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GNU Guix

This document describes GNU Guix version 1.1.0, a functional package management tool written for the GNU system.

This manual is also available in Simplified Chinese (see GNU Guix), French (see Manuel de référence de GNU Guix), German (see Referenzhandbuch zu GNU Guix), Spanish (see Manual de referencia de GNU Guix), and Russian (see GNU Guix). If you would like to translate it in your native language, consider joining the Translation Project (https://translationproject.org/domain/guix-manual.html).
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 5), or you can use it as a standalone operating system distribution, Guix System\(^2\). See Section 1.2 [GNU Distribution], page 3.

1.1 Managing Software the Guix Way

Guix provides a command-line package management interface (see Chapter 4 [Package Management], page 34), tools to help with software development (see Chapter 5 [Development], page 63), command-line utilities for more advanced usage, (see Chapter 7 [Utilities], page 112), as well as Scheme programming interfaces (see Chapter 6 [Programming Interface], page 72). 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 4.3 [Substitutes], page 43).

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 6.2 [Defining Packages], page 73) and make them available as independent package modules (see Section 6.1 [Package Modules], page 72). It is also customizable: users can derive specialized package definitions from existing ones, including from the command line (see Section 7.1.2 [Package Transformation Options], page 115).

Under the hood, Guix implements the functional package management discipline pioneered by Nix (see Chapter 15 [Acknowledgments], page 424). 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 6.4 [The Store], page 93). 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 4.1 [Features], page 34).

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 22), 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 5). 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 4.2 [Invoking guix package], page 35):

```
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.

- **mips64el-linux**
  - 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, the project’s build farms no longer provide substitutes for this architecture.

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 8 [System Configuration], page 151). 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`.

---

\(^3\) The term “free” here refers to the freedom provided to users of that software (https://www.gnu.org/philosophy/free-sw.html).
For information on porting to other architectures or kernels, see Chapter 13 [Porting], page 407.

Building this distribution is a cooperative effort, and you are invited to join! See Chapter 14 [Contributing], page 408, for information about how you can help.
2 Installation

Note: We recommend the use of this shell installer script (https://git.savannah.gnu.org/cgit/guix.git/plain/etc/guix-install.sh) to install Guix on top of a running GNU/Linux system, thereafter called a foreign distro. 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 4.6 [Invoking guix pull], page 49).

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/cgit/guix.git/plain/etc/guix-install.sh). The script automates the download, installation, and initial configuration steps described below. It should be run as the root user.

Installing goes along these lines:

1. Download the binary tarball from 'https://ftp.gnu.org/gnu/guix/guix-binary-1.1.0.system.tar.xz', where system is x86_64-linux for an x86_64 machine already running the kernel Linux, and so on.

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-1.1.0.system.tar.xz.sig
   $ gpg --verify guix-binary-1.1.0.system.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.

---

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 22.
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-1.1.0.system.tar.xz
# mv var/guix /var/ && mv gnu /
```

This creates `/gnu/store` (see Section 6.4 [The Store], page 93) 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 zero (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 4.6 [Invoking guix pull], page 49):

```
# 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/guix-daemon.service 
/etc/systemd/system/
# systemctl start guix-daemon && systemctl enable guix-daemon
```

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 or one of its mirrors (see Section 4.3 [Substitutes], page 43), authorize them:

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

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 18.

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 5.2 [Invoking guix pack], page 67, 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 or 2.2.x;
- Guile-Gcrypt (https://notabug.org/cwebber/guile-gcrypt), version 0.1.0 or later;
- GnuTLS (https://gnutls.org/), specifically its Guile bindings (see Section “Guile Preparations” in GnuTLS-Guile);
- Guile-SQLite3 (https://notabug.org/guile-sqlite3/guile-sqlite3), version 0.1.0 or later;
- Guile-Git (https://gitlab.com/guile-git/guile-git), from August 2017 or later;
- Guile-JSON (https://savannah.nongnu.org/projects/guile-json/) 3.x;
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- zlib (https://zlib.net);
- 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 10) and `guix copy` (see Section 7.12 [Invoking guix copy], page 146) depends on Guile-SSH (https://github.com/artem-poptsov/guile-ssh), version 0.12.0 or later.
- When zlib (https://www.nongnu.org/lzlib/lzlib.html) is available, zlib substitutes can be used and `guix publish` can compress substitutes with lzlib.
- 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 6.4 [The Store], page 93).

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"
```

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 4.3 [Substitutes], page 43). 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 4.3 [Substitutes], page 43, 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 2).

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' \
```

```
Chapter 2: Installation

The number of build users determines how many build jobs may run in parallel, as specified by the \texttt{--max-jobs} option (see Section 2.5 [Invoking guix-daemon], page 14). To use \texttt{guix system vm} and related commands, you may need to add the build users to the \texttt{kvm} group so they can access \texttt{/dev/kvm}, using \texttt{-G guixbuild,kvm} instead of \texttt{-G guixbuild} (see Section 8.14 [Invoking guix system], page 374).

The \texttt{guix-daemon} program may then be run as \texttt{root} with the following command\footnote{If your machine uses the systemd init system, dropping the \texttt{prefix/lib/systemd/system/guix-daemon.service} file in \texttt{/etc/systemd/system} will ensure that \texttt{guix-daemon} is automatically started. Similarly, if your machine uses the Upstart init system, drop the \texttt{prefix/lib/upstart/system/guix-daemon.conf} file in \texttt{/etc/init}.}:\footnote{“Mostly”, because while the set of files that appear in the chroot’s \texttt{/dev} is fixed, most of these files can only be created if the host has them.}

\begin{verbatim}
# guix-daemon --build-users-group=guixbuild
\end{verbatim}

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

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

You can influence the directory where the daemon stores build trees \textit{via} the \texttt{TMPDIR} environment variable. However, the build tree within the chroot is always called \texttt{/tmp/guix-build-name.drv-0}, where \textit{name} is the derivation name—e.g., \texttt{coreutils-8.24}. This way, the value of \texttt{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 \texttt{http_proxy} environment variable for HTTP downloads it performs, be it for fixed-output derivations (see Section 6.5 [Derivations], page 95) or for substitutes (see Section 4.3 [Substitutes], page 43).

If you are installing Guix as an unprivileged user, it is still possible to run \texttt{guix-daemon} provided you pass \texttt{--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 \textit{pure} functions.

### 2.4.2 Using the Offload Facility

When desired, the build daemon can \textit{offload} derivation builds to other machines running Guix, using the \texttt{offload build hook}\footnote{This feature is available only when Guile-SSH (https://github.com/artyom-poptsov/guile-ssh) is present.}. 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 type—e.g., `x86_64-linux`. 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 /etc/guix/machines.scm file typically looks like this:

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

(build-machine
  (name "meeps.example.org")
  (system "mips64el-linux")
  (host-key "ssh-rsa AAAAB3Nza...")
  (user "alice")
  (private-key
    (string-append (getenv "HOME"
                    "/.ssh/identity-for-guix"))))
```

In the example above we specify a list of two build machines, one for the x86_64 architecture and one for the mips64el 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.
- **system** The system type of the remote machine—e.g., "x86_64-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 AAAAB3NzaC1yc2EAAAAE0p8FoQAAAQEA1eB46LV...
```

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.

- **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 4.11 [Invoking guix archive], page 60):

```
# 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 \textit{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 
\texttt{/etc/guix/machines.scm}, make sure Guile and the Guix modules are 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 \texttt{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 \texttt{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 \texttt{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 \texttt{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 preferrable 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.

   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
```

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 6 [Programming Interface], page 72), 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 4.1 [Features], page 34).

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 7.1 [Invoking guix build], page 112).

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 7.15 [Invoking guix processes], page 149, 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 4.3 [Substitutes], page 43).

When the daemon runs with --no-substitutes, clients can still explicitly enable substitution via the set-build-options remote procedure call (see Section 6.4 [The Store], page 93).

--substitute-urls=urls
Consider urls the default whitespace-separated list of substitute source URLs. When this option is omitted, ‘https://ci.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 4.3 [Substitutes], page 43).

--no-offload
Do not use offload builds to other machines (see Section 2.4.2 [Daemon Offload Setup], page 10). 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 4.5 [Invoking guix gc], page 46.

--cores=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 7.1 [Invoking guix build], page 112).
The effect is to define the \texttt{NIX\_BUILD\_CORES} environment variable in the build process, which can then use it to exploit internal parallelism—for instance, by running \texttt{make \textasciitilde \$NIX\_BUILD\_CORES}.

\texttt{--max-jobs=n}  
\texttt{-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 10), or simply fail.

\texttt{--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 7.1.1 \[Common Build Options\], page 112).

\texttt{--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 7.1.1 \[Common Build Options\], page 112).

\texttt{--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 \texttt{guix build} (see Section 7.1 \[Invoking \texttt{guix build}\], page 112).  
When used in conjunction with \texttt{--keep-failed}, the differing output is kept in the store, under \texttt{/gnu/store/...-check}. This makes it easy to look for differences between the two results.

\texttt{--debug}  
Produce debugging output.  
This is useful to debug daemon start-up issues, but then it may be overridden by clients, for example the \texttt{--verbosity} option of \texttt{guix build} (see Section 7.1 \[Invoking \texttt{guix build}\], page 112).

\texttt{--chroot-directory=dir}  
Add \texttt{dir} to the build chroot.  
Doing this may change the result of build processes—for instance if they use optional dependencies found in \texttt{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.

\texttt{--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 \texttt{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 bzip2 by default.

--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 4.5 [Invoking guix gc], page 46, 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 6.4 [The Store], page 93).

Note: The daemon protocol is unauthenticated and unencrypted.
Using --listen=host is suitable on local networks, such as clus-
ters, 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 917 MiB. Alternatively, the glibc-utf8-locales is
smaller but limited to a few UTF-8 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 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 **gs-fonts**, **font-dejavu**, and **font-gnu-freefont-ttf**.
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:

```bash
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 4.4 [Packages with Multiple Outputs], page 45). For instance, the following command installs fonts for Chinese languages:

```bash
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:

```bash
-*-*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:

```bash
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 8.10 [X.509 Certificates], page 366, 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*).

### 2.6.6 The GCC toolchain

Guix offers individual compiler packages such as `gcc` but if you are in need of a complete toolchain for compiling and linking source code what you really want is 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 \texttt{-L} and \texttt{-l} switches passed to the linker, add corresponding \texttt{-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 \texttt{GUIX_LD_WRAPPER_ALLOW_IMPURITIES} environment variable to \texttt{no}.

### 2.7 Upgrading Guix

To upgrade Guix, run:

```
guix pull
```

See Section 4.6 [Invoking guix pull], page 49, 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 8.14 [Invoking guix system], page 374).
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 5.

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 1.1.0:

- Support for the Logical Volume Manager (LVM) is missing.
- More and more system services are provided (see Section 8.8 [Services], page 172), but some may be missing.
- GNOME, Xfce, LXDE, and Enlightenment are available (see Section 8.8.7 [Desktop Services], page 223), 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 14 [Contributing], page 408, 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 8.2 [operating-system Reference], page 158).

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-1.1.0.system.iso.xz' where system is 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-1.1.0.system.iso.xz.sig
$ gpg --verify guix-system-install-1.1.0.system.iso.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.

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

To copy the image to a USB stick, follow these steps:

1. Decompress the image using the `xz` command:

   ```bash
   xz -d guix-system-install-1.1.0.system.iso.xz
   ```

2. 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:

   ```bash
   dd if=guix-system-install-1.1.0.system.iso of=/dev/sdX sync
   ```

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

Burning on a DVD

To copy the image to a DVD, follow these steps:

1. Decompress the image using the `xz` command:

   ```bash
   xz -d guix-system-install-1.1.0.system.iso.xz
   ```

2. 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:

   ```bash
   growisofs -dvd-compat -Z /dev/srX=guix-system-install-1.1.0.system.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 32, 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 24). Alternately, 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.
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.
Note that, at any time, the installer allows you to exit the current installation step and resume at a previous step, as shown in the image below.

Once you’re done, the installer produces an operating system configuration and displays it (see Section 8.1 [Using the Configuration System], page 151). 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 24).

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 it is also a full-blown Guix System, which means that you can install additional packages, should you need it, using `guix package` (see Section 4.2 [Invoking guix package], page 35).

#### 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 8.13 [Bootloader Configuration], page 371, 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). For the ESP, if you have one and assuming it is `/dev/sda1`, run:

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

Preferably, assign file systems a label so that you can easily and reliably refer to them in file-system declarations (see Section 8.3 [File Systems], page 162). 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
```

---

1 Currently Guix System only supports ext4, btrfs, and JFS file systems. In particular, code that reads file system UUIDs and labels only works for these file system types.
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.) Assuming you want to store the root partition on /dev/sda2, the command sequence would be along these lines:

```bash
cryptsetup luksFormat /dev/sda2
cryptsetup open --type luks /dev/sda2 my-partition
mkfs.ext4 -L my-root /devmapper/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):

```bash
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 “Memory Concepts” in The GNU C Library Reference Manual), make sure to initialize them with mkswap. Assuming you have one swap partition on /dev/sda3, you would run:

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

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:\n
```
# 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 GNU Zile (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 8.1 [Using the Configuration System], page 151, 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 target 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 `target` field names a device, like `/dev/sda`; for UEFI systems it names a path to a mounted EFI partition, like `/boot/efi`; do make sure the path is 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 8.4 [Mapped Devices], page 164).

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 8.14 [Invoking guix system], page 374. 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 167). 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 8.14 [Invoking guix system], page 374). We recommend doing that regularly so that your system includes the latest security updates (see Chapter 11 [Security Updates], page 399).

**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 ran as. This means that if you choose to use `guix system reconfigure` in root’s login shell, you’ll need to `guix pull` separately.

Join us on #guix on the Freenode 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 23).
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-1.1.0.system.iso
   -enable-kvm
   ```
   is optional, but significantly improves performance, see Section 8.16 [Running Guix in a VM], page 384.
4. You’re now root in the VM, proceed with the installation process. See Section 3.4 [Preparing for Installation], page 24, and follow the instructions.

Once installation is complete, you can boot the system that’s on your `guix-system.img` image. See Section 8.16 [Running Guix in a VM], page 384, 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 disk-image --file-system-type=iso9660
   gnu/system/install.scm
```
Have a look at `gnu/system/install.scm` in the source tree, and see also Section 8.14 [Invoking guix system], page 374, for more information about the installation image.

### 3.10 Building the Installation Image for ARM Boards


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 disk-image --system=armhf-linux -e '(@(gnu system install) os-with-u-boot) A20-OLinuXino-Lime2'
```

`A20-OLinuXino-Lime2` is the name of the board. If you specify an invalid board, a list of possible boards will be printed.
4 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 4.2 [Invoking guix package], page 35), 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):

```bash
guix install emacs-guix
```

4.1 Features

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 4.2 [Invoking guix package], page 35). 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 8.1 [Using the Configuration System], page 151).

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 4.5 [Invoking guix gc], page 46). 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 2). 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 14).

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 4.3 [Substitutes], page 43). 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 7.11 [Invoking guix challenge], page 143).

Control over the build environment is a feature that is also useful for developers. The guix environment 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 5.1 [Invoking guix environment], page 63).

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 4.6 [Invoking guix pull], page 49). 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.

### 4.2 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. It operates only on the user's own profile, and works with normal user privileges (see Section 4.1 [Features], page 34). 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 38).
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 “/.ash_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="$HOME/.guix-profile" ; \
source "$HOME/.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 4.5 [Invoking guix gc], page 46).
That directory is normally localstatedir/guix/profiles/per-user/user, where local-
statedir 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 either a simple package name, such as guile, or a
package name followed by an at-sign and version number, such as guile@1.8.8
or simply guile@1.8 (in the latter case, the newest version prefixed by 1.8 is
selected.)

If no version number is specified, the newest available version will be selected.
In addition, package 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 4.4
[Packages with Multiple Outputs], page 45). Packages with a corresponding
name (and optionally version) are searched for among the GNU distribution
modules (see Section 6.1 [Package Modules], page 72).

Sometimes packages have propagated inputs: these are dependencies
that automatically get installed along with the required package (see
[package-propagated-inputs], page 77, 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.

```bash
--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 6.2 [Defining Packages], page 73):

```scheme
(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
        "0ssi1wpaf7plaswqqjwigppsg5fyh99vd1b9kz17c9l9ng8nqd1i")))))

(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 5.1 [Invoking guix environment], page 63).

```bash
--remove=package ...
-r package ...
```

Remove the specified packages.

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`.

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

Upgrade all the installed packages. If one or more `regexps` 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 4.6 [Invoking guix pull], page 49).
--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

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")))
```

In this example we have to know which modules define the emacs and guile-2.0 variables to provide the right use-package-modules line, which can be cumbersome. We can instead provide regular package specifications and let specifications->manifest look up the corresponding package objects, like this:

```
(specifications->manifest
 '("emacs" "guile@2.2" "guile@2.2:debug")
```

--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 gen-
eration 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, re-
spectively.

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 recommen-
dation.

--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. Con-
cretely, 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=python | recsel -p name,version
name: python
version: 2.7.6

name: python
version: 3.3.5
```

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 python@3.4 | recsel -p name,version
name: python
version: 3.4.3
```

```
--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 3). 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 4.4 [Packages with Multiple Outputs], page 45), 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 4.4 [Packages with Multiple Outputs], page 45), 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.

Finally, since `guix package` may actually start build processes, it supports all the common build options (see Section 7.1.1 [Common Build Options], page 112). It also supports package transformation options, such as `--with-source` (see Section 7.1.2 [Package Transformation Options], page 115). However, note that package transformations are lost when
upgrading; to preserve transformations across upgrades, you should define your own package variant in a Guile module and add it to \texttt{GUIX\_PACKAGE\_PATH} (see Section 6.2 [Defining Packages], page 73).

### 4.3 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 \textit{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 6.5 [Derivations], page 95). 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.

#### 4.3.1 Official Substitute Server

The \texttt{ci.guix.gnu.org} server is a front-end to an official build farm that builds packages from Guix continuously for some architectures, and makes them available as substitutes. This is the default source of substitutes; it can be overridden by passing the \texttt{--substitute-urls} option either to \texttt{guix-daemon} (see \cite{guix-daemon --substitute-urls}, page 15) or to client tools such as \texttt{guix package} (see \cite{client --substitute-urls option}, page 113).

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 farm are enabled by default when using Guix System (see Section 1.2 [GNU Distribution], page 3). 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 5). 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.

#### 4.3.2 Substitute Server Authorization

To allow Guix to download substitutes from \texttt{ci.guix.gnu.org} or a mirror thereof, you must add its public key to the access control list (ACL) of archive imports, using the \texttt{guix archive} command (see Section 4.11 [Invoking guix archive], page 60). Doing so implies that you trust \texttt{ci.guix.gnu.org} to not be compromised and to serve genuine substitutes.

The public key for \texttt{ci.guix.gnu.org} is installed along with Guix, in \texttt{prefix/share/guix/ci.guix.gnu.org.pub}, where \texttt{prefix} is the installation prefix of Guix. If you installed Guix from source, make sure you checked the GPG signature of \texttt{guix-1.1.0.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
```

Once this is in place, the output of a command like \texttt{guix build} should change from something like:

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

```
The following derivations would be built:

```
/gnu/store/yr7bnx8xwcyay6j95r2clmd11qh688w-emacs-24.3.drv
/gnu/store/x8qshih1lgjx6cswjyvbnfzv21i37z23w-dbus-1.6.4.tar.gz.drv
/gnu/store/1ixwp12f1950d15h2cj11c73733jhay0z-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/2yn4nccnhpr61rassa6z0d9x22si0va3-libjpeg-8d
/gnu/store/71yz6lgr4dzma9dwcvjixah9w777jq-cairo-1.12.16
/gnu/store/7zdhgp0n1518lvfn8mb96sxqfmtvql7v-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 ci.guix.gnu.org 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 14). It can also be disabled temporarily by passing the `--no-substitutes` option to `guix package`, `guix build`, and other command-line tools.

### 4.3.3 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.)

### 4.3.4 Proxy Settings

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

### 4.3.5 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 113). 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 7.14 [Invoking guix weather], page 147). This command provides statistics on the substitutes provided by a server.

### 4.3.6 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 `ci.guix.gnu.org` substitutes can be convenient, we encourage users to also build on their own, or even run their own build farm, such that `ci.guix.gnu.org` is 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 7.10 [Invoking guix publish], page 140).

Guix has the foundations to maximize build reproducibility (see Section 4.1 [Features], page 34). 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 7.11 [Invoking guix challenge], page 143). 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 119).

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`.

### 4.4 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 7.8 [Invoking guix size], page 135). `guix graph` can also be helpful (see Section 7.9 [Invoking guix graph], page 136).

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 10 [Installing Debugging Files], page 398). The outputs of a package are listed in the third column of the output of `guix package --list-available` (see Section 4.2 [Invoking guix package], page 35).

### 4.5 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 7.1 [Invoking guix build], page 112). 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 4.2 [Invoking guix package], page 35).

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 8.8.2 [Scheduled Job Execution], page 184, 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; 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 14).

--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 7.8 [Invoking guix size], page 135, for a tool to profile the size of the closure of an element. See Section 7.9 [Invoking guix graph], page 136, for a tool to visualize the graph of references.

--derivers
Return the derivation(s) leading to the given store items (see Section 6.5 [Derivations], page 95).
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.
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Using --verify=repair or --verify=contents,repair causes the daemon to
try to repair corrupt store items by fetching substitutes for them (see Section 4.3
[Substitutes], page 43). 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 7.1 [Invoking guix build], page 112).
--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 14). Thus, this option is primarily useful when
the daemon was running with --disable-deduplication.

4.6 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) repository, by default the official GNU Guix repository, though this can be customized.
Specifically, guix pull downloads code from the channels (see Section 4.7 [Channels],
page 52) 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 justretrieved 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 9
[Documentation], page 397):
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


Generation 2 Jun 11 2018 11:02:49
  guix e0cc7f6
  repository URL: https://git.savannah.gnu.org/git/guix.git
  branch: origin/master
  commit: 65956ad3526ba09e1f7a40722c96c6ef7c0936fe
  2 new packages: keepalived, libnfnetlink
  6 packages upgraded: emacs-nix-mode@2.0.4, guile2.0-guix@0.14.0-12.77a1aac, guix@0.14.0-12.77a1aac, heimdal@7.5.0, milkytracker@1.02.00, nix@2.0.4

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: 844cc1c8f394f03b404c5bb3ae086922373490c
  28 new packages: emacs-helm-ls-git, emacs-helm-mu, ...
  69 packages upgraded: borg@1.1.6, cheese@3.28.0, ...

See Section 4.10 [Invoking guix describe], page 59, 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 4.2 [Invoking guix package], page 35). 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 4.2 [Invoking guix package], page 35) 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 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`

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 Section 4.7 [Channels], page 52, for more information.

`--news`

Display the list of packages added or upgraded since the previous generation, as well as, occasionally, news written by channel authors for their users (see Section 4.7 [Channels], page 52).

The package information is the same as displayed upon `guix pull` completion, but without ellipses; it is also similar to the output of `guix pull -1` for the last generation (see below).

`--list-generations[=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 4.2 [Invoking guix package], page 35).

