action will fail if the specified generation does not exist.

`roll-back`
: Switch to the preceding home generation. This is the inverse of `reconfigure`, and it is exactly the same as invoking `switch-generation` with an argument of `-1`.

`delete-generations`
: Delete home generations, making them candidates for garbage collection (see Section 6.5 [Invoking guix gc], page 53, for information on how to run the "garbage collector").

  This works in the same way as '`guix package --delete-generations`' (see Section 6.2 [Invoking guix package], page 39). With no arguments, all home generations but the current one are deleted:

  ```
  guix home delete-generations
  ```

  You can also select the generations you want to delete. The example below deletes all the home generations that are more than two months old:

  ```
  guix home delete-generations 2m
  ```

`build`
: Build the derivation of the home environment, which includes all the configuration files and programs needed. This action does not actually install anything.

`describe`
: Describe the current home generation: its file name, as well as provenance information when available.

  To show installed packages in the current home generation's profile, the `--list-installed` flag is provided, with the same syntax that is used in `guix package --list-installed` (see Section 6.2 [Invoking guix package], page 39). For instance, the following command shows a table of all the packages with "emacs" in their name that are installed in the current home generation's profile:

  ```
  guix home describe --list-installed=emacs
  ```

`list-generations`
: List a summary of each generation of the home environment available on disk, in a human-readable way. This is similar to the `--list-generations` option of `guix package` (see Section 6.2 [Invoking guix package], page 39).

  Optionally, one can specify a pattern, with the same syntax that is used in `guix package --list-generations`, to restrict the list of generations displayed. For instance, the following command displays generations that are up to 10 days old:

```
guix home list-generations 10d
```

  The `--list-installed` flag may also be specified, with the same syntax that is used in `guix home describe`. This may be helpful if trying to determine when a package was added to the home profile.

`import`
: Generate a *home environment* from the packages in the default profile and configuration files found in the user's home directory. The configuration files will be copied to the specified directory, and a `home-configuration.scm` will be populated with the home environment. Note that not every home service that exists is supported (see Section 13.3 [Home Services], page 582).

```
$ guix home import ~/guix-config
guix home: '/home/alice/guix-config' populated with all the Home configurati
```

And there's more! `guix home` also provides the following sub-commands to visualize how the services of your home environment relate to one another:

`extension-graph`
: Emit to standard output the *service extension graph* of the home environment defined in *file* (see Section 12.18.1 [Service Composition], page 560, for more information on service extensions). By default the output is in Dot/Graphviz format, but you can choose a different format with `--graph-backend`, as with `guix graph` (see Section 10.10 [Invoking guix graph], page 201):

  The command:

```
guix home extension-graph file | xdot -
```

  shows the extension relations among services.

`shepherd-graph`
: Emit to standard output the *dependency graph* of shepherd services of the home environment defined in *file*. See Section 12.18.4 [Shepherd Services], page 568, for more information and for an example graph.

  Again, the default output format is Dot/Graphviz, but you can pass `--graph-backend` to select a different one.

options can contain any of the common build options (see Section 10.1.1 [Common Build Options], page 166). In addition, *options* can contain one of the following:

`--expression=`*expr*
`-e` *expr*
: Consider the home-environment *expr* evaluates to. This is an alternative to specifying a file which evaluates to a home environment.

`--allow-downgrades`
: Instruct `guix home reconfigure` to allow system downgrades.

  Just like `guix system`, `guix home reconfigure`, by default, prevents you from downgrading your home to older or unrelated revisions compared to the channel revisions that were used to deploy it—those shown by `guix home describe`. Using `--allow-downgrades` allows you to bypass that check, at the risk of downgrading your home—be careful!

14 Documentation

In most cases packages installed with Guix come with documentation. There are two main documentation formats: "Info", a browsable hypertext format used for GNU software, and "manual pages" (or "man pages"), the linear documentation format traditionally found on Unix. Info manuals are accessed with the `info` command or with Emacs, and man pages are accessed using `man`.

You can look for documentation of software installed on your system by keyword. For example, the following command searches for information about "TLS" in Info manuals:

```
$ info -k TLS
"(emacs)Network Security" -- STARTTLS
"(emacs)Network Security" -- TLS
"(gnutls)Core TLS API" -- gnutls_certificate_set_verify_flags
"(gnutls)Core TLS API" -- gnutls_certificate_set_verify_function
...
```

The command below searches for the same keyword in man pages[1]:

```
$ man -k TLS
SSL (7)             - OpenSSL SSL/TLS library
certtool (1)        - GnuTLS certificate tool
...
```

These searches are purely local to your computer so you have the guarantee that documentation you find corresponds to what you have actually installed, you can access it off-line, and your privacy is respected.

Once you have these results, you can view the relevant documentation by running, say:

```
$ info "(gnutls)Core TLS API"
```

or:

```
$ man certtool
```

Info manuals contain sections and indices as well as hyperlinks like those found in Web pages. The `info` reader (see *Stand-alone GNU Info*) and its Emacs counterpart (see Section "Misc Help" in *The GNU Emacs Manual*) provide intuitive key bindings to navigate manuals. See Section "Getting Started" in *Info: An Introduction*, for an introduction to Info navigation.

[1] The database searched by `man -k` is only created in profiles that contain the `man-db` package.

15 Platforms

The packages and systems built by Guix are intended, like most computer programs, to run on a CPU with a specific instruction set, and under a specific operating system. Those programs are often also targeting a specific kernel and system library. Those constraints are captured by Guix in `platform` records.

15.1 `platform` Reference

The `platform` data type describes a *platform*: an ISA (instruction set architecture), combined with an operating system and possibly additional system-wide settings such as the ABI (application binary interface).

`platform` [Data Type]

This is the data type representing a platform.

`target` This field specifies the platform's GNU triplet as a string (see Section "Specifying Target Triplets" in *Autoconf*).

`system` This string is the system type as it is known to Guix and passed, for instance, to the `--system` option of most commands.

It usually has the form `"`*`cpu-kernel`*`"`, where *cpu* is the target CPU and *kernel* the target operating system kernel.

It can be for instance `"aarch64-linux"` or `"armhf-linux"`. You will encounter system types when you perform native builds (see Section 11.2 [Native Builds], page 218).

`linux-architecture` (default: `#false`)

This optional string field is only relevant if the kernel is Linux. In that case, it corresponds to the ARCH variable used when building Linux, `"mips"` for instance.

`glibc-dynamic-linker`

This field is the name of the GNU C Library dynamic linker for the corresponding system, as a string. It can be `"/lib/ld-linux-armhf.so.3"`.

15.2 Supported Platforms

The `(guix platforms ...)` modules export the following variables, each of which is bound to a `platform` record.

`armv7-linux` [Scheme Variable]

Platform targeting ARM v7 CPU running GNU/Linux.

`aarch64-linux` [Scheme Variable]

Platform targeting ARM v8 CPU running GNU/Linux.

`mips64-linux` [Scheme Variable]

Platform targeting MIPS little-endian 64-bit CPU running GNU/Linux.

`powerpc-linux` [Scheme Variable]

Platform targeting PowerPC big-endian 32-bit CPU running GNU/Linux.

`powerpc64le-linux` [Scheme Variable]
: Platform targeting PowerPC little-endian 64-bit CPU running GNU/Linux.

`riscv64-linux` [Scheme Variable]
: Platform targeting RISC-V 64-bit CPU running GNU/Linux.

`i686-linux` [Scheme Variable]
: Platform targeting x86 CPU running GNU/Linux.

`x86_64-linux` [Scheme Variable]
: Platform targeting x86 64-bit CPU running GNU/Linux.

`i686-mingw` [Scheme Variable]
: Platform targeting x86 CPU running Windows, with run-time support from MinGW.

`x86_64-mingw` [Scheme Variable]
: Platform targeting x86 64-bit CPU running Windows, with run-time support from MinGW.

`i586-gnu` [Scheme Variable]
: Platform targeting x86 CPU running GNU/Hurd (also referred to as “GNU”).

16 Creating System Images

When it comes to installing Guix System for the first time on a new machine, you can basically proceed in three different ways. The first one is to use an existing operating system on the machine to run the `guix system init` command (see Section 12.15 [Invoking guix system], page 545). The second one, is to produce an installation image (see Section 3.9 [Building the Installation Image], page 32). This is a bootable system which role is to eventually run `guix system init`. Finally, the third option would be to produce an image that is a direct instantiation of the system you wish to run. That image can then be copied on a bootable device such as an USB drive or a memory card. The target machine would then directly boot from it, without any kind of installation procedure.

The `guix system image` command is able to turn an operating system definition into a bootable image. This command supports different image types, such as `efi-raw`, `iso9660` and `docker`. Any modern `x86_64` machine will probably be able to boot from an `iso9660` image. However, there are a few machines out there that require specific image types. Those machines, in general using `ARM` processors, may expect specific partitions at specific offsets.

This chapter explains how to define customized system images and how to turn them into actual bootable images.

16.1 `image` Reference

The `image` record, described right after, allows you to define a customized bootable system image.

`image` [Data Type]

This is the data type representing a system image.

`name` (default: `#false`)
: The image name as a symbol, `'my-iso9660` for instance. The name is optional and it defaults to `#false`.

`format`
: The image format as a symbol. The following formats are supported:

- `disk-image`, a raw disk image composed of one or multiple partitions.
- `compressed-qcow2`, a compressed qcow2 image composed of one or multiple partitions.
- `docker`, a Docker image.
- `iso9660`, an ISO-9660 image.
- `tarball`, a tar.gz image archive.
- `wsl2`, a WSL2 image.

`platform` (default: `#false`)
: The `platform` record the image is targeting (see Chapter 15 [Platforms], page 601), `aarch64-linux` for instance. By default, this field is set to `#false` and the image will target the host platform.

`size` (default: `'guess`)
: The image size in bytes or `'guess`. The `'guess` symbol, which is the default, means that the image size will be inferred based on the image content.

`operating-system`
: The image's `operating-system` record that is instanciated.

`partition-table-type` (default: `'mbr`)
: The image partition table type as a symbol. Possible values are `'mbr` and `'gpt`. It default to `'mbr`.

`partitions` (default: `'()`)
: The image partitions as a list of `partition` records (see Section 16.1.1 [partition Reference], page 604).

`compression?` (default: `#true`)
: Whether the image content should be compressed, as a boolean. It defaults to `#true` and only applies to `'iso9660` image formats.

`volatile-root?` (default: `#true`)
: Whether the image root partition should be made volatile, as a boolean.

  This is achieved by using a RAM backed file system (overlayfs) that is mounted on top of the root partition by the initrd. It defaults to `#true`. When set to `#false`, the image root partition is mounted as read-write partition by the initrd.

`shared-store?` (default: `#false`)
: Whether the image's store should be shared with the host system, as a boolean. This can be useful when creating images dedicated to virtual machines. When set to `#false`, which is the default, the image's `operating-system` closure is copied to the image. Otherwise, when set to `#true`, it is assumed that the host store will be made available at boot, using a `9p` mount for instance.

`shared-network?` (default: `#false`)
: Whether to use the host network interfaces within the image, as a boolean. This is only used for the `'docker` image format. It defaults to `#false`.

`substitutable?` (default: `#true`)
: Whether the image derivation should be substitutable, as a boolean. It defaults to `true`.

16.1.1 `partition` Reference

In `image` record may contain some partitions.

`partition` [Data Type]

This is the data type representing an image partition.

`size` (default: `'guess`)
: The partition size in bytes or `'guess`. The `'guess` symbol, which is the default, means that the partition size will be inferred based on the partition content.

`offset` (default: `0`)
: The partition's start offset in bytes, relative to the image start or the previous partition end. It defaults to `0` which means that there is no offset applied.

`file-system` (default: `"ext4"`)
: The partition file system as a string, defaulting to `"ext4"`. The supported values are `"vfat"`, `"fat16"`, `"fat32"` and `"ext4"`.

`file-system-options` (default: `'()`)
: The partition file system creation options that should be passed to the partition creation tool, as a list of strings. This is only supported when creating `"ext4"` partitions.

  See the `"extended-options"` man page section of the `"mke2fs"` tool for a more complete reference.

`label`
: The partition label as a mandatory string, `"my-root"` for instance.

`uuid` (default: `#false`)
: The partition UUID as an `uuid` record (see Section 12.3 [File Systems], page 232). By default it is `#false`, which means that the partition creation tool will attribute a random UUID to the partition.

`flags` (default: `'()`)
: The partition flags as a list of symbols. Possible values are `'boot` and `'esp`. The `'boot` flags should be set if you want to boot from this partition. Exactly one partition should have this flag set, usually the root one. The `'esp` flag identifies a UEFI System Partition.

`initializer` (default: `#false`)
: The partition initializer procedure as a gexp. This procedure is called to populate a partition. If no initializer is passed, the `initialize-root-partition` procedure from the `(gnu build image)` module is used.

16.2 Instantiate an Image

Let's say you would like to create an MBR image with three distinct partitions:

- The ESP (EFI System Partition), a partition of 40 MiB at offset 1024 KiB with a vfat file system.
- an ext4 partition of 50 MiB data file, and labeled "data".
- an ext4 bootable partition containing the `%simple-os` operating-system.

You would then write the following image definition in a `my-image.scm` file for instance.

```
(use-modules (gnu)
             (gnu image)
             (gnu tests)
             (gnu system image)
             (guix gexp))

(define MiB (expt 2 20))
```

```
(image
 (format 'disk-image)
 (operating-system %simple-os)
 (partitions
  (list
   (partition
    (size (* 40 MiB))
    (offset (* 1024 1024))
    (label "GNU-ESP")
    (file-system "vfat")
    (flags '(esp))
    (initializer (gexp initialize-efi-partition)))
   (partition
    (size (* 50 MiB))
    (label "DATA")
    (file-system "ext4")
    (initializer #~(lambda* (root . rest)
                    (mkdir root)
                    (call-with-output-file
                        (string-append root "/data")
                      (lambda (port)
                        (format port "my-data"))))))
   (partition
    (size 'guess)
    (label root-label)
    (file-system "ext4")
    (flags '(boot))
    (initializer (gexp initialize-root-partition))))))
```

Note that the first and third partitions use generic initializers procedures, initialize-efi-partition and initialize-root-partition respectively. The initialize-efi-partition installs a GRUB EFI loader that is loading the GRUB bootloader located in the root partition. The initialize-root-partition instantiates a complete system as defined by the `%simple-os` operating-system.

You can now run:

```
guix system image my-image.scm
```

to instantiate the `image` definition. That produces a disk image which has the expected structure:

```
$ parted $(guix system image my-image.scm) print
...
Model:  (file)
Disk /gnu/store/yhylv1bp5b2ypb97pd3bbhz6jk5nbhxw-disk-image: 1714MB
Sector size (logical/physical): 512B/512B
Partition Table: msdos
Disk Flags:
```

```
Number  Start   End     Size    Type     File system  Flags
 1      1049kB  43.0MB  41.9MB  primary  fat16        esp
 2      43.0MB  95.4MB  52.4MB  primary  ext4
 3      95.4MB  1714MB  1619MB  primary  ext4         boot
```

The size of the `boot` partition has been inferred to `1619MB` so that it is large enough to host the `%simple-os` operating-system.

You can also use existing `image` record definitions and inherit from them to simplify the `image` definition. The `(gnu system image)` module provides the following `image` definition variables.

`efi-disk-image` [Scheme Variable]
: A MBR disk-image composed of two partitions: a 64 bits ESP partition and a ROOT boot partition. This image can be used on most `x86_64` and `i686` machines, supporting BIOS or UEFI booting.

`efi32-disk-image` [Scheme Variable]
: Same as `efi-disk-image` but with a 32 bits EFI partition.

`iso9660-image` [Scheme Variable]
: An ISO-9660 image composed of a single bootable partition. This image can also be used on most `x86_64` and `i686` machines.

`docker-image` [Scheme Variable]
: A Docker image that can be used to spawn a Docker container.

