

Cross-Compiled Linux From Scratch

Version 3.0.0-RC1-x86_64-Pure64

Cross-Compiled Linux From Scratch: Version 3.0.0-RC1-x86_64-Pure64

Copyright © 2005–2014 Joe Ciccone, Jim Gifford & Ryan Oliver

Based on LFS, Copyright © 1999–2014 Gerard Beekmans

Copyright © 2005–2014, Joe Ciccone, Jim Gifford, & Ryan Oliver

All rights reserved.

This material may be distributed only subject to the terms and conditions set forth in the Open Publication License v1.0 or later (the latest version is presently available at <http://www.opencontent.org/openpub/>).

Linux® is a registered trademark of Linus Torvalds.

This book is based on the "Linux From Scratch" book, that was released under the following license:

Copyright © 1999–2014, Gerard Beekmans

All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistributions in any form must retain the above copyright notice, this list of conditions and the following disclaimer
- Neither the name of "Linux From Scratch" nor the names of its contributors may be used to endorse or promote products derived from this material without specific prior written permission
- Any material derived from Linux From Scratch must contain a reference to the "Linux From Scratch" project

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE REGENTS OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Table of Contents

Preface	viii
i. Foreword	viii
ii. Audience	viii
iii. Prerequisites	ix
iv. Host System Requirements	x
v. Typography	xi
vi. Structure	xii
vii. Errata	xiii
I. Introduction	1
1. Introduction	2
1.1. Cross-LFS Acknowledgements	2
1.2. How to Build a CLFS System	3
1.3. Master Changelog	4
1.4. Changelog for x86_64-64	14
1.5. Resources	14
1.6. Help	15
II. Preparing for the Build	18
2. Preparing a New Partition	19
2.1. Introduction	19
2.2. Setting The <code>{CLFS}</code> Variable	19
2.3. Creating a New Partition	19
2.4. Creating a File System on the Partition	20
2.5. Mounting the New Partition	21
3. Packages and Patches	22
3.1. Introduction	22
3.2. All Packages	22
3.3. Additional Packages for x86_64	30
3.4. Needed Patches	30
3.5. Additional Patches for x86_64	31
4. Final Preparations	32
4.1. Introduction	32
4.2. Creating the <code>{CLFS}/tools</code> Directory	32
4.3. Creating the <code>{CLFS}/cross-tools</code> Directory	32
4.4. Adding the CLFS User	33
4.5. Setting Up the Environment	34
4.6. Build Variables	35
4.7. About the Test Suites	35
III. Make the Cross-Compile Tools	36
5. Constructing Cross-Compile Tools	37
5.1. Introduction	37
5.2. File-5.19	38
5.3. Linux-3.14.13 Headers	39
5.4. M4-1.4.17	40
5.5. Ncurses-5.9	41
5.6. Pkg-config-lite-0.28-1	42

5.7. GMP-6.0.0	43
5.8. MPFR-3.1.2	44
5.9. MPC-1.0.2	45
5.10. ISL-0.12.2	46
5.11. CLoog-0.18.2	47
5.12. Cross Binutils-2.24	48
5.13. Cross GCC-4.8.3 - Static	50
5.14. Glibc-2.19	52
5.15. Cross GCC-4.8.3 - Final	54
IV. Building the Basic Tools	56
6. Constructing a Temporary System	57
6.1. Introduction	57
6.2. Build Variables	57
6.3. GMP-6.0.0	58
6.4. MPFR-3.1.2	59
6.5. MPC-1.0.2	60
6.6. ISL-0.12.2	61
6.7. CLoog-0.18.2	62
6.8. Zlib-1.2.8	63
6.9. Binutils-2.24	64
6.10. GCC-4.8.3	65
6.11. Ncurses-5.9	67
6.12. Bash-4.3	68
6.13. Bzip2-1.0.6	70
6.14. Check-0.9.13	71
6.15. Coreutils-8.22	72
6.16. Diffutils-3.3	73
6.17. File-5.19	74
6.18. Findutils-4.4.2	75
6.19. Gawk-4.1.1	76
6.20. Gettext-0.19.1	77
6.21. Grep-2.19	78
6.22. Gzip-1.6	79
6.23. Make-4.0	80
6.24. Patch-2.7.1	81
6.25. Sed-4.2.2	82
6.26. Tar-1.27.1	83
6.27. Texinfo-5.2	84
6.28. Util-linux-2.24.2	85
6.29. Vim-7.4	86
6.30. XZ Utils-5.0.5	88
6.31. To Boot or to Chroot?	89
7. If You Are Going to Boot	90
7.1. Introduction	90
7.2. Bc-1.06.95	91
7.3. Boot-scripts for CLFS 3.0-20140710	92
7.4. E2fsprogs-1.42.9	94

7.5. Kmod-18	95
7.6. Shadow-4.1.5.1	96
7.7. Sysvinit-2.88dsf	97
7.8. Eudev-1.7	100
7.9. Linux-3.14.13	102
7.10. GRUB-2.00	104
7.11. Creating Directories	105
7.12. Creating Essential Symlinks	106
7.13. Populating /dev	107
7.14. Creating the passwd and group Files	107
7.15. Creating the /etc/fstab File	109
7.16. Setting Up the Environment	109
7.17. Build Flags	110
7.18. Changing Ownership	110
7.19. How to View the Book	110
7.20. What to do next	110
8. If You Are Going to Chroot	111
8.1. Introduction	111
8.2. Mounting Virtual Kernel File Systems	111
8.3. Entering the Chroot Environment	112
8.4. Changing Ownership	112
8.5. Creating Directories	113
8.6. Creating Essential Symlinks	113
8.7. Build Flags	114
8.8. Creating the passwd and group Files	115
V. Building the CLFS System	118
9. Constructing Testsuite Tools	119
9.1. Introduction	119
9.2. Tcl-8.6.1	120
9.3. Expect-5.45	121
9.4. DejaGNU-1.5.1	122
10. Installing Basic System Software	123
10.1. Introduction	123
10.2. Package Management	123
10.3. About Test Suites, Again	126
10.4. Temporary Perl-5.20.0	127
10.5. Linux-3.14.13 Headers	128
10.6. Man-pages-3.68	129
10.7. Glibc-2.19	130
10.8. Adjusting the Toolchain	137
10.9. M4-1.4.17	138
10.10. GMP-6.0.0	139
10.11. MPFR-3.1.2	141
10.12. MPC-1.0.2	142
10.13. ISL-0.12.2	143
10.14. CLoog-0.18.2	144
10.15. Zlib-1.2.8	145

10.16. Flex-2.5.39	146
10.17. Bison-3.0.2	148
10.18. Binutils-2.24	149
10.19. GCC-4.8.3	152
10.20. Attr-2.4.47	155
10.21. ACL-2.2.52	156
10.22. Sed-4.2.2	157
10.23. Ncurses-5.9	158
10.24. Pkg-config-lite-0.28-1	160
10.25. Shadow-4.1.5.1	161
10.26. Util-linux-2.24.2	164
10.27. Procps-ng-3.3.9	169
10.28. E2fsprogs-1.42.9	171
10.29. Libcap-2.24	174
10.30. Coreutils-8.22	175
10.31. Iana-Etc-2.30	180
10.32. Libtool-2.4.2	181
10.33. IPRoute2-3.14.0	182
10.34. GDBM-1.11	184
10.35. Perl-5.20.0	185
10.36. Readline-6.3	188
10.37. Autoconf-2.69	189
10.38. Automake-1.14.1	190
10.39. Bash-4.3	192
10.40. Bc-1.06.95	194
10.41. Bzip2-1.0.6	195
10.42. Diffutils-3.3	197
10.43. File-5.19	198
10.44. Gawk-4.1.1	199
10.45. Findutils-4.4.2	200
10.46. Gettext-0.19.1	201
10.47. Gperf-3.0.4	203
10.48. Grep-2.19	204
10.49. Groff-1.22.2	205
10.50. Less-462	208
10.51. Gzip-1.6	209
10.52. IPutils-s20121221	210
10.53. Kbd-2.0.1	211
10.54. Libpipeline-1.3.0	213
10.55. Man-DB-2.6.7.1	214
10.56. Make-4.0	217
10.57. XZ Utils-5.0.5	218
10.58. Expat-2.1.0	220
10.59. XML::Parser-2.42_01	221
10.60. Intltool-0.50.2	222
10.61. Kmod-18	223
10.62. Patch-2.7.1	225

10.63. Psmisc-22.21	226
10.64. Systemd-213	227
10.65. D-Bus-1.8.6	231
10.66. Tar-1.27.1	232
10.67. Texinfo-5.2	233
10.68. Vim-7.4	234
10.69. GRUB-2.00	237
10.70. About Debugging Symbols	240
10.71. Stripping	240
11. System Configuration	241
11.1. Introduction	241
11.2. How does Systemd work?	241
11.3. Configuring the system clock	242
11.4. Configuring the Linux Console	243
11.5. Device and Module Handling on a CLFS System	244
11.6. Creating custom symlinks to devices	247
11.7. The Bash Shell Startup Files	249
11.8. Setting Up Locale Information	249
11.9. Creating the /etc/inputrc File	251
11.10. Creating the /etc/fstab File	253
12. Networking Configuration	254
12.1. Configuring the system hostname	254
12.2. Customizing the /etc/hosts File	254
12.3. Creating the /etc/resolv.conf File	255
12.4. Systemd Networking?	255
12.5. Networking Configuration with Systemd-networkd	256
12.6. CLFS-Network-Scripts-20140224	258
12.7. Static Networking Configuration	259
12.8. DHCPD-6.3.2	261
13. Making the CLFS System Bootable	263
13.1. Introduction	263
13.2. Linux-3.14.13	264
13.3. Making the CLFS System Bootable	268
14. The End	269
14.1. The End	269
14.2. Download Client	269
14.3. Rebooting the System	270
14.4. What Now?	271
VI. Appendices	273
A. Acronyms and Terms	274
B. Dependencies	277
C. x86 Dependencies	287
D. Package Rationale	288
E. Open Publication License	293
Index	296

Preface

Foreword

The Linux From Scratch Project has seen many changes in the few years of its existence. I personally became involved with the project in 1999, around the time of the 2.x releases. At that time, the build process was to create static binaries with the host system, then chroot and build the final binaries on top of the static ones.

Later came the use of the /static directory to hold the initial static builds, keeping them separated from the final system, then the PureLFS process developed by Ryan Oliver and Greg Schafer, introducing a new toolchain build process that divorces even our initial builds from the host. Finally, LFS 6 brought Linux Kernel 2.6, the udev dynamic device structure, sanitized kernel headers, and other improvements to the Linux From Scratch system.

The one "flaw" in LFS is that it has always been based on an x86 class processor. With the advent of the Athlon 64 and Intel EM64T processors, the x86-only LFS is no longer ideal. Throughout this time, Ryan Oliver developed and documented a process by which you could build Linux for any system and from any system, by use of cross-compilation techniques. Thus, the Cross-Compiled LFS (CLFS) was born.

CLFS follows the same guiding principles the LFS project has always followed, e.g., knowing your system inside and out by virtue of having built the system yourself. Additionally, during a CLFS build, you will learn advanced techniques such as cross-build toolchains, multilib support (32 & 64-bit libraries side-by-side), alternative architectures such as Sparc, MIPS, and much more.

We hope you enjoy building your own CLFS system, and the benefits that come from a system tailored to your needs.

```
--
Jeremy Utle, CLFS 1.x Release Manager (Page Author)
Jonathan Norman, Release Manager
Jim Gifford, CLFS Project Co-leader
Ryan Oliver, CLFS Project Co-leader
Joe Ciccone, CLFS Project Co-leader
Jonathan Norman, Justin Knierim, Chris Staub, Matt Darcy, Ken Moffat,
Manuel Canales Esparcia, Nathan Coulson and William Harrington - CLFS Developers
```

Audience

There are many reasons why somebody would want to read this book. The principal reason is to install a Linux system from the source code. A question many people raise is, "why go through all the hassle of manually building a Linux system from scratch when you can just download and install an existing one?" That is a good question and is the impetus for this section of the book.

One important reason for the existence of CLFS is to help people understand how a Linux system works. Building an CLFS system helps demonstrate what makes Linux tick, and how things work together and depend on each other. One of the best things this learning experience provides is the ability to customize Linux to your own tastes and needs.

A key benefit of CLFS is that it allows users to have more control over their system without any reliance on a Linux implementation designed by someone else. With CLFS, *you* are in the driver's seat and dictate every aspect of the system, such as the directory layout and bootscript setup. You also dictate where, why, and how programs are installed.

Another benefit of CLFS is the ability to create a very compact Linux system. When installing a regular distribution, one is often forced to include several programs which are probably never used. These programs waste disk space or CPU cycles. It is not difficult to build an CLFS system of less than 100 megabytes (MB), which is substantially smaller than the majority of existing installations. Does this still sound like a lot of space? A few of us have been working on creating a very small embedded CLFS system. We successfully built a system that was specialized to run the Apache web server with approximately 8MB of disk space used. Further stripping could bring this down to 5 MB or less. Try that with a regular distribution! This is only one of the many benefits of designing your own Linux implementation.

We could compare Linux distributions to a hamburger purchased at a fast-food restaurant—you have no idea what might be in what you are eating. CLFS, on the other hand, does not give you a hamburger. Rather, CLFS provides the recipe to make the exact hamburger desired. This allows users to review the recipe, omit unwanted ingredients, and add your own ingredients to enhance the flavor of the burger. When you are satisfied with the recipe, move on to preparing it. It can be made to exact specifications—broil it, bake it, deep-fry it, or barbecue it.

Another analogy that we can use is that of comparing CLFS with a finished house. CLFS provides the skeletal plan of a house, but it is up to you to build it. CLFS maintains the freedom to adjust plans throughout the process, customizing it to the needs and preferences of the user.

Security is an additional advantage of a custom built Linux system. By compiling the entire system from source code, you are empowered to audit everything and apply all the security patches desired. It is no longer necessary to wait for somebody else to compile binary packages that fix a security hole. Unless you examine the patch and implement it yourself, you have no guarantee that the new binary package was built correctly and adequately fixes the problem.

The goal of Cross Linux From Scratch is to build a complete and usable foundation-level system. Readers who do not wish to build their own Linux system from scratch may not benefit from the information in this book. If you only want to know what happens while the computer boots, we recommend the “From Power Up To Bash Prompt” HOWTO located at <http://axiom.anu.edu.au/~okeefe/p2b/> or on The Linux Documentation Project's (TLDP) website at <http://www.tldp.org/HOWTO/From-PowerUp-To-Bash-Prompt-HOWTO.html>. The HOWTO builds a system which is similar to that of this book, but it focuses strictly on creating a system capable of booting to a BASH prompt. Consider your objective. If you wish to build a Linux system and learn along the way, this book is your best choice.

There are too many good reasons to build your own CLFS system to list them all here. This section is only the tip of the iceberg. As you continue in your CLFS experience, you will find the power that information and knowledge truly bring.

Prerequisites

Building a CLFS system is not a simple task. It requires a certain level of existing knowledge of Unix system administration in order to resolve problems, and correctly execute the commands listed. In particular, as an absolute minimum, the reader should already have the ability to use the command line (shell) to copy or move files and directories, list directory and file contents, and change the current directory. It is also expected that the reader has a reasonable knowledge of using and installing Linux software. A basic knowledge of the architectures being used in the Cross LFS process and the host operating systems in use is also required.

Because the CLFS book assumes *at least* this basic level of skill, the various CLFS support forums are unlikely to be able to provide you with much assistance in these areas. Your questions regarding such basic knowledge will likely go unanswered, or you will be referred to the CLFS essential pre-reading list.

Before building a CLFS system, we recommend reading the following HOWTOs:

- Software-Building-HOWTO

<http://www.tldp.org/HOWTO/Software-Building-HOWTO.html>

This is a comprehensive guide to building and installing “generic” Unix software distributions under Linux.

- The Linux Users' Guide

<http://www.tldp.org/pub/Linux/docs/ldp-archived/users-guide/>

This guide covers the usage of assorted Linux software.

- The Essential Pre-Reading Hint

http://hints.cross-lfs.org/index.php/Essential_Prereading

This is a hint written specifically for users new to Linux. It includes a list of links to excellent sources of information on a wide range of topics. Anyone attempting to install CLFS should have an understanding of many of the topics in this hint.

Host System Requirements

You should be able to build a CLFS system from just about any Unix-type operating system. Your host system should have the following software with the minimum versions indicated. Also note that many distributions will place software headers into separate packages, often in the form of “[package-name]-devel” or “[package-name]-dev”. Be sure to install those if your distribution provides them.

- **Bash-2.05a**
- **Binutils-2.12** (Versions greater than 2.24 are not recommended as they have not been tested)
- **Bison-1.875**
- **Bzip2-1.0.2**
- **Coreutils-5.0**
- **Diffutils-2.8**
- **Findutils-4.1.20**
- **Gawk-3.1.5**
- **GCC-4.1.2** and the C++ compiler, **g++** (Versions greater than 4.8.3 are not recommended as they have not been tested)
- **Glibc-2.2.5** (Versions greater than 2.19 are not recommended as they have not been tested)
- **Grep-2.5**
- **Gzip-1.2.4**
- **Make-3.80**
- **Ncurses-5.3**
- **Patch-2.5.4**
- **Sed-3.0.2**
- **Tar-1.22**
- **Texinfo-4.7**
- **XZ Utils-4.999.8beta**

To see whether your host system has all the appropriate versions, create and run the following script. Read the output carefully for any errors, and make sure to install any packages that are reported as not found.

```

cat > version-check.sh << "EOF"
#!/bin/bash

# Simple script to list version numbers of critical development tools

bash --version | head -n1 | cut -d" " -f2-4
echo -n "Binutils: "; ld --version | head -n1 | cut -d" " -f3-
bison --version | head -n1
bzip2 --version 2>&1 < /dev/null | head -n1 | cut -d" " -f1,6-
echo -n "Coreutils: "; chown --version | head -n1 | cut -d")" -f2
diff --version | head -n1
find --version | head -n1
gawk --version | head -n1
gcc --version | head -n1
g++ --version | head -n1
ldd $(which ${SHELL}) | grep libc.so | cut -d ' ' -f 3 | ${SHELL} | head -n 1 | c
grep --version | head -n1
gzip --version | head -n1
make --version | head -n1
tic -V
patch --version | head -n1
sed --version | head -n1
tar --version | head -n1
makeinfo --version | head -n1
xz --version | head -n1
echo 'main(){}' | gcc -v -o /dev/null -x c - > dummy.log 2>&1
if ! grep -q 'error' dummy.log; then
    echo "Compilation successful" && rm dummy.log
else
    echo 1>&2 "Compilation FAILED - more development packages may need to be \
installed. If you like, you can also view dummy.log for more details."
fi
EOF

bash version-check.sh 2>errors.log &&
[ -s errors.log ] && echo -e "\nThe following packages could not be found:\n$(cat

```

Typography

To make things easier to follow, there are a few typographical conventions used throughout this book. This section contains some examples of the typographical format found throughout Cross-Compiled Linux From Scratch.

```
./configure --prefix=/usr
```

This form of text is designed to be typed exactly as seen unless otherwise noted in the surrounding text. It is also used in the explanation sections to identify which of the commands is being referenced.

```
install-info: unknown option '--dir-file=/mnt/clfs/usr/info/dir'
```

This form of text (fixed-width text) shows screen output, probably as the result of commands issued. This format is also used to show filenames, such as `/etc/ld.so.conf`.

Emphasis

This form of text is used for several purposes in the book. Its main purpose is to emphasize important points or items.

<http://cross-lfs.org/>

This format is used for hyperlinks, both within the CLFS community and to external pages. It includes HOWTOs, download locations, and websites.

```
cat > ${CLFS}/etc/group << "EOF"
root:x:0:
bin:x:1:
.....
EOF
```

This format is used when creating configuration files. The first command tells the system to create the file `${CLFS}/etc/group` from whatever is typed on the following lines until the sequence end of file (EOF) is encountered. Therefore, this entire section is generally typed as seen.

[REPLACED TEXT]

This format is used to encapsulate text that is not to be typed as seen or copied-and-pasted.

```
passwd(5)
```

This format is used to refer to a specific manual page (hereinafter referred to simply as a “man” page). The number inside parentheses indicates a specific section inside of **man**. For example, **passwd** has two man pages. Per CLFS installation instructions, those two man pages will be located at `/usr/share/man/man1/passwd.1` and `/usr/share/man/man5/passwd.5`. Both man pages have different information in them. When the book uses `passwd(5)` it is specifically referring to `/usr/share/man/man5/passwd.5`. **man passwd** will print the first man page it finds that matches “passwd”, which will be `/usr/share/man/man1/passwd.1`. For this example, you will need to run **man 5 passwd** in order to read the specific page being referred to. It should be noted that most man pages do not have duplicate page names in different sections. Therefore, **man [program name]** is generally sufficient.

Structure

This book is divided into the following parts.

Part I - Introduction

Part I explains a few important notes on how to proceed with the Cross-LFS installation. This section also provides meta-information about the book.

Part II - Preparing for the Build

Part II describes how to prepare for the building process—making a partition and downloading the packages.

Part III - Make the Cross-Compile Tools

Part III shows you how to make a set of Cross-Compiler tools. These tools can run on your host system but allow you to build packages that will run on your target system.

Part IV - Building the Basic Tools

Part IV explains how to build a tool chain designed to operate on your target system. These are the tools that will allow you to build a working system on your target computer.

Part V - Building the CLFS System

Part V guides the reader through the building of the CLFS system—compiling and installing all the packages one by one, setting up the boot scripts, and installing the kernel. The resulting Linux system is the foundation on which other software can be built to expand the system as desired. At the end of this book, there is an easy to use reference listing all of the programs, libraries, and important files that have been installed.

Appendices

The appendices contain information that doesn't really fit anywhere else in the book. Appendix A contains definitions of acronyms and terms used in the book; Appendices B and C have information about package dependencies and the build order. Some architectures may have additional appendices for arch-specific issues.

Errata

The software used to create a CLFS system is constantly being updated and enhanced. Security warnings and bug fixes may become available after the CLFS book has been released. Some host systems may also have problems building CLFS. To check whether the package versions or instructions in this release of CLFS need any modifications to accommodate security vulnerabilities, other bug fixes, or host-specific issues, please visit <http://trac.cross-lfs.org/wiki/errata> before proceeding with your build. You should note any changes shown and apply them to the relevant section of the book as you progress with building the CLFS system.

Part I. Introduction

Chapter 1. Introduction

1.1. Cross-LFS Acknowledgements

The CLFS team would like to acknowledge people who have assisted in making the book what it is today.

Our Leaders:

- William Harrington - Lead Developer.
- Jonathan Norman - x86, x86_64, PowerPC & UltraSPARC builds, Release Manager 2.x Series
- Chris Staub - x86 and x86_64 builds. Leader of Quality Control.

Our CLFS Team:

- Matt Darcy - x86, X86_64, and Sparc builds.
- Manuel Canales Esparcia - Book XML.
- Justin Knierim - Website Architect.
- Ken Moffat - PowerPC and X86_64 builds. Developer of Pure 64 Hint.

Outside the Development Team

- Jürg Billeter - Testing and assisting in the development of the Linux Headers Package
- Richard Downing - Testing, typo, and content fixes.
- Peter Ennis - Typo and content fixes.
- Tony Morgan - Typo and content fixes.

The CLFS team would also like to acknowledge contributions of people from *clfs-dev@lists.cross-lfs.org* and associated mailing lists who have provided valuable technical and editorial corrections while testing the Cross-LFS book.

- G. Moko - Text updates and Typos
- Maxim Osipov - MIPS Testing.
- Doug Ronne - Various x86_64 fixes.
- Theo Schneider - Testing of the Linux Headers Package
- Martin Ward - Recommendations for Systemd and the Boot method, among other contributions
- William Zhou - Text updates and Typos

Former Team Members

- Joe Ciccone - Lead Developer.
- Nathan Coulson - Bootscripts.
- Jim Gifford - Lead Developer.
- Jeremy Huntwork - PowerPC, x86, Sparc builds.
- Karen McGuinness - Proofreader.
- Ryan Oliver - Build Process Developer.

- Alexander E. Patrakov - Udev/Hotplug Integration
- Jeremy Utley - Release Manager 1.x Series.
- Zack Winkles - Unstable book work.

The Linux From Scratch Project

- *Gerard Beekmans* <gerard@linuxfromscratch.org> – Creator of Linux From Scratch, on which Cross-LFS is based

Thank you all for your support.

1.2. How to Build a CLFS System

The CLFS system will be built by using a previously installed Unix system or Linux distribution (such as Debian, Fedora, openSUSE, or Ubuntu). This existing system (the host) will be used as a starting point to provide necessary programs, including a compiler, linker, and shell, to build the new system. Select the “development” option during the distribution installation to be able to access these tools.

As an alternative to installing an entire separate distribution onto your machine, you may wish to use a livecd. Most distributions provide a livecd, which provides an environment to which you can add the required tools onto, allowing you to successfully follow the instructions in this book. Remember that if you reboot the livecd you will need to reconfigure the host environment before continuing with your build.

Preparing a New Partition of this book describes how to create a new Linux native partition and file system, the place where the new CLFS system will be compiled and installed. Packages and Patches explains which packages and patches need to be downloaded to build a CLFS system and how to store them on the new file system. Final Preparations discusses the setup for an appropriate working environment. Please read Final Preparations carefully as it explains several important issues the developer should be aware of before beginning to work through Constructing Cross-Compile Tools and beyond.

Constructing Cross-Compile Tools explains the installation of cross-compile tools which will be built on the host but be able to compile programs that run on the target machine. These cross-compile tools will be used to create a temporary, minimal system that will be the basis for building the final CLFS system. Some of these packages are needed to resolve circular dependencies—for example, to compile a compiler, you need a compiler.

The process of building cross-compile tools first involves building and installing all the necessary tools to create a build system for the target machine. With these cross-compiled tools, we eliminate any dependencies on the toolchain from our host distro.

After we build our “Cross-Tools”, we start building a very minimal working system in `/tools`, using the cross-toolchain in `/cross-tools`. Once the temporary system is finished, we perform a few additional tasks to prepare to enter this temporary build environment, either by booting or chrooting into it. For more details about the difference between these methods, see Section 6.31, “To Boot or to Chroot?”.

In Installing Basic System Software, after having booted or chrooted into the temporary build environment, the full CLFS system is built.

To finish the installation, several configuration files are created in System Configuration, and the kernel and boot loader are set up in Making the CLFS System Bootable. The End contains information on furthering the CLFS experience beyond this book. After the steps in this book have been implemented, the computer will be ready to reboot into the new CLFS system.

This is the process in a nutshell. Detailed information on each step is discussed in the following chapters and package descriptions. Items that may seem complicated will be clarified, and everything will fall into place as the reader embarks on the CLFS adventure.

1.3. Master Changelog

This is version 3.0.0-RC1 of the Cross-Compiled Linux From Scratch book, dated July 24, 2014. If this book is more than six months old, a newer and better version is probably already available. To find out, please check one of the mirrors via <http://trac.cross-lfs.org/>.

Below is a list of detailed changes made since the previous release of the book.

Changelog Entries:

- 24 July 2014
 - [Chris] - Added config flag descriptions to kernel config pages. Thanks to Hazel Russman for the idea.
 - [Chris] - Removed commands to recreate /usr/share/info to reduce possible user confusion.
- 21 July 2014
 - [William Harrington] - Update MPFR 3.1.2 fixes patch for patch level 10 update.
 - [William Harrington] - Update VIM 7.4 Branch Update patch to patch level 373.
 - [William Harrington] - Update Linux to 3.14.13.
- 18 July 2014
 - [Chris] - Changed title on Linux Headers installation pages to reduce potential confusion with previous Linux-Headers package.
- 17 July 2014
 - [Chris] - Updated D-Bus to 1.8.6 for security fixes. Closes ticket #974.
- 14 July 2014
 - [Chris] - Modified instructions for mounting file systems for chroot so that they are all mounted before entering chroot, and added a tmpfs on /run. Took solution for /dev/shm symlink from LFS. Fixes ticket #971.
 - [Chris] - Updated Linux sublevel to 3.14.12.
- 10 July 2014
 - [Chris] - Add back instruction to create /var/log/lastlog, so that it can actually be used.
- 02 July 2014
 - [William Harrington] - Update Linux sublevel patch to 3.14.10.
- 30 June 2014
 - [Chris] - Added documentation installation instructions for Zlib.
- 27 June 2014
 - [William Harrington] - Updated KMOD to 18. Fixes ticket #965.
- 24 June 2014
 - [Chris] - Remove reference to a non-existent man page from timesyncd.conf.
 - [Chris] - Prevent systemd from running **setcap** during installation.

- [Chris] - Prevent **systemd-fsck** from using **fsck -l**, to avoid boot errors. Fixes ticket #968.
- 23 June 2014
 - [Chris] - Added info about systemd-timesyncd to network configuration section. Fixes ticket #958.
- 20 June 2014
 - [William Harrington] - Remove **make -C man install** from final-system KMOD as man pages are installed during **make install**.
 - [William Harrington] - Add Linux sublevel patch.
 - [Chris] - Changed GMP documentation installation instructions to use the Makefile to install docs instead of doing so manually.
- 17 June 2014
 - [William Harrington] - Use --with-isl=system for temp-system CLooG.
- 17 June 2014
 - [William Harrington] - Move Man-DB right after Libpipeline.
- 15 June 2014
 - [Chris] - Added commands to create and install HTML documentation for MPC.
- 13 June 2014
 - [William Harrington] - Update D-Bus to 1.8.4.
 - [William Harrington] - Update File to 5.19.
 - [Chris] - Text updates to kernel installation page.
- 11 June 2014
 - [Chris] - Placed file before findutils in temp-system.
- 10 June 2014
 - [William Harrington] - Upgraded Gettext to 0.19.1.
- 04 June 2014
 - [Chris] - Added Introduction page to final-preps.
- 03 June 2014
 - [Chris] - Moved installation of /tools/include/libiberty.h from Cross-Tools to Temp-System.
 - [Chris] - Moved creation of /var/run symlink to a more appropriate location in the Creating Directories page.
- 02 June 2014
 - [William Harrington] - Upgraded Gettext to 0.19.
- 01 June 2014
 - [Chris] - Upgraded GCC to 4.8.3.
 - [William Harrington] - Upgraded Eudev to 1.7.
- 31 May 2014
 - [William Harrington] - Update Check to 0.9.13.
 - [William Harrington] - Update Linux to 3.14.5.

- [William Harrington] - Update Vim 7.4 branch update patch to level 316.
- 30 May 2014
 - [William Harrington] - Add --host=\${CLFS_TARGET} during cross-tools Pkg-config configure.
- 29 May 2014
 - [William Harrington] - Update Perl to 5.20.0.
 - [Chris] - Edited "how" page - removed details about booting/chrooting and moved them to the "choose" page for temp-system.
- 28 May 2014
 - [William Harrington] - Upgrade Systemd to 213.
 - [William Harrington] - Upgrade TZData to 2014d.
 - [William Harrington] - Upgrade Man-pages to 3.68.
- 25 May 2014
 - [William Harrington] - Upgrade Grep to 2.19.
- 24 May 2014
 - [Chris] - Moved Bc from Cross-Tools to Boot section, as it's only needed to compile the kernel.
 - [Chris] - Moved "About \${CLFS}" page from final-preps to partitioning - best to have the page explaining \${CLFS} before it's actually used.
- 22 May 2014
 - [Chris] - Swapped build order of Linux-headers and File in Cross-Tools - no particular reason for File to be after Linux-headers, so just make them alphabetical.
- 21 May 2014
 - [Chris] - Rewrote Udev page in system-config section.
 - [Chris] - Moved creation of /etc/fstab to system-config.
 - [William Harrington] - Update Man-pages to 3.67.
- 19 May 2014
 - [Chris] - Added commands to unset CFLAGS and CXXFLAGS to the clfs user's default .bashrc, and removed the separate page where this was done.
 - [Chris] - Removed separate "Build flags" pages and moved that info to "Build Variables" pages, and moved those from cross-tools to final-preps.
- 18 May 2014
 - [Chris] - Added Pkg-config-lite to Cross-Tools and removed PKG_CONFIG parameters from temp-system and boot packages.
- 17 May 2014
 - [William Harrington] - Upgrade TZData to 2014c.
 - [William Harrington] - Add --disable-werror for cross-tools Binutils.
- 11 May 2014
 - [Chris] - Added explanations for Essential Symlinks.

- 08 May 2014
 - [William Harrington] - Update Man-pages to 3.66.
 - [William Harrington] - Add GDBM 1.11 to the books.
 - [William Harrington] - Add Libpipeline 1.3.0 to the books.
 - [William Harrington] - Add Man-DB 2.6.7.1 to the books.
 - [William Harrington] - Remove Man-1.6g from the books.
 - [William Harrington] - Remove zsoelim link from Groff.
- 06 May 2014
 - [Chris] - Removed unneeded configure switches specifying GMP/MPFR/MPC/ISL/CLOOG in /tools.
 - [Chris] - Removed unneeded --libexecdir switches from temp-system GCC.
- 02 May 2014
 - [Chris] - Removed command to copy gconv-modules in Glibc instructions, as it is no longer needed.
- 30 April 2014
 - [Chris] - Added "PKG_CONFIG=" to boot section kmod commands, otherwise it will use pkg-config to find the "bash-completion" package and install stuff to that prefix if found. Thanks to boloco in IRC for finding this.
 - [William Harrington] - Upgrade Dbus to 1.8.2.
- 28 April 2014
 - [Chris] - Remove all mentions of Alpha architecture, as it has not been tested for a long time.
- 27 April 2014
 - [William Harrington] - Update IPRoute2 to 3.14.0.
- 27 April 2014
 - [Chris] - Updated Acknowledgements page.
 - [William Harrington] - Update Linux to 3.14.2.
- 26 April 2014
 - [Chris] - Renamed bootscripts package to boot-scripts (thanks to William Harrington for the suggestion) and removed the patch as it is not needed for the new package.
 - [Chris] - Renamed bootscripts chapter to "System Configuration".
 - [William Harrington] - Update Util-linux to 2.24.2.
 - [Chris] - Added new page about how to view the book from inside the temporary boot environment.
 - [Chris] - Don't move binaries from Findutils or Psmisc to /bin, as they're no longer needed there.
 - [William Harrington] - Update Vim 7.4 branch update patch to level 265.
- 24 April 2014
 - [William Harrington] - Update Eudev to 1.6.
 - [William Harrington] - Update Man-pages to 3.65.
 - [William Harrington] - Update Bash branch update patch to level 11.
 - [William Harrington] - Update Readline branch update patch to level 5.

- 22 April 2014
 - [Chris] - Removed several virtual filesystems from `/${CLFS}/fstab` for the boot method, as they're already mounted by the bootscrip.
 - [Chris] - Removed creation of `gtbl` and `geqn` symlinks, as they are no longer needed.
- 21 April 2014
 - [Chris] - Re-added manual creation of `/usr/bin/perl` symlink, as it is not created automatically under some circumstances.
- 20 April 2014
 - [Chris] - Reorganized "boot" section to allow everything to be installed into `/tools`, remove the need to `chown ${CLFS}` to the `clfs` user, and generally make the chapter's instructions flow better.
- 18 April 2014
 - [Chris] - Added `--disable-makeinstall-setuid` to `temp-system Util-linux`, as nothing there needs to be `suid`.
- 16 April 2014
 - [Chris] - Removed creation of `/usr/bin/perl` symlink, as Perl creates a link itself when installed.
- 13 April 2014
 - [Chris] - Updated most packages in the Boot section to install into `/tools` instead of `CLFS`. Thanks to Martin Ward and William Harrington for assistance.
- 12 April 2014
 - [Chris] - Modified `sysvinit` installation to allow it to use `/tools/etc/inittab` and `/tools/sbin/agetty`.
 - [Chris] - Moved `Util-linux` installation out of `boot/chroot` sections into the `temp-system`, as it can be installed the same way with either method.
- 11 April 2014
 - [Chris] - Updated MPC to 1.0.2.
 - [Chris] - Removed unneeded `--disable-login` and `--disable-su` switches from `Util-linux` configure in `boot/chroot` sections.
- 09 April 2014
 - [William Harrington] - Update Eudev to 1.5.3.
- 09 April 2014
 - [Chris] - Remove obsolete `--enable-clog-backend` parameter from GCC configure.
 - [William Harrington] - Remove unneeded `--disable-isl-version-check` parameter from GCC configure.
 - [William Harrington] - Update Gawk to 4.1.1.
- 08 April 2014
 - [William Harrington] - Add versioned doc directories for Automake, DBus, Flex, Gawk, Gettext, GMP, IPRoute2, KBD, MPFR, Readline, Sed, Tar, Util-linux and XZ.
- 06 April 2014
 - [William Harrington] - Update KMOD to 17.
 - [William Harrington] - Update Man-pages to 3.64.

- 05 April 2014
 - [William Harrington] - Move Flex before Bison in final system and remove bison and flex from temp system.
 - [William Harrington] - Add M4=m4 before configure command in final-system Bison and Flex.
 - [William Harrington] - Remove Bison and Flex from temp system.
 - [William Harrington] - Move M4 before GMP in final-system and remove M4 from temp system.
- 02 April 2014
 - [William Harrington] - Add test commands to Attr and Acl.
- 30 March 2014
 - [Chris] - Modified network section to split systemd/sysconfig network configurations.
 - [Chris] - Removed instructions to install systemd manpages - they are now automatically installed by default.
 - [Chris] - Updated installed program lists for several packages.
 - [William Harrington] - Remove link of libl to libfl during Flex installation.
 - [William Harrington] - Update DHCPCD to 6.3.2.
 - [William Harrington] - Update VIM 7.4 patch to level 229.
 - [William Harrington] - Update Bash 4.3 patch to level 8.
 - [William Harrington] - Update Readline 6.3 patch to level 3.
 - [William Harrington] - Update GCC 4.8.2 branch update patch to revision 208943.
- 23 March 2014
 - [William Harrington] - Update Man-pages to 3.63.
- 28 March 2014
 - [William Harrington] - Update File to 5.18.
 - [William Harrington] - Update Flex to 2.5.39.
 - [William Harrington] - Update Linux to 3.12.15.
 - [William Harrington] - Update Systemd to 212.
 - [William Harrington] - Update Tzdata to 2014b.
 - [William Harrington] - Update GMP to 6.0.0a.
 - [William Harrington] - Move Bison and Flex before Binutils.
- 17 March 2014
 - [William Harrington] - Remove libdbus and Update Systemd to 211.
 - [William Harrington] - Add Systemd compat patch to install pkg-config files.
- 12 March 2014
 - [Chris] - Updated documentation installation instructions for Readline and Bash.
 - [Chris] - Deleted --remove-destination parameter when creating /etc/localtime - it's no longer needed.
 - [William Harrington] - Update Man-pages to 3.62.
- 10 March 2014
 - [William Harrington] - Update TZData to 2014a.