`--roll-back`

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

`--switch-generation=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]`

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 4.10 [Invoking guix describe], page 59, 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.

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

--verbose
Produce verbose output, writing build logs to the standard error output.

--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 Section 4.7 [Channels], page 52, for more information.

In addition, guix pull supports all the common build options (see Section 7.1.1 [Common Build Options], page 112).

4.7 Channels

Guix and its package collection are updated by running guix pull (see Section 4.6 [Invoking guix pull], page 49). 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.

4.7.1 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 your own 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 my own repo.
(list (channel
  (name ’guix)
  (url "https://example.org/my-guix.git")
  (branch "super-hacks")))
```

From there on, guix pull will fetch code from the super-hacks branch of the repository at example.org.

4.7.2 Specifying Additional Channels

You can also specify additional channels to pull from. 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 6.1 [Package Modules], page 72), 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 *sooo 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 14 [Contributing], page 408). 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](https://www.gnu.org/philosophy/free-sw.html)). Please email us at guix-devel@gnu.org if you’d like to discuss this.

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):

```scheme
;; Add my personal packages to those Guix provides.
(cons (channel
       (name 'my-personal-packages)
       (url "https://example.org/personal-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 pull --list-generations
...
Generation 19 Aug 27 2018 16:20:48
```

```
guix d894ab8
  repository URL: https://git.savannah.gnu.org/git/guix.git
  branch: master
  commit: d894ab8e9bfabecea6c49d9ba2e834dd5a73a300
```
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my-personal-packages dd3df5e
  repository URL: https://example.org/personal-packages.git
  branch: master
  commit: dd3df5e2c8818760a8fc0bd699e55d3b69fef2bb
11 new packages: my-gimp, my-emacs-with-cool-features, ...
4 packages upgraded: emacs-racket-mode@0.0.2-2.1b78827, ...

The output of guix pull above shows that Generation 19 includes both Guix and packages from the my-personal-packages channel. Among the new and upgraded packages that are listed, some like my-gimp and my-emacs-with-cool-features might come from my-personal-packages, while others come from the Guix default channel.

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).

4.7.3 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"))
    (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.

4.7.4 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:
4.7.5 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:

```lisp
(channel
  (version 0)
  (news-file "etc/news.txt"))
```

The news file itself, `etc/news.txt` in this example, must look something like this:

```lisp
(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 funkciaj nun!")))
  (entry (commit "bdcabe815cd28144a2d2b4bc3c5057b051fa9906")
    (title (en "Added a great package")
        (ca "Qu` e vol di guix?")
    (body (en "Don’t miss the @code{hello} package!"))))
```

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.scm
```

To sum up, yes, you could use your channel as a blog. But beware, this is not quite what your users might expect.

4.7.6 Replicating Guix

The `guix pull --list-generations` output above shows precisely which commits were used to build this instance of Guix. We can thus replicate it, say, on another machine,
by providing a channel specification in 
```
~/.config/guix/channels.scm
```
that is “pinned” to these commits:

```scheme
;; Deploy specific commits of my channels of interest.
(list (channel
  (name 'guix)
  (url "https://git.savannah.gnu.org/git/guix.git")
  (commit "d894ab8e9bfabcefa6c49d9ba2e884dd5a73a300")
)
(channel
  (name 'my-personal-packages)
  (url "https://example.org/personal-packages.git")
  (commit "dd3df5e2c8818760a8fc0bd699e555d3b69efef2bb"))
)
```

The `guix describe --format=channels` command can even generate this list of channels directly (see Section 4.10 [Invoking guix describe], page 59). The resulting file can be used with the `-C` options of `guix pull` (see Section 4.6 [Invoking guix pull], page 49) or `guix time-machine` (see Section 4.8 [Invoking guix time-machine], page 56).

At this point the two machines run the exact same Guix, with access to the exact same packages. The output of `guix build gimp` on one machine will be exactly the same, bit for bit, as the output of the same command on the other machine. It also means both machines have access to all the source code of Guix and, transitively, to all the source code of every package it defines.

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 4.9 [Inferiors], page 57, for another way to take advantage of these super powers.

### 4.8 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 4.10 [Invoking guix describe], page 59).

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 4.6 [Invoking guix pull], page 49):

```
--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 `branch`.

```
--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 Section 4.7 [Channels], page 52, 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 7.1.1 [Common Build Options], page 112).

### 4.9 Inferiors

**Note:** The functionality described here is a “technology preview” as of version 1.1.0. 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 6.8 [Invoking guix repl], page 110). 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 Section 4.7 [Channels], page 52), 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 4.2 [Invoking guix package], page 35); 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
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;; 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]

- **Returns 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.**

The following procedures are defined for each inferior package:

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

These procedures are the counterpart of package record accessors (see Section 6.2.1 [package Reference], page 76). 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 6.7 [G-Expressions], page 102). They are also transparently handled by the packages->manifest procedure, which is commonly use in manifests (see Section 4.2 [Invoking guix package], page 35). 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.

4.10 Invoking system 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 pulled guix, guix describe displays the channel(s) that it was built from, including their repository URL and commit IDs (see Section 4.7 [Channels], page 52):

$ 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: e0fa68c7718fffd33d81af415279d6dddb518f727

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 4.6 [Invoking guix pull], page 49). 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
    "e0fa68c7718fffd33d81af415279d6dddb518f727")))

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 4.6 [Invoking guix pull], page 49). 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:

```markdown
--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 4.6 [Invoking guix pull], page 49);
- json  produce a list of channel specifications in JSON format;
- recutils  produce a list of channel specifications in Recutils format.
```

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

### 4.11 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 5.2 [Invoking guix pack], page 67.

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

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

`specifications` may be either store file names or package specifications, as for `guix package` (see Section 4.2 [Invoking guix package], page 35). For instance, the following command creates an archive containing the `gui` output of the `git` package and the main output of `emacs`:

```bash
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 7.1.1 [Common Build Options], page 112).

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

```bash
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:

```bash
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 7.12 [Invoking guix copy], page 146).
Archives are stored in the “normalized archive” or “nar” format, which 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.

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**. Note that this operation usually takes time, because it needs to gather enough entropy to generate the key pair. 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 4.3 [Substitutes], page 43) 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/...-emacs-24.5 \ 
   | bunzip2 | 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.

--list
-t
Read a single-item archive as served by substitute servers (see Section 4.3 [Substitutes], page 43) 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
```
5 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 environment` command provides a convenient way to set up development environments containing all the dependencies and tools necessary to work on the software package of your choice. The `guix pack` command allows you to create application bundles that can be easily distributed to users who do not run Guix.

5.1 Invoking `guix environment`

The purpose of `guix environment` is to assist hackers in creating reproducible development environments without polluting their package profile. The `guix environment` tool takes one or more packages, builds all of their inputs, and creates a shell environment to use them.

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\(^1\).

`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
```

\(^1\) 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.
Sometimes an interactive shell session is not desired. An arbitrary command may be invoked by placing the \texttt{--} token to separate the command from the rest of the arguments:

\begin{verbatim}
guix environment guile -- make -j4
\end{verbatim}

In other situations, it is more convenient to specify the list of packages needed in the environment. For example, the following command runs \texttt{python} from an environment containing Python 2.7 and NumPy:

\begin{verbatim}
guix environment --ad-hoc python2-numpy python-2.7 -- python
\end{verbatim}

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 \texttt{--ad-hoc} flag is positional. Packages appearing before \texttt{--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:

\begin{verbatim}
guix environment --pure guix --ad-hoc git strace
\end{verbatim}

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 \texttt{/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:

\begin{verbatim}
guix environment --ad-hoc --container guile -- guile
\end{verbatim}

\textbf{Note:} The \texttt{--container} option requires Linux-libre 3.19 or newer.

The available options are summarized below.

\begin{description}
\item[--root=\texttt{file}] Make \texttt{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 \texttt{guix environment} session. This means that next time you recreate the same environment, you could have to rebuild or re-download packages. See Section 4.5 [Invoking guix gc], page 46, for more on GC roots.

\item[--expression=\texttt{expr}] Create an environment for the package or list of packages that \texttt{expr} evaluates to.

For example, running:

\begin{verbatim}
guix environment -e '@ (gnu packages maths) petsc-openmpi')
\end{verbatim}

starts a shell with the environment for this specific variant of the PETSc package.

Running:

\begin{verbatim}
guix environment --ad-hoc -e '@ (gnu) %base-packages')
\end{verbatim}
\end{description}
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`

- `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 6.2 [Defining Packages], page 73):

```
(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 '((("autoconf" ,autoconf-2.64)
      ("automake" ,automake)
      ("texinfo" ,texinfo)
  ,@(package-native-inputs gdb))))
```

`--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 38) and uses the same manifest files.

`--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 4.4 [Packages with Multiple Outputs], page 45).

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.
--pure  Unset existing environment variables when building the new environment, ex-
cept 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 reg-
exp—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 out-
side the container is mapped inside the container. Additionally, unless overrid-
den 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. This is equivalent to running the command ln -s $GUIX_-
ENVIRONMENT ~/.guix-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; --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.

For example, the fontconfig package inspects ~/.guix-profile/share/fonts for additional fonts.
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.

```bash
# 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 
  --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:

```bash
guix environment --container --expose=$HOME=/exchange --ad-hoc guile -- guile
```

guix environment also supports all of the common build options that guix build supports (see Section 7.1.1 [Common Build Options], page 112) as well as package transformation options (see Section 7.1.2 [Package Transformation Options], page 115).

## 5.2 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 7.12 [Invoking guix copy], page 146, Section 7.10 [Invoking guix publish], page 140, and Section 4.11 [Invoking guix archive], page 60.

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:

```bash
$ guix pack guile 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 5).

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:

```bash
guix pack -S /opt/gnu/bin=bin guile 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 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:

```bash
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`:

```bash
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:

```bash
guix pack -f squashfs bash guile 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://singularity.lbl.gov), 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.

**--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\(^3\), relocatable binaries fall back to PRoot 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 PRoot if user namespaces are not supported.

\(^3\) 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?
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.

**--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**

*expr* Consider the package *expr* evaluates to.

This has the same purpose as the same-named option in *guix build* (see Section 7.1.3 [Additional Build Options], page 117).

**--manifest=file**

*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 38) 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.

**--system=system**

*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 "mips64el-linux-gnu" (see Section “Specifying target triplets” in Autoconf).

**--compression=tool**

*tool* Compress the resulting tarball using *tool*—one of *gzip*, *bzip2*, *xz*, *lzip*, or *none* for no compression.

**--symlink=spec**

*spec* Add the symlinks specified by *spec* to the pack. This option can appear several times.
spec has the form \texttt{source=\textit{target}}, where \textit{source} is the symlink that will be created and \textit{target} is the symlink target.

For instance, \texttt{-S /opt/gnu/bin=bin} creates a \texttt{/opt/gnu/bin} symlink pointing to the \texttt{bin} sub-directory of the profile.

\texttt{--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 Section 4.7 [Channels], page 52). Provenance information is saved in the \texttt{/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.

\texttt{--root=file}

\texttt{-r file} Make file a symlink to the resulting pack, and register it as a garbage collector root.

\texttt{--localstatedir}

\texttt{--profile-name=name}

Include the “local state directory”, \texttt{/var/guix}, in the resulting pack, and notably the \texttt{/var/guix/profiles/per-user/root/name} profile—by default \textit{name} is \texttt{guix-profile}, which corresponds to \texttt{~root/.guix-profile}.

\texttt{/var/guix} contains the store database (see Section 6.4 [The Store], page 93) as well as garbage-collector roots (see Section 4.5 [Invoking guix gc], page 46). 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 5).

\texttt{--derivation}

\texttt{-d} Print the name of the derivation that builds the pack.

\texttt{--bootstrap}

Use the bootstrap binaries to build the pack. This option is only useful to Guix developers.

In addition, \texttt{guix pack} supports all the common build options (see Section 7.1.1 [Common Build Options], page 112) and all the package transformation options (see Section 7.1.2 [Package Transformation Options], page 115).
6 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 a 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.

6.1 Package Modules

From a programming viewpoint, the package definitions of the GNU distribution are provided by Guile modules in the (gnu packages ...) name space (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 6.2 [Defining Packages], page 73).

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). 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 7.1.1 [Common Build Options], page 112), 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 Section 4.7 [Channels], page 52, 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

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 12 [Bootstrapping], page 401.

6.2 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
          "0ssi1wpaf7plaswqqjwigppsg5fyh99vd1b9kz17c91ng89ndq1i"))
    ))
    (build-system gnu-build-system)
    (arguments '(#:configure-flags '("--enable-silent-rules"))
    (inputs '("gawk","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 7.5 [Invoking guix import], page 123).

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 6.1 [Package Modules], page 72).

There are a few points worth noting in the above package definition:

- The `source` field of the package is an `<origin>` object (see Section 6.2.2 [origin Reference], page 79, 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 7.3 [Invoking guix download], page 121) and `guix hash` (see Section 7.4 [Invoking guix hash], page 122).

  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 6.3 [Build Systems], page 80). 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.

  What about these quote (`'`) characters? They are Scheme syntax to introduce a literal list; `'` is synonymous with `quote`. 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 `inputs` field specifies inputs to the build process—i.e., build-time or run-time dependencies of the package. Here, we define an input called "gawk" whose value is that of the `gawk` variable; `gawk` is itself bound to a `<package>` object.

  Again, `'` (a backquote, synonymous with `quasiquote`) allows us to introduce a literal list in the `inputs` field, while `,` (a comma, synonymous with `unquote`) allows us to insert a value in that list (see Section “Expression Syntax” in GNU Guile Reference Manual).
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 6.3 [Build Systems], page 80).

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 6.2.1 [package Reference], page 76, for a full description of possible fields.

Once a package definition is in place, the package may actually be built using the guix build command-line tool (see Section 7.1 [Invoking guix build], page 112), troubleshooting any build failures you encounter (see Section 7.1.4 [Debugging Build Failures], page 120). You can easily jump back to the package definition using the guix edit command (see Section 7.2 [Invoking guix edit], page 121). See Section 14.4 [Packaging Guidelines], page 411, for more information on how to test package definitions, and Section 7.7 [Invoking guix lint], page 132, for information on how to check a definition for style conformance. Lastly, see Section 4.7 [Channels], page 52, 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 automate by the guix refresh command (see Section 7.6 [Invoking guix refresh], page 128).

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 6.4 [The Store], page 93).

**package-derivation** (store package [system])

Return the <derivation> object of package for system (see Section 6.5 [Derivations], page 95).

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 6.4 [The Store], page 93).

Similarly, it is possible to compute a derivation that cross-builds a package for some other system:

**package-cross-derivation** (store package target [system])

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 "mips64el-linux-gnu" (see Section “Specifying Target Triplets” in Autoconf).

Packages can be manipulated in arbitrary ways. An example of a useful transformation is **input rewriting**, whereby the dependency tree of a package is rewritten by replacing specific inputs by others:
package-input-rewriting replacements [rewrite-name] [Scheme Procedure]
Return a procedure that, when passed a package, replaces its direct and indirect dependencies (but not its implicit inputs) 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 7.1.2 [Package Transformation Options], page 115).

The following variant of package-input-rewriting can match packages to be replaced by name rather than by identity.

package-input-rewriting/spec replacements [Scheme Procedure]
Return a procedure that, given a package, applies the given replacements to all the package graph (excluding implicit inputs). 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?] [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.

6.2.1 package Reference
This section summarizes all the options available in package declarations (see Section 6.2 [Defining Packages], page 73).
package

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.

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 6.2.2 [origin Reference], page 79). 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 6.7 [G-Expressions], page 102).

build-system

The build system that should be used to build the package (see Section 6.3 [Build Systems], page 80).

arguments (default: '())

The arguments that should be passed to the build system. This is a list, typically containing sequential keyword-value pairs.

inputs (default: '())

native-inputs (default: '())

propagated-inputs (default: '())

These fields list dependencies of the package. Each one is 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" (see Section 4.4 [Packages with Multiple Outputs], page 45, for more on package outputs). For example, the list below specifies three inputs:

'(('"libffi" ,libffi) ('"libunistring" ,libunistring) ('"glib:bin" ,glib "bin")) ;the "bin" output of Glib

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 7.7 [Invoking guix lint], page 132).

Lastly, propagated-inputs is similar to inputs, but the specified packages will be automatically installed alongside the package they belong to (see [package-cmd-propagated-inputs], page 36, for information on how guix package deals with propagated inputs.)

For example this is necessary when a C/C++ library 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. To ensure that libraries written in those languages can find library code they depend on at run time, run-time dependencies must be listed in `propagated-inputs` rather than `inputs`.

**outputs** (default: `'("out")`)  
The list of output names of the package. See Section 4.4 [Packages with Multiple Outputs], page 45, for typical uses of additional outputs.

**native-search-paths** (default: `'(())`)  
A list of `search-path-specification` objects describing search-path environment variables honored by the package.

**replacement** (default: `#f`)  
This must be either `#f` or a package object that will be used as a `replacement` for this package. See Chapter 11 [Security Updates], page 399, for details.

**synopsis**  
A one-line description of the package.

**description**  
A more elaborate description of the package.

**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:

```scheme
(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)
    '((("self" ,this-package))
       '())))

It is an error to refer to this-package outside a package definition.

6.2.2 origin Reference

This section summarizes all the options available in origin declarations (see Section 6.2 [Defining Packages], page 73).

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 procedure that handles the URI.

Examples include:

download a file from the HTTP, HTTPS, or FTP URL specified in the uri field;

    url-fetch from (guix download)
    git-fetch from (guix git-download)

    clone the Git version control repository, and check out the revision specified in the uri field as a git-reference object;

    a git-reference looks like this:

    (git-reference
       (url "https://git.savannah.gnu.org/git/hello.git")
       (commit "v2.10")
    )

sha256 A bytevector containing the SHA-256 hash of the source. Typically the base32 form is used here to generate the bytevector from a base-32 string. You can obtain this information using guix download (see Section 7.3 [Invoking guix download], page 121) or guix hash (see Section 7.4 [Invoking guix hash], page 122).

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 6.7 [G-Expressions], page 102) 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 6.7 [G-Expressions], page 102) 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.

6.3 Build Systems

Each package definition specifies a build system and arguments for that build system (see Section 6.2 [Defining Packages], page 73). 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 6.5 [Derivations], page 95).

Build systems accept an optional list of arguments. In package definitions, these are passed via the arguments field (see Section 6.2 [Defining Packages], page 73). 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 6.5 [Derivations], page 95).

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 prac-
tice, a few additional steps are often needed. All these steps are split up in separate phases, notably:

**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 10 [Installing Debugging Files], page 398).

The build-side module `(guix build gnu-build-system)` defines `%(standard-phases)` as the default list of build phases. `%(standard-phases)` is a list of symbol/procedure pairs, where the procedure implements the actual phase.

The list of phases used for a particular package can be changed with the `#:phases` parameter. For instance, passing:

`#:phases (modify-phases %(standard-phases) (delete 'configure))`

means that all the phases described above will be used, except the `configure` phase.

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.

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.

---

3 Please see the `(guix build gnu-build-system)` modules for more details about the build phases.
ant-build-system

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

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" of 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

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.
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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 14.4.5 [Python Modules], page 415), using the cl- prefix.

For binary packages, each system should be defined as a Guix package. If one package origin contains several systems, package variants can be created in order to build all the systems. Source packages, which use asdf-build-system/source, may contain several systems.

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-symlinks 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.

If the system is not defined within its own .asd file of the same name, then the #:asd-file parameter should be used to specify which file the system is defined in.

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, the #:asd-system-name parameter can be used to specify the name of the system.

cargo-build-system

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 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 install phase installs any crate the binaries if they are defined by the crate.

copy-build-system

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**

This variable is exported by (guix build-system clojure). It implements a simple build procedure for Clojure ([https://clojure.org/](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.

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.

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 not run.

Julia packages require the source file-name to be the real name of the package, correctly capitalized.

For packages requiring shared library dependencies, you may need to write the /deps/deps.jl file manually. It’s usually a line of const variable = /gnu/store/library.so for each dependency, plus a void function check_deps() = nothing.

Some older packages that aren’t using Package.toml yet, will require this file to be created, too. The function julia-create-package-toml helps creating the file. You need to pass the outputs and the source of the package, it’s name (the same as the file-name parameter), the package uuid, the package version, and a list of dependencies specified by their name and their uuid.

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

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

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 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.
perl-build-system  
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`.

qt-build-system  
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  
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  
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.

texlive-build-system

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

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

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

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

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

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

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

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

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. The default Meson is meson-for-build, which is special because it doesn’t clear the RUNPATH of binaries and libraries when they are installed.

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 --build-type is always set to plain 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 ninja with the target specified in #:test-target, which is "test" by default.

**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-for-build, 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**

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

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

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 6.5 [Derivations], page 95).

6.4 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 14). 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 2).

See Section 4.5 [Invoking guix gc], page 46, 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

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 14).

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 7.12 [Invoking guix copy], page 146).

Additional URI schemes may be supported in the future.

Note: The ability to connect to remote build daemons is considered experimental as of 1.1.0. Please get in touch with us to share any problems or suggestions you may have (see Chapter 14 [Contributing], page 408).

**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 6.6 [The Store Monad], page 98).

This section is currently incomplete.

6.5 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 6.4 [The Store], page 93).

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 4.5 [Invoking
guix gc], page 46). 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)"] [Scheme Procedure]
[#:hash #f] [#:hash-algo #f] [#:recursive? #f] [#:inputs ()] [#:env-vars ()] [#:system (%current-system)] [#:references-graphs #f]

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 10). 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 4.3 [Substitutes], page 43). 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")))
```
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 6.7 [G-Expressions], page 102.

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` takes the following arguments:

- `store name exp`:
  - `store` is the name of the store where the derivation will be created.
  - `name` is the name of the derivation.
  - `exp` is a Scheme expression that will be evaluated as a builder for the derivation.

The `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.

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 => ...>
```
Chapter 6: Programming Interface

6.6 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:

```scheme
(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:

```scheme
(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 6.7 [G-Expressions], page 102):

```scheme
(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:

```scheme
(run-with-store (open-connection) (sh-symlink))
```
Note that the (guix monad-repl) module extends the Guile REPL with new "meta-commands" to make it easier to deal with monadic procedures: run-in-store, and enter-store-monad. 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.

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....

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

---

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.
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` ...

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*` ...

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*` ...

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.

**%state-monad**

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:

```scheme
(define (square x)
  (mlet %state-monad ((count (current-state)))
    (mbegin %state-monad
      (set-current-state (+ 1 count))
      (return (* x x)))))
```

```scheme
(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**

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:

```scheme
(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**
  ```scheme
  package [file] [#:system (%current-system)] [#:target #f] [#:output "out"]
  ```
  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.

- **package->derivation**
  ```scheme
  package [system]
  ```
  Monadic version of `package-derivation` and `package-cross-derivation` (see Section 6.2 [Defining Packages], page 73).

- **package->cross-derivation**
  ```scheme
  package target [system]
  ```

6.7 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 6.5 [Derivations], page 95). 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 14).

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:\footnote{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*.} 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`, etc.

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 gexp\_s, 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:

- Gexp\_s 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.
Gexp syntax can be used to build, depending on how a package is defined, a derivation that is a directory containing only one symlink to /gnu/store/...-coreutils-8.22/bin/ls:

```
(gexp->derivation "the-thing" build-exp)
```

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 "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 "mips64el-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"))))))
```
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:

```
(gexp->derivation "something-with-vms"
  #~(begin
    (use-modules (guix build utils)
      (gnu build vm))
    ...
  ))
```

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:

```
(gexp->derivation "something-with-json"
  #~(begin
    (use-modules (json))
    ...
  ))
```

The syntactic form to construct gexps is summarized below.

```
#~exp
(gexp exp)  \[\text{Scheme Syntax}\]
```

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.

```scheme
#$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 4.4 [Packages with Multiple Outputs], page 45).