Using the `efi-disk-image` we can simplify our previous `image` declaration this way:

```
(use-modules (gnu)
             (gnu image)
             (gnu tests)
             (gnu system image)
             (guix gexp)
             (ice-9 match))

(define MiB (expt 2 20))

(define data
  (partition
   (size (* 50 MiB))
   (label "DATA")
   (file-system "ext4")
   (initializer #~(lambda* (root . rest)
                    (mkdir root)
                    (call-with-output-file
                        (string-append root "/data")
                      (lambda (port)
                        (format port "my-data")))))))

(image
 (inherit efi-disk-image)
 (operating-system %simple-os)
 (partitions
  (match (image-partitions efi-disk-image)
    ((esp root)
     (list esp data root)))))
```

This will give the exact same `image` instantiation but the `image` declaration is simpler.

16.3 image-type Reference

The `guix system image` command can, as we saw above, take a file containing an `image` declaration as argument and produce an actual disk image from it. The same command can also handle a file containing an `operating-system` declaration as argument. In that case, how is the `operating-system` turned into an image?

That's where the `image-type` record intervenes. This record defines how to transform an `operating-system` record into an `image` record.

`image-type` [Data Type]

This is the data type representing an image-type.

`name` The image-type name as a mandatory symbol, `'efi32-raw` for instance.

`constructor`
The image-type constructor, as a mandatory procedure that takes an `operating-system` record as argument and returns an `image` record.

There are several `image-type` records provided by the `(gnu system image)` and the `(gnu system images ...)` modules.

`efi-raw-image-type` [Scheme Variable]

Build an image based on the `efi-disk-image` image.

`efi32-raw-image-type` [Scheme Variable]

Build an image based on the `efi32-disk-image` image.

`qcow2-image-type` [Scheme Variable]

Build an image based on the `efi-disk-image` image but with the `compressed-qcow2` image format.

`iso-image-type` [Scheme Variable]

Build a compressed image based on the `iso9660-image` image.

`uncompressed-iso-image-type` [Scheme Variable]

Build an image based on the `iso9660-image` image but with the `compression?` field set to `#false`.

`docker-image-type` [Scheme Variable]

Build an image based on the `docker-image` image.

`raw-with-offset-image-type` [Scheme Variable]

Build an MBR image with a single partition starting at a `1024KiB` offset. This is useful to leave some room to install a bootloader in the post-MBR gap.

`pinebook-pro-image-type` [Scheme Variable]
: Build an image that is targeting the Pinebook Pro machine. The MBR image contains a single partition starting at a `9MiB` offset. The `u-boot-pinebook-pro-rk3399-bootloader` bootloader will be installed in this gap.

`rock64-image-type` [Scheme Variable]
: Build an image that is targeting the Rock64 machine. The MBR image contains a single partition starting at a `16MiB` offset. The `u-boot-rock64-rk3328-bootloader` bootloader will be installed in this gap.

`novena-image-type` [Scheme Variable]
: Build an image that is targeting the Novena machine. It has the same characteristics as `raw-with-offset-image-type`.

`pine64-image-type` [Scheme Variable]
: Build an image that is targeting the Pine64 machine. It has the same characteristics as `raw-with-offset-image-type`.

`hurd-image-type` [Scheme Variable]
: Build an image that is targeting a `i386` machine running the Hurd kernel. The MBR image contains a single ext2 partitions with specific `file-system-options` flags.

`hurd-qcow2-image-type` [Scheme Variable]
: Build an image similar to the one built by the `hurd-image-type` but with the `format` set to `'compressed-qcow2`.

`wsl2-image-type` [Scheme Variable]
: Build an image for the WSL2 (Windows Subsystem for Linux 2). It can be imported by running:

```
wsl --import Guix ./guix ./wsl2-image.tar.gz
wsl -d Guix
```

So, if we get back to the `guix system image` command taking an `operating-system` declaration as argument. By default, the `efi-raw-image-type` is used to turn the provided `operating-system` into an actual bootable image.

To use a different `image-type`, the `--image-type` option can be used. The `--list-image-types` option will list all the supported image types. It turns out to be a textual listing of all the `image-types` variables described just above (see Section 12.15 [Invoking guix system], page 545).

16.4 Image Modules

Let's take the example of the Pine64, an ARM based machine. To be able to produce an image targeting this board, we need the following elements:

- An `operating-system` record containing at least an appropriate kernel (`linux-libre-arm64-generic`) and bootloader `u-boot-pine64-lts-bootloader`) for the Pine64.
- Possibly, an `image-type` record providing a way to turn an `operating-system` record to an `image` record suitable for the Pine64.

- An actual `image` that can be instantiated with the `guix system image` command.

The `(gnu system images pine64)` module provides all those elements: `pine64-barebones-os`, `pine64-image-type` and `pine64-barebones-raw-image` respectively.

The module returns the `pine64-barebones-raw-image` in order for users to be able to run:

```
guix system image gnu/system/images/pine64.scm
```

Now, thanks to the `pine64-image-type` record declaring the `'pine64-raw image-type`, one could also prepare a `my-pine.scm` file with the following content:

```
(use-modules (gnu system images pine64))
(operating-system
  (inherit pine64-barebones-os)
  (timezone "Europe/Athens"))
```

to customize the `pine64-barebones-os`, and run:

```
$ guix system image --image-type=pine64-raw my-pine.scm
```

Note that there are other modules in the `gnu/system/images` directory targeting `Novena`, `Pine64`, `PinebookPro` and `Rock64` machines.

17 Installing Debugging Files

Program binaries, as produced by the GCC compilers for instance, are typically written in the ELF format, with a section containing *debugging information*. Debugging information is what allows the debugger, GDB, to map binary code to source code; it is required to debug a compiled program in good conditions.

This chapter explains how to use separate debug info when packages provide it, and how to rebuild packages with debug info when it's missing.

17.1 Separate Debug Info

The problem with debugging information is that is takes up a fair amount of disk space. For example, debugging information for the GNU C Library weighs in at more than 60 MiB. Thus, as a user, keeping all the debugging info of all the installed programs is usually not an option. Yet, space savings should not come at the cost of an impediment to debugging—especially in the GNU system, which should make it easier for users to exert their computing freedom (see Section 1.2 [GNU Distribution], page 2).

Thankfully, the GNU Binary Utilities (Binutils) and GDB provide a mechanism that allows users to get the best of both worlds: debugging information can be stripped from the binaries and stored in separate files. GDB is then able to load debugging information from those files, when they are available (see Section "Separate Debug Files" in *Debugging with GDB*).

The GNU distribution takes advantage of this by storing debugging information in the `lib/debug` sub-directory of a separate package output unimaginatively called `debug` (see Section 6.4 [Packages with Multiple Outputs], page 53). Users can choose to install the `debug` output of a package when they need it. For instance, the following command installs the debugging information for the GNU C Library and for GNU Guile:

```
guix install glibc:debug guile:debug
```

GDB must then be told to look for debug files in the user's profile, by setting the `debug-file-directory` variable (consider setting it from the `~/.gdbinit` file, see Section "Startup" in *Debugging with GDB*):

```
(gdb) set debug-file-directory ~/.guix-profile/lib/debug
```

From there on, GDB will pick up debugging information from the `.debug` files under `~/.guix-profile/lib/debug`.

Below is an alternative GDB script which is useful when working with other profiles. It takes advantage of the optional Guile integration in GDB. This snippet is included by default on Guix System in the `~/.gdbinit` file.

```
guile
(use-modules (gdb))
(execute (string-append "set debug-file-directory "
                        (or (getenv "GDB_DEBUG_FILE_DIRECTORY")
                            "~/.guix-profile/lib/debug")))
end
```

In addition, you will most likely want GDB to be able to show the source code being debugged. To do that, you will have to unpack the source code of the package of interest (obtained with `guix build --source`, see Section 10.1 [Invoking guix build], page 166), and to point GDB to that source directory using the `directory` command (see Section "Source Path" in *Debugging with GDB*).

The `debug` output mechanism in Guix is implemented by the `gnu-build-system` (see Section 9.5 [Build Systems], page 114). Currently, it is opt-in—debugging information is available only for the packages with definitions explicitly declaring a `debug` output. To check whether a package has a `debug` output, use `guix package --list-available` (see Section 6.2 [Invoking guix package], page 39).

Read on for how to deal with packages lacking a `debug` output.

17.2 Rebuilding Debug Info

As we saw above, some packages, but not all, provide debugging info in a `debug` output. What can you do when debugging info is missing? The `--with-debug-info` option provides a solution to that: it allows you to rebuild the package(s) for which debugging info is missing—and only those—and to graft those onto the application you're debugging. Thus, while it's not as fast as installing a `debug` output, it is relatively inexpensive.

Let's illustrate that. Suppose you're experiencing a bug in Inkscape and would like to see what's going on in GLib, a library that's deep down in its dependency graph. As it turns out, GLib does not have a `debug` output and the backtrace GDB shows is all sadness:

```
(gdb) bt
#0  0x00007ffff5f92190 in g_getenv ()
   from /gnu/store/...-glib-2.62.6/lib/libglib-2.0.so.0
#1  0x00007ffff608a7d6 in gobject_init_ctor ()
   from /gnu/store/...-glib-2.62.6/lib/libgobject-2.0.so.0
#2  0x00007ffff7fe275a in call_init (l=<optimized out>, argc=argc@entry=1, argv=argv@e
    env=env@entry=0x7fffffffcfe8) at dl-init.c:72
#3  0x00007ffff7fe2866 in call_init (env=0x7fffffffcfe8, argv=0x7fffffffcfd8, argc=1,
    at dl-init.c:118
```

To address that, you install Inkscape linked against a variant GLib that contains debug info:

```
guix install inkscape --with-debug-info=glib
```

This time, debugging will be a whole lot nicer:

```
$ gdb --args sh -c 'exec inkscape'
...
(gdb) b g_getenv
Function "g_getenv" not defined.
Make breakpoint pending on future shared library load? (y or [n]) y
Breakpoint 1 (g_getenv) pending.
(gdb) r
Starting program: /gnu/store/...-profile/bin/sh -c exec\ inkscape
...
(gdb) bt
#0  g_getenv (variable=variable@entry=0x7ffff60c7a2e "GOBJECT_DEBUG") at ../glib-2.62.
#1  0x00007ffff608a7d6 in gobject_init () at ../glib-2.62.6/gobject/gtype.c:4380
```

```
#2  gobject_init_ctor () at ../glib-2.62.6/gobject/gtype.c:4493
#3  0x00007ffff7fe275a in call_init (l=<optimized out>, argc=argc@entry=3, argv=argv@e
    env=env@entry=0x7fffffffd0a8) at dl-init.c:72
...
```

Much better!

Note that there can be packages for which `--with-debug-info` will not have the desired effect. See Section 10.1.2 [Package Transformation Options], page 168, for more information.

18 Using TEX and LATEX

Guix provides packages for the TEX, LATEX, ConTeXt, LuaTeX, and related typesetting systems, taken from the TEX Live distribution (`https://www.tug.org/texlive/`). However, because TEX Live is so huge and because finding your way in this maze is tricky, we thought that you, dear user, would welcome guidance on how to deploy the relevant packages so you can compile your TEX and LATEX documents.

TEX Live currently comes in two flavors in Guix:

- The "monolithic" `texlive` package: it comes with *every single TEX Live package* (more than 7,000 of them), but it is huge (more than 4 GiB for a single package!).
- The "modular" `texlive-` packages: you install `texlive-base`, which provides core functionality and the main commands—`pdflatex`, `dvips`, `luatex`, `mf`, etc.—together with individual packages that provide just the features you need—`texlive-listings` for the `listings` package, `texlive-hyperref` for `hyperref`, `texlive-beamer` for Beamer, `texlive-pgf` for PGF/TikZ, and so on.

We recommend using the modular package set because it is much less resource-hungry. To build your documents, you would use commands such as:

```
guix shell texlive-base texlive-wrapfig \
  texlive-hyperref texlive-cm-super -- pdflatex doc.tex
```

You can quickly end up with unreasonably long command lines though. The solution is to instead write a manifest, for example like this one:

```
(specifications->manifest
 '("rubber"

   "texlive-base"
   "texlive-wrapfig"

   "texlive-microtype"
   "texlive-listings" "texlive-hyperref"

   ;; PGF/TikZ
   "texlive-pgf"

   ;; Additional fonts.
   "texlive-cm-super" "texlive-amsfonts"
   "texlive-times" "texlive-helvetic" "texlive-courier"))
```

You can then pass it to any command with the `-m` option:

```
guix shell -m manifest.scm -- pdflatex doc.tex
```

See Section 9.4 [Writing Manifests], page 110, for more on manifests. In the future, we plan to provide packages for TEX Live *collections*—"meta-packages" such as `fontsrecommended`, `humanities`, or `langarabic` that provide the set of packages needed in this particular domain. That will allow you to list fewer packages.

The main difficulty here is that using the modular package set forces you to select precisely the packages that you need. You can use `guix search`, but finding the right package can prove to be tedious. When a package is missing, `pdflatex` and similar commands fail with an obscure message along the lines of:

```
doc.tex: File `tikz.sty' not found.
doc.tex:7: Emergency stop.
```

or, for a missing font:

```
kpathsea: Running mktexmf phvr7t
! I can't find file `phvr7t'.
```

How do you determine what the missing package is? In the first case, you'll find the answer by running:

```
$ guix search texlive tikz
name: texlive-pgf
version: 59745
...
```

In the second case, `guix search` turns up nothing. Instead, you can search the TEX Live package database using the `tlmgr` command:

```
$ guix shell texlive-base -- tlmgr info phvr7t
tlmgr: cannot find package phvr7t, searching for other matches:

Packages containing `phvr7t' in their title/description:

Packages containing files matching `phvr7t':
helvetic:
        texmf-dist/fonts/tfm/adobe/helvetic/phvr7t.tfm
        texmf-dist/fonts/tfm/adobe/helvetic/phvr7tn.tfm
        texmf-dist/fonts/vf/adobe/helvetic/phvr7t.vf
        texmf-dist/fonts/vf/adobe/helvetic/phvr7tn.vf
tex4ht:
        texmf-dist/tex4ht/ht-fonts/alias/adobe/helvetic/phvr7t.htf
```

The file is available in the TEX Live `helvetic` package, which is known in Guix as `texlive-helvetic`. Quite a ride, but we found it!

There is one important limitation though: Guix currently provides a subset of the TEX Live packages. If you stumble upon a missing package, you can try and import it (see Section 10.5 [Invoking guix import], page 181):

```
guix import texlive package
```

Additional options include:

`--recursive`
`-r` Traverse the dependency graph of the given upstream package recursively and generate package expressions for all those packages that are not yet in Guix.

> **Note:** TEX Live packaging is still very much work in progress, but you can help! See Chapter 22 [Contributing], page 625, for more information.

19 Security Updates

Occasionally, important security vulnerabilities are discovered in software packages and must be patched. Guix developers try hard to keep track of known vulnerabilities and to apply fixes as soon as possible in the `master` branch of Guix (we do not yet provide a "stable" branch containing only security updates). The `guix lint` tool helps developers find out about vulnerable versions of software packages in the distribution:

```
$ guix lint -c cve
gnu/packages/base.scm:652:2: glibc@2.21: probably vulnerable to CVE-2015-1781, CVE-2015-7547█
gnu/packages/gcc.scm:334:2: gcc@4.9.3: probably vulnerable to CVE-2015-5276
gnu/packages/image.scm:312:2: openjpeg@2.1.0: probably vulnerable to CVE-2016-1923, CVE-2016-1924█
...
```

See Section 10.8 [Invoking guix lint], page 196, for more information.

Guix follows a functional package management discipline (see Chapter 1 [Introduction], page 1), which implies that, when a package is changed, *every package that depends on it* must be rebuilt. This can significantly slow down the deployment of fixes in core packages such as libc or Bash, since basically the whole distribution would need to be rebuilt. Using pre-built binaries helps (see Section 6.3 [Substitutes], page 48), but deployment may still take more time than desired.

To address this, Guix implements *grafts*, a mechanism that allows for fast deployment of critical updates without the costs associated with a whole-distribution rebuild. The idea is to rebuild only the package that needs to be patched, and then to "graft" it onto packages explicitly installed by the user and that were previously referring to the original package. The cost of grafting is typically very low, and order of magnitudes lower than a full rebuild of the dependency chain.