- [William Harrington] - Update MPFR fixes patch to patch level 5.
- 09 March 2014
 - [William Harrington] - Add configure command descriptions and testsuite commands to Systemd.
 - [William Harrington] - Update testsuite description for D-BUS.
 - [William Harrington] - Add note to final-system Util-Linux regarding extra functionality with libudev.
 - [William Harrington] - Add commands and descriptions for `/etc/adjtime`.
- 02 March 2014
 - [William Harrington] - Update DHCPCD to 6.3.1.
- 27 February 2014
 - [William Harrington] - Update Grep to 2.18.
 - [William Harrington] - Update DHCPCD to 6.3.0.
 - [William Harrington] - Update Man-pages to 3.61.
 - [William Harrington] - Update Readline to 6.3.
 - [William Harrington] - Update Bash to 4.3.
- 24 February 2014
 - [William Harrington] - Remove installation of `nscd` `tmpfile` and `unit` service file in `clfs-network-scripts`.
- 23 February 2014
 - [William Harrington] - Add commands for `nscd` config, runtime, and Systemd unit files installation to GLIBC.
- 18 February 2014
 - [William Harrington] - Migrate EGLIBC to GLIBC and upgrade to version 2.19.
 - [William Harrington] - Update D-Bus to stable version 1.8.0.
 - [William Harrington] - Update File to version 5.17.
 - [William Harrington] - Update Grep to version 2.17.
 - [William Harrington] - Update Linux to version 3.12.11.
 - [William Harrington] - Update Man-pages to version 3.60.
 - [William Harrington] - Update Psmisc to version 22.21.
- 13 February 2014
 - [William Harrington] - Correct `nobody` `gid` to use `nogroup` `gid`.
- 03 February 2014
 - [William Harrington] - Add configure options to `systemd` so `loadkeys` and `setfont` is searched in `/bin` instead of `/usr/bin`.
- 02 February 2014
 - [William Harrington] - Remove note in `Iana-etc` page and update `iana-etc` update numbers patch for proper operation with current `iana-etc` format.
- 29 January 2014

- [William Harrington] - Add PKG_CONFIG= to temp-system make configure command.
- 27 January 2014
 - [William Harrington] - Add PERL=/usr/bin/perl to temp-system Texinfo build.
- 26 January 2014
 - [William Harrington] - Update LESS to 462.
- 25 January 2014
 - [William Harrington] - Create a link from /proc/self/mounts to /etc/mtab in boot and chroot createfiles section.
- 23 January 2014
 - [William Harrington] - Update text and redo some commands regarding Systemd in the System and Network configuration chapters.
 - [William Harrington] - Add a clock configuration script to system configuration chapter with regards to systemd.
 - [William Harrington] - Add CLFS-Network-Scripts and add commands to install them in the network configuration chapter.
 - [William Harrington] - Update Util-linux to 2.24.1.
 - [William Harrington] - Update Check to 0.9.12.
- 21 January 2014
 - [William Harrington] - Add D-Bus libraries before Systemd in final-system for a circular dependency issue.
- 19 January 2014
 - [William Harrington] - Update DHCPCD to 6.2.1.
 - [William Harrington] - Use readlink when creating links for dynamic libraries for zlib, xz, ncurses, and readline.
- 13 January 2014
 - [William Harrington] - Update ISL to 0.12.2.
 - [William Harrington] - Update Man-pages to 3.56.
- 10 January 2014
 - [William Harrington] - Migrate Procps to Procps-ng.
- 09 January 2014
 - [Chris] - Updated Linux to 3.12.7.
 - [Chris] - Updated Perl to 5.18.2.
 - [Chris] - Updated Gettext to 0.18.3.2.
 - [Chris] - Updated Libcap to 2.24.
 - [Chris] - Removed unneeded command to create a /usr/lib/terminfo symlink from Ncurses instructions.
 - [Chris] - Removed /usr/{doc,info,man} symlinks and edited instructions for packages to ensure all documentation is installed to /usr/share.
 - [Chris] - Moved libcap so it's built just before iputils, which can use libcap.
- 08 January 2014

- [Chris] - Removed commands to create files in /var/run and /var/log - systemd now used its journal for all logs.
- [Chris] - Removed obsolete sed command from temp-system Coreutils.
- [Chris] - Removed unneeded command to rename stubs-64.h.
- [Chris] - Removed unneeded "make configure-host" commands from Binutils.
- [Chris] - Moved Attr and ACL to just after GCC in the final system.
- 07 January 2014
 - [Chris] - Added command, from LFS, to modify /tools/lib/libstdc++.la to prevent a /tools reference in the final system.
 - [Chris] - Use libiberty from GCC, since Binutils no longer installs it by default.
- 06 January 2014
 - [Chris] - Added msgmerge and xgettext to /tools Gettext installation - needed for attr.
 - [William Harrington] - Update DHCPD to 6.2.0.
 - [William Harrington] - Update Grep to 2.16.
- 05 January 2014
 - [Chris] - Removed rsyslog and its dependencies, libee and libestr.
 - [Chris] - Updated Expat to 2.1.0.
 - [Chris] - Updated Attr to 2.4.47.
 - [Chris] - Updated D-Bus to 1.6.18.
 - [Chris] - Updated Libcap to 2.23.
- 04 January 2014
 - [Chris] - Updated Systemd to 208.
 - [Chris] - Added Gperf, XML::Parser, Intltool, and ACL - needed by systemd.
- 01 January 2014
 - [Chris] - Added command to EGLIBC instructions to remove extraneous '.x' files from /usr/include/rpcsvc.
- 23 December 2013
 - [William Harrington] - Update E2fsprogs to 1.42.9.
 - [William Harrington] - Update Automake to 1.14.1.
- 21 December 2013
 - [William Harrington] - Update CLoog to 0.18.2.
 - [William Harrington] - Update Tzdata to 2013i.
 - [William Harrington] - Update EGLIBC 2.18 to revision 24829.
 - [William Harrington] - Update Linux to 3.12.6.
- 14 December 2013
 - [William Harrington] - Update Coreutils to 8.22.
 - [William Harrington] - Update Man-pages to 3.55.

- 08 December 2013
 - [William Harrington] - Update Bison to 3.0.2.
- 06 December 2013
 - [Chris] - Modified XZ instructions so that it won't install liblzma.{a,la} in /lib.
- 04 December 2013
 - [William Harrington] - Updated Binutils to version 2.24.
 - [William Harrington] - Updated File to version 5.16.
- 26 November 2013
 - [Chris] - Updated installed program lists for several packages.
 - [Chris] - Removed redundant --disable-su and --disable-login switches from Util-linux - they aren't built anyway if PAM isn't found.
- 25 November 2013
 - [William Harrington] - Update Iproute2 to 3.12.0.
 - [William Harrington] - Update Tar to 1.27.1.
- 23 November 2013
 - [Chris] - Use nologin from Util-linux instead of Shadow.
- 22 November 2013
 - [Chris] - Util-linux now installs last and mesg by default, so use those instead of the versions in Sysvinit.
- 18 November 2013
 - [William Harrington] - Move creation of dummy groups and user to final-system Util-linux.
 - [William Harrington] - Remove SUBDIRS variable from final-system Coreutils test command.
 - [William Harrington] - Adjust Util-linux test commands.
- 13 November 2013
 - [William Harrington] - Adjust Util-linux check commands.
 - [William Harrington] - Move Shadow before Util-Linux in final-system.
 - [William Harrington] - Update Bison to 3.0.1.
 - [William Harrington] - Remove Bison 3.0 eof patch.
- 11 November 2013
 - [William Harrington] - Update TZDATA to 2013h.
 - [William Harrington] - Add MPFR 3.1.2 Fixes patch.
 - [William Harrington] - Update Grep to 2.15.
 - [William Harrington] - Update Linux to 3.12.
 - [William Harrington] - Add a sed for Texinfo 5.x to all sections of Binutils.
 - [William Harrington] - Update Texinfo to 5.2.
 - [William Harrington] - Update KBD to 2.0.1.
 - [William Harrington] - Update Check to 0.9.11.

- [William Harrington] - Update Automake to 1.14.
- [William Harrington] - Update Make to 4.0.
- [William Harrington] - Add a Sed command to EGLIBC for Make-4.x.
- [William Harrington] - Move Check to temp-system.
- 09 November 2013
 - [William Harrington] - Add PKG_CONFIG= in front of configure line for chroot and boot Util-linux for hosts with pkg-config installed.
- 25 October 2013
 - [William Harrington] - Updated Util-Linux to 2.24.
 - [William Harrington] - Updated Tar to 1.27.
 - [William Harrington] - Updated Linux to 3.10.17.
 - [William Harrington] - Updated GCC to 4.8.2.
 - [William Harrington] - Updated CLooG to 0.18.1.
 - [William Harrington] - Changelog restarted, see the 2.1.0 book for the old changelog.

1.4. Changelog for x86_64-64

Below is a list of changes specific for this architecture made since the previous release of the book. For general changes see Master Changelog,

Changelog Entries:

- 25 May 2014
 - [Chris] - Added `#{BUILD64}` to `variables.xml` in `temp-system`, and removed `CC="#{CC} #{BUILD64}"` from `temp-system` and `boot` packages.
- 27 April 2014
 - [Chris] - Removed obsolete `CFLAGS` from `x86 Glibc` configure commands.
- 24 October 2013
 - [William Harrington] - Changelog restarted, see the 2.1.0 book for the old changelog.

1.5. Resources

1.5.1. FAQ

If during the building of the CLFS system you encounter any errors, have any questions, or think there is a typo in the book, please start by consulting the Frequently Asked Questions (FAQ) that is located at <http://trac.cross-lfs.org/wiki/faq>.

1.5.2. Mailing Lists

The `cross-lfs.org` server hosts a number of mailing lists used for the development of the CLFS project. These lists include the main development and support lists, among others. If the FAQ does not contain your answer, you can search the CLFS lists via The Mail Archive <http://www.mail-archive.com>. You can find the mail lists with the following link:

<http://www.mail-archive.com/index.php?hunt=clfs>

For information on the different lists, how to subscribe, archive locations, and additional information, visit <http://trac.cross-lfs.org/wiki/lists>.

1.5.3. News Server

Cross-LFS does not maintain its own News Server, but we do provide access via gmane.org. If you want to subscribe to the Cross-LFS lists via a newsreader you can utilize gmane.org. You can find the [gmane](http://gmane.org) search for CLFS with the following link:

<http://dir.gmane.org/search.php?match=clfs>

1.5.4. IRC

Several members of the CLFS community offer assistance on our community Internet Relay Chat (IRC) network. Before using this support, please make sure that your question is not already answered in the CLFS FAQ or the mailing list archives. You can find the IRC network at chat.freenode.net. The support channel for cross-lfs is named #cross-lfs. If you need to show people the output of your problems, please use <http://pastebin.cross-lfs.org> and reference the pastebin URL when asking your questions.

1.5.5. Mirror Sites

The CLFS project has a number of world-wide mirrors to make accessing the website and downloading the required packages more convenient. Please visit the CLFS website at <http://trac.cross-lfs.org/wiki/mirrors> for mirrors of CLFS.

1.5.6. Contact Information

Please direct all your questions and comments to the CLFS mailing lists (see above).

1.6. Help

If an issue or a question is encountered while working through this book, check the FAQ page at <http://trac.cross-lfs.org/wiki/faq#generalfaq>. Questions are often already answered there. If your question is not answered on this page, try to find the source of the problem. The following hint will give you some guidance for troubleshooting: <http://hints.cross-lfs.org/index.php/Errors>.

We also have a wonderful CLFS community that is willing to offer assistance through the mailing lists and IRC (see the Section 1.5, “Resources” section of this book). However, we get several support questions everyday and many of them can be easily answered by going to the FAQ and by searching the mailing lists first. So for us to offer the best assistance possible, you need to do some research on your own first. This allows us to focus on the more unusual support needs. If your searches do not produce a solution, please include all relevant information (mentioned below) in your request for help.

1.6.1. Things to Mention

Apart from a brief explanation of the problem being experienced, the essential things to include in any request for help are:

- The version of the book being used (in this case 3.0.0-RC1)

- The host distribution and version being used to create CLFS.
- The architecture of the host and target.
- The value of the `{CLFS_HOST}` and `{CLFS_TARGET}` environment variables, and if applicable, `{BUILD32}`, `{BUILD64}`, `{BUILDN32}`, and `{GCCTARGET}`.
- The package or section in which the problem was encountered.
- The exact error message or symptom received. See Section 1.6.3, “Compilation Problems” below for an example.
- Note whether you have deviated from the book at all. A package version change or even a minor change to any command is considered deviation.



Note

Deviating from this book does *not* mean that we will not help you. After all, the CLFS project is about personal preference. Be upfront about any changes to the established procedure—this helps us evaluate and determine possible causes of your problem.

1.6.2. Configure Script Problems

If something goes wrong while running the **configure** script, review the `config.log` file. This file may contain the errors you encountered during **configure**. It often logs errors that may have not been printed to the screen. Include only the *relevant* lines if you need to ask for help.

1.6.3. Compilation Problems

Both the screen output and the contents of various files are useful in determining the cause of compilation problems. The screen output from the **configure** script and the **make** run can be helpful. It is not necessary to include the entire output, but do include enough of the relevant information. Below is an example of the type of information to include from the screen output from **make**:

```
gcc -DALIASPATH=\"/mnt/clfs/usr/share/locale:.\"
-DLOCALEDIR=\"/mnt/clfs/usr/share/locale\"
-DLIBDIR=\"/mnt/clfs/usr/lib\"
-DINCLUDEDIR=\"/mnt/clfs/usr/include\" -DHAVE_CONFIG_H -I. -I.
-g -O2 -c getopt1.c
gcc -g -O2 -static -o make ar.o arscan.o commands.o dir.o
expand.o file.o function.o getopt.o implicit.o job.o main.o
misc.o read.o remake.o rule.o signame.o variable.o vpath.o
default.o remote-stub.o version.o opt1.o
-lutil job.o: In function `load_too_high':
/clfs/tmp/make-3.79.1/job.c:1565: undefined reference
to `getloadavg'
collect2: ld returned 1 exit status
make[2]: *** [make] Error 1
make[2]: Leaving directory `/clfs/tmp/make-3.79.1'
make[1]: *** [all-recursive] Error 1
make[1]: Leaving directory `/clfs/tmp/make-3.79.1'
make: *** [all-recursive-am] Error 2
```

In this case, many people would just include the bottom section:

```
make [2]: *** [make] Error 1
```

This is not enough information to properly diagnose the problem because it only notes that something went wrong, not *what* went wrong. The entire section, as in the example above, is what should be saved because it includes the command that was executed and the associated error message(s).

An excellent article about asking for help on the Internet is available online at <http://catb.org/~esr/faqs/smart-questions.html>. Read and follow the hints in this document to increase the likelihood of getting the help you need.

Part II. Preparing for the Build

Chapter 2. Preparing a New Partition

2.1. Introduction

In this chapter, the partition which will host the CLFS system is prepared. We will create the partition itself, create a file system on it, and mount it.

2.2. Setting The `{CLFS}` Variable

Throughout this book, the environment variable `CLFS` will be used several times. You should ensure that this variable is always defined throughout the CLFS build process. It should be set to the name of the directory where you will be building your CLFS system - we will use `/mnt/clfs` as an example, but the directory choice is up to you. If you are building CLFS on a separate partition, this directory will be the mount point for the partition. Choose a directory location and set the variable with the following command:

```
export CLFS=[/mnt/clfs]
```

Having this variable set is beneficial in that commands such as `install -dv {CLFS}/tools` can be typed literally. The shell will automatically replace “`{CLFS}`” with “`/mnt/clfs`” (or whatever the variable was set to) when it processes the command line.

Do not forget to check that `{CLFS}` is set whenever you leave and reenter the current working environment (such as when doing a `su` to `root` or another user). Check that the `CLFS` variable is set up properly with:

```
echo {CLFS}
```

Make sure the output shows the path to your CLFS system's build location, which is `/mnt/clfs` if the provided example was followed. If the output is incorrect, use the command given earlier on this page to set `{CLFS}` to the correct directory name.

2.3. Creating a New Partition

Like most other operating systems, CLFS is usually installed on a dedicated partition. The recommended approach to building a CLFS system is to use an available empty partition or, if you have enough unpartitioned space, to create one. However, if you're building for a different architecture you can simply build everything in “`/mnt/clfs`” (or whatever directory you want to use) and transfer it to your target machine. If you do not plan to use a separate partition for building CLFS, you can skip the rest of this chapter and continue on to Packages and Patches.

A minimal system requires around 6 gigabytes (GB). This is enough to store all the source tarballs and compile the packages. The CLFS system itself will not take up this much room. A large portion of this requirement is to provide sufficient free temporary storage. Compiling packages can require a lot of disk space which will be reclaimed after the package is installed. If the CLFS system is intended to be the primary Linux system, additional software will probably be installed which will require additional space (2-10 GB).

Because there is not always enough Random Access Memory (RAM) available for compilation processes, it is a good idea to use a small disk partition as swap space. This is used by the kernel to store seldom-used data and leave more memory available for active processes. The swap partition for an CLFS system can be the same as the one used by the host system, in which case it is not necessary to create another one.

As the `root` user, start a disk partitioning program such as **cfdisk** or **fdisk** with a command line option naming the hard disk on which the new partition will be created—for example `/dev/sda` for the primary Integrated Drive Electronics (IDE) or Serial ATA (SATA) disk. Create a Linux native partition and a swap partition, if needed. Please refer to `cfdisk(8)` or `fdisk(8)` if you do not yet know how to use the programs.

Remember the designation of the new partition (e.g., `sda5`). This book will refer to this as the CLFS partition. Also remember the designation of the swap partition. These names will be needed later for the `/etc/fstab` file.

2.4. Creating a File System on the Partition

Now that a blank partition has been set up, the file system can be created. The most widely-used system in the Linux world is the second extended file system (`ext2`), but with newer high-capacity hard disks, journaling file systems are becoming increasingly popular. We will create an `ext2` file system. Instructions for other file systems can be found at http://cblfs.cross-lfs.org/index.php?section=6#File_System.

To create an `ext2` file system on the CLFS partition, run the following as `root`:

```
mke2fs /dev/[xxx]
```

Replace `[xxx]` with the name of the CLFS partition (`sda5` in our previous example).



Note

Some host distributions use custom features in their filesystem creation tools (E2fsprogs). This can cause problems when booting into your new CLFS system, as those features will not be supported by the CLFS-installed E2fsprogs; you will get an error similar to `unsupported filesystem features`, upgrade your `e2fsprogs`. To check if your host system uses custom enhancements, run the following command:

```
debugfs -R feature /dev/[xxx]
```

If the output contains features other than: `dir_index`; `filetype`; `large_file`; `resize_inode` or `sparse_super` then your host system may have custom enhancements. In that case, to avoid later problems, you should compile the stock E2fsprogs package and use the resulting binaries to re-create the filesystem on your CLFS partition. To do this, run the following commands as `root`:

```
cd /tmp
tar xjf /path/to/sources/e2fsprogs-1.42.9.tar.bz2
cd e2fsprogs-1.42.9
mkdir build
cd build
../configure
make #note that we intentionally don't 'make install' here!
./misc/mke2fs /dev/[xxx]
cd /tmp
rm -rf e2fsprogs-1.42.9
```

If you created a swap partition, you will need to initialize it for use by issuing the command below as `root`:

```
mkswap /dev/[yyy]
```

Replace `[yyy]` with the name of the swap partition. If you are using an existing swap partition, there is no need to format it.

2.5. Mounting the New Partition

Now that a file system has been created, the partition needs to be made accessible. In order to do this, the partition needs to be mounted at a chosen mount point.

As the `root` user, ensure the `CLFS` variable is set, if you haven't already:

```
export CLFS=[/mnt/clfs]
```

Next, create the mount point and mount the CLFS file system by running the following commands as `root`:

```
mkdir -pv ${CLFS}
mount -v /dev/[xxx] ${CLFS}
```

Replace `[xxx]` with the designation of the CLFS partition.

If using multiple partitions for CLFS (e.g., one for `/` and another for `/usr`), mount them as `root` using:

```
mkdir -pv ${CLFS}
mount -v /dev/[xxx] ${CLFS}
mkdir -v ${CLFS}/usr
mount -v /dev/[yyy] ${CLFS}/usr
```

Replace `[xxx]` and `[yyy]` with the appropriate partition names.

Ensure that this new partition is not mounted with permissions that are too restrictive (such as the `nosuid`, `nodev`, or `noatime` options). Run `mount | grep ${CLFS}` to see what options are set for the mounted CLFS partition. If `nosuid`, `nodev`, and/or `noatime` are set, the partition will need to be remounted.

Now that there is an established place to work, it is time to download the packages.

Chapter 3. Packages and Patches

3.1. Introduction

This chapter includes a list of packages that need to be downloaded for building a basic Linux system. The listed version numbers correspond to versions of the software that are known to work, and this book is based on their use. We highly recommend not using newer versions because the build commands for one version may not work with a newer version. The newest package versions may also have problems that require work-arounds. These work-arounds will be developed and stabilized in the development version of the book.

Download locations may not always be accessible. If a download location has changed since this book was published, Google (<http://www.google.com/>) provides a useful search engine for most packages. If this search is unsuccessful, try one of the alternative means of downloading discussed at <http://cross-lfs.org/files/packages/3.0.0-RC1/SYSTEMD/>.

Create a directory called `${CLFS}/sources` and use it to store your sources and patches. All packages should be compiled there as well. Using any other location for compiling may have unexpected results.

To create this directory, execute, as user `root`, the following command before starting the download session:

```
mkdir -v ${CLFS}/sources
```

Make this directory writable and sticky. When a directory is marked “sticky”, that means that even if multiple users have write permission on that directory, any file within that directory can only be deleted or modified by its owner. The following command, run as `root`, will enable the write and sticky modes:

```
chmod -v a+wt ${CLFS}/sources
```

You can download all needed packages and patches into this directory either by using the links on the following pages in this section, or by passing the *download list* to `wget`:

```
wget -i dl.list -P ${CLFS}/sources
```

Verification of downloaded packages can be done by downloading the following MD5 or SHA1 checksum lists:

MD5SUMS:

```
pushd ${CLFS}/sources
md5sum -c MD5SUMS
popd
```

SHA1SUMS:

```
pushd ${CLFS}/sources
sha1sum -c SHA1SUMS
popd
```

3.2. All Packages

Download or otherwise obtain the following packages:

- **ACL (2.2.52) - 384 KB:**

Home page: <http://acl.bestbits.at/>

Download: <http://download.savannah.gnu.org/releases/acl/acl-2.2.52.src.tar.gz>

MD5 sum: a61415312426e9c2212bd7dc7929abda

• **Attr (2.4.47) - 340 KB:**

Home page: <http://acl.bestbits.at/>

Download: <http://download.savannah.gnu.org/releases/attr/attr-2.4.47.src.tar.gz>

MD5 sum: 84f58dec00b60f2dc8fd1c9709291cc7

• **Autoconf (2.69) - 1,188 KB:**

Home page: <http://www.gnu.org/software/autoconf>

Download: <http://ftp.gnu.org/gnu/autoconf/autoconf-2.69.tar.xz>

MD5 sum: 50f97f4159805e374639a73e2636f22e

• **Automake (1.14.1) - 1,489 KB:**

Home page: <http://www.gnu.org/software/automake>

Download: <http://ftp.gnu.org/gnu/automake/automake-1.14.1.tar.xz>

MD5 sum: 7fc29854c520f56b07aa232a0f880292

• **Bash (4.3) - 7,956 KB:**

Home page: <http://www.gnu.org/software/bash>

Download: <http://ftp.gnu.org/gnu/bash/bash-4.3.tar.gz>

MD5 sum: 81348932d5da294953e15d4814c74dd1

• **Bc (1.06.95) - 284 KB:**

Home page: <http://www.gnu.org/software/bc/>

Download: <ftp://alpha.gnu.org/gnu/bc/bc-1.06.95.tar.bz2>

MD5 sum: 5126a721b73f97d715bb72c13c889035

• **Binutils (2.24) - 22,717 KB:**

Home page: <http://sources.redhat.com/binutils>

Download: <http://ftp.gnu.org/gnu/binutils/binutils-2.24.tar.bz2>

MD5 sum: e0f71a7b2ddab0f8612336ac81d9636b

• **Bison (3.0.2) - 1,927 KB:**

Home page: <http://www.gnu.org/software/bison>

Download: <http://ftp.gnu.org/gnu/bison/bison-3.0.2.tar.xz>

MD5 sum: 146be9ff9fbd27497f0bf2286a5a2082

• **Boot-scripts for CLFS (3.0-20140710) - 22 KB:**

Download: <http://cross-lfs.org/files/packages/3.0.0-RC1/SYSTEMD/boot-scripts-cross-lfs-3.0-20140710.tar.xz>

MD5 sum: bac3e8a54e5ab124a2df0713dc4e4ca4

• **Bzip2 (1.0.6) - 764 KB:**

Home page: <http://www.bzip.org/>

Download: <http://www.bzip.org/1.0.6/bzip2-1.0.6.tar.gz>

MD5 sum: 00b516f4704d4a7cb50a1d97e6e8e15b

• **Check (0.9.13) - 753 KB:**

Home page: <http://check.sourceforge.net/>

Download: <http://sourceforge.net/projects/check/files/check/0.9.13/check-0.9.13.tar.gz>

MD5 sum: 95530868f81a9496b2518fd2b713008a

• **CLFS Network Scripts (20140224) - 22 KB:**

Download: <http://cross-lfs.org/files/clfs-network-scripts-20140224.tar.xz>

MD5 sum: 831308d5e80bdaa3f494dc218ee43f78

• **Cloog (0.18.2) - 2,377 KB:**

Home page: <http://cloog.org>

Download: <http://www.bastoul.net/cloog/pages/download/cloog-0.18.2.tar.gz>

MD5 sum: 69116aa6cd5e73f6b688d871875e1292

• **Coreutils (8.22) - 5,335 KB:**

Home page: <http://www.gnu.org/software/coreutils>

Download: <http://ftp.gnu.org/gnu/coreutils/coreutils-8.22.tar.xz>

MD5 sum: 8fb0ae2267aa6e728958adc38f8163a2

• **D-Bus (1.8.6) - 1,824 KB:**

Home page: <http://www.freedesktop.org/wiki/Software/dbus>

Download: <http://dbus.freedesktop.org/releases/dbus/dbus-1.8.6.tar.gz>

MD5 sum: 6a08ba555d340e9dfe2d623b83c0eea8

• **DejaGNU (1.5.1) - 568 KB:**

Home page: <http://www.gnu.org/software/dejagnu>

Download: <http://ftp.gnu.org/gnu/dejagnu/dejagnu-1.5.1.tar.gz>

MD5 sum: 8386e04e362345f50ad169f052f4c4ab

• **DHCPD (6.3.2) - 137 KB:**

Home page: <http://roy.marples.name/projects/dhcpd>

Download: <http://roy.marples.name/downloads/dhcpd/dhcpd-6.3.2.tar.bz2>

MD5 sum: bb7d8e8533161fbe0ee3b8830fdbdf4

• **Diffutils (3.3) - 1,172 KB:**

Home page: <http://www.gnu.org/software/diffutils>

Download: <http://ftp.gnu.org/gnu/diffutils/diffutils-3.3.tar.xz>

MD5 sum: 99180208ec2a82ce71f55b0d7389f1b3

• **E2fsprogs (1.42.9) - 4,656 KB:**

Home page: <http://e2fsprogs.sourceforge.net>

Download: <http://www.kernel.org/pub/linux/kernel/people/tytso/e2fsprogs/v1.42.9/e2fsprogs-1.42.9.tar.xz>

MD5 sum: 55cc59c587a7199fd9d93b2843842236

• **Eudev (1.7) - 1,756 KB:**

Home page: <http://www.gentoo.org/proj/en/eudev/>

Download: <ftp://mirror.ovh.net/gentoo-distfiles/distfiles/eudev-1.7.tar.gz>

MD5 sum: 80649a0350ff9620fc2da9562d9f2a6a

• **Expat (2.1.0) - 556 KB:**

Download: <http://downloads.sourceforge.net/expat/expat-2.1.0.tar.gz>

MD5 sum: dd7dab7a5fea97d2a6a43f511449b7cd

• **Expect (5.45) - 616 KB:**

Home page: <http://expect.sourceforge.net>

Download: <http://downloads.sourceforge.net/project/expect/Expect/5.45/expect5.45.tar.gz>

MD5 sum: 44e1a4f4c877e9ddc5a542dfa7ecc92b

- **File (5.19) - 719 KB:**

Home page: <http://www.darwinsys.com/file>

Download: <ftp://ftp.astron.com/pub/file/file-5.19.tar.gz>

MD5 sum: e3526f59023f3f7d1ffa4d541335edab



Note

File (5.19) may no longer be available at the listed location. The site administrators of the master download location occasionally remove older versions when new ones are released. An alternative download location that may have the correct version available is <http://cross-lfs.org/files/packages/3.0.0-RC1/SYSTEMD/>.

- **Findutils (4.4.2) - 2,100 KB:**

Home page: <http://www.gnu.org/software/findutils>

Download: <http://ftp.gnu.org/gnu/findutils/findutils-4.4.2.tar.gz>

MD5 sum: 351cc4adb07d54877fa15f75fb77d39f

- **Flex (2.5.39) - 1,612 KB:**

Home page: <http://flex.sourceforge.net>

Download: <http://downloads.sourceforge.net/flex/flex-2.5.39.tar.bz2>

MD5 sum: 77d44c6bb8c0705e0017ab9a84a1502b

- **Gawk (4.1.1) - 2,197 KB:**

Home page: <http://www.gnu.org/software/gawk>

Download: <http://ftp.gnu.org/gnu/gawk/gawk-4.1.1.tar.xz>

MD5 sum: a2a26543ce410eb74bc4a508349ed09a

- **GCC (4.8.3) - 84,108 KB:**

Home page: <http://gcc.gnu.org>

Download: <ftp://gcc.gnu.org/pub/gcc/releases/gcc-4.8.3/gcc-4.8.3.tar.bz2>

MD5 sum: 7c60f24fab389f77af203d2516ee110f

- **GDBM (1.11) - 812 KB:**

Home page: <http://www.gnu.org/software/gdbm>

Download: <http://ftp.gnu.org/gnu/gdbm/gdbm-1.11.tar.gz>

MD5 sum: 72c832680cf0999caedbe5b265c8c1bd

- **Gettext (0.19.1) - 16,886 KB:**

Home page: <http://www.gnu.org/software/gettext>

Download: <http://ftp.gnu.org/gnu/gettext/gettext-0.19.1.tar.gz>

MD5 sum: 8949a57e82abe88274a93174ade515e4

- **Glibc (2.19) - 12,083 KB:**

Home page: <http://www.gnu.org/software/libc/>

Download: <ftp://ftp.gnu.org/pub/gnu/glibc/glibc-2.19.tar.xz>

MD5 sum: e26b8cc666b162f999404b03970f14e4

- **GMP (6.0.0) - 1,904 KB:**

Home page: <http://gmplib.org/>

Download: <http://ftp.gnu.org/gnu/gmp/gmp-6.0.0a.tar.xz>

MD5 sum: 1e6da4e434553d2811437aa42c7f7c76

• **Gperf (3.0.4) - 968 KB:**

Home page: <http://www.gnu.org/software/gperf>

Download: <http://ftp.gnu.org/gnu/gperf/gperf-3.0.4.tar.gz>

MD5 sum: c1f1db32fb6598d6a93e6e88796a8632

• **Grep (2.19) - 1,235 KB:**

Home page: <http://www.gnu.org/software/grep>

Download: <http://ftp.gnu.org/gnu/grep/grep-2.19.tar.xz>

MD5 sum: ac732142227d9fe9567d71301e127979

• **Groff (1.22.2) - 3,928 KB:**

Home page: <http://www.gnu.org/software/groff>

Download: <http://ftp.gnu.org/gnu/groff/groff-1.22.2.tar.gz>

MD5 sum: 9f4cd592a5efc7e36481d8d8d8af6d16

• **Gzip (1.6) - 812 KB:**

Home page: <http://www.gnu.org/software/gzip/gzip.html>

Download: <http://ftp.gnu.org/gnu/gzip/gzip-1.6.tar.xz>

MD5 sum: da981f86677d58a106496e68de6f8995

• **Iana-Etc (2.30) - 204 KB:**

Home page: <http://www.archlinux.org/packages/core/any/iana-etc/>

Download: <http://ftp.cross-lfs.org/pub/clfs/conglomeration/iana-etc/iana-etc-2.30.tar.bz2>

MD5 sum: 3ba3afb1d1b261383d247f46cb135ee8

• **Intltool (0.50.2) - 192 KB:**

Home page: <http://freedesktop.org/wiki/Software/intltool>

Download: <http://launchpad.net/intltool/trunk/0.50.2/+download/intltool-0.50.2.tar.gz>

MD5 sum: 23fbd879118253cb99aeac067da5f591

• **IPRoute2 (3.14.0) - 436 KB:**

Home page: <http://www.linuxfoundation.org/collaborate/workgroups/networking/iproute2>

Download: <http://www.kernel.org/pub/linux/utils/net/iproute2/iproute2-3.14.0.tar.xz>

MD5 sum: bd9d7567bbb987c88120669f5e1a1092

• **IPutils (s20121221) - 155 KB:**

Home page: <http://www.linuxfoundation.org/en/Net:Iputils>

Download: <http://www.skbuff.net/iputils/iputils-s20121221.tar.bz2>

MD5 sum: 6072aef64205720dd1893b375e184171

• **ISL (0.12.2) - 1,171 KB:**

Home page: <http://freecode.com/projects/isl>

Download: <http://isl.gforge.inria.fr/isl-0.12.2.tar.lzma>

MD5 sum: b7d59eb79d3884e14b9788cc396f7687

• **Kbd (2.0.1) - 951 KB:**

Home page: <http://kbd-project.org/>

Download: <http://kbd-project.org/download/kbd-2.0.1.tar.xz>

MD5 sum: 55453cb09d90370005e696949092b8f6

• **Kmod (18) - 1,474 KB:**

Home page: <http://git.kernel.org/?p=utils/kernel/kmod/kmod.git;a=summary>

Download: <http://www.kernel.org/pub/linux/utils/kernel/kmod/kmod-18.tar.xz>

MD5 sum: 82835c7f01983634e06ca72b4ee30cc6

• **Less (462) - 312 KB:**

Home page: <http://www.greenwoodsoftware.com/less>

Download: <http://www.greenwoodsoftware.com/less/less-462.tar.gz>

MD5 sum: 55a001838501ed8a129682de047960df

• **Libcap (2.24) - 68 KB:**

Home page: <http://sites.google.com/site/fullycapable/>

Download: <http://www.kernel.org/pub/linux/libs/security/linux-privs/libcap2/libcap-2.24.tar.xz>

MD5 sum: d43ab9f680435a7ffff35b4ace8d45b80

• **Libpipeline (1.3.0) - 787 KB:**

Home page: <http://libpipeline.nongnu.org/>

Download: <http://download.savannah.gnu.org/releases/libpipeline/libpipeline-1.3.0.tar.gz>

MD5 sum: 242428c01dca255cdcb2195073a9c6ed

• **Libtool (2.4.2) - 852 KB:**

Home page: <http://www.gnu.org/software/libtool>

Download: <http://ftp.gnu.org/gnu/libtool/libtool-2.4.2.tar.xz>

MD5 sum: 2ec8997e0c07249eb4cbd072417d70fe

• **Linux (3.14) - 78,399 KB:**

Home page: <http://www.kernel.org>

Download: <http://www.kernel.org/pub/linux/kernel/v3.0/linux-3.14.tar.xz>

MD5 sum: b621207b3f6ecbb67db18b13258f8ea8

• **M4 (1.4.17) - 1,149 KB:**

Home page: <http://www.gnu.org/software/m4>

Download: <http://ftp.gnu.org/gnu/m4/m4-1.4.17.tar.xz>

MD5 sum: 12a3c829301a4fd6586a57d3fcf196dc

• **Make (4.0) - 1,342 KB:**

Home page: <http://www.gnu.org/software/make>

Download: <http://ftp.gnu.org/gnu/make/make-4.0.tar.bz2>

MD5 sum: 571d470a7647b455e3af3f92d79f1c18

• **Man-DB (2.6.7.1) - 1,452 KB:**

Download: <http://cross-lfs.org/files/packages/3.0.0-RC1/SYSTEMD/man-db-2.6.7.1.tar.xz>

MD5 sum: ce7b697f8e8016a085d9f5975ae6c4fb

• **Man-pages (3.68) - 1,254 KB:**

Home page: <http://www.win.tue.nl/~aeb/linux/man>

Download: <http://www.kernel.org/pub/linux/docs/man-pages/man-pages-3.68.tar.xz>

MD5 sum: 43965ed65b34aef f75767b162f97eb01

• **MPC (1.0.2) - 624 KB:**

Home page: <http://www.multiprecision.org/>

Download: <http://www.multiprecision.org/mpc/download/mpc-1.0.2.tar.gz>

MD5 sum: 68fadff3358fb3e7976c7a398a0af4c3

• **MPFR (3.1.2) - 1,050 KB:**

Home page: <http://www.mpfr.org/>

Download: <http://www.mpfr.org/mpfr-3.1.2/mpfr-3.1.2.tar.xz>

MD5 sum: e3d203d188b8fe60bb6578dd3152e05c

• **Ncurses (5.9) - 2,764 KB:**

Home page: <http://www.gnu.org/software/ncurses>

Download: <ftp://ftp.gnu.org/pub/gnu/ncurses/ncurses-5.9.tar.gz>

MD5 sum: 8cb9c412e5f2d96bc6f459aa8c6282a1

• **Patch (2.7.1) - 668 KB:**

Home page: <http://savannah.gnu.org/projects/patch>

Download: <http://ftp.gnu.org/gnu/patch/patch-2.7.1.tar.xz>

MD5 sum: e9ae5393426d3ad783a300a338c09b72

• **Perl (5.20.0) - 13,770 KB:**

Home page: <http://www.perl.org>

Download: <http://www.cpan.org/src/5.0/perl-5.20.0.tar.bz2>

MD5 sum: 20cbecd4e9e880ee7a50a136c8b1484e

• **Pkg-config-lite (0.28-1) - 384 KB:**

Home page: <http://sourceforge.net/projects/pkgconfiglite>

Download: <http://sourceforge.net/projects/pkgconfiglite/files/0.28-1/pkg-config-lite-0.28-1.tar.gz>

MD5 sum: 61f05feb6bab0a6bbfab4b6e3b2f44b6

• **Procps-ng (3.3.9) - 548 KB:**

Home page: <http://sourceforge.net/projects/procps-ng>

Download: <http://sourceforge.net/projects/procps-ng/files/Production/procps-ng-3.3.9.tar.xz>

MD5 sum: 0980646fa25e0be58f7afb6b98f79d74

• **Psmisc (22.21) - 458 KB:**

Home page: <http://psmisc.sourceforge.net>

Download: <http://downloads.sourceforge.net/psmisc/psmisc-22.21.tar.gz>

MD5 sum: 935c0fd6eb208288262b385fa656f1bf

• **Readline (6.3) - 2,469 KB:**

Home page: <http://cnswww.cns.cwru.edu/php/chet/readline/rltop.html>

Download: <http://ftp.gnu.org/gnu/readline/readline-6.3.tar.gz>

MD5 sum: 33c8fb279e981274f485fd91da77e94a

• **Sed (4.2.2) - 1,036 KB:**

Home page: <http://www.gnu.org/software/sed>

Download: <http://ftp.gnu.org/gnu/sed/sed-4.2.2.tar.bz2>

MD5 sum: 7ffe1c7cdc3233e1e0c4b502df253974

• **Shadow (4.1.5.1) - 2,144 KB:**

Home page: <http://pkg-shadow.alioth.debian.org>

Download: <http://pkg-shadow.alioth.debian.org/releases/shadow-4.1.5.1.tar.bz2>

MD5 sum: a00449aa439c69287b6d472191dc2247

• **Sysvinit (2.88dsf) - 104 KB:**

Home page: <http://savannah.nongnu.org/projects/sysvinit>

Download: <http://download.savannah.gnu.org/releases/sysvinit/sysvinit-2.88dsf.tar.bz2>

MD5 sum: 6eda8a97b86e0a6f59dabbf25202aa6f

• **Systemd (213) - 2,783 KB:**

Home page: <http://freedesktop.org/wiki/Software/systemd>

Download: <http://www.freedesktop.org/software/systemd/systemd-213.tar.xz>

MD5 sum: 06496edcf86ddf6d8c12d72ba78e735d

- **Tar (1.27.1) - 1,880 KB:**

Home page: <http://www.gnu.org/software/tar>

Download: <http://ftp.gnu.org/gnu/tar/tar-1.27.1.tar.xz>

MD5 sum: e0382a4064e09a4943f3adef1435978

- **Tcl (8.6.1) - 8,756 KB:**

Home page: <http://www.tcl.tk>

Download: <http://downloads.sourceforge.net/tcl/tcl8.6.1-src.tar.gz>

MD5 sum: aae4b701ee527c6e4e1a6f9c7399882e

- **Texinfo (5.2) - 3,813 KB:**

Home page: <http://www.gnu.org/software/texinfo>

Download: <http://ftp.gnu.org/gnu/texinfo/texinfo-5.2.tar.xz>

MD5 sum: cb489df8a7ee9d10a236197aefdb32c5

- **Time Zone Data (2014d) - 221 KB:**

Home page: <http://www.iana.org/time-zones>

Download: <http://www.iana.org/time-zones/repository/releases/tzdata2014d.tar.gz>

MD5 sum: 299b86c0368ecfb321f15d5c408a1d9b

- **Util-linux (2.24.2) - 3,587 KB:**

Download: <http://www.kernel.org/pub/linux/utils/util-linux/v2.24/util-linux-2.24.2.tar.xz>

MD5 sum: 3f191727a0d28f7204b755cf1b6ea0aa

- **Vim (7.4) - 9,843 KB:**

Home page: <http://www.vim.org>

Download: <ftp://ftp.vim.org/pub/vim/unix/vim-7.4.tar.bz2>

MD5 sum: 607e135c559be642f210094ad023dc65

- **XML::Parser (2.42_01) - 240 KB:**

Home page: <https://github.com/chorny/XML-Parser>

Download: http://search.cpan.org/CPAN/authors/id/T/TO/TODDR/XML-Parser-2.42_01.tar.gz

MD5 sum: a4650aebcc464bb91113c2c356da8210

- **XZ Utils (5.0.5) - 908 KB:**

Home page: <http://tukaani.org/xz/>

Download: <http://tukaani.org/xz/xz-5.0.5.tar.xz>

MD5 sum: aa17280f4521dbeebd0fbd11cd7fa30

- **Zlib (1.2.8) - 440 KB:**

Home page: <http://www.zlib.net>

Download: <http://zlib.net/zlib-1.2.8.tar.xz>

MD5 sum: 28f1205d8dd2001f26fec1e8c2cebe37



Note

Zlib (1.2.8) may no longer be available at the listed location. The site administrators of the master download location occasionally remove older versions when new ones are released. An alternative download location that may have the correct version available is <http://cross-lfs.org/files/packages/3.0.0-RC1/SYSTEMD/>.