```scheme
#+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.

```scheme
#$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`.

```scheme
#$@lst
(ungexp-splicing lst)
```

Like the above, but splices the contents of `lst` inside the containing list.

```scheme
#+@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.)

```scheme
with-imported-modules modules body...
```

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:

```scheme
`((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...  

Mark the gexp 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

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 6.6 [The Store Monad], page 98, for more information about monads.)

gexp->derivation name exp [#:system (%current-system)]  
  [#: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-warings #f]  
  [:#local-build? #f] [:#substitutable? #t] [:#properties '()]]  
  [:#guile-for-build #f]

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 \texttt{#f}, \texttt{#t}, or \texttt{"detailed.}

The other arguments are as for derivation (see Section 6.5 [Derivations], page 95).

The \texttt{local-file}, \texttt{plain-file}, \texttt{computed-file}, \texttt{program-file}, and \texttt{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:

\begin{verbatim}
  #"(system* #$(file-append glibc "/sbin/nscd") "-f"
        #$(local-file "/tmp/my-nscd.conf"))
\end{verbatim}

The effect here is to “intern” \texttt{/tmp/my-nscd.conf} by copying it to the store. Once expanded, for instance via \texttt{gexp->derivation}, the G-expression refers to that copy under \texttt{/gnu/store}; thus, modifying or removing the file in \texttt{/tmp} does not have any effect on what the G-expression does. \texttt{plain-file} can be used similarly; it differs in that the file content is directly passed as a string.

\textbf{local-file file [name] [#:recursive? \#f] [#:select? (const \#t)]} \hfill [Scheme Procedure]

Return an object representing local file \texttt{file} to add to the store; this object can be used in a gexp. If \texttt{file} is a literal string denoting a relative file name, it is looked up relative to the source file where it appears; if \texttt{file} is not a literal string, it is looked up relative to the current working directory at run time. \texttt{file} will be added to the store under \texttt{name}—by default the base name of \texttt{file}.

When \texttt{recursive?} is true, the contents of \texttt{file} are added recursively; if \texttt{file} designates a flat file and \texttt{recursive?} is true, its contents are added, and its permission bits are kept.

When \texttt{recursive?} is true, call (select? \texttt{file} \texttt{stat}) for each directory entry, where \texttt{file} is the entry’s absolute file name and \texttt{stat} is the result of \texttt{lstat}; exclude entries for which \texttt{select?} does not return true.

This is the declarative counterpart of the \texttt{interned-file} monadic procedure (see Section 6.6 [The Store Monad], page 98).

\textbf{plain-file name content} \hfill [Scheme Procedure]

Return an object representing a text file called \texttt{name} with the given \texttt{content} (a string or a bytevector) to be added to the store.

This is the declarative counterpart of \texttt{text-file}.

\textbf{computed-file name gexp [#:options \{#:local-build? \#t\}]} \hfill [Scheme Procedure]

Return an object representing the store item \texttt{name}, a file or directory computed by \texttt{gexp}. \texttt{options} is a list of additional arguments to pass to \texttt{gexp->derivation}.

This is the declarative counterpart of \texttt{gexp->derivation}.

\textbf{gexp->script name exp [#:guile (default-guile)]} \hfill [Monadic Procedure]

\begin{verbatim}
  [#:module-path %load-path] [#:system (%current-system)] [#:target \#f]
\end{verbatim}

Return an executable script \texttt{name} that runs \texttt{exp} using \texttt{guile}, with \texttt{exp}’s imported modules in its search path. Look up \texttt{exp}’s modules in \texttt{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 6.6 [The Store Monad], page 98), 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.
)
```

```
    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] [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:")
```
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.
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>.

6.8 Invoking guix repl

The guix repl command spawns a Guile read-eval-print loop (REPL) for interactive programming (see Section “Using Guile Interactively” 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. You can use it this way:

$ 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 6.1 [Package Modules], page 72). This allows users to define their own packages and make them visible to the command-line tool.

-q
Inhibit loading of the ~/.guile file. By default, that configuration file is loaded when spawning a guile REPL.
7 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.

7.1 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 4.2 [Invoking guix package], page 35). 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 | cut -f1,2 --output-delimiter=\0'
```

`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 6.1 [Package Modules], page 72).

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.

7.1.1 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 6.1 [Package Modules], page 72). 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 7.1.4 [Debugging Build Failures], page 120, 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 6.4 [The Store], page 93).

--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 4.3.5 [Substitution Failure], page 45).

--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 15).

This means that substitutes may be downloaded from urls, provided they are signed by a key authorized by the system administrator (see Section 4.3 [Substitutes], page 43).

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 4.3 [Substitutes], page 43).

--no-grafts
Do not “graft” packages. In practice, this means that package updates available as grafts are not applied. See Chapter 11 [Security Updates], page 399, 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 7.11 [Invoking guix challenge], page 143, for more.

Note that, currently, the differing build results are not kept around, so you will have to manually investigate in case of an error—e.g., by stashing one of the build results with guix archive --export (see Section 4.11 [Invoking guix archive], page 60), then rebuilding, and finally comparing the two results.
--no-offload
Do not use offload builds to other machines (see Section 2.4.2 [Daemon Offload Setup], page 10). 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 14).

--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 14).

-v level
--verbosity=level
Use the given verbosity level, an integer. Choosing 0 means that no output is produced, 1 is for quiet output, and 2 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 14, 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.
7.1.2 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 6.2 [Defining Packages], page 73).

`--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 7.3 [Invoking `guix download`], page 121).

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-1.7.tar.gz
```

As a developer, `--with-source` makes it easy to test release candidates:

```
guix build guile --with-source=../guile-2.0.9.219-e1bb7.tar.xz
```

... or to build from a checkout in a pristine environment:

```
s $ git clone git://git.sv.gnu.org/guix.git
s $ 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 6.2 [Defining Packages], page 73).

`--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 11 [Security Updates], page 399, 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:

```bash
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-git-url=package=url`

Build `package` from the latest commit of the `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:

```bash
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 6.2.2 [origin Reference], page 79) 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:

```bash
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 or a tag.
7.1.3 Additional Build Options

The command-line options presented below are specific to `guix build`.

`--quiet`

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`

Build the package, derivation, or other file-like object that the code within file evaluates to (see Section 6.7 [G-Expressions], page 102). As an example, `file` might contain a package definition like this (see Section 6.2 [Defining Packages], page 73):

```guile
(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
        "0ssi1wpaf7plaswqqjwigppsg5fyh99vdlb9kzl7c9lng89ndqi")))))

(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+))
```

`--manifest=manifest`

Build all packages listed in the given manifest (see [profile-manifest], page 38).

`--expression=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 6.7 [G-Expressions], page 102).

Lastly, `expr` may refer to a zero-argument monadic procedure (see Section 6.6 [The Store Monad], page 98). 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 6.2 [Defining Packages], page 73).

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 8.8.24 [Virtualization Services], page 331), 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 10, for more information on offloading.

`--target=triplet`
Cross-build for `triplet`, which must be a valid GNU triplet, such as "mips64el-linux-gnu" (see Section “Specifying Target Triplets” in Autoconf).

`--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 4.3 [Substitutes], page 43), or whether the build result of a package is deterministic. See Section 7.11 [Invoking guix challenge], page 143, 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 4.5 [Invoking guix gc], page 46, 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 MIPS, but you are actually on an x86_64 machine:

```
$ guix build --log-file gdb -s mips64el-linux
https://ci.guix.gnu.org/log/...-gdb-7.10
```

You can freely access a huge library of build logs!

### 7.1.4 Debugging Build Failures

When defining a new package (see Section 6.2 [Defining Packages], page 73), 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 7.1 [Invoking guix build], page 112).

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 -K foo
... 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 environment --no-grafts -C foo --ad-hoc strace gdb
```
[env]# source ./environment-variables
[env]# cd foo-1.2

Here, `guix environment -C` creates a container and spawns a new shell in it (see Section 5.1 [Invoking guix environment], page 63). The `--ad-hoc strace gdb` part adds the `strace` and `gdb` commands to the container, which would may find handy while debugging. The `--no-grafts` option makes sure we get the exact same environment, with ungrafted packages (see Chapter 11 [Security Updates], page 399, 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 environment`.)

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.

### 7.2 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 14.1 [Building from Git], page 408), or have created your own packages on `GUIX_PACKAGE_PATH` (see Section 6.1 [Package Modules], page 72), 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.

### 7.3 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 6.2 [Defining Packages], page 73). 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 4.5 [Invoking guix gc], page 46).
The \texttt{guix download} command supports the same URIs as used in package definitions. In particular, it supports \texttt{mirror://} URIs. \texttt{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 \textit{GnuTLS-Guile}, for more information.

\texttt{guix download} verifies HTTPS server certificates by loading the certificates of X.509 authorities from the directory pointed to by the \texttt{SSL\_CERT\_DIR} environment variable (see Section 8.10 \textit{[X.509 Certificates]}, page 366), unless \texttt{--no-check-certificate} is used.

The following options are available:

\begin{itemize}
\item \texttt{--format=fmt} \\
\texttt{-f fmt} \hspace{1em} Write the hash in the format specified by \texttt{fmt}. For more information on the valid values for \texttt{fmt}, see Section 7.4 \textit{[Invoking guix hash]}, page 122.
\item \texttt{--no-check-certificate} \\
Do not validate the X.509 certificates of HTTPS servers.
\item When using this option, you have \textit{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.
\item \texttt{--output=file} \\
\texttt{-o file} \hspace{1em} Save the downloaded file to \texttt{file} instead of adding it to the store.
\end{itemize}

\section*{7.4 Invoking \texttt{guix hash}}

The \texttt{guix hash} command computes the SHA256 hash of a file. It is primarily a convenience tool for anyone contributing to the distribution: it computes the cryptographic hash of a file, which can be used in the definition of a package (see Section 6.2 \textit{[Defining Packages]}, page 73).

The general syntax is:

\begin{verbatim}
guix hash option file
\end{verbatim}

When \texttt{file} is \texttt{-} (a hyphen), \texttt{guix hash} computes the hash of data read from standard input. \texttt{guix hash} has the following options:

\begin{itemize}
\item \texttt{--format=fmt} \\
\texttt{-f fmt} \hspace{1em} Write the hash in the format specified by \texttt{fmt}.
\item Supported formats: \texttt{nix-base32, base32, base16} (hex and hexadecimal can be used as well).
\item If the \texttt{--format} option is not specified, \texttt{guix hash} will output the hash in \texttt{nix-base32}. This representation is used in the definitions of packages.
\item \texttt{--recursive} \\
\texttt{-r} \hspace{1em} Compute the hash on \texttt{file} recursively.
\item In this case, the hash is computed on an archive containing \texttt{file}, including its children if it is a directory. Some of the metadata of \texttt{file} is part of the archive; for instance, when \texttt{file} is a regular file, the hash is different depending on whether \texttt{file} is executable or not. Metadata such as time stamps has no impact on the hash (see Section 4.11 \textit{[Invoking guix archive]}, page 60).
\end{itemize}
--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 6.2.2 [origin Reference], page 79):

$ git clone http://example.org/foo.git
$ cd foo
$ guix hash -rx .

7.5 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 6.2 [Defining Packages], page 73).

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 7.6 [Invoking guix refresh], page 128.

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 `itsdangerous` Python package:

```bash
guix import pypi itsdangerous
```

|--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:

```bash
guix import gem rails
```

|--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:

```bash
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:

```bash
guix import cran Cairo
```

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 `--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=biocductor 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
```

Import metadata from CTAN (https://www.ctan.org/), the comprehensive TeX archive network for TeX packages that are part of the TeX Live distribution (https://www.tug.org/texlive/).

Information about the package is obtained through the XML API provided by CTAN, while the source code is downloaded from the SVN repository of the Tex Live project. This is done because the CTAN does not keep versioned archives.

The command command below imports metadata for the fontspec TeX package:

```
  guix import texlive fontspec
```

When `--archive=DIRECTORY` is added, the source code is downloaded not from the `latex` sub-directory of the `texmf-dist/source` tree in the TeX Live SVN repository, but from the specified sibling directory under the same root.

The command below imports metadata for the ifxetex package from CTAN while fetching the sources from the directory `texmf/source/generic`:

```
  guix import texlive --archive=generic ifxetex
```

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 6.2 [Defining Packages], page 73). 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": "0ssi1wpaf7plaswqqjwigppsg5fyh99vdlb9kzl7c91ng89ndq1i"
}
}
...

The command below reads metadata from the JSON file hello.json and outputs a package expression:

```
guix import json hello.json
```

**nix** Import metadata from a local copy of the source of the Nixpkgs distribution ([https://nixos.org/nixpkgs/](https://nixos.org/nixpkgs/)). Package definitions in Nixpkgs are typically written in a mixture of Nix-language and Bash code. This command only imports the high-level package structure that is written in the Nix language. It normally includes all the basic fields of a package definition.

When importing a GNU package, the synopsis and descriptions are replaced by their canonical upstream variant.

Usually, you will first need to do:

```
export NIX_REMOTE=daemon
```

so that `nix-instantiate` does not try to open the Nix database.

As an example, the command below imports the package definition of LibreOffice (more precisely, it imports the definition of the package bound to the `libreoffice` top-level attribute):

```
guix import nix ~/path/to/nixpkgs libreoffice
```

**hackage** Import metadata from the Haskell community’s central package archive Hackage ([https://hackage.haskell.org/](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.
```

---

1 This relies on the `nix-instantiate` command of Nix ([https://nixos.org/nix/](https://nixos.org/nix/)).
--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)
```
Chapter 7: Utilities

in the emacs package (see Section “Package Installation” in The GNU Emacs Manual).

- 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.

opam Import metadata from the OPAM (https://opam.ocaml.org/) package repository used by the OCaml community.

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 14 [Contributing], page 408).

7.6 Invoking guix refresh

The primary audience of the guix refresh command is developers of the GNU software distribution. By default, it 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

Alternately, 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:35:2: warning: no updater for acl
gnu/packages/m4.scm:30:12: info: 1.4.18 is already the latest version of m4
gnu/packages/xml.scm:68:2: warning: no updater for expat
...
```

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 6.2 [Defining Packages], page 73). 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 14.2 [Running Guix Before It Is Installed], page 409):

```
$ ./pre-inst-env guix refresh -s non-core -u
```

See Section 6.2 [Defining Packages], page 73, 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.

```plaintext
--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.

```plaintext
--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;
- `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;
- `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.
- `launchpad` the updater for Launchpad (https://launchpad.net) packages.

For instance, the following command only checks for updates of Emacs packages hosted at elpa.gnu.org and for updates of CRAN packages:

```plaintext
$ guix refresh --type=elpa,cran
```
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.

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-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.

**--list-dependent**

- List top-level dependent packages that would need to be rebuilt as a result of upgrading one or more packages.
  See Section 7.9 [Invoking guix graph], page 136, 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 geiser@0.4 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
```

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`

Add `directory` to the front of the package module search path (see Section 6.1 [Package Modules], page 72).

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.

### 7.7 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 \texttt{--list-checkers} for a complete list):

\texttt{synopsis}  
\texttt{description}  
Validate certain typographical and stylistic rules about package descriptions and synopses.

\texttt{inputs-should-be-native}  
Identify inputs that should most likely be native inputs.

\texttt{source}  
\texttt{home-page}  
\texttt{mirror-url}  
\texttt{github-url}  
\texttt{source-file-name}  
Probes \texttt{home-page} and \texttt{source} URLs and report those that are invalid. Suggest a \texttt{mirror://} URL when applicable. If the \texttt{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 \texttt{file-name} (see Section 6.2.2 [origin Reference], page 79).

\texttt{source-unstable-tarball}  
Parse the \texttt{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.

\texttt{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 \texttt{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 \texttt{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, \texttt{guix lint} prints a message and the \texttt{archival} checker stops doing anything until that limit has been reset.

\texttt{cve}  

To view information about a particular vulnerability, visit pages such as:

\begin{itemize}
  \item \url{https://web.nvd.nist.gov/view/vuln/detail?vulnId=CVE-YYYY-ABCD}
\end{itemize}
• ‘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:

```guix
(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:

```guix
(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.

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

List and describe all the available checkers that will be run on packages and exit.

--checkers

Only enable the checkers specified in a comma-separated list using the names returned by --list-checkers.

--load-path=directory

Add `directory` to the front of the package module search path (see Section 6.1 [Package Modules], page 72).

This allows users to define their own packages and make them visible to the command-line tools.
7.8 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 4.4 [Packages with Multiple Outputs], page 45). 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

<table>
<thead>
<tr>
<th>store item</th>
<th>total</th>
<th>self</th>
</tr>
</thead>
<tbody>
<tr>
<td>/gnu/store/...-gcc-5.5.0-lib</td>
<td>60.4</td>
<td>30.1</td>
</tr>
<tr>
<td>/gnu/store/...-glibc-2.27</td>
<td>30.3</td>
<td>28.8</td>
</tr>
<tr>
<td>/gnu/store/...-coreutils-8.28</td>
<td>78.9</td>
<td>15.0</td>
</tr>
<tr>
<td>/gnu/store/...-gmp-6.1.2</td>
<td>63.1</td>
<td>2.7</td>
</tr>
<tr>
<td>/gnu/store/...-bash-static-4.4.12</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>/gnu/store/...-acl-2.2.52</td>
<td>61.1</td>
<td>0.4</td>
</tr>
<tr>
<td>/gnu/store/...-attr-2.4.47</td>
<td>60.6</td>
<td>0.2</td>
</tr>
<tr>
<td>/gnu/store/...-libcap-2.25</td>
<td>60.5</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>total:</strong> 78.9 MiB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.)

When the package(s) passed to `guix size` are available in the store\(^2\), `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 4.3 [Substitutes], page 43). This makes it possible it to profile disk usage of store items that are not even on disk, only available remotely.

You can also specify several package names:

$ guix size coreutils grep sed bash

<table>
<thead>
<tr>
<th>store item</th>
<th>total</th>
<th>self</th>
</tr>
</thead>
<tbody>
<tr>
<td>/gnu/store/...-coreutils-8.24</td>
<td>77.8</td>
<td>13.8</td>
</tr>
<tr>
<td>/gnu/store/...-grep-2.22</td>
<td>73.1</td>
<td>0.8</td>
</tr>
<tr>
<td>/gnu/store/...-bash-4.3.42</td>
<td>72.3</td>
<td>4.7</td>
</tr>
</tbody>
</table>

\(^2\) More precisely, `guix size` looks for the ungrafted variant of the given package(s), as returned by `guix build package --no-grafts`. See Chapter 11 [Security Updates], page 399, for information on grafts.
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.

The available options are:

--substitute-urls=urls
Use substitute information from urls. See [client-substitute-urls], page 113.

--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 6.1 [Package Modules], page 72).
This allows users to define their own packages and make them visible to the command-line tools.

7.9 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. 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:

![DAG diagram of GNU Core Utilities](image)

Nice little graph, no?

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 7.6 [Invoking guix refresh], page 128).

- **bag-emerged** This is the package DAG, *including* implicit inputs.

For instance, the following command:

```
guix graph --type=bag-emerged coreutils | dot -Tpdf > dag.pdf
```
... yields this bigger graph:

At the bottom of the graph, we see all the implicit inputs of *gnu-build-system* (see Section 6.3 [Build Systems], page 80).

Now, note that the dependencies of these implicit inputs—that is, the *bootstrap dependencies* (see Chapter 12 [Bootstrapping], page 401)—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 6.5 [Derivations], page 95) 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 6.1 [Package Modules], page 72). For example, the following command shows the graph for the package module that defines the guile package:

```
guix graph -t module guile | dot -Tpdf > module-graph.pdf
```

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 4.5 [Invoking guix gc], page 46).

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 4.5 [Invoking guix gc], page 46).

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.

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-backends
List the supported graph backends.
Currently, the available backends are Graphviz and d3.js.

--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 6.1 [Package Modules], page 72).
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 7.1.2 [Package Transformation Options], page 115). 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!

7.10 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 4.3 [Substitutes], page 43).

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 4.3 [Substitutes], page 43). 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 4.11 [Invoking guix archive], page 60).
The general syntax is:

```
guix publish options...
```

Running `guix publish` without any additional arguments will spawn an HTTP server on port 8080:

```
guix publish
```

Once a publishing server has been authorized (see Section 4.11 [Invoking guix archive], page 60), the daemon may download substitutes from it:

```
guix-daemon --substitute-urls=http://example.org:8080
```

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 7.14 [Invoking guix weather], page 147).

As a bonus, `guix publish` also serves as a content-addressed mirror for source files referenced in `origin` records (see Section 6.2.2 [origin Reference], page 79). 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 7.4 [Invoking guix hash], page 122):

```
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 14), `/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 -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 `lzzip` 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](https://nongnu.org/lzip/lzip_benchmark.html)).

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) returns 404 and 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.

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 \textit{ttl}. However, note that \texttt{guix publish} does not itself guarantee that the store items it provides will indeed remain available for as long as \textit{ttl}. Additionally, when \texttt{--cache} is used, cached entries that have not been accessed for \textit{ttl} and that no longer have a corresponding item in the store, may be deleted.

\texttt{--nar-path=path}

Use \textit{path} as the prefix for the URLs of “nar” files (see Section 4.11 [Invoking \texttt{guix archive}], page 60). 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 \textit{path}.

\texttt{--public-key=\textit{file}}
\texttt{--private-key=\textit{file}}

Use the specific \textit{files} 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 \texttt{guix archive --generate-key} (see Section 4.11 [Invoking \texttt{guix archive}], page 60). By default, /etc/guix/signing-key.pub and /etc/guix/signing-key.sec are used.

\texttt{--repl[=\textit{port}]}  
\texttt{-r [\textit{port}]}  

Spawn a Guile REPL server (see Section “REPL Servers” in \textit{GNU Guile Reference Manual}) on \textit{port} (37146 by default). This is used primarily for debugging a running \texttt{guix publish} server.

Enabling \texttt{guix publish} on Guix System is a one-liner: just instantiate a \texttt{guix-publish-service-type} service in the \texttt{services} field of the \texttt{operating-system} declaration (see \[\texttt{guix-publish-service-type}], page 183).

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.

7.11 Invoking \texttt{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 \texttt{guix challenge} command attempts to answer.