For instance, suppose a security update needs to be applied to Bash. Guix developers will provide a package definition for the "fixed" Bash, say `bash-fixed`, in the usual way (see Section 9.2 [Defining Packages], page 96). Then, the original package definition is augmented with a `replacement` field pointing to the package containing the bug fix:

```
(define bash
  (package
    (name "bash")
    ;; ...
    (replacement bash-fixed)))
```

From there on, any package depending directly or indirectly on Bash—as reported by `guix gc --requisites` (see Section 6.5 [Invoking guix gc], page 53)—that is installed is automatically "rewritten" to refer to `bash-fixed` instead of `bash`. This grafting process takes time proportional to the size of the package, usually less than a minute for an "average" package on a recent machine. Grafting is recursive: when an indirect dependency requires grafting, then grafting "propagates" up to the package that the user is installing.

Currently, the length of the name and version of the graft and that of the package it replaces (`bash-fixed` and `bash` in the example above) must be equal. This restriction mostly comes from the fact that grafting works by patching files, including binary files, directly. Other restrictions may apply: for instance, when adding a graft to a package providing a shared library, the original shared library and its replacement must have the same `SONAME` and be binary-compatible.

The `--no-grafts` command-line option allows you to forcefully avoid grafting (see Section 10.1.1 [Common Build Options], page 166). Thus, the command:

```
guix build bash --no-grafts
```

returns the store file name of the original Bash, whereas:

```
guix build bash
```

returns the store file name of the "fixed", replacement Bash. This allows you to distinguish between the two variants of Bash.

To verify which Bash your whole profile refers to, you can run (see Section 6.5 [Invoking guix gc], page 53):

```
guix gc -R $(readlink -f ~/.guix-profile) | grep bash
```

. . . and compare the store file names that you get with those above. Likewise for a complete Guix system generation:

```
guix gc -R $(guix system build my-config.scm) | grep bash
```

Lastly, to check which Bash running processes are using, you can use the `lsof` command:

```
lsof | grep /gnu/store/.*bash
```

20 Bootstrapping

Bootstrapping in our context refers to how the distribution gets built "from nothing". Remember that the build environment of a derivation contains nothing but its declared inputs (see Chapter 1 [Introduction], page 1). So there's an obvious chicken-and-egg problem: how does the first package get built? How does the first compiler get compiled?

It is tempting to think of this question as one that only die-hard hackers may care about. However, while the answer to that question is technical in nature, its implications are wide-ranging. How the distribution is bootstrapped defines the extent to which we, as individuals and as a collective of users and hackers, can trust the software we run. It is a central concern from the standpoint of *security* and from a *user freedom* viewpoint.

The GNU system is primarily made of C code, with libc at its core. The GNU build system itself assumes the availability of a Bourne shell and command-line tools provided by GNU Coreutils, Awk, Findutils, 'sed', and 'grep'. Furthermore, build programs—programs that run `./configure`, `make`, etc.—are written in Guile Scheme (see Section 9.10 [Derivations], page 146). Consequently, to be able to build anything at all, from scratch, Guix relies on pre-built binaries of Guile, GCC, Binutils, libc, and the other packages mentioned above—the *bootstrap binaries*.

These bootstrap binaries are "taken for granted", though we can also re-create them if needed (see Section 20.2 [Preparing to Use the Bootstrap Binaries], page 620).

20.1 The Reduced Binary Seed Bootstrap

Guix—like other GNU/Linux distributions—is traditionally bootstrapped from a set of bootstrap binaries: Bourne shell, command-line tools provided by GNU Coreutils, Awk, Findutils, 'sed', and 'grep' and Guile, GCC, Binutils, and the GNU C Library (see Chapter 20 [Bootstrapping], page 618). Usually, these bootstrap binaries are "taken for granted."

Taking the bootstrap binaries for granted means that we consider them to be a correct and trustworthy "seed" for building the complete system. Therein lies a problem: the combined size of these bootstrap binaries is about 250MB (see Section "Bootstrappable Builds" in *GNU Mes*). Auditing or even inspecting these is next to impossible.

For `i686-linux` and `x86_64-linux`, Guix now features a "Reduced Binary Seed" bootstrap[1].

The Reduced Binary Seed bootstrap removes the most critical tools—from a trust perspective—from the bootstrap binaries: GCC, Binutils and the GNU C Library are replaced by: `bootstrap-mescc-tools` (a tiny assembler and linker) and `bootstrap-mes` (a small Scheme Interpreter and a C compiler written in Scheme and the Mes C Library, built for TinyCC and for GCC).

Using these new binary seeds the "missing" Binutils, GCC, and the GNU C Library are built from source. From here on the more traditional bootstrap process resumes. This approach has reduced the bootstrap binaries in size to about 145MB in Guix v1.1.

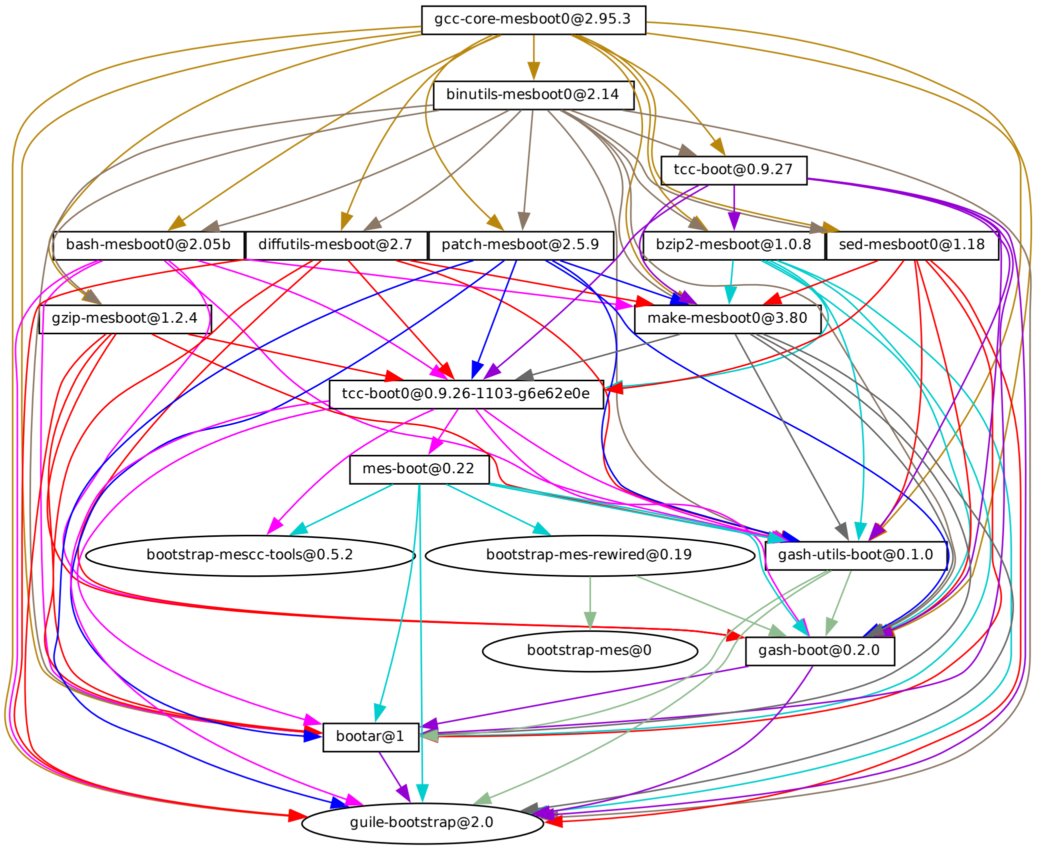
The next step that Guix has taken is to replace the shell and all its utilities with implementations in Guile Scheme, the *Scheme-only bootstrap*. Gash (see Section "Gash" in *The*

[1] We would like to say: "Full Source Bootstrap" and while we are working towards that goal it would be hyperbole to use that term for what we do now.

Gash manual) is a POSIX-compatible shell that replaces Bash, and it comes with Gash Utils which has minimalist replacements for Awk, the GNU Core Utilities, Grep, Gzip, Sed, and Tar. The rest of the bootstrap binary seeds that were removed are now built from source.

Building the GNU System from source is currently only possible by adding some historical GNU packages as intermediate steps[2]. As Gash and Gash Utils mature, and GNU packages become more bootstrappable again (e.g., new releases of GNU Sed will also ship as gzipped tarballs again, as alternative to the hard to bootstrap `xz`-compression), this set of added packages can hopefully be reduced again.

The graph below shows the resulting dependency graph for `gcc-core-mesboot0`, the bootstrap compiler used for the traditional bootstrap of the rest of the Guix System.



The only significant binary bootstrap seeds that remain[3] are a Scheme interpreter and a Scheme compiler: GNU Mes and GNU Guile[4].

[2] Packages such as `gcc-2.95.3`, `binutils-2.14`, `glibc-2.2.5`, `gzip-1.2.4`, `tar-1.22`, and some others. For details, see `gnu/packages/commencement.scm`.

[3] Ignoring the 68KB `mescc-tools`; that will be removed later, together with `mes`.

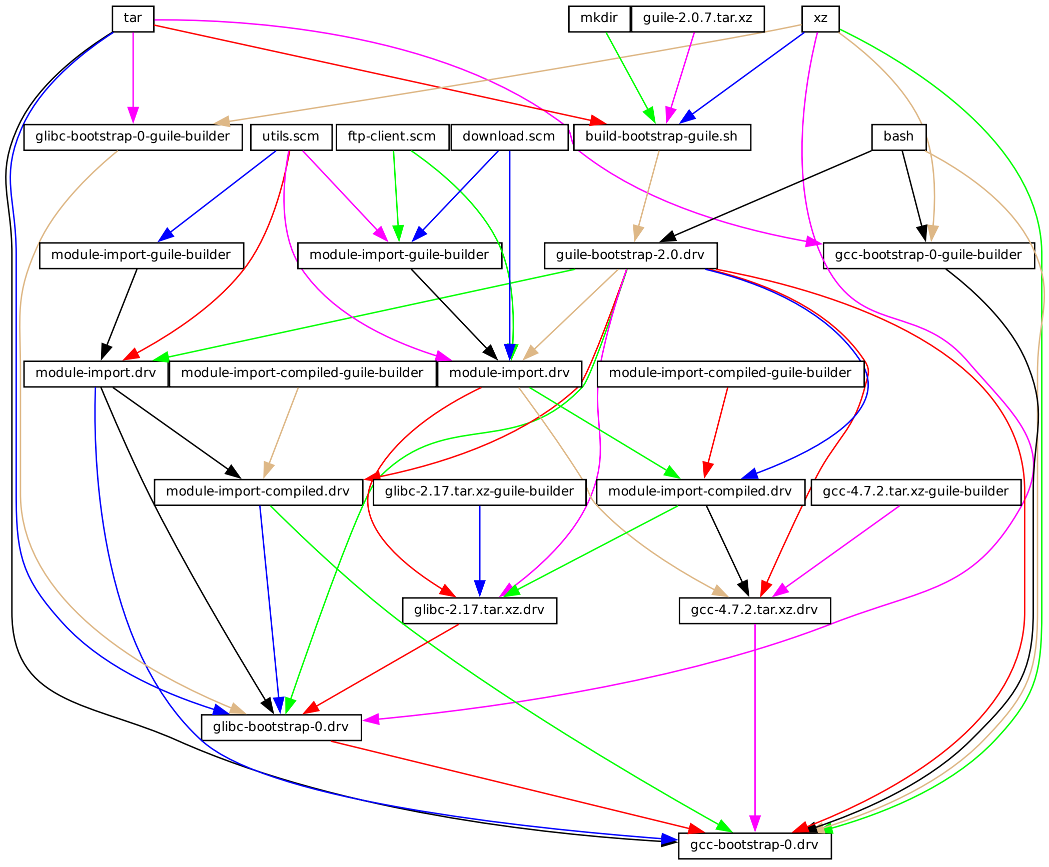
[4] Not shown in this graph are the static binaries for `bash`, `tar`, and `xz` that are used to get Guile running.

This further reduction has brought down the size of the binary seed to about 60MB for `i686-linux` and `x86_64-linux`.

Work is ongoing to remove all binary blobs from our free software bootstrap stack, working towards a Full Source Bootstrap. Also ongoing is work to bring these bootstraps to the `arm-linux` and `aarch64-linux` architectures and to the Hurd.

If you are interested, join us on '`#bootstrappable`' on the Freenode IRC network or discuss on `bug-mes@gnu.org` or `gash-devel@nongnu.org`.

20.2 Preparing to Use the Bootstrap Binaries


tar
mkdir
guile-2.0.7.tar.xz
xz
glibc-bootstrap-0-guile-builder
utils.scm
ftp-client.scm
download.scm
build-bootstrap-guile.sh
bash
module-import-guile-builder
module-import-guile-builder
guile-bootstrap-2.0.drv
gcc-bootstrap-0-guile-builder
module-import.drv
module-import-compiled-guile-builder
module-import.drv
module-import-compiled-guile-builder
module-import-compiled.drv
glibc-2.17.tar.xz-guile-builder
module-import-compiled.drv
gcc-4.7.2.tar.xz-guile-builder
glibc-2.17.tar.xz.drv
gcc-4.7.2.tar.xz.drv
glibc-bootstrap-0.drv
gcc-bootstrap-0.drv

The figure above shows the very beginning of the dependency graph of the distribution, corresponding to the package definitions of the `(gnu packages bootstrap)` module. A similar figure can be generated with `guix graph` (see Section 10.10 [Invoking guix graph], page 201), along the lines of:

```
guix graph -t derivation \
  -e '(@@ (gnu packages bootstrap) %bootstrap-gcc)' \
    | dot -Tps > gcc.ps
```

or, for the further Reduced Binary Seed bootstrap

```
guix graph -t derivation \
  -e '(@@ (gnu packages bootstrap) %bootstrap-mes)' \
  | dot -Tps > mes.ps
```

At this level of detail, things are slightly complex. First, Guile itself consists of an ELF executable, along with many source and compiled Scheme files that are dynamically loaded when it runs. This gets stored in the `guile-2.0.7.tar.xz` tarball shown in this graph. This tarball is part of Guix's "source" distribution, and gets inserted into the store with `add-to-store` (see Section 9.9 [The Store], page 144).

But how do we write a derivation that unpacks this tarball and adds it to the store? To solve this problem, the `guile-bootstrap-2.0.drv` derivation—the first one that gets built—uses `bash` as its builder, which runs `build-bootstrap-guile.sh`, which in turn calls `tar` to unpack the tarball. Thus, `bash`, `tar`, `xz`, and `mkdir` are statically-linked binaries, also part of the Guix source distribution, whose sole purpose is to allow the Guile tarball to be unpacked.

Once `guile-bootstrap-2.0.drv` is built, we have a functioning Guile that can be used to run subsequent build programs. Its first task is to download tarballs containing the other pre-built binaries—this is what the `.tar.xz.drv` derivations do. Guix modules such as `ftp-client.scm` are used for this purpose. The `module-import.drv` derivations import those modules in a directory in the store, using the original layout. The `module-import-compiled.drv` derivations compile those modules, and write them in an output directory with the right layout. This corresponds to the `#:modules` argument of `build-expression->derivation` (see Section 9.10 [Derivations], page 146).

Finally, the various tarballs are unpacked by the derivations `gcc-bootstrap-0.drv`, `glibc-bootstrap-0.drv`, or `bootstrap-mes-0.drv` and `bootstrap-mescc-tools-0.drv`, at which point we have a working C tool chain.