Total size of these packages: about 327 MB

3.3. Additional Packages for x86_64

- **GRUB (2.00) - 5,020 KB:**

Home page: <http://www.gnu.org/software/grub>

Download: <http://ftp.gnu.org/gnu/grub/grub-2.00.tar.xz>

MD5 sum: a1043102fbc7bcedbf53e7ee3d17ab91

Total size of these packages: about 5 MB

3.4. Needed Patches

In addition to the packages, several patches are also required. These patches correct any mistakes in the packages that should be fixed by the maintainer. The patches also make small modifications to make the packages easier to work with. The following patches will be needed to build a CLFS system:

- **Bash Branch Update Patch - 61 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/bash-4.3-branch_update-3.patch

MD5 sum: 7d3f44211d9d962019b78c0b8a76b970

- **Coreutils Uname Patch - 4.9 KB:**

Download: <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/coreutils-8.22-uname-1.patch>

MD5 sum: 6eeba217c88ec83b807e305e594fe13d

- **Coreutils Noman Patch - 14 KB:**

Download: <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/coreutils-8.22-noman-1.patch>

MD5 sum: 6ed8f515391580e51f170a32af6fc7b9

- **GCC Branch Update Patch - 3.5 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/gcc-4.8.3-branch_update-1.patch

MD5 sum: ba8abbb0696f8e0d75eb26ae7c9ad219

- **Iana-Etc Protocol and Port Numbers Update - 282 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/iana-etc-2.30-numbers_update-20140202-2.patch.xz

MD5 sum: b0e7051fef0b3ba064209a5f3d23bd2a

- **IPUtils Fixes Patch - 158 KB:**

Download: <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/iputils-s20121221-fixes-2.patch>

MD5 sum: c2344acdd81607685886f617da7d66e0

- **Linux Sublevel Patch - 338 KB:**

Download: <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/patch-3.14.13.xz>

MD5 sum: 132470897fc5d57f5ac7d658100cc430

- **MPFR Fixes Patch - 55 KB:**

Download: <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/mpfr-3.1.2-fixes-4.patch>

MD5 sum: b6c1c0dcbf7661298037eeb346a8669c

- **Ncurses Bash Patch - .743 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/ncurses-5.9-bash_fix-1.patch

MD5 sum: c6f7f2ab0ebaf7721eb266641352db

- **Ncurses Branch Update Patch - 2,492 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/ncurses-5.9-branch_update-4.patch

MD5 sum: c2b2dc2d31b02c218359e6218f12a72c

- **Readline Branch Update - 4.182 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/readline-6.3-branch_update-3.patch

MD5 sum: db39169d31ee08517e69d5eaec2c61c6

- **Systemd Compat Patch - 7.863 KB:**

Download: <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/systemd-213-compat-1.patch>

MD5 sum: 2a5816fdffc8bd2376a40c382004ad1ac

- **Sysvinit Tools Updates Patch - 2.339 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/sysvinit-2.88dsf-tools_updates-1.patch

MD5 sum: c3f6981c46868b68bfd58921570ea51f

- **Tar Man Page Patch - 7.924 KB:**

Download: <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/tar-1.27.1-manpage-1.patch>

MD5 sum: 68c86c67e67a5c074872a293818f361d

- **Vim Branch Update Patch - 3,139 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/vim-7.4-branch_update-5.patch

MD5 sum: ef591881ff7aa8baac8aecc201e20f12

Total size of these patches: about 6 MB

In addition to the above required patches, there exist a number of optional patches created by the CLFS community. These optional patches solve minor problems or enable functionality that is not enabled by default. Feel free to peruse the patches database located at <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/> and acquire any additional patches to suit the system needs.

3.5. Additional Patches for x86_64

- **GCC Pure 64 Patch - 9.7 KB:**

Download: <http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/gcc-4.8.3-pure64-1.patch>

MD5 sum: 96b7f0b29cfb3dd665be12269cde1139

- **GCC Specs Patch - 23 KB:**

Download: http://patches.cross-lfs.org/3.0.0-RC1/SYSTEMD/gcc-4.8.3-pure64_specs-1.patch

MD5 sum: b950e79ec42d64fee0f823ce5c8a2ba4

Total size of these patches: about 32.7 KB

Chapter 4. Final Preparations

4.1. Introduction

In this chapter, we will perform a few additional tasks to prepare for building the cross-compile tools. We will create directories in `/${CLFS}` for the installation of the cross-toolchain and temporary system, add an unprivileged user to reduce risk, and create an appropriate build environment for that user.

4.2. Creating the `/${CLFS}/tools` Directory

All programs compiled in Constructing a Temporary System will be installed under `/${CLFS}/tools` to keep them separate from the programs compiled in Installing Basic System Software. The programs compiled here are temporary tools and will not be a part of the final CLFS system. By keeping these programs in a separate directory, they can easily be discarded later after their use. This also prevents these programs from ending up in the host production directories (easy to do by accident in Constructing a Temporary System).

Create the required directory by running the following as `root`:

```
install -dv ${CLFS}/tools
```

The next step is to create a `/tools` symlink on the host system. This will point to the newly-created directory on the CLFS partition. Run this command as `root` as well:

```
ln -sv ${CLFS}/tools /
```



Note

The above command is correct. The `ln` command has a few syntactic variations, so be sure to check **info coreutils ln** and `ln(1)` before reporting what you may think is an error.

The created symlink enables the toolchain to be compiled so that it always refers to `/tools`, meaning that the compiler, assembler, and linker will work. This will provide a common place for our temporary tools system.

4.3. Creating the `/${CLFS}/cross-tools` Directory

The cross-binutils and cross-compiler built in Constructing Cross-Compile Tools will be installed under `/${CLFS}/cross-tools` to keep them separate from the host programs. The programs compiled here are cross-tools and will not be a part of the final CLFS system or the temp-system. By keeping these programs in a separate directory, they can easily be discarded later after their use.

Create the required directory by running the following as `root`:

```
install -dv ${CLFS}/cross-tools
```

The next step is to create a `/cross-tools` symlink on the host system. This will point to the newly-created directory on the CLFS partition. Run this command as `root` as well:

```
ln -sv ${CLFS}/cross-tools /
```

4.4. Adding the CLFS User

When logged in as user `root`, making a single mistake can damage or destroy a system. Therefore, we recommend building the packages as an unprivileged user. You could use your own user name, but to make it easier to set up a clean work environment, create a new user called `clfs` as a member of a new group (also named `clfs`) and use this user during the installation process. As `root`, issue the following commands to add the new user:

```
groupadd clfs
useradd -s /bin/bash -g clfs -d /home/clfs clfs
mkdir -pv /home/clfs
chown -v clfs:clfs /home/clfs
```

The meaning of the command line options:

`-s /bin/bash`

This makes **bash** the default shell for user `clfs`.



Important

The build instructions assume that the **bash** shell is in use.

`-g clfs`

This option adds the new user to the `clfs` group.

`-d /home/clfs`

This option sets the user's home directory, but does not create it. We could have used `-m` to tell **useradd** to create the directory as well, but this would also copy the contents of the host system's `/etc/skel` directory into the new user's home. We would prefer to have a clean user environment, so we just create an empty directory after adding the user.

`clfs`

This is the actual name for the created group and user.

To log in as `clfs` (as opposed to switching to user `clfs` when logged in as `root`, which does not require the `clfs` user to have a password), give `clfs` a password:

```
passwd clfs
```

As `root`, grant `clfs` full access to `${CLFS}/cross-tools` and `${CLFS}/tools` by making `clfs` the directory's owner:

```
chown -v clfs ${CLFS}/tools
chown -v clfs ${CLFS}/cross-tools
```

If a separate working directory was created as suggested, run the following command as `root` to give user `clfs` ownership of this directory as well:

```
chown -v clfs ${CLFS}/sources
```

Next, login as user `clfs`. This can be done via a virtual console, through a display manager, or with the following substitute user command:

```
su - clfs
```

The “-” instructs **su** to start a login shell as opposed to a non-login shell. The difference between these two types of shells can be found in detail in `bash(1)` and **info bash**.



Note

Until specified otherwise, all commands from this point on should be done as the `clfs` user.

4.5. Setting Up the Environment

Set up a good working environment by creating two new startup files for the **bash** shell. While logged in as user `clfs`, issue the following command to create a new `.bash_profile`:

```
cat > ~/.bash_profile << "EOF"
exec env -i HOME=${HOME} TERM=${TERM} PS1='\u:\w\$ ' /bin/bash
EOF
```

When logged on as user `clfs`, the initial shell is usually a *login* shell which reads the `/etc/profile` of the host (probably containing some settings and environment variables) and then `.bash_profile`. The **exec env -i./bin/bash** command in the `.bash_profile` file replaces the running shell with a new one with a completely empty environment, except for the `HOME`, `TERM`, and `PS1` variables. This ensures that no unwanted and potentially hazardous environment variables from the host system leak into the build environment. The technique used here achieves the goal of ensuring a clean environment.

The new instance of the shell is a *non-login* shell, which does not read the `/etc/profile` or `.bash_profile` files, but rather reads the `.bashrc` file instead. Create the `.bashrc` file now:

```
cat > ~/.bashrc << "EOF"
set +h
umask 022
CLFS=/mnt/clfs
LC_ALL=POSIX
PATH=/cross-tools/bin:/bin:/usr/bin
export CLFS LC_ALL PATH
unset CFLAGS CXXFLAGS
EOF
```

The **set +h** command turns off **bash**'s hash function. Hashing is ordinarily a useful feature—**bash** uses a hash table to remember the full path of executable files to avoid searching the `PATH` time and again to find the same executable. However, the new tools should be used as soon as they are installed. By switching off the hash function, the shell will always search the `PATH` when a program is to be run. As such, the shell will find the newly compiled tools in `/cross-tools` as soon as they are available without remembering a previous version of the same program in a different location.

Setting the user file-creation mask (`umask`) to `022` ensures that newly created files and directories are only writable by their owner, but are readable and executable by anyone (assuming default modes are used by the `open(2)` system call, new files will end up with permission mode `644` and directories with mode `755`).

The `CLFS` variable should be set to the chosen mount point.

The `LC_ALL` variable controls the localization of certain programs, making their messages follow the conventions of a specified country. Setting `LC_ALL` to “`POSIX`” or “`C`” (the two are equivalent) ensures that everything will work as expected in the temporary build environment.

By putting `/cross-tools/bin` at the beginning of the `PATH`, the cross-compiler built in Constructing Cross-Compile Tools will be picked up by the build process for the temp-system packages before anything that may be installed on the host. This, combined with turning off hashing, helps to ensure that you will be using the cross-compile tools to build the temp-system in `/tools`.

The `CFLAGS` and `CXXFLAGS` variables should not be set while building the temporary system, so we unset them.

Finally, to have the environment fully prepared for building the temporary tools, source the just-created user profile:

```
source ~/.bash_profile
```

4.6. Build Variables

Setting Host and Target

During the building of the cross-compile tools you will need to set a few variables that will be dependent on your particular needs. The first variable will be the triplet of the host machine, which will be put into the `CLFS_HOST` variable. To account for the possibility that the host and target are the same arch, as cross-compiling won't work when host and target are the same, part of the triplet needs to be changed slightly - in our case, we will change part of the triplet to "cross". Set `CLFS_HOST` using the following command:

```
export CLFS_HOST=$(echo ${MACHTYPE} | sed -e 's/-[^-]*/-cross/')
```

Now you will need to set the triplet for the target architecture. Set the target variable using the following command:

```
export CLFS_TARGET="x86_64-unknown-linux-gnu"
```

We will need to setup target-specific flags for the compiler and linker:

```
export BUILD64="-m64"
```

Copy settings to Environment

Now add the host and target variables, and compiler and linker flags, to `~/.bashrc`, just in case you have to exit and restart building later:

```
cat >> ~/.bashrc << EOF
export CLFS_HOST="${CLFS_HOST}"
export CLFS_TARGET="${CLFS_TARGET}"
export BUILD64="${BUILD64}"
EOF
```

4.7. About the Test Suites

Most packages provide a test suite, usually a script or **make** target, which tests the just-compiled programs or libraries by executing or linking to them. Test suites are often useful for verifying that a package compiled correctly. However, they cannot be run while cross-compiling so we will not mention test suite commands for any packages until Installing Basic System Software.

Part III. Make the Cross-Compile Tools

Chapter 5. Constructing Cross-Compile Tools

5.1. Introduction

This chapter shows you how to create cross platform tools.

If for some reason you have to stop and come back later, remember to use the `su - cifs` command, and it will setup the build environment that you left.

5.1.1. Common Notes



Important

Before issuing the build instructions for a package, the package should be unpacked, and a `cd` into the created directory should be performed.

Several of the packages are patched before compilation, but only when the patch is needed to circumvent a problem. A patch is often needed in both this and the next chapters, but sometimes in only one or the other. Therefore, do not be concerned if instructions for a downloaded patch seem to be missing. Warning messages about *offset* or *fuzz* may also be encountered when applying a patch. Do not worry about these warnings, as the patch was still successfully applied.

During the compilation of most packages, there will be several warnings that scroll by on the screen. These are normal and can safely be ignored. These warnings are as they appear—warnings about deprecated, but not invalid, use of the C or C++ syntax. C standards change fairly often, and some packages still use the older standard. This is not a problem, but does prompt the warning.



Important

After installing each package, both in this and the next chapters, delete its source and build directories, unless specifically instructed otherwise. Deleting the sources prevents mis-configuration when the same package is reinstalled later.

5.2. File-5.19

The File package contains a utility for determining the type of a given file or files.

5.2.1. Installation of File

One method that **file** uses for identifying a given file is to run “magic tests”, where it compares the file's contents to data in “magic files”, which contain information about a number of standard file formats. When File is compiled, it will run **file -C** to combine the information from the magic files in its source tree into a single `magic.mgc` file, which it will use after it is installed. When we build File in Constructing a Temporary System, it will be cross-compiled, so it will not be able to run the **file** program that it just built, which means that we need one that will run on the host system.

Prepare File for compilation:

```
./configure --prefix=/cross-tools --disable-static
```

The meaning of the configure options:

--prefix=/cross-tools

This tells the configure script to prepare to install the package in the `/cross-tools` directory.

--disable-static

This tells the File package not to compile or install static libraries, which are not needed for the Cross-Tools

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.43.2, “Contents of File.”

5.3. Linux-3.14.13 Headers

The Linux Kernel contains a **make** target that installs “sanitized” kernel headers.

5.3.1. Installation of Linux Headers



Note

For this step you will need to unpack the kernel tarball (`linux-3.14.tar.xz`) and **cd** into its source directory before entering the commands on this page.

Apply the latest Linux sublevel patch:

```
xzcat ../patch-3.14.13.xz | patch -Np1 -i -
```

Install the kernel header files:

```
make mrproper
make ARCH=x86_64 headers_check
make ARCH=x86_64 INSTALL_HDR_PATH=/tools headers_install
```

The meaning of the make commands:

make mrproper

Ensures that the kernel source dir is clean.

make ARCH=x86_64 headers_check

Sanitizes the raw kernel headers so that they can be used by userspace programs.

make ARCH=x86_64 INSTALL_HDR_PATH=/tools headers_install

This will install the kernel headers into `/tools/include`.

Details on this package are located in Section 10.5.2, “Contents of Linux Headers.”

5.4. M4-1.4.17

The M4 package contains a macro processor.

5.4.1. Installation of M4

M4 is required to build GMP. We will compile and install an **m4** program into `/cross-tools`, so that we have a known-good version which can be used to build GMP, both in Cross-Tools and the Temporary System.

Prepare M4 for compilation:

```
./configure --prefix=/cross-tools
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.9.2, “Contents of M4.”

5.5. Ncurses-5.9

The Ncurses package contains libraries for terminal-independent handling of character screens.

5.5.1. Installation of Ncurses

When Ncurses is compiled, it executes **tic** to create a terminfo database in `${prefix}/share/terminfo`. If possible, the `Makefile` will use the **tic** binary that was just compiled in its source tree, but this does not work when Ncurses is cross-compiled. To allow the Ncurses build in Constructing a Temporary System to succeed, we will build and install a **tic** program that can be run on the host system.

The following patch fixes an issue with some Bash versions:

```
patch -Np1 -i ../ncurses-5.9-bash_fix-1.patch
```

Prepare Ncurses for compilation:

```
./configure --prefix=/cross-tools \
  --without-debug --without-shared
```

The meaning of the new configure options:

--without-debug

Tells Ncurses to build without debugging information.

--without-shared

This prevents Ncurses from building its shared libraries, which are not needed at this time.

Only one binary is needed for the Cross-Tools. Build the headers and then build **tic**:

```
make -C include
make -C progs tic
```

Install **tic** with the following command:

```
install -v -m755 progs/tic /cross-tools/bin
```

Details on this package are located in Section 10.23.2, “Contents of Ncurses.”

5.6. Pkg-config-lite-0.28-1

Pkg-config-lite is a tool to help you insert the correct compiler options on the command line when compiling applications and libraries.

5.6.1. Installation of Pkg-config-lite

Several packages in the temporary system will use **pkg-config** to find various required and optional dependencies. Unfortunately, this could result in those packages finding libraries on the host system and trying to link against them, which will not work. To avoid this problem, we will install a **pkg-config** binary in `/cross-tools` and configure it so that it will look for Pkg-config files only in `/tools`.

Prepare Pkg-config-lite for compilation:

```
./configure --prefix=/cross-tools --host=${CLFS_TARGET}\  
--with-pc-path=/tools/lib/pkgconfig:/tools/share/pkgconfig
```

The meaning of the new configure option:

--with-pc-path

This sets the default `PKG_CONFIG_PATH` to `/tools/lib/pkgconfig` and `/tools/share/pkgconfig`.

--host=\${CLFS_TARGET}

Several packages that we will cross-compile later will try to search for `${CLFS_TARGET}-pkg-config`. Setting this option ensures that Pkg-config-lite will create a hard link in `/cross-tools/bin` with this name, so that it will be used instead of any similarly-named program that might exist on the host.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.24.2, “Contents of Pkg-config-lite.”

5.7. GMP-6.0.0

GMP is a library for arithmetic on arbitrary precision integers, rational numbers, and floating-point numbers.

5.7.1. Installation of GMP

This package and the next two - MPFR and MPC - will be installed into `/cross-tools` because GCC requires them to build.



Note

If you are building with a host which has 32-bit user-space with a 64-bit capable CPU, cross-tools GMP will attempt to link with 64-bit libraries. Add the following variable during **configure** to force GMP's ABI:
`./configure ABI=32`

Prepare GMP for compilation:

```
./configure --prefix=/cross-tools --enable-cxx \  
--disable-static
```

The meaning of the new configure option:

`--enable-cxx`

This tells GMP to enable C++ support.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.10.2, “Contents of GMP.”

5.8. MPFR-3.1.2

The MPFR library is a C library for multiple-precision floating-point computations with correct rounding.

5.8.1. Installation of MPFR

Apply a patch with upstream fixes:

```
patch -Np1 -i ../mpfr-3.1.2-fixes-4.patch
```

Prepare MPFR for compilation:

```
LDFLAGS="-Wl,-rpath,/cross-tools/lib" \  
./configure --prefix=/cross-tools \  
--disable-static --with-gmp=/cross-tools
```

The meaning of the new configure options:

```
LDFLAGS="-Wl,-rpath,/cross-tools/lib"
```

This tells **configure** to search in `/cross-tools` for libraries.

```
--with-gmp=/cross-tools
```

This tells **configure** where to find GMP.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.11.2, “Contents of MPFR.”

5.9. MPC-1.0.2

MPC is a C library for the arithmetic of complex numbers with arbitrarily high precision and correct rounding of the result.

5.9.1. Installation of MPC

Prepare MPC for compilation:

```
LDFLAGS="-Wl,-rpath,/cross-tools/lib" \  
./configure --prefix=/cross-tools --disable-static \  
--with-gmp=/cross-tools --with-mpfr=/cross-tools
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.12.2, “Contents of MPC.”

5.10. ISL-0.12.2

ISL is a library for manipulating sets and relations of integer points bounded by linear constraints.

5.10.1. Installation of ISL

We will install ISL and CLoG to enable extra functionality for GCC. They are not strictly required, but GCC can link to them to enable its new loop generation feature called Graphite.

Prepare ISL for compilation:

```
LDFLAGS="-Wl,-rpath,/cross-tools/lib" \  
./configure --prefix=/cross-tools --disable-static \  
--with-gmp-prefix=/cross-tools
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.13.2, “Contents of ISL.”

5.11. CLooG-0.18.2

CLooG is a library to generate code for scanning Z-polyhedra. In other words, it finds code that reaches each integral point of one or more parameterized polyhedra. GCC links with this library in order to enable the new loop generation code known as Graphite.

5.11.1. Installation of CLooG

Prepare CLooG for compilation:

```
LDFLAGS="-Wl,-rpath,/cross-tools/lib" \  
./configure --prefix=/cross-tools --disable-static \  
--with-gmp-prefix=/cross-tools --with-isl-prefix=/cross-tools
```

Apply a `sed` which prevents the attempted installation of an invalid file:

```
cp -v Makefile{,.orig}  
sed '/cmake/d' Makefile.orig > Makefile
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.14.2, “Contents of CLooG.”

5.12. Cross Binutils-2.24

The Binutils package contains a linker, an assembler, and other tools for handling object files.

5.12.1. Installation of Cross Binutils

It is important that Binutils be compiled before Glibc and GCC because both Glibc and GCC perform various tests on the available linker and assembler to determine which of their own features to enable.

The Binutils documentation recommends building Binutils outside of the source directory in a dedicated build directory:

```
mkdir -v ../binutils-build
cd ../binutils-build
```

Prepare Binutils for compilation:

```
AR=ar AS=as ../binutils-2.24/configure \
  --prefix=/cross-tools --host=${CLFS_HOST} --target=${CLFS_TARGET} \
  --with-sysroot=${CLFS} --with-lib-path=/tools/lib --disable-nls \
  --disable-static --enable-64-bit-bfd --disable-multilib --disable-werror
```

The meaning of the new configure options:

AR=ar AS=as

This prevents Binutils from compiling with `${CLFS_HOST}-ar` and `${CLFS_HOST}-as` as they are provided by this package and therefore not installed yet.

--host=\${CLFS_HOST}

When used with `--target`, this creates a cross-architecture executable that creates files for `${CLFS_TARGET}` but runs on `${CLFS_HOST}`.

--target=\${CLFS_TARGET}

When used with `--host`, this creates a cross-architecture executable that creates files for `${CLFS_TARGET}` but runs on `${CLFS_HOST}`.

--with-sysroot=\${CLFS}

Tells configure to build a linker that uses `${CLFS}` as its root directory for its search paths.

--with-lib-path=/tools/lib

This tells the configure script to specify the library search path during the compilation of Binutils, resulting in `/tools/lib` being passed to the linker. This prevents the linker from searching through library directories on the host.

--disable-nls

This disables internationalization as `i18n` is not needed for the cross-compile tools.

--disable-multilib

This option disables the building of a multilib capable Binutils.

--enable-64-bit-bfd

This adds 64 bit support to Binutils.

--disable-werror

This prevents the build from stopping in the event that there are warnings from the host's compiler.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.18.2, “Contents of Binutils.”

5.13. Cross GCC-4.8.3 - Static

The GCC package contains the GNU compiler collection, which includes the C and C++ compilers.

5.13.1. Installation of Cross GCC Compiler with Static libgcc and no Threads

Here we will compile GCC, as a cross-compiler that will create executables for our target architecture, statically so that it will not need to look for Glibc's startfiles, which do not yet exist in `/tools`. We will use this cross-compiler, plus the cross-linker we have just installed with Binutils, to compile Glibc. After Glibc is installed into `/tools`, we can rebuild GCC so that it will then be able to build executables that link against the libraries in `/tools`.

The following patch contains a number of updates to the 4.8.3 branch by the GCC developers:

```
patch -Np1 -i ../gcc-4.8.3-branch_update-1.patch
```

Make a couple of essential adjustments to GCC's specs to ensure GCC uses our build environment:

```
patch -Np1 -i ../gcc-4.8.3-pure64_specs-1.patch
```

Change the StartFile Spec so that GCC looks in `/tools`:

```
echo -en '\n#undef STANDARD_STARTFILE_PREFIX_1\n#define STANDARD_STARTFILE_PREFIX_1 "/tools" \n' > /tools/specs
echo -en '\n#undef STANDARD_STARTFILE_PREFIX_2\n#define STANDARD_STARTFILE_PREFIX_2 "/tools" \n' > /tools/specs
```

We will create a dummy `limits.h` so the build will not use the one provided by the host distro:

```
touch /tools/include/limits.h
```

The GCC documentation recommends building GCC outside of the source directory in a dedicated build directory:

```
mkdir -v ../gcc-build
cd ../gcc-build
```

Prepare GCC for compilation:

```
AR=ar LDFLAGS="-Wl,-rpath,/cross-tools/lib" \
  ../gcc-4.8.3/configure --prefix=/cross-tools \
  --build=${CLFS_HOST} --host=${CLFS_HOST} --target=${CLFS_TARGET} \
  --with-sysroot=${CLFS} --with-local-prefix=/tools \
  --with-native-system-header-dir=/tools/include --disable-nls \
  --disable-shared --with-mpfr=/cross-tools --with-gmp=/cross-tools \
  --with-isl=/cross-tools --with-cloog=/cross-tools --with-mpc=/cross-tools \
  --without-headers --with-newlib --disable-decimal-float --disable-libgomp \
  --disable-libmudflap --disable-libssp --disable-libatomic --disable-libitm \
  --disable-libsanitizer --disable-libquadmath --disable-threads \
  --disable-multilib --disable-target-zlib --with-system-zlib \
  --enable-languages=c --enable-checking=release
```

The meaning of the new configure options:

`--with-local-prefix=/tools`

The purpose of this switch is to remove `/usr/local/include` from `gcc`'s include search path. This is not absolutely essential, however, it helps to minimize the influence of the host system.

--with-native-system-headers-dir=/tools/include

This switch ensures that GCC will search for the system headers in `/tools/include` and that host system headers will not be searched.

--disable-shared

This tells GCC not to create a shared library.

--without-headers

Disables GCC from using the target's Libc when cross compiling.

--with-newlib

This causes GCC to enable the `inhibit_libc` flag, which prevents `libgcc` from building code that uses `libc` support.

--disable-decimal-float

Disables support for the C decimal floating point extension.

*--disable-lib**

These options prevent GCC from building a number of libraries that are not needed at this time.

--disable-threads

This will prevent GCC from looking for the multi-thread include files, since they haven't been created for this architecture yet. GCC will be able to find the multi-thread information after the Glibc headers are created.

--disable-target-zlib

This tells GCC not to build the copy of Zlib in its source tree.

--with-system-zlib

This tells GCC to link to the system-installed `zlib` instead of the one in its source tree.

--enable-languages=c

This option ensures that only the C compiler is built.

--enable-checking=release

This option selects the complexity of the internal consistency checks and adds error checking within the compiler.

Continue with compiling the package:

```
make all-gcc all-target-libgcc
```

The meaning of the new make options:

all-gcc all-target-libgcc

Compiles only the parts of GCC that are needed at this time, rather than the full package.

Install the package:

```
make install-gcc install-target-libgcc
```

Details on this package are located in Section 10.19.2, "Contents of GCC."

5.14. Glibc-2.19

The Glibc package contains the main C library. This library provides the basic routines for allocating memory, searching directories, opening and closing files, reading and writing files, string handling, pattern matching, arithmetic, and so on.

5.14.1. Installation of Glibc

It should be noted that compiling Glibc in any way other than the method suggested in this book puts the stability of the system at risk.

Apply the following **sed** so the **tzselect** script works properly:

```
cp -v timezone/Makefile{,.orig}
sed 's/\\\$$(pwd)/`pwd`/' timezone/Makefile.orig > timezone/Makefile
```

The Glibc documentation recommends building Glibc outside of the source directory in a dedicated build directory:

```
mkdir -v ../glibc-build
cd ../glibc-build
```

Add the following to `config.cache` to disable ssp when building Glibc:

```
echo "libc_cv_ssp=no" > config.cache
```

Prepare Glibc for compilation:

```
BUILD_CC="gcc" CC="{CLFS_TARGET}-gcc {BUILD64}" \
  AR="{CLFS_TARGET}-ar" RANLIB="{CLFS_TARGET}-ranlib" \
  ../glibc-2.19/configure --prefix=/tools \
  --host={CLFS_TARGET} --build={CLFS_HOST} \
  --disable-profile --with-tls --enable-kernel=2.6.32 --with-__thread \
  --with-binutils=/cross-tools/bin --with-headers=/tools/include \
  --enable-obsolete-rpc --cache-file=config.cache
```

The meaning of the new configure options:

BUILD_CC="gcc"

This sets Glibc to use the current compiler on our system. This is used to create the tools Glibc uses during its build.

CC="{CLFS_TARGET}-gcc {BUILD64}"

Forces Glibc to build using our target architecture GCC utilizing the 64 Bit flags.

AR="{CLFS_TARGET}-ar"

This forces Glibc to use the **ar** utility we made for our target architecture.

RANLIB="{CLFS_TARGET}-ranlib"

This forces Glibc to use the **ranlib** utility we made for our target architecture.

--disable-profile

This builds the libraries without profiling information. Omit this option if profiling on the temporary tools is necessary.

`--with-tls`

This tells Glibc to use Thread Local Storage.

`--enable-kernel=2.6.32`

This tells Glibc to compile the library with support for 2.6.32 and later Linux kernels.

`--with-__thread`

This tells Glibc to use the `__thread` for `libc` and `libpthread` builds.

`--with-binutils=/cross-tools/bin`

This tells Glibc to use the Binutils that are specific to our target architecture.

`--with-headers=/tools/include`

This tells Glibc to compile itself against the headers recently installed to the `/tools` directory, so that it knows exactly what features the kernel has and can optimize itself accordingly.

`--enable-obsolete-rpc`

This tells Glibc to install `rpc` headers that are not installed by default but may be needed by other packages.

`--cache-file=config.cache`

This tells Glibc to utilize a premade cache file.

During this stage the following warning might appear:

```
configure: WARNING:
*** These auxiliary programs are missing or
*** incompatible versions: msgfmt
*** some features will be disabled.
*** Check the INSTALL file for required versions.
```

The missing or incompatible **msgfmt** program is generally harmless. This **msgfmt** program is part of the `Gettext` package which the host distribution should provide. You might also see a similar (also harmless) message about missing **autoconf**.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.7.5, “Contents of Glibc.”

5.15. Cross GCC-4.8.3 - Final

The GCC package contains the GNU compiler collection, which includes the C and C++ compilers.

5.15.1. Installation of GCC Cross Compiler

The following patch contains a number of updates to the 4.8.3 branch by the GCC developers:

```
patch -Np1 -i ../gcc-4.8.3-branch_update-1.patch
```

Make a couple of essential adjustments to GCC's specs to ensure GCC uses our build environment:

```
patch -Np1 -i ../gcc-4.8.3-pure64_specs-1.patch
```

Change the StartFile Spec so that GCC looks in /tools:

```
echo -en '\n#undef STANDARD_STARTFILE_PREFIX_1\n#define STANDARD_STARTFILE_PREFIX_1 "/tools"
echo -en '\n#undef STANDARD_STARTFILE_PREFIX_2\n#define STANDARD_STARTFILE_PREFIX_2 "/tools"
```

The GCC documentation recommends building GCC outside of the source directory in a dedicated build directory:

```
mkdir -v ../gcc-build
cd ../gcc-build
```

Prepare GCC for compilation:

```
AR=ar LDFLAGS="-Wl,-rpath,/cross-tools/lib" \
  ../gcc-4.8.3/configure --prefix=/cross-tools \
  --build=${CLFS_HOST} --target=${CLFS_TARGET} --host=${CLFS_HOST} \
  --with-sysroot=${CLFS} --with-local-prefix=/tools \
  --with-native-system-header-dir=/tools/include --disable-nls \
  --enable-shared --disable-static --enable-languages=c,c++ \
  --enable-__cxa_atexit --enable-c99 \
  --enable-long-long --enable-threads=posix --disable-multilib \
  --with-mpc=/cross-tools --with-mpfr=/cross-tools --with-gmp=/cross-tools \
  --with-clog=/cross-tools --with-isl=/cross-tools --with-system-zlib \
  --enable-checking=release --enable-libstdcxx-time
```

The meaning of the new configure options:

--enable-languages=c,c++

This option ensures that only the C and C++ compilers are built.

--enable-__cxa_atexit

This option allows use of `__cxa_atexit`, rather than `atexit`, to register C++ destructors for local statics and global objects and is essential for fully standards-compliant handling of destructors. It also affects the C++ ABI and therefore results in C++ shared libraries and C++ programs that are interoperable with other Linux distributions.

--enable-c99

Enable C99 support for C programs.

--enable-long-long

Enables long long support in the compiler.

--enable-threads=posix

This enables C++ exception handling for multi-threaded code.

--enable-libstdcxx-time

This enables link-time checks for the availability of `clock_gettime`, `clocks`, and `nanosleep` and `sched_yield` functions, in the C library.

Continue with compiling the package:

```
make AS_FOR_TARGET="${CLFS_TARGET}-as" \  
LD_FOR_TARGET="${CLFS_TARGET}-ld"
```

Install the package:

```
make install
```

Details on this package are located in Section 10.19.2, “Contents of GCC.”

Part IV. Building the Basic Tools

Chapter 6. Constructing a Temporary System

6.1. Introduction

This chapter shows how to compile and install a minimal Linux system. This system will contain just enough tools to start constructing the final CLFS system in Installing Basic System Software and allow a working environment with more user convenience than a minimum environment would.

The tools in this chapter are cross-compiled using the toolchain in `/cross-tools` and will be installed under the `${CLFS}/tools` directory to keep them separate from the files installed in Installing Basic System Software and the host production directories. Since the packages compiled here are temporary, we do not want them to pollute the soon-to-be CLFS system.

Check one last time that the CLFS environment variable is set up properly:

```
echo ${CLFS}
```

Make sure the output shows the path to the CLFS partition's mount point, which is `/mnt/clfs`, using our example.

During this section of the build you will see several WARNING messages like the ones below. It is safe to ignore these messages.

```
configure: WARNING: result yes guessed because of cross compilation
configure: WARNING: cannot check WCONTINUED if cross compiling -- defaulting to r
```

6.2. Build Variables

Setup target-specific variables for the compiler and linkers:

```
export CC="${CLFS_TARGET}-gcc ${BUILD64}"
export CXX="${CLFS_TARGET}-g++ ${BUILD64}"
export AR="${CLFS_TARGET}-ar"
export AS="${CLFS_TARGET}-as"
export RANLIB="${CLFS_TARGET}-ranlib"
export LD="${CLFS_TARGET}-ld"
export STRIP="${CLFS_TARGET}-strip"
```

The meaning of the new configure options:

```
CXX="${CXX} ${BUILD64}"
```

This forces the C++ compiler to use our 64 Bit flags.

Then add the build variables to `~/ .bashrc` to prevent issues if you stop and come back later:

```
echo export CC="\${CC}" >> ~/.bashrc
echo export CXX="\${CXX}" >> ~/.bashrc
echo export AR="\${AR}" >> ~/.bashrc
echo export AS="\${AS}" >> ~/.bashrc
echo export RANLIB="\${RANLIB}" >> ~/.bashrc
echo export LD="\${LD}" >> ~/.bashrc
echo export STRIP="\${STRIP}" >> ~/.bashrc
```

6.3. GMP-6.0.0

GMP is a library for arithmetic on arbitrary precision integers, rational numbers, and floating-point numbers.

6.3.1. Installation of GMP

As with the Cross-Tools, we will compile GMP, MPFR, MPC, ISL, and CLoG so that GCC can use them, though this time we will cross-compile them into `/tools`.

Prepare GMP for compilation:

```
CC_FOR_BUILD=gcc ./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \  
  --enable-cxx
```

The meaning of the new `configure` option:

```
CC_FOR_BUILD=gcc
```

Tells **configure** to use the host's **gcc** instead of our cross-compiler to build native tools it needs while compiling.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.10.2, “Contents of GMP.”

6.4. MPFR-3.1.2

The MPFR library is a C library for multiple-precision floating-point computations with correct rounding.

6.4.1. Installation of MPFR

Apply a patch with upstream fixes:

```
patch -Np1 -i ../mpfr-3.1.2-fixes-4.patch
```

Prepare MPFR for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.11.2, “Contents of MPFR.”

6.5. MPC-1.0.2

MPC is a C library for the arithmetic of complex numbers with arbitrarily high precision and correct rounding of the result.

6.5.1. Installation of MPC

Prepare MPC for compilation:

```
./configure --prefix=/tools \  
--build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.12.2, “Contents of MPC.”

6.6. ISL-0.12.2

ISL is a library for manipulating sets and relations of integer points bounded by linear constraints.

6.6.1. Installation of ISL

Prepare ISL for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.13.2, “Contents of ISL.”

6.7. CLooG-0.18.2

CLooG is a library to generate code for scanning Z-polyhedra. In other words, it finds code that reaches each integral point of one or more parameterized polyhedra. GCC links with this library in order to enable the new loop generation code known as Graphite.

6.7.1. Installation of CLooG

Prepare CLooG for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \  
  --with-isl=system
```

Apply a **sed** which prevents the attempted installation of an invalid file:

```
sed -i '/cmake/d' Makefile
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.14.2, “Contents of CLooG.”

6.8. Zlib-1.2.8

The Zlib package contains compression and decompression routines used by some programs.

6.8.1. Installation of Zlib

Several packages in the temporary system use Zlib, including Binutils, GCC, and Util-linux, so we will add it to `/tools`.

Prepare Zlib for compilation:

```
./configure --prefix=/tools
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.15.2, “Contents of Zlib.”

6.9. Binutils-2.24

The Binutils package contains a linker, an assembler, and other tools for handling object files.