The former is obviously an important question: Before using a substitute server (see Section 4.3 [Substitutes], page 43), one had better \textit{verify} that it provides the right binaries,
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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 2). 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:

```bash
updating list of substitutes from 'https://ci.guix.gnu.org'... 100.0%
updating list of 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: 1zy4fmaaqcnjrzzajkdn3f5gmj7k764b43qk4711byak9z0qjyin
  differing files:
    /lib/libcrypto.so.1.1
    /lib/libssl.so.1.1

/gnu/store/...-git-2.5.0 contents differ:
  local hash: 00p3bmryhjxrhpn2gxs2fy0a151nlp05197205p0b9859359bhba
  https://ci.guix.gnu.org/nar/...-git-2.5.0: 069nb85by4d4a6slw1c4cm4cswpm3kdbmbyb81d6zckj3nq9f
  https://guix.example.org/nar/...-git-2.5.0: 0mdqa9w1p6cmli6976v4zi0w9r4p5prkj71zf6177wk11c9c73
  differing file:
    /libexec/git-core/git-fsck

/gnu/store/...-pius-2.1.1 contents differ:
  local hash: 0k4v3m9z1zp8zzxizb7d8kjj72f9172vx078s4w173vsnq9ig3ax
  https://ci.guix.gnu.org/nar/...-pius-2.1.1: 0k4v3m9z1zp8zzxizb7d8kjj72f9172vx078s4w173vsnq9ig3ax
  https://guix.example.org/nar/...-pius-2.1.1: 1cy25x1a4fzq5rko0pmvc6xhymfnq59h2bvpqsz2mpv1bncy0ge
  differing file:
    /share/man/man1/pius.1.gz

...

6,406 store items were analyzed:
- 4,749 (74.1%) were identical
- 525 (8.2%) differed
- 1,132 (17.7%) were inconclusive
```

In this example, guix challenge first scans the store to determine the set of locally-built derivations—as opposed to store items that were downloaded from a substitute server—and then queries all the substitute servers. It then reports those store items for which the servers obtained a result different from the local build.

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 4.1 [Features], page 34). 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 \n  --substitute-urls="https://ci.guix.gnu.org https://guix.example.org"
```

This automatically invokes `diffoscope`, which displays detailed information about files that differ.

Alternately, we can do something along these lines (see Section 4.11 [Invoking `guix archive`], page 60):

```
  $ wget -q -O - https://ci.guix.gnu.org/nar/...-git-2.5.0 \
   | 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
```

where `package` is a package specification such as `guile@2.0` or `glibc:debug`.

The general syntax is:

```
  guix challenge options [packages...]
```

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.
```
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Invoking Diffoscope

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.

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.

---

7.12 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\(^3\). For example, the following command copies the `coreutils` package, the user’s profile, and all their dependencies over to `host`, logged in as `user`:

```sh
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:

```sh
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 4.11 [Invoking `guix archive`], page 60, for more information about store item authentication.

The general syntax is:

```sh
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`.

---

\(^3\) This command is available only when Guile-SSH was found. See Section 2.2 [Requirements], page 7, for details.
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 7.1.1 [Common Build Options], page 112).

7.13 Invoking guix container

Note: As of version 1.1.0, 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 environment (see Section 5.1 [Invoking guix environment], page 63) and guix system container (see Section 8.14 [Invoking guix system], page 374) commands.

The general syntax is:

guix container action options...

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.

7.14 Invoking guix weather

Occasionally you’re grumpy because substitutes are lacking and you end up building packages by yourself (see Section 4.3 [Substitutes], page 43). 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 7.10 [Invoking guix publish], page 140).

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 list of 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 4.2 [Invoking guix package], page 35).

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 -c 10
computing 8,983 package derivations for x86_64-linux...
looking for 9,343 store items on https://ci.guix.gnu.org...
updating substitutes from 'https://ci.guix.gnu.org'... 100.0%
https://ci.guix.gnu.org
64.7% substitutes available (6,047 out of 9,343)
...
2502 packages are missing from 'https://ci.guix.gnu.org' for 'x86_64-linux',
  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.info; 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.

7.15 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\(^4\). Here’s an example of the information it returns:

$ sudo guix processes
SessionPID: 19002
ClientPID: 19090
ClientCommand: guix environment --ad-hoc python

SessionPID: 19402
ClientPID: 19367
ClientCommand: guix publish -u guix-publish -p 3000 -C 9 ...

SessionPID: 19444

\(^4\) Remote sessions, when guix-daemon is started with --listen specifying a TCP endpoint, are not listed.
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
ChildProcess: 20495: guix offload x86_64-linux 7200 1 28800
ChildProcess: 27733: guix offload x86_64-linux 7200 1 28800
ChildProcess: 27793: 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.

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 ChildProcess field, we understand that these three builds are being offloaded (see Section 2.4.2 [Daemon Offload Setup], page 10).

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 ...
8 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 4.1 [Features], page 34). 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.

8.1 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 8.14 [Invoking guix system], page 374). A simple setup, with the default system services, the default Linux-Libre kernel, initial RAM disk, and boot loader looks like this:

```scheme
;; 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)

(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)
             (target "/dev/sdX")))

(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.

(u (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
                          (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 8.2 [operating-system Reference], page 158, 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)
  (target "/boot/efi")

See Section 8.13 [Bootloader Configuration], page 371, 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 4.2 [Invoking guix package], page 35). 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 GNU Zile lightweight text editor, `find`, `grep`, etc. The example above adds GNU Screen to those, taken from the `gnu packages screen` module (see Section 6.1 [Package Modules], page 72). The (list package output) syntax can be used to add a specific output of a package:

```guile
(use-modules (gnu packages))
(use-modules (gnu packages dns))

(operating-system
 ;; ...
 (packages (cons (list bind "utils")
               %base-packages)))
```

Referring to packages by variable name, like `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:

```guile
(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 8.8 [Services], page 172). 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 8.8.4 [Networking Services], page 188). 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 8.17 [Defining Services], page 386).

Occasionally, instead of using the base services as is, you will want to customize them. To do this, use `modify-services` (see Section 8.17.3 [Service Reference], page 389) to modify the list.

For example, suppose you want to modify `guix-daemon` and Mingetty (the console login) in the `%base-services` list (see Section 8.8.1 [Base Services], page 172). To do that, you can write the following in your operating system declaration:

```guile
(define %my-services
```

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My very own list of services.

```lisp
(modify-services %base-services
  (guix-service-type config =>
    (guix-configuration
     (inherit config)
     (use-substitutes? #f)
     (extra-options '("--gc-keep-derivations")))
    (mingetty-service-type config =>
     (mingetty-configuration
      (inherit config)))))

(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. 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, 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:

```lisp
;; This is an operating system configuration template
;; for a "desktop" setup with GNOME and Xfce where the
;; root partition is encrypted with LUKS.

(use-modules (gnu) (gnu system nss))
(use-service-modules desktop 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)
```
(target "/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))

(users (cons (user-account
 (name "bob")
 (comment "Alice’s brother")
 (group "users")
 (supplementary-groups '("wheel" "netdev"
 "audio" "video")))
 %base-user-accounts))

;; 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 (append (list (service gnome-desktop-service-type)
 (service xfce-desktop-service-type)
 (set-xorg-configuration
 (xorg-configuration
(keyboard-layout keyboard-layout)))
(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 ratpoison suckless wm)
(use-package-modules bootloaders certs 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)
    (target "/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")))
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%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
    ;; 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 8.8.7 [Desktop Services], page 223, for the exact list of services provided
by %desktop-services. See Section 8.10 [X.509 Certificates], page 366, 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)

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 config-
uration, and makes it the default GRUB boot entry (see Section 8.14 [Invoking guix system],
page 374).

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 sys-
tem 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 8.14 [Invoking guix system], page 374).

The Programming Interface

At the Scheme level, the bulk of an operating-system declaration is instantiated with the following monadic procedure (see Section 6.6 [The Store Monad], page 98):

\[
\text{operating-system-derivation os} \quad \text{[Monadic Procedure]}
\]

\[\text{Return a derivation that builds os, an operating-system object (see Section 6.5 [Derivations], page 95).}\]

\[\text{The output of the derivation is a single directory that refers to all the packages, configuration files, and other supporting files needed to instantiate os.}\]

This procedure is provided by the (gnu system) module. Along with (gnu services) (see Section 8.8 [Services], page 172), this module contains the guts of Guix System. Make sure to visit it!

8.2 operating-system Reference

This section summarizes all the options available in operating-system declarations (see Section 8.1 [Using the Configuration System], page 151).

\[
\text{operating-system} \quad \text{[Data Type]}
\]

\[\text{This is the data type representing an operating system configuration. By that, we mean all the global system configuration, not per-user configuration (see Section 8.1 [Using the Configuration System], page 151).}\]

\[
\text{kernel (default: linux-libre)}
\]

\[\text{The package object of the operating system kernel to use}^1.\]

\[
\text{kernel-loadable-modules (default: '())}
\]

\[\text{A list of objects (usually packages) to collect loadable kernel modules from—e.g. (list ddcci-driver-linux).}\]

\[
\text{kernel-arguments (default: '("quiet"))}
\]

\[\text{List of strings or gexpes representing additional arguments to pass on the command-line of the kernel—e.g., ("console=ttyS0").}\]

\[
\text{bootloader}
\]

\[\text{The system bootloader configuration object. See Section 8.13 [Bootloader Configuration], page 371.}\]

---

\[1\] Currently only the Linux-libre kernel is supported. In the future, it will be possible to use the GNU Hurd.
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.

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.

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 \(\text{luks-device-mapping}\) mapped device (see Section 8.4 [Mapped Devices], page 164).

Note: This does not specify the keyboard layout used by the bootloader, nor that used by the graphical display server. See Section 8.13 [Bootloader Configuration], page 371, for information on how to specify the bootloader’s keyboard layout. See Section 8.8.5 [X Window], page 205, 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 8.12 [Initial RAM Disk], page 369.

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 8.12 [Initial RAM Disk], page 369.

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 \text{ath9k} and \text{b43-open}, respectively). See Section 3.2 [Hardware Considerations], page 22, for more info on supported hardware.

host-name

The host name.

hosts-file

A file-like object (see Section 6.7 [G-Expressions], page 102) for use as \text{/etc/hosts} (see Section “Host Names” in The GNU C Library Reference Manual). The default is a file with entries for \text{localhost} and \text{host-name}.

mapped-devices (default: '() )

A list of mapped devices. See Section 8.4 [Mapped Devices], page 164.

file-systems

A list of file systems. See Section 8.3 [File Systems], page 162.

swap-devices (default: '() )

A list of strings identifying devices or files to be used for “swap space” (see Section “Memory Concepts” in The GNU C Library Reference Manual).
ual). For example, ‘("/dev/sda3") or ‘("/swapfile")'. It is possible to specify a swap file in a file system on a mapped device, provided that the necessary device mapping and file system are also specified. See Section 8.4 [Mapped Devices], page 164, and Section 8.3 [File Systems], page 162.

**users** (default: %base-user-accounts)

**groups** (default: %base-groups)

List of user accounts and groups. See Section 8.5 [User Accounts], page 166.

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 target file name/file-like object tuples (see Section 6.7 [G-Expressions], page 102). 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)

The set of packages installed in the global profile, which is accessible at /run/current-system/profile.

The default set includes core utilities and it is good practice to install non-core utilities in user profiles (see Section 4.2 [Invoking guix package], page 35).

**timezone**

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 8.7 [Locales], page 170, for more information.

**locale-definitions** (default: %default-locale-definitions)

The list of locale definitions to be compiled and that may be used at runtime. See Section 8.7 [Locales], page 170.
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 8.7 [Locales], page 170, 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 8.11 [Name Service Switch], page 367, for details.

services (default: %base-services)
   A list of service objects denoting system services. See Section 8.8 [Services], page 172.

essential-services (default: ...)
   The list of “essential services”—i.e., things like instances of system-service-type and host-name-service-type (see Section 8.17.3 [Service Reference], page 389), 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 string-valued G-expressions denoting setuid programs. See Section 8.9 [Setuid Programs], page 365.

sudoers-file (default: %sudoers-specification)
   The contents of the /etc/sudoers file as a file-like object (see Section 6.7 [G-Expressions], page 102).
   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.
8.3 File Systems

The list of file systems to be mounted is specified in the `file-systems` field of the operating system declaration (see Section 8.1 [Using the Configuration System], page 151). 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**

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.

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, 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 8.4 [Mapped Devices], page 164), 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), `strict-atime` (update file access time), `lazy-time` (only update time on the in-memory version of the file inode), and `no-exec` (disallow program execution). 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 and run `man 8 mount` for options for various file systems.

**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 needs to be checked for errors before being mounted.

**create-mount-point?** (default: #f)

When true, the mount point is created if it does not exist yet.

**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 8.4 [Mapped Devices], page 164).

The *(gnu system file-systems)* exports the following useful variables.
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%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 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.

8.4 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. 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. Other examples, not yet implemented, are LVM logical volumes.

Mapped devices are declared using the mapped-device form, defined as follows; for examples, see below.

---

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).
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.

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.

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.

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 8.3 [File Systems], page 162).

(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 3.4 [Disk Partitioning], page 24, 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 8.3 [File Systems], page 162). 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.

8.5 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")
  (home-directory "/home/alice"))

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.
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 6.7 [G-Expressions], page 102).

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.


User group declarations are even simpler:

```
(user-group (name "students"))
```

user-group
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
  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
  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.

### 8.6 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 8.13 [Bootloader Configuration], page 371). 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 8.2 [operating-system Reference], page 158).
- The **graphical display server**, usually Xorg, also has its own idea of the keyboard layout (see Section 8.8.5 [X Window], page 205).

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. Here are a few example:

```
;; The German QWERTZ layout. Here we assume a standard
```
;; "pc105" keyboard model.
(bootstrap "de")

;; The bépo variant of the French layout.
(bootstrap "fr" "bepo")

;; The Catalan layout.
(bootstrap "es" "cat")

;; Arabic layout with "Alt-Shift" to switch to US layout.
(bootstrap "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.
(bootstrap "latam"
  #:options '(#"ctrl:nocaps" "compose:menu")

;; The Russian layout for a ThinkPad keyboard.
(bootstrap "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.
(bootstrap "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
  ;; ...
  (bootstrap (bootstrap "tr") ;for the console
  (bootstrap (bootstrap grub-efi-bootloader)
    (target "/boot/efi")
    (bootstrap (bootstrap keyboard-layout))) ;for GRUB
  (bootstrap (bootstrap (bootstrap %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
  ```

### 8.7 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 8.2 [operating-system Reference], page 158).

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 18).

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**

- **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](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 `uk_UA.UTF-8`.

### 8.7.1 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 8.2 [operating-system Reference], page 158). “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. 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.

For example, 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. 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 18).

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`:

```scheme
(use-package-modules base)
```

---

5 Versions 2.23 and later of GNU libc will simply skip the incompatible locale data, which is already an improvement.
(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.

8.8 Services

An important part of preparing an operating-system declaration is listing system services and their configuration (see Section 8.1 [Using the Configuration System], page 151). 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 8.17.1 [Service Composition], page 386), but many services are managed by the GNU Shepherd (see Section 8.17.4 [Shepherd Services], page 393). 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
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.
```

The following sections document the available services, starting with the core services, that may be used in an operating-system declaration.

8.8.1 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 8.17.2 [Service Types and Services], page 387, 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**  
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")))
```

If you want to add, say, /usr/bin/env to your system, you can change it to:

```
'(("/bin/sh" ,(file-append bash " /bin/sh"))
   ("/usr/bin/env" ,(file-append coreutils " /bin/env")))
```

Since this is part of %base-services, you can use modify-services to customize the set of special files (see Section 8.17.3 [Service Reference], page 389). But the simple way to add a special file is via the extra-special-file procedure (see below.)

**extra-special-file file target**  
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**  
Return a service that sets the host name to name.

**console-font-service-type**  
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"))
```

Since this is part of %base-services, you can use modify-services to customize the set of special files (see Section 8.17.3 [Service Reference], page 389). But the simple way to add a special file is via the extra-special-file procedure (see below.)

**login-service config**  
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**

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**

Return a service to run mingetty according to `config`, a `<mingetty-configuration>` object, which specifies the tty to run, among other things.

**mingetty-configuration**

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.
- **mingetty** (default: mingetty)
  
  The Mingetty package to use.

**agetty-service config**

Return a service to run agetty according to `config`, an `<agetty-configuration>` object, which specifies the tty to run, among other things.

**agetty-configuration**

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.

croot (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 in-
   terpreted 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.

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.

kmscon (default: kmscon)
The Kmscon package to use.

\texttt{nsdc-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 \texttt{<nscd-configuration>} object. See Section 8.11 [Name Service Switch], page 367, for an example.

For convenience, the Shepherd service for nscd provides the following actions:

\texttt{invalidate}
This invalidate the given cache. For instance, running:
\begin{verbatim}
  herd invalidate nscd hosts
\end{verbatim}
invalidates the host name lookup cache of nscd.

\texttt{statistics}
Running \texttt{herd statistics nscd} displays information about nscd usage and caches.

\texttt{%nscd-default-configuration}  [Scheme Variable]
This is the default \texttt{<nscd-configuration>} value (see below) used by \texttt{nsdc-service}. It uses the caches defined by \texttt{%nscd-default-caches}; see below.

\texttt{nsdc-configuration}  [Data Type]
This is the data type representing the name service cache daemon (nscd) configuration.

\texttt{name-services} (default: '())
List of packages denoting name services that must be visible to the nscd—e.g., (list nss-mdns).

\texttt{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 \texttt{<nscd-cache>} objects denoting things to be cached; see below.
nscl-d-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.

%nscl-d-default-caches  [Scheme Variable]
List of `<nscl-d-cache>` objects used by default by `nscl-d-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 14). 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 14, 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` (see Section 4.3 [Substitutes], page 43).

**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 4.11 [Invoking guix archive], page 60). By default, it contains that of `ci.guix.gnu.org` (see Section 4.3 [Substitutes], page 43).

**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.

**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: `'bzip2`)
The type of compression used for build logs—one of `gzip`, `bzip2`, or `none`.

**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:

```
```
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.

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 and file->udev-rule from (gnu services base) simplify the creation of such rule files.

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"))))

The herd rules udev command, as root, returns the name of the directory containing all the active udev rules.

Here we show how the default udev-service can be extended with it.

(operating-system
  ;; ...
  (services
    (modify-services %desktop-services
      (udev-service-type config =>
        (udev-service-configuration (inherit config)
          (rules (append (udev-configuration-rules config)
                        (list %example-udev-rule)))))))

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)
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 field of the operating-system record.

```
(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")))))

  (groups (cons (user-group (system? #t) (name "adbusers"))
            %base-groups))

  ;; ...

  (services
   (modify-services %desktop-services
    (udev-service-type
     config =>
     (udev-configuration (inherit config)
      (rules (cons android-udev-rules
               (udev-configuration-rules config))))))))

(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**  
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 representing the configuration of GPM.

- **options** (default: *%default-gpm-options*)  

- **gpm** (default: *gpm*)  
  The GPM package to use.

**guix-publish-service-type**  
This is the service type for *guix publish* (see Section 7.10 [Invoking guix publish], page 140). 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 4.11 [Invoking guix archive], page 60). If that is not the case, the service will fail to start.

**guix-publish-configuration**  
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.

- **compression** (default: '(*("gzip" 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.

  An empty list disables compression altogether.

- **nar-path** (default: "nar")  
  The URL path at which “nars” can be fetched. See Section 7.10 [Invoking guix publish], page 140, 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 7.10 [Invoking guix publish], page 140, 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 7.10 [Invoking guix publish], page 140, 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 7.10 [Invoking guix publish], page 140, 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 'rt prio 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.

8.8.2 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 cr on 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 4.5 [Invoking guix gc], page 46) daily, as well as the mkid command on behalf of an unprivileged user (see Section “mkid invocation” in ID Database Utilities). It uses gexp s to introduce job definitions that are passed to mcron (see Section 6.7 [G-Expressions], page 102).

(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"))))

(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
  ;; ...
  (services (cons (service mcron-service-type
                   (mcron-configuration
                    (jobs (list garbage-collector-job
                           updatedb-job
                           idutils-job))))
            %base-services)))

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 6.7
[G-Expressions], page 102). 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)))
         #$begin
               (define %min-level 20)
(use-modules (guix build utils)
  (ice-9 popen)
  (ice-9 regex)
  (ice-9 textual-ports)
  (srfi srfi-2))
(setenv "LC_ALL" "C") ; ensure English output
(and-let* ((input-pipe (open-pipe* OPEN_READ
  #$(@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 it additional job specifications (see Section 8.17.1 [Service Composition], page 386). In other words, it is possible to define services that provide additional mcron jobs to run.

**mcron-configuration** [Data Type]

Data type representing the configuration of mcron.

**mcron** (default: mcron)

The mcron package to use.

**jobs**

This is a list of gexp (see Section 6.7 [G-Expressions], page 102), where each gexp corresponds to an mcron job specification (see Section “Syntax” in GNU mcron).

### 8.8.3 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 \textit{rotation}, should you need to do that (usually, services that produce log files already take care of that):

\begin{verbatim}
(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)))
\end{verbatim}

\textbf{rottlog-service-type} [Scheme Variable]
This is the type of the Rottlog service, whose value is a \textit{rottlog-configuration} object.

Other services can extend this one with new \textit{log-rotation} objects (see below), thereby augmenting the set of files to be rotated.

This service type can define \texttt{mcron} jobs (see Section 8.8.2 [Scheduled Job Execution], page 184) to run the rottlog service.

\textbf{rottlog-configuration} [Data Type]
Data type representing the configuration of rottlog.

\begin{itemize}
    \item \texttt{rottlog} (default: \texttt{rottlog})
        The Rottlog package to use.
    \item \texttt{rc-file} (default: \texttt{(file-append rottlog "/etc/rc")})
        The Rottlog configuration file to use (see Section “Mandatory RC Variables” in \textit{GNU Rot[t]log Manual}).
    \item \texttt{rotations} (default: \texttt{%default-rotations})
        A list of \textit{log-rotation} objects as defined below.
    \item \texttt{jobs}
        This is a list of \texttt{gexp}s where each \texttt{gexp} corresponds to an \texttt{mcron} job specification (see Section 8.8.2 [Scheduled Job Execution], page 184).
\end{itemize}

\textbf{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 \textit{GNU Rot[t]log Manual}), a log rotation might be defined like this:

\begin{verbatim}
(log-rotation
    (frequency 'daily)
    (files '("/var/log/apache/"))
\end{verbatim}
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: '())

The list of rottlog options for this rotation (see Section “Configuration parameters” in GNU Rot[t]lg 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")).

### 8.8.4 Networking Services

The (gnu services networking) module provides services to configure the network interface.

**dhcp-client-service-type** [Scheme Variable]

This is the type of services that run dhcp, a Dynamic Host Configuration Protocol (DHCP) client, on all the non-loopback network interfaces. Its value is the DHCP client package to use, *isc-dhcp* by default.

**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]

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/products/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 6.7 [G-Expressions], page 102). 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.

static-networking-service-type
This is the type for statically-configured network interfaces.

static-networking-service interface ip [#:netmask #f] [#:gateway #f] [#:name-servers '()] [#:requirement '(udev)]
[Scheme Procedure]
Return a service that starts interface with address ip. If netmask is true, use it as the network mask. If gateway is true, it must be a string specifying the default network gateway. requirement can be used to declare a dependency on another service before configuring the interface.

This procedure can be called several times, one for each network interface of interest. Behind the scenes what it does is extend static-networking-service-type with additional network interfaces to handle.

For example:

(static-networking-service "eno1" "192.168.1.82"
 #:gateway "192.168.1.2"
 #:name-servers "("192.168.1.2")")

wicd-service [#:wicd wicd]
[Scheme Procedure]
Return a service that runs Wicd (https://launchpad.net/wicd), a network management daemon that aims to simplify wired and wireless networking.

This service adds the wicd package to the global profile, providing several commands to interact with the daemon and configure networking: wicd-client, a graphical user interface, and the wicd-cli and wicd-curses user interfaces.
modem-manager-service-type

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 8.8.7 [Desktop Services], page 223).

modem-manager-configuration

Data type representing the configuration of ModemManager.

modem-manager (default: modem-manager)
The ModemManager package to use.

usb-modeswitch-service-type

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 8.8.7 [Desktop Services], page 223).

usb-modeswitch-configuration

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.

network-manager-service-type

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 8.8.7 [Desktop Services], page 223).
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 name-
server, 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 32). With a host-to-guest connection, you can e.g. access a Web
server running on the VM (see Section 8.8.16 [Web Services],
page 284) from a Web browser on your host system, or connect to the VM via SSH (see Section 8.8.4 [Networking Ser-
vices], page 188). 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 8.16 [Running Guix in a VM], page 384), pass
-nic tap,ifname=tap0,script=no,dns=none,dns=None 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 a `connman-configuration` record as in this example:

```scheme
(s 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/](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.