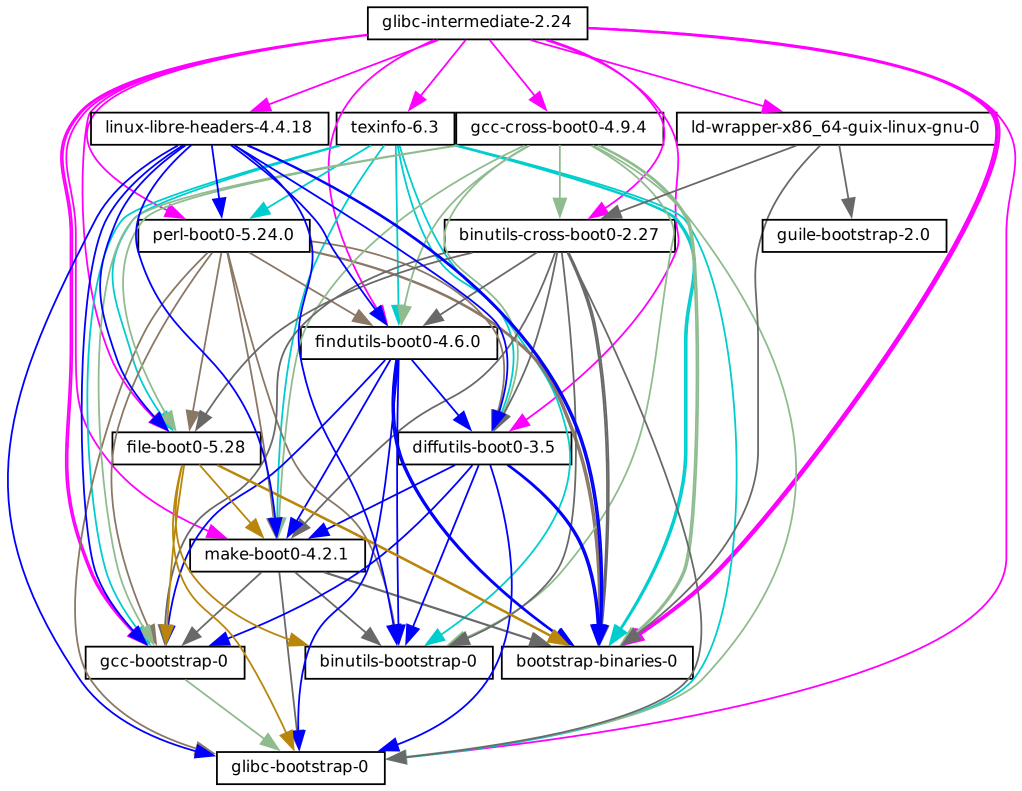
Building the Build Tools

Bootstrapping is complete when we have a full tool chain that does not depend on the pre-built bootstrap tools discussed above. This no-dependency requirement is verified by checking whether the files of the final tool chain contain references to the `/gnu/store` directories of the bootstrap inputs. The process that leads to this "final" tool chain is described by the package definitions found in the `(gnu packages commencement)` module.

The `guix graph` command allows us to "zoom out" compared to the graph above, by looking at the level of package objects instead of individual derivations—remember that a package may translate to several derivations, typically one derivation to download its source, one to build the Guile modules it needs, and one to actually build the package from source. The command:

```
guix graph -t bag \
  -e '(@@ (gnu packages commencement)
          glibc-final-with-bootstrap-bash)' | xdot -
```

displays the dependency graph leading to the “final” C library[5], depicted below.



The first tool that gets built with the bootstrap binaries is GNU Make—noted `make-boot0` above—which is a prerequisite for all the following packages. From there Findutils and Diffutils get built.

Then come the first-stage Binutils and GCC, built as pseudo cross tools—i.e., with `--target` equal to `--host`. They are used to build libc. Thanks to this cross-build trick, this libc is guaranteed not to hold any reference to the initial tool chain.

From there the final Binutils and GCC (not shown above) are built. GCC uses `ld` from the final Binutils, and links programs against the just-built libc. This tool chain is used to build the other packages used by Guix and by the GNU Build System: Guile, Bash, Coreutils, etc.

And voilà! At this point we have the complete set of build tools that the GNU Build System expects. These are in the `%final-inputs` variable of the `(gnu packages commencement)` module, and are implicitly used by any package that uses `gnu-build-system` (see Section 9.5 [Build Systems], page 114).

[5] You may notice the `glibc-intermediate` label, suggesting that it is not *quite* final, but as a good approximation, we will consider it final.

Building the Bootstrap Binaries

Because the final tool chain does not depend on the bootstrap binaries, those rarely need to be updated. Nevertheless, it is useful to have an automated way to produce them, should an update occur, and this is what the `(gnu packages make-bootstrap)` module provides.

The following command builds the tarballs containing the bootstrap binaries (Binutils, GCC, glibc, for the traditional bootstrap and linux-libre-headers, bootstrap-mescc-tools, bootstrap-mes for the Reduced Binary Seed bootstrap, and Guile, and a tarball containing a mixture of Coreutils and other basic command-line tools):

```
guix build bootstrap-tarballs
```

The generated tarballs are those that should be referred to in the `(gnu packages bootstrap)` module mentioned at the beginning of this section.

Still here? Then perhaps by now you've started to wonder: when do we reach a fixed point? That is an interesting question! The answer is unknown, but if you would like to investigate further (and have significant computational and storage resources to do so), then let us know.

Reducing the Set of Bootstrap Binaries

Our traditional bootstrap includes GCC, GNU Libc, Guile, etc. That's a lot of binary code! Why is that a problem? It's a problem because these big chunks of binary code are practically non-auditable, which makes it hard to establish what source code produced them. Every unauditable binary also leaves us vulnerable to compiler backdoors as described by Ken Thompson in the 1984 paper *Reflections on Trusting Trust*.

This is mitigated by the fact that our bootstrap binaries were generated from an earlier Guix revision. Nevertheless it lacks the level of transparency that we get in the rest of the package dependency graph, where Guix always gives us a source-to-binary mapping. Thus, our goal is to reduce the set of bootstrap binaries to the bare minimum.

The Bootstrappable.org web site (`https://bootstrappable.org`) lists on-going projects to do that. One of these is about replacing the bootstrap GCC with a sequence of assemblers, interpreters, and compilers of increasing complexity, which could be built from source starting from a simple and auditable assembler.

Our first major achievement is the replacement of of GCC, the GNU C Library and Binutils by MesCC-Tools (a simple hex linker and macro assembler) and Mes (see *GNU Mes*, a Scheme interpreter and C compiler in Scheme). Neither MesCC-Tools nor Mes can be fully bootstrapped yet and thus we inject them as binary seeds. We call this the Reduced Binary Seed bootstrap, as it has halved the size of our bootstrap binaries! Also, it has eliminated the C compiler binary; i686-linux and x86_64-linux Guix packages are now bootstrapped without any binary C compiler.

Work is ongoing to make MesCC-Tools and Mes fully bootstrappable and we are also looking at any other bootstrap binaries. Your help is welcome!

21 Porting to a New Platform

As discussed above, the GNU distribution is self-contained, and self-containment is achieved by relying on pre-built "bootstrap binaries" (see Chapter 20 [Bootstrapping], page 618). These binaries are specific to an operating system kernel, CPU architecture, and application binary interface (ABI). Thus, to port the distribution to a platform that is not yet supported, one must build those bootstrap binaries, and update the `(gnu packages bootstrap)` module to use them on that platform.

Fortunately, Guix can *cross compile* those bootstrap binaries. When everything goes well, and assuming the GNU tool chain supports the target platform, this can be as simple as running a command like this one:

```
guix build --target=armv5tel-linux-gnueabi bootstrap-tarballs
```

For this to work, it is first required to register a new platform as defined in the `(guix platform)` module. A platform is making the connection between a GNU triplet (see Section "Specifying Target Triplets" in *Autoconf*), the equivalent *system* in Nix notation, the name of the *glibc-dynamic-linker*, and the corresponding Linux architecture name if applicable (see Chapter 15 [Platforms], page 601).

Once the bootstrap tarball are built, the `(gnu packages bootstrap)` module needs to be updated to refer to these binaries on the target platform. That is, the hashes and URLs of the bootstrap tarballs for the new platform must be added alongside those of the currently supported platforms. The bootstrap Guile tarball is treated specially: it is expected to be available locally, and `gnu/local.mk` has rules to download it for the supported architectures; a rule for the new platform must be added as well.

In practice, there may be some complications. First, it may be that the extended GNU triplet that specifies an ABI (like the `eabi` suffix above) is not recognized by all the GNU tools. Typically, glibc recognizes some of these, whereas GCC uses an extra `--with-abi` configure flag (see `gcc.scm` for examples of how to handle this). Second, some of the required packages could fail to build for that platform. Lastly, the generated binaries could be broken for some reason.

22 Contributing

This project is a cooperative effort, and we need your help to make it grow! Please get in touch with us on `guix-devel@gnu.org` and `#guix` on the Libera Chat IRC network. We welcome ideas, bug reports, patches, and anything that may be helpful to the project. We particularly welcome help on packaging (see Section 22.4 [Packaging Guidelines], page 629).

We want to provide a warm, friendly, and harassment-free environment, so that anyone can contribute to the best of their abilities. To this end our project uses a "Contributor Covenant", which was adapted from `https://contributor-covenant.org/`. You can find a local version in the `CODE-OF-CONDUCT` file in the source tree.

Contributors are not required to use their legal name in patches and on-line communication; they can use any name or pseudonym of their choice.

22.1 Building from Git

If you want to hack Guix itself, it is recommended to use the latest version from the Git repository:

```
git clone https://git.savannah.gnu.org/git/guix.git
```

How do you ensure that you obtained a genuine copy of the repository? To do that, run `guix git authenticate`, passing it the commit and OpenPGP fingerprint of the *channel introduction* (see Section 8.5 [Invoking guix git authenticate], page 93):

```
git fetch origin keyring:keyring
guix git authenticate 9edb3f66fd807b096b48283debdcddccfea34bad \
  "BBB0 2DDF 2CEA F6A8 0D1D  E643 A2A0 6DF2 A33A 54FA"
```

This command completes with exit code zero on success; it prints an error message and exits with a non-zero code otherwise.

As you can see, there is a chicken-and-egg problem: you first need to have Guix installed. Typically you would install Guix System (see Chapter 3 [System Installation], page 23) or Guix on top of another distro (see Section 2.1 [Binary Installation], page 4); in either case, you would verify the OpenPGP signature on the installation medium. This "bootstraps" the trust chain.

The easiest way to set up a development environment for Guix is, of course, by using Guix! The following command starts a new shell where all the dependencies and appropriate environment variables are set up to hack on Guix:

```
guix shell -D guix --pure
```

See Section 8.1 [Invoking guix shell], page 76, for more information on that command.

If you are unable to use Guix when building Guix from a checkout, the following are the required packages in addition to those mentioned in the installation instructions (see Section 2.2 [Requirements], page 7).

- GNU Autoconf (`https://gnu.org/software/autoconf/`);
- GNU Automake (`https://gnu.org/software/automake/`);
- GNU Gettext (`https://gnu.org/software/gettext/`);
- GNU Texinfo (`https://gnu.org/software/texinfo/`);
- Graphviz (`https://www.graphviz.org/`);

- GNU Help2man (optional) (https://www.gnu.org/software/help2man/).

On Guix, extra dependencies can be added by instead running `guix shell`:

```
guix shell -D guix help2man git strace --pure
```

From there you can generate the build system infrastructure using Autoconf and Automake:

```
./bootstrap
```

If you get an error like this one:

```
configure.ac:46: error: possibly undefined macro: PKG_CHECK_MODULES
```

it probably means that Autoconf couldn't find `pkg.m4`, which is provided by pkg-config. Make sure that `pkg.m4` is available. The same holds for the `guile.m4` set of macros provided by Guile. For instance, if you installed Automake in `/usr/local`, it wouldn't look for `.m4` files in `/usr/share`. In that case, you have to invoke the following command:

```
export ACLOCAL_PATH=/usr/share/aclocal
```

See Section "Macro Search Path" in *The GNU Automake Manual*, for more information.

Then, run:

```
./configure --localstatedir=/var
```

... where `/var` is the normal `localstatedir` value (see Section 9.9 [The Store], page 144, for information about this). Note that you will probably not run `make install` at the end (you don't have to) but it's still important to pass the right `localstatedir`.

Finally, you can build Guix and, if you feel so inclined, run the tests (see Section 2.3 [Running the Test Suite], page 8):

```
make
make check
```

If anything fails, take a look at installation instructions (see Chapter 2 [Installation], page 4) or send a message to the mailing list.

From there on, you can authenticate all the commits included in your checkout by running:

```
make authenticate
```

The first run takes a couple of minutes, but subsequent runs are faster.

Or, when your configuration for your local Git repository doesn't match the default one, you can provide the reference for the `keyring` branch through the variable `GUIX_GIT_KEYRING`. The following example assumes that you have a Git remote called '`myremote`' pointing to the official repository:

```
make authenticate GUIX_GIT_KEYRING=myremote/keyring
```

> **Note:** You are advised to run `make authenticate` after every `git pull` invocation. This ensures you keep receiving valid changes to the repository.

After updating the repository, `make` might fail with an error similar to the following example:

```
error: failed to load 'gnu/packages/dunst.scm':
ice-9/eval.scm:293:34: In procedure abi-check: #<record-type <origin>>: record ABI mis
```

This means that one of the record types that Guix defines (in this example, the `origin` record) has changed, and all of guix needs to be recompiled to take that change into account. To do so, run `make clean-go` followed by `make`.

22.2 Running Guix Before It Is Installed

In order to keep a sane working environment, you will find it useful to test the changes made in your local source tree checkout without actually installing them. So that you can distinguish between your “end-user” hat and your “motley” costume.

To that end, all the command-line tools can be used even if you have not run `make install`. To do that, you first need to have an environment with all the dependencies available (see Section 22.1 [Building from Git], page 625), and then simply prefix each command with `./pre-inst-env` (the `pre-inst-env` script lives in the top build tree of Guix; it is generated by running `./bootstrap` followed by `./configure`). As an example, here is how you would build the `hello` package as defined in your working tree (this assumes `guix-daemon` is already running on your system; it’s OK if it’s a different version):

```
$ ./pre-inst-env guix build hello
```

Similarly, an example for a Guile session using the Guix modules:

```
$ ./pre-inst-env guile -c '(use-modules (guix utils)) (pk (%current-system))'

;;; ("x86_64-linux")
```

. . . and for a REPL (see Section 9.14 [Using Guix Interactively], page 164):

```
$ ./pre-inst-env guile
scheme@(guile-user)> ,use(guix)
scheme@(guile-user)> ,use(gnu)
scheme@(guile-user)> (define snakes
                       (fold-packages
                         (lambda (package lst)
                           (if (string-prefix? "python"
                                               (package-name package))
                               (cons package lst)
                               lst))
                         '()))
scheme@(guile-user)> (length snakes)
$1 = 361
```

If you are hacking on the daemon and its supporting code or if `guix-daemon` is not already running on your system, you can launch it straight from the build tree[1]:

```
$ sudo -E ./pre-inst-env guix-daemon --build-users-group=guixbuild
```

The `pre-inst-env` script sets up all the environment variables necessary to support this, including `PATH` and `GUILE_LOAD_PATH`.

Note that `./pre-inst-env guix pull` does *not* upgrade the local source tree; it simply updates the `~/.config/guix/current` symlink (see Section 6.6 [Invoking guix pull], page 56). Run `git pull` instead if you want to upgrade your local source tree.

Sometimes, especially if you have recently updated your repository, running `./pre-inst-env` will print a message similar to the following example:

```
;;; note: source file /home/user/projects/guix/guix/progress.scm
```

[1] The `-E` flag to `sudo` guarantees that `GUILE_LOAD_PATH` is correctly set such that `guix-daemon` and the tools it uses can find the Guile modules they need.

```
;;;       newer than compiled /home/user/projects/guix/guix/progress.go
```

This is only a note and you can safely ignore it. You can get rid of the message by running `make -j4`. Until you do, Guile will run slightly slower because it will interpret the code instead of using prepared Guile object (`.go`) files.

You can run `make` automatically as you work using `watchexec` from the `watchexec` package. For example, to build again each time you update a package file, run '`watchexec -w gnu/packages -- make -j4`'.