6.9.1. Installation of Binutils

The Binutils documentation recommends building Binutils outside of the source directory in a dedicated build directory:

```
mkdir -v ../binutils-build
cd ../binutils-build
```

Prepare Binutils for compilation:

```
../binutils-2.24/configure \
  --prefix=/tools --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --target=${CLFS_TARGET} --with-lib-path=/tools/lib --disable-nls \
  --enable-shared --enable-64-bit-bfd --disable-multilib
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.18.2, “Contents of Binutils.”

6.10. GCC-4.8.3

The GCC package contains the GNU compiler collection, which includes the C and C++ compilers.

6.10.1. Installation of GCC

The following patch contains a number of updates to the 4.8.3 branch by the GCC developers:

```
patch -Np1 -i ../gcc-4.8.3-branch_update-1.patch
```

Make a couple of essential adjustments to GCC's specs to ensure GCC uses our build environment:

```
patch -Np1 -i ../gcc-4.8.3-pure64_specs-1.patch
```

Change the StartFile Spec so that GCC looks in /tools:

```
echo -en '\n#undef STANDARD_STARTFILE_PREFIX_1\n#define STANDARD_STARTFILE_PREFIX_1 "/tools"
echo -en '\n#undef STANDARD_STARTFILE_PREFIX_2\n#define STANDARD_STARTFILE_PREFIX_2 "/tools"
```

Apply a **sed** substitution that will suppress the execution of the **fixincludes** script:

```
sed -i 's@./fixinc\.sh@-c true@' gcc/Makefile.in
```

The GCC documentation recommends building GCC outside of the source directory in a dedicated build directory:

```
mkdir -v ../gcc-build
cd ../gcc-build
```

Before starting to build GCC, remember to unset any environment variables that override the default optimization flags.

Prepare GCC for compilation:

```
../gcc-4.8.3/configure --prefix=/tools \
  --build=${CLFS_HOST} --host=${CLFS_TARGET} --target=${CLFS_TARGET} \
  --with-local-prefix=/tools --enable-long-long --enable-c99 --enable-shared \
  --enable-threads=posix --disable-multilib --disable-nls \
  --enable-__cxa_atexit --enable-languages=c,c++ --disable-libstdcxx-pch \
  --with-system-zlib --with-native-system-header-dir=/tools/include \
  --disable-libssp --enable-checking=release --enable-libstdcxx-time
```

The meaning of the new configure option:

```
--disable-libstdcxx-pch
```

Do not build the pre-compiled header (PCH) for `libstdc++`. It takes up a lot of space, and we have no use for it.

The following will prevent GCC from looking in the wrong directories for headers and libraries:

```
cp -v Makefile{,.orig}
sed "/^HOST_\(GMP\|ISL\|CLOG\)\(LIBS\|INC\)\/s:/tools:/cross-tools:g" \
  Makefile.orig > Makefile
```

Compile the package:

```
make AS_FOR_TARGET="${AS}" \
  LD_FOR_TARGET="${LD}"
```

Install the package:

```
make install
```

Install the `libiberty` header file that is needed by some packages:

```
cp -v ../gcc-4.8.3/include/libiberty.h /tools/include
```

Details on this package are located in Section 10.19.2, “Contents of GCC.”

6.11. Ncurses-5.9

The Ncurses package contains libraries for terminal-independent handling of character screens.

6.11.1. Installation of Ncurses

We will need Ncurses for several other packages in the temporary environment, including Bash, Util-linux, and Vim.

The following patch fixes an issue with some Bash versions:

```
patch -Np1 -i ../ncurses-5.9-bash_fix-1.patch
```

Prepare Ncurses for compilation:

```
./configure --prefix=/tools --with-shared \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \  
  --without-debug --without-ada \  
  --enable-overwrite --with-build-cc=gcc
```

The meaning of the new configure options:

--with-shared

This tells Ncurses to create a shared library.

--without-debug

This tells Ncurses not to build with debug information.

--without-ada

This ensures that Ncurses does not build support for the Ada compiler which may be present on the host but will not be available when building the final system.

--enable-overwrite

This tells Ncurses to install its header files into `/tools/include`, instead of `/tools/include/ncurses`, to ensure that other packages can find the Ncurses headers successfully.

--with-build-cc=gcc

This tells Ncurses which compiler to use to build native tools when cross-compiling.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.23.2, “Contents of Ncurses.”

6.12. Bash-4.3

The Bash package contains the Bourne-Again SHell.

6.12.1. Installation of Bash

The following patch contains updates from the maintainer. The maintainer of Bash only releases these patches to fix serious issues:

```
patch -Np1 -i ../bash-4.3-branch_update-3.patch
```

When Bash is cross-compiled, it cannot test for the presence of named pipes, among other things. If you used **su** to become an unprivileged user, this combination will cause Bash to build without *process substitution*, which will break one of the C++ test scripts in `glibc`. The following prevents future problems by skipping the check for named pipes, as well as other tests that can not run while cross-compiling or that do not run properly:

```
cat > config.cache << "EOF"
ac_cv_func_mmap_fixed_mapped=yes
ac_cv_func_strcoll_works=yes
ac_cv_func_working_mktime=yes
bash_cv_func_sigsetjmp=present
bash_cv_getcwd_malloc=yes
bash_cv_job_control_missing=present
bash_cv_printf_a_format=yes
bash_cv_sys_named_pipes=present
bash_cv_ulimit_maxfds=yes
bash_cv_under_sys_siglist=yes
bash_cv_unusable_rtsigs=no
gt_cv_int_divbyzero_sigfpe=yes
EOF
```

Prepare Bash for compilation:

```
./configure --prefix=/tools \
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --without-bash-malloc --cache-file=config.cache
```

The meaning of the new configure option:

--without-bash-malloc

This option turns off the use of Bash's memory allocation (`malloc`) function which is known to cause segmentation faults. By turning this option off, Bash will use the `malloc` functions from `Glibc` which are more stable.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.39.2, “Contents of Bash.”

6.13. Bzip2-1.0.6

The Bzip2 package contains programs for compressing and decompressing files. Compressing text files with **bzip2** yields a much better compression percentage than with the traditional **gzip**.

6.13.1. Installation of Bzip2

Bzip2's default `Makefile` target automatically runs the test suite as well. Disable the tests since they won't work on a multi-architecture build:

```
cp -v Makefile{,.orig}
sed -e 's@^\(all:.*\) test@l@g' Makefile.orig > Makefile
```

The Bzip2 package does not contain a **configure** script. Compile it with:

```
make CC="${CC}" AR="${AR}" RANLIB="${RANLIB}"
```

Install the package:

```
make PREFIX=/tools install
```

Details on this package are located in Section 10.41.2, “Contents of Bzip2.”

6.14. Check-0.9.13

The Check package is a unit testing framework for C.

6.14.1. Installation of Check

We will install Check into `/tools` to satisfy a dependency on it for Kbd and Libpipeline in the final system.

Prepare Check for compilation:

```
./configure --prefix=/tools \
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Build the package:

```
make
```

Install the package:

```
make install
```

6.14.2. Contents of Check

Installed program:	checkmk
Installed library:	libcheck.{a,so}

Short Descriptions

checkmk	Awk script for generating C unit tests for use with the C the Check unit testing framework
<code>libcheck.{a,so}</code>	Contains functions that allow Check to be called from a test program

6.15. Coreutils-8.22

The Coreutils package contains utilities for showing and setting the basic system characteristics.

6.15.1. Installation of Coreutils

Configure can not properly determine how to get free space when cross-compiling - as a result, the **df** program will not be built. Add the following entries to `config.cache` to correct this, and fix various cross-compiling issues:

```
cat > config.cache << EOF
fu_cv_sys_stat_statfs2_bsize=yes
gl_cv_func_working_mkstemp=yes
EOF
```

Apply a patch to prevent Coreutils from generating manpages :

```
patch -Np1 -i ../coreutils-8.22-noman-1.patch
```

Prepare Coreutils for compilation:

```
./configure --prefix=/tools \
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --enable-install-program=hostname --cache-file=config.cache
```

The meaning of the new configure option:

```
--enable-install-program=hostname
```

Tells Coreutils to install **hostname**, which is needed for the Perl test suite.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.30.2, “Contents of Coreutils.”

6.16. Diffutils-3.3

The Diffutils package contains programs that show the differences between files or directories.

6.16.1. Installation of Diffutils

Prepare Diffutils for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.42.2, “Contents of Diffutils.”

6.17. File-5.19

The File package contains a utility for determining the type of a given file or files.

6.17.1. Installation of File

Prepare File for compilation:

```
./configure --prefix=/tools \  
--build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.43.2, “Contents of File.”

6.18. Findutils-4.4.2

The Findutils package contains programs to find files. These programs are provided to recursively search through a directory tree and to create, maintain, and search a database (often faster than the recursive find, but unreliable if the database has not been recently updated).

6.18.1. Installation of Findutils

The following cache entries set the values for tests that do not run while cross-compiling:

```
echo "gl_cv_func_wcwidth_works=yes" > config.cache
echo "ac_cv_func_fnmatch_gnu=yes" >> config.cache
```

Prepare Findutils for compilation:

```
./configure --prefix=/tools \
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --cache-file=config.cache
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.45.2, “Contents of Findutils.”

6.19. Gawk-4.1.1

The Gawk package contains programs for manipulating text files.

6.19.1. Installation of Gawk

Prepare Gawk for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.44.2, “Contents of Gawk.”

6.20. Gettext-0.19.1

The Gettext package contains utilities for internationalization and localization. These allow programs to be compiled with NLS (Native Language Support), enabling them to output messages in the user's native language.

6.20.1. Installation of Gettext

Many packages' installation procedures use the **msgfmt** program for i18n support, so we will compile and install it into `/tools`. Attr also needs **msgmerge** and **xgettext**, so we will install those as well.

Only the programs in the `gettext-tools` directory need to be installed for the temp-system:

```
cd gettext-tools
```

When cross-compiling, the Gettext **configure** script assumes we don't have a working `wcwidth` even when we do. The following will fix possible compilation errors because of this assumption:

```
echo "gl_cv_func_wcwidth_works=yes" > config.cache
```

Prepare Gettext for compilation:

```
./configure --prefix=/tools \
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --disable-shared --cache-file=config.cache
```

Compile the required programs and support library:

```
make -C gnulib-lib
make -C src msgfmt msgmerge xgettext
```

Install the **msgfmt**, **msgmerge** and **xgettext** binaries:

```
cp -v src/{msgfmt,msgmerge,xgettext} /tools/bin
```

Details on this package are located in Section 10.46.2, "Contents of Gettext."

6.21. Grep-2.19

The Grep package contains programs for searching through files.

6.21.1. Installation of Grep

Prepare Grep for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \  
  --without-included-regex
```

The meaning of the new configure option:

--without-included-regex

When cross-compiling, Grep's **configure** assumes there is no usable `regex.h` installed and instead uses the one included with Grep. This switch forces the use of the regex functions from Glibc.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.48.2, “Contents of Grep.”

6.22. Gzip-1.6

The Gzip package contains programs for compressing and decompressing files.

6.22.1. Installation of Gzip

Prepare Gzip for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.51.2, “Contents of Gzip.”

6.23. Make-4.0

The Make package contains a program for compiling packages.

6.23.1. Installation of Make

Prepare Make for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.56.2, “Contents of Make.”

6.24. Patch-2.7.1

The Patch package contains a program for modifying or creating files by applying a “patch” file typically created by the **diff** program.

6.24.1. Installation of Patch

Prepare Patch for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.62.2, “Contents of Patch.”

6.25. Sed-4.2.2

The Sed package contains a stream editor.

6.25.1. Installation of Sed

Prepare Sed for compilation:

```
./configure --prefix=/tools \  
--build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.22.2, “Contents of Sed.”

6.26. Tar-1.27.1

The Tar package contains an archiving program.

6.26.1. Installation of Tar

Configure can not properly determine the results of a few tests. Set them manually:

```
cat > config.cache << EOF
gl_cv_func_wcwidth_works=yes
gl_cv_func_btowc_eof=yes
ac_cv_func_malloc_0_nonnull=yes
gl_cv_func_mbrtowc_incomplete_state=yes
gl_cv_func_mbrtowc_nul_retval=yes
gl_cv_func_mbrtowc_null_arg1=yes
gl_cv_func_mbrtowc_null_arg2=yes
gl_cv_func_mbrtowc_retval=yes
gl_cv_func_wcrtomb_retval=yes
EOF
```

Prepare Tar for compilation:

```
./configure --prefix=/tools \
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --cache-file=config.cache
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.66.2, “Contents of Tar.”

6.27. Texinfo-5.2

The Texinfo package contains programs for reading, writing, and converting info pages.

6.27.1. Installation of Texinfo

Prepare Texinfo for compilation:

```
PERL=/usr/bin/perl ./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

The meaning of the new configure option:

```
PERL=/usr/bin/perl
```

This forces Texinfo to use `/usr/bin` as the location of `perl`, as some host systems may have it in `/bin`.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.67.2, “Contents of Texinfo.”

6.28. Util-linux-2.24.2

The Util-linux package contains miscellaneous utility programs. Among them are utilities for handling file systems, consoles, partitions, and messages.

6.28.1. Installation of Util-linux

Prepare Util-linux for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \  
  --disable-makeinstall-chown --disable-makeinstall-setuid
```

The meaning of the new configure option:

--disable-makeinstall-chown

This prevents Util-linux from trying to perform any chown commands when it is installed.

--disable-makeinstall-setuid

This prevents Util-linux from enabling the setuid bit on any of its installed programs.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.26.3, “Contents of Util-linux.”

6.29. Vim-7.4

The Vim package contains a powerful text editor.

6.29.1. Installation of VIM

We will cross-compile Vim so that we can have a text editor in `/tools`. Vim is not technically necessary in the temporary system, in that it is not there to satisfy any package dependencies in the final system, but we believe that a text editor is an extremely useful tool to have there.

The following patch merges all updates from the 7.4 Branch from the Vim developers:

```
patch -Np1 -i ../vim-7.4-branch_update-5.patch
```

The `configure` script is full of logic that aborts at the first sign of cross compiling. Work around this by setting the cached values of several tests with the following command:

```
cat > src/auto/config.cache << "EOF"
vim_cv_getcwd_broken=no
vim_cv_memmove_handles_overlap=yes
vim_cv_stat_ignores_slash=no
vim_cv_terminfo=yes
vim_cv_toupper_broken=no
vim_cv_tty_group=world
EOF
```

Change the default location of the `vimrc` configuration file to `/tools/etc`:

```
echo '#define SYS_VIMRC_FILE "/tools/etc/vimrc"' >> src/feature.h
```

Prepare Vim for compilation:

```
./configure \
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --prefix=/tools --enable-multibyte --enable-gui=no \
  --disable-gtktest --disable-xim --with-features=normal \
  --disable-gpm --without-x --disable-netbeans \
  --with-tlib=ncurses
```

The meaning of the new configure options:

`--enable-multibyte`

This optional but highly recommended switch enables support for editing files in multibyte character encodings. This is needed if using a locale with a multibyte character set. This switch is also helpful to be able to edit text files initially created in Linux distributions like Fedora that use UTF-8 as a default character set.

`--enable-gui=no --disable-gtktest --disable-xim --with-features=normal --disable-gpm --without-x --disable-netbeans`

These options prevent Vim from trying to link to libraries that might be on the host but won't exist inside the temporary build environment.

`--with-tlib=ncurses`

Tells Vim to use Ncurses as its terminal library.

Compile the package:

```
make
```

Install the package:

```
make install
```

Many users are accustomed to using **vi** instead of **vim**. Some programs, such as **vigr** and **vipw**, also use **vi**. Create a symlink to permit execution of **vim** when users habitually enter **vi** and allow programs that use **vi** to work:

```
ln -sv vim /tools/bin/vi
```

Create a temporary vimrc to make it function more the way you may expect it to. This is explained more in the final system:

```
cat > /tools/etc/vimrc << "EOF"
" Begin /tools/etc/vimrc

set nocompatible
set backspace=2
set ruler
syntax on

" End /tools/etc/vimrc
EOF
```

Details on this package are located in Section 10.68.3, “Contents of Vim.”

6.30. XZ Utils-5.0.5

The XZ Utils package contains programs for compressing and decompressing files. Compressing text files with **XZ Utils** yields a much better compression percentage than with the traditional **gzip**.

6.30.1. Installation of XZ Utils

Prepare XZ Utils for compilation:

```
./configure --prefix=/tools \  
--build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.57.2, “Contents of XZ Utils.”

6.31. To Boot or to Chroot?

There are two different ways you can proceed from this point to build the final system. You can build a kernel, a bootloader, and a few other utilities, boot into the temporary system, and build the rest there. Alternatively, you can mount a few virtual filesystems and chroot into the temporary system.

The **chroot** (change root) program is used to enter a virtual environment and start a new shell whose root directory will be set to the CLFS partition. This is very similar to rebooting and instructing the kernel to mount the CLFS partition as the root partition. The major advantage is that “chrooting” allows the builder to continue using the host while CLFS is being built. While waiting for package compilation to complete, a user can switch to a different virtual console (VC) or X desktop and continue using the computer as normal.

The main downside to chrooting is that you are more limited in when you can use it - booting will always work for any CLFS build, but the chroot method can only be used when you are building on the same architecture. For example, if you are building on, and for, an x86 system, you can simply chroot. Booting is required when you are compiling for a different architecture, such as building a PowerPC system from an x86. The rule of thumb here is that if the architectures match and you are running the same series kernel (specifically, a 2.6.32 or newer Linux kernel) you can just chroot. If you aren't running the same series kernel, or are wanting to run a different ABI, you will need to use the boot option.

If you are in any doubt about this, you can try the following commands to see if you can chroot:

```
/tools/lib/libc.so.6  
/tools/bin/gcc -v
```

If either of these commands fail, you will have to follow the boot method.

For the boot method, follow [If You Are Going to Boot](#).

For the chroot method, follow [If You Are Going to Chroot](#).

Chapter 7. If You Are Going to Boot

7.1. Introduction

This chapter shows how to complete the build of temporary tools to create a minimal system that will be used to boot the target machine and to build the final system packages.

7.2. Bc-1.06.95

The Bc package contains an arbitrary precision numeric processing language.

7.2.1. Installation of Bc

We will install a `bc` program that can run on the host system, as this is needed to compile the kernel.

Prepare Bc for compilation:

```
CC=gcc ./configure --prefix=/cross-tools
```

The meaning of the configure option:

```
CC=gcc
```

This ensures that we use the host's compiler to build Bc, since we need it to run on the host system.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.40.2, “Contents of Bc.”

7.3. Boot-scripts for CLFS 3.0-20140710

The Boot-scripts package contains a set of scripts to start/stop the CLFS system at bootup/shutdown.

7.3.1. Installation of Boot-scripts

Install the package:

```
make DESTDIR=/tools install-boot-scripts
```

The **setclock** script reads the time from the hardware clock, also known as the BIOS or the Complementary Metal Oxide Semiconductor (CMOS) clock. If the hardware clock is set to UTC, this script will convert the hardware clock's time to the local time using the `/tools/etc/sysconfig/clock` file (which tells the **hwclock** program which timezone the user is in). There is no way to detect whether or not the hardware clock is set to UTC, so this needs to be configured manually.

If you do not know whether or not the hardware clock is set to UTC, you can find out after you have booted the new machine by running the **hwclock --localtime --show** command, and if necessary editing the `/tools/etc/sysconfig/clock` file. The worst that will happen if you make a wrong guess here is that the time displayed will be wrong.

Change the value of the UTC variable below to a value of 0 (zero) if the hardware clock is *not* set to UTC time.

```
cat > /tools/etc/sysconfig/clock << "EOF"
# Begin /tools/etc/sysconfig/clock

UTC=1

# End /tools/etc/sysconfig/clock
EOF
```

7.3.2. Contents of Boot-scripts

Installed scripts: checkfs, cleanfs, functions, halt, localnet, mountfs, mountkernfs, rc, reboot, sendsignals, setclock, swap, and udev.

Short Descriptions

checkfs	Checks the integrity of the file systems before they are mounted (with the exception of journal and network based file systems)
cleanfs	Removes files that should not be preserved between reboots, such as those in <code>/run/</code> and <code>/var/lock/</code> ; it re-creates <code>/run/utmp</code> and removes the possibly present <code>/etc/nologin</code> , <code>/fastboot</code> , and <code>/forcefsck</code> files
functions	Contains common functions, such as error and status checking, that are used by several boot-scripts
halt	Halts the system
localnet	Sets up the system's hostname and local loopback device
mountfs	Mounts all file systems, except ones that are marked <i>noauto</i> or are network based
mountkernfs	Mounts virtual kernel file systems, such as <code>proc</code>

rc	The master run-level control script; it is responsible for running all the other boot-scripts one-by-one, in a sequence determined by the name of the symbolic links being processed
reboot	Reboots the system
sendsignals	Makes sure every process is terminated before the system reboots or halts
setclock	Resets the kernel clock to local time in case the hardware clock is not set to UTC time
swap	Enables and disables swap files and partitions
udev	Starts and stops the Eudev daemon

7.4. E2fsprogs-1.42.9

The E2fsprogs package contains the utilities for handling the `ext2` file system. It also supports the `ext3` and `ext4` journaling file systems.

7.4.1. Installation of E2fsprogs

The E2fsprogs documentation recommends that the package be built in a subdirectory of the source tree:

```
mkdir -v build
cd build
```

Prepare E2fsprogs for compilation:

```
../configure --prefix=/tools \
  --enable-elf-shlibs --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --disable-libblkid --disable-libuuid --disable-fsck \
  --disable-uuid
```

The meaning of the configure options:

`--enable-elf-shlibs`

This creates the shared libraries which some programs in this package use.

`--disable-*`

This prevents E2fsprogs from building and installing the `libuuid` and `libblkid` libraries, the `uuid` daemon, and the `fsck` wrapper, as Util-Linux installed all of them earlier.

Compile the package:

```
make
```

Install the binaries, documentation and shared libraries:

```
make install
```

Install the static libraries and headers:

```
make install-libs
```

Details on this package are located in Section 10.28.2, “Contents of E2fsprogs.”

7.5. Kmod-18

The Kmod package contains programs for loading, inserting and removing kernel modules for Linux. Kmod replaces the Module-Init-tools package.

7.5.1. Installation of Kmod

Tell Kmod to use `/tools/lib/modules`:

```
cp -v libkmod/libkmod.c{,.orig}
sed '/dirname_default_prefix /s@/lib/modules@/tools&@' \
    libkmod/libkmod.c.orig > libkmod/libkmod.c
```

Prepare Kmod for compilation:

```
./configure --prefix=/tools \
    --build=${CLFS_HOST} --host=${CLFS_TARGET} --with-xz --with-zlib
```

The meaning of the new configure options:

`--with-zlib` `--with-xz`

These allow the Kmod package to handle zlib and XZ compressed kernel modules.

Compile the package:

```
make
```

Install the package:

```
make install
```

Create symbolic links for programs that expect Module-Init-Tools:

```
ln -sfv kmod /tools/bin/lsmmod
for tool in depmod insmod modprobe modinfo rmmmod; do
    ln -sv ../bin/kmod /tools/sbin/${tool}
done
```

Details on this package are located in Section 10.61.2, “Contents of Kmod.”

7.6. Shadow-4.1.5.1

The Shadow package contains programs for handling passwords in a secure way.

7.6.1. Installation of Shadow

Disable the installation of the **groups** and **nologin** programs, as better versions of these programs are provided by Coreutils and Util-linux:

```
cp -v src/Makefile.in{,.orig}
sed -e 's/groups$(EXEEXT) //' -e 's/= nologin$(EXEEXT)/= /' \
    src/Makefile.in.orig > src/Makefile.in
```

Prepare Shadow for compilation:

```
./configure --prefix=/tools \
    --build=${CLFS_HOST} --host=${CLFS_TARGET}
```

Tell Shadow to use **passwd** in `/tools/bin`:

```
cp -v config.h{,.orig}
sed '/PASSWD_PROGRAM/s@/bin/passwd@/tools&@' config.h.orig > config.h
```

Prevent Shadow from setting installed programs **suid**:

```
cp -v src/Makefile{,.orig}
sed 's/\(^suidu*bins = \).*\/\1/' src/Makefile.orig > src/Makefile
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.25.4, “Contents of Shadow.”

7.7. Sysvinit-2.88dsf

The Sysvinit package contains programs for controlling the startup, running, and shutdown of the system.

7.7.1. Installation of Sysvinit

Apply a patch to prevent installation of unneeded programs, and allow Sysvinit to be installed in `/tools`:

```
patch -Np1 -i ../sysvinit-2.88dsf-tools_updates-1.patch
```

Compile the package:

```
make -C src clobber
make -C src CC="${CC}"
```

Install the package:

```
make -C src ROOT=/tools install
```

7.7.2. Configuring Sysvinit

Create a new file `/tools/etc/inittab` by running the following:

```
cat > /tools/etc/inittab << "EOF"
# Begin /tools/etc/inittab

id:3:initdefault:

si::sysinit:/tools/etc/rc.d/init.d/rc sysinit

10:0:wait:/tools/etc/rc.d/init.d/rc 0
11:S1:wait:/tools/etc/rc.d/init.d/rc 1
12:2:wait:/tools/etc/rc.d/init.d/rc 2
13:3:wait:/tools/etc/rc.d/init.d/rc 3
14:4:wait:/tools/etc/rc.d/init.d/rc 4
15:5:wait:/tools/etc/rc.d/init.d/rc 5
16:6:wait:/tools/etc/rc.d/init.d/rc 6

ca:12345:ctrlaltdel:/tools/sbin/shutdown -t1 -a -r now

su:S016:once:/tools/sbin/sulogin

EOF
```

The following command adds the standard virtual terminals to `/tools/etc/inittab`. If your system only has a serial console skip the following command:

```
cat >> /tools/etc/inittab << "EOF"
1:2345:respawn:/tools/sbin/agetty --noclear -I '\033(K' tty1 9600
2:2345:respawn:/tools/sbin/agetty --noclear -I '\033(K' tty2 9600
3:2345:respawn:/tools/sbin/agetty --noclear -I '\033(K' tty3 9600
4:2345:respawn:/tools/sbin/agetty --noclear -I '\033(K' tty4 9600
5:2345:respawn:/tools/sbin/agetty --noclear -I '\033(K' tty5 9600
6:2345:respawn:/tools/sbin/agetty --noclear -I '\033(K' tty6 9600

EOF
```

If your system has a serial console, run the following command to add the entry to `/tools/etc/inittab`.

```
cat >> /tools/etc/inittab << "EOF"
c0:12345:respawn:/tools/sbin/agetty --noclear 115200 ttyS0 vt100

EOF
```

Finally, add the end line to `/tools/etc/inittab`.

```
cat >> /tools/etc/inittab << "EOF"
# End /tools/etc/inittab
EOF
```

The `-I '\033(K'` option tells **agetty** to send this escape sequence to the terminal before doing anything else. This escape sequence switches the console character set to a user-defined one, which can be modified by running the **setfont** program. Sending this escape sequence is necessary for people who use non-ISO 8859-1 screen fonts, but it does not affect native English speakers.

7.7.3. Contents of Sysvinit

Installed programs: bootlogd, fstab-decode, halt, init, killall5, poweroff (link to halt), reboot (link to halt), runlevel, shutdown, and telinit (link to init)

Short Descriptions

bootlogd	Logs boot messages to a log file
fstab-decode	Runs a command with fstab-encoded arguments
halt	Normally invokes shutdown with the <code>-h</code> option, except when already in run-level 0, then it tells the kernel to halt the system; it notes in the file <code>/var/log/wtmp</code> that the system is being brought down
init	The first process to be started when the kernel has initialized the hardware which takes over the boot process and starts all the processes it is instructed to
killall5	Sends a signal to all processes, except the processes in its own session so it will not kill the shell running the script that called it
poweroff	Tells the kernel to halt the system and switch off the computer (see halt)
reboot	Tells the kernel to reboot the system (see halt)

runlevel	Reports the previous and the current run-level, as noted in the last run-level record in <code>/run/utmp</code>
shutdown	Brings the system down in a secure way, signaling all processes and notifying all logged-in users
telinit	Tells init which run-level to change to

7.8. Eudev-1.7

The Eudev package contains programs for dynamic creation of device nodes.

7.8.1. Installation of Eudev

Prepare Eudev for compilation:

```
./configure --prefix=/tools --build=${CLFS_HOST} --host=${CLFS_TARGET} \
  --disable-introspection --disable-gtk-doc-html \
  --disable-gudev --disable-keymap --with-firmware-path=/tools/lib/firmware \
  --enable-libkmod
```

Compile the package:

```
make
```

Install the package:

```
make install
```

Create a directory for storing firmware that can be loaded by **udev**:

```
install -dv /tools/lib/firmware
```

Create a dummy rule so that Eudev will name ethernet devices properly for the system.

```
echo "# dummy, so that network is once again on eth*" > \
  /tools/etc/udev/rules.d/80-net-name-slot.rules
```

7.8.2. Contents of Eudev

Installed programs:	ata_id, cdrom_id, collect, create_floppy_devices, edd_id, firmware.sh, fstab_import, path_id, scsi_id, udevadm, udevd, usb_id, v4l_id, write_cd_rules, write_net_rules
Installed library:	libudev
Installed directories:	/tools/etc/udev, /tools/lib/firmware, /tools/lib/udev

Short Descriptions

udevadm	Controls the runtime behavior of Eudev, requests kernel events, manages the event queue, and provides simple debugging.
udev	A daemon that reorders hotplug events before submitting them to udev , thus avoiding various race conditions
ata_id	Provides Eudev with a unique string and additional information (uuid, label) for an ATA drive
cdrom_id	Prints the capabilities of a CDROM or DVDROM drive.
collect	Given an ID for the current uevent and a list of IDs (for all target uevents), registers the current ID and indicates whether all target IDs have been registered.
create_floppy_devices	Creates all possible floppy devices based on the CMOS type
edd_id	Identifies x86 disk drives from Enhanced Disk Drive calls

firmware.sh	Script to load firmware for a device
fstab_import	Finds an entry in <code>/etc/fstab</code> that matches the current device, and provides its information to Udev.
path_id	Provides the shortest possible unique hardware path to a device
scsi_id	Retrieves or generates a unique SCSI identifier.
usb_id	Identifies a USB block device.
v4l_id	Determines V4L capabilities for a given device.
write_cd_rules	A script which generates Eudev rules to provide stable names for network interfaces.
write_net_rules	A script which generates Eudev rules to provide stable names for network interfaces.
<code>libudev</code>	A library interface to eudev device information.
<code>/etc/udev</code>	Contains udev configuration files, device permissions, and rules for device naming
<code>/lib/udev</code>	Contains udev helper programs and static devices which get copied to <code>/dev</code> when booted.

7.9. Linux-3.14.13

The Linux package contains the Linux kernel.

7.9.1. Installation of the kernel



Warning

Here a temporary cross-compiled kernel will be built. When configuring it, select the minimal amount of options required to boot the target machine and build the final system. I.e., no support for sound, printers, etc. will be needed.

Also, try to avoid the use of modules if possible, and don't use the resulting kernel image for production systems.

Building the kernel involves a few steps—configuration, compilation, and installation. Read the README file in the kernel source tree for alternative methods to the way this book configures the kernel.

To ensure that your system boots and you can properly run both 32 bit and 64 bit binaries, please make sure that you enable support for ELF and emulations for 32bit ELF into the kernel.

Apply the latest Linux sublevel patch:

```
xzcat ../patch-3.14.13.xz | patch -Np1 -i -
```

Prepare for compilation by running the following command:

```
make mrproper
```

This ensures that the kernel tree is absolutely clean. The kernel team recommends that this command be issued prior to each kernel compilation. Do not rely on the source tree being clean after un-tarring.

Configure the kernel via a menu-driven interface:

```
make ARCH=x86_64 CROSS_COMPILE=${CLFS_TARGET}- menuconfig
```

Compile the kernel image and modules:

```
make ARCH=x86_64 CROSS_COMPILE=${CLFS_TARGET}-
```

If the use of kernel modules can't be avoided, an `/etc/modprobe.conf` file may be needed. Information pertaining to modules and kernel configuration is located in the kernel documentation in the `Documentation` directory of the kernel sources tree. The `modprobe.conf` man page may also be of interest.

Install the modules, if the kernel configuration uses them:

```
make ARCH=x86_64 CROSS_COMPILE=${CLFS_TARGET}- \
  INSTALL_MOD_PATH=/tools modules_install
```

Install the firmware, if the kernel configuration uses them:

```
make ARCH=x86_64 CROSS_COMPILE=${CLFS_TARGET}- \
  INSTALL_MOD_PATH=/tools firmware_install
```

After kernel compilation is complete, additional steps are required to complete the installation. Some files need to be copied to the `/tools/boot` directory.

Issue the following commands to install the kernel:

```
mkdir -pv /tools/boot  
cp -v arch/x86_64/boot/bzImage /tools/boot/vmlinuz-clfs-3.14.13
```

`System.map` is a symbol file for the kernel. It maps the function entry points of every function in the kernel API, as well as the addresses of the kernel data structures for the running kernel. Issue the following command to install the map file:

```
cp -v System.map /tools/boot/System.map-3.14.13
```

The kernel configuration file `.config` produced by the **make menuconfig** step above contains all the configuration selections for the kernel that was just compiled. It is a good idea to keep this file for future reference:

```
cp -v .config /tools/boot/config-3.14.13
```

Details on this package are located in Section 13.2.2, “Contents of Linux.”

7.10. GRUB-2.00

The GRUB package contains the GRand Unified Bootloader.

7.10.1. Installation of GRUB



Note

If you would like use a different bootloader than this one you can go to the following link for alternative bootloaders and the instructions to use them. <http://trac.cross-lfs.org/wiki/bootloaders>

Glibc-2.19 does not declare `gets()`:

```
sed -i -e '/gets is a/d' grub-core/gnulib/stdio.in.h
```

Prepare GRUB for compilation:

```
./configure --prefix=/tools \  
  --build=${CLFS_HOST} --host=${CLFS_TARGET} \  
  --disable-werror --enable-grub-mkfont=no --with-bootdir=tools/boot
```

The meaning of the new configure option:

```
--enable-grub-mkfont=no
```

Prevents GRUB from trying to build **grub-mkfont**, which requires Freetype.

Compile the package:

```
make
```

Install the package:

```
make install
```

Details on this package are located in Section 10.69.3, “Contents of GRUB.”

7.11. Creating Directories



Note

The commands in the remainder of the book should be run as the `root` user. Check that `${CLFS}` is set in the `root` user's environment before proceeding.

It is time to create some structure in the CLFS file system. Create a standard directory tree by issuing the following commands:

```
mkdir -pv ${CLFS}/{bin,boot,dev,{etc/,}opt,home,lib/firmware,mnt}
mkdir -pv ${CLFS}/{proc,media/{floppy,cdrom},run/{,shm},sbin,svr,sys}
mkdir -pv ${CLFS}/var/{lock,log,mail,spool}
mkdir -pv ${CLFS}/var/{opt,cache,lib/{misc,locate},local}
install -dv -m 0750 ${CLFS}/root
install -dv -m 1777 ${CLFS}/{/var,}/tmp
ln -sv ../run ${CLFS}/var/run
mkdir -pv ${CLFS}/usr/{,local/}{bin,include,lib,sbin,src}
mkdir -pv ${CLFS}/usr/{,local}/share/{doc,info,locale,man}
mkdir -pv ${CLFS}/usr/{,local}/share/{misc,terminfo,zoneinfo}
mkdir -pv ${CLFS}/usr/{,local}/share/man/man{1,2,3,4,5,6,7,8}
```

Directories are, by default, created with permission mode 755, but this is not desirable for all directories. In the commands above, two changes are made—one to the home directory of user `root`, and another to the directories for temporary files.

The first mode change ensures that not just anybody can enter the `/root` directory—the same as a normal user would do with his or her home directory. The second mode change makes sure that any user can write to the `/tmp` and `/var/tmp` directories, but cannot remove another user's files from them. The latter is prohibited by the so-called “sticky bit,” the highest bit (1) in the 1777 bit mask.

7.11.1. FHS Compliance Note

The directory tree is based on the Filesystem Hierarchy Standard (FHS) (available at <http://www.pathname.com/fhs/>). In addition to the tree created above, this standard stipulates the existence of `/usr/local/games` and `/usr/share/games`. The FHS is not precise as to the structure of the `/usr/local/share` subdirectory, so we create only the directories that are needed. However, feel free to create these directories if you prefer to conform more strictly to the FHS.

7.12. Creating Essential Symlinks

Some programs use hard-wired paths to files which do not exist yet. In order to satisfy these programs, create a number of symbolic links which will be replaced by real files throughout the course of the next chapter after the software has been installed.

```
ln -sv /tools/bin/{bash,cat,echo,grep,login,pwd,stty} ${CLFS}/bin
ln -sv /tools/bin/file ${CLFS}/usr/bin
ln -sv /tools/lib/libgcc_s.so{,.1} ${CLFS}/usr/lib
ln -sv /tools/lib/libstdc++.so{.6,} ${CLFS}/usr/lib
sed -e 's/tools/usr/' /tools/lib/libstdc++.la > ${CLFS}/usr/lib/libstdc++.la
ln -sv bash ${CLFS}/bin/sh
ln -sv /tools/sbin/init ${CLFS}/sbin
ln -sv /tools/etc/{login.{access,defs},limits} ${CLFS}/etc
```

The purpose of each link:

/bin/bash

Many **bash** scripts specify */bin/bash*.

/bin/cat

This pathname is hard-coded into Glibc's configure script.

/bin/echo

This is to satisfy one of the tests in Glibc's test suite, which expects */bin/echo*.

/bin/grep

This to avoid a hard-coded */tools* reference in Libtool.

/bin/login

The **agetty** program expects to find **login** in */bin*.

/bin/pwd

Some **configure** scripts, particularly Glibc's, have this pathname hard-coded.

/bin/stty

This pathname is hard-coded into Expect, therefore it is needed for Binutils and GCC test suites to pass.

/usr/bin/file

Binutils' **configure** scripts specify this command location.

/usr/lib/libgcc_s.so{,.1}

Glibc needs this for the pthreads library to work.

/usr/lib/libstdc++{,.6}

This is needed by several tests in Glibc's test suite, as well as for C++ support in GMP.

/usr/lib/libstdc++.la

This prevents a */tools* reference that would otherwise be in */usr/lib/libstdc++.la* after GCC is installed.

/bin/sh

Many shell scripts hard-code */bin/sh*.

/sbin/init

This is where the kernel expects to find **init**.

```
/etc/{login.{access,defs},limits}
```

These are configuration files used by Shadow and are expected to be found in `/etc`, for programs such as **login** and **su** to work.

To enable some C++ tests in the Glibc and Binutils test suites to link, create a directory and make some symbolic links:

```
mkdir -pv ${CLFS}/usr/lib64
ln -sv /tools/lib/libstdc++.so{.6,} ${CLFS}/usr/lib64
```

Historically, Linux maintains a list of the mounted file systems in the file `/etc/mtab`. Modern kernels maintain this list internally and expose it to the user via the `/proc` filesystem. To satisfy utilities that expect the presence of `/etc/mtab`, create the following symbolic link:

```
ln -sv /proc/self/mounts ${CLFS}/etc/mtab
```

7.13. Populating `/dev`

7.13.1. Creating Initial Device Nodes

When the kernel boots the system, it requires the presence of a few device nodes, in particular the `console` and `null` devices. The device nodes will be created on the hard disk so that they are available before **udev** has been started, and additionally when Linux is started in single user mode (hence the restrictive permissions on `console`). Create these by running the following commands:

```
mknod -m 0600 ${CLFS}/dev/console c 5 1
mknod -m 0666 ${CLFS}/dev/null c 1 3
```

7.14. Creating the `passwd` and `group` Files

In order for user `root` to be able to login and for the name “`root`” to be recognized, there must be relevant entries in the `/etc/passwd` and `/etc/group` files.

Create the `${CLFS}/etc/passwd` file by running the following command:

```
cat > ${CLFS}/etc/passwd << "EOF"
root::0:0:root:/root:/bin/bash
bin:x:1:1:/bin:/bin/false
daemon:x:2:6:/sbin:/bin/false
messagebus:x:27:27:D-Bus Message Daemon User:/dev/null:/bin/false
nobody:x:65534:65533:Unprivileged User:/dev/null:/bin/false
EOF
```

The actual password for `root` (the “`::`” used here is just a placeholder and allows you to login with no password) will be set later.

Additional users you may want to add if not already included:

```
adm:x:3:16:adm:/var/adm:/bin/false
```

Was used for programs that performed administrative tasks.