- `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.

**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.

```scheme
(s service iptables-service-type
  (iptables-configuration
    (ipv4-rules (plain-file "iptables.rules" "*filter

:INPUT ACCEPT
```


:FORWARD ACCEPT
:OUTPUT 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 -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 6.7 [G-Expressions], page 102).

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 6.7 [G-Expressions], page 102).

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 6.7 [G-Expressions], page 102).
**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.

```scheme
(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.

```scheme
(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/"))
(allow-large-adjustment? #t)))

%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.
allow-large-adjustment? (default: #f)
Determines if ntpd is allowed to make an initial adjustment of more than 180 seconds.

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`:

```lisp
(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 argu-
ments, starting with the zeroth argument, i.e. the name of the pro-
gram 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.

tor-service-type  [Scheme Variable]
This is the type for a service that runs the Tor (https://torproject.org) anony-
mous 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) implemen-
tation.

config-file (default: (plain-file "empty" ""))
The configuration file to use. It will be appended to a default config-
uration file, and the final configuration file will be passed to tor via
its -f option. This may be any “file-like” object (see Section 6.7 [G-
Expressions], page 102). 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.

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:

(service rsync-service-type)

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.

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.

use-chroot? (default: #t)
Whether to use chroot for rsync shared directory.

share-path (default: /srv/rsync)
Location of the rsync shared directory.

share-comment (default: "Rsync share")
Comment of the rsync shared directory.

read-only? (default: #f)
Read-write permissions to shared directory.

timeout (default: 300)
I/O timeout in seconds.

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.

Furthermore, (gnu services ssh) provides the following services.

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**  
This is the type for the OpenSSH (http://www.openssh.org) secure shell daemon, ssd. Its value must be an openssh-configuration record as in this example:

```
(service openssh-service-type  
  (openssh-configuration  
    (x11-forwarding? #t)  
    (permit-root-login 'without-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**  
This is the configuration record for OpenSSH’s ssd.

- **pid-file** (default: "/var/run/sshd.pid")
  Name of the file where ssd writes its PID.

- **port-number** (default: 22)
  TCP port on which ssd listens for incoming connections.

- **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 ‘without-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, \texttt{ssh} options \texttt{-X} and \texttt{-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 \texttt{challenge-response-authentication?} and \texttt{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 \texttt{challenge-response-authentication?} or \texttt{password-authentication?}.

print-last-log? (default: #t)
Specifies whether \texttt{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 \texttt{internal-sftp} implements an in-process SFTP server. Alternately, one can specify the \texttt{sftp-server} command:

\begin{verbatim}
(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 \texttt{AcceptEnv} option in \texttt{man sshd_config}.
This example allows ssh-clients to export the \texttt{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.

\[
\begin{align*}
\text{(service openssh-service-type)} \\
&\quad (\text{openssh-configuration}) \\
&\quad \text{(accepted-environment'("COLOTERM"))})
\end{align*}
\]

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:

\[
\begin{align*}
&\quad (\text{openssh-configuration}) \\
&\quad \text{(authorized-keys}) \\
&\quad \quad '(('rekado" ,\text{(local-file "rekado.pub"))} \\
&\quad \quad ("chris" ,\text{(local-file "chris.pub"))}) \\
&\quad \quad ("root" ,\text{(local-file "rekado.pub"))}) \\
\end{align*}
\]
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.

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:

\[
\begin{align*}
&\quad (\text{openssh-configuration}) \\
&\quad \text{(extra-content "\}) \\
&\quad \quad \text{Match Address 192.168.0.1} \\
&\quad \quad \text{PermitRootLogin yes")}) \\
\end{align*}
\]

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:

\[
\begin{align*}
&\quad (\text{dropbear-service (dropbear-configuration}} \\
&\quad \quad \text{(port-number 1234))})
\end{align*}
\]

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.

\%facebook-host-aliases
This variable contains a string for use in /etc/hosts (see Section “Host Names” in The GNU C Library Reference Manual). Each line contains an 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 8.2 [operating-system Reference], page 158):

(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
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 a zero-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 8.11 [Name Service Switch], page 367, 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.
avaahi-configuration

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:

```
avaahi-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

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 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

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:

```scheme
(service pagekite-service-type
  (pagekite-configuration
    (kites '("http:@kitename:localhost:80:@kitesecret" 
       "raw/22:@kitename:localhost:22:@kitesecret")
    (extra-file "/etc/pagekite.rc"))
```
8.8.5 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 8.2 [operating-system Reference], page 158).

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 and allows users to choose a session from the log-in screen. Packages such as gnome, xfce, and i3 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`.

- **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.

- **xsessions** (default: (xinitrc))
  
  Script to run before starting a X session.

- **dbus-daemon** (default: dbus-daemon-wrapper)
  
  File name of the `dbus-daemon` executable.

- **gdm** (default: gdm)
  
  The GDM package to use.

**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.

```scheme
(use-modules (gnu services)
  (gnu services desktop)
  (gnu services xorg)
  (srfi srfi-1)) ;for 'remove'

(operating-system
  ;; ...
  (services (cons* (service slim-service-type (slim-configuration
      (display ":0")
      (vt "vt7")))
    (service slim-service-type (slim-configuration
      (display ":1")
      (vt "vt8")))
    (remove (lambda (service)
      (eq? (service-kind service) gdm-service-type))
      (%desktop-services)))))
```
**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.

- **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-configuration** [Data Type]

This is the data type representing the sddm service configuration.

- **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 
  Command to run when halting.
reboot-command (default 
  Command to run when rebooting.

theme (default "maldives")
  Theme to use. Default themes provided by SDDM are "elarun", "maldives" or "maya".

themes-directory (default 
  Directory to look for themes.

faces-directory (default 
  Directory to look for faces.

default-path (default 
  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 
  Users with shells listed will be hidden from the SDDM greeter.

session-command (default 
  Script to run before starting a wayland session.

sessions-directory (default 
  Directory to look for desktop files starting wayland sessions.

xorg-configuration (default (xorg-configuration))
  Configuration of the Xorg graphical server.

xauth-path (default 
  Path to xauth.

xephyr-path (default 
  Path to Xephyr.
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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.

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 to use for auto-login.

auto-login-session (default 
"")
  Desktop file to use for auto-login.

relogin? (default #f)
  Relogin after logout.

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")
  This must be either "x11" or "wayland".

auto-login-user (default: 
"")
  If non-empty, this is the user account under which to log in automatically.

auto-login-session (default: 
"")
  If non-empty, this is the .desktop file name to use as the auto-login 
  session.
**xorg-configuration**

This data type represents the configuration of the Xorg graphical display server. Note that there is not Xorg service; instead, the X server is started by a “display manager” such as GDM, SDDM, and 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 8.6 [Keyboard Layout], page 168, 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**

```
[login-manager-service-type]

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]

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]  
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.

8.8.6 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

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 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 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  
The CUPS package.

package-list extensions  
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.
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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-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: a .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  [files-configuration parameter]
    system-group
    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  [cups-configuration parameter]
    browse-dns-sd-sub-types
    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  [cups-configuration parameter]
    browse-local-protocols
    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
  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
  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
  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
  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
  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
  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
  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?
  Specifies whether to support HTTP keep-alive connections.
  Defaults to ‘#t’.
non-negative-integer keep-alive-timeout [cups-configuration parameter]

Specifies how long an idle client connection remains open, in seconds.
Defaults to ‘30’.

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 [cups-configuration parameter]

location-access-controls

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 [location-access-controls parameter]

access-controls

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 [location-access-controls parameter]

method-access-controls

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**

Methods to which this access control applies.

Defaults to ‘()’.

**access-control-list**

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**

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**

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**

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**

Specifies the maximum number of simultaneous clients that are allowed by the scheduler.

Defaults to ‘100’.

**non-negative-integer max-clients-per-host**

Specifies the maximum number of simultaneous clients that are allowed from a single address.

Defaults to ‘100’.

**non-negative-integer max-copies**

Specifies the maximum number of copies that a user can print of each job.

Defaults to ‘9999’.

**non-negative-integer max-hold-time**

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**

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 ‘300’.

string page-log-format [cups-configuration parameter]
  Specifies the format of PageLog lines. Sequences beginning with percent (‘%’) char-
  acters 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

Passes the specified environment variable(s) to child processes; a list of strings.
Defaults to ‘()’.

policy-configuration-list

Specifies named access control policies.
Available policy-configuration fields are:

- **string name**
  Name of the policy.

- **string job-private-access**
  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-config 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**
  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**
  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-config 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**
  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 control by IPP operation.
Defaults to ‘()’. 
**boolean-or-non-negative-integer [cups-configuration parameter]**

**preserve-job-files**

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 [cups-configuration parameter]**

**preserve-job-history**

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’.
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**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** [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 disable all CBC cipher suites. The *DenyTLS1.0* option disable 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 ‘300’.

**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
```
8.8.7 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

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 8.8.5 [X Window], page 205), screen lockers, a network management tool (see Section 8.8.4 [Networking Services], page 188) with modem support (see Section 8.8.4 [Networking Services], page 188), 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 8.8.4 [Networking Services], page 188), the Avahi daemon, and has the name service switch service configured to be able to use nss-mdns (see Section 8.11 [Name Service Switch], page 367).

The %desktop-services variable can be used as the services field of an operating-system declaration (see Section 8.2 [operating-system Reference], page 158).

Additionally, the gnome-desktop-service-type, xfce-desktop-service, mate-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 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.  

```plaintext  
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.

**xfce-desktop-configuration**  
[Data Type]  
Configuration record for the Xfce desktop environment.  

```plaintext  
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.  

```plaintext  
mate (default: mate)  
The MATE 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:

```scheme
(use-modules (gnu))
(use-service-modules desktop)

;; 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 ’()]

Return a service that runs the “system bus”, using dbus, with support for services.

D-Bus ([https://dbus.freedesktop.org/](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]

Return a service that runs the elogind login and seat management daemon. Elogind ([https://github.com/elogind/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:

```scheme
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
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]
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]
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
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
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 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: #f)
Whether battery percentage based policy should be used. The default is
to use the time left, change to #t to use the percentage.

percentage-low (default: 10)
When use-percentage-for-policy? is #t, this sets the percentage at
which the battery is considered low.

percentage-critical (default: 3)
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 sec-
onds at which the battery is considered low.

time-critical (default: 300)
When use-time-for-policy? is #f, this sets the time remaining in sec-
onds at which the battery is considered critical.

time-action (default: 120)
When use-time-for-policy? is #f, this sets the time remaining in sec-
onds 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.

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/color/ ) for more
information.
geoclue-application name [#:allowed? #t] [#:system? #f] [#:users '()]
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.

sane-service-type
This service provides access to scanners via SANE (http://www.sane-project.org) by installing the necessary udev rules.

%standard-geoclue-applications
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 '()]
[#: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]
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.

gnome-keyring-service-type
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  
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 \(passwd\).

8.8.8 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  
This is the type for the Advanced Linux Sound Architecture (https://alsa-project.org/) (ALSA) system, which generates the \(\text{/etc/asound.conf}\) configuration file. The value for this type is a \(\text{alsa-configuration}\) record as in this example:

\((\text{service alsa-service-type})\)

See below for details about \(\text{alsa-configuration}\).

alsa-configuration  
Data type representing the configuration for \(\text{alsa-service}\).

alsa-plugins (default: \(\text{alsa-plugins}\))  
\(\text{alsa-plugins}\) 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 \(\text{pavucontrol}\), among other things.

extra-options (default: \"\")  
String to append to the \(\text{/etc/asound.conf}\) file.

Individual users who want to override the system configuration of ALSA can do it with the \(\sim/.asoundrc\) 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"
    }
}


pulseaudio-service-type [Scheme Variable]
This is the type for the PulseAudio ([https://www.pulseaudio.org/](https://www.pulseaudio.org/)) sound server. It exists to allow system overrides of the default settings via pulseaudio-configuration, see below.

**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 a 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 as default.pa.

system-script-file (default: (file-append pulseaudio "/etc/pulse/system.pa"))
   Script file to use as as system.pa.

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))))

8.8.9 Database Services
   The (gnu services databases) module provides the following services.

   [Scheme Procedure]
   Return a service that runs postgresql, the PostgreSQL database server.
   The PostgreSQL daemon loads its runtime configuration from config-file, creates a database cluster with locale as the default locale, stored in data-directory. It then listens on port.
   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)
   (services
      (cons*
         (postgresql-service #: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.

**mysql-service [#:config (mysql-configuration)]**

[Scheme Procedure]

Return a service that runs mysqld, the MySQL or MariaDB database server.

The optional config argument specifies the configuration for mysqld, which should be a <mysql-configuration> object.

**mysql-configuration**

[Data Type]

Data type representing the configuration of mysql-service.

- **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.

- **port** (default: 3306)
  - TCP port on which the database server listens for incoming connections.

**memcached-service-type**

[Scheme Variable]

This is the service type for the Memcached ([https://memcached.org/](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 on.

- **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.

**mongodb-service-type**

[Scheme Variable]

This is the service type for MongoDB ([https://www.mongodb.com/](https://www.mongodb.com/)). The value for the service type is a mongodb-configuration object.

```
(service mongodb-service-type)
```
**mongodb-configuration**  
Data type representing the configuration of mongodb.

`mongodb` (default: `mongodb`)  
The MongoDB package to use.

`config-file` (default: `%(default-mongodb-configuration-file)`)  
The configuration file for MongoDB.

`data-directory` (default: `"/var/lib/mongodb"`)  
This value is used to create the directory, so that it exists and is owned by the mongodb user. It should match the data-directory which MongoDB is configured to use through the configuration file.

**redis-service-type**  
This is the service type for the Redis ([https://redis.io/](https://redis.io/)) key/value store, whose value is a `redis-configuration` object.

**redis-configuration**  
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.

### 8.8.10 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)]`  
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:

```scheme
(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
 The dovecot package.

comma-separated-string-list listen
 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
 List of protocols we want to serve. Available protocols include ‘imap’, ‘pop3’, and ‘lmtp’.

Available protocol-configuration fields are:

string name
 The name of the protocol.

string auth-socket-path
 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”’.

space-separated-string-list mail-plugins
 Space separated list of plugins to load.

non-negative-integer mail-max-userip-connections
 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

Available service-configuration fields are:

string kind
 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

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
Path to the file, relative to base-dir field. This is also used as the section name.

string mode
The access mode for the socket. Defaults to ‘"0600”’.

string user
The user to own the socket. Defaults to ‘””’.

string group
The group to own the socket. Defaults to ‘””’.

Available fifo-listener-configuration fields are:

string path
Path to the file, relative to base-dir field. This is also used as the section name.

string mode
The access mode for the socket. Defaults to ‘"0600”’.

string user
The user to own the socket. Defaults to ‘””’.

string group
The group to own the socket. Defaults to ‘””’.

Available inet-listener-configuration fields are:

string protocol
The protocol to listen for.

string address
The address on which to listen, or empty for all addresses. Defaults to ‘””’.

non-negative-integer

port
The port on which to listen.

boolean ssl?
Whether to use SSL for this service; ‘yes’, ‘no’, or ‘required’. Defaults to ‘#t’.
non-negative-integer \[service-configuration\] parameter
client-limit
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 \[service-configuration\] parameter
service-count
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 \[service-configuration\] parameter
process-limit
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 \[service-configuration\] parameter
process-min-avail
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  
List of userdb configurations, each one created by the userdb-configuration constructor.

Available userdb-configuration fields are:

string driver  
The driver that the userdb should use. Valid values include 'passwd' and 'static'. Defaults to 'passwd'.

space-separated-string-list args  
Space separated list of arguments to the userdb driver. Defaults to '"

free-form-args override-fields  
Override fields from passwd. Defaults to '('.

plugin-configuration  
Plug-in configuration, created by the plugin-configuration constructor.

list-of-namespace-configuration namespaces  
List of namespaces. Each item in the list is created by the namespace-configuration constructor.

Available namespace-configuration fields are:

string name  
Name for this namespace.

string type  
Namespace type: 'private', 'shared' or 'public'. Defaults to 'private'.

string separator  
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  
Prefix required to access this namespace. This needs to be different for all namespaces. For example 'Public/'. Defaults to '"'.

string location  
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?  
There can be only one INBOX, and this setting defines which namespace has it. Defaults to '#f'.

boolean hidden?  
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?  
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 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  
List of predefined mailboxes in this namespace. Defaults to ‘()’.

Available mailbox-configuration fields are:

string name  
Name for this mailbox.

string auto  
‘create’ will automatically create this mailbox. ‘subscribe’ will both create and subscribe to the mailbox. Defaults to ‘"no"’.

space-separated-string-list  
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  
Base directory where to store runtime data. Defaults to ‘"/var/run/dovecot/"’.

string login-greeting  
Greeting message for clients. Defaults to ‘"Dovecot ready."’.

space-separated-string-list  
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 [dovecot-configuration parameter]
  login-access-sockets
  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 [dovecot-configuration parameter]
  doveadm-worker-count
  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 [dovecot-configuration parameter]
  import-environment
  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  [dovecot-configuration parameter]
          auth-realms
          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 ”%

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><seperator><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  [dovecot-configuration parameter]
          auth-worker-max-count
          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’.

c-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’,
        ‘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**
  - 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
    - %v
      - 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, eg.:
    - ‘%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 over-
ride 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 "".

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 ‘0_EXCL’ to work when creating dotlock files. NFS supports ‘0_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
   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
   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 [dovecot-configuration parameter]
mail-plugins
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 [dovecot-configuration parameter]
mail-cache-min-mail-count
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 [dovecot-configuration parameter]
mbox-read-locks
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 im-
portant 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 [dovecot-configuration parameter]
mbox-write-locks

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 [dovecot-configuration parameter]
mbox-min-index-size
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 [dovecot-configuration parameter]
mdbbox-rotate-size
Maximum dbox file size until it’s rotated. Defaults to ’10000000’.
stringMDBbox-rotate-interval[dovecot-configurationparameter]
MaximumMDBboxfileageuntilit’srotated.Typicallyindays.Daybeginsfrommidnight,so1d=today,2d=yesterday,etc.0=checkdisabled.Defaultsto‘"1d"’.

booleanMDBbox-preallocate-space?[dovecot-configurationparameter]
WhencreatingnewMDBboxfiles,immediatelypreallocatetheirsizeof‘MDBbox-rotate-size’.ThissettingcurrentlyworksonlyinLinuxwithsomefilesystems(ext4,xfs).Defaultsto‘"f"’.

stringmail-attachment-dir[dovecot-configurationparameter]
sdboxandMDboxsupportsavingmailboxattachmentstoexternalfiles,whichalsolowssingleinstancestorageforthem.Otherbackendsdon’tsupportthisfornow.
WARNING:Thisfeaturehasn’tbtestestedmuchyet.Useatyourownrisk.
Directoryrootwheretostoremailboxattachments.Disabled,ifempty.Defaultsto‘""’.

non-negative-integermail-attachment-min-size[dovecot-configurationparameter]
Attachmentssmallerthanthisaren’tsavedexternally.It’salsopossibletowriteapluginabledisablesavingspecificattachmentsexternally.Defaultsto‘128000’.

stringmail-attachment-fsd[dovecot-configurationparameter]
Filesystembackendtouseforsavingattachments:
posixNoSiSdonebyDovecot(butthismighthelpFS’sowndeduplication)
sisposixSiSwithimmediatebyte-by-bytecomparisonduringsaving
sis-queueposixSiSwithdelayedcomparisonanddeduplication.

Defaults to ‘"sis posix"’.

stringmail-attachment-hash[dovecot-configurationparameter]
Hashformattousedinattachmentfilenames.Youcanaddanytextandvariables:
%{md4},%{md5},%{sha1},%{sha512},%{size}.Variablescanbetruncated,goalg.%{sha256:80}returnsonlyfirst80bits.Defaultsto‘"%{sha1}"’.

non-negative-integerdefault-process-limit[dovecot-configurationparameter]
Defaults to ‘100’.

non-negative-integerdefault-client-limit[dovecot-configurationparameter]
Defaults to ‘1000’.

non-negative-integerdefault-vsz-limit[dovecot-configurationparameter]
DefaultVSZ(virtualmemorysize)limitforserviceprocesses.Thisismainlyintended
tocatchandkillprocessesthatleakmemorybeforesentheyeatupeverything.Defaultsto‘256000000’.

stringMDBbox-rotate-interval[dovecot-configurationparameter]
Maximum MDBbox 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 MDBbox-preallocate-space? [dovecot-configuration parameter]
When creating new MDBbox files, immediately preallocate their size to ‘MDBbox-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]
dsbox and MDBbox 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}, %{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]
PESM encoded X.509 SSL/TLS certificate (public key). Defaults to "</etc/dovecot/default.pem".

string ssl-key [dovecot-configuration parameter]
PESM 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]
PESM 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. De-
  fault 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    \%n   CRLF
  \%r   reason
  \%s   original subject
  \%t   recipient
  Defaults to ‘Your message to <\%t> was automatically rejected:\n
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  [dovecot-configuration parameter]
  imap-max-line-length
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 argu-
ment" 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  [dovecot-configuration parameter]
imap-client-workarounds
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-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.


**Exim Service**

**exim-service-type**  
This is the type of the Exim ([https://exim.org](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 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**  
This is the type of the Getmail ([http://pyropus.ca/software/getmail/](http://pyropus.ca/software/getmail/)) mail retriever, whose value should be a getmail-configuration.

Available getmail-configuration fields are:

- **symbol name**  
  A symbol to identify the getmail service. Defaults to "unset".

- **package package**  
  The getmail package to use.

- **string user**  
  The user to run getmail as. Defaults to "getmail".

- **string group**  
  The group to run getmail as. Defaults to "getmail".

- **string directory**  
  The getmail directory to use. Defaults to "/var/lib/getmail/default".
**getmail-configuration-file** rcfile

The getmail configuration file to use.

Available **getmail-configuration-file** fields are:

**getmail-retriever-configuration**

**retriever**

What mail account to retrieve mail from, and how to access that account.

Available **getmail-retriever-configuration** fields are:

**string type**

The type of mail retriever to use. Valid values include ‘passwd’ and ‘static’.

Defaults to ‘"SimpleIMAPSSLRetriever"’.

**string server**

Username to login to the mail server with.

Defaults to ‘unset’.

**string username**

Username to login to the mail server with.

Defaults to ‘unset’.

**non-negative-integer**

**port**

Port number to connect to.

Defaults to ‘#f’.

**string password**

Override fields from passwd.

Defaults to ‘””’.

**list**

**password-command**

Override fields from passwd.

Defaults to ‘(‘).

**string keyfile**

PEM-formatted key file to use for the TLS negotiation.

Defaults to ‘””’.

**string certfile**

PEM-formatted certificate file to use for the TLS negotiation.

Defaults to ‘””’.

**string ca-certs**

CA certificates to use.

Defaults to ‘””’.
parameter-alist

extra-parameters
Extra retriever parameters.
Defaults to ‘()’.

getchain-retriever-configuration

getchain-configuration-file parameter

destination
What to do with retrieved messages.
Available getchain-configuration fields are:

string type
The type of mail destination. Valid values include ‘Maildir’, ‘Mboxrd’ and ‘MDA_external’.
Defaults to ‘unset’.

string-or-filelike path
The path option for the mail destination. The behaviour depends on the chosen type.
Defaults to ‘”’.

parameter-alist
Extra destination parameters
Defaults to ‘()’.

getchain-options-configuration
options
Configure getchain.
Available getchain-options-configuration fields are:

non-negative-integer verbose
If set to ‘0’, getchain 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’, getchain will print messages about each of it’s actions.
Defaults to ‘1’.

boolean read-all
If true, getchain will retrieve all available messages. Otherwise it will only retrieve messages it hasn’t seen previously.
Defaults to ‘#t’.

boolean delete
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 [getmail-options-configuration parameter] delete-after
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 [getmail-options-configuration parameter] delete-bigger-than
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 [getmail-options-configuration parameter] max-bytes-per-session
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 [getmail-options-configuration parameter] max-message-size
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 [getmail-options-configuration parameter] message-log-syslog
If true, getmail will record a log of its actions using the system logger.
Defaults to ‘#f’.
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boolean [getmail-options-configuration parameter]
message-log-verbose
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 [getmail-options-configuration parameter]
extra-parameters
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 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.

8.8.11 Messaging Services

The (gnu services messaging) module provides Guix service definitions for messaging services: currently only Prosody is supported.

Prosody Service

prosody-service-type

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 ’disabled.
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 6.7 [G-Expressions], page 102) or a file name.

Available `prosody-configuration` fields are:

```
package prosody  
  The Prosody package.

file-name data-path  
  Location of the Prosody data storage directory. See https://prosody.im/doc/configure. Defaults to ‘"/var/lib/prosody"’.

file-object-list plugin-paths  
  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  
  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  
  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?  
  Enable use of libevent for better performance under high load. See https://prosody.im/doc/libevent. Defaults to ‘#f’.

module-list modules-enabled  
  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  
  ‘"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  
  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 [prosody-configuration parameter]

virtualhosts
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 [prosody-configuration parameter]

int-components
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 [int-component-configuration parameter]

mod-muc
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 [prosody-configuration parameter]
ext-components
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  [prosody-configuration parameter]
    component-ports
    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:

(same 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
            interface "127.0.0.1"
            port 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/](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/](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"`)Read 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.