22.3 The Perfect Setup

The Perfect Setup to hack on Guix is basically the perfect setup used for Guile hacking (see Section "Using Guile in Emacs" in *Guile Reference Manual*). First, you need more than an editor, you need Emacs (`https://www.gnu.org/software/emacs`), empowered by the wonderful Geiser (`https://nongnu.org/geiser/`). To set that up, run:

```
guix install emacs guile emacs-geiser emacs-geiser-guile
```

Geiser allows for interactive and incremental development from within Emacs: code compilation and evaluation from within buffers, access to on-line documentation (docstrings), context-sensitive completion, *M-.* to jump to an object definition, a REPL to try out your code, and more (see Section "Introduction" in *Geiser User Manual*). For convenient Guix development, make sure to augment Guile's load path so that it finds source files from your checkout:

```
;; Assuming the Guix checkout is in ~/src/guix.
(with-eval-after-load 'geiser-guile
  (add-to-list 'geiser-guile-load-path "~/src/guix"))
```

To actually edit the code, Emacs already has a neat Scheme mode. But in addition to that, you must not miss Paredit (`https://www.emacswiki.org/emacs/ParEdit`). It provides facilities to directly operate on the syntax tree, such as raising an s-expression or wrapping it, swallowing or rejecting the following s-expression, etc.

We also provide templates for common git commit messages and package definitions in the `etc/snippets` directory. These templates can be used to expand short trigger strings to interactive text snippets. If you use YASnippet (`https://joaotavora.github.io/yasnippet/`), you may want to add the `etc/snippets/yas` snippets directory to the *yas-snippet-dirs* variable. If you use Tempel (`https://github.com/minad/tempel/`), you may want to add the `etc/snippets/tempel/*` path to the *tempel-path* variable in Emacs.

```
;; Assuming the Guix checkout is in ~/src/guix.
;; Yasnippet configuration
(with-eval-after-load 'yasnippet
  (add-to-list 'yas-snippet-dirs "~/src/guix/etc/snippets/yas"))
;; Tempel configuration
(with-eval-after-load 'tempel
   ;; Ensure tempel-path is a list -- it may also be a string.
   (unless (listp 'tempel-path)
     (setq tempel-path (list tempel-path)))
   (add-to-list 'tempel-path "~/src/guix/etc/snippets/tempel/*"))
```

The commit message snippets depend on Magit (`https://magit.vc/`) to display staged files. When editing a commit message type `add` followed by *TAB* to insert a commit message template for adding a package; type `update` followed by *TAB* to insert a template for updating a package; type `https` followed by *TAB* to insert a template for changing the home page URI of a package to HTTPS.

The main snippet for `scheme-mode` is triggered by typing `package...` followed by *TAB*. This snippet also inserts the trigger string `origin...`, which can be expanded further. The `origin` snippet in turn may insert other trigger strings ending on `...`, which also can be expanded further.

We additionally provide insertion and automatic update of a copyright in `etc/copyright.el`. You may want to set your full name, mail, and load a file.

```
(setq user-full-name "Alice Doe")
(setq user-mail-address "alice@mail.org")
;; Assuming the Guix checkout is in ~/src/guix.
(load-file "~/src/guix/etc/copyright.el")
```

To insert a copyright at the current line invoke `M-x guix-copyright`.

To update a copyright you need to specify a `copyright-names-regexp`.

```
(setq copyright-names-regexp
      (format "%s <%s>" user-full-name user-mail-address))
```

You can check if your copyright is up to date by evaluating `M-x copyright-update`. If you want to do it automatically after each buffer save then add `(add-hook 'after-save-hook 'copyright-update)` in Emacs.

22.4 Packaging Guidelines

The GNU distribution is nascent and may well lack some of your favorite packages. This section describes how you can help make the distribution grow.

Free software packages are usually distributed in the form of *source code tarballs*—typically `tar.gz` files that contain all the source files. Adding a package to the distribution means essentially two things: adding a *recipe* that describes how to build the package, including a list of other packages required to build it, and adding *package metadata* along with that recipe, such as a description and licensing information.

In Guix all this information is embodied in *package definitions*. Package definitions provide a high-level view of the package. They are written using the syntax of the Scheme programming language; in fact, for each package we define a variable bound to the package definition, and export that variable from a module (see Section 9.1 [Package Modules], page 95). However, in-depth Scheme knowledge is *not* a prerequisite for creating packages. For more information on package definitions, see Section 9.2 [Defining Packages], page 96.

Once a package definition is in place, stored in a file in the Guix source tree, it can be tested using the `guix build` command (see Section 10.1 [Invoking guix build], page 166). For example, assuming the new package is called `gnew`, you may run this command from the Guix build tree (see Section 22.2 [Running Guix Before It Is Installed], page 627):

```
./pre-inst-env guix build gnew --keep-failed
```

Using `--keep-failed` makes it easier to debug build failures since it provides access to the failed build tree. Another useful command-line option when debugging is `--log-file`, to access the build log.

If the package is unknown to the `guix` command, it may be that the source file contains a syntax error, or lacks a `define-public` clause to export the package variable. To figure it out, you may load the module from Guile to get more information about the actual error:

```
./pre-inst-env guile -c '(use-modules (gnu packages gnew))'
```

Once your package builds correctly, please send us a patch (see Section 22.6 [Submitting Patches], page 639). Well, if you need help, we will be happy to help you too. Once the patch is committed in the Guix repository, the new package automatically gets built on the supported platforms by our continuous integration system (`https://ci.guix.gnu.org`).

Users can obtain the new package definition simply by running `guix pull` (see Section 6.6 [Invoking guix pull], page 56). When `ci.guix.gnu.org` is done building the package, installing the package automatically downloads binaries from there (see Section 6.3 [Substitutes], page 48). The only place where human intervention is needed is to review and apply the patch.

22.4.1 Software Freedom

The GNU operating system has been developed so that users can have freedom in their computing. GNU is *free software*, meaning that users have the four essential freedoms (`https://www.gnu.org/philosophy/free-sw.html`): to run the program, to study and change the program in source code form, to redistribute exact copies, and to distribute modified versions. Packages found in the GNU distribution provide only software that conveys these four freedoms.

In addition, the GNU distribution follow the free software distribution guidelines (`https://www.gnu.org/distros/free-system-distribution-guidelines.html`). Among other things, these guidelines reject non-free firmware, recommendations of non-free software, and discuss ways to deal with trademarks and patents.

Some otherwise free upstream package sources contain a small and optional subset that violates the above guidelines, for instance because this subset is itself non-free code. When that happens, the offending items are removed with appropriate patches or code snippets in the `origin` form of the package (see Section 9.2 [Defining Packages], page 96). This way, `guix build --source` returns the "freed" source rather than the unmodified upstream source.

22.4.2 Package Naming

A package actually has two names associated with it. First, there is the name of the *Scheme variable*, the one following `define-public`. By this name, the package can be made known in the Scheme code, for instance as input to another package. Second, there is the string in the `name` field of a package definition. This name is used by package management commands such as `guix package` and `guix build`.

Both are usually the same and correspond to the lowercase conversion of the project name chosen upstream, with underscores replaced with hyphens. For instance, GNUnet is available as `gnunet`, and SDL_net as `sdl-net`.

A noteworthy exception to this rule is when the project name is only a single character, or if an older maintained project with the same name already exists—regardless of whether it has already been packaged for Guix. Use common sense to make such names unambiguous and meaningful. For example, Guix's package for the shell called "s" upstream is `s-shell` and *not* `s`. Feel free to ask your fellow hackers for inspiration.

We do not add `lib` prefixes for library packages, unless these are already part of the official project name. But see Section 22.4.7 [Python Modules], page 634, and Section 22.4.8 [Perl Modules], page 635, for special rules concerning modules for the Python and Perl languages.

Font package names are handled differently, see Section 22.4.12 [Fonts], page 637.

22.4.3 Version Numbers

We usually package only the latest version of a given free software project. But sometimes, for instance for incompatible library versions, two (or more) versions of the same package are needed. These require different Scheme variable names. We use the name as defined in Section 22.4.2 [Package Naming], page 630, for the most recent version; previous versions use the same name, suffixed by `-` and the smallest prefix of the version number that may distinguish the two versions.

The name inside the package definition is the same for all versions of a package and does not contain any version number.

For instance, the versions 2.24.20 and 3.9.12 of GTK+ may be packaged as follows:

```
(define-public gtk+
  (package
    (name "gtk+")
    (version "3.9.12")
    ...))
(define-public gtk+-2
  (package
    (name "gtk+")
    (version "2.24.20")
    ...))
```

If we also wanted GTK+ 3.8.2, this would be packaged as

```
(define-public gtk+-3.8
  (package
    (name "gtk+")
    (version "3.8.2")
    ...))
```

Occasionally, we package snapshots of upstream's version control system (VCS) instead of formal releases. This should remain exceptional, because it is up to upstream developers to clarify what the stable release is. Yet, it is sometimes necessary. So, what should we put in the `version` field?

Clearly, we need to make the commit identifier of the VCS snapshot visible in the version string, but we also need to make sure that the version string is monotonically increasing so that `guix package --upgrade` can determine which version is newer. Since commit identifiers, notably with Git, are not monotonically increasing, we add a revision number that we increase each time we upgrade to a newer snapshot. The resulting version string looks like this:

```
2.0.11-3.cabba9e
  ^    ^    ^
  |    |    `-- upstream commit ID
  |    |
  |    `--- Guix package revision
  |
latest upstream version
```

It is a good idea to strip commit identifiers in the `version` field to, say, 7 digits. It avoids an aesthetic annoyance (assuming aesthetics have a role to play here) as well as problems related to OS limits such as the maximum shebang length (127 bytes for the Linux kernel). There are helper functions for doing this for packages using `git-fetch` or `hg-fetch` (see below). It is best to use the full commit identifiers in `origins`, though, to avoid ambiguities. A typical package definition may look like this:

```
(define my-package
  (let ((commit "c3f29bc928d5900971f65965feaae59e1272a3f7")
        (revision "1"))          ;Guix package revision
    (package
      (version (git-version "0.9" revision commit))
      (source (origin
                (method git-fetch)
                (uri (git-reference
                      (url "git://example.org/my-package.git")
                      (commit commit)))
                (sha256 (base32 "1mbikn..."))
                (file-name (git-file-name name version))))
      ;; ...
      )))
```

`git-version` *VERSION REVISION COMMIT* [Scheme Procedure]

Return the version string for packages using `git-fetch`.

```
(git-version "0.2.3" "0" "93818c936ee7e2f1ba1b315578bde363a7d43d05")
⇒ "0.2.3-0.93818c9"
```

`hg-version` *VERSION REVISION CHANGESET* [Scheme Procedure]

Return the version string for packages using `hg-fetch`. It works in the same way as `git-version`.

22.4.4 Synopses and Descriptions

As we have seen before, each package in GNU Guix includes a synopsis and a description (see Section 9.2 [Defining Packages], page 96). Synopses and descriptions are important: They are what `guix package --search` searches, and a crucial piece of information to help users determine whether a given package suits their needs. Consequently, packagers should pay attention to what goes into them.

Synopses must start with a capital letter and must not end with a period. They must not start with “a” or “the”, which usually does not bring anything; for instance, prefer “Filefrobbing tool" over "A tool that frobs files". The synopsis should say what the package is—e.g., "Core GNU utilities (file, text, shell)"—or what it is used for—e.g., the synopsis for GNU grep is "Print lines matching a pattern".

Keep in mind that the synopsis must be meaningful for a very wide audience. For example, "Manipulate alignments in the SAM format" might make sense for a seasoned bioinformatics researcher, but might be fairly unhelpful or even misleading to a non-specialized audience. It is a good idea to come up with a synopsis that gives an idea of the application domain of the package. In this example, this might give something like "Manipulate nucleotide sequence alignments", which hopefully gives the user a better idea of whether this is what they are looking for.

Descriptions should take between five and ten lines. Use full sentences, and avoid using acronyms without first introducing them. Please avoid marketing phrases such as "world-leading", "industrial-strength", and "next-generation", and avoid superlatives like "the most advanced"—they are not helpful to users looking for a package and may even sound suspicious. Instead, try to be factual, mentioning use cases and features.

Descriptions can include Texinfo markup, which is useful to introduce ornaments such as `@code` or `@dfn`, bullet lists, or hyperlinks (see Section "Overview" in *GNU Texinfo*). However you should be careful when using some characters for example '`@`' and curly braces which are the basic special characters in Texinfo (see Section "Special Characters" in *GNU Texinfo*). User interfaces such as `guix show` take care of rendering it appropriately.

Synopses and descriptions are translated by volunteers at Weblate (`https://translate.fedoraproject.org/projects/guix/packages`) so that as many users as possible can read them in their native language. User interfaces search them and display them in the language specified by the current locale.

To allow `xgettext` to extract them as translatable strings, synopses and descriptions *must be literal strings*. This means that you cannot use `string-append` or `format` to construct these strings:

```
(package
  ;; ...
  (synopsis "This is translatable")
  (description (string-append "This is " "*not*" " translatable.")))
```

Translation is a lot of work so, as a packager, please pay even more attention to your synopses and descriptions as every change may entail additional work for translators. In order to help them, it is possible to make recommendations or instructions visible to them by inserting special comments like this (see Section "xgettext Invocation" in *GNU Gettext*):

```
;; TRANSLATORS: "X11 resize-and-rotate" should not be translated.
(description "ARandR is designed to provide a simple visual front end
for the X11 resize-and-rotate (RandR) extension. ...")
```

22.4.5 Snippets versus Phases

The boundary between using an origin snippet versus a build phase to modify the sources of a package can be elusive. Origin snippets are typically used to remove unwanted files such as bundled libraries, nonfree sources, or to apply simple substitutions. The source derived from an origin should produce a source that can be used to build the package on any system that the upstream package supports (i.e., act as the corresponding source). In particular, origin snippets must not embed store items in the sources; such patching should rather be done using build phases. Refer to the `origin` record documentation for more information (see Section 9.2.2 [origin Reference], page 103).

22.4.6 Emacs Packages

Emacs packages should preferably use the Emacs build system (see [emacs-build-system], page 129), for uniformity and the benefits provided by its build phases, such as the auto-generation of the autoloads file and the byte compilation of the sources. Because there is no standardized way to run a test suite for Emacs packages, tests are disabled by default. When a test suite is available, it should be enabled by setting the `#:tests?` argument to `#true`. By default, the command to run the test is `make check`, but any command can be specified via the `#:test-command` argument. The `#:test-command` argument expects a list containing a command and its arguments, to be invoked during the `check` phase.

The Elisp dependencies of Emacs packages are typically provided as `propagated-inputs` when required at run time. As for other packages, build or test dependencies should be specified as `native-inputs`.

Emacs packages sometimes depend on resources directories that should be installed along the Elisp files. The `#:include` argument can be used for that purpose, by specifying a list of regexps to match. The best practice when using the `#:include` argument is to extend rather than override its default value (accessible via the `%default-include` variable). As an example, a yasnippet extension package typically include a `snippets` directory, which could be copied to the installation directory using:

```
#:include (cons "^snippets/" %default-include)
```

When encountering problems, it is wise to check for the presence of the `Package-Requires` extension header in the package main source file, and whether any dependencies and their versions listed therein are satisfied.

22.4.7 Python Modules

We currently package Python 2 and Python 3, under the Scheme variable names `python-2` and `python` as explained in Section 22.4.3 [Version Numbers], page 631. To avoid confusion and naming clashes with other programming languages, it seems desirable that the name of a package for a Python module contains the word `python`.

Some modules are compatible with only one version of Python, others with both. If the package Foo is compiled with Python 3, we name it `python-foo`. If it is compiled with Python 2, we name it `python2-foo`. Packages should be added when they are necessary; we don't add Python 2 variants of the package unless we are going to use them.

If a project already contains the word `python`, we drop this; for instance, the module python-dateutil is packaged under the names `python-dateutil` and `python2-dateutil`. If the project name starts with `py` (e.g. `pytz`), we keep it and prefix it as described above.

> **Note:** Currently there are two different build systems for Python packages in Guix: *python-build-system* and *pyproject-build-system*. For the longest time, Python packages were built from an informally specified `setup.py` file. That worked amazingly well, considering Python's success, but was difficult to build tooling around. As a result, a host of alternative build systems emerged and the community eventually settled on a formal standard (`https://peps.python.`

org/pep-0517/) for specifying build requirements. *pyproject-build-system* is Guix's implementation of this standard. It is considered "experimental" in that it does not yet support all the various PEP-517 *build backends*, but you are encouraged to try it for new Python packages and report any problems. It will eventually be deprecated and merged into *python-build-system*.