```
lp:x:10:9:lp:/var/spool/lp:/bin/false
```

Used by programs for printing

mail:x:30:30:mail:/var/mail:/bin/false

Often used by email programs

news:x:31:31:news:/var/spool/news:/bin/false

Often used for network news servers

operator:x:50:0:operator:/root:/bin/bash

Often used to allow system operators to access the system

postmaster:x:51:30:postmaster:/var/spool/mail:/bin/false

Generally used as an account that receives all the information of troubles with the mail server

Create the `/${CLFS}/etc/group` file by running the following command:

```
cat > ${CLFS}/etc/group << "EOF"
```

```
root:x:0:
```

```
bin:x:1:
```

```
sys:x:2:
```

```
kmem:x:3:
```

```
tty:x:5:
```

```
tape:x:4:
```

```
daemon:x:6:
```

```
floppy:x:7:
```

```
disk:x:8:
```

```
lp:x:9:
```

```
dialout:x:10:
```

```
audio:x:11:
```

```
video:x:12:
```

```
utmp:x:13:
```

```
usb:x:14:
```

```
cdrom:x:15:
```

```
adm:x:16:
```

```
messagebus:x:27:
```

```
systemd-journal:x:28:
```

```
mail:x:30:
```

```
wheel:x:39:
```

```
nogroup:x:65533:
```

```
EOF
```

Additional groups you may want to add if not already included:

```
console:x:17:
```

This group has direct access to the console

```
cdrw:x:18:
```

This group is allowed to use the CDRW drive

```
news:x:31:news
```

Used by Network News Servers

```
users:x:1000:
```

The default GID used by shadow for new users

```
nobody:x:65533:
```

This is used by NFS

The created groups are not part of any standard—they are groups decided on in part by the requirements of the Systemd configuration in the final system, and in part by common convention employed by a number of existing Linux distributions. The Linux Standard Base (LSB, available at <http://www.linuxbase.org>) recommends only that, besides the group “root” with a Group ID (GID) of 0, a group “bin” with a GID of 1 be present. All other group names and GIDs can be chosen freely by the system administrator since well-written programs do not depend on GID numbers, but rather use the group's name.

7.15. Creating the /etc/fstab File

The `/etc/fstab` file is used by some programs to determine where file systems are to be mounted by default, which must be checked, and in which order. Create a new file systems table like this:

```
cat > ${CLFS}/etc/fstab << "EOF"
# Begin /etc/fstab

# file system  mount-point  type  options  dump  fsck
#                                     order

/dev/[xxx]    /             [fff]  defaults  1      1
/dev/[yyy]    swap          swap   pri=1     0      0
devpts       /dev/pts     devpts gid=5,mode=620 0      0
shm          /dev/shm     tmpfs  defaults  0      0

# End /etc/fstab
EOF
```

Replace `[xxx]`, `[yyy]`, and `[fff]` with the values appropriate for the system, for example, `sda2`, `sda5`, and `ext2`. For details on the six fields in this file, see **man 5 fstab**.

The `/dev/shm` mount point for `tmpfs` is included to allow enabling POSIX-shared memory. The kernel must have the required support built into it for this to work (more about this is in the next section). Please note that very little software currently uses POSIX-shared memory. Therefore, consider the `/dev/shm` mount point optional. For more information, see `Documentation/filesystems/tmpfs.txt` in the kernel source tree.

7.16. Setting Up the Environment

The new instance of the shell that will start when the system is booted is a *login* shell, which will read the `.bash_profile` file. Create `.bash_profile` now:

```
cat > ${CLFS}/root/.bash_profile << "EOF"
set +h
PS1='\u:\w\$ '
LC_ALL=POSIX
PATH=/bin:/usr/bin:/sbin:/usr/sbin:/tools/bin:/tools/sbin
export LC_ALL PATH PS1
EOF
```

The `LC_ALL` variable controls the localization of certain programs, making their messages follow the conventions of a specified country. Setting `LC_ALL` to “POSIX” or “C” (the two are equivalent) ensures that everything will work as expected on your temporary system.

By putting `/tools/bin` and `/tools/sbin` at the end of the standard `PATH`, all the programs installed in Constructing a Temporary System are only picked up by the shell if they have not yet been built on the target system. This configuration forces use of the final system binaries as they are built over the temp-system, minimising the chance of final system programs being built against the temp-system.

7.17. Build Flags

We will need to copy our build variables into our new system:

```
echo export BUILD64="\${BUILD64}" >> ${CLFS}/root/.bash_profile
```

7.18. Changing Ownership

Currently, the `/tools` and `/cross-tools` directories are owned by the user `clfs`, a user that exists only on the host system. Although `/tools` and `/cross-tools` can be deleted once the CLFS system has been finished, they can be retained to build additional CLFS systems. If the `/tools` and `/cross-tools` directories are kept as is, the files are owned by a user ID without a corresponding account. This is dangerous because a user account created later could get this same user ID and would own these directories and all the files therein, thus exposing those files to possible malicious manipulation.

One possible fix for this issue might be to add the `clfs` user to the new CLFS system later when creating the `/etc/passwd` file, taking care to assign it the same user and group IDs as on the host system. Alternatively, assign the contents of the `/tools` and `/cross-tools` directories to user `root` by running the following commands:

```
chown -Rv 0:0 ${CLFS}/tools
chown -Rv 0:0 ${CLFS}/cross-tools
```

7.19. How to View the Book

Most likely, you have been using a web browser or PDF viewer to read the CLFS book so far. However, the temporary system in `/tools` does not have any of these, so you will need to find a way to continue following the book after booting into the temporary build environment. Possible solutions include:

- Simply have the book open on another computer, or even read a printed copy, though one downside to this is that you cannot copy-and-paste commands.
- Convert the CLFS book into plain text, thus allowing it to be viewed with **more** or **view**, by using a command such as the following:

```
lynx -dump /path/to/clfs/book.html > ${CLFS}/root/CLFS-book.txt
```

- Cross-compile and install additional programs before booting, such as Lynx or Links to view the book, or Dropbear to allow remote login. See the CLFS Hints website at <http://hints.cross-lfs.org/index.php/> for more suggestions by other users.

7.20. What to do next

Now you're at the point to get your `${CLFS}` directory copied over to your target machine. The easiest method would be to tar it up and copy the file.

```
tar -jcvf ${CLFS}.tar.bz2 ${CLFS}
```

Chapter 8. If You Are Going to Chroot

8.1. Introduction

This chapter shows how to prepare a **chroot** jail to build the final system packages into.

8.2. Mounting Virtual Kernel File Systems



Note

The commands in the remainder of the book should be run as the `root` user. Check that `${CLFS}` is set in the `root` user's environment before proceeding.

Various file systems exported by the kernel are used to communicate to and from the kernel itself. These file systems are virtual in that no disk space is used for them. The content of the file systems resides in memory.

Begin by creating directories onto which the file systems will be mounted:

```
mkdir -pv ${CLFS}/{dev,proc,run,sys}
```

Two device nodes, `/dev/console` and `/dev/null`, are required to be present on the file system. These are needed by the kernel even before starting Udev early in the boot process, so we create them here:

```
mknod -m 600 ${CLFS}/dev/console c 5 1  
mknod -m 666 ${CLFS}/dev/null c 1 3
```

Once the system is complete and booting, the rest of our device nodes will be created by the kernel's `devtmpfs` file system. For now though, we will just use the “bind” option in the `mount` command to make our host system's `/dev` structure appear in the new CLFS file system:

```
mount -v -o bind /dev ${CLFS}/dev
```

Now mount the remaining file systems:

```
mount -vt devpts -o gid=5,mode=620 devpts ${CLFS}/dev/pts  
mount -vt proc proc ${CLFS}/proc  
mount -vt tmpfs tmpfs ${CLFS}/run  
mount -vt sysfs sysfs ${CLFS}/sys
```

On some host systems, `/dev/shm` is a symbolic link to `/run/shm`. If it is, create a directory in `/run`:

```
[ -h ${CLFS}/dev/shm ] && mkdir -pv ${CLFS}/${readlink ${CLFS}/dev/shm}
```

Remember that if for any reason you stop working on the CLFS system and start again later, it is important to check that these file systems are mounted again before entering the `chroot` environment.

8.3. Entering the Chroot Environment

It is time to enter the chroot environment to begin building and installing the final CLFS system. As user `root`, run the following command to enter the realm that is, at the moment, populated with only the temporary tools:

```
chroot "${CLFS}" /tools/bin/env -i \
  HOME=/root TERM="${TERM}" PS1='\u:\w\$ ' \
  PATH=/bin:/usr/bin:/sbin:/usr/sbin:/tools/bin \
  /tools/bin/bash --login +h
```

The `-i` option given to the `env` command will clear all variables of the chroot environment. After that, only the `HOME`, `TERM`, `PS1`, and `PATH` variables are set again. The `TERM=${TERM}` construct will set the `TERM` variable inside chroot to the same value as outside chroot. This variable is needed for programs like `vim` and `less` to operate properly. If other variables are needed, such as `CFLAGS` or `CXXFLAGS`, this is a good place to set them again.

From this point on, there is no need to use the `CLFS` variable anymore, because all work will be restricted to the CLFS file system. This is because the Bash shell is told that `${CLFS}` is now the root (`/`) directory.

Notice that `/tools/bin` comes last in the `PATH`. This means that a temporary tool will no longer be used once its final version is installed. This occurs when the shell does not “remember” the locations of executed binaries—for this reason, hashing is switched off by passing the `+h` option to `bash`.

It is important that all the commands throughout the remainder of this chapter and the following chapters are run from within the chroot environment. If you leave this environment for any reason (rebooting for example), remember to first mount the `proc` and `devpts` file systems (discussed in the previous section) and enter chroot again before continuing with the installations.

Note that the `bash` prompt will say `I have no name!` This is normal because the `/etc/passwd` file has not been created yet.

8.4. Changing Ownership

Currently, the `/tools` and `/cross-tools` directories are owned by the user `clfs`, a user that exists only on the host system. Although `/tools` and `/cross-tools` can be deleted once the CLFS system has been finished, they can be retained to build additional CLFS systems. If the `/tools` and `/cross-tools` directories are kept as is, the files are owned by a user ID without a corresponding account. This is dangerous because a user account created later could get this same user ID and would own these directories and all the files therein, thus exposing those files to possible malicious manipulation.

One possible fix for this issue might be to add the `clfs` user to the new CLFS system later when creating the `/etc/passwd` file, taking care to assign it the same user and group IDs as on the host system. Alternatively, assign the contents of the `/tools` and `/cross-tools` directories to user `root` by running the following commands:

```
chown -Rv 0:0 /tools
chown -Rv 0:0 /cross-tools
```

The commands use `0:0` instead of `root:root`, because `chown` is unable to resolve the name “root” until the `passwd` file has been created.

8.5. Creating Directories

It is time to create some structure in the CLFS file system. Create a standard directory tree by issuing the following commands:

```
mkdir -pv /{bin,boot,dev,{etc/,}opt,home,lib,mnt}
mkdir -pv /{proc,media/{floppy,cdrom},run/shm,sbin,svr,sys}
mkdir -pv /var/{lock,log,mail,spool}
mkdir -pv /var/{opt,cache,lib/{misc,locate},local}
install -dv -m 0750 /root
install -dv -m 1777 {/var,}/tmp
ln -sv ../run /var/run
mkdir -pv /usr/{,local/}{bin,include,lib,sbin,src}
mkdir -pv /usr/{,local/}share/{doc,info,locale,man}
mkdir -pv /usr/{,local/}share/{misc,terminfo,zoneinfo}
mkdir -pv /usr/{,local/}share/man/man{1..8}
```

Directories are, by default, created with permission mode 755, but this is not desirable for all directories. In the commands above, two changes are made—one to the home directory of user `root`, and another to the directories for temporary files.

The first mode change ensures that not just anybody can enter the `/root` directory—the same as a normal user would do with his or her home directory. The second mode change makes sure that any user can write to the `/tmp` and `/var/tmp` directories, but cannot remove another user's files from them. The latter is prohibited by the so-called “sticky bit,” the highest bit (1) in the 1777 bit mask.

8.5.1. FHS Compliance Note

The directory tree is based on the Filesystem Hierarchy Standard (FHS) (available at <http://www.pathname.com/fhs/>). In addition to the tree created above, this standard stipulates the existence of `/usr/local/games` and `/usr/share/games`. The FHS is not precise as to the structure of the `/usr/local/share` subdirectory, so we create only the directories that are needed. However, feel free to create these directories if you prefer to conform more strictly to the FHS.

8.6. Creating Essential Symlinks

Some programs use hard-wired paths to files which do not exist yet. In order to satisfy these programs, create a number of symbolic links which will be replaced by real files throughout the course of the next chapter after the software has been installed.

```
ln -sv /tools/bin/{bash,cat,echo,grep,pwd,stty} /bin
ln -sv /tools/bin/file /usr/bin
ln -sv /tools/lib/libgcc_s.so{,.1} /usr/lib
ln -sv /tools/lib/libstdc++.so{.6,} /usr/lib
sed -e 's/tools/usr/' /tools/lib/libstdc++.la > /usr/lib/libstdc++.la
ln -sv bash /bin/sh
```

The purpose of each link:

`/bin/bash`

Many **bash** scripts specify `/bin/bash`.

/bin/cat

This pathname is hard-coded into Glibc's configure script.

/bin/echo

This is to satisfy one of the tests in Glibc's test suite, which expects */bin/echo*.

/bin/grep

This to avoid a hard-coded */tools* reference in Libtool.

/bin/login

The **agetty** program expects to find **login** in */bin*.

/bin/pwd

Some **configure** scripts, particularly Glibc's, have this pathname hard-coded.

/bin/stty

This pathname is hard-coded into Expect, therefore it is needed for Binutils and GCC test suites to pass.

/usr/bin/file

Binutils' **configure** scripts specify this command location.

/usr/lib/libgcc_s.so{,.1}

Glibc needs this for the pthreads library to work.

/usr/lib/libstdc++.so{,.6}

This is needed by several tests in Glibc's test suite, as well as for C++ support in GMP.

/usr/lib/libstdc++.la

This prevents a */tools* reference that would otherwise be in */usr/lib/libstdc++.la* after GCC is installed.

/bin/sh

Many shell scripts hard-code */bin/sh*.

/sbin/init

This is where the kernel expects to find **init**.

/etc/{login.{access,defs},limits}

These are configuration files used by Shadow and are expected to be found in */etc*, for programs such as **login** and **su** to work.

To enable some C++ tests in the Glibc and Binutils test suites to link, create a directory and make some symbolic links:

```
mkdir -pv /usr/lib64
ln -sv /tools/lib/libstdc++.so{.6,} /usr/lib64
```

Historically, Linux maintains a list of the mounted file systems in the file */etc/mtab*. Modern kernels maintain this list internally and expose it to the user via the */proc* filesystem. To satisfy utilities that expect the presence of */etc/mtab*, create the following symbolic link:

```
ln -sv /proc/self/mounts /etc/mtab
```

8.7. Build Flags

We will need to setup target specific flags for the compiler and linkers.

```
export BUILD64="-m64"
```

To prevent errors when you come back to your build, we will export these variables to prevent any build issues in the future:

```
echo export BUILD64=\"\"${BUILD64}\"\" >> ~/.bash_profile
```

8.8. Creating the passwd and group Files

In order for user `root` to be able to login and for the name “`root`” to be recognized, there must be relevant entries in the `/etc/passwd` and `/etc/group` files.

Create the `/etc/passwd` file by running the following command:

```
cat > /etc/passwd << "EOF"
root:x:0:0:root:/root:/bin/bash
bin:x:1:1:/bin:/bin/false
daemon:x:2:6:/sbin:/bin/false
messagebus:x:27:27:D-Bus Message Daemon User:/dev/null:/bin/false
nobody:x:65534:65533:Unprivileged User:/dev/null:/bin/false
EOF
```

The actual password for `root` (the “`x`” used here is just a placeholder) will be set later.

Additional users you may want to add if not already included:

```
adm:x:3:16:adm:/var/adm:/bin/false
```

Was used for programs that performed administrative tasks.

```
lp:x:10:9:lp:/var/spool/lp:/bin/false
```

Used by programs for printing

```
mail:x:30:30:mail:/var/mail:/bin/false
```

Often used by email programs

```
news:x:31:31:news:/var/spool/news:/bin/false
```

Often used for network news servers

```
operator:x:50:0:operator:/root:/bin/bash
```

Often used to allow system operators to access the system

```
postmaster:x:51:30:postmaster:/var/spool/mail:/bin/false
```

Generally used as an account that receives all the information of troubles with the mail server

Create the `/etc/group` file by running the following command:

```
cat > /etc/group << "EOF"
root:x:0:
bin:x:1:
sys:x:2:
kmem:x:3:
tty:x:5:
tape:x:4:
daemon:x:6:
floppy:x:7:
disk:x:8:
lp:x:9:
dialout:x:10:
audio:x:11:
video:x:12:
utmp:x:13:
usb:x:14:
cdrom:x:15:
adm:x:16:
messagebus:x:27:
systemd-journal:x:28:
mail:x:30:
wheel:x:39:
nogroup:x:65533:
EOF
```

Additional groups you may want to add if not already included:

```
console:x:17:
```

This group has direct access to the console

```
cdrw:x:18:
```

This group is allowed to use the CDRW drive

```
news:x:31:news
```

Used by Network News Servers

```
users:x:1000:
```

The default GID used by shadow for new users

```
nobody:x:65533:
```

This is used by NFS

The created groups are not part of any standard—they are groups decided on in part by the requirements of the Systemd configuration in the final system, and in part by common convention employed by a number of existing Linux distributions. The Linux Standard Base (LSB, available at <http://www.linuxbase.org>) recommends only that, besides the group “root” with a Group ID (GID) of 0, a group “bin” with a GID of 1 be present. All other group names and GIDs can be chosen freely by the system administrator since well-written programs do not depend on GID numbers, but rather use the group's name.

To remove the “I have no name!” prompt, start a new shell. Since a full Glibc was installed in Constructing Cross-Compile Tools and the `/etc/passwd` and `/etc/group` files have been created, user name and group name resolution will now work.

```
exec /tools/bin/bash --login +h
```

Note the use of the `+h` directive. This tells **bash** not to use its internal path hashing. Without this directive, **bash** would remember the paths to binaries it has executed. To ensure the use of the newly compiled binaries as soon as they are installed, the `+h` directive will be used for the duration of the next chapters.

Part V. Building the CLFS System

Chapter 9. Constructing Testsuite Tools

9.1. Introduction

This chapter builds the tools needed by some packages to run the tests that they have. I.e., **make check**. Tcl, Expect, and DejaGNU are needed for the GCC, Binutils, and Findutils test suites. Installing three packages for testing purposes may seem excessive, but it is very reassuring, if not essential, to know that the most important tools are working properly.

9.2. Tcl-8.6.1

The Tcl package contains the Tool Command Language.

9.2.1. Installation of Tcl

Increase memory size for regular expressions where required.

```
sed -i s/500/5000/ generic/regc_nfa.c
```

Prepare Tcl for compilation:

```
cd unix
./configure --prefix=/tools
```

Build the package:

```
make
```

Install the package:

```
make install
```

Tcl's private header files are needed for the next package, Expect. Install them into /tools:

```
make install-private-headers
```

Now make a necessary symbolic link:

```
ln -sv tclsh8.6 /tools/bin/tclsh
```

9.2.2. Contents of Tcl

Installed programs: tclsh (link to tclsh8.6) and tclsh8.6

Installed libraries: libtcl8.6.so, libtclstub8.6.a

Short Descriptions

tclsh8.6 The Tcl command shell

tclsh A link to tclsh8.6

libtcl8.6.so The Tcl library

libtclstub8.6.a The Tcl Stub library

9.3. Expect-5.45

The Expect package contains a program for carrying out scripted dialogues with other interactive programs.

9.3.1. Installation of Expect

Now prepare Expect for compilation:

```
./configure --prefix=/tools --with-tcl=/tools/lib \
  --with-tclinclude=/tools/include
```

The meaning of the configure options:

--with-tcl=/tools/lib

This ensures that the configure script finds the Tcl installation in the temporary testsuite-tools location.

--with-tclinclude=/tools/include

This explicitly tells Expect where to find Tcl's internal headers. Using this option avoids conditions where **configure** fails because it cannot automatically discover the location of the Tcl source directory.

Build the package:

```
make
```

Install the package:

```
make SCRIPTS="" install
```

The meaning of the make parameter:

SCRIPTS=""

This prevents installation of the supplementary expect scripts, which are not needed.

9.3.2. Contents of Expect

Installed program:	expect
Installed library:	libexpect-5.43.a

Short Descriptions

expect	Communicates with other interactive programs according to a script
libexpect-5.43.a	Contains functions that allow Expect to be used as a Tcl extension or to be used directly from C or C++ (without Tcl)

9.4. DejaGNU-1.5.1

The DejaGNU package contains a framework for testing other programs.

9.4.1. Installation of DejaGNU

Prepare DejaGNU for compilation:

```
./configure --prefix=/tools
```

Build and install the package:

```
make install
```

9.4.2. Contents of DejaGNU

Installed program: runtest

Short Descriptions

runtest A wrapper script that locates the proper **expect** shell and then runs DejaGNU

Chapter 10. Installing Basic System Software

10.1. Introduction

In this chapter, we enter the building site and start constructing the CLFS system in earnest. The installation of this software is straightforward. Although in many cases the installation instructions could be made shorter and more generic, we have opted to provide the full instructions for every package to minimize the possibilities for mistakes. The key to learning what makes a Linux system work is to know what each package is used for and why the user (or the system) needs it. For every installed package, a summary of its contents is given, followed by concise descriptions of each program and library the package installed.

If using compiler optimizations, please review the optimization hint at <http://hints.cross-lfs.org/index.php/Optimization>. Compiler optimizations can make a program run slightly faster, but they may also cause compilation difficulties and problems when running the program. If a package refuses to compile when using optimization, try to compile it without optimization and see if that fixes the problem. Even if the package does compile when using optimization, there is the risk it may have been compiled incorrectly because of the complex interactions between the code and build tools. Also note that the `-march` and `-mtune` options may cause problems with the toolchain packages (Binutils, GCC and Glibc). The small potential gains achieved in using compiler optimizations are often outweighed by the risks. First-time builders of CLFS are encouraged to build without custom optimizations. The subsequent system will still run very fast and be stable at the same time.

The order that packages are installed in this chapter needs to be strictly followed to ensure that no program accidentally acquires a path referring to `/tools` hard-wired into it. For the same reason, do not compile packages in parallel. Compiling in parallel may save time (especially on dual-CPU machines), but it could result in a program containing a hard-wired path to `/tools`, which will cause the program to stop working when that directory is removed.

To keep track of which package installs particular files, a package manager can be used. For a general overview of different styles of package managers, please take a look at the next page.

10.2. Package Management

Package Management is an often-requested addition to the CLFS Book. A Package Manager allows tracking the installation of files making it easy to remove and upgrade packages. Before you begin to wonder, NO—this section will not talk about nor recommend any particular package manager. What it provides is a roundup of the more popular techniques and how they work. The perfect package manager for you may be among these techniques or may be a combination of two or more of these techniques. This section briefly mentions issues that may arise when upgrading packages.

Some reasons why no specific package manager is recommended in CLFS or CBLFS include:

- Dealing with package management takes the focus away from the goals of these books—teaching how a Linux system is built.
- There are multiple solutions for package management, each having its strengths and drawbacks. Including one that satisfies all audiences is difficult.

There are some hints written on the topic of package management. Visit the *Hints subproject* and see if one of them fits your need.

10.2.1. Upgrade Issues

A Package Manager makes it easy to upgrade to newer versions when they are released. Generally the instructions in CLFS and CBLFS can be used to upgrade to the newer versions. Here are some points that you should be aware of when upgrading packages, especially on a running system.

- If one of the toolchain packages (Glibc, GCC or Binutils) needs to be upgraded to a newer minor version, it is safer to rebuild CLFS. Though you *may* be able to get by rebuilding all the packages in their dependency order, we do not recommend it. For example, if glibc-2.2.x needs to be updated to glibc-2.3.x, it is safer to rebuild. For micro version updates, a simple reinstallation usually works, but is not guaranteed. For example, upgrading from glibc-2.3.4 to glibc-2.3.5 will not usually cause any problems.
- If a package containing a shared library is updated, and if the name of the library changes, then all the packages dynamically linked to the library need to be recompiled to link against the newer library. (Note that there is no correlation between the package version and the name of the library.) For example, consider a package foo-1.2.3 that installs a shared library with name `libfoo.so.1`. Say you upgrade the package to a newer version foo-1.2.4 that installs a shared library with name `libfoo.so.2`. In this case, all packages that are dynamically linked to `libfoo.so.1` need to be recompiled to link against `libfoo.so.2`. Note that you should not remove the previous libraries until the dependent packages are recompiled.
- If you are upgrading a running system, be on the lookout for packages that use **cp** instead of **install** to install files. The latter command is usually safer if the executable or library is already loaded in memory.

10.2.2. Package Management Techniques

The following are some common package management techniques. Before making a decision on a package manager, do some research on the various techniques, particularly the drawbacks of the particular scheme.

10.2.2.1. It is All in My Head!

Yes, this is a package management technique. Some folks do not find the need for a package manager because they know the packages intimately and know what files are installed by each package. Some users also do not need any package management because they plan on rebuilding the entire system when a package is changed.

10.2.2.2. Install in Separate Directories

This is a simplistic package management that does not need any extra package to manage the installations. Each package is installed in a separate directory. For example, package foo-1.1 is installed in `/usr/pkg/foo-1.1` and a symlink is made from `/usr/pkg/foo` to `/usr/pkg/foo-1.1`. When installing a new version foo-1.2, it is installed in `/usr/pkg/foo-1.2` and the previous symlink is replaced by a symlink to the new version.

Environment variables such as `PATH`, `LD_LIBRARY_PATH`, `MANPATH`, `INFOPATH` and `CPPFLAGS` need to be expanded to include `/usr/pkg/foo`. For more than a few packages, this scheme becomes unmanageable.

10.2.2.3. Symlink Style Package Management

This is a variation of the previous package management technique. Each package is installed similar to the previous scheme. But instead of making the symlink, each file is symlinked into the `/usr` hierarchy. This removes the need to expand the environment variables. Though the symlinks can be created by the user to automate the creation, many package managers have been written using this approach. A few of the popular ones include Stow, Epkg, Graft, and Depot.

The installation needs to be faked, so that the package thinks that it is installed in `/usr` though in reality it is installed in the `/usr/pkg` hierarchy. Installing in this manner is not usually a trivial task. For example, consider that you are installing a package `libfoo-1.1`. The following instructions may not install the package properly:

```
./configure --prefix=/usr/pkg/libfoo/1.1
make
make install
```

The installation will work, but the dependent packages may not link to `libfoo` as you would expect. If you compile a package that links against `libfoo`, you may notice that it is linked to `/usr/pkg/libfoo/1.1/lib/libfoo.so.1` instead of `/usr/lib/libfoo.so.1` as you would expect. The correct approach is to use the `DESTDIR` strategy to fake installation of the package. This approach works as follows:

```
./configure --prefix=/usr
make
make DESTDIR=/usr/pkg/libfoo/1.1 install
```

Most packages support this approach, but there are some which do not. For the non-compliant packages, you may either need to manually install the package, or you may find that it is easier to install some problematic packages into `/opt`.

10.2.2.4. Timestamp Based

In this technique, a file is timestamped before the installation of the package. After the installation, a simple use of the `find` command with the appropriate options can generate a log of all the files installed after the timestamp file was created. A package manager written with this approach is `install-log`.

Though this scheme has the advantage of being simple, it has two drawbacks. If, during installation, the files are installed with any timestamp other than the current time, those files will not be tracked by the package manager. Also, this scheme can only be used when one package is installed at a time. The logs are not reliable if two packages are being installed on two different consoles.

10.2.2.5. LD_PRELOAD Based

In this approach, a library is preloaded before installation. During installation, this library tracks the packages that are being installed by attaching itself to various executables such as `cp`, `install`, `mv` and tracking the system calls that modify the filesystem. For this approach to work, all the executables need to be dynamically linked without the `suid` or `sgid` bit. Preloading the library may cause some unwanted side-effects during installation. Therefore, it is advised that one performs some tests to ensure that the package manager does not break anything and logs all the appropriate files.

10.2.2.6. Creating Package Archives

In this scheme, the package installation is faked into a separate tree as described in the `Symlink` style package management. After the installation, a package archive is created using the installed files. This archive is then used to install the package either on the local machine or can even be used to install the package on other machines.

This approach is used by most of the package managers found in the commercial distributions. Examples of package managers that follow this approach are `RPM` (which, incidentally, is required by the *Linux Standard Base Specification*), `pkg-utils`, Debian's `apt`, and Gentoo's `Portage` system. A hint describing how to adopt this style of package management for `CLFS` systems is located at <http://hints.cross-lfs.org/index.php/Fakeroot>.

10.3. About Test Suites, Again

In the final-system build, you are no longer cross-compiling so it is possible to run package test suites. Running the test suite for a newly built package is a good idea because it can provide a “sanity check” indicating that everything compiled correctly. A test suite that passes its set of checks usually proves that the package is functioning as the developer intended. It does not, however, guarantee that the package is totally bug free.

Some test suites are more important than others. For example, the test suites for the core toolchain packages—GCC, Binutils, and Glibc—are of the utmost importance due to their central role in a properly functioning system. The test suites for GCC and Glibc can take a very long time to complete, especially on slower hardware, but are strongly recommended.

A common issue with running the test suites for Binutils and GCC is running out of pseudo terminals (PTYs). This can result in a high number of failing tests. This may happen for several reasons, but the most likely cause (if you chrooted) is that the host system does not have the `devpts` file system set up correctly. This issue is discussed in greater detail at <http://trac.cross-lfs.org/wiki/faq#no-ptys>.

Sometimes package test suites will fail, but for reasons which the developers are aware of and have deemed non-critical. Consult the logs located at <http://cross-lfs.org/testsuite-logs/3.0.0-RC1/SYSTEMD/> to verify whether or not these failures are expected. This site is valid for all tests throughout this book.

10.4. Temporary Perl-5.20.0

The Perl package contains the Practical Extraction and Report Language.

10.4.1. Installation of Perl



Note

In this section, we will add Perl to the temporary system in `/tools`. This package installation should technically be part of Constructing a Temporary System, but Perl has often had problems with cross-compiling, so we will compile and install it while in the final build environment.

Change a hardcoded path from `/usr/include` to `/tools/include`:

```
sed -i 's@/usr/include@/tools/include@g' ext/Errno/Errno_pm.PL
```

Prepare Temporary Perl for compilation:

```
./configure.gnu --prefix=/tools -Dcc="gcc"
```

The meaning of the configure option:

```
-Dcc="gcc"
```

Tells Perl to use **gcc** instead of the default **cc**.

Compile the package:

```
make
```

Although Perl comes with a test suite, it is not recommended to run it at this point, as this Perl installation is only temporary. The test suite can be run later in this chapter if desired.

Install the package:

```
make install
```

Finally, create a necessary symlink:

```
ln -sfv /tools/bin/perl /usr/bin
```

Details on this package are located in Section 10.35.2, “Contents of Perl.”

10.5. Linux-3.14.13 Headers

The Linux Kernel contains a **make** target that installs “sanitized” kernel headers.

10.5.1. Installation of Linux Headers



Note

For this step you will need to unpack the kernel tarball (`linux-3.14.tar.xz`) and **cd** into its source directory before entering the commands on this page.

Apply the latest Linux sublevel patch:

```
xzcat ../patch-3.14.13.xz | patch -Np1 -i -
```

Install the kernel header files:

```
make mrproper
make headers_check
make INSTALL_HDR_PATH=/usr headers_install
find /usr/include -name .install -or -name ..install.cmd | xargs rm -fv
```

The meaning of the make commands:

make mrproper

Ensures that the kernel source dir is clean.

make headers_check

Sanitizes the raw kernel headers so that they can be used by userspace programs.

make INSTALL_HDR_PATH=/usr headers_install

This will install the kernel headers into `/usr/include`.

find /usr/include -name .install -or -name ..install.cmd | xargs rm -fv

Removes a number of unneeded debugging files that were installed.

10.5.2. Contents of Linux Headers

Installed headers:	<code>/usr/include/{asm,asm-generic,drm,linux,mtd,rdma,scsi,sound,video,xen}/*.h</code>
Installed directories:	<code>/usr/include/asm, /usr/include/asm-generic, /usr/include/drm, /usr/include/linux, /usr/include/mtd, /usr/include/rdma, /usr/include/scsi, /usr/include/sound, /usr/include/uapi, /usr/include/video, /usr/include/xen</code>

Short Descriptions

`/usr/include/{asm,asm-generic,drm,linux,mtd,rdma,sound,video}/*.h` The Linux API headers

10.6. Man-pages-3.68

The Man-pages package contains over 2,200 man pages.

10.6.1. Installation of Man-pages

Install Man-pages by running:

```
make install
```

10.6.2. Contents of Man-pages

Installed files: various man pages

Short Descriptions

`man pages` This package contains man pages that describe the following: POSIX headers (section 0p), POSIX utilities (section 1p), POSIX functions (section 3p), user commands (section 1), system calls (section 2), libc calls (section 3), device information (section 4), file formats (section 5), games (section 6), conventions and macro packages (section 7), system administration (section 8), and kernel (section 9).

10.7. Glibc-2.19

The Glibc package contains the main C library. This library provides the basic routines for allocating memory, searching directories, opening and closing files, reading and writing files, string handling, pattern matching, arithmetic, and so on.

10.7.1. Installation of Glibc



Note

Some packages outside of CLFS suggest installing GNU libiconv in order to translate data from one encoding to another. The project's home page (<http://www.gnu.org/software/libiconv/>) says “This library provides an `iconv()` implementation, for use on systems which don't have one, or whose implementation cannot convert from/to Unicode.” Glibc provides an `iconv()` implementation and can convert from/to Unicode, therefore libiconv is not required on a CLFS system.

At the end of the installation, the build system will run a sanity test to make sure everything installed properly. This script will attempt to test for a library that is only used in the test suite and is never installed. Prevent the script from testing for this library with the following command:

```
sed -i 's/\(&& $name ne\) "db1"/ & \1 "nss_test1"/' scripts/test-installation.pl
```

This same script performs its tests by attempting to compile test programs against certain libraries. However it does not specify the path to `ld.so`, and our toolchain is still configured to use the one in `/tools`. The following set of commands will force the script to use the complete path of the new `ld.so` that was just installed:

```
LINKER=$(readelf -l /tools/bin/bash | sed -n 's@.*interpret.*@/tools/(.*)]$@\1@p
sed -i "s|libs -o|libs -L/usr/lib -Wl,-dynamic-linker=${LINKER} -o|" \
  scripts/test-installation.pl
unset LINKER
```

The Glibc build system is self-contained and will install perfectly, even though the compiler specs file and linker are still pointing at `/tools`. The specs and linker cannot be adjusted before the Glibc install because the Glibc Autoconf tests would give false results and defeat the goal of achieving a clean build.

Apply the following `sed` so the `tzselect` script works properly:

```
sed -i 's/\\\$$(pwd)/`pwd`/' timezone/Makefile
```

The Glibc documentation recommends building Glibc outside of the source directory in a dedicated build directory:

```
mkdir -v ../glibc-build
cd ../glibc-build
```

Tell Glibc to install its libraries into `/lib`:

```
echo "slibdir=/lib" >> configparms
```

Prepare Glibc for compilation:

```
../glibc-2.19/configure --prefix=/usr \
  --disable-profile --enable-kernel=2.6.32 \
  --libexecdir=/usr/lib/glibc --libdir=/usr/lib \
  --enable-obsolete-rpc
```

The meaning of the new configure option:

```
--libexecdir=/usr/lib/glibc
```

This changes the location of the **getconf** utility from its default of `/usr/libexec` to `/usr/lib/glibc`.

Compile the package:

```
make
```

**Important**

The test suite for Glibc is considered critical. Do not skip it under any circumstance.

Use the following commands to run the test suite and output any test failures:

```
make -k check 2>&1 | tee glibc-check-log; grep Error glibc-check-log
```

The Glibc test suite is highly dependent on certain functions of the host system, in particular the kernel. The *posix/annexc* and *conform/run-conformtest* tests normally fail and you should see `Error 1 (ignored)` in the output. Apart from this, the Glibc test suite is always expected to pass. However, in certain circumstances, some failures are unavoidable. If a test fails because of a missing program (or missing symbolic link), or a segfault, you will see an error code greater than 127 and the details will be in the log. More commonly, tests will fail with `Error 2` - for these, the contents of the corresponding `.out` file, e.g. *posix/annexc.out* may be informative. Here is a list of the most common issues:

- The *nptl/tst-clock2*, *nptl/tst-attr3*, *tst/tst-cputimer1*, and *rt/tst-cpuclock2* tests have been known to fail. The reason is not completely understood, but indications are that minor timing issues can trigger these failures.
- The *math* tests sometimes fail. Certain optimization settings are known to be a factor here.
- If you have mounted the CLFS partition with the *noatime* option, the *atime* test will fail. As mentioned in Section 2.5, “Mounting the New Partition”, do not use the *noatime* option while building CLFS.
- When running on older and slower hardware, some tests can fail because of test timeouts being exceeded. Modifying the make check command to set a `TIMEOUTFACTOR` is reported to help eliminate these errors (e.g. `TIMEOUTFACTOR=16 make -k check`).
- *posix/tst-getaddrinfo4* will always fail due to not having a network connection when the test is run.

Though it is a harmless message, the install stage of Glibc will complain about the absence of `/etc/ld.so.conf`. Prevent this warning with:

```
touch /etc/ld.so.conf
```

The install will finish by checking that everything is correctly installed. Unfortunately, it will test for a multilib installation. On `x86_64 Pure64` this means it will try to test the non-existent 32-bit loader which has a different name from the 64-bit loader (unlike on other 64-bit architectures). We fool it by creating a symlink to the real loader.

```
ln -sv ld-2.19.so /lib/ld-linux.so.2
```

Install the package, and remove unneeded files from `/usr/include/rpcsvc`:

```
make install &&
rm -v /usr/include/rpcsvc/*.x
```


Now we can remove this symlink. We also need to correct the `/usr/bin/ldd` script - if you look at this, you will see it references not only the 32-bit linker, but also `/lib64` where it thinks the 64-bit linker is. The following `sed` will correct this:

```
rm -v /lib/ld-linux.so.2
sed -i.bak '/RTLDFLIST/s%/ld-linux.so.2 /lib64%%' /usr/bin/ldd
```

Check the script to make sure the `sed` worked correctly, then delete the backup.

```
rm -v /usr/bin/ldd.bak
```

Install the configuration file and runtime directory for `nscd`:

```
cp -v ../glibc-2.19/nscd/nscd.conf /etc/nscd.conf
mkdir -pv /var/cache/nscd
```

Install the systemd support files for `nscd`:

```
install -v -Dm644 ../glibc-2.19/nscd/nscd.tmpfiles /usr/lib/tmpfiles.d/nscd.conf
install -v -Dm644 ../glibc-2.19/nscd/nscd.service /lib/systemd/system/nscd.service
```

10.7.2. Internationalization

The locales that can make the system respond in a different language were not installed by the above command. Install them with:

```
make localedata/install-locales
```

To save time, an alternative to running the previous command (which generates and installs every locale listed in the `glibc-2.19/localedata/SUPPORTED` file) is to install only those locales that are wanted and needed. This can be achieved by using the `localedef` command. Information on this command is located in the `INSTALL` file in the Glibc source. However, there are a number of locales that are essential in order for the tests of future packages to pass, in particular, the `libstdc++` tests from GCC. The following instructions, instead of the `install-locales` target used above, will install the minimum set of locales necessary for the tests to run successfully:

```
mkdir -pv /usr/lib/locale
localedef -i cs_CZ -f UTF-8 cs_CZ.UTF-8
localedef -i de_DE -f ISO-8859-1 de_DE
localedef -i de_DE@euro -f ISO-8859-15 de_DE@euro
localedef -i en_HK -f ISO-8859-1 en_HK
localedef -i en_PH -f ISO-8859-1 en_PH
localedef -i en_US -f ISO-8859-1 en_US
localedef -i es_MX -f ISO-8859-1 es_MX
localedef -i fa_IR -f UTF-8 fa_IR
localedef -i fr_FR -f ISO-8859-1 fr_FR
localedef -i fr_FR@euro -f ISO-8859-15 fr_FR@euro
localedef -i it_IT -f ISO-8859-1 it_IT
localedef -i ja_JP -f EUC-JP ja_JP
```

Some locales installed by the `make localedata/install-locales` command above are not properly supported by some applications that are in CLFS and CBLFS. Because of the various problems that arise due to application programmers making assumptions that break in such locales, CLFS should not be used in locales that utilize multibyte character sets (including UTF-8) or right-to-left writing order. Numerous unofficial and unstable patches are required to fix

these problems, and it has been decided by the CLFS developers not to support such complex locales at this time. This applies to the `ja_JP` and `fa_IR` locales as well—they have been installed only for GCC and Gettext tests to pass, and the **watch** program (part of the Procps-ng package) does not work properly in them. Various attempts to circumvent these restrictions are documented in internationalization-related hints.

10.7.3. Configuring Glibc

The `/etc/nsswitch.conf` file needs to be created because, although Glibc provides defaults when this file is missing or corrupt, the Glibc defaults do not work well in a networked environment. The time zone also needs to be configured.

Create a new file `/etc/nsswitch.conf` by running the following:

```
cat > /etc/nsswitch.conf << "EOF"
# Begin /etc/nsswitch.conf

passwd: files
group: files
shadow: files

hosts: files dns
networks: files

protocols: files
services: files
ethers: files
rpc: files

# End /etc/nsswitch.conf
EOF
```

Install timezone data:

```
tar -xf ../tzdata2014d.tar.gz

ZONEINFO=/usr/share/zoneinfo
mkdir -pv $ZONEINFO/{posix,right}

for tz in etcetera southamerica northamerica europe africa antarctica \
        asia australasia backward pacificnew \
        systemv; do
    zic -L /dev/null -d $ZONEINFO -y "sh yearistype.sh" ${tz}
    zic -L /dev/null -d $ZONEINFO/posix -y "sh yearistype.sh" ${tz}
    zic -L leapseconds -d $ZONEINFO/right -y "sh yearistype.sh" ${tz}
done

cp -v zone.tab iso3166.tab $ZONEINFO
zic -d $ZONEINFO -p America/New_York
unset ZONEINFO
```

The meaning of the `zic` commands:

```
zic -L /dev/null ...
```

This creates posix timezones, without any leap seconds. It is conventional to put these in both `zoneinfo` and `zoneinfo/posix`. It is necessary to put the POSIX timezones in `zoneinfo`, otherwise various test-suites will report errors. On an embedded system, where space is tight and you do not intend to ever update the timezones, you could save 1.9MB by not using the `posix` directory, but some applications or test-suites might give less good results

```
zic -L leapseconds ...
```

This creates right timezones, including leap seconds. On an embedded system, where space is tight and you do not intend to ever update the timezones, or care about the correct time, you could save 1.9MB by omitting the `right` directory.