### 8.8.12 Telephony Services

This section describes how to set up and run a Murmur server. Murmur is the server of the Mumble ([https://mumble.info](https://mumble.info)) voice-over-IP (VoIP) suite.

**murmur-configuration** [Data Type]The service type for the Murmur server. An example configuration can look like this:

```scheme
(service murmur-service-type
 (murmur-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 murmur 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 `murmur-configuration` fields are:

- **package** (default: `mumble`)
  - Package that contains `bin/murmurd`.
- **user** (default: "murmur")
  - User who will run the Murmur server.
- **group** (default: "murmur")
  - Group of the user who will run the murmur 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/murmur/db.sqlite")
  - File name of the sqlite database. The service’s user will become the owner of the directory.
- **log-file** (default: "/var/log/murmur/murmur.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 murmur 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 murmur server version be exposed in ping requests.

log-days (default: 31)
   Murmur 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 Murmur log to ensure that Murmur is using the cipher suites that you expected it to.

Note: Changing this option may impact the backwards compatibility of your Murmur server, and can remove the ability for older Mumble clients to be able to connect to it.

public-registration (default: #f)
Must be a <murmur-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.

murmur-public-registration-configuration
Configuration for public registration of a murmur 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.

8.8.13 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 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 6.7 [G-Expressions], page 102).

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"))))

tailon-configuration-file

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
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 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
  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 record as in this example:

```
(service prometheus-node-exporter-service-type
  (prometheus-node-exporter-configuration
   (web-listen-address ":9100")))
```

prometheus-node-exporter-configuration
  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.

Zabbix server
Zabbix provides monitoring metrics, among others network utilization, CPU load and disk space consumption:
- High performance, high capacity (able to monitor hundreds of thousands of devices).
- Auto-discovery of servers and network devices and interfaces.
- Low-level discovery, allows to automatically start monitoring new items, file systems or network interfaces among others.
- Distributed monitoring with centralized web administration.
- Native high performance agents.
- SLA, and ITIL KPI metrics on reporting.
- High-level (business) view of monitored resources through user-defined visual console screens and dashboards.
- Remote command execution through Zabbix proxies.

Available zabbix-server-configuration fields are:

package zabbix-server
  The zabbix-server package.
string user  
User who will run the Zabbix server.
Defaults to "zabbix".

group group  
Group who will run the Zabbix server.
Defaults to "zabbix".

string db-host  
Database host name.
Defaults to "127.0.0.1".

string db-name  
Database name.
Defaults to "zabbix".

string db-user  
Database user.
Defaults to "zabbix".

string db-password  
Database password. Please, use include-files with DBPassword=SECRET inside a specified file instead.
Defaults to "".

number db-port  
Database port.
Defaults to '5432'.

string log-type  
Specifies where log messages are written to:

- system - syslog.
- file - file specified with log-file parameter.
- console - standard output.

Defaults to "".

string log-file  
Log file name for log-type file parameter.
Defaults to "'/var/log/zabbix/server.log'".

string pid-file  
Name of PID file.
Defaults to "'/var/run/zabbix/zabbix_server.pid'".

string ssl-ca-location  
The location of certificate authority (CA) files for SSL server certificate verification.
Defaults to "'/etc/ssl/certs/ca-certificates.crt'".
string ssl-cert-location  
Location of SSL client certificates.
Defaults to "/etc/ssl/certs".

string extra-options  
Extra options will be appended to Zabbix server configuration file.
Defaults to "".

include-files include-files  
You may include individual files or all files in a directory in the configuration file.
Defaults to '()'.

Zabbix agent
Zabbix agent gathers information for Zabbix server.

Available zabbix-agent-configuration fields are:

package zabbix-agent  
The zabbix-agent package.

string user  
User who will run the Zabbix agent.
Defaults to "zabbix".

group group  
Group who will run the Zabbix agent.
Defaults to "zabbix".

string hostname  
Unique, case sensitive hostname which is required for active checks and must match hostname as configured on the server.
Defaults to "Zabbix server".

string log-type  
Specifies where log messages are written to:
- system - syslog.
- file - file specified with log-file parameter.
- console - standard output.
Defaults to "".

string log-file  
Log file name for log-type file parameter.
Defaults to "/var/log/zabbix/agent.log".

string pid-file  
Name of PID file.
Defaults to "/var/run/zabbix/zabbix_agent.pid".


list server
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.
Defaults to ‘("127.0.0.1")’.

list server-active
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.
Defaults to ‘("127.0.0.1")’.

string extra-options
Extra options will be appended to Zabbix server configuration file.
Defaults to ‘""’.

include-files
You may include individual files or all files in a directory in the configuration file.
Defaults to ‘()’.

Zabbix front-end
This service provides a WEB interface to Zabbix server.
Available zabbix-front-end-configuration fields are:

nginx-server-configuration-list
NGINX configuration.

string db-host
Database host name.
Defaults to ‘"localhost"’.

number db-port
Database port.
Defaults to ‘5432’.

string db-name
Database name.
Defaults to ‘"zabbix"’.

string db-user
Database user.
Defaults to ‘"zabbix"’.

string db-password
Database password. Please, use db-secret-file instead.
Defaults to ‘""’.
string db-secret-file

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.
Defaults to "".

string zabbix-host

Zabbix server hostname.
Defaults to "localhost".

number zabbix-port

Zabbix server port.
Defaults to ‘10051’.

8.8.14 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

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

**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

**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**
A service type for the Kerberos 5 PAM module.

**pam-krb5-configuration**
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.
8.8.15 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 8.11 [Name Service Switch], page 367, 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

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

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

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

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

Specifies the credentials with which to bind. This option is only applicable when used with binddn.

Defaults to ‘disabled’.

maybe-string rootpwmoddn

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

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

Specifies the SASL mechanism to be used when performing SASL authentication.

Defaults to ‘disabled’.

maybe-string sasl-realm

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 connection 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-reqcrt-option tls-reqcrt [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 authentication. 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 [nslcd-configuration parameter]
nss-initgroups-ignoreusers
This option prevents group membership lookups through LDAP for the specified users. Alternatively, the value 'all-local may be used. With that value nsclcd 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
  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

  List of pam service names for which LDAP authentication should suffice.

  Defaults to ‘()’. 

8.8.16 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

  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

  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**  
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**  
A default list of `httpd-module` objects.

**httpd-config-file**  
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_fcg.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
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.

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")]))))

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.
(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.

(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 "\n/etc/nginx/modules/ngx_http_accept_language_module.so")))

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.

**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 290, 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.
**Data Type**

`varnish-configuration`

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:

  ```scheme
  (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.


- **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**

Service type for Patchwork.

The following example is an example of a minimal service for Patchwork, for the `patchwork.example.com` domain.

```scheme
(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 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](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](https://bugs.gnu.org)). Mumi is a Web server, but it also fetches and indexes mail retrieved from Debbugs.
mumi-service-type

This is the service type for Mumi.

mumi-configuration

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

A service type for the `fcgiwrap` FastCGI proxy.

fcgiwrap-configuration

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 (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.

```plaintext
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.address: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-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 it’s 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 [Scheme Procedure]
(string-append "/var/run/php" (version-major (package-version php)) 
"-fpm.sock")]
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 [:path "/var/cache/cat-avatar-generator"] [:package cat-avatar-generator] [:configuration (nginx-server-configuration)]
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:

```scheme
(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/](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

The service type for hpcguix-web.

### hpcguix-web-configuration

Data type for the hpcguix-web service configuration.

- **specs**
  A gexp (see Section 6.7 [G-Expressions], page 102) 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 Section 4.7 [Channels], page 52).
  - **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](https://github.com/UMCUGenetics/hpcguix-web/blob/master/hpcweb-configuration.scm)).
The hpcguix-web package to use.

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 8.10 [X.509 Certificates], page 366, for more information on X.509 certificates.

### 8.8.17 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/](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](https://acme-v01.api.letsencrypt.org/directory).

#### certbot-service-type

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-configuration for which to generate certificates and request signatures. Each certificate has a name and several domains.

email Mandatory email used for registration, recovery contact, and important account notifications.

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 8.8.16 [Web Services], page 284, 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`

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 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.

- **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/fullchain.pem and the key is saved to /etc/letsencrypt/live/name/privkey.pem.

8.8.18 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.thekelles.org.uk/dnsmasq/doc.html).

Knot Service

An example configuration of an authoritative server for two zones, one master and one slave, is:

```scheme
(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

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 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)
  

  secret (default: ")"
  
  The secret key itself.

knot-acl-configuration

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 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 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 inexistant records. This delay is usually short because
   you want your new domains to reach everyone quickly.

knot-remote-configuration
   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 se-
      quence. 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 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 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 key-store 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: "ecdsa-p256-sha256")
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.
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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.

disable-any? (default: #f)
   When set, this forbids queries of the ANY type.

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

This is the type of the knot resolver service, whose value should be an knot-resolver-configuration object as in this example:

```
(s service knot-resolver-service-type
  (k 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
    "
    )))
```


knot-resolver-configuration

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

This is the type of the dnsmasq service, whose value should be an dnsmasq-configuration object as in this example:

```
(s service dnsmasq-service-type
  (d dnsmasq-configuration
    (no-resolv? #t)
    (servers "("192.168.1.1")")))
```

dnsmasq-configuration

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.

servers (default: '(())

Specify IP address of upstream servers directly.

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.

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 '()'.

8.8.19 VPN Services
The (gnu services vpn) module provides services related to virtual private networks (VPNs). It provides a client service for your machine to connect to a VPN, and a server service for your machine to host a VPN. Both services use OpenVPN (https://openvpn.net/).

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.

Available openvpn-client-configuration fields are:

package openvpn [openvpn-client-configuration parameter]
The OpenVPN package.
string pid-file [openvpn-client-configuration parameter]
The OpenVPN pid file.
Defaults to "/var/run/openvpn/openvpn.pid".

proto proto [openvpn-client-configuration parameter]
The protocol (UDP or TCP) used to open a channel between clients and servers.
Defaults to 'udp'.

dev dev [openvpn-client-configuration parameter]
The device type used to represent the VPN connection.
Defaults to 'tun'.

string ca [openvpn-client-configuration parameter]
The certificate authority to check connections against.
Defaults to "'/etc/openvpn/ca.crt'".

string cert [openvpn-client-configuration parameter]
The certificate of the machine the daemon is running on. It should be signed by the
authority given in ca.
Defaults to "'/etc/openvpn/client.crt'".

string key [openvpn-client-configuration parameter]
The key of the machine the daemon is running on. It must be the key whose certificate
is cert.
Defaults to "'/etc/openvpn/client.key'".

boolean comp-lzo? [openvpn-client-configuration parameter]
Whether to use the lzo compression algorithm.
Defaults to '#t'.

boolean persist-key? [openvpn-client-configuration parameter]
Don't re-read key files across SIGUSR1 or –ping-restart.
Defaults to '#t'.

boolean persist-tun? [openvpn-client-configuration parameter]
Don't close and reopen TUN/TAP device or run up/down scripts across SIGUSR1 or
–ping-restart restarts.
Defaults to '#t'.

boolean fast-io? [openvpn-client-configuration parameter]
(Experimental) Optimize TUN/TAP/UDP I/O writes by avoiding a call to
poll/epoll/select prior to the write operation.
Defaults to '#f'.

number verbosity [openvpn-client-configuration parameter]
Verbosity level.
Defaults to '3'.
tls-auth-client tls-auth
Add an additional layer of HMAC authentication on top of the TLS control channel to protect against DoS attacks.
Defaults to '#f'.

maybe-string auth-user-pass
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.
Defaults to 'disabled'.

key-usage verify-key-usage?
Whether to check the server certificate has server usage extension.
Defaults to '#t'.

bind bind?
Bind to a specific local port number.
Defaults to '#f'.

resolv-retry resolv-retry?
Retry resolving server address.
Defaults to '#t'.

openvpn-remote-list remote
A list of remote servers to connect to.
Defaults to '()'.

Available openvpn-remote-configuration fields are:

string name
Server name.
Defaults to "my-server".

number port
Port number the server listens to.
Defaults to '1194'.

Available openvpn-server-configuration fields are:

package openvpn
The OpenVPN package.

string pid-file
The OpenVPN pid file.
Defaults to "*/var/run/openvpn/openvpn.pid".

proto proto
The protocol (UDP or TCP) used to open a channel between clients and servers.
Defaults to 'udp'.

dev dev
The device type used to represent the VPN connection.
Defaults to ‘tun’.

string ca
The certificate authority to check connections against.
Defaults to ‘"/etc/openvpn/ca.crt"’.

string cert
The certificate of the machine the daemon is running on. It should be signed by the
authority given in ca.
Defaults to ‘"/etc/openvpn/client.crt"’.

string key
The key of the machine the daemon is running on. It must be the key whose certificate is cert.
Defaults to ‘"/etc/openvpn/client.key"’.

boolean comp-lzo?
Whether to use the lzo compression algorithm.
Defaults to ‘#t’.

boolean persist-key?
Don’t re-read key files across SIGUSR1 or –ping-restart.
Defaults to ‘#t’.

boolean persist-tun?
Don’t close and reopen TUN/TAP device or run up/down scripts across SIGUSR1 or –ping-restart restarts.
Defaults to ‘#t’.

boolean fast-io?
(Experimental) Optimize TUN/TAP/UDP I/O writes by avoiding a call to poll/epoll/select prior to the write operation.
Defaults to ‘#f’.

number verbosity
Verbosity level.
Defaults to ‘3’.

tls-auth-server tls-auth
Add an additional layer of HMAC authentication on top of the TLS control channel to protect against DoS attacks.
Defaults to ‘#f’.

number port
Specifies the port number on which the server listens.
Defaults to ‘1194’.
ip-mask server [openvpn-server-configuration parameter]
An ip and mask specifying the subnet inside the virtual network.
Defaults to "10.8.0.0 255.255.255.0".

cidr6 server-ipv6 [openvpn-server-configuration parameter]
A CIDR notation specifying the IPv6 subnet inside the virtual network.
Defaults to '#f'.

string dh [openvpn-server-configuration parameter]
The Diffie-Hellman parameters file.
Defaults to ""/etc/openvpn/dh2048.pem".

string ifconfig-pool-persist [openvpn-server-configuration parameter]
The file that records client IPs.
Defaults to ""/etc/openvpn/ipp.txt"".

gateway redirect-gateway? [openvpn-server-configuration parameter]
When true, the server will act as a gateway for its clients.
Defaults to '#f'.

boolean client-to-client? [openvpn-server-configuration parameter]
When true, clients are allowed to talk to each other inside the VPN.
Defaults to '#f'.

keepalive keepalive [openvpn-server-configuration parameter]
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.

number max-clients [openvpn-server-configuration parameter]
The maximum number of clients.
Defaults to '100'.

string status [openvpn-server-configuration parameter]
The status file. This file shows a small report on current connection. It is truncated
and rewritten every minute.
Defaults to ""/var/run/openvpn/status"".

openvpn-ccd-list [openvpn-server-configuration parameter]
client-config-dir
The list of configuration for some clients.
Defaults to '()'.
Available openvpn-ccd-configuration fields are:

string name [openvpn-ccd-configuration parameter]
Client name.
Defaults to ""client"".
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ip-mask iroute  [openvpn-ccd-configuration parameter]
Client own network
Defaults to ‘#f’.

ip-mask ifconfig-push  [openvpn-ccd-configuration parameter]
Client VPN IP.
Defaults to ‘#f’.

8.8.20 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 subsys-
tems.
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.

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
A service type for the RPC portmapper daemon.

rpcbind-configuration
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
A service type for the pipefs pseudo file system.

pipefs-configuration
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 8.8.14 [Kerberos Services], page 276).

```scheme
(gss-service-type) [Scheme Variable]
A service type for the Global Security System (GSS) daemon.
```

```scheme
(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.

```scheme
(idmap-service-type) [Scheme Variable]
A service type for the Identity Mapper (IDMAP) daemon.
```

```scheme
(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.
```

### 8.8.21 Continuous Integration

Cuirass (https://git.savannah.gnu.org/cgit/guix/guix-cuirass.git) is a continuous integration tool for Guix. It can be used both for development and for providing substitutes to others (see Section 4.3 [Substitutes], page 43).

The (gnu services cuirass) module provides the following service.

```scheme
(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. Here is an example of a service that polls the Guix repository and builds the packages from a manifest. Some of the packages are defined in the "custom-packages" input, which is the equivalent of `GUIX_PACKAGE_PATH`.

```scheme
(define %cuirass-specs
  '(list
     '((#:name . "my-manifest")
       (#:load-path-inputs . ("guix"))
       (#:package-path-inputs . ("custom-packages"))
       (#:proc-input . "guix")
       (#:proc-file . "build-aux/cuirass/gnu-system.scm")
       (#:proc . cuirass-jobs)
       (#:proc-args . ((subset . "manifests")
                       (systems . ("x86_64-linux"))
                       (manifests . ("config" . "guix/manifest.scm")))))

  (#:inputs . (((#:name . "guix")
                 (#:url . "git://git.savannah.gnu.org/guix.git")
                 (#:load-path . ".")
                 (#:branch . "master")
                 (#:no-compile? . #t))
               ((#:name . "config")
                (#:url . "https://git.example.org/config.git")
                (#:load-path . ".")
                (#:branch . "master")
                (#:no-compile? . #t))
               ((#:name . "custom-packages")
                (#:url . "https://git.example.org/custom-packages.git")
                (#:load-path . ".")
                (#:branch . "master")
                (#:no-compile? . #t)))))

  (service cuirass-service-type
    (cuirass-configuration
     (specifications %cuirass-specs))))
```

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 representing the configuration of Cuirass.

- **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.

database (default: "/var/lib/cuirass/cuirass.db")
Location of sqlite database which contains the build results and previously added specifications.

ttl (default: (* 30 24 3600))
Specifies the time-to-live (TTL) in seconds of garbage collector roots that are registered for build results. This means that build results are protected from garbage collection for at least ttl seconds.

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 6.7 [G-Expressions], page 102) that evaluates to a list of specifications, where a specification is an association list (see Section “Associations Lists” in GNU Guile Reference Manual) whose keys are keywords (#:keyword-example) as shown in the example above.

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 (default: cuirass)
The Cuirass package to use.

8.8.22 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).

```
[Scheme Variable] tlp-service-type
```

The service type for the TLP tool. Its value should be a valid TLP configuration (see below). To use the default settings, simply write:

```
(service tlp-service-type)
```

By default TLP does not need much configuration but most TLP parameters can be tweaked using `tlp-configuration`.

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 `disabled`.