22.4.7.1 Specifying Dependencies

Dependency information for Python packages is usually available in the package source tree, with varying degrees of accuracy: in the `pyproject.toml` file, the `setup.py` file, in `requirements.txt`, or in `tox.ini` (the latter mostly for test dependencies).

Your mission, when writing a recipe for a Python package, is to map these dependencies to the appropriate type of "input" (see Section 9.2.1 [package Reference], page 99). Although the `pypi` importer normally does a good job (see Section 10.5 [Invoking guix import], page 181), you may want to check the following check list to determine which dependency goes where.

- We currently package Python with `setuptools` and `pip` installed per default. This is about to change, and users are encouraged to use `python-toolchain` if they want a build environment for Python.

  `guix lint` will warn if `setuptools` or `pip` are added as native-inputs because they are generally not necessary.
- Python dependencies required at run time go into `propagated-inputs`. They are typically defined with the `install_requires` keyword in `setup.py`, or in the `requirements.txt` file.
- Python packages required only at build time—e.g., those listed under `build-system.requires` in `pyproject.toml` or with the `setup_requires` keyword in `setup.py`—or dependencies only for testing—e.g., those in `tests_require` or `tox.ini`—go into `native-inputs`. The rationale is that (1) they do not need to be propagated because they are not needed at run time, and (2) in a cross-compilation context, it's the "native" input that we'd want.

  Examples are the `pytest`, `mock`, and `nose` test frameworks. Of course if any of these packages is also required at run-time, it needs to go to `propagated-inputs`.
- Anything that does not fall in the previous categories goes to `inputs`, for example programs or C libraries required for building Python packages containing C extensions.
- If a Python package has optional dependencies (`extras_require`), it is up to you to decide whether to add them or not, based on their usefulness/overhead ratio (see Section 22.6 [Submitting Patches], page 639).

22.4.8 Perl Modules

Perl programs standing for themselves are named as any other package, using the lowercase upstream name. For Perl packages containing a single class, we use the lowercase class name, replace all occurrences of `::` by dashes and prepend the prefix `perl-`. So the class `XML::Parser` becomes `perl-xml-parser`. Modules containing several classes keep their lowercase upstream name and are also prepended by `perl-`. Such modules tend to have the word `perl` somewhere in their name, which gets dropped in favor of the prefix. For instance, `libwww-perl` becomes `perl-libwww`.

22.4.9 Java Packages

Java programs standing for themselves are named as any other package, using the lowercase upstream name.

To avoid confusion and naming clashes with other programming languages, it is desirable that the name of a package for a Java package is prefixed with `java-`. If a project already contains the word `java`, we drop this; for instance, the package `ngsjava` is packaged under the name `java-ngs`.

For Java packages containing a single class or a small class hierarchy, we use the lowercase class name, replace all occurrences of `.` by dashes and prepend the prefix `java-`. So the class `apache.commons.cli` becomes package `java-apache-commons-cli`.

22.4.10 Rust Crates

Rust programs standing for themselves are named as any other package, using the lowercase upstream name.

To prevent namespace collisions we prefix all other Rust packages with the `rust-` prefix. The name should be changed to lowercase as appropriate and dashes should remain in place.

In the rust ecosystem it is common for multiple incompatible versions of a package to be used at any given time, so all package definitions should have a versioned suffix. The versioned suffix is the left-most non-zero digit (and any leading zeros, of course). This follows the “caret” version scheme intended by Cargo. Examples `rust-clap-2`, `rust-rand-0.6`.

Because of the difficulty in reusing rust packages as pre-compiled inputs for other packages the Cargo build system (see Section 9.5 [Build Systems], page 114) presents the `#:cargo-inputs` and `cargo-development-inputs` keywords as build system arguments. It would be helpful to think of these as similar to `propagated-inputs` and `native-inputs`. Rust `dependencies` and `build-dependencies` should go in `#:cargo-inputs`, and `dev-dependencies` should go in `#:cargo-development-inputs`. If a Rust package links to other libraries then the standard placement in `inputs` and the like should be used.

Care should be taken to ensure the correct version of dependencies are used; to this end we try to refrain from skipping the tests or using `#:skip-build?` when possible. Of course this is not always possible, as the package may be developed for a different Operating System, depend on features from the Nightly Rust compiler, or the test suite may have atrophied since it was released.

22.4.11 Elm Packages

Elm applications can be named like other software: their names need not mention Elm.

Packages in the Elm sense (see `elm-build-system` under Section 9.5 [Build Systems], page 114) are required use names of the format *author/project*, where both the *author* and the *project* may contain hyphens internally, and the *author* sometimes contains uppercase letters.

To form the Guix package name from the upstream name, we follow a convention similar to Python packages (see Section 22.4.7 [Python Modules], page 634), adding an `elm-` prefix unless the name would already begin with `elm-`.

In many cases we can reconstruct an Elm package’s upstream name heuristically, but, since conversion to a Guix-style name involves a loss of information, this is not always possible. Care should be taken to add the `'upstream-name` property when necessary so that '`guix import elm`' will work correctly (see Section 10.5 [Invoking guix import], page 181). The most notable scenarios when explicitly specifying the upstream name is necessary are:

1. When the *author* is `elm` and the *project* contains one or more hyphens, as with `elm/virtual-dom`; and
2. When the *author* contains hyphens or uppercase letters, as with `Elm-Canvas/raster-shapes`—unless the *author* is `elm-explorations`, which is handled as a special case, so packages like `elm-explorations/markdown` do *not* need to use the `'upstream-name` property.

The module `(guix build-system elm)` provides the following utilities for working with names and related conventions:

`elm-package-origin` *`elm-name version hash`* [Scheme procedure]

Returns a Git origin using the repository naming and tagging regime required for a published Elm package with the upstream name *elm-name* at version *version* with sha256 checksum *hash*.

For example:

```
(package
  (name "elm-html")
  (version "1.0.0")
  (source
   (elm-package-origin
    "elm/html"
    version
    (base32 "15k1679ja57vvlpinpv06znmrxy09lbhzfkzdc89i01qa8c4gb4a")))
  ...)
```

`elm->package-name` *`elm-name`* [Scheme procedure]

Returns the Guix-style package name for an Elm package with upstream name *elm-name*.

Note that there is more than one possible *elm-name* for which `elm->package-name` will produce a given result.

`guix-package->elm-name` *`package`* [Scheme procedure]

Given an Elm *package*, returns the possibly-inferred upstream name, or `#f` the upstream name is not specified via the `'upstream-name` property and can not be inferred by `infer-elm-package-name`.

`infer-elm-package-name` *`guix-name`* [Scheme procedure]

Given the *guix-name* of an Elm package, returns the inferred upstream name, or `#f` if the upstream name can't be inferred. If the result is not `#f`, supplying it to `elm->package-name` would produce *guix-name*.

22.4.12 Fonts

For fonts that are in general not installed by a user for typesetting purposes, or that are distributed as part of a larger software package, we rely on the general packaging rules for software; for instance, this applies to the fonts delivered as part of the X.Org system or fonts that are part of TeX Live.

To make it easier for a user to search for fonts, names for other packages containing only fonts are constructed as follows, independently of the upstream package name.

The name of a package containing only one font family starts with `font-`; it is followed by the foundry name and a dash `-` if the foundry is known, and the font family name, in which spaces are replaced by dashes (and as usual, all upper case letters are transformed to lower case). For example, the Gentium font family by SIL is packaged under the name `font-sil-gentium`.

For a package containing several font families, the name of the collection is used in the place of the font family name. For instance, the Liberation fonts consist of three families, Liberation Sans, Liberation Serif and Liberation Mono. These could be packaged separately under the names `font-liberation-sans` and so on; but as they are distributed together under a common name, we prefer to package them together as `font-liberation`.

In the case where several formats of the same font family or font collection are packaged separately, a short form of the format, prepended by a dash, is added to the package name. We use `-ttf` for TrueType fonts, `-otf` for OpenType fonts and `-type1` for PostScript Type 1 fonts.

22.5 Coding Style

In general our code follows the GNU Coding Standards (see *GNU Coding Standards*). However, they do not say much about Scheme, so here are some additional rules.

22.5.1 Programming Paradigm

Scheme code in Guix is written in a purely functional style. One exception is code that involves input/output, and procedures that implement low-level concepts, such as the `memoize` procedure.

22.5.2 Modules

Guile modules that are meant to be used on the builder side must live in the `(guix build ...)` name space. They must not refer to other Guix or GNU modules. However, it is OK for a "host-side" module to use a build-side module.

Modules that deal with the broader GNU system should be in the `(gnu ...)` name space rather than `(guix ...)`.

22.5.3 Data Types and Pattern Matching

The tendency in classical Lisp is to use lists to represent everything, and then to browse them "by hand" using `car`, `cdr`, `cadr`, and co. There are several problems with that style, notably the fact that it is hard to read, error-prone, and a hindrance to proper type error reports.

Guix code should define appropriate data types (for instance, using `define-record-type*`) rather than abuse lists. In addition, it should use pattern matching, via Guile's `(ice-9 match)` module, especially when matching lists (see Section "Pattern Matching" in

GNU Guile Reference Manual); pattern matching for records is better done using `match-record` from `(guix records)`, which, unlike `match`, verifies field names at macro-expansion time.

22.5.4 Formatting Code

When writing Scheme code, we follow common wisdom among Scheme programmers. In general, we follow the Riastradh's Lisp Style Rules (`https://mumble.net/~campbell/scheme/style.txt`). This document happens to describe the conventions mostly used in Guile's code too. It is very thoughtful and well written, so please do read it.

Some special forms introduced in Guix, such as the `substitute*` macro, have special indentation rules. These are defined in the `.dir-locals.el` file, which Emacs automatically uses. Also note that Emacs-Guix provides `guix-devel-mode` mode that indents and highlights Guix code properly (see Section "Development" in *The Emacs-Guix Reference Manual*).

If you do not use Emacs, please make sure to let your editor knows these rules. To automatically indent a package definition, you can also run:

```
./pre-inst-env guix style package
```

See Section 10.7 [Invoking guix style], page 194, for more information.

If you are editing code with Vim, we recommend that you run `:set autoindent` so that your code is automatically indented as you type. Additionally, `paredit.vim` (`https://www.vim.org/scripts/script.php?script_id=3998`) may help you deal with all these parentheses.

We require all top-level procedures to carry a docstring. This requirement can be relaxed for simple private procedures in the `(guix build ...)` name space, though.

Procedures should not have more than four positional parameters. Use keyword parameters for procedures that take more than four parameters.

22.6 Submitting Patches

Development is done using the Git distributed version control system. Thus, access to the repository is not strictly necessary. We welcome contributions in the form of patches as produced by `git format-patch` sent to the `guix-patches@gnu.org` mailing list (see Section "Submitting patches to a project" in *Git User Manual*). Contributors are encouraged to take a moment to set some Git repository options (see Section 22.6.1 [Configuring Git], page 642) first, which can improve the readability of patches. Seasoned Guix developers may also want to look at the section on commit access (see Section 22.8 [Commit Access], page 646).

This mailing list is backed by a Debbugs instance, which allows us to keep track of submissions (see Section 22.7 [Tracking Bugs and Patches], page 645). Each message sent to that mailing list gets a new tracking number assigned; people can then follow up on the submission by sending email to `ISSUE_NUMBER@debbugs.gnu.org`, where *ISSUE_NUMBER* is the tracking number (see Section 22.6.2 [Sending a Patch Series], page 642).

Please write commit logs in the ChangeLog format (see Section "Change Logs" in *GNU Coding Standards*); you can check the commit history for examples.

Before submitting a patch that adds or modifies a package definition, please run through this check list:

1. If the authors of the packaged software provide a cryptographic signature for the release tarball, make an effort to verify the authenticity of the archive. For a detached GPG signature file this would be done with the `gpg --verify` command.
2. Take some time to provide an adequate synopsis and description for the package. See Section 22.4.4 [Synopses and Descriptions], page 632, for some guidelines.
3. Run `guix lint` *`package`*, where *package* is the name of the new or modified package, and fix any errors it reports (see Section 10.8 [Invoking guix lint], page 196).
4. Run `guix style` *`package`* to format the new package definition according to the project's conventions (see Section 10.7 [Invoking guix style], page 194).
5. Make sure the package builds on your platform, using `guix build` *`package`*.
6. We recommend you also try building the package on other supported platforms. As you may not have access to actual hardware platforms, we recommend using the `qemu-binfmt-service-type` to emulate them. In order to enable it, add the `virtualization` service module and the following service to the list of services in your `operating-system` configuration:

   ```
   (service qemu-binfmt-service-type
    (qemu-binfmt-configuration
      (platforms (lookup-qemu-platforms "arm" "aarch64"))))
   ```

   Then reconfigure your system.

   You can then build packages for different platforms by specifying the `--system` option. For example, to build the "hello" package for the armhf or aarch64 architectures, you would run the following commands, respectively:

   ```
   guix build --system=armhf-linux --rounds=2 hello
   guix build --system=aarch64-linux --rounds=2 hello
   ```
7. Make sure the package does not use bundled copies of software already available as separate packages.

   Sometimes, packages include copies of the source code of their dependencies as a convenience for users. However, as a distribution, we want to make sure that such packages end up using the copy we already have in the distribution, if there is one. This improves resource usage (the dependency is built and stored only once), and allows the distribution to make transverse changes such as applying security updates for a given software package in a single place and have them affect the whole system—something that bundled copies prevent.
8. Take a look at the profile reported by `guix size` (see Section 10.9 [Invoking guix size], page 199). This will allow you to notice references to other packages unwillingly retained. It may also help determine whether to split the package (see Section 6.4 [Packages with Multiple Outputs], page 53), and which optional dependencies should be used. In particular, avoid adding `texlive` as a dependency: because of its extreme size, use the `texlive-tiny` package or `texlive-union` procedure instead.
9. For important changes, check that dependent packages (if applicable) are not affected by the change; `guix refresh --list-dependent` *`package`* will help you do that (see Section 10.6 [Invoking guix refresh], page 189).

Depending on the number of dependent packages and thus the amount of rebuilding induced, commits go to different branches, along these lines:

300 dependent packages or less
: `master` branch (non-disruptive changes).

between 300 and 1,800 dependent packages
: `staging` branch (non-disruptive changes). This branch is intended to be merged in `master` every 6 weeks or so. Topical changes (e.g., an update of the GNOME stack) can instead go to a specific branch (say, `gnome-updates`). This branch is not expected to be buildable or usable until late in its development process.

more than 1,800 dependent packages
: `core-updates` branch (may include major and potentially disruptive changes). This branch is intended to be merged in `master` every 6 months or so. This branch is not expected to be buildable or usable until late in its development process.

All these branches are tracked by our build farm (`https://ci.guix.gnu.org`) and merged into `master` once everything has been successfully built. This allows us to fix issues before they hit users, and to reduce the window during which pre-built binaries are not available.

When we decide to start building the `staging` or `core-updates` branches, they will be forked and renamed with the suffix `-frozen`, at which time only bug fixes may be pushed to the frozen branches. The `core-updates` and `staging` branches will remain open to accept patches for the next cycle. Please ask on the mailing list or IRC if unsure where to place a patch.

10. Check whether the package's build process is deterministic. This typically means checking whether an independent build of the package yields the exact same result that you obtained, bit for bit.

    A simple way to do that is by building the same package several times in a row on your machine (see Section 10.1 [Invoking guix build], page 166):

    ```
    guix build --rounds=2 my-package
    ```

    This is enough to catch a class of common non-determinism issues, such as timestamps or randomly-generated output in the build result.

    Another option is to use `guix challenge` (see Section 10.12 [Invoking guix challenge], page 209). You may run it once the package has been committed and built by `ci.guix.gnu.org` to check whether it obtains the same result as you did. Better yet: Find another machine that can build it and run `guix publish`. Since the remote build machine is likely different from yours, this can catch non-determinism issues related to the hardware—e.g., use of different instruction set extensions—or to the operating system kernel—e.g., reliance on `uname` or `/proc` files.