```
zic ... -p ...
```

This creates the `posixrules` file. We use New York because POSIX requires the daylight savings time rules to be in accordance with US rules.

To determine the local time zone, run the following script:

```
tzselect
```

After answering a few questions about the location, the script will output the name of the time zone (e.g., *EST5EDT* or *Canada/Eastern*). Then create the `/etc/localtime` file by running:

```
cp -v /usr/share/zoneinfo/[xxx] \
    /etc/localtime
```

Replace `[xxx]` with the name of the time zone that **tzselect** provided (e.g., *Canada/Eastern*).

10.7.4. Configuring The Dynamic Loader

By default, the dynamic loader (`/lib/ld-linux-x86-64.so.2`) searches through `/lib` and `/usr/lib` for dynamic libraries that are needed by programs as they are run. However, if there are libraries in directories other than `/lib` and `/usr/lib`, these need to be added to the `/etc/ld.so.conf` file in order for the dynamic loader to find them. Two directories that are commonly known to contain additional libraries are `/usr/local/lib` and `/opt/lib`, so add those directories to the dynamic loader's search path.

Create a new file `/etc/ld.so.conf` by running the following:

```
cat > /etc/ld.so.conf << "EOF"
# Begin /etc/ld.so.conf

/usr/local/lib
/opt/lib

# End /etc/ld.so.conf
EOF
```

10.7.5. Contents of Glibc

Installed programs:	catchsegv, gencat, getconf, getent, iconv, iconvconfig, ldconfig, ldd, lddlibc4, locale, localedef, makedb, mtrace, nscd, pcprofiledump, pldd, rpcgen, sln, sotruss, sprof, tzselect, xtrace, zdump, zic
Installed libraries:	ld.so, libBrokenLocale.[a,so], libSegFault.so, libanl.[a,so], libc.[a,so], libc_nonshared.a, libcidn.[a,so], libcrypt.[a,so], libdl.[a,so], libg.a, libieee.a, libm.[a,so], libmcheck.a, libmemusage.so, libnsl.a, libnss_compat.so, libnss_dns.so, libnss_files.so, libnss_hesiod.so, libnss_nis.so, libnss_nisplus.so, libpcprofile.so, libpthread.[a,so], libpthread_nonshared.a, libresolv.[a,so], librpcsvc.a, librt.[a,so], libthread_db.so, libutil.[a,so]
Installed directories:	/usr/include/arpa, /usr/include/bits, /usr/include/gnu, /usr/include/net, /usr/include/netash, /usr/include/netatalk, /usr/include/netax25, /usr/include/neteconet, /usr/include/netinet, /usr/include/netipx, /usr/include/netiucv, /usr/include/netpacket, /usr/include/netrom, /usr/include/netrose, /usr/include/nfs, /usr/include/protocols, /usr/include/rpc, /usr/include/rpcsvc, /usr/include/sys, /usr/lib/audit, /usr/lib/gconv, /usr/lib/glibc, /usr/lib/locale, /usr/share/i18n, /usr/share/zoneinfo, /var/cache/ldconfig, /var/cache/nscd

Short Descriptions

catchsegv	Can be used to create a stack trace when a program terminates with a segmentation fault
gencat	Generates message catalogues
getconf	Displays the system configuration values for file system specific variables
getent	Gets entries from an administrative database
iconv	Performs character set conversion
iconvconfig	Creates fastloading iconv module configuration files
ldconfig	Configures the dynamic linker runtime bindings
ldd	Reports which shared libraries are required by each given program or shared library
lddlibc4	Assists ldd with object files
locale	Tells the compiler to enable or disable the use of POSIX locales for built-in operations
localedef	Compiles locale specifications
makedb	Creates a simple database from textual input
mtrace	Reads and interprets a memory trace file and displays a summary in human-readable format
nscd	A daemon that provides a cache for the most common name service requests
pcprofiledump	Dumps information generated by PC profiling
pldd	Lists dynamic shared objects used by running processes
rpcgen	Generates C code to implement the Remote Procedure Call (RPC) protocol
sln	A statically linked program that creates symbolic links
sotruss	Traces shared library procedure calls of a specified command
sprof	Reads and displays shared object profiling data

tzselect	Asks the user about the location of the system and reports the corresponding time zone description
xtrace	Traces the execution of a program by printing the currently executed function
zdump	The time zone dumper
zic	The time zone compiler
<code>ld.so</code>	The helper program for shared library executables
<code>libBrokenLocale</code>	Used by programs, such as Mozilla, to solve broken locales
<code>libSegFault</code>	The segmentation fault signal handler
<code>libanl</code>	An asynchronous name lookup library
<code>libc</code>	The main C library
<code>libcidn</code>	Used internally by Glibc for handling internationalized domain names in the <code>getaddrinfo()</code> function
<code>libcrypt</code>	The cryptography library
<code>libdl</code>	The dynamic linking interface library
<code>libg</code>	A runtime library for <code>g++</code>
<code>libieee</code>	The Institute of Electrical and Electronic Engineers (IEEE) floating point library
<code>libm</code>	The mathematical library
<code>libmcheck</code>	Contains code run at boot
<code>libmemusage</code>	Used by memusage (included in Glibc, but not built in a base CLFS system as it has additional dependencies) to help collect information about the memory usage of a program
<code>libnsl</code>	The network services library
<code>libnss</code>	The Name Service Switch libraries, containing functions for resolving host names, user names, group names, aliases, services, protocols, etc.
<code>libpcprofile</code>	Contains profiling functions used to track the amount of CPU time spent in specific source code lines
<code>libpthread</code>	The POSIX threads library
<code>libresolv</code>	Contains functions for creating, sending, and interpreting packets to the Internet domain name servers
<code>librpcsvc</code>	Contains functions providing miscellaneous RPC services
<code>librt</code>	Contains functions providing most of the interfaces specified by the POSIX.1b Realtime Extension
<code>libthread_db</code>	Contains functions useful for building debuggers for multi-threaded programs
<code>libutil</code>	Contains code for “standard” functions used in many different Unix utilities

10.8. Adjusting the Toolchain

Now we adjust GCC's specs so that they point to the new dynamic linker. A **perl** command accomplishes this:

```
gcc -dumpspecs | \
perl -p -e 's@/tools/lib/ld@/lib/ld@g;' \
      -e 's@\*startfile_prefix_spec:\n@$_/usr/lib/ @g;' > \
      $(dirname $(gcc --print-libgcc-file-name))/specs
```

The **perl** command above makes 2 modifications to GCC's specs: it removes “/tools” from the pathname to the dynamic linker, and adds “/usr/lib/” to the `startfile_prefix_spec`. It is a good idea to visually inspect the `specs` file, and compare with the output of **gcc -dumpspecs**, to verify that the intended changes were actually made.

Note that `/lib` is now the prefix of our dynamic linker.



Caution

It is imperative at this point to stop and ensure that the basic functions (compiling and linking) of the adjusted toolchain are working as expected. To do this, perform a sanity check:

```
echo 'main(){}' > dummy.c
gcc dummy.c
readelf -l a.out | grep ': /lib'
```

If everything is working correctly, there should be no errors, and the output of the last command will be:

```
[Requesting program interpreter: /lib/ld-linux-x86-64.so.2]
```

Note that `/lib` is now the prefix of our dynamic linker.

If the output does not appear as shown above or is not received at all, then something is seriously wrong. Investigate and retrace the steps to find out where the problem is and correct it. The most likely reason is that something went wrong with the specs file amendment above. Any issues will need to be resolved before continuing on with the process.

Once everything is working correctly, clean up the test files:

```
rm -v dummy.c a.out
```

10.9. M4-1.4.17

The M4 package contains a macro processor.

10.9.1. Installation of M4

Prepare M4 for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.9.2. Contents of M4

Installed program: m4

Short Descriptions

m4 copies the given files while expanding the macros that they contain. These macros are either built-in or user-defined and can take any number of arguments. Besides performing macro expansion, **m4** has built-in functions for including named files, running Unix commands, performing integer arithmetic, manipulating text, recursion, etc. The **m4** program can be used either as a front-end to a compiler or as a macro processor in its own right.

10.10. GMP-6.0.0

GMP is a library for arithmetic on arbitrary precision integers, rational numbers, and floating-point numbers.

10.10.1. Installation of GMP



Note

If you are compiling this package on a different CPU than you plan to run the CLFS system on, you must replace GMP's `config.guess` and `config.sub` wrappers with the originals. This will prevent GMP from optimizing for the wrong CPU. You can make this change with the following command:

```
mv -v config{fsf,}.guess
mv -v config{fsf,}.sub
```

Prepare GMP for compilation:

```
CC="gcc -isystem /usr/include" \
CXX="g++ -isystem /usr/include" \
LDFLAGS="-Wl,-rpath-link,/usr/lib:/lib" \
./configure --prefix=/usr --enable-cxx \
--docdir=/usr/share/doc/gmp-6.0.0
```

Compile the package:

```
make
```

Build the HTML documentation:

```
make html
```



Important

The test suite for GMP is considered critical. Do not skip it under any circumstance.

Test the results:

```
make check
```

Install the package:

```
make install
```

Install the documentation:

```
make install-html
```

10.10.2. Contents of GMP

Installed libraries: libgmp.[a,so], libgmpxx.[a,so]
Installed directory: /usr/share/doc/gmp-6.0.0

Short Descriptions

- `libgmp` Contains the definitions for GNU multiple precision functions.
- `libgmpxx` Contains a C++ class wrapper for GMP types.

10.11. MPFR-3.1.2

The MPFR library is a C library for multiple-precision floating-point computations with correct rounding.

10.11.1. Installation of MPFR

Apply a patch with upstream fixes:

```
patch -Np1 -i ../mpfr-3.1.2-fixes-4.patch
```

Prepare MPFR for compilation:

```
CC="gcc -isystem /usr/include" \
LDFLAGS="-Wl,-rpath-link,/usr/lib:/lib" \
./configure --prefix=/usr --with-gmp=/usr \
--docdir=/usr/share/doc/mpfr-3.1.2
```

Compile the package:

```
make
```



Important

The test suite for MPFR is considered critical. Do not skip it under any circumstance.

Test the results:

```
make check
```

Install the package:

```
make install
```

10.11.2. Contents of MPFR

Installed libraries:	libmpfr.[a,so]
Installed directory:	/usr/share/doc/mpfr-3.1.2

Short Descriptions

`libmpfr` The Multiple Precision Floating-Point Reliable Library.

10.12. MPC-1.0.2

MPC is a C library for the arithmetic of complex numbers with arbitrarily high precision and correct rounding of the result.

10.12.1. Installation of MPC

Prepare MPC for compilation:

```
CC="gcc -isystem /usr/include" \
LD_FLAGS="-Wl,-rpath-link,/usr/lib:/lib" \
./configure --prefix=/usr --docdir=/usr/share/doc/mpc-1.0.2
```

Compile the package:

```
make
```

Build the HTML documentation:

```
make html
```



Important

The test suite for MPC is considered critical. Do not skip it under any circumstance.

Test the results:

```
make check
```

Install the package:

```
make install
```

Install the HTML documentation:

```
make install-html
```

10.12.2. Contents of MPC

Installed libraries:	libmpc.[a,so]
Installed directory:	/usr/share/doc/mpc-1.0.2

Short Descriptions

`libmpc` The Multiple Precision Complex Library.

10.13. ISL-0.12.2

ISL is a library for manipulating sets and relations of integer points bounded by linear constraints.

10.13.1. Installation of ISL

Prepare ISL for compilation:

```
CC="gcc -isystem /usr/include" \
LDFLAGS="-Wl,-rpath-link,/usr/lib:/lib" \
./configure --prefix=/usr
```

Compile the package:

```
make
```



Important

The test suite for ISL is considered critical. Do not skip it under any circumstance.

Test the results:

```
make check
```

Install the package:

```
make install
```

Finally, move a misplaced file:

```
mkdir -pv /usr/share/gdb/auto-load/usr/lib
mv -v /usr/lib/libisl*gdb.py /usr/share/gdb/auto-load/usr/lib
```

10.13.2. Contents of ISL

Installed libraries: libisl.[a,so]
Installed directory: /usr/include/isl

Short Descriptions

`libisl` The Integer Set Library.

10.14. CLoog-0.18.2

CLoog is a library to generate code for scanning Z-polyhedra. In other words, it finds code that reaches each integral point of one or more parameterized polyhedra. GCC links with this library in order to enable the new loop generation code known as Graphite.

10.14.1. Installation of CLoog

Prepare CLoog for compilation:

```
CC="gcc -isystem /usr/include" \
LD_FLAGS="-Wl,-rpath-link,/usr/lib:/lib" \
./configure --prefix=/usr --enable-shared --with-isl=system
```

Apply a `sed` which prevents the attempted installation of an invalid file:

```
sed -i '/cmake/d' Makefile
```

Compile the package:

```
make
```



Important

The test suite for CLoog is considered critical. Do not skip it under any circumstance.

Test the results:

```
make check
```

Install the package:

```
make install
```

10.14.2. Contents of CLoog

Installed program:	cloog
Installed libraries:	libcloog-isl.[a,so]
Installed directories:	/usr/include/cloog

Short Descriptions

cloog	Loop generator for scanning Z-polyhedra
libcloog-isl	Isl backend for CLoog.

10.15. Zlib-1.2.8

The Zlib package contains compression and decompression routines used by some programs.

10.15.1. Installation of Zlib

Prepare Zlib for compilation:

```
CC="gcc -isystem /usr/include" \
CXX="g++ -isystem /usr/include" \
LDFLAGS="-Wl,-rpath-link,/usr/lib:/lib" \
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

The previous command installed two `.so` files into `/usr/lib`. We will move it into `/lib` and then relink it to `/usr/lib`:

```
mv -v /usr/lib/libz.so.* /lib
ln -sfv ../../lib/$(readlink /usr/lib/libz.so) /usr/lib/libz.so
```

Install the documentation:

```
mkdir -pv /usr/share/doc/zlib-1.2.8
cp -rv doc/* examples /usr/share/doc/zlib-1.2.8
```

10.15.2. Contents of Zlib

Installed libraries:	libz.[a,so]
Installed directory:	/usr/share/doc/zlib-1.2.8

Short Descriptions

`libz` Contains compression and decompression functions used by some programs

10.16. Flex-2.5.39

The Flex package contains a utility for generating programs that recognize patterns in text.

10.16.1. Installation of Flex

Prepare Flex for compilation:

```
M4=m4 ./configure --prefix=/usr --docdir=/usr/share/doc/flex-2.5.39
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

The test suite will report 3 failures for tests that use **bison**, which is not installed yet. For full test coverage, you can run Flex's test suite again after Bison is installed.

Install the package:

```
make install
```

A few programs do not know about **flex** yet and try to run its predecessor, **lex**. To support those programs, create a wrapper script named `lex` that calls `flex` in **lex** emulation mode:

```
cat > /usr/bin/lex << "EOF"
#!/bin/sh
# Begin /usr/bin/lex

exec /usr/bin/flex -l "$@"

# End /usr/bin/lex
EOF
chmod -v 755 /usr/bin/lex
```

10.16.2. Contents of Flex

Installed programs:	flex, flex++ (link to flex), lex
Installed libraries:	libfl.[a,so], libfl_pic.[a,so]
Installed directory:	/usr/share/doc/flex-2.5.39

Short Descriptions

flex	A tool for generating programs that recognize patterns in text; it allows for the versatility to specify the rules for pattern-finding, eradicating the need to develop a specialized program
flex++	Link to flex which makes it generate C++ scanner classes
lex	A script that runs flex in lex emulation mode
libfl	The flex library

`libfl_pic` The flex library

10.17. Bison-3.0.2

The Bison package contains a parser generator.

10.17.1. Installation of Bison

Prepare Bison for compilation:

```
M4=m4 ./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.17.2. Contents of Bison

Installed programs:	bison, yacc
Installed library:	liby.a
Installed directory:	/usr/share/bison

Short Descriptions

bison Generates, from a series of rules, a program for analyzing the structure of text files; Bison is a replacement for Yacc (Yet Another Compiler Compiler)

yacc A wrapper for **bison**, meant for programs that still call **yacc** instead of **bison**; it calls **bison** with the `-y` option

`liby.a` The Yacc library containing implementations of Yacc-compatible `yyerror` and `main` functions; this library is normally not very useful, but POSIX requires it

10.18. Binutils-2.24

The Binutils package contains a linker, an assembler, and other tools for handling object files.

10.18.1. Installation of Binutils

Verify that the PTYs are working properly inside the build environment. Check that everything is set up correctly by performing a simple test:

```
expect -c "spawn ls"
```

This command should give the following output:

```
spawn ls
```

If, instead, it gives a message saying to create more ptys, then the environment is not set up for proper PTY operation. This issue needs to be resolved before running the test suites for Binutils and GCC.

The Binutils documentation recommends building Binutils outside of the source directory in a dedicated build directory:

```
mkdir -v ../binutils-build
cd ../binutils-build
```

Prepare Binutils for compilation:

```
CC="gcc -isystem /usr/include" \
LDFLAGS="-Wl,-rpath-link,/usr/lib:/lib" \
  ../binutils-2.24/configure --prefix=/usr \
  --libdir=/usr/lib --enable-shared \
  --disable-multilib --enable-64-bit-bfd
```

Compile the package:

```
make tooldir=/usr
```



Important

During `make tooldir=/usr` you may receive the following error message. It is safe to ignore.

```
WARNING: `flex' is missing on your system. You should only
need it if you modified a `.l' file. You may need the `Flex'
package in order for those modifications to take effect. You
can get `Flex' from any GNU archive site.
```

The meaning of the make parameter:

```
tooldir=/usr
```

Normally, the `tooldir` (the directory where the executables will ultimately be located) is set to `$(exec_prefix)/$(target_alias)`. Because this is a custom system, this target-specific directory in `/usr` is not required.

**Important**

The test suite for Binutils is considered critical. Do not skip it under any circumstance.

The **ld** test suite accesses `/lib64/ld-linux-x86-64.so` in some of the tests. The following symbolic link will allow this:

```
ln -sv /lib /lib64
```

Test the results:

```
make check
```

Now remove the temporary symlink:

```
rm -v /lib64
```

Now that the tests have completed, remove the symlinks in `/usr/lib64` - they should be the only things in that directory, so we can remove it without force:

```
rm -v /usr/lib64/libstd*so*
rmdir -v /usr/lib64
```

Install the package:

```
make tooldir=/usr install
```

10.18.2. Contents of Binutils

Installed programs:	addr2line, ar, as, c++filt, elfedit, gprof, ld, ld.bfd, nm, objcopy, objdump, ranlib, readelf, size, strings, strip
Installed libraries:	libbfd.[a,so], libopcodes.[a,so]
Installed directory:	/usr/lib/ldscripts

Short Descriptions

addr2line	Translates program addresses to file names and line numbers; given an address and the name of an executable, it uses the debugging information in the executable to determine which source file and line number are associated with the address
ar	Creates, modifies, and extracts from archives
as	An assembler that assembles the output of gcc into object files
c++filt	Used by the linker to de-mangle C++ and Java symbols and to keep overloaded functions from clashing
elfedit	Updates the ELF header of ELF files
gprof	Displays call graph profile data
ld	A linker that combines a number of object and archive files into a single file, relocating their data and tying up symbol references
ld.bfd	Hard link to ld
nm	Lists the symbols occurring in a given object file

objcopy	Translates one type of object file into another
objdump	Displays information about the given object file, with options controlling the particular information to display; the information shown is useful to programmers who are working on the compilation tools
ranlib	Generates an index of the contents of an archive and stores it in the archive; the index lists all of the symbols defined by archive members that are relocatable object files
readelf	Displays information about ELF type binaries
size	Lists the section sizes and the total size for the given object files
strings	Outputs, for each given file, the sequences of printable characters that are of at least the specified length (defaulting to four); for object files, it prints, by default, only the strings from the initializing and loading sections while for other types of files, it scans the entire file
strip	Discards symbols from object files
<code>libbfd</code>	The Binary File Descriptor library
<code>libopcodes</code>	A library for dealing with opcodes—the “readable text” versions of instructions for the processor; it is used for building utilities like objdump .

10.19. GCC-4.8.3

The GCC package contains the GNU compiler collection, which includes the C and C++ compilers.

10.19.1. Installation of GCC

The following patch contains a number of updates to the 4.8.3 branch by the GCC developers:

```
patch -Np1 -i ../gcc-4.8.3-branch_update-1.patch
```

Apply the following patch so that GCC links to `/lib` instead of `/lib64`:

```
patch -Np1 -i ../gcc-4.8.3-pure64-1.patch
```

Apply a `sed` substitution that will suppress the execution of the `fixincludes` script:

```
sed -i 's@\.\/fixinc\.sh@-c true@' gcc/Makefile.in
```

The GCC documentation recommends building GCC outside of the source directory in a dedicated build directory:

```
mkdir -v ../gcc-build
cd ../gcc-build
```

Prepare GCC for compilation:

```
SED=sed CC="gcc -isystem /usr/include" \
CXX="g++ -isystem /usr/include" \
LDFLAGS="-Wl,-rpath-link,/usr/lib:/lib" \
  ../gcc-4.8.3/configure --prefix=/usr \
  --libexecdir=/usr/lib --enable-shared --enable-threads=posix \
  --enable-__cxa_atexit --enable-c99 --enable-long-long \
  --enable-clocale=gnu --enable-languages=c,c++ \
  --disable-multilib --disable-libstdcxx-pch \
  --with-system-zlib --enable-checking=release --enable-libstdcxx-time
```

The meaning of the new configure option:

```
SED=sed
```

This prevents a hard-coded path to `/tools/bin/sed` in the `fixincl` program.

Compile the package:

```
make
```



Important

The test suite for GCC is considered critical. Do not skip it under any circumstance.

Increase the stack size prior to running the tests:

```
ulimit -s 32768
```

Test the results, but do not stop at errors:

```
make -k check
```

The `-k` flag is used to make the test suite run through to completion and not stop at the first failure. The GCC test suite is very comprehensive and is almost guaranteed to generate a few failures. To receive a summary of the test suite results, run:

```
../gcc-4.8.3/contrib/test_summary
```

For only the summaries, pipe the output through `grep -A7 Summ`.

A few unexpected failures cannot always be avoided. The GCC developers are usually aware of these issues, but have not resolved them yet.

Install the package:

```
make install
```

Install the `libiberty` header file that is needed by some packages:

```
cp -v ../gcc-4.8.3/include/libiberty.h /usr/include
```

Some packages expect the C preprocessor to be installed in the `/lib` directory. To support those packages, create this symlink:

```
ln -sv ../usr/bin/cpp /lib
```

Many packages use the name `cc` to call the C compiler. To satisfy those packages, create a symlink:

```
ln -sv gcc /usr/bin/cc
```

Finally, move a misplaced file:

```
mv -v /usr/lib/libstdc++*gdb.py /usr/share/gdb/auto-load/usr/lib
```

10.19.2. Contents of GCC

Installed programs:	<code>c++</code> , <code>cc</code> (link to <code>gcc</code>), <code>cpp</code> , <code>g++</code> , <code>gcc</code> , <code>gcov</code>
Installed libraries:	<code>libasan.[a,so]</code> , <code>libatomic.[a,so]</code> , <code>libgcc.a</code> , <code>libgcc_eh.a</code> , <code>libgcc_s.so</code> , <code>libgcov.a</code> , <code>libgomp.[a,so]</code> , <code>libiberty.a</code> , <code>libitm.[a,so]</code> , <code>liblto_plugin.so</code> , <code>libmudflap.[a,so]</code> , <code>libmudflapth.[a,so]</code> , <code>libquadmath.[a,so]</code> , <code>libssp.[a,so]</code> , <code>libssp_nonshared.a</code> , <code>libstdc++.a</code> , <code>libstdc++.so</code> , <code>libsupc++.[a,so]</code> , <code>libtsan.[a,so]</code>
Installed directories:	<code>/usr/include/c++</code> , <code>/usr/lib/gcc</code> , <code>/usr/share/gcc-4.8.3</code>

Short Descriptions

cc	The C compiler
cpp	The C preprocessor; it is used by the compiler to expand the <code>#include</code> , <code>#define</code> , and similar statements in the source files
c++	The C++ compiler
g++	The C++ compiler
gcc	The C compiler
gcov	A coverage testing tool; it is used to analyze programs to determine where optimizations will have the most effect

<code>libasan</code>	The Address Sanitizer runtime library
<code>libatomic</code>	A GCC support runtime library for atomic operations not supported by hardware
<code>libgcc</code>	Contains run-time support for gcc
<code>libgcov</code>	Library that is linked into a program when gcc is instructed to enable profiling
<code>libgomp</code>	GNU implementation of the OpenMP API for multi-platform shared-memory parallel programming in C/C++ and Fortran
<code>libiberty</code>	Contains routines used by various GNU programs, including getopt , obstack , strerror , strtol , and strtoul
<code>libitm</code>	The GNU Transactional Memory Library, which provides transaction support for accesses to a process's memory
<code>liblto_plugin</code>	Runtime library for GCC's link-time optimization plugin
<code>libmudflap</code>	The libmudflap libraries are used by GCC for instrumenting pointer and array dereferencing operations.
<code>libquadmath</code>	The GCC Quad-Precision Math Library API
<code>libssp</code>	Contains routines supporting GCC's stack-smashing protection functionality
<code>libstdc++</code>	The standard C++ library
<code>libsupc++</code>	Provides supporting routines for the C++ programming language
<code>libtsan</code>	The Thread Sanitizer runtime library

10.20. Attr-2.4.47

Attr is a library for getting and setting POSIX.1e (formerly POSIX 6) draft 15 capabilities.

10.20.1. Installation of Attr

Apply a sed to install the documentation with a versioned directory:

```
sed -i -e 's|/@pkg_name@|&-@pkg_version@|' include/builddefs.in
```

Prepare Attr for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

The tests need to run with a filesystem which supports extended attributes. Test the results:

```
make -j1 tests root-tests
```

Install the package:

```
make install install-dev install-lib
```

Move the shared library to `/lib` and recreate the symlink in `/usr/lib` :

```
mv -v /usr/lib/libattr.so.* /lib
ln -sfv ../../lib/$(readlink /usr/lib/libattr.so) /usr/lib/libattr.so
```

Set the proper permissions on the shared library:

```
chmod 755 -v /lib/libattr.so.1.1.0
```

10.20.2. Contents of Attr

Installed programs:	attr, getfattr, setfattr
Installed libraries:	libattr.[a,so]
Installed directories:	/usr/include/attr, /usr/share/doc/attr-2.4.47

Short Descriptions

attr	Manage extended attributes on filesystem objects
getfattr	Get extended attributes of filesystem objects
setfattr	Set extended attributes of filesystem objects
libattr	Library to manage extended attributes on filesystem objects

10.21. ACL-2.2.52

ACL is a library for getting and setting POSIX Access Control Lists.

10.21.1. Installation of ACL

Apply a sed to install the documentation with a versioned directory:

```
sed -i -e 's|/@pkg_name@|&-@pkg_version@|' include/builddefs.in
```

Apply a sed to fix a few tests:

```
sed -i "s:| sed.*::g" test/{sbits-restore,cp,misc}.test
```

Prepare ACL for compilation:

```
./configure --prefix=/usr --libexecdir=/usr/lib
```

Compile the package:

```
make
```

The Acl tests need a filesystem which supports access controls after Coreutils has been built with the Acl libraries. Return to this section after Coreutils has been installed. Test the results:

```
make tests
```

Install the package:

```
make install install-dev install-lib
```

Move the shared library to /lib and recreate the symlink in /usr/lib:

```
mv -v /usr/lib/libacl.so.* /lib
ln -sfv ../../lib/libacl.so.1 /usr/lib/libacl.so
```

Set the proper permissions on the shared library:

```
chmod 755 -v /lib/libacl.so.1.1.0
```

10.21.2. Contents of ACL

Installed programs:	chacl, getfacl, setfacl
Installed libraries:	libattr.[a,so]
Installed directories:	/usr/include/acl, /usr/share/doc/acl-2.2.52

Short Descriptions

chacl	Changes the access control list of a file or directory
getfacl	Get file access control lists
setfacl	Set file access control lists
libacl	Library to manage access control lists

10.22. Sed-4.2.2

The Sed package contains a stream editor.

10.22.1. Installation of Sed

Prepare Sed for compilation:

```
./configure --prefix=/usr --bindir=/bin \  
--docdir=/usr/share/doc/sed-4.2.2
```

Compile the package:

```
make
```

Build the HTML documentation:

```
make html
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

Install the HTML documentation:

```
make -C doc install-html
```

10.22.2. Contents of Sed

Installed program:	sed
Installed directory:	/usr/share/doc/sed-4.2.2

Short Descriptions

sed Filters and transforms text files in a single pass

10.23. Ncurses-5.9

The Ncurses package contains libraries for terminal-independent handling of character screens.

10.23.1. Installation of Ncurses

The following patch contains updates from the 5.9 branch by the Ncurses developers:

```
patch -Np1 -i ../ncurses-5.9-branch_update-4.patch
```

Prepare Ncurses for compilation:

```
./configure --prefix=/usr --libdir=/lib \
  --with-shared --without-debug --enable-widex \
  --with-manpage-format=normal \
  --with-default-terminfo-dir=/usr/share/terminfo
```

Compile the package:

```
make
```

This package has a test suite, but it can only be run after the package is installed. The tests are in the `test/` directory. See the README file in that directory for details.

Install the package:

```
make install
```

Move the Ncurses static libraries to the proper location:

```
mv -v /lib/lib{panelw,menuw,formw,ncursesw,ncurses++w}.a /usr/lib
```

Create symlinks in `/usr/lib`:

```
ln -svf ../../lib/${readlink /lib/libncursesw.so} /usr/lib/libncursesw.so
ln -svf ../../lib/${readlink /lib/libmenuw.so} /usr/lib/libmenuw.so
ln -svf ../../lib/${readlink /lib/libpanelw.so} /usr/lib/libpanelw.so
ln -svf ../../lib/${readlink /lib/libformw.so} /usr/lib/libformw.so
rm -v /lib/lib{ncursesw,menuw,panelw,formw}.so
```

Many packages that use Ncurses will compile just fine against the widechar libraries, but won't know to look for them. Create linker scripts and symbolic links to allow older and non-widec compatible programs to build properly:

```
for lib in curses ncurses form panel menu ; do
  echo "INPUT(-l${lib}w)" > /usr/lib/lib${lib}.so
  ln -sfv lib${lib}w.a /usr/lib/lib${lib}.a
done
ln -sfv libncursesw.so /usr/lib/libcursesw.so
ln -sfv libncursesw.a /usr/lib/libcursesw.a
ln -sfv libncurses++w.a /usr/lib/libncurses++w.a
ln -sfv ncursesw5-config /usr/bin/ncurses5-config
```

10.23.2. Contents of Ncurses

Installed programs:	captoinfo (link to tic), clear, infocmp, infotocap (link to tic), ncursesw5-config, reset (link to tset), tabs, tic, toe, tput, tset
Installed libraries:	libcursesw.so (link to libncursesw.so), libformw.[a,so], libmenuw.[a,so], libncursesw.a, libncursesw.[a,so], libpanelw.[a,so]
Installed directories:	/usr/share/tabset, /usr/share/terminfo

Short Descriptions

captoinfo	Converts a termcap description into a terminfo description
clear	Clears the screen, if possible
infocmp	Compares or prints out terminfo descriptions
infotocap	Converts a terminfo description into a termcap description
ncursesw5-config	Provides configuration information for ncurses
reset	Reinitializes a terminal to its default values
tabs	Sets and clears tab stops on a terminal
tic	The terminfo entry-description compiler that translates a terminfo file from source format into the binary format needed for the ncurses library routines. A terminfo file contains information on the capabilities of a certain terminal
toe	Lists all available terminal types, giving the primary name and description for each
tput	Makes the values of terminal-dependent capabilities available to the shell; it can also be used to reset or initialize a terminal or report its long name
tset	Can be used to initialize terminals
libcursesw	A link to libncursesw
libncursesw	Contains functions to display text in many complex ways on a terminal screen; a good example of the use of these functions is the menu displayed during the kernel's make menuconfig
libformw	Contains functions to implement forms
libmenuw	Contains functions to implement menus
libpanelw	Contains functions to implement panels

10.24. Pkg-config-lite-0.28-1

Pkg-config-lite is a tool to help you insert the correct compiler options on the command line when compiling applications and libraries.

10.24.1. Installation of Pkg-config-lite

Prepare Pkg-config-lite for compilation:

```
./configure --prefix=/usr --docdir=/usr/share/doc/pkg-config-0.28-1
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.24.2. Contents of Pkg-config-lite

Installed programs:	pkg-config
Installed directory:	/usr/share/doc/pkg-config-0.28-1

Short Descriptions

pkg-config The **pkg-config** program is used to retrieve information about installed libraries in the system. It is typically used to compile and link against one or more libraries.

10.25. Shadow-4.1.5.1

The Shadow package contains programs for handling passwords in a secure way.

10.25.1. Installation of Shadow



Note

If you would like to enforce the use of strong passwords, refer to <http://cblfs.cross-lfs.org/index.php/Cracklib> for installing Cracklib prior to building Shadow. Then add `--with-libcrack` to the **configure** command below.

Disable the installation of the **groups** and **nologin** programs and their man pages, as better versions of these programs are provided by Coreutils and Util-linux:

```
sed -i src/Makefile.in \
  -e 's/groups$(EXEEXT) //' -e 's/= nologin$(EXEEXT)/= /'
find man -name Makefile.in -exec sed -i \
  -e 's/man1\/groups\.1 //' -e 's/man8\nologin\.8 //' '{} ' \;
```

Prepare Shadow for compilation:

```
./configure --sysconfdir=/etc
```

The meaning of the configure options:

```
--sysconfdir=/etc
```

Tells Shadow to install its configuration files into `/etc`, rather than `/usr/etc`.

Compile the package:

```
make
```

This package does not come with a test suite.

Install the package:

```
make install
```

Instead of using the default `crypt` method, use the more secure `SHA512` method of password encryption, which also allows passwords longer than 8 characters. It is also necessary to change the obsolete `/var/spool/mail` location for user mailboxes that Shadow uses by default to the `/var/mail` location used currently. Use the following `sed` command to make these changes to the appropriate configuration file:

```
sed -i /etc/login.defs \
  -e 's@#\ (ENCRYPT_METHOD \) .*@\1SHA512@' \
  -e 's@/var/spool/mail@/var/mail@'
```



Note

If you built Shadow with Cracklib support, execute this `sed` to correct the path to the Cracklib dictionary:

```
sed -i 's@DICTPATH.*@DICTPATH\t/lib/cracklib/pw_dict@' /etc/login.defs
```

Move a misplaced program to its proper location:

```
mv -v /usr/bin/passwd /bin
```

The **login** program will write to `/var/log/lastlog`, if it exists, to record the date and time of the latest successful login for each user. This log file is not created automatically if it does not already exist, so we will create it now and give it appropriate ownership and permissions:

```
touch /var/log/lastlog
chgrp -v utmp /var/log/lastlog
chmod -v 664 /var/log/lastlog
```

10.25.2. Configuring Shadow

This package contains utilities to add, modify, and delete users and groups; set and change their passwords; and perform other administrative tasks. For a full explanation of what *password shadowing* means, see the `doc/HOWTO` file within the unpacked source tree. If using Shadow support, keep in mind that programs which need to verify passwords (display managers, FTP programs, pop3 daemons, etc.) must be Shadow-compliant. That is, they need to be able to work with shadowed passwords.

To enable shadowed passwords, run the following command:

```
pwconv
```

To enable shadowed group passwords, run:

```
grpconv
```

To view or change the default settings for new user accounts that you create, you can edit `/etc/default/useradd`. See **man useradd** or http://cblfs.cross-lfs.org/index.php/Configuring_for_Adding_Users for more information.

10.25.3. Setting the root password

Choose a password for user `root` and set it by running:

```
passwd root
```

10.25.4. Contents of Shadow

Installed programs:	chage, chfn, chgpaswd, chpasswd, chsh, expiry, faillog, gpaswd, groupadd, groupdel, groupmems, groupmod, grpck, grpconv, grpunconv, lastlog, login, logoutd, newgrp, newusers, passwd, pwck, pwconv, pwunconv, sg (link to newgrp), su, useradd, userdel, usermod, vigr (link to vipw), vipw
Installed directory:	/etc/default

Short Descriptions

chage	Used to change the maximum number of days between obligatory password changes
chfn	Used to change a user's full name and other information
chgpaswd	Used to update group passwords in batch mode

chpasswd	Used to update the passwords of an entire series of user accounts
chsh	Used to change a user's default login shell
expiry	Checks and enforces the current password expiration policy
faillog	Is used to examine the log of login failures, to set a maximum number of failures before an account is blocked, or to reset the failure count
gpasswd	Is used to add and delete members and administrators to groups
groupadd	Creates a group with the given name
groupdel	Deletes the group with the given name
groupmems	Allows a user to administer his/her own group membership list without the requirement of superuser privileges
groupmod	Is used to modify the given group's name or GID
grpck	Verifies the integrity of the group files <code>/etc/group</code> and <code>/etc/gshadow</code>
grpconv	Creates or updates the shadow group file from the normal group file
grpunconv	Updates <code>/etc/group</code> from <code>/etc/gshadow</code> and then deletes the latter
lastlog	Reports the most recent login of all users or of a given user
login	Is used by the system to let users sign on
logoutd	Is a daemon used to enforce restrictions on log-on time and ports
newgrp	Is used to change the current GID during a login session
newusers	Is used to create or update an entire series of user accounts
passwd	Is used to change the password for a user or group account
pwck	Verifies the integrity of the password files <code>/etc/passwd</code> and <code>/etc/shadow</code>
pwconv	Creates or updates the shadow password file from the normal password file
pwunconv	Updates <code>/etc/passwd</code> from <code>/etc/shadow</code> and then deletes the latter
sg	Executes a given command while the user's GID is set to that of the given group
su	Runs a shell with substitute user and group IDs
useradd	Creates a new user with the given name, or updates the default new-user information
userdel	Deletes the given user account
usermod	Is used to modify the given user's login name, User Identification (UID), shell, initial group, home directory, etc.
vigr	Edits the <code>/etc/group</code> or <code>/etc/gshadow</code> files
vipw	Edits the <code>/etc/passwd</code> or <code>/etc/shadow</code> files

10.26. Util-linux-2.24.2

The Util-linux package contains miscellaneous utility programs. Among them are utilities for handling file systems, consoles, partitions, and messages.

10.26.1. FHS compliance notes

The FHS recommends using the `/var/lib/hwclock` directory instead of the usual `/etc` directory as the location for the `adjtime` file. To make the `hwclock` program FHS-compliant, run the following:

```
sed -i -e 's@etc/adjtime@var/lib/hwclock/adjtime@g' \
    $(grep -rl '/etc/adjtime' .)
mkdir -pv /var/lib/hwclock
```

10.26.2. Installation of Util-linux



Note

`findmnt`, and `lsblk` can utilize `libudev` for WWN and serial number information. If this is desired, rebuild Util-linux after Section 10.64, “Systemd-213”

Prepare Util-linux for compilation:

```
./configure --enable-write --docdir=/usr/share/doc/util-linux-2.24.2
```

The meaning of the configure options:

`--enable-write`

This option allows the `write` program to be installed.