Available `tlp-configuration` fields are:

```
package tlp
The TLP package.

boolean tlp-enable?
Set to true if you wish to enable TLP.
Defaults to `#t`.

string tlp-default-mode
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
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
Same as `disk-idle-ac` but on BAT mode.
Defaults to `2`.

non-negative-integer max-lost-work-secs-on-ac
Dirty pages flushing periodicity, expressed in seconds.
Defaults to `15`.

non-negative-integer max-lost-work-secs-on-bat
Same as `max-lost-work-secs-on-ac` but on BAT mode.
Defaults to `60`.
```
maybe-space-separated-string-list [tlp-configuration parameter]
cpu-scaling-governor-on-ac
   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 [tlp-configuration parameter]
cpu-scaling-governor-on-bat
   Same as cpu-scaling-governor-on-ac but on BAT mode.
   Defaults to ‘disabled’.

maybe-non-negative-integer [tlp-configuration parameter]
cpu-scaling-min-freq-on-ac
   Set the min available frequency for the scaling governor on AC.
   Defaults to ‘disabled’.

maybe-non-negative-integer [tlp-configuration parameter]
cpu-scaling-max-freq-on-ac
   Set the max available frequency for the scaling governor on AC.
   Defaults to ‘disabled’.

maybe-non-negative-integer [tlp-configuration parameter]
cpu-scaling-min-freq-on-bat
   Set the min available frequency for the scaling governor on BAT.
   Defaults to ‘disabled’.

maybe-non-negative-integer [tlp-configuration parameter]
cpu-scaling-max-freq-on-bat
   Set the max available frequency for the scaling governor on BAT.
   Defaults to ‘disabled’.

maybe-non-negative-integer [tlp-configuration parameter]
cpu-min-perf-on-ac
   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 [tlp-configuration parameter]
cpu-max-perf-on-ac
   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 [tlp-configuration parameter]
cpu-min-perf-on-bat
   Same as cpu-min-perf-on-ac on BAT mode.
   Defaults to ‘disabled’.
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maybe-non-negative-integer

cpu-max-perf-on-bat
Same as cpu-max-perf-on-ac on BAT mode.
Defaults to ‘disabled’.

maybe-boolean cpu-boost-on-ac?
Enable CPU turbo boost feature on AC mode.
Defaults to ‘disabled’.

maybe-boolean cpu-boost-on-bat?
Same as cpu-boost-on-ac? on BAT mode.
Defaults to ‘disabled’.

boolean sched-powersave-on-ac?
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?
Same as sched-powersave-on-ac? but on BAT mode.
Defaults to ‘#t’.

boolean nmi-watchdog?
Enable Linux kernel NMI watchdog.
Defaults to ‘#f’.

maybe-string phc-controls
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
Set CPU performance versus energy saving policy on AC. Alternatives are performance, normal, powersave.
Defaults to ‘"performance"’.

string energy-perf-policy-on-bat
Same as energy-perf-policy-ac but on BAT mode.
Defaults to ‘"powersave"’.

space-separated-string-list disks-devices
Hard disk devices.

space-separated-string-list disk-apm-level-on-ac
Hard disk advanced power management level.

space-separated-string-list disk-apm-level-on-bat
Same as disk-apm-bat but on BAT mode.
maybe-space-separated-string-list [tlp-configuration parameter]
  disk-spindown-timeout-on-ac
  Hard disk spin down timeout. One value has to be specified for each declared hard disk.
  Defaults to ‘disabled’.

maybe-space-separated-string-list [tlp-configuration parameter]
  disk-spindown-timeout-on-bat
  Same as disk-spindown-timeout-on-ac but on BAT mode.
  Defaults to ‘disabled’.

maybe-space-separated-string-list [tlp-configuration parameter]
  disk-iosched
  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 [tlp-configuration parameter]
  ahci-runtime-pm-on-ac?
  Enable Runtime Power Management for AHCI controller and disks on AC mode.
  Defaults to ‘disabled’.

maybe-on-off-boolean [tlp-configuration parameter]
  ahci-runtime-pm-on-bat?
  Same as ahci-runtime-pm-on-ac on BAT mode.
  Defaults to ‘disabled’.

non-negative-integer [tlp-configuration parameter]
  ahci-runtime-pm-timeout
  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".

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 [tlp-configuration parameter]

sound-power-save-on-bat
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 Man-
gement.

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 [tlp-configuration parameter]
  usb-autosuspend-disable-on-shutdown?
  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.

  ignore-cpuid-check? (default: #f)
    Ignore cpuid check for supported CPU models.

  thermald (default: thermald)
    Package object of thermald.

8.8.23 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

The service type for mpd.

mpd-configuration

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 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")))))))

8.8.24 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
This is the type of the libvirt daemon (https://libvirt.org). Its value must be a libvirt-configuration.

(scheme-variable "libvirt-service-type"
 (libvirt-configuration
  (unix-sock-group "libvirt")
  (tls-port "16555")))

Available libvirt-configuration fields are:
package libvirt

Libvirt package.

boolean listen-tls?

Flag listening for secure TLS connections on the public TCP/IP port. 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?

Listen for unencrypted TCP connections on the public TCP/IP port. 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

Port for accepting secure TLS connections This can be a port number, or service name

Defaults to "16514".

string tcp-port

Port for accepting insecure TCP connections This can be a port number, or service name

Defaults to "16509".

string listen-addr

IP address or hostname used for client connections.

Defaults to "0.0.0.0".

boolean mdns-adv?

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

Default mDNS advertisement name. This must be unique on the immediate broadcast network.

Defaults to "Virtualization Host <hostname>".

string unix-sock-group

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 if it is desired for libvirtd 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)))

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
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**

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 cases, 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**

Maximum number of concurrent client connections to allow over all sockets combined.

Defaults to 1024.

**integer max-size**

Maximum file size before rolling over.

Defaults to 2MB

**integer max-backups**

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.

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 emulate:

(service qemu-binfmt-service-type
  (qemu-binfmt-configuration
   (platforms (lookup-qemu-platforms "arm" "aarch64" "mips64el"))))

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).

guix-support? (default: #f)
When it is true, QEMU and all its dependencies are added to the build environment of guix-daemon (see Section 2.5 [Invoking guix-daemon], page 14). This allows the binfmt_misc handlers to be used within the build environment, which in turn means that you can transparently build programs for another architecture.

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"))
   (guix-support? #t)))

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.
8.8.25 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 exported6 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.

---
6 By creating the magic file "git-daemon-export-ok" in the repository directory.
Extra options will be passed to `git daemon`, please run `man git-daemon` for more information.

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 8.8.16 [Web Services], page 284, 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 `git-http-service`.

  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 8.8.16 [Web Services], page 284.

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]

  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
```
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(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 8.8.17 [Certificate Services], page 300. 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 8.8.16 [Web Services], page 284.

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 6.7 [G-Expressions], page 102) 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**  
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**  
Path used to store the cgit cache entries.  
Defaults to ‘/var/cache/cgit’.

**integer cache-static-ttl**  
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**  
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**  
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**  
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**  
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**  
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**  
Number which specifies the time-to-live, in minutes, for the cached version of snapshots.  
Defaults to ‘5’.

**integer cache-size**  
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 cgitre 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 a 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 ‘#f’, 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?**  
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**  
URL used as link to a shortcut icon for cgit.  
Defaults to '/favicon.ico'.

**string footer**  
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**  
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**  
The content of the file specified with this option will be included verbatim at the top of all pages.  
Defaults to ''. 

**file-object include**  
Name of a configfile to include before the rest of the current config-file is parsed.  
Defaults to ''. 

**string index-header**  
The content of the file specified with this option will be included verbatim above the repository index.  
Defaults to ''. 

**string index-info**  
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?**  
Flag which, if set to '#t', makes cgit print commit and tag times in the servers timezone.  
Defaults to '#f'. 

**file-object logo**  
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
  URL loaded when clicking on the cgit logo image.
  Defaults to "".

file-object owner-filter
  Command which will be invoked to format the Owner column of the main page.
  Defaults to "".

integer max-atom-items
  Number of items to display in atom feeds view.
  Defaults to '10'.

integer max-commit-count
  Number of entries to list per page in "log" view.
  Defaults to '50'.

integer max-message-length
  Number of commit message characters to display in "log" view.
  Defaults to '80'.

integer max-repo-count
  Specifies the number of entries to list per page on the repository index page.
  Defaults to '50'.

integer max-repodesc-length
  Specifies the maximum number of repo description characters to display on the repository index page.
  Defaults to '80'.

integer max-blob-size
  Specifies the maximum size of a blob to display HTML for in KBytes.
  Defaults to '0'.

string max-stats
  Maximum statistics period. Valid values are 'week', 'month', 'quarter' and 'year'.
  Defaults to "".

mimetype-alist mimetype
  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
  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

Specifies the number of branches to display in the repository "summary" view.
Defaults to ‘10’.

integer summary-log

Specifies the number of log entries to display in the repository "summary" view.
Defaults to ‘10’.

integer summary-tags

Specifies the number of tags to display in the repository "summary" view.
Defaults to ‘10’.

string strict-export

Filename which, if specified, needs to be present within the repository for cgit to allow access to that repository.
Defaults to ‘”’.

string virtual-root

URL which, if specified, will be used as root for all cgit links.
Defaults to ‘”/”’.

repository-cgit-configuration-list

A list of cgit-repo records to use with config.
Defaults to ‘()’.

Available repository-cgit-configuration fields are:

repo-list snapshots

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

Override the default source-filter.
Defaults to ‘””’.

repo-string url

The relative URL used to access the repository.
Defaults to ‘””’.

repo-file-object

about-filter

Override the default about-filter.
Defaults to ‘””’.  

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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  [repository-cgit-configuration parameter]
  commit-filter
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  [repository-cgit-configuration parameter]
  email-filter
Override the default email-filter.
Defaults to ‘’.

maybe-repo-boolean  [repository-cgit-configuration parameter]
  enable-commit-graph?
A flag which can be used to disable the global setting enable-commit-graph?.
Defaults to ‘disabled’.

maybe-repo-boolean  [repository-cgit-configuration parameter]
  enable-log-filecount?
A flag which can be used to disable the global setting enable-log-filecount?.
Defaults to ‘disabled’.
maybe-repo-boolean  
repository-cgit-configuration parameter  
enable-log-linecount?
A flag which can be used to disable the global setting enable-log-linecount?. Defaults to ‘disabled’.

maybe-repo-boolean  
repository-cgit-configuration parameter  
enable-remote-branches?
Flag which, when set to #t, will make cgit display remote branches in the summary and refs views. Defaults to ‘disabled’.

maybe-repo-boolean  
repository-cgit-configuration parameter  
enable-subject-links?
A flag which can be used to override the global setting enable-subject-links?. Defaults to ‘disabled’.

maybe-repo-boolean  
repository-cgit-configuration parameter  
enable-html-serving?
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  
repository-cgit-configuration parameter  
owner-filter
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

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

Override the default maximum statistics period.
Defaults to ‘’.

repo-string name

The value to show as repository name.
Defaults to ‘’.

repo-string owner

A value used to identify the owner of the repository.
Defaults to ‘’.

repo-string path

An absolute path to the repository directory.
Defaults to ‘’.

repo-string readme

A path (relative to repo) which specifies a file to include verbatim as the "About" page for this repo.
Defaults to ‘’.

repo-string section

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

Extra options will be appended to cgitr file.
Defaults to ‘()’.

list extra-options

Extra options will be appended to cgitr file.
Defaults to ‘()’.

However, it could be that you just want to get a cgitr up and running. In that case, you can pass an opaque-cgit-configuration as a record to cgitservice-type. As its name indicates, an opaque configuration does not have easy reflective capabilities.

Available opaque-cgit-configuration fields are:

package cgit

The cgit package.
string string  \[opaque-cgit-configuration parameter\]  

The contents of the \texttt{cgitrc}, as a string.

For example, if your \texttt{cgitrc} is just the empty string, you could instantiate a cgit service like this:

\begin{verbatim}
(service cgit-service-type
   (opaque-cgit-configuration
      (cgitrc ""))
\end{verbatim}

\section*{Gitolite Service}

Gitolite (\url{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 \texttt{git} user, and the provided SSH public key:

\begin{verbatim}
(service gitolite-service-type
   (gitolite-configuration
      (admin-pubkey (plain-file
         "yourname.pub"
         "ssh-rsa AAAA... guix@example.com"))))
\end{verbatim}

Gitolite is configured through a special admin repository which you can clone, for example, if you setup Gitolite on \texttt{example.com}, you would run the following command to clone the admin repository.

\begin{verbatim}
git clone git@example.com:gitolite-admin
\end{verbatim}

When the Gitolite service is activated, the provided \texttt{admin-pubkey} will be inserted into the \texttt{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”.

\section*{gitolite-configuration}  \[Data Type\]  

Data type representing the configuration for \texttt{gitolite-service-type}.

\begin{description}
\item[package] (default: \texttt{gitolite})
  Gitolite package to use.
\item[user] (default: \texttt{git})
  User to use for Gitolite. This will be user that you use when accessing
  Gitolite over SSH.
\item[group] (default: \texttt{git})
  Group to use for Gitolite.
\item[home-directory] (default: "/var/lib/gitolite")
  Directory in which to store the Gitolite configuration and repositories.
\item[rc-file] (default: \texttt{(gitolite-rc-file)})
  A “file-like” object (see Section 6.7 [G-Expressions], page 102), representing the configuration for Gitolite.
\end{description}
**admin-pubkey** (default: 

A “file-like” object (see Section 6.7 [G-Expressions], page 102) 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 representing the Gitolite RC file.

**umask** (default: 

This controls the permissions Gitolite sets on the repositories and their contents.

A value like `

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.

**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] ["WITERS" . ])

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.

### 8.8.26 Game Services

#### The Battle for Wesnoth Service

The Battle for Wesnoth ([https://wesnoth.org](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**

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 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.
8.8.27 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`  
Service type for PAM Mount support.

**pam-mount-configuration**  
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 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).

8.8.28 Guix Services

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

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.

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.
commit-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.

Linux Services

8.8.29 Early OOM Service

Early OOM ([https://github.com/rfjakob/earlyoom](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:

(serves 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.
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.

8.8.29.1 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 it’s 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)))

8.8.30 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.

(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:
  \[
  \text{(service sysctl-service-type}
  \text{ (sysctl-configuration}
  \text{ (settings '("net.ipv4.ip_forward" . "1")))))
  \]

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: '())
  An association list specifies kernel parameters and their values.

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:
  \[
  \text{(service pcscd-service-type)}
  \]

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]  [Scheme Procedure]
  [#:config-file #f] [#:extra-options '()]
  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.

\[\text{spice-vdagent-service}\ [\#:\text{spice-vdagent}] \]  
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.

\[\text{inputattach-service-type}\]  
Type of a service that runs inputattach on a device and dispatches events from it.

\[\text{inputattach-configuration}\]  
\begin{itemize}
  \item \text{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.
  \item \text{device} (default: "/dev/ttyS0")
  The device file to connect to the device.
  \item \text{baud-rate} (default: \#f)
  Baud rate to use for the serial connection. Should be a number or \#f.
  \item \text{log-file} (default: \#f)
  If true, this must be the name of a file to log messages to.
\end{itemize}

8.8.31 Dictionary Services
The (gnu services dict) module provides the following service:

\[\text{dicod-service}\ [\#:\text{config (dicod-configuration)}]\]  
Returns a service that runs the dicod daemon, an implementation of DICT server (see Section “Dicod” in GNU Dico Manual).

The optional \text{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).

\[\text{dicod-configuration}\]  
\begin{itemize}
  \item \text{dico} (default: dico)
  Package object of the GNU Dico dictionary server.
  \item \text{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).\end{itemize}
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 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 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

%dicod-database:gcide
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.

`package` (default: `docker`)
The Docker package to use.

`containerd` (default: `containerd`)
The Containerd package to use.

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 `/etc/audit/audit.rules`. `aureport` from the `audit` package can be used in order to view a report of all recorded events. The audit daemon usually logs into the directory `/var/log/audit`.

`auditd-configuration` [Data Type]
This is the data type representing the configuration of auditd.

`audit` (default: `audit`)
The audit package to use.

`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 8.9 [Setuid Programs], page 365) such that unprivileged users can invoke `singularity run` and similar commands.
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:

- 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
```

8.9 Setuid Programs

Some programs need to run with “root” 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, these executables are setuid-root, meaning that they always run 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 6.4 [The Store], page 93). Thus, a different mechanism is used: instead of changing the setuid bit directly on files that are in the store, we let the system administrator declare which programs should be setuid root.

The setuid-programs field of an operating-system declaration contains a list of G-expressions denoting the names of programs to be setuid-root (see Section 8.1 [Using the Configuration System], page 151). For instance, the `passwd` program, which is part of the Shadow package, can be designated by this G-expression (see Section 6.7 [G-Expressions], page 102):

```
#"(string-append #$shadow "/bin/passwd")
```

A default set of setuid programs is defined by the %setuid-programs variable of the (gnu system) module.
\%setuid-programs

A list of G-expressions 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.

8.10 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 8.2 [operating-system Reference], page 158). 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.
8.11 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 8.2 [operating-system Reference], page 158).

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 8.8.4 [Networking Services], page 188), or %desktop-services, which includes it (see Section 8.8.7 [Desktop Services], page 223). Doing this makes nss-mdns accessible to the name service cache daemon (see Section 8.8.1 [Base Services], page 172).

For convenience, the following variables provide typical NSS configurations.
%default-nss

This is the default name service switch configuration, a name-service-switch object.

%mdns-host-lookup-nss

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

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

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 8.8.1 [Base Services], page 172).

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))
8.12 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

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:

```
--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.

**--system=system**

Have `/run/bootted-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`.

**--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]

[#: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 8.4 [Mapped Devices], page 164). `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 '()]**

[Scheme Procedure]

[#:keyboard-layout #f] [#:qemu-networking? #f] [#:volatile-root? #f]

[#:linux-modules '()]

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 \texttt{--root}. \textit{mapped-devices} is a list of device mappings to realize before \textit{file-systems} are mounted.

When true, \texttt{keyboard-layout} is a \texttt{<keyboard-layout>} record denoting the desired console keyboard layout. This is done before \textit{mapped-devices} are set up and before \textit{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.

\textit{qemu-networking?} and \textit{volatile-root?} behaves as in \texttt{raw-initrd}.

The initrd is automatically populated with all the kernel modules necessary for \textit{file-systems} and for the given options. Additional kernel modules can be listed in \textit{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 \texttt{expression->initrd} procedure builds such an initrd, given the program to run in that initrd.

\begin{verbatim}
expression->initrd exp [#guile %guile-static-stripped] [Scheme Procedure]
    [#name "guile-initrd"]

Return as a file-like object a Linux initrd (a gzipped cpio archive) containing \texttt{guile} and that evaluates \texttt{exp}, a G-expression, upon booting. All the derivations referenced by \texttt{exp} are automatically copied to the initrd.
\end{verbatim}

\section{8.13 Bootloader Configuration}

The operating system supports multiple bootloaders. The bootloader is configured using \texttt{bootloader-configuration} declaration. All the fields of this structure are bootloader agnostic except for one field, \texttt{bootloader} that indicates the bootloader to be configured and installed.

Some of the bootloaders do not honor every field of \texttt{bootloader-configuration}. For instance, the extlinux bootloader does not support themes and thus ignores the \texttt{theme} field.

\begin{verbatim}
bootloader-configuration [Data Type]
    The type of a bootloader configuration declaration.

    bootloader
        The bootloader to use, as a bootloader object. For now \texttt{grub-bootloader}, \texttt{grub-efi-bootloader}, \texttt{extlinux-bootloader} and \texttt{u-boot-bootloader} are supported.

        \texttt{grub-efi-bootloader} allows to boot on modern systems using the \textit{Unified Extensible Firmware Interface} (UEFI). This is what you should use if the installation image contains a \texttt{/sys/firmware/efi} directory when you boot it on your system.

        \texttt{grub-bootloader} allows you to boot in particular Intel-based machines in “legacy” BIOS mode.

        Available bootloaders are described in \texttt{(gnu bootloader ...)} modules. In particular, \texttt{(gnu bootloader u-boot)} contains definitions of bootloader-
ers for a wide range of ARM and AArch64 systems, using the U-Boot bootloader (https://www.denx.de/wiki/U-Boot/).

**target**
This is a string denoting the target onto which to install the bootloader. The interpretation depends on the bootloader in question. For grub-bootloader, for example, it should be a device name 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, it should be the mount point of the EFI file system, usually /boot/efi.

**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 8.6 [Keyboard Layout], page 168).

*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).

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 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/vmlinux"
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 A G-Expression or string denoting the file name of the initial RAM disk to use (see Section 6.7 [G-Expressions], page 102).

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 8.3 [File Systems], page 162), 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.
For now only GRUB has theme support. GRUB themes are created using the `grub-theme` form, which is not fully documented yet.

```scheme
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 see Section “gfxmode” in GNU GRUB manual).

%default-theme
  [Scheme Variable]
  This is 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
    (grub-configuration
      ;; ...
      (theme (grub-theme
        (inherit %default-theme)
        (gfxmode '("1024x768x32" "auto")))))

8.14 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:

```bash
  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:

  ```bash
  $ 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
  ```
As for `guix package --search`, the result is written in `recutils` format, which makes it easy to filter the output (see `GNU recutils manual`).

`reconfigure`  
Build the operating system described in `file`, activate it, and switch to it\(^7\).

**Note:** It is highly recommended to run `guix pull` once before you run `guix system reconfigure` for the first time (see Section 4.6 [Invoking guix pull], page 49). 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 4.2 [Invoking guix package], page 35).

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 Section 4.7 [Channels], page 52) and `file` itself, when available. This information

\(^7\) This action (and the related actions `switch-generation` and `roll-back`) are usable only on systems already running Guix System.
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:

\[
\text{guix time-machine} \ \\
-C /var/guix/profiles/system-n-link/channels.scm -- \ \\
\text{system reconfigure} \ \\
/var/guix/profiles/system-n-link/configuration.scm
\]

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 8.17.3 [Service Reference], page 389, for more information on provenance tracking.

**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 4.5 [Invoking guix gc], page 46, for information on how to run the “garbage collector”).
This works in the same way as guix package --delete-generations (see Section 4.2 [Invoking guix package], page 35). 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 month 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 target specified in my-os-config, unless the --no-bootloader option was passed.

vm
Build a virtual machine that contains the operating system declared in file, and return a script to run that virtual machine (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 -net user,model=virtio-net-pci
```
The VM shares its store with the host system.
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.

**vm-image**

Return a virtual machine, disk image, or Docker image of the operating system declared in file that stands alone. By default, guix system estimates the size of the image needed to store the system, but you can use the --image-size option to specify a value. Docker images are built to contain exactly what they need, so the --image-size option is ignored in the case of docker-image.

You can specify the root file system type by using the --file-system-type option. It defaults to ext4.

When using vm-image, the returned image is in qcow2 format, which the QEMU emulator can efficiently use. See Section 8.16 [Running Guix in a VM], page 384, for more information on how to run the image in a virtual machine.

When using disk-image, 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 disk-image my-os.scm) of=/dev/sdc
```

When using docker-image, 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`.

**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 377), 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
```

**Note:** This option requires Linux-libre 3.19 or newer.

`options` can contain any of the common build options (see Section 7.1.1 [Common Build Options], page 112). In addition, `options` can contain one of the following:

- **--expression=**`expr` *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` *system*
  Attempt to build for `system` instead of the host system type. This works as per `guix build` (see Section 7.1 [Invoking guix build], page 112).

- **--derivation**
  - **--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 8.17.3 [Service Reference], page 389). 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 vm-image --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.

- **--file-system-type=**`type` *type*
  For the `disk-image` action, create a file system of the given `type` on the image. When this option is omitted, `guix system` uses `ext4`. 
--file-system-type=iso9660 produces an ISO-9660 image, suitable for burning on CDs and DVDs.

--image-size=size

For the `vm-image` and `disk-image` actions, 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 8.3 [File Systems], page 162), and that any Linux kernel modules that may be needed at boot time are listed in `initrd-modules` (see Section 8.12 [Initial RAM Disk], page 369). Passing this option skips these tests altogether.

--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 current system generation: its file name, the kernel and bootloader used, etc., as well as provenance information when available.

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 4.2 [Invoking guix package], page 35).
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 `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 in Dot/Graphviz format to standard output the service extension graph of the operating system defined in `file` (see Section 8.17.1 [Service Composition], page 386, for more information on service extensions.)

The command:

```
$ guix system extension-graph file | dot -Tpdf > services.pdf
```

produces a PDF file showing the extension relations among services.

**shepherd-graph**

Emit in Dot/Graphviz format to standard output the dependency graph of shepherd services of the operating system defined in `file`. See Section 8.17.4 [Shepherd Services], page 393, for more information and for an example graph.