11. When writing documentation, please use gender-neutral wording when referring to people, such as singular "they", "their", "them" (`https://en.wikipedia.org/wiki/Singular_they`), and so forth.

12. Verify that your patch contains only one set of related changes. Bundling unrelated changes together makes reviewing harder and slower.

Examples of unrelated changes include the addition of several packages, or a package update along with fixes to that package.

13. Please follow our code formatting rules, possibly running `guix style` script to do that automatically for you (see Section 22.5.4 [Formatting Code], page 639).
14. When possible, use mirrors in the source URL (see Section 10.3 [Invoking guix download], page 179). Use reliable URLs, not generated ones. For instance, GitHub archives are not necessarily identical from one generation to the next, so in this case it's often better to clone the repository. Don't use the `name` field in the URL: it is not very useful and if the name changes, the URL will probably be wrong.
15. Check if Guix builds (see Section 22.1 [Building from Git], page 625) and address the warnings, especially those about use of undefined symbols.
16. Make sure your changes do not break Guix and simulate a `guix pull` with:

    ```
    guix pull --url=/path/to/your/checkout --profile=/tmp/guix.master
    ```

When posting a patch to the mailing list, use '`[PATCH] ...`' as a subject, if your patch is to be applied on a branch other than `master`, say `core-updates`, specify it in the subject like '`[PATCH core-updates] ...`'.

You may use your email client or the `git send-email` command (see Section 22.6.2 [Sending a Patch Series], page 642). We prefer to get patches in plain text messages, either inline or as MIME attachments. You are advised to pay attention if your email client changes anything like line breaks or indentation which could potentially break the patches.

Expect some delay when you submit your very first patch to `guix-patches@gnu.org`. You have to wait until you get an acknowledgement with the assigned tracking number. Future acknowledgements should not be delayed.

When a bug is resolved, please close the thread by sending an email to *`ISSUE_NUMBER`*`-done@debbugs.gnu.org`.

22.6.1 Configuring Git

If you have not done so already, you may wish to set a name and email that will be associated with your commits (see Section "Telling Git your name" in *Git User Manual*). If you wish to use a different name or email just for commits in this repository, you can use `git config --local`, or edit `.git/config` in the repository instead of `~/.gitconfig`.

We provide some default settings in `etc/git/gitconfig` which modify how patches are generated, making them easier to read and apply. These settings can be applied by manually copying them to `.git/config` in your checkout, or by telling Git to include the whole file:

```
git config --local include.path ../etc/git/gitconfig
```

From then on, any changes to `etc/git/gitconfig` would automatically take effect.

Since the first patch in a series must be sent separately (see Section 22.6.2 [Sending a Patch Series], page 642), it can also be helpful to tell `git format-patch` to handle the e-mail threading instead of `git send-email`:

```
git config --local format.thread shallow
git config --local sendemail.thread no
```

22.6.2 Sending a Patch Series

Single Patches

The `git send-email` command is the best way to send both single patches and patch series (see [Multiple Patches], page 644) to the Guix mailing list. Sending patches as email attachments may make them difficult to review in some mail clients, and `git diff` does not store commit metadata.

> **Note:** The `git send-email` command is provided by the `send-email` output of the `git` package, i.e. `git:send-email`.

The following command will create a patch email from the latest commit, open it in your *EDITOR* or *VISUAL* for editing, and send it to the Guix mailing list to be reviewed and merged:

```
$ git send-email -1 -a --base=auto --to=guix-patches@gnu.org
```

> **Tip:** To add a prefix to the subject of your patch, you may use the `--subject-prefix` option. The Guix project uses this to specify that the patch is intended for a branch or repository other than the `master` branch of `https://git.savannah.gnu.org/cgit/guix.git`.
>
> ```
> git send-email -1 -a --base=auto \
>     --subject-prefix='PATCH core-updates' \
>     --to=guix-patches@gnu.org
> ```

The patch email contains a three-dash separator line after the commit message. You may “annotate” the patch with explanatory text by adding it under this line. If you do not wish to annotate the email, you may drop the `-a` flag (which is short for `--annotate`).

The `--base=auto` flag automatically adds a note at the bottom of the patch of the commit it was based on, making it easier for maintainers to rebase and merge your patch.

If you need to send a revised patch, don’t resend it like this or send a “fix” patch to be applied on top of the last one; instead, use `git commit -a` or `git rebase` (`https://git-rebase.io`) to modify the commit, and use the *`ISSUE_NUMBER`*`@debbugs.gnu.org` address and the `-v` flag with `git send-email`.

```
$ git commit -a
$ git send-email -1 -a --base=auto -v REVISION \
      --to=ISSUE_NUMBER@debbugs.gnu.org
```

You can find out *ISSUE_NUMBER* either by searching on the mumi interface at `issues.guix.gnu.org` for the name of your patch or reading the acknowledgement email sent automatically by Debbugs in reply to incoming bugs and patches, which contains the bug number.

Notifying Teams

The `etc/teams.scm` script may be used to notify all those who may be interested in your patch of its existence (see Section 22.6.3 [Teams], page 644). Use `etc/teams.scm list-teams` to display all the teams, decide which team(s) your patch relates to, and use `etc/teams.scm cc` to output various `git send-email` flags which will notify the appropriate team members, or use `etc/teams.scm cc-members` to detect the appropriate teams automatically.

Multiple Patches

While `git send-email` alone will suffice for a single patch, an unfortunate flaw in Debbugs means you need to be more careful when sending multiple patches: if you send them all to the `guix-patches@gnu.org` address, a new issue will be created for each patch!

When sending a series of patches, it's best to send a Git "cover letter" first, to give reviewers an overview of the patch series. We can create a directory called `outgoing` containing both our patch series and a cover letter called `0000-cover-letter.patch` with `git format-patch`.

```
$ git format-patch -NUMBER_COMMITS -o outgoing \
      --cover-letter --base=auto
```

We can now send *just* the cover letter to the `guix-patches@gnu.org` address, which will create an issue that we can send the rest of the patches to.

```
$ git send-email outgoing/0000-cover-letter.patch -a \
      --to=guix-patches@gnu.org \
      $(etc/teams.scm cc-members ...)
$ rm outgoing/0000-cover-letter.patch # we don't want to resend it!
```

Ensure you edit the email to add an appropriate subject line and blurb before sending it. Note the automatically generated shortlog and diffstat below the blurb.

Once the Debbugs mailer has replied to your cover letter email, you can send the actual patches to the newly-created issue address.

```
$ git send-email outgoing/*.patch \
      --to=ISSUE_NUMBER@debbugs.gnu.org \
      $(etc/teams.scm cc-members ...)
$ rm -rf outgoing # we don't need these anymore
```

Thankfully, this `git format-patch` dance is not necessary to send an amended patch series, since an issue already exists for the patchset.

```
$ git send-email -NUMBER_COMMITS \
      -vREVISION --base=auto \
      --to ISSUE_NUMBER@debbugs.gnu.org
```

If need be, you may use `--cover-letter -a` to send another cover letter, e.g. for explaining what's changed since the last revision, and these changes are necessary.

22.6.3 Teams

There are several teams mentoring different parts of the Guix source code. To list all those teams, you can run from a Guix checkout:

```
$ ./etc/teams.scm list-teams
id: mentors
name: Mentors
description: A group of mentors who chaperone contributions by newcomers.
members:
+ Christopher Baines <mail@cbaines.net>
+ Ricardo Wurmus <rekado@elephly.net>
+ Mathieu Othacehe <othacehe@gnu.org>
+ jgart <jgart@dismail.de>
+ Ludovic Courtès <ludo@gnu.org>
...
```

You can run the following command to have the `Mentors` team put in CC of a patch series:

```
$ git send-email --to ISSUE_NUMBER@debbugs.gnu.org $(./etc/teams.scm cc mentors) *.pat
```

The appropriate team or teams can also be inferred from the modified files. For instance, if you want to send the two latest commits of the current Git repository to review, you can run:

```
$ guix shell -D guix
[env]$ git send-email --to ISSUE_NUMBER@debbugs.gnu.org $(./etc/teams.scm cc-members H
```

22.7 Tracking Bugs and Patches

This section describes how the Guix project tracks its bug reports and patch submissions.

22.7.1 The Issue Tracker

Bug reports and patch submissions are currently tracked using the Debbugs instance at `https://bugs.gnu.org`. Bug reports are filed against the `guix` "package" (in Debbugs parlance), by sending email to `bug-guix@gnu.org`, while patch submissions are filed against the `guix-patches` package by sending email to `guix-patches@gnu.org` (see Section 22.6 [Submitting Patches], page 639).

22.7.2 Debbugs User Interfaces

A web interface (actually *two* web interfaces!) are available to browse issues:

- `https://issues.guix.gnu.org` provides a pleasant interface[2] to browse bug reports and patches, and to participate in discussions;
- `https://bugs.gnu.org/guix` lists bug reports;
- `https://bugs.gnu.org/guix-patches` lists patch submissions.

To view discussions related to issue number *n*, go to '`https://issues.guix.gnu.org/n`' or '`https://bugs.gnu.org/n`'.

If you use Emacs, you may find it more convenient to interact with issues using `debbugs.el`, which you can install with:

```
guix install emacs-debbugs
```

For example, to list all open issues on `guix-patches`, hit:

```
C-u M-x debbugs-gnu RET RET guix-patches RET n y
```

See *Debbugs User Guide*, for more information on this nifty tool!

22.7.3 Debbugs Usertags

Debbugs provides a feature called *usertags* that allows any user to tag any bug with an arbitrary label. Bugs can be searched by usertag, so this is a handy way to organize bugs[3].

---

[2] The web interface at `https://issues.guix.gnu.org` is powered by Mumi, a nice piece of software written in Guile, and you can help! See `https://git.elephly.net/gitweb.cgi?p=software/mumi.git`.

[3] The list of usertags is public information, and anyone can modify any user's list of usertags, so keep that in mind if you choose to use this feature.

For example, to view all the bug reports (or patches, in the case of `guix-patches`) tagged with the usertag `powerpc64le-linux` for the user `guix`, open a URL like the following in a web browser: `https://debbugs.gnu.org/cgi-bin/pkgreport.cgi?tag=powerpc64le-linux;users=guix`.

For more information on how to use usertags, please refer to the documentation for Debbugs or the documentation for whatever tool you use to interact with Debbugs.

In Guix, we are experimenting with usertags to keep track of architecture-specific issues. To facilitate collaboration, all our usertags are associated with the single user `guix`. The following usertags currently exist for that user:

`powerpc64le-linux`
: The purpose of this usertag is to make it easy to find the issues that matter most for the `powerpc64le-linux` system type. Please assign this usertag to bugs or patches that affect `powerpc64le-linux` but not other system types. In addition, you may use it to identify issues that for some reason are particularly important for the `powerpc64le-linux` system type, even if the issue affects other system types, too.

`reproducibility`
: For issues related to reproducibility. For example, it would be appropriate to assign this usertag to a bug report for a package that fails to build reproducibly.

If you're a committer and you want to add a usertag, just start using it with the `guix` user. If the usertag proves useful to you, consider updating this section of the manual so that others will know what your usertag means.

22.8 Commit Access

Everyone can contribute to Guix without having commit access (see Section 22.6 [Submitting Patches], page 639). However, for frequent contributors, having write access to the repository can be convenient. As a rule of thumb, a contributor should have accumulated fifty (50) reviewed commits to be considered as a committer and have sustained their activity in the project for at least 6 months. This ensures enough interactions with the contributor, which is essential for mentoring and assessing whether they are ready to become a committer. Commit access should not be thought of as a "badge of honor" but rather as a responsibility a contributor is willing to take to help the project.

The following sections explain how to get commit access, how to be ready to push commits, and the policies and community expectations for commits pushed upstream.

22.8.1 Applying for Commit Access

When you deem it necessary, consider applying for commit access by following these steps:

1. Find three committers who would vouch for you. You can view the list of committers at `https://savannah.gnu.org/project/memberlist.php?group=guix`. Each of them should email a statement to `guix-maintainers@gnu.org` (a private alias for the collective of maintainers), signed with their OpenPGP key.

   Committers are expected to have had some interactions with you as a contributor and to be able to judge whether you are sufficiently familiar with the project's practices. It is *not* a judgment on the value of your work, so a refusal should rather be interpreted as "let's try again later".

2. Send `guix-maintainers@gnu.org` a message stating your intent, listing the three committers who support your application, signed with the OpenPGP key you will use to sign commits, and giving its fingerprint (see below). See `https://emailselfdefense.fsf.org/en/`, for an introduction to public-key cryptography with GnuPG.

   Set up GnuPG such that it never uses the SHA1 hash algorithm for digital signatures, which is known to be unsafe since 2019, for instance by adding the following line to `~/.gnupg/gpg.conf` (see Section "GPG Esoteric Options" in *The GNU Privacy Guard Manual*):

   ```
   digest-algo sha512
   ```

3. Maintainers ultimately decide whether to grant you commit access, usually following your referrals' recommendation.
4. If and once you've been given access, please send a message to `guix-devel@gnu.org` to say so, again signed with the OpenPGP key you will use to sign commits (do that before pushing your first commit). That way, everyone can notice and ensure you control that OpenPGP key.

   > **Important:** Before you can push for the first time, maintainers must:
   > 1. add your OpenPGP key to the `keyring` branch;
   > 2. add your OpenPGP fingerprint to the `.guix-authorizations` file of the branch(es) you will commit to.

5. Make sure to read the rest of this section and... profit!

> **Note:** Maintainers are happy to give commit access to people who have been contributing for some time and have a track record—don't be shy and don't underestimate your work!
>
> However, note that the project is working towards a more automated patch review and merging system, which, as a consequence, may lead us to have fewer people with commit access to the main repository. Stay tuned!

All commits that are pushed to the central repository on Savannah must be signed with an OpenPGP key, and the public key should be uploaded to your user account on Savannah and to public key servers, such as `keys.openpgp.org`. To configure Git to automatically sign commits, run:

```
git config commit.gpgsign true

# Substitute the fingerprint of your public PGP key.
git config user.signingkey CABBA6EA1DC0FF33
```

To check that commits are signed with correct key, use:

```
make authenticate
```

You can prevent yourself from accidentally pushing unsigned or signed with the wrong key commits to Savannah by using the pre-push Git hook located at `etc/git/pre-push`:

```
cp etc/git/pre-push .git/hooks/pre-push
```

It additionally calls `make check-channel-news` to be sure `news.scm` file is correct.

22.8.2 Commit Policy

If you get commit access, please make sure to follow the policy below (discussions of the policy can take place on `guix-devel@gnu.org`).

Non-trivial patches should always be posted to `guix-patches@gnu.org` (trivial patches include fixing typos, etc.). This mailing list fills the patch-tracking database (see Section 22.7 [Tracking Bugs and Patches], page 645).

For patches that just add a new package, and a simple one, it's OK to commit, if you're confident (which means you successfully built it in a chroot setup, and have done a reasonable copyright and license auditing). Likewise for package upgrades, except upgrades that trigger a lot of rebuilds (for example, upgrading GnuTLS or GLib). We have a mailing list for commit notifications (`guix-commits@gnu.org`), so people can notice. Before pushing your changes, make sure to run `git pull --rebase`.

When pushing a commit on behalf of somebody else, please add a `Signed-off-by` line at the end of the commit log message—e.g., with `git am --signoff`. This improves tracking of who did what.

When adding channel news entries (see Chapter 7 [Channels], page 68), make sure they are well-formed by running the following command right before pushing:

```
make check-channel-news
```

For anything else, please post to `guix-patches@gnu.org` and leave time for a review, without committing anything (see Section 22.6 [Submitting Patches], page 639). If you didn't receive any reply after two weeks, and if you're confident, it's OK to commit.

That last part is subject to being adjusted, allowing individuals to commit directly on non-controversial changes on parts they're familiar with.

22.8.3 Addressing Issues

Peer review (see Section 22.6 [Submitting Patches], page 639) and tools such as `guix lint` (see Section 10.8 [Invoking guix lint], page 196) and the test suite (see Section 2.3 [Running the Test Suite], page 8) should catch issues before they are pushed. Yet, commits that "break" functionality might occasionally go through. When that happens, there are two priorities: mitigating the impact, and understanding what happened to reduce the chance of similar incidents in the future. The responsibility for both these things primarily lies with those involved, but like everything this is a group effort.