Compile the package:

```
make
```

To test the results, issue:

```
chown -Rv nobody . &&
su nobody -s /bin/bash -c "PATH=$PATH make -k check"
```

Install the package:

```
make install
```

10.26.3. Contents of Util-linux

Installed programs:	addpart, agetty, blkdiscard, blkid, blockdev, cal, cfdisk, chcpu, chrt, col, colcrt, colrm, column, ctrlaltdel, cytone, delpart, dmesg, eject, fallocate, fdformat, fdisk, findfs, findmnt, flock, fsck, fsck.cramfs, fsck.minix, fsfreeze, fstrim, getopt, hexdump, hwclock, ionice, ipcmk, ipcrm, ipcs, isosize, kill, last, lastb (link to last), ldattach, logger, look, losetup, lsblk, lscpu, lslocks, mcookie, mesg, mkfs, mkfs.bfs, mkfs.cramfs, mkfs.minix, mkswap, more, mount, mountpoint, namei, nologin, nsenter, partx, pg, pivot_root, prlimit, raw, readprofile, rename, renice, resizepart, rev, rtcwake, script, scriptreplay, setarch, setsid, setterm, sfdisk, sulogin, swaplabel, swapoff, swapon, switch_root, tailf, taskset, ul, umount, unshare, utmpdump, uuuid, uuidgen, wall, wdctl, whereis, wipefs, write
Installed libraries:	libblkid.[a,so], libmount.[a,so], libuuid.[a,so]
Installed directories:	/usr/include/blkid, /usr/include/libmount, /usr/include/uuid, /usr/share/bash-completion, /usr/share/doc/util-linux-2.24.2/getopt, /var/lib/hwclock

Short Descriptions

addpart	Informs the kernel of a new partition
agetty	Opens a tty port, prompts for a login name, and then invokes the login program
blkdiscard	Discards sectors on a device
blkid	A command line utility to locate and print block device attributes
blockdev	Allows users to call block device ioctls from the command line
cal	Displays a simple calendar
cfdisk	Manipulates the partition table of the given device
chcpu	Utility to configure CPUs
chrt	Manipulates real-time attributes of a process
col	Filters out reverse line feeds
colcrt	Filters nroff output for terminals that lack some capabilities, such as overstriking and half-lines
colrm	Filters out the given columns
column	Formats a given file into multiple columns
ctrlaltdel	Sets the function of the Ctrl+Alt+Del key combination to a hard or a soft reset
cytone	Tunes the parameters of the serial line drivers for Cyclades cards
delpart	Asks the kernel to remove a partition
dmesg	Dumps the kernel boot messages
eject	Eject removable media
fallocate	Preallocates space to a file
fdformat	Low-level formats a floppy disk
fdisk	Manipulates the partition table of the given device
findfs	Finds a file system by label or Universally Unique Identifier (UUID)
findmnt	Lists mounted filesystems or searches for a filesystem

flock	Acquires a file lock and then executes a command with the lock held
fsck	Is used to check, and optionally repair, file systems
fsck.cramfs	Performs a consistency check on the Cramfs file system on the given device
fsck.minix	Performs a consistency check on the Minix file system on the given device
fsfreeze	Suspends and resumes access to a filesystem
fstrim	Discards unused blocks on a mounted filesystem
getopt	Parses options in the given command line
hexdump	Dumps the given file in hexadecimal or in another given format
hwclock	Reads or sets the system's hardware clock, also called the Real-Time Clock (RTC) or Basic Input-Output System (BIOS) clock
ionice	Gives and sets program I/O scheduling class and priority
ipcmk	Creates various IPC resources
ipcrm	Removes the given Inter-Process Communication (IPC) resource
ipcs	Provides IPC status information
isozsize	Reports the size of an iso9660 file system
kill	Send a signal to a process
last	Shows which users last logged in (and out), searching back through the <code>/var/log/wtmp</code> file; it also shows system boots, shutdowns, and run-level changes
lastb	Shows the failed login attempts, as logged in <code>/var/log/btmp</code>
ldattach	Attaches a line discipline to a serial line
logger	Enters the given message into the system log
look	Displays lines that begin with the given string
losetup	Sets up and controls loop devices
lsblk	Prints information about block devices
lscpu	Prints CPU architecture information
lslocks	Lists local system locks
mcookie	Generates magic cookies (128-bit random hexadecimal numbers) for xauth
mesg	Controls whether other users can send messages to the current user's terminal
mkfs	Builds a file system on a device (usually a hard disk partition)
mkfs.bfs	Creates a Santa Cruz Operations (SCO) bfs file system
mkfs.cramfs	Creates a cramfs file system
mkfs.minix	Creates a Minix file system
mkswap	Initializes the given device or file to be used as a swap area
more	A filter for paging through text one screen at a time
mount	Attaches the file system on the given device to a specified directory in the file-system tree
mountpoint	Tells you whether or not a directory is a mount point.
namei	Shows the symbolic links in the given pathnames

nologin	Displays a message that an account is not available. Designed to be used as the default shell for accounts that have been disabled
nsenter	Runs a program with namespaces of other processes
partx	Tells the kernel about the presence and numbering of on-disk partitions
pg	Displays a text file one screen full at a time
pivot_root	Makes the given file system the new root file system of the current process
prlimit	Gets and sets a process' resource limits
raw	Binds a Linux raw character device to a block device
readprofile	Reads kernel profiling information
rename	Renames the given files, replacing a given string with another
renice	Alters the priority of running processes
resizepart	Asks the Linux kernel to resize a partition
rev	Reverses the lines of a given file
rtcwake	Enters a system sleep state until a specified wakeup time
script	Makes a typescript of a terminal session
scriptreplay	Plays back typescripts created by script
setarch	Changes reported architecture in new program environment and sets personality flags
setsid	Runs the given program in a new session
setterm	Sets terminal attributes
sfdisk	A disk partition table manipulator
sulogin	Allows <i>root</i> to log in; it is normally invoked by init when the system goes into single user mode
swapon	Enables devices and files for paging and swapping and lists the devices and files currently in use
swapoff	Disables devices and files for paging and swapping
swapon	Enables devices and files for paging and swapping and lists the devices and files currently in use
switch_root	Switches to another filesystem as the root of the mount tree
tailf	Tracks the growth of a log file. Displays the last 10 lines of a log file, then continues displaying any new entries in the log file as they are created
taskset	Retrieves or sets a process's CPU affinity
ul	A filter for translating underscores into escape sequences indicating underlining for the terminal in use
umount	Disconnects a file system from the system's file tree
unshare	Runs a program with some namespaces unshared from parent
utmpdump	Displays the content of the given login file in a more user-friendly format
uudd	A daemon used by the UUID library to generate time-based UUIDs in a secure and guranteed-unique fashion.
uuidgen	Creates new UUIDs. Each new UUID can reasonably be considered unique among all UUIDs created, on the local system and on other systems, in the past and in the future

wall	Writes a message to all logged-in users
wdctl	Show hardware watchdog status
whereis	Reports the location of the binary, source, and man page for the given command
wipefs	Wipes a filesystem signature from a device
write	Sends a message to the given user <i>if</i> that user has not disabled receipt of such messages
libblkid	Contains routines for device identification and token extraction
libmount	Contains routines for parsing the <code>/etc/fstab</code> , <code>/etc/mtab</code> , and <code>/proc/self/mountinfo</code> files, managing <code>/etc/mtab</code> , and configuring various mount options
libuuid	Contains routines for generating unique identifiers for objects that may be accessible beyond the local system

10.27. Procps-ng-3.3.9

The Procps-ng package contains programs for monitoring processes.

10.27.1. Installation of Procps-ng

Prepare procps-ng for compilation:

```
./configure --prefix=/usr --exec-prefix= \
  --libdir=/usr/lib --docdir=/usr/share/doc/procps-ng-3.3.9 \
  --disable-kill
```

The meaning of the configure options:

`--disable-kill`

This switch disables building the **kill** program - a better version was installed by the Util-linux package.

Compile the package:

```
make
```



Note

When using the boot method, two tests will fail if the hostname is not set. If you have booted the temporary system, and want to run the test suite, run the following command:

```
hostname clfs
```

If running the testsuite, first disable a test which fails when scripting does not use a tty device:

```
sed -i -r 's|(pmap_initname)\\\|\\\|\\\|\\\|' testsuite/pmap.test/pmap.exp
make check
```

Install the package:

```
make install
```

Move essential files to a location that can be found if `/usr` is not mounted:

```
mv -v /usr/bin/pidof /bin
mv -v /usr/lib/libprocps.so.* /lib
ln -sfv ../../lib/$(readlink /usr/lib/libprocps.so) /usr/lib/libprocps.so
```

10.27.2. Contents of Procps-ng

Installed programs:	free, pgrep, pidof, pkill, pmap, ps, pwdx, slabtop, sysctl, tload, top, uptime, vmstat, w, watch
Installed library:	libprocps.{a,so}
Installed directories:	/usr/include/proc, /usr/share/doc/procps-ng-3.3.9

Short Descriptions

free Reports the amount of free and used memory (both physical and swap memory) in the system

pgrep	Looks up processes based on their name and other attributes
pidof	Reports the PIDs of the given programs
pkill	Signals processes based on their name and other attributes
pmap	Reports the memory map of the given process
ps	Lists the current running processes
pwdx	Reports the current working directory of a process
slabtop	Displays detailed kernel slab cache information in real time
sysctl	Modifies kernel parameters at run time
tload	Prints a graph of the current system load average
top	Displays a list of the most CPU intensive processes; it provides an ongoing look at processor activity in real time
uptime	Reports how long the system has been running, how many users are logged on, and the system load averages
vmstat	Reports virtual memory statistics, giving information about processes, memory, paging, block Input/Output (IO), traps, and CPU activity
w	Shows which users are currently logged on, where, and since when
watch	Runs a given command repeatedly, displaying the first screen-full of its output; this allows a user to watch the output change over time
libprocps	Contains the functions used by most programs in this package

10.28. E2fsprogs-1.42.9

The E2fsprogs package contains the utilities for handling the `ext2` file system. It also supports the `ext3` and `ext4` journaling file systems.

10.28.1. Installation of E2fsprogs

The E2fsprogs documentation recommends that the package be built in a subdirectory of the source tree:

```
mkdir -v build
cd build
```

Prepare E2fsprogs for compilation:

```
../configure --prefix=/usr --with-root-prefix="" \
  --enable-elf-shlibs --disable-libblkid \
  --disable-libuuid --disable-fsck \
  --disable-uidd
```

The meaning of the configure options:

`--with-root-prefix=""`

Certain programs (such as the `e2fsck` program) are considered essential programs. When, for example, `/usr` is not mounted, these programs still need to be available. They belong in directories like `/lib` and `/sbin`. If this option is not passed to E2fsprogs' configure, the programs are installed into the `/usr` directory.

`--enable-elf-shlibs`

This creates the shared libraries which some programs in this package use.

`--disable-*`

This prevents E2fsprogs from building and installing the `libuuid` and `libblkid` libraries, the `uidd` daemon, and the `fsck` wrapper, as Util-Linux installed all of them earlier.

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the binaries, documentation and shared libraries:

```
make install
```

Install the static libraries and headers:

```
make install-libs
```


10.28.2. Contents of E2fsprogs

Installed programs:	badblocks, chattr, compile_et, debugfs, dumpe2fs, e2freefrag, e2fsck, e2image, e2initrd_helper, e2label, e2undo, e4defrag, filefrag, fsck.ext2, fsck.ext3, fsck.ext4, fsck.ext4dev, logsave, lsattr, mk_cmds, mke2fs, mkfs.ext2, mkfs.ext3, mkfs.ext4, mkfs.ext4dev, mklost+found, resize2fs, tune2fs
Installed libraries:	libcom_err.[a,so], libe2p.[a,so], libext2fs.[a,so], libss.[a,so], libquota.a
Installed directories:	/usr/include/e2p, /usr/include/et, /usr/include/ext2fs, /usr/include/quota, /usr/include/ss, /usr/share/et, /usr/share/ss

Short Descriptions

badblocks	Searches a device (usually a disk partition) for bad blocks
chattr	Changes the attributes on a Linux file system
compile_et	An error table compiler; it converts a table of error-code names and messages into a C source file suitable for use with the <code>com_err</code> library
debugfs	A file system debugger; it can be used to examine and change the state of an <code>ext2</code> file system
dumpe2fs	Prints the super block and blocks group information for the file system present on a given device
e2freefrag	Reports free space fragmentation information
e2fsck	Is used to check, and optionally repair <code>ext2</code> , <code>ext3</code> and <code>ext4</code> file systems
e2image	Is used to save critical <code>ext2</code> file system data to a file
e2initrd_helper	Prints the FS type of a given filesystem, given either a device name or label
e2label	Displays or changes the file system label on the <code>ext2</code> file system present on a given device
e2undo	Replays an undo log for an <code>ext2/ext3/ext4</code> filesystem
e4defrag	Online defragmenter for <code>ext4</code> filesystems
filefrag	Reports on how badly fragmented a particular file might be
fsck.ext2	By default checks <code>ext2</code> file systems
fsck.ext3	By default checks <code>ext3</code> file systems
fsck.ext4	By default checks <code>ext4</code> file systems
fsck.ext4dev	By default checks <code>ext4dev</code> file systems
logsave	Saves the output of a command in a log file
lsattr	Lists the attributes of files on a second extended file system
mk_cmds	Converts a table of command names and help messages into a C source file suitable for use with the <code>libss</code> subsystem library
mke2fs	Creates an <code>ext2</code> , <code>ext3</code> or <code>ext4</code> file system on the given device
mkfs.ext2	By default creates <code>ext2</code> file systems
mkfs.ext3	By default creates <code>ext3</code> file systems
mkfs.ext4	By default creates <code>ext4</code> file systems
mkfs.ext4dev	By default creates <code>ext4dev</code> file systems

mklost+found	Used to create a <code>lost+found</code> directory on an <code>ext2</code> file system; it pre-allocates disk blocks to this directory to lighten the task of e2fsck
resize2fs	Can be used to enlarge or shrink an <code>ext2</code> file system
tune2fs	Adjusts tunable file system parameters on an <code>ext2</code> file system
<code>libcom_err</code>	The common error display routine
<code>libe2p</code>	Used by dumpe2fs , chattr , and lsattr
<code>libext2fs</code>	Contains routines to enable user-level programs to manipulate an <code>ext2</code> file system
<code>libquota</code>	Provides an interface for creating and updating quota files and <code>ext4</code> superblock fields
<code>libss</code>	Used by debugfs

10.29. Libcap-2.24

Libcap is a library for getting and setting POSIX.1e (formerly POSIX 6) draft 15 capabilities.

10.29.1. Installation of Libcap

Compile the package:

```
make
```

This package does not come with a test suite.

Install the package:

```
make RAISE_SETFCAP=no install
chmod -v 755 /lib/libcap.so.2.24
ln -sfv ../../lib/$(readlink /lib/libcap.so) /usr/lib/libcap.so
rm -v /lib/libcap.so
mv -v /lib/libcap.a /usr/lib
```

The meaning of the make option:

RAISE_SETFCAP=no

This prevents **setcap** from being run on itself, which will fail if the kernel or file system does not support extended capabilities.

10.29.2. Contents of Libcap

Installed programs: capsh, getcap, getpcaps, setcap
Installed libraries: libcap.[a,so]

Short Descriptions

capsh	Capability support and use can be explored and constrained with this tool
getcap	Examines file capabilities
getpcaps	Displays the capabilities on the queried process(es)
setcap	Sets file capabilities
libcap	Library for setting and clearing POSIX.1e capabilities

10.30. Coreutils-8.22

The Coreutils package contains utilities for showing and setting the basic system characteristics.

10.30.1. Installation of Coreutils

A known issue with the `uname` program from this package is that the `-p` switch always returns unknown. The following patch fixes this behavior for all architectures:

```
patch -Np1 -i ../coreutils-8.22-uname-1.patch
```

Now prepare Coreutils for compilation:

```
FORCE_UNSAFE_CONFIGURE=1 \  
./configure --prefix=/usr \  
--enable-no-install-program=kill,uptime \  
--enable-install-program=hostname --libexecdir=/usr/lib
```

The meaning of the configure options:

```
FORCE_UNSAFE_CONFIGURE=1
```

Forces Coreutils to compile when using the root user.

Compile the package:

```
make
```

Now the test suite is ready to be run. First, run the tests that are meant to be run as user `root`:

```
make NON_ROOT_USERNAME=nobody check-root
```

The test suite will now be run as the `nobody` user. Some tests require that the user be a member of more than one group. Add a temporary group and make the user `nobody` a part of it so that the tests are not skipped:

```
echo "dummy:x:1000:nobody" >> /etc/group
```

Fix permissions of some files so the non-root user can compile and run the tests:

```
chown -Rv nobody .
```

Then run the remainder of the tests as the `nobody` user:

```
su nobody -s /bin/bash \  
-c "PATH=$PATH make RUN_EXPENSIVE_TESTS=yes -k check || true"
```

Remove the temporary group:

```
sed -i '/dummy/d' /etc/group
```

Install the package:

```
make install
```

Move programs to the locations specified by the FHS:

```
mv -v /usr/bin/{cat,chgrp,chmod,chown,cp,date} /bin
mv -v /usr/bin/{dd,df,echo,false,hostname,ln,ls,mkdir,mknod} /bin
mv -v /usr/bin/{mv,pwd,rm,rmdir,stty,true,uname} /bin
mv -v /usr/bin/chroot /usr/sbin
```

10.30.2. Contents of Coreutils

Installed programs: [, base64, basename, cat, chcon, chgrp, chmod, chown, chroot, cksum, comm, cp, csplit, cut, date, dd, df, dir, dircolors, dirname, du, echo, env, expand, expr, factor, false, fmt, fold, groups, head, hostid, hostname, id, install, join, link, ln, logname, ls, md5sum, mkdir, mkfifo, mknod, mktemp, mv, nice, nl, nohup, nproc, numfmt, od, paste, pathchk, pinky, pr, printenv, printf, ptx, pwd, readlink, realpath, rm, rmdir, runcon, seq, sha1sum, sha224sum, sha256sum, sha384sum, sha512sum, shred, shuf, sleep, sort, split, stat, stdbuf, stty, sum, sync, tac, tail, tee, test, timeout, touch, tr, true, truncate, tsort, tty, uname, unexpand, uniq, unlink, users, vdir, wc, who, whoami, yes

Installed library: libstdbuf.so

Installed directory: /usr/lib/coreutils

Short Descriptions

base64 Base64 encode/decode data and print to standard output

basename Strips any path and a given suffix from a file name

cat Concatenates files to standard output

chcon Changes security context for files and directories

chgrp Changes the group ownership of files and directories

chmod Changes the permissions of each file to the given mode; the mode can be either a symbolic representation of the changes to make or an octal number representing the new permissions

chown Changes the user and/or group ownership of files and directories

chroot Runs a command with the specified directory as the / directory

cksum Prints the Cyclic Redundancy Check (CRC) checksum and the byte counts of each specified file

comm Compares two sorted files, outputting in three columns the lines that are unique and the lines that are common

cp Copies files

csplit Splits a given file into several new files, separating them according to given patterns or line numbers and outputting the byte count of each new file

cut Prints sections of lines, selecting the parts according to given fields or positions

date Displays the current time in the given format, or sets the system date

dd Copies a file using the given block size and count, while optionally performing conversions on it

df Reports the amount of disk space available (and used) on all mounted file systems, or only on the file systems holding the selected files

dir Lists the contents of each given directory (the same as the **ls** command)

dircolors	Outputs commands to set the <code>LS_COLOR</code> environment variable to change the color scheme used by <code>ls</code>
dirname	Strips the non-directory suffix from a file name
du	Reports the amount of disk space used by the current directory, by each of the given directories (including all subdirectories) or by each of the given files
echo	Displays the given strings
env	Runs a command in a modified environment
expand	Converts tabs to spaces
expr	Evaluates expressions
factor	Prints the prime factors of all specified integer numbers
false	Does nothing, unsuccessfully; it always exits with a status code indicating failure
fmt	Reformats the paragraphs in the given files
fold	Wraps the lines in the given files
groups	Reports a user's group memberships
head	Prints the first ten lines (or the given number of lines) of each given file
hostid	Reports the numeric identifier (in hexadecimal) of the host
hostname	Reports or sets the name of the host
id	Reports the effective user ID, group ID, and group memberships of the current user or specified user
install	Copies files while setting their permission modes and, if possible, their owner and group
join	Joins the lines that have identical join fields from two separate files
link	Creates a hard link with the given name to a file
ln	Makes hard links or soft (symbolic) links between files
logname	Reports the current user's login name
ls	Lists the contents of each given directory
md5sum	Reports or checks Message Digest 5 (MD5) checksums
mkdir	Creates directories with the given names
mkfifo	Creates First-In, First-Outs (FIFOs), a “named pipe” in UNIX parlance, with the given names
mknod	Creates device nodes with the given names; a device node is a character special file, a block special file, or a FIFO
mktemp	Creates temporary files in a secure manner; it is used in scripts
mv	Moves or renames files or directories
nice	Runs a program with modified scheduling priority
nl	Numbers the lines from the given files
nohup	Runs a command immune to hangups, with its output redirected to a log file
nproc	Prints the number of processing units available to the current process
numfmt	Converts numbers to or from human-readable strings
od	Dumps files in octal and other formats

paste	Merges the given files, joining sequentially corresponding lines side by side, separated by tab characters
pathchk	Checks if file names are valid or portable
pinky	Is a lightweight finger client; it reports some information about the given users
pr	Paginates and columnates files for printing
printenv	Prints the environment
printf	Prints the given arguments according to the given format, much like the C printf function
ptx	Produces a permuted index from the contents of the given files, with each keyword in its context
pwd	Reports the name of the current working directory
readlink	Reports the value of the given symbolic link
realpath	Prints the resolved path
rm	Removes files or directories
rmdir	Removes directories if they are empty
runcon	Runs a command with specified security context
seq	Prints a sequence of numbers within a given range and with a given increment
sha1sum	Prints or checks 160-bit Secure Hash Algorithm 1 (SHA1) checksums
sha224sum	Prints or checks SHA224 checksums
sha256sum	Prints or checks SHA256 checksums
sha384sum	Prints or checks SHA384 checksums
sha512sum	Prints or checks SHA512 checksums
shred	Overwrites the given files repeatedly with complex patterns, making it difficult to recover the data
shuf	Write a random permutation of the input lines to standard output or a file
sleep	Pauses for the given amount of time
sort	Sorts the lines from the given files
split	Splits the given file into pieces, by size or by number of lines
stat	Displays file or filesystem status
stdbuf	Runs a command with modified buffering operations for its standard streams
stty	Sets or reports terminal line settings
sum	Prints checksum and block counts for each given file
sync	Flushes file system buffers; it forces changed blocks to disk and updates the super block
tac	Concatenates the given files in reverse
tail	Prints the last ten lines (or the given number of lines) of each given file
tee	Reads from standard input while writing both to standard output and to the given files
test or [test	Compares values and checks file types
timeout	Runs a command with a time limit
touch	Changes file timestamps, setting the access and modification times of the given files to the current time; files that do not exist are created with zero length

tr	Translates, squeezes, and deletes the given characters from standard input
true	Does nothing, successfully; it always exits with a status code indicating success
truncate	Shrinks or expands a file to the specified size
tsort	Performs a topological sort; it writes a completely ordered list according to the partial ordering in a given file
tty	Reports the file name of the terminal connected to standard input
uname	Reports system information
unexpand	Converts spaces to tabs
uniq	Discards all but one of successive identical lines
unlink	Removes the given file
users	Reports the names of the users currently logged on
vdir	Is the same as ls -l
wc	Reports the number of lines, words, and bytes for each given file, as well as a total line when more than one file is given
who	Reports who is logged on
whoami	Reports the user name associated with the current effective user ID
yes	Repeatedly outputs “y” or a given string until killed
<code>libstdbuf</code>	Library used by stdbuf

10.31. Iana-Etc-2.30

The Iana-Etc package provides data for network services and protocols.

10.31.1. Installation of Iana-Etc

The following patch contains xml files which provide updates to the services and protocol files:

```
xzcat ../iana-etc-2.30-numbers_update-20140202-2.patch.xz | patch -Np1 -i -
```

The following command converts the raw data provided by IANA into the correct formats for the `/etc/protocols` and `/etc/services` data files:

```
make
```

This package does not come with a test suite.

Install the package:

```
make install
```

10.31.2. Contents of Iana-Etc

Installed files: `/etc/protocols, /etc/services`

Short Descriptions

<code>/etc/protocols</code>	Describes the various DARPA Internet protocols that are available from the TCP/IP subsystem
<code>/etc/services</code>	Provides a mapping between friendly textual names for internet services, and their underlying assigned port numbers and protocol types

10.32. Libtool-2.4.2

The Libtool package contains the GNU generic library support script. It wraps the complexity of using shared libraries in a consistent, portable interface.

10.32.1. Installation of Libtool

Prepare Libtool for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.32.2. Contents of Libtool

Installed programs:	libtool, libtoolize
Installed libraries:	libltdl.[a,so]
Installed directories:	/usr/include/libltdl, /usr/share/libtool

Short Descriptions

libtool	Provides generalized library-building support services
libtoolize	Provides a standard way to add libtool support to a package
libltdl	Hides the various difficulties of dlopening libraries

10.33. IPRoute2-3.14.0

The IPRoute2 package contains programs for basic and advanced IPV4-based networking.

10.33.1. Installation of IPRoute2

By default, this package builds the **arpd** program, which is dependent on Berkeley DB. Because **arpd** is not a very common requirement on a base Linux system, remove the dependency on Berkeley DB by using the commands below. If the **arpd** binary is needed, instructions for compiling Berkeley DB can be found in CBLFS at http://cblfs.cross-lfs.org/index.php/Berkeley_DB.

```
sed -i '/^TARGETS/s@arpd@g' misc/Makefile
sed -i '/ARPD/d' Makefile
sed -i 's/arpd.8//' man/man8/Makefile
```

Compile the package:

```
make
```

This package does not come with a test suite.

Install the package:

```
make DOCDIR=/usr/share/doc/iproute2-3.14.0 install
```

10.33.2. Contents of IPRoute2

Installed programs: bridge, ctstat (link to lstat), genl, ifcfg, ifstat, ip, lstat, nstat, routef, routel, rtacct, rtmon, rtpr, rtstat (link to lstat), ss, tc

Installed directories: /etc/iproute2, /usr/lib/tc, /usr/share/doc/iproute2-3.14.0

Short Descriptions

bridge Configures network bridges

ctstat Connection status utility

genl Needs description

ifcfg A shell script wrapper for the **ip** command

ifstat Shows the interface statistics, including the amount of transmitted and received packets by interface

ip The main executable. It has several different functions:

- ip link [device]** allows users to look at the state of devices and to make changes
- ip addr** allows users to look at addresses and their properties, add new addresses, and delete old ones
- ip neighbor** allows users to look at neighbor bindings and their properties, add new neighbor entries, and delete old ones
- ip rule** allows users to look at the routing policies and change them
- ip route** allows users to look at the routing table and change routing table rules
- ip tunnel** allows users to look at the IP tunnels and their properties, and change them
- ip maddr** allows users to look at the multicast addresses and their properties, and change them
- ip mroute** allows users to set, change, or delete the multicast routing
- ip monitor** allows users to continuously monitor the state of devices, addresses and routes

lnstat	Provides Linux network statistics. It is a generalized and more feature-complete replacement for the old rtstat program
nstat	Shows network statistics
routef	A component of ip route . This is for flushing the routing tables
routel	A component of ip route . This is for listing the routing tables
rtacct	Displays the contents of <code>/proc/net/rt_acct</code>
rtmon	Route monitoring utility
rtpr	Converts the output of ip -o back into a readable form
rtstat	Route status utility
ss	Similar to the netstat command; shows active connections
tc	Traffic Controlling Executable; this is for Quality Of Service (QOS) and Class Of Service (COS) implementations tc qdisc allows users to setup the queueing discipline tc class allows users to setup classes based on the queueing discipline scheduling tc estimator allows users to estimate the network flow into a network tc filter allows users to setup the QOS/COS packet filtering tc policy allows users to setup the QOS/COS policies

10.34. GDBM-1.11

The GDBM package contains the GNU Database Manager. This is a disk file format database which stores key/data-pairs in single files. The actual data of any record being stored is indexed by a unique key, which can be retrieved in less time than if it was stored in a text file.

10.34.1. Installation of GDBM

Prepare GDBM for compilation:

```
./configure --prefix=/usr --enable-libgdbm-compat
```

The meaning of the `configure` option:

```
--enable-libgdbm-compat
```

This switch enables the libgdbm compatibility library to be built, as some packages outside of CLFS may require the older DBM routines it provides.

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.34.2. Contents of GDBM

Installed programs: gdbm_dump, gdbm_load, gdbmtool
Installed libraries: libgdbm.{a,so}, libgdbm_compat.{a,so}

Short Descriptions

gdbm_dump	Dumps a GDBM database to a file.
gdbm_load	Recreates a GDBM database from a dump file.
gdbmtool	Tests and modifies a GDBM database
libgdbm	Contains functions to manipulate a hashed database
libgdbm_compat	Compatibility library containing older DBM functions

10.35. Perl-5.20.0

The Perl package contains the Practical Extraction and Report Language.

10.35.1. Installation of Perl

By default, Perl's Compress::Raw::Zlib module builds and links against its own internal copy of Zlib. The following command will tell it to use the system-installed Zlib:

```
sed -i -e '/^BUILD_ZLIB/s/True/False/' \
    -e '/^INCLUDE/s,\./zlib-src,/usr/include,' \
    -e '/^LIB/s,\./zlib-src,/usr/lib,' \
    cpan/Compress-Raw-Zlib/config.in
```



Note

If you are following the boot method you will need to enable the loopback device:

```
ip link set lo up
```

Before starting to configure, create a basic `/etc/hosts` file which will be referenced by one of Perl's configuration files as well as used by the test suite:

```
echo "127.0.0.1 localhost $(hostname)" > /etc/hosts
```

To have full control over the way Perl is set up, you can run the interactive **Configure** script and hand-pick the way this package is built. If you prefer instead to use the defaults that Perl auto-detects, prepare Perl for compilation with:

```
./configure.gnu --prefix=/usr \
    -Dvendorprefix=/usr \
    -Dman1dir=/usr/share/man/man1 \
    -Dman3dir=/usr/share/man/man3 \
    -Dpager="/bin/less -isR" \
    -Dusetthreads -Duseshrplib
```

The meaning of the configure option:

`-Dpager="/bin/less -isR"`

Less has not yet been installed, so by default **perldoc** will invoke the **more** program for viewing documentation. This option ensures that it will use **less** instead.

`-Dman1dir=/usr/share/man/man1 -Dman3dir=/usr/share/man/man3`

Since Groff is not installed yet, **configure.gnu** thinks that we do not want man pages for Perl. Issuing these parameters overrides this decision.

`-Dusetthreads`

This tells Perl to use threads.

`-Duseshrplib`

This tells Perl to build a shared libperl.

Compile the package:

```
make
```

To test the results, issue:

```
make test
```

Install the package:

```
make install
```

10.35.2. Contents of Perl

Installed programs: a2p, c2ph, config_data, corelist, cpan, cpan2dist, cpanp, cpanp-run-perl, enc2xs, find2perl, h2ph, h2xs, instmodsh, json_pp, libnetcfg, perl, perl5.20.0 (link to perl), perlbug, perldoc, perlivp, perlthanks (link to perlbug), piconv, pl2pm, pod2html, pod2latex, pod2man, pod2text, pod2usage, podchecker, podselect, prove, psed (link to s2p), pstruct (link to c2ph), ptar, ptardiff, ptargrep, s2p, shasum, splain, xsubpp, zipdetails

Installed libraries: Several hundred which cannot all be listed here

Installed directory: /usr/lib/perl5

Short Descriptions

a2p Translates `awk` to Perl

c2ph Dumps C structures as generated from `cc -g -S`

config_data Queries or changes configuration of Perl modules

corelist A commandline frontend to `Module::CoreList`

cpan Shell script that provides a command interface to `CPAN.pm`

cpan2dist The CPANPLUS distribution creator

cpanp The CPANPLUS launcher

cpanp-run-perl Perl script that (description needed)

enc2xs Builds a Perl extension for the Encode module from either Unicode Character Mappings or Tcl Encoding Files

find2perl Translates `find` commands to Perl

h2ph Converts `.h` C header files to `.ph` Perl header files

h2xs Converts `.h` C header files to Perl extensions

instmodsh A shell script for examining installed Perl modules, and can even create a tarball from an installed module

json_pp Converts data between certain input and output formats

libnetcfg Can be used to configure the `libnet`

perl Combines some of the best features of C, `sed`, `awk` and `sh` into a single swiss-army-knife language

perl5.20.0 A hard link to `perl`

perlbug Used to generate bug reports about Perl, or the modules that come with it, and mail them

perldoc Displays a piece of documentation in pod format that is embedded in the Perl installation tree or in a Perl script

perlivp	The Perl Installation Verification Procedure; it can be used to verify that Perl and its libraries have been installed correctly
perlthanks	Used to generate thank you messages to mail to the Perl developers
piconv	A Perl version of the character encoding converter iconv
pl2pm	A rough tool for converting Perl4 <code>.pl</code> files to Perl5 <code>.pm</code> modules
pod2html	Converts files from pod format to HTML format
pod2latex	Converts files from pod format to LaTeX format
pod2man	Converts pod data to formatted <code>*roff</code> input
pod2text	Converts pod data to formatted ASCII text
pod2usage	Prints usage messages from embedded pod docs in files
podchecker	Checks the syntax of pod format documentation files
podselect	Displays selected sections of pod documentation
prove	A command-line tool for running tests against <code>Test::Harness</code>
psed	A Perl version of the stream editor sed
pstruct	Dumps C structures as generated from <code>cc -g -S</code> stabs
ptar	A tar -like program written in Perl
ptardiff	A Perl program that compares an extracted archive with an unextracted one
ptargrep	A Perl program that applies pattern matching to the contents of files in a tar archive
s2p	Translates sed to Perl
shasum	Prints or checks SHA checksums
splain	Is used to force verbose warning diagnostics in Perl
xsubpp	Converts Perl XS code into C code
zipdetails	Displays details about the internal structure of a Zip file

10.36. Readline-6.3

The Readline package is a set of libraries that offers command-line editing and history capabilities.

10.36.1. Installation of Readline

The following patch contains updates from the maintainer. The maintainer of Readline only releases these patches to fix serious issues:

```
patch -Np1 -i ../readline-6.3-branch_update-3.patch
```

Prepare Readline for compilation:

```
./configure --prefix=/usr --libdir=/lib \
  --docdir=/usr/share/doc/readline-6.3
```

Compile the package:

```
make SHLIB_LIBS=-lcurses
```

This package does not come with a test suite.

Install the package:

```
make SHLIB_LIBS=-lcurses htmdir=/usr/share/doc/readline-6.3 install
```

Now move the static libraries to a more appropriate location:

```
mv -v /lib/lib{readline,history}.a /usr/lib
```

Next, relink the dynamic libraries into `/usr/lib` and remove the `.so` files in `/lib`.

```
ln -svf ../../lib/${readlink /lib/libreadline.so} /usr/lib/libreadline.so
ln -svf ../../lib/${readlink /lib/libhistory.so} /usr/lib/libhistory.so
rm -v /lib/lib{readline,history}.so
```

10.36.2. Contents of Readline

Installed libraries: libhistory.[a,so], libreadline.[a,so]
Installed directories: /usr/include/readline, /usr/share/doc/readline-6.3, /usr/share/readline

Short Descriptions

`libhistory` Provides a consistent user interface for recalling lines of history

`libreadline` Aids in the consistency of user interface across discrete programs that need to provide a command line interface

10.37. Autoconf-2.69

The Autoconf package contains programs for producing shell scripts that can automatically configure source code.

10.37.1. Installation of Autoconf

Prepare Autoconf for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check VERBOSE=yes
```

17 tests are skipped that use Automake and different GCC languages. For full test coverage, Autoconf can be re-tested after Automake has been installed.

Install the package:

```
make install
```

10.37.2. Contents of Autoconf

Installed programs: autoconf, autoheader, autom4te, autoreconf, autoscan, autoupdate, ifnames
Installed directory: /usr/share/autoconf

Short Descriptions

autoconf	Produces shell scripts that automatically configure software source code packages to adapt to many kinds of Unix-like systems. The configuration scripts it produces are independent—running them does not require the autoconf program.
autoheader	A tool for creating template files of C <i>#define</i> statements for configure to use
autom4te	A wrapper for the M4 macro processor
autoreconf	Automatically runs autoconf , autoheader , aclocal , automake , gettextize , and libtoolize in the correct order to save time when changes are made to autoconf and automake template files
autoscan	Helps to create a <code>configure.in</code> file for a software package; it examines the source files in a directory tree, searching them for common portability issues, and creates a <code>configure.scan</code> file that serves as a preliminary <code>configure.in</code> file for the package
autoupdate	Modifies a <code>configure.in</code> file that still calls autoconf macros by their old names to use the current macro names
ifnames	Helps when writing <code>configure.in</code> files for a software package; it prints the identifiers that the package uses in C preprocessor conditionals. If a package has already been set up to have some portability, this program can help determine what configure needs to check for. It can also fill in gaps in a <code>configure.in</code> file generated by autoscan

10.38. Automake-1.14.1

The Automake package contains programs for generating Makefiles for use with Autoconf.

10.38.1. Installation of Automake

Prepare Automake for compilation:

```
./configure --prefix=/usr --docdir=/usr/share/doc/automake-1.14.1
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.38.2. Contents of Automake

Installed programs: aclocal, aclocal-1.14, automake, automake-1.14, compile, config.guess, config.sub, depcomp, install-sh, mdate-sh, missing, mknstalldirs, py-compile, symlink-tree, ylwrap

Installed directories: /usr/share/aclocal-1.14, /usr/share/automake-1.14, /usr/share/doc/automake

Short Descriptions

aclocal	Generates <code>aclocal.m4</code> files based on the contents of <code>configure.in</code> files
aclocal-1.14	A hard link to aclocal
automake	A tool for automatically generating <code>Makefile.in</code> files from <code>Makefile.am</code> files. To create all the <code>Makefile.in</code> files for a package, run this program in the top-level directory. By scanning the <code>configure.in</code> file, it automatically finds each appropriate <code>Makefile.am</code> file and generates the corresponding <code>Makefile.in</code> file
automake-1.14	A hard link to automake
compile	A wrapper for compilers
config.guess	A script that attempts to guess the canonical triplet for the given build, host, or target architecture
config.sub	A configuration validation subroutine script
depcomp	A script for compiling a program so that dependency information is generated in addition to the desired output
install-sh	A script that installs a program, script, or data file
mdate-sh	A script that prints the modification time of a file or directory
missing	A script acting as a common stub for missing GNU programs during an installation
mknstalldirs	A script that creates a directory tree

py-compile	Compiles a Python program
symlink-tree	A script to create a symlink tree of a directory tree
ylwrap	A wrapper for lex and yacc

10.39. Bash-4.3

The Bash package contains the Bourne-Again SHell.

10.39.1. Installation of Bash

The following patch contains updates from the maintainer. The maintainer of Bash only releases these patches to fix serious issues:

```
patch -Np1 -i ../bash-4.3-branch_update-3.patch
```

Prepare Bash for compilation:

```
./configure --prefix=/usr --bindir=/bin \  
  --without-bash-malloc --with-installed-readline \  
  --docdir=/usr/share/doc/bash-4.3
```

The meaning of the configure option:

--with-installed-readline

This option tells Bash to use the `readline` library that is already installed on the system rather than using its own `readline` version.

Compile the package:

```
make
```

To test the results, issue:

```
make tests
```

Install the package:

```
make install
```

Run the newly compiled `bash` program (replacing the one that is currently being executed):

```
exec /bin/bash --login +h
```



Note

The parameters used make the `bash` process an interactive login shell and continue to disable hashing so that new programs are found as they become available.

10.39.2. Contents of Bash

Installed programs: bash, bashbug, sh (link to bash)
Installed directory: /usr/share/doc/bash-4.3

Short Descriptions

bash A widely-used command interpreter; it performs many types of expansions and substitutions on a given command line before executing it, thus making this interpreter a powerful tool

- bashbug** A shell script to help the user compose and mail standard formatted bug reports concerning **bash**
- sh** A symlink to the **bash** program; when invoked as **sh**, **bash** tries to mimic the startup behavior of historical versions of **sh** as closely as possible, while conforming to the POSIX standard as well

10.40. Bc-1.06.95

The Bc package contains an arbitrary precision numeric processing language.

10.40.1. Installation of Bc

Prepare Bc for compilation:

```
./configure --prefix=/usr --with-readline \  
--mandir=/usr/share/man --infodir=/usr/share/info
```

Compile the package:

```
make
```

To test the results, issue:

```
echo "quit" | ./bc/bc -l Test/checklib.b
```

Install the package:

```
make install
```

10.40.2. Contents of Bc

Installed programs: bc, dc

Short Descriptions

bc is a command line calculator

dc is a reverse-polish command line calculator

10.41. Bzip2-1.0.6

The Bzip2 package contains programs for compressing and decompressing files. Compressing text files with **bzip2** yields a much better compression percentage than with the traditional **gzip**.

10.41.1. Installation of Bzip2

By default Bzip2 creates some symlinks that use absolute pathnames. The following sed will cause them to be created with relative paths instead:

```
sed -i -e 's:ln -s -f $(PREFIX)/bin/:ln -s :' Makefile
```

Make Bzip2 install its manpages in `/usr/share/man` instead of `/usr/man`:

```
sed -i 's@X)/man@X)/share/man@g' ./Makefile
```

The Bzip2 package does not contain a **configure** script. Compile it with:

```
make -f Makefile-libbz2_so
make clean
```

The `-f` flag will cause Bzip2 to be built using a different Makefile file, in this case the `Makefile-libbz2_so` file, which creates a dynamic `libbz2.so` library and links the Bzip2 utilities against it.

Recompile the package using a non-shared library and test it:

```
make
```

Install the programs:

```
make PREFIX=/usr install
```

Install the shared **bzip2** binary into the `/bin` directory, make some necessary symbolic links, and clean up:

```
cp -v bzip2-shared /bin/bzip2
cp -av libbz2.so* /lib
ln -sv ../../lib/libbz2.so.1.0 /usr/lib/libbz2.so
rm -v /usr/bin/{bunzip2,bzcat,bzip2}
ln -sv bzip2 /bin/bunzip2
ln -sv bzip2 /bin/bzcat
```

10.41.2. Contents of Bzip2

Installed programs: bunzip2 (link to bzip2), bzcat (link to bzip2), bzcmp (link to bzdiff), bzdiff, bzgrep (link to bzgrep), bzfgrep (link to bzgrep), bzgrep, bzip2, bzip2recover, bzless (link to bzmores), bzmores

Installed libraries: libbz2.a, libbz2.so (link to libbz2.so.1.0), libbz2.so.1.0 (link to libbz2.so.1.0.6), libbz2.so.1.0.6

Short Descriptions

bunzip2 Decompresses bziped files
bzcat Decompresses to standard output

bzcmp	Runs cmp on bziped files
bzdiff	Runs diff on bziped files
bzegrep	Runs egrep on bziped files
bzfgrep	Runs fgrep on bziped files
bzgrep	Runs grep on bziped files
bzip2	Compresses files using the Burrows-Wheeler block sorting text compression algorithm with Huffman coding; the compression rate is better than that achieved by more conventional compressors using “Lempel-Ziv” algorithms, like gzip
bzip2recover	Tries to recover data from damaged bziped files
bzless	Runs less on bziped files
bzmore	Runs more on bziped files
libbz2*	The library implementing lossless, block-sorting data compression, using the Burrows-Wheeler algorithm

10.42. Diffutils-3.3

The Diffutils package contains programs that show the differences between files or directories.

10.42.1. Installation of Diffutils

Fix a file so locale files are installed:

```
sed -i 's:= @mkdir_p@:= /bin/mkdir -p:' po/Makefile.in.in
```

Prepare Diffutils for compilation:

```
./configure --prefix=/usr
```

Diffutils wants **ed** as the default editor for **sdiff**. The following **sed** will change the default to **vi**:

```
sed -i 's@\(^#define DEFAULT_EDITOR_PROGRAM \).*@\1"vi"@' lib/config.h
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.42.2. Contents of Diffutils

Installed programs: `cmp, diff, diff3, sdiff`

Short Descriptions

cmp	Compares two files and reports whether or in which bytes they differ
diff	Compares two files or directories and reports which lines in the files differ
diff3	Compares three files line by line
sdiff	Merges two files and interactively outputs the results

10.43. File-5.19

The File package contains a utility for determining the type of a given file or files.

10.43.1. Installation of File

Prepare File for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.43.2. Contents of File

Installed programs:	file
Installed library:	libmagic.[a,so]

Short Descriptions

file Tries to classify each given file; it does this by performing several tests—file system tests, magic number tests, and language tests

libmagic Contains routines for magic number recognition, used by the **file** program

10.44. Gawk-4.1.1

The Gawk package contains programs for manipulating text files.

10.44.1. Installation of Gawk

Prepare Gawk for compilation:

```
./configure --prefix=/usr --libexecdir=/usr/lib
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

Install the documentation:

```
mkdir -v /usr/share/doc/gawk-4.1.1
cp -v doc/{awkforai.txt,*.{eps,pdf,jpg}} /usr/share/doc/gawk-4.1.1
```

10.44.2. Contents of Gawk

Installed programs: awk (link to gawk), gawk, gawk-4.1.1, grcat, igawk, pgawk, pgawk-4.1.1, pwcats
Installed directories: /usr/lib/awk, /usr/lib/gawk, /usr/share/awk, /usr/share/doc/gawk-4.1.1

Short Descriptions

awk	A link to gawk
gawk	A program for manipulating text files; it is the GNU implementation of awk
gawk-4.1.1	A hard link to gawk
grcat	Dumps the group database <code>/etc/group</code>
igawk	Gives gawk the ability to include files
pgawk	The profiling version of gawk
pgawk-4.1.1	Hard link to pgawk
pwcats	Dumps the password database <code>/etc/passwd</code>

10.45. Findutils-4.4.2

The Findutils package contains programs to find files. These programs are provided to recursively search through a directory tree and to create, maintain, and search a database (often faster than the recursive find, but unreliable if the database has not been recently updated).

10.45.1. Installation of Findutils

Prepare Findutils for compilation:

```
./configure --prefix=/usr --libexecdir=/usr/lib/locate \
  --localstatedir=/var/lib/locate
```

The meaning of the configure options:

--localstatedir

This option changes the location of the **locate** database to be in `/var/lib/locate`, which is FHS-compliant.

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.45.2. Contents of Findutils

Installed programs: bigram, code, find, frcode, locate, oldfind, updatedb, xargs

Installed directory: /usr/lib/locate

Short Descriptions

bigram	Was formerly used to produce locate databases
code	Was formerly used to produce locate databases; it is the ancestor of frcode .
find	Searches given directory trees for files matching the specified criteria
frcode	Is called by updatedb to compress the list of file names; it uses front-compression, reducing the database size by a factor of four to five.
locate	Searches through a database of file names and reports the names that contain a given string or match a given pattern
oldfind	Older version of find, using a different algorithm
updatedb	Updates the locate database; it scans the entire file system (including other file systems that are currently mounted, unless told not to) and puts every file name it finds into the database
xargs	Can be used to apply a given command to a list of files

10.46. Gettext-0.19.1

The Gettext package contains utilities for internationalization and localization. These allow programs to be compiled with NLS (Native Language Support), enabling them to output messages in the user's native language.

10.46.1. Installation of Gettext

Prepare Gettext for compilation:

```
./configure --prefix=/usr --docdir=/usr/share/doc/gettext-0.19.1
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.46.2. Contents of Gettext

Installed programs:	autopoint, config.charset, config.rpath, envsubst, gettext, gettext.sh, gettextize, hostname, msgattrib, msgcat, msgcmp, msgcomm, msgconv, msgen, msgexec, msgfilter, msgfmt, msggrep, msginit, msgmerge, msgunfmt, msguniq, ngettext, recode-sr-latin, xgettext
Installed libraries:	libasprintf.[a,so], libgettextlib.so, libgettextpo.[a,so], libgettextsrc.so, preloadable_libintl.so
Installed directories:	/usr/lib/gettext, /usr/share/doc/gettext-0.19.1, /usr/share/gettext

Short Descriptions

autopoint	Copies standard Gettext infrastructure files into a source package
config.charset	Outputs a system-dependent table of character encoding aliases
config.rpath	Outputs a system-dependent set of variables, describing how to set the runtime search path of shared libraries in an executable
envsubst	Substitutes environment variables in shell format strings
gettext	Translates a natural language message into the user's language by looking up the translation in a message catalog
gettext.sh	Primarily serves as a shell function library for gettext
gettextize	Copies all standard Gettext files into the given top-level directory of a package to begin internationalizing it
hostname	Displays a network hostname in various forms
msgattrib	Filters the messages of a translation catalog according to their attributes and manipulates the attributes

msgcat	Concatenates and merges the given <code>.po</code> files
msgcmp	Compares two <code>.po</code> files to check that both contain the same set of msgid strings
msgcomm	Finds the messages that are common to the given <code>.po</code> files
msgconv	Converts a translation catalog to a different character encoding
msgen	Creates an English translation catalog
msgexec	Applies a command to all translations of a translation catalog
msgfilter	Applies a filter to all translations of a translation catalog
msgfmt	Generates a binary message catalog from a translation catalog
msggrep	Extracts all messages of a translation catalog that match a given pattern or belong to some given source files
msginit	Creates a new <code>.po</code> file, initializing the meta information with values from the user's environment
msgmerge	Combines two raw translations into a single file
msgunfmt	Decompiles a binary message catalog into raw translation text
msguniq	Unifies duplicate translations in a translation catalog
ngettext	Displays native language translations of a textual message whose grammatical form depends on a number
recode-sr-latin	Recode Serbian text from Cyrillic to Latin script.
xgettext	Extracts the translatable message lines from the given source files to make the first translation template
<code>libasprintf</code>	defines the <i>autosprintf</i> class, which makes C formatted output routines usable in C++ programs, for use with the <code><string></code> strings and the <code><iostream></code> streams
<code>libgettextlib</code>	a private library containing common routines used by the various Gettext programs; these are not intended for general use
<code>libgettextpo</code>	Used to write specialized programs that process <code>.po</code> files; this library is used when the standard applications shipped with Gettext (such as msgcomm , msgcmp , msgattrib , and msgen) will not suffice
<code>libgettextsrc</code>	A private library containing common routines used by the various Gettext programs; these are not intended for general use
<code>preloadable_libintl.so</code>	A library, intended to be used by LD_PRELOAD, that assists libintl in logging untranslated messages.

10.47. Gperf-3.0.4

Gperf generates a perfect hash function from a key set.

10.47.1. Installation of Gperf

Prepare Gperf for compilation:

```
./configure --prefix=/usr --docdir=/usr/share/doc/gperf-3.0.4
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.47.2. Contents of Gperf

Installed programs:	gperf
Installed directory:	/usr/share/doc/gperf-3.0.4

Short Descriptions

gperf Generates a perfect hash function from a key set

10.48. Grep-2.19

The Grep package contains programs for searching through files.

10.48.1. Installation of Grep

Prepare Grep for compilation:

```
./configure --prefix=/usr --bindir=/bin
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.48.2. Contents of Grep

Installed programs: egrep, fgrep, grep

Short Descriptions

egrep Prints lines matching an extended regular expression
fgrep Prints lines matching a list of fixed strings
grep Prints lines matching a basic regular expression

10.49. Groff-1.22.2

The Groff package contains programs for processing and formatting text.

10.49.1. Installation of Groff

Groff expects the environment variable `PAGE` to contain the default paper size. For users in the United States, `PAGE=letter` is appropriate. Elsewhere, `PAGE=A4` may be more suitable.

Prepare Groff for compilation:

```
PAGE=[paper_size] ./configure --prefix=/usr
```

Compile the package:

```
make
```

This package does not come with a test suite.

Install the package:

```
make install
```

10.49.2. Contents of Groff

Installed programs: addftinfo, afmtodit, chem, eqn, eqn2graph, gdiffmk, grap2graph, grn, grodvi, groff, groffer, grog, grolbp, grolj4, grops, grotty, hpftodit, indxbib, lkbib, lookbib, mmroff, neqn, nroff, pdfroff, pfbtops, pic, pic2graph, post-grohtml, pre-grohtml, precon, refer, roff2dvi, roff2html, roff2pdf, roff2ps, roff2text, roff2x, soelim, tbl, tfmtodit, troff

Installed directories: /usr/lib/groff, /usr/share/doc/groff-1.22.2, /usr/share/groff

Short Descriptions

addftinfo	Reads a troff font file and adds some additional font-metric information that is used by the groff system
afmtodit	Creates a font file for use with groff and grops
chem	Groff preprocessor for producing chemical structure diagrams
eqn	Compiles descriptions of equations embedded within troff input files into commands that are understood by troff
eqn2graph	Converts a troff EQN (equation) into a cropped image
gdiffmk	Marks differences between groff/nroff/troff files
grap2graph	Converts a grap diagram into a cropped bitmap image
grn	A groff preprocessor for gremlin files
grodvi	A driver for groff that produces TeX dvi format
groff	A front-end to the groff document formatting system; normally, it runs the troff program and a post-processor appropriate for the selected device
groffer	Displays groff files and man pages on X and tty terminals

grog	Reads files and guesses which of the groff options <code>-e</code> , <code>-man</code> , <code>-me</code> , <code>-mm</code> , <code>-ms</code> , <code>-p</code> , <code>-s</code> , and <code>-t</code> are required for printing files, and reports the groff command including those options
grolbp	Is a groff driver for Canon CAPSL printers (LBP-4 and LBP-8 series laser printers)
grolj4	Is a driver for groff that produces output in PCL5 format suitable for an HP LaserJet 4 printer
grops	Translates the output of GNU troff to PostScript
grotty	Translates the output of GNU troff into a form suitable for typewriter-like devices
hpfodit	Creates a font file for use with groff -Tlj4 from an HP-tagged font metric file
indxbib	Creates an inverted index for the bibliographic databases with a specified file for use with refer , lookbib , and lkbib
lkbib	Searches bibliographic databases for references that contain specified keys and reports any references found
lookbib	Prints a prompt on the standard error (unless the standard input is not a terminal), reads a line containing a set of keywords from the standard input, searches the bibliographic databases in a specified file for references containing those keywords, prints any references found on the standard output, and repeats this process until the end of input
mmroff	A simple preprocessor for groff
neqn	Formats equations for American Standard Code for Information Interchange (ASCII) output
nroff	A script that emulates the nroff command using groff
pdfroff	Creates pdf documents using groff
pfbtops	Translates a PostScript font in <code>.pfb</code> format to ASCII
pic	Compiles descriptions of pictures embedded within troff or TeX input files into commands understood by TeX or troff
pic2graph	Converts a PIC diagram into a cropped image
post-grohtml	Translates the output of GNU troff to HTML
pre-grohtml	Translates the output of GNU troff to HTML
preconv	Converts encoding of input files to something GNU troff understands
refer	Copies the contents of a file to the standard output, except that lines between <code>./</code> and <code>./</code> are interpreted as citations, and lines between <code>.R1</code> and <code>.R2</code> are interpreted as commands for how citations are to be processed
roff2dvi	Transforms roff files into other formats
roff2html	Transforms roff files into other formats
roff2pdf	Transforms roff files into other formats
roff2ps	Transforms roff files into other formats
roff2text	Transforms roff files into other formats
roff2x	Transforms roff files into other formats
soelim	Reads files and replaces lines of the form <code>.so file</code> by the contents of the mentioned <i>file</i>
tbl	Compiles descriptions of tables embedded within troff input files into commands that are understood by troff

tfmtofit

Creates a font file for use with **groff -Ttvi**

troff Is highly compatible with Unix **troff**; it should usually be invoked using the **groff** command, which will also run preprocessors and post-processors in the appropriate order and with the appropriate options

10.50. Less-462

The Less package contains a text file viewer.

10.50.1. Installation of Less

Prepare Less for compilation:

```
./configure --prefix=/usr --sysconfdir=/etc
```

The meaning of the configure option:

```
--sysconfdir=/etc
```

This option tells the programs created by the package to look in `/etc` for the configuration files.

Compile the package:

```
make
```

This package does not come with a test suite.

Install the package:

```
make install
```

Move `less` to `/bin`:

```
mv -v /usr/bin/less /bin
```

10.50.2. Contents of Less

Installed programs: `less`, `lessecho`, `lesskey`

Short Descriptions

less	A file viewer or pager; it displays the contents of the given file, letting the user scroll, find strings, and jump to marks
lessecho	Needed to expand meta-characters, such as <code>*</code> and <code>?</code> , in filenames on Unix systems
lesskey	Used to specify the key bindings for less

10.51. Gzip-1.6

The Gzip package contains programs for compressing and decompressing files.

10.51.1. Installation of Gzip

Prepare Gzip for compilation:

```
./configure --prefix=/usr --bindir=/bin
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

Now we will move some of the utilities to `/usr/bin` to meet FHS compliance:

```
mv -v /bin/z{egrep,cmp,diff,fgrep,force,grep,less,more,new} /usr/bin
```

10.51.2. Contents of Gzip

Installed programs: gunzip, gzexe, gzip, uncompress, zcat, zcmp, zdiff, zegrep, zfgrep, zforce, zgrep, zless, zmore, znew

Short Descriptions

gunzip	Decompresses gzipped files
gzexe	Creates self-decompressing executable files
gzip	Compresses the given files using Lempel-Ziv (LZ77) coding
uncompress	Decompresses compressed files
zcat	Decompresses the given gzipped files to standard output
zcmp	Runs cmp on gzipped files
zdiff	Runs diff on gzipped files
zegrep	Runs egrep on gzipped files
zfgrep	Runs fgrep on gzipped files
zforce	Forces a <code>.gz</code> extension on all given files that are gzipped files, so that gzip will not compress them again; this can be useful when file names were truncated during a file transfer
zgrep	Runs grep on gzipped files
zless	Runs less on gzipped files
zmore	Runs more on gzipped files
znew	Re-compresses files from compress format to gzip format— <code>.Z</code> to <code>.gz</code>

10.52. IPutils-s20121221

The IPutils package contains programs for basic networking.

10.52.1. Installation of IPutils

IPutils has various issues addressed by the following patch:

```
patch -Np1 -i ../iputils-s20121221-fixes-2.patch
```

Compile the package:

```
make \
  IPV4_TARGETS="tracepath ping clockdiff rdisc" \
  IPV6_TARGETS="tracepath6 traceroute6"
```

This package does not come with a test suite.

Install the package:

```
install -v -m755 ping /bin
install -v -m755 clockdiff /usr/bin
install -v -m755 rdisc /usr/bin
install -v -m755 tracepath /usr/bin
install -v -m755 trace{path,route}6 /usr/bin
install -v -m644 doc/*.8 /usr/share/man/man8
```

10.52.2. Contents of iputils

Installed programs: clockdiff, ping, rdisc, tracepath, tracepath6, traceroute6

Short Descriptions

clockdiff	Measures the clock difference between hosts
ping	Sends echo-request packets and reports how long the replies take. This is the IPV4 version
rdisc	Network router discovery daemon
tracepath	Traces the path to a network host discovering MTU along the path. This is the IPV4 version.
tracepath6	Traces the path to a network host discovering MTU along the path. This is the IPV6 version.
traceroute6	Traces the path to a network host on an IPV6 network

10.53. Kbd-2.0.1

The Kbd package contains key-table files and keyboard utilities.

10.53.1. Installation of Kbd

Prepare Kbd for compilation:

```
PKG_CONFIG_PATH="/tools/lib/pkgconfig" \
./configure --prefix=/usr --disable-vlock --enable-optional-progs
```

The meaning of the new configure options:

`PKG_CONFIG_PATH`

Use pkg-config to obtain the location of the test library metadata built in Section 6.14, “Check-0.9.13”.

`--disable-vlock`

Prevents Kbd from trying to build the **vlock** program, which requires Linux-PAM.

`--enable-optional-progs`

Installs several additional programs.

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

Some of the programs from Kbd are used by systemd to initialize the system, so those binaries need to be on the root partition:

```
mv -v /usr/bin/{loadkeys,setfont} /bin
```

Install the documentation:

```
mkdir -v /usr/share/doc/kbd-2.0.1
cp -R -v docs/doc/* /usr/share/doc/kbd-2.0.1
```

10.53.2. Contents of Kbd

Installed programs: chvt, dealloctv, dumpkeys, fgconsole, getkeycodes, kbinfo, kbd_mode, kbdrate, loadkeys, loadunimap, mapscrn, openvt, psfaddtable (link to psfxtable), psfgettable (link to psfxtable), psfstrietable (link to psfxtable), psfxtable, resizecons, setfont, setkeycodes, setleds, setmetamode, setvtrgb, showconsolefont, showkey, unicode_start, unicode_stop

Installed directories: /usr/share/consolefonts, /usr/share/consoletrans, /usr/share/doc/kbd-2.0.1, /usr/share/keymaps, /usr/share/unimaps

Short Descriptions

chvt	Changes the foreground virtual terminal
deallocvt	Deallocates unused virtual terminals
dumpkeys	Dumps the keyboard translation tables
fgconsole	Prints the number of the active virtual terminal
getkeycodes	Prints the kernel scancode-to-keycode mapping table
kbdinfo	Obtains information about the console
kbd_mode	Reports or sets the keyboard mode
kbdrate	Sets the keyboard repeat and delay rates
loadkeys	Loads the keyboard translation tables
loadunimap	Loads the kernel unicode-to-font mapping table
mapscrn	An obsolete program that used to load a user-defined output character mapping table into the console driver; this is now done by setfont
openvt	Starts a program on a new virtual terminal (VT)
psfaddtable	Adds a Unicode character table to a console font
psfgettable	Extracts the embedded Unicode character table from a console font
psfstrietable	Removes the embedded Unicode character table from a console font
psfxtable	Handle Unicode character tables for console fonts
resizecons	Changes the kernel idea of the console size
setfont	Changes the Enhanced Graphic Adapter (EGA) and Video Graphics Array (VGA) fonts on the console
setkeycodes	Loads kernel scancode-to-keycode mapping table entries; this is useful if there are unusual keys on the keyboard
setleds	Sets the keyboard flags and Light Emitting Diodes (LEDs)
setmetamode	Defines the keyboard meta-key handling
setvtrgb	Sets the virtual terminal RGB colors
showconsolefont	Shows the current EGA/VGA console screen font
showkey	Reports the scancodes, keycodes, and ASCII codes of the keys pressed on the keyboard
unicode_start	Puts the keyboard and console in UNICODE mode. Never use it on CLFS, because applications are not configured to support UNICODE.
unicode_stop	Reverts keyboard and console from UNICODE mode

10.54. Libpipeline-1.3.0

The Libpipeline package contains a library for manipulating pipelines of subprocesses in a flexible and convenient way.

10.54.1. Installation of Libpipeline

Prepare Libpipeline for compilation:

```
PKG_CONFIG_PATH=/tools/lib/pkgconfig ./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.54.2. Contents of Libpipeline

Installed libraries: libpipeline.so

Short Descriptions

`libpipeline` This library is used to safely construct pipeline between subprocesses

10.55. Man-DB-2.6.7.1

The Man-DB package contains programs for finding and viewing man pages.

10.55.1. Installation of Man-DB

Prepare Man-DB for compilation:

```
./configure --prefix=/usr --libexecdir=/usr/lib \
  --docdir=/usr/share/doc/man-db-2.6.7.1 --sysconfdir=/etc \
  --disable-setuid --with-browser=/usr/bin/lynx \
  --with-vgrind=/usr/bin/vgrind --with-grap=/usr/bin/grap
```

The meaning of the configure options:

--disable-setuid

This disables making the **man** program setuid to user man.

--with-...

These three parameters are used to set some default programs. **lynx** is a text-based web browser (see CBLFS for installation instructions), **vgrind** converts program sources to Groff input, and **grap** is useful for typesetting graphs in Groff documents. The **vgrind** and **grap** programs are not normally needed for viewing manual pages. They are not part of CLFS or CBLFS, but you should be able to install them yourself after finishing CLFS if you wish to do so.

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.55.2. Non-English Manual Pages in CLFS

The following table shows the character set that Man-DB assumes manual pages installed under `/usr/share/man/<ll>` will be encoded with. In addition to this, Man-DB correctly determines if manual pages installed in that directory are UTF-8 encoded.

Table 10.1. Expected character encoding of legacy 8-bit manual pages

Language (code)	Encoding	Language (code)	Encoding
Danish (da)	ISO-8859-1	Croatian (hr)	ISO-8859-2
German (de)	ISO-8859-1	Hungarian (hu)	ISO-8859-2
English (en)	ISO-8859-1	Japanese (ja)	EUC-JP
Spanish (es)	ISO-8859-1	Korean (ko)	EUC-KR
Estonian (et)	ISO-8859-1	Lithuanian (lt)	ISO-8859-13
Finnish (fi)	ISO-8859-1	Latvian (lv)	ISO-8859-13
French (fr)	ISO-8859-1	Macedonian (mk)	ISO-8859-5
Irish (ga)	ISO-8859-1	Polish (pl)	ISO-8859-2
Galician (gl)	ISO-8859-1	Romanian (ro)	ISO-8859-2
Indonesian (id)	ISO-8859-1	Russian (ru)	KOI8-R
Icelandic (is)	ISO-8859-1	Slovak (sk)	ISO-8859-2
Italian (it)	ISO-8859-1	Slovenian (sl)	ISO-8859-2
Norwegian Bokmal (nb)	ISO-8859-1	Serbian Latin (sr@latin)	ISO-8859-2
Dutch (nl)	ISO-8859-1	Serbian (sr)	ISO-8859-5
Norwegian Nynorsk (nn)	ISO-8859-1	Turkish (tr)	ISO-8859-9
Norwegian (no)	ISO-8859-1	Ukrainian (uk)	KOI8-U
Portuguese (pt)	ISO-8859-1	Vietnamese (vi)	TCVN5712-1
Swedish (sv)	ISO-8859-1	Simplified Chinese (zh_CN)	GBK
Belarusian (be)	CP1251	Simplified Chinese, Singapore (zh_SG)	GBK
Bulgarian (bg)	CP1251	Traditional Chinese, Hong Kong (zh_HK)	BIG5HKSCS
Czech (cs)	ISO-8859-2	Traditional Chinese (zh_TW)	BIG5
Greek (el)	ISO-8859-7		

**Note**

Manual pages in languages not in the list are not supported.

10.55.3. Contents of Man-DB

- Installed programs:** accessdb, apropos (link to whatis), catman, lexgrog, man, mandb, manpath, whatis, zsoelim
- Installed libraries:** libman.so, libmandb.so
- Installed directories:** /usr/lib/man-db, /usr/share/doc/man-db-2.6.7.1

Short Descriptions

accessdb	Dumps the whatis database contents in human-readable form
apropos	Searches the whatis database and displays the short descriptions of system commands that contain a given string
catman	Creates or updates the pre-formatted manual pages
lexgrog	Displays one-line summary information about a given manual page
man	Formats and displays the requested manual page
mandb	Creates or updates the whatis database
manpath	Displays the contents of \$MANPATH or (if \$MANPATH is not set) a suitable search path based on the settings in man.conf and the user's environment
whatis	Searches the whatis database and displays the short descriptions of system commands that contain the given keyword as a separate word
zsoelim	Reads files and replaces lines of the form <i>.so file</i> by the contents of the mentioned <i>file</i>
libman	Contains run-time support for man
libmandb	Contains run-time support for man

10.56. Make-4.0

The Make package contains a program for compiling packages.

10.56.1. Installation of Make

Prepare Make for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.56.2. Contents of Make

Installed program: make

Short Descriptions

make Automatically determines which pieces of a package need to be (re)compiled and then issues the relevant commands

10.57. XZ Utils-5.0.5

The XZ Utils package contains programs for compressing and decompressing files. Compressing text files with **XZ Utils** yields a much better compression percentage than with the traditional **gzip**.

10.57.1. Installation of XZ Utils

Prepare XZ Utils for compilation:

```
./configure --prefix=/usr --docdir=/usr/share/doc/xz-5.0.5
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the programs:

```
make install
```

Move the xz binary, and several symlinks that point to it, into the /bin directory:

```
mv -v /usr/bin/{xz,lzma,lzcat,unlzma,unxz,xzcat} /bin
```

Finally, move the shared library to a more appropriate location, and recreate the symlink pointing to it:

```
mv -v /usr/lib/liblzma.so.* /lib
ln -sfv ../../lib/$(readlink /usr/lib/liblzma.so) /usr/lib/liblzma.so
```

10.57.2. Contents of XZ Utils

Installed programs:	lzcat (link to xz), lzcmp (link to xzdiff), lzdiff (link to xzdiff), lzegrep (link to xzgrep), lzfgrep (link to xzgrep), lzgrep (link to xzgrep), lzless (link to xzless), lzma (link to xz), lzmadec, lzmainfo, lzmore (link to xzmore), unlzma (link to xz), unxz (link to xz), xz, xzcat (link to xz), xzcmp (link to xzdiff), xzdec, xzdiff, xzegrep (link to xzgrep), xzfgrep (link to xzgrep), xzgrep, xzless, xzmore
Installed libraries:	liblzma.[a,so]
Installed directories:	/usr/include/lzma, /usr/share/doc/xz-5.0.5

Short Descriptions

lzcat	Decompresses LZMA and xz files
lzcmp	Compares lzma compressed files
lzdiff	Compares lzma compressed files
lzegrep	Runs egrep on lzma compressed files
lzfgrep	Runs fgrep on lzma compressed files
lzgrep	Runs grep on lzma compressed files
lzless	Runs less on lzma files

lzma	Compresses lzma files
lzmadec	Decompresses lzma files
lzmainfo	Displays information stored in an .lzma file header
lzmore	Runs more on lzma files
unlzma	Uncompresses lzma files
unxz	Uncompresses xz files
xz	Creates xz compressed files
xzcat	Decompresses xz files
xzcmp	Compares xz compressed files
xzdec	Decompresses to standard output
xzdiff	Compares xz compressed files
xzegrep	Runs egrep on xz compressed files
xzfgrep	Runs fgrep on xz compressed files
xzgrep	Runs grep on xz compressed files
xzless	Runs less on xz files
xzmore	Runs more on xz files
liblzma	The LZMA library

10.58. Expat-2.1.0

Expat is a stream-oriented XML parser library written in C.

10.58.1. Installation of Expat

Prepare Expat for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

Install the documentation:

```
install -v -m755 -d /usr/share/doc/expat-2.1.0  
install -v -m644 doc/*.{html,png,css} /usr/share/doc/expat-2.1.0
```

10.58.2. Contents of Expat

Installed program:	xmlwf
Installed library:	libexpat.[so,a]
Installed directory:	/usr/share/doc/expat-2.1.0

Short Descriptions

xmlwf is a non-validating utility to check whether or not XML documents are well formed

libexpat contains API functions for parsing XML

10.59. XML::Parser-2.42_01

XML::Parser is a perl module for parsing XML documents.

10.59.1. Installation of XML::Parser

Prepare XML::Parser for compilation:

```
perl Makefile.PL
```

Compile the package:

```
make
```

To test the results, issue:

```
make test
```

Install the package:

```
make install
```

10.59.2. Contents of XML::Parser

Installed program: None

Installed libraries: None

10.60. Intltool-0.50.2

The Intltool package contains internationalization tools.

10.60.1. Installation of Intltool

Prepare Intltool for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.60.2. Contents of Intltool

Installed programs:	intltool-extract, intltool-merge, intltool-prepare, intltool-update, intltoolize
Installed directories:	/usr/share/intltool

Short Descriptions

intltool-extract	Generates header files which can be read by gettext
intltool-merge	Merges translated strings into various types of files
intltool-prepare	Prepares software to make use of intltool
intltool-update	Updates PO template files and merges translations with them
intltoolize	Copies intltool related files to software packages

10.61. Kmod-18

The Kmod package contains programs for loading, inserting and removing kernel modules for Linux. Kmod replaces the Module-Init-tools package.

10.61.1. Installation of Kmod

Prepare Kmod for compilation:

```
./configure --prefix=/usr \
  --bindir=/bin --sysconfdir=/etc \
  --with-rootlibdir=/lib \
  --with-zlib --with-xz
```

The meaning of the configure option:

```
--with-rootlibdir=/lib
```

Install location for shared libraries.

```
--with-zlib --with-xz
```

This allows the Kmod package to handle zlib and XZ compressed kernel modules.

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

Create symbolic links for programs that expect Module-Init-Tools:

```
ln -sfv kmod /bin/lsmmod
for tool in depmod insmod modinfo modprobe rmmmod; do
  ln -sfv ../bin/kmod /sbin/${tool}
done
```

10.61.2. Contents of Kmod

Installed programs: depmod (link to kmod), insmod (link to kmod), kmod, lsmmod (link to kmod), modinfo (link to kmod), modprobe (link to kmod), rmmmod (link to kmod)

Short Descriptions

depmod Creates a dependency file based on the symbols it finds in the existing set of modules; this dependency file is used by **modprobe** to automatically load the required modules

insmod Installs a loadable module in the running kernel

kmod Loads and unloads kernel modules

lsmod	Lists currently loaded modules
modinfo	Examines an object file associated with a kernel module and displays any information that it can glean
modprobe	Uses a dependency file, created by depmod , to automatically load relevant modules
rmmmod	Unloads modules from the running kernel

10.62. Patch-2.7.1

The Patch package contains a program for modifying or creating files by applying a “patch” file typically created by the **diff** program.

10.62.1. Installation of Patch

Prepare Patch for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.62.2. Contents of Patch

Installed program: patch

Short Descriptions

patch Modifies files according to a patch file. A patch file is normally a difference listing created with the **diff** program. By applying these differences to the original files, **patch** creates the patched versions.

10.63. Psmisc-22.21

The Psmisc package contains programs for displaying information about running processes.

10.63.1. Installation of Psmisc

Prepare Psmisc for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

This package does not come with a test suite.

Install the package:

```
make install
```

10.63.2. Contents of Psmisc

Installed programs: fuser, killall, peekfd, prtstat, pstree, pstree.x11 (link to pstree)

Short Descriptions

fuser	Reports the Process IDs (PIDs) of processes that use the given files or file systems
killall	Kills processes by name; it sends a signal to all processes running any of the given commands
peekfd	Peeks at file descriptors of running processes
prtstat	Prints information about a process
pstree	Displays running processes as a tree
pstree.x11	Same as pstree , except that it waits for confirmation before exiting

10.64. Systemd-213

The systemd package is a system and service manager for Linux operating systems.

10.64.1. Installation of Systemd

Systemd 209 merged several libraries into `libsystemd`, but some packages that use systemd still expect those separate libraries. Apply a patch to allow backwards compatibility with these packages by installing Pkg-config files for the old libraries:

```
patch -Np1 -i ../systemd-213-compat-1.patch
```

Prevent the `Makefile` from trying to run `setcap` on `systemd-detect-virt`, which will fail if the kernel or file system does not support extended capabilities:

```
sed -i '/virt-install-hook /d' Makefile.in
```

The `timesyncd.conf` file contains a reference to a non-existent `timesyncd.conf(5)` man page. Remove that reference to avoid possible confusion:

```
sed -i '/timesyncd.conf/d' src/timesync/timesyncd.conf.in
```

By default, `systemd-fsck` will run `/sbin/fsck` with the `-l` option, which applies an `flock` on the file system being checked. This can conflict with an `flock` that systemd itself puts on the file system, which could result in problems booting. `fsck` will be fixed to avoid this problem in a future release of Util-linux, but for now we will work around the issue by simply preventing `systemd-fsck` from using `-l`:

```
sed -i '/-l/d' src/fsck/fsck.c
```

Prepare systemd for compilation:

```
./configure --prefix=/usr \
  --sysconfdir=/etc --localstatedir=/var \
  --libexecdir=/usr/lib --docdir=/usr/share/doc/systemd-213 \
  --with-rootprefix="" --with-rootlibdir=/lib \
  --enable-split-usr --disable-gudev --with-kbd-loadkeys=/bin/loadkeys \
  --with-kbd-setfont=/bin/setfont --with-dbuspolicydir=/etc/dbus-1/system.d \
  --with-dbusinterfacedir=/usr/share/dbus-1/interfaces \
  --with-dbussessionservicedir=/usr/share/dbus-1/services \
  --with-dbus-systemservicedir=/usr/share/dbus-1/system-services
```

The meaning of the configure options:

`--with-root*`

These switches ensure that core programs and shared libraries are installed in the subdirectories of the root partition.

`--enable-split-usr`

This switch ensures that systemd will work on systems where `/bin`, `/lib` and `/sbin` directories are not symlinks to their `/usr` counterparts.

`--disable-gudev`

This switch prevents systemd from building libgudev as it requires Glib, which is not installed in CLFS.

`--with-dbus*`

These switches ensure that D-Bus configuration files get installed to the correct locations.

Compile the package:

```
make
```

Prevent a broken test case from running:

```
sed -e "s:test/udev-test.pl::g" \  
-e "s:test-bus-cleanup\$(EXEEXT) ::g" \  
-e "s:test-bus-gvariant\$(EXEEXT) ::g" \  
-i Makefile
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

Install documentation files that are not installed by default:

```
install -v -m644 man/*.html /usr/share/doc/systemd-213
```

Move the nss_myhostname library to /lib:

```
mv -v /usr/lib/libnss_myhostname.so.2 /lib
```

Remove an unnecessary directory:

```
rm -rfv /usr/lib/rpm
```

Create symlinks for backwards-compatibility with Sysvinit:

```
for tool in runlevel reboot shutdown poweroff halt telinit; do  
  ln -sfv ../bin/systemctl /sbin/$tool  
done  
ln -sfv ../lib/systemd/systemd /sbin/init
```

Modify a configuration file which references a group that doesn't exist:

```
sed -i "s@root lock@root root@g" /usr/lib/tmpfiles.d/legacy.conf
```

10.64.2. Configuring Systemd

Create /etc/machine-id which is needed by Journald:

```
systemd-machine-id-setup
```

Create a file to identify the operating system. **systemd** will use this file on boot to put information on the screen.

```
cat > /etc/os-release << "EOF"
# Begin /etc/os-release

NAME=Cross-LFS
ID=clfs

PRETTY_NAME=Cross Linux From Scratch
ANSI_COLOR=0;33

VERSION=3.0.0-RC1
VERSION_ID=20140724

# End /etc/os-release
EOF
```

10.64.3. Contents of Systemd

Installed programs: bootctl, busctl, halt (link to systemctl), hostnamectl, init (link to systemd), journalctl, kernel-install, localectl, loginctl, machinectl, poweroff (link to systemctl), reboot (link to systemctl), runlevel (link to systemctl), shutdown (link to systemctl), systemctl, systemd, system-analyze, systemd-ask-password, systemd-cat, systemd-cgls, systemd-cgtop, systemd-coredumpctl, systemd-delta, systemd-detect-virt, systemd-inhibit, systemd-machine-id-setup, systemd-notify, systemd-nspawn, systemd-run, systemd-stdio-bridge (link to systemd-bus-proxyd), systemd-tmpfiles, systemd-tty-ask-password-agent, telinit (link to systemctl), timedatectl, udevadm

Installed libraries: libnss_myhostname.so, libsystemd.so, libudev.so

Installed directories: /etc/binfmt.d, /etc/init.d, /etc/kernel, /etc/modules-load.d, /etc/sysctl.d, /etc/systemd, /etc/tmpfiles.d, /etc/udev, /etc/xdg/systemd, /lib/systemd, /lib/udev, /usr/include/systemd, /usr/lib/binfmt.d, /usr/lib/kernel, /usr/lib/modules-load.d, /usr/lib/sysctl.d, /usr/lib/systemd, /usr/share/doc-systemd-213, /usr/share/systemd, /usr/share/zsh, /var/lib/systemd

Short Descriptions

bootctl	Controls the firmware and boot manager settings
busctl	Introspects and monitors the D-Bus bus
halt	Halts, powers off, or reboots the machine
hostnamectl	Controls the system hostname
init	systemd system and service manager
journalctl	Queries the systemd journal
kernel-install	Adds and removes kernel and initramfs images to and from /boot
localectl	Controls the system locale and keyboard layout settings
loginctl	Controls the systemd login manager
machinectl	Controls the systemd machine manager

poweroff	Halts, powers off, or reboots the machine
reboot	Halts, powers off, or reboots the machine
runlevel	Prints previous and current SysV runlevel
shutdown	Halts, powers off, or reboots the machine
systemctl	Control the systemd system and service manager
systemd	System and service manager for Linux
systemd-analyze	Analyzes system boot-up performance
systemd-ask-password	Queries the user for a system passphrase, via the TTY or an UI agent.
systemd-cat	Connects a pipeline or program's output with the journal
systemd-cgls	Recursively shows control group contents
systemd-cgtop	Shows top control groups by resource usage
systemd-coredumpctl	Retrieves coredumps from the journal
systemd-delta	Finds overridden configuration files
systemd-detect-virt	Detects execution in a virtual environment
systemd-inhibit	Executes a program with an inhibition lock taken
systemd-machine-id-setup	Initializes the machine ID in <code>/etc/machine-id</code>
systemd-notify	Notifies init system about start-up completion and other daemon status changes
systemd-nspawn	Spawns a namespace container for debugging, testing, and building
systemd-run	Runs programs in transient scope or service units
systemd-stdio-bridge	Connects stdio or a socket to a given bus address
systemd-tmpfiles	Creates, deletes, and cleans up