### 8.15 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:

```gregx
;; 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)
```

```gregx
(define %system
  (operating-system
    (host-name "gnu-deployed")
    (timezone "Etc/UTC")
)```
(bootloader (bootloader-configuration
  (bootloader grub-bootloader)
  (target "/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 4.11 [Invoking guix archive], page 60).

  # 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.

**machine**  
This is the data type representing a single machine in a heterogeneous Guix deploy-
ment.

- **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**  
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 de-
  ployed 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.
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8.16 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-1.1.0.x86_64-linux.xz](https://ftp.gnu.org/gnu/guix/guix-system-vm-image-1.1.0.x86_64-linux.xz). This image is a compressed image in QCOW format. You will first need to decompress with `xz -d`, and then you can pass it to an emulator such as QEMU (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 4.2 [Invoking guix package], page 35). You can also reconfigure the system based on its initial configuration file available as `/etc/config.scm` (see Section 8.1 [Using the Configuration System], page 151).

Instead of using this pre-built image, one can also build their own virtual machine image using `guix system vm-image` (see Section 8.14 [Invoking guix system], page 374). The returned image is in qcow2 format, which the QEMU emulator ([https://qemu.org/](https://qemu.org/)) can efficiently use.

If you built your own image, you must copy it out of the store (see Section 6.4 [The Store], page 93) 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 vm-image` on x86_64 hardware:

```
$ qemu-system-x86_64 -
```
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```
-qemu-system-x86_64
-nic user,model=virtio-net-pci
-enable-kvm -m 1024
-device virtio-blk,drive=myhd
-drive if=none,file=/tmp/qemu-image,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 1024**
  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 performance 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 /tmp/qemu-image file, as the backing store the 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`.

### 8.16.1 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 8.8.4 [Networking Services], page 188). 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
```

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.

8.16.2 Using \texttt{virt-viewer} with Spice

As an alternative to the default \texttt{qemu} graphical client you can use the \texttt{remote-viewer} from the \texttt{virt-viewer} package. To connect pass the \texttt{-spice port=5930,disable-ticketing} flag to \texttt{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 \texttt{qemu}:

\begin{verbatim}
-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
\end{verbatim}

You’ll also need to add the \texttt{(spice-vdagent-service)} to your system definition (see Section 8.8.30 [Miscellaneous Services], page 360).

8.17 Defining Services

The previous sections show the available services and how one can combine them in an \texttt{operating-system} declaration. But how do we define them in the first place? And what is a service anyway?

8.17.1 Service Composition

Here we define a \textit{service} as, broadly, something that extends the functionality of the operating system. Often a service is a process—a \textit{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 \texttt{inetd} or a D-Bus service activated by \texttt{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 \texttt{/etc} service populates the \texttt{/etc} directory of the system.

Guix system services are connected by \textit{extensions}. For instance, the secure shell service \textit{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 8.8.4 [Networking Services], page 188); the UPower service extends the D-Bus service by passing it its \texttt{.service} specification, and extends the udev service by passing it device management rules (see Section 8.8.7 [Desktop Services], page 223); 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 8.8.1 [Base Services], page 172).
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 8.17.3 [Service Reference], page 389, to learn about the other service types shown here. See [system-extension-graph], page 381, 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.

### 8.17.2 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 14):
(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 8.17.4 [Shepherd Services], page 393).

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 14).

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)
             (use-substitutes? #f)))

   The second argument to the service form is a value representing the parameters of this specific service instance. See [guix-configuration-type], page 180, 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
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 8.14 [Invoking guix system], page 374).

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.

### 8.17.3 Service Reference

We have seen an overview of service types (see Section 8.17.2 [Service Types and Services], page 387). 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.

```scheme
(service? obj)
Return true if `obj` is a service.
```

```scheme
(service-kind service)
Return the type of `service`—i.e., a `<service-type>` object.
```

```scheme
(service-value service)
Return the value associated with `service`. It represents its parameters.
```

Here is an example of how a service is created and manipulated:

```scheme
(define s
  (service nginx-service-type
     (nginx-configuration
      (nginx nginx)
      (log-directory log-directory)
      (run-directory run-directory)
      (file config-file))))
```

```scheme
(service? s)
⇒ #t
```

```scheme
(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 8.8.1 [Base Services], page 172). 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.

```scheme
modify-services services (type variable => body) ...
```

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.

See Section 8.1 [Using the Configuration System], page 151, 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**

This is the representation of a service type (see Section 8.17.2 [Service Types and Services], page 387).

- **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.

See Section 8.17.2 [Service Types and Services], page 387, for examples.

**service-extension**

- **target-type compute**
  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**: 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**
  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 8.8.2 [Scheduled Job Execution], page 184) with an additional job:

\[
\text{(\texttt{simple-service 'my-mcron-job mcron-service-type}} \\
\quad \text{"\texttt{#(job '(next-hour (3)) "guix gc -F 2G")"}})
\]

At the core of the service abstraction lies the \texttt{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 \texttt{guix system build} command (see Section 8.14 [Invoking \texttt{guix system}], page 374). In essence, it propagates service extensions down the service graph, updating each node parameters on the way, until it reaches the root node.

\texttt{fold-services services [#:target-type system-service-type]}

Fold services by propagating their extensions down to the root of type target-type; return the root service adjusted accordingly.

Lastly, the (\texttt{gnu services}) module also defines several essential service types, some of which are listed below.

\texttt{system-service-type [Scheme Variable]}

This is the root of the service graph. It produces the system directory as returned by the \texttt{guix system build} command.

\texttt{boot-service-type [Scheme Variable]}

The type of the “boot service”, which produces the \texttt{boot script}. The boot script is what the initial RAM disk runs when booting.

\texttt{etc-service-type [Scheme Variable]}

The type of the \texttt{/etc} service. This service is used to create files under \texttt{/etc} and can be extended by passing it name/file tuples such as:

\[
\text{(list ("issue", (\texttt{plain-file "issue" "Welcome!\n"})}})
\]

In this example, the effect would be to add an \texttt{/etc/issue} file pointing to the given file.

\texttt{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-root programs on the system (see Section 8.9 [Setuid Programs], page 365).

\texttt{profile-service-type [Scheme Variable]}

Type of the service that populates the \texttt{system profile}—i.e., the programs under \texttt{/run/current-system/profile}. Other services can extend it by passing it lists of packages to add to the system profile.

\texttt{provenance-service-type [Scheme Variable]}

This is the type of the service that records \texttt{provenance meta-data} in the system itself. It creates several files under \texttt{/run/current-system}:

\texttt{channels.scm}

This is a “channel file” that can be passed to \texttt{guix pull -C} or \texttt{guix time-machine -C}, and which describes the channels used to build the
system, if that information was available (see Section 4.7 [Channels], page 52).

**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`.

### 8.17.4 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 8.1 [Using the Configuration System], page 151) 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 381).

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**

The data type representing a service managed by the Shepherd.

**[Data Type]**

**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 un-
derlying 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 ex-
panded in the Shepherd configuration file (see Section 6.7 [G-Expressions],
page 102).

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 “In-
voking 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.

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 run-
ning:

    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:

```scheme
(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:

```bash
# 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-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 8.17.2 [Service Types and Services], page 387, for an example). Each extension must pass a list of `<shepherd-service>`.

%shepherd-root-service

[Scheme Variable]

This service represents PID 1.
9 Documentation

In most cases packages installed with Guix come with documentation. There are two main documentation formats: “Info”, a browseable 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:

```
$ 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.
10 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.

The problem with debugging information is that it 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 3).

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 4.4 [Packages with Multiple Outputs], page 45). 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`.

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 7.1 [Invoking guix build], page 112), 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 6.3 [Build Systems], page 80). Currently, it is opt-in—debugging information is available only for the packages with definitions explicitly declaring a `debug` output. This may be changed to opt-out in the future if our build farm servers can handle the load. To check whether a package has a `debug` output, use `guix package --list-available` (see Section 4.2 [Invoking guix package], page 35).
11 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:

```bash
$ 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 7.7 [Invoking guix lint], page 132, for more information.

Guix follows a functional package management discipline (see Chapter 1 [Introduction], page 2), 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 4.3 [Substitutes], page 43), 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 6.2 [Defining Packages], page 73). Then, the original package definition is augmented with a replacement field pointing to the package containing the bug fix:

```scheme
(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 4.5 [Invoking guix gc], page 46)—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 7.1.1 [Common Build Options], page 112). 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 4.5 [Invoking guix gc], page 46):

```
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
```
12 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 2). So there’s an obvious chicken-and-egg problem: how does the first package get built? How does the first compiler get compiled? Note that this is a question of interest only to the curious hacker, not to the regular user, so you can shamelessly skip this section if you consider yourself a “regular user”.

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 6.5 [Derivations], page 95). 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 (more on that later).

For i686-linux and x86_64-linux the Guix bootstrap process is more elaborate, see Section 12.1 [Reduced Binary Seed Bootstrap], page 401.

12.1 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 12 [Bootstrapping], page 401). Usually, these bootstrap binaries are “taken for granted.”

Taking these 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 current 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.

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 and a new set of packages\(^2\) the “missing” Binutils, GCC, and the GNU C Library are built from source. From here on 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.

2 `nyacc-boot`, `mes-boot`, `tcc-boot0`, `tcc-boot`, `make-mesboot0`, `diffutils-mesboot`, `binutils-mesboot0`, `gcc-core-mesboot`, `mesboot-headers`, `glibc-mesboot0`, `gcc-mesboot0`, `binutils-mesboot`, `make-mesboot`, `gcc-mesboot1`, `gcc-mesboot1-cscc`, `glibc-headers-mesboot`, `glibc-mesboot`, `gcc-mesboot`, and `gcc-mesboot-wrapper`. 
more traditional bootstrap process resumes. This approach has reduced the bootstrap binaries in size to about 130MB. Work is ongoing to reduce this further. If you are interested, join us on #bootstrappable on the Freenode IRC network.

Below is the generated dependency graph for gcc-mesboot, the bootstrap compiler used to build the rest of GuixSD.
12.2 Preparing to Use the Bootstrap Binaries

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 7.9 [Invoking guix graph], page 136), along the lines of:

```
guix graph -t derivation \
eg '(@@ (gnu packages bootstrap) %bootstrap-gcc)’ \
| dot -Tps > gcc.ps
```

or, for the Reduced Binary Seed bootstrap

```
guix graph -t derivation \
eg '(@@ (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.
Chapter 12: Bootstrapping

This tarball is part of Guix’s “source” distribution, and gets inserted into the store with `add-to-store` (see Section 6.4 [The Store], page 93).

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 6.5 [Derivations], page 95).

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)' | dot -Tps > t.ps
```
produces the dependency graph leading to the “final” C library\(^3\), 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 6.3 [Build Systems], page 80).

\(^3\) You may notice the `glibc-intermediate` label, suggesting that it is not quite final, but as a good approximation, we will consider it final.
Chapter 12: Bootstrapping

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!
13 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 12 [Bootstrapping], page 401). 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, the glibc-dynamic-linker procedure in (gnu packages bootstrap) must be augmented to return the right file name for libc’s dynamic linker on that platform; likewise, `system->linux-architecture` in (gnu packages linux) must be taught about the new platform.

Once these 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.
14 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 Freenode 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 14.4 [Packaging Guidelines], page 411).

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.

14.1 Building from Git

If you want to hack Guix itself, it is recommended to use the latest version from the Git repository:

```bash
    git clone https://git.savannah.gnu.org/git/guix.git
```

How do you ensure that you obtained a genuine copy of the repository? Guix itself provides a tool to authenticate your checkout, but you must first make sure this tool is genuine in order to “bootstrap” the trust chain. To do that, run:

```bash
    git verify-commit 'git log --format=%H build-aux/git-authenticate.scm'
```

The output must look something like:

```
gpg: Signature made Fri 27 Dec 2019 01:27:41 PM CET
gpg: using RSA key 3CE464558A84FDC69DB40CFB090B11993D9AEBB5
...  
gpg: Signature made Fri 27 Dec 2019 01:25:22 PM CET
gpg: using RSA key 3CE464558A84FDC69DB40CFB090B11993D9AEBB5
...  
```

... meaning that changes to this file are all signed with key 3CE464558A84FDC69DB40CFB090B11993D9AEBB5 (you may need to fetch this key from a key server, if you have not done it yet).

From there on, you can authenticate all the commits included in your checkout by running:

```bash
    make authenticate
```

The first run takes a couple of minutes, but subsequent runs are faster.

**Note:** You are advised to run `make authenticate` after every `git pull` invocation. This ensures you keep receiving valid changes to the repository.

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:

```bash
    guix environment guix --pure
```

See Section 5.1 [Invoking guix environment], page 63, 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 environment with --ad-hoc:

```
guix environment guix --pure --ad-hoc help2man git strace
```

Run `./bootstrap` to generate the build system infrastructure using Autoconf and Automake. 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` as usual. Make sure to pass `--localstatedir=directory` where `directory` is the `localstatedir` value used by your current installation (see Section 6.4 [The Store], page 93, for information about this). We recommend to use the value `/var`.

Finally, you have to invoke `make check` to run tests (see Section 2.3 [Running the Test Suite], page 8). If anything fails, take a look at installation instructions (see Chapter 2 [Installation], page 5) or send a message to the mailing list.

### 14.2 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 14.1 [Building from Git], page 408), 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 `./configure`). An example:

```
$ sudo -E ./pre-inst-env guix-daemon --build-users-group=guixbuild
$ ./pre-inst-env guix build hello
```

---

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.
Similarly, an example for a Guile session using the Guix modules:

```sh
$ ./pre-inst-env guile -c '(use-modules (guix utils)) (pk (%current-system))'

;;; ("x86_64-linux")
```

... and for a REPL (see Section “Using Guile Interactively” in *Guile Reference Manual*):

```sh
$ ./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
```

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 4.6 [Invoking guix pull], page 49). Run `git pull` instead if you want to upgrade your local source tree.

### 14.3 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](https://www.gnu.org/software/emacs)), empowered by the wonderful Geiser ([https://nongnu.org/geiser/](https://nongnu.org/geiser/)). To set that up, run:

```
guix package -i emacs guile emacs-geiser
```

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:

```lisp
;;; 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](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 with YASnippet (https://joaotavora.github.io/yasnippet/) to expand short trigger strings to interactive text snippets. You may want to add the snippets directory to the `yas-snippet-dirs` variable in Emacs.

```lisp
;; Assuming the Guix checkout is in "~/src/guix.
(with-eval-after-load 'yasnippet
  (add-to-list 'yas-snippet-dirs "~/src/guix/etc/snippets")
)
```

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.

Additionally, we 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.

```lisp
(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`.

```lisp
(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.

### 14.4 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 6.1 [Package Modules],
However, in-depth Scheme knowledge is not a prerequisite for creating packages. For more information on package definitions, see Section 6.2 [Defining Packages], page 73.

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 7.1 [Invoking guix build], page 112). For example, assuming the new package is called `gnew`, you may run this command from the Guix build tree (see Section 14.2 [Running Guix Before It Is Installed], page 409):

`./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 14.6 [Submitting Patches], page 419). 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 (ci.guix.gnu.org).

Users can obtain the new package definition simply by running `guix pull` (see Section 4.6 [Invoking guix pull], page 49). When `ci.guix.gnu.org` is done building the package, installing the package automatically downloads binaries from there (see Section 4.3 [Substitutes], page 43). The only place where human intervention is needed is to review and apply the patch.

### 14.4.1 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 6.2 [Defining Packages], page 73). This way, `guix build --source` returns the “freed” source rather than the unmodified upstream source.

### 14.4.2 Package Naming

A package has actually 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.

We do not add lib prefixes for library packages, unless these are already part of the
official project name. But see Section 14.4.5 [Python Modules], page 415, and Section 14.4.6
[Perl Modules], page 416, for special rules concerning modules for the Python and Perl
languages.

Font package names are handled differently, see Section 14.4.9 [Fonts], page 417.

14.4.3 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 14.4.2 [Package Naming], page 412, 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
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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
```

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.) 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))))
)); ...
))
```

14.4.4 Synopses and Descriptions

As we have seen before, each package in GNU Guix includes a synopsis and a description (see Section 6.2 [Defining Packages], page 73). 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 “File-frobbing 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 package --show take care of rendering it appropriately.

Synopses and descriptions are translated by volunteers at the Translation Project (https://translationproject.org/domain/guix-packages.html) 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:

```guile
(packages
  ;; ...
  (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):

```guile
;; 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. ...")
```

14.4.5 Python Modules

We currently package Python 2 and Python 3, under the Scheme variable names python-2 and python as explained in Section 14.4.3 [Version Numbers], page 413. 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.
14.4.5.1 Specifying Dependencies

Dependency information for Python packages is usually available in the package source tree, with varying degrees of accuracy: in the `setup.py` file, in `requirements.txt`, or in `tox.ini`.

Your mission, when writing a recipe for a Python package, is to map these dependencies to the appropriate type of “input” (see Section 6.2.1 [package Reference], page 76). Although the pypi importer normally does a good job (see Section 7.5 [Invoking guix import], page 123), you may want to check the following check list to determine which dependency goes where.

- We currently package Python 2 with `setuptools` and `pip` installed like Python 3.4 has per default. Thus you don’t need to specify either of these as an input. `guix lint` will warn you if you do.
- 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 with the `setup_requires` keyword in `setup.py`—or only for testing—e.g., those in `tests_require`—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 14.6 [Submitting Patches], page 419).

14.4.6 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`.

14.4.7 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.

14.4.8 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 packages should have a versioned suffix. If a package has passed version 1.0.0 then just the major version number is sufficient (e.g. rust-clap-2), otherwise the version suffix should contain both the major and minor version (e.g. 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 6.3 [Build Systems], page 80) 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.

14.4.9 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.
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We use -tff for TrueType fonts, -otf for OpenType fonts and -type1 for PostScript Type 1 fonts.

14.5 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.

14.5.1 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.

14.5.2 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 ...).

14.5.3 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.

14.5.4 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:

```
./etc/indent-code.el gnu/packages/file.scm package
```

This automatically indents the definition of package in gnu/packages/file.scm by running Emacs in batch mode. To indent a whole file, omit the second argument:

```
./etc/indent-code.el gnu/services/file.scm
```
If you are editing code with Vim, we recommend that you run \texttt{:set autoindent} so that your code is automatically indented as you type. Additionally, \texttt{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 \texttt{(guix build \ldots)} name space, though.

Procedures should not have more than four positional parameters. Use keyword parameters for procedures that take more than four parameters.

### 14.6 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 \texttt{git format-patch} sent to the \texttt{guix-patches@gnu.org} mailing list. Seasoned Guix developers may also want to look at the section on commit access (see Section 14.8 [Commit Access], page 422).

This mailing list is backed by a Debbugs instance, which allows us to keep track of submissions (see Section 14.7 [Tracking Bugs and Patches], page 422). 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 \texttt{NNN@debbugs.gnu.org}, where \texttt{NNN} is the tracking number (see [Sending a Patch Series], page 421).

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 \texttt{gpg --verify} command.
2. Take some time to provide an adequate synopsis and description for the package. See Section 14.4.4 [Synopses and Descriptions], page 414, for some guidelines.
3. Run \texttt{guix lint package}, where \texttt{package} is the name of the new or modified package, and fix any errors it reports (see Section 7.7 [Invoking guix lint], page 132).
4. Make sure the package builds on your platform, using \texttt{guix build package}.
5. 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 \texttt{qemu-binfmt-service-type} to emulate them. In order to enable it, add the following service to the list of services in your \texttt{operating-system} configuration:

\begin{verbatim}
(service qemu-binfmt-service-type
 (qemu-binfmt-configuration
  (Platforms (lookup-qemu-platforms "arm" "aarch64" "mips64el"))
  (guix-support? #t))))
\end{verbatim}

Then reconfigure your system.

You can then build packages for different platforms by specifying the \texttt{--system} option. For example, to build the "hello" package for the armhf, aarch64, or mips64 architectures, you would run the following commands, respectively:
6. 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.

7. Take a look at the profile reported by `guix size` (see Section 7.8 [Invoking guix size], page 135). This will allow you to notice references to other packages unwillingly retained. It may also help determine whether to split the package (see Section 4.4 [Packages with Multiple Outputs], page 45), and which optional dependencies should be used. In particular, avoid adding texlive as a dependency: because of its extreme size, use texlive-tiny or texlive-union instead.

8. For important changes, check that dependent package (if applicable) are not affected by the change; `guix refresh --list-dependent package` will help you do that (see Section 7.6 [Invoking guix refresh], page 128).

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 1,200 dependent packages

   staging branch (non-disruptive changes). This branch is intended to be merged in master every 3 weeks or so. Topical changes (e.g., an update of the GNOME stack) can instead go to a specific branch (say, gnome-updates).

more than 1,200 dependent packages

   core-updates branch (may include major and potentially disruptive changes). This branch is intended to be merged in master every 2.5 months or so.

All these branches are tracked by our build farm (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.

Generally, branches other than master are considered frozen if there has been a recent evaluation, or there is a corresponding -next branch. Please ask on the mailing list or IRC if unsure where to place a patch.

9. 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 7.1 [Invoking guix build], page 112):

```
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 7.11 [Invoking guix challenge], page 143). 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.

10. 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.

11. 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.

12. Please follow our code formatting rules, possibly running the `etc/indent-code.el` script to do that automatically for you (see Section 14.5.4 [Formatting Code], page 418).

13. When possible, use mirrors in the source URL (see Section 7.3 [Invoking guix download], page 121). 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.

14. Check if Guix builds (see Section 14.1 [Building from Git], page 408) and address the warnings, especially those about use of undefined symbols.

15. 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. You may use your email client or the `git send-email` command (see [Sending a Patch Series], page 421). 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.

When a bug is resolved, please close the thread by sending an email to `NNN-done@debbugs.gnu.org`.

Sending a Patch Series

When sending a patch series (e.g., using `git send-email`), please first send one message to `guix-patches@gnu.org`, and then send subsequent patches to `NNN@debbugs.gnu.org` to make sure they are kept together. See the Debugs documentation (https://debbugs.gnu.org/Advanced.html) for more information. You can install `git send-email` with `guix install git:send-email`.
14.7 Tracking Bugs and Patches

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 14.6 [Submitting Patches], page 419).

A web interface (actually two web interfaces!) are available to browse issues:
- https://bugs.gnu.org/guix lists bug reports;

You can also access both of these via the (nicer) https://issues.guix.gnu.org interface\(^2\). To view discussions related to issue number \(n\), go to ‘https://issues.guix.gnu.org/issue/\(n\)’ 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!

14.8 Commit Access

For frequent contributors, having write access to the repository is convenient. 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.

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.

\(^2\) 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.
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!

   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 14.7 [Tracking Bugs and Patches], page 422).

   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.

   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
     git config user.signingkey CABBA6EA1DC0FF33

   You can prevent yourself from accidentally pushing unsigned commits to Savannah by using the pre-push Git hook called located at etc/git/pre-push:

     cp etc/git/pre-push .git/hooks/pre-push

   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.

   For anything else, please post to guix-patches@gnu.org and leave time for a review, without committing anything (see Section 14.6 [Submitting Patches], page 419). 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.

   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!
15 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!
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