Some issues can directly affect all users—for instance because they make `guix pull` fail or break core functionality, because they break major packages (at build time or run time), or because they introduce known security vulnerabilities.

The people involved in authoring, reviewing, and pushing such commit(s) should be at the forefront to mitigate their impact in a timely fashion: by pushing a followup commit to fix it (if possible), or by reverting it to leave time to come up with a proper fix, and by communicating with other developers about the problem.

If these persons are unavailable to address the issue in time, other committers are entitled to revert the commit(s), explaining in the commit log and on the mailing list what the problem was, with the goal of leaving time to the original committer, reviewer(s), and author(s) to propose a way forward.

Once the problem has been dealt with, it is the responsibility of those involved to make sure the situation is understood. If you are working to understand what happened, focus on gathering information and avoid assigning any blame. Do ask those involved to describe what happened, do not ask them to explain the situation—this would implicitly blame them, which is unhelpful. Accountability comes from a consensus about the problem, learning from it and improving processes so that it's less likely to reoccur.

22.8.4 Commit Revocation

In order to reduce the possibility of mistakes, committers will have their Savannah account removed from the Guix Savannah project and their key removed from `.guix-authorizations` after 12 months of inactivity; they can ask to regain commit access by emailing the maintainers, without going through the vouching process.

Maintainers[4] may also revoke an individual's commit rights, as a last resort, if cooperation with the rest of the community has caused too much friction—even within the bounds of the project's code of conduct (see Chapter 22 [Contributing], page 625). They would only do so after public or private discussion with the individual and a clear notice. Examples of behavior that hinders cooperation and could lead to such a decision include:

- repeated violation of the commit policy stated above;
- repeated failure to take peer criticism into account;
- breaching trust through a series of grave incidents.

When maintainers resort to such a decision, they notify developers on `guix-devel@gnu.org`; inquiries may be sent to `guix-maintainers@gnu.org`. Depending on the situation, the individual may still be welcome to contribute.

22.8.5 Helping Out

One last thing: the project keeps moving forward because committers not only push their own awesome changes, but also offer some of their time *reviewing* and pushing other people's changes. As a committer, you're welcome to use your expertise and commit rights to help other contributors, too!

22.9 Updating the Guix Package

It is sometimes desirable to update the `guix` package itself (the package defined in `(gnu packages package-management)`), for example to make new daemon features available for use by the `guix-service-type` service type. In order to simplify this task, the following command can be used:

```
make update-guix-package
```

The `update-guix-package` make target will use the last known *commit* corresponding to `HEAD` in your Guix checkout, compute the hash of the Guix sources corresponding to that commit and update the `commit`, `revision` and hash of the `guix` package definition.

To validate that the updated `guix` package hashes are correct and that it can be built successfully, the following command can be run from the directory of your Guix checkout:

```
./pre-inst-env guix build guix
```

[4] See `https://guix.gnu.org/en/about` for the current list of maintainers. You can email them privately at `guix-maintainers@gnu.org`.

To guard against accidentally updating the `guix` package to a commit that others can't refer to, a check is made that the commit used has already been pushed to the Savannah-hosted Guix git repository.

This check can be disabled, *at your own peril*, by setting the `GUIX_ALLOW_ME_TO_USE_PRIVATE_COMMIT` environment variable. When this variable is set, the updated package source is also added to the store. This is used as part of the release process of Guix.

22.10 Writing Documentation

Guix is documented using the Texinfo system. If you are not yet familiar with it, we accept contributions for documentation in most formats. That includes plain text, Markdown, Org, etc.

Documentation contributions can be sent to `guix-patches@gnu.org`. Prepend '`[DOCUMENTATION]`' to the subject.

When you need to make more than a simple addition to the documentation, we prefer that you send a proper patch as opposed to sending an email as described above. See Section 22.6 [Submitting Patches], page 639, for more information on how to send your patches.

To modify the documentation, you need to edit `doc/guix.texi` and `doc/contributing.texi` (which contains this documentation section), or `doc/guix-cookbook.texi` for the cookbook. If you compiled the Guix repository before, you will have many more `.texi` files that are translations of these documents. Do not modify them, the translation is managed through Weblate (`https://translate.fedoraproject.org/projects/guix`). See Section 22.11 [Translating Guix], page 650, for more information.

To render documentation, you must first make sure that you ran `./configure` in your source tree (see Section 22.2 [Running Guix Before It Is Installed], page 627). After that you can run one of the following commands:

- '`make doc/guix.info`' to compile the Info manual. You can check it with `info doc/guix.info`.
- '`make doc/guix.html`' to compile the HTML version. You can point your browser to the relevant file in the `doc/guix.html` directory.
- '`make doc/guix-cookbook.info`' for the cookbook Info manual.
- '`make doc/guix-cookbook.html`' for the cookbook HTML version.

22.11 Translating Guix

Writing code and packages is not the only way to provide a meaningful contribution to Guix. Translating to a language you speak is another example of a valuable contribution you can make. This section is designed to describe the translation process. It gives you advice on how you can get involved, what can be translated, what mistakes you should avoid and what we can do to help you!

Guix is a big project that has multiple components that can be translated. We coordinate the translation effort on a Weblate instance (`https://translate.fedoraproject.org/projects/guix/`) hosted by our friends at Fedora. You will need an account to submit translations.

Some of the software packaged in Guix also contain translations. We do not host a translation platform for them. If you want to translate a package provided by Guix, you should contact their developers or find the information on their website. As an example, you can find the homepage of the `hello` package by typing `guix show hello`. On the "homepage" line, you will see `https://www.gnu.org/software/hello/` as the homepage.

Many GNU and non-GNU packages can be translated on the Translation Project (`https://translationproject.org`). Some projects with multiple components have their own platform. For instance, GNOME has its own platform, Damned Lies (`https://l10n.gnome.org/`).

Guix has five components hosted on Weblate.

- `guix` contains all the strings from the Guix software (the guided system installer, the package manager, etc), excluding packages.
- `packages` contains the synopsis (single-sentence description of a package) and description (longer description) of packages in Guix.
- `website` contains the official Guix website, except for blog posts and multimedia content.
- `documentation-manual` corresponds to this manual.
- `documentation-cookbook` is the component for the cookbook.

General Directions

Once you get an account, you should be able to select a component from the guix project (`https://translate.fedoraproject.org/projects/guix/`), and select a language. If your language does not appear in the list, go to the bottom and click on the "Start new translation" button. Select the language you want to translate to from the list, to start your new translation.

Like lots of other free software packages, Guix uses GNU Gettext (`https://www.gnu.org/software/gettext`) for its translations, with which translatable strings are extracted from the source code to so-called PO files.

Even though PO files are text files, changes should not be made with a text editor but with PO editing software. Weblate integrates PO editing functionality. Alternatively, translators can use any of various free-software tools for filling in translations, of which Poedit (`https://poedit.net/`) is one example, and (after logging in) upload (`https://docs.weblate.org/en/latest/user/files.html`) the changed file. There is also a special PO editing mode (`https://www.emacswiki.org/emacs/PoMode`) for users of GNU Emacs. Over time translators find out what software they are happy with and what features they need.

On Weblate, you will find various links to the editor, that will show various subsets (or all) of the strings. Have a look around and at the documentation (`https://docs.weblate.org/en/latest/`) to familiarize yourself with the platform.

Translation Components

In this section, we provide more detailed guidance on the translation process, as well as details on what you should or should not do. When in doubt, please contact us, we will be happy to help!

guix
: Guix is written in the Guile programming language, and some strings contain special formatting that is interpreted by Guile. These special formatting should be highlighted by Weblate. They start with `~` followed by one or more characters.

  When printing the string, Guile replaces the special formatting symbols with actual values. For instance, the string ‘`ambiguous package specification `~a'`’ would be substituted to contain said package specification instead of `~a`. To properly translate this string, you must keep the formatting code in your translation, although you can place it where it makes sense in your language. For instance, the French translation says ‘`spécification du paquet « ~a » ambiguë`’ because the adjective needs to be placed in the end of the sentence.

  If there are multiple formatting symbols, make sure to respect the order. Guile does not know in which order you intended the string to be read, so it will substitute the symbols in the same order as the English sentence.

  As an example, you cannot translate ‘`package '~a' has been superseded by '~a'`’ by ‘`'~a' superseeds package '~a'`’, because the meaning would be reversed. If *foo* is superseded by *bar*, the translation would read ‘`'foo' superseeds package 'bar'`’. To work around this problem, it is possible to use more advanced formatting to select a given piece of data, instead of following the default English order. See Section “Formatted Output” in *GNU Guile Reference Manual*, for more information on formatting in Guile.

packages
: Package descriptions occasionally contain Texinfo markup (see Section 22.4.4 [Synopses and Descriptions], page 632). Texinfo markup looks like ‘`@code{rm -rf}`’, ‘`@emph{important}`’, etc. When translating, please leave markup as is.

  The characters after “@” form the name of the markup, and the text between “{” and “}” is its content. In general, you should not translate the content of markup like `@code`, as it contains literal code that do not change with language. You can translate the content of formatting markup such as `@emph`, `@i`, `@itemize`, `@item`. However, do not translate the name of the markup, or it will not be recognized. Do not translate the word after `@end`, it is the name of the markup that is closed at this position (e.g. `@itemize ... @end itemize`).

documentation-manual and documentation-cookbook
: The first step to ensure a successful translation of the manual is to find and translate the following strings *first*:

  - `version.texi`: Translate this string as `version-xx.texi`, where `xx` is your language code (the one shown in the URL on weblate).
  - `contributing.texi`: Translate this string as `contributing.xx.texi`, where `xx` is the same language code.
  - `Top`: Do not translate this string, it is important for Texinfo. If you translate it, the document will be empty (missing a Top node). Please look for it, and register `Top` as its translation.

Translating these strings first ensure we can include your translation in the guix repository without breaking the make process or the `guix pull` machinery.

The manual and the cookbook both use Texinfo. As for `packages`, please keep Texinfo markup as is. There are more possible markup types in the manual than in the package descriptions. In general, do not translate the content of `@code`, `@file`, `@var`, `@value`, etc. You should translate the content of formatting markup such as `@emph`, `@i`, etc.

The manual contains sections that can be referred to by name by `@ref`, `@xref` and `@pxref`. We have a mechanism in place so you do not have to translate their content. If you keep the English title, we will automatically replace it with your translation of that title. This ensures that Texinfo will always be able to find the node. If you decide to change the translation of the title, the references will automatically be updated and you will not have to update them all yourself.

When translating references from the cookbook to the manual, you need to replace the name of the manual and the name of the section. For instance, to translate `@pxref{Defining Packages,,, guix, GNU Guix Reference Manual}`, you would replace `Defining Packages` with the title of that section in the translated manual *only* if that title is translated. If the title is not translated in your language yet, do not translate it here, or the link will be broken. Replace `guix` with `guix.xx` where `xx` is your language code. `GNU Guix Reference Manual` is the text of the link. You can translate it however you wish.

website

The website pages are written using SXML, an s-expression version of HTML, the basic language of the web. We have a process to extract translatable strings from the source, and replace complex s-expressions with a more familiar XML markup, where each markup is numbered. Translators can arbitrarily change the ordering, as in the following example.

```
#. TRANSLATORS: Defining Packages is a section name
#. in the English (en) manual.
#: apps/base/templates/about.scm:64
msgid "Packages are <1>defined<1.1>en</1.1><1.2>Defining-Packages.html</1.2>
msgstr "Pakete werden als reine <2>Guile</2>-Module <1>definiert<1.1>de</1.1
```

Note that you need to include the same markups. You cannot skip any.

In case you make a mistake, the component might fail to build properly with your language, or even make guix pull fail. To prevent that, we have a process in place to check the content of the files before pushing to our repository. We will not be able to update the translation for your language in Guix, so we will notify you (through weblate and/or by email) so you get a chance to fix the issue.

Outside of Weblate

Currently, some parts of Guix cannot be translated on Weblate, help wanted!

- `guix pull` news can be translated in `news.scm`, but is not available from Weblate. If you want to provide a translation, you can prepare a patch as described above, or simply send us your translation with the name of the news entry you translated and your language. See Section 7.11 [Writing Channel News], page 74, for more information about channel news.

- Guix blog posts cannot currently be translated.
- The installer script (for foreign distributions) is entirely in English.
- Some of the libraries Guix uses cannot be translated or are translated outside of the Guix project. Guile itself is not internationalized.
- Other manuals linked from this manual or the cookbook might not be translated.

Conditions for Inclusion

There are no conditions for adding new translations of the `guix` and `guix-packages` components, other than they need at least one translated string. New languages will be added to Guix as soon as possible. The files may be removed if they fall out of sync and have no more translated strings.

Given that the web site is dedicated to new users, we want its translation to be as complete as possible before we include it in the language menu. For a new language to be included, it needs to reach at least 80% completion. When a language is included, it may be removed in the future if it stays out of sync and falls below 60% completion.

The manual and cookbook are automatically added in the default compilation target. Every time we synchronize translations, developers need to recompile all the translated manuals and cookbooks. This is useless for what is essentially the English manual or cookbook. Therefore, we will only include a new language when it reaches 10% completion in the component. When a language is included, it may be removed in the future if it stays out of sync and falls below 5% completion.

Translation Infrastructure

Weblate is backed by a git repository from which it discovers new strings to translate and pushes new and updated translations. Normally, it would be enough to give it commit access to our repositories. However, we decided to use a separate repository for two reasons. First, we would have to give Weblate commit access and authorize its signing key, but we do not trust it in the same way we trust guix developers, especially since we do not manage the instance ourselves. Second, if translators mess something up, it can break the generation of the website and/or guix pull for all our users, independently of their language.

For these reasons, we use a dedicated repository to host translations, and we synchronize it with our guix and artworks repositories after checking no issue was introduced in the translation.

Developers can download the latest PO files from weblate in the Guix repository by running the `make download-po` command. It will automatically download the latest files from weblate, reformat them to a canonical form, and check they do not contain issues. The manual needs to be built again to check for additional issues that might crash Texinfo.

Before pushing new translation files, developers should add them to the make machinery so the translations are actually available. The process differs for the various components.

- New po files for the `guix` and `packages` components must be registered by adding the new language to `po/guix/LINGUAS` or `po/packages/LINGUAS`.

- New po files for the `documentation-manual` component must be registered by adding the file name to `DOC_PO_FILES` in `po/doc/local.mk`, the generated `%D%/guix.xx.texi` manual to `info_TEXINFOS` in `doc/local.mk` and the generated `%D%/guix.xx.texi` and `%D%/contributing.xx.texi` to `TRANSLATED_INFO` also in `doc/local.mk`.
- New po files for the `documentation-cookbook` component must be registered by adding the file name to `DOC_COOKBOOK_PO_FILES` in `po/doc/local.mk`, the generated `%D%/guix-cookbook.xx.texi` manual to `info_TEXINFOS` in `doc/local.mk` and the generated `%D%/guix-cookbook.xx.texi` to `TRANSLATED_INFO` also in `doc/local.mk`.
- New po files for the `website` component must be added to the `guix-artwork` repository, in `website/po/`. `website/po/LINGUAS` and `website/po/ietf-tags.scm` must be updated accordingly (see `website/i18n-howto.txt` for more information on the process).

23 Acknowledgments

Guix is based on the Nix package manager (`https://nixos.org/nix/`), which was designed and implemented by Eelco Dolstra, with contributions from other people (see the `nix/AUTHORS` file in Guix). Nix pioneered functional package management, and promoted unprecedented features, such as transactional package upgrades and rollbacks, per-user profiles, and referentially transparent build processes. Without this work, Guix would not exist.

The Nix-based software distributions, Nixpkgs and NixOS, have also been an inspiration for Guix.

GNU Guix itself is a collective work with contributions from a number of people. See the `AUTHORS` file in Guix for more information on these fine people. The `THANKS` file lists people who have helped by reporting bugs, taking care of the infrastructure, providing artwork and themes, making suggestions, and more—thank you!

Appendix A GNU Free Documentation License

Concept Index

Programming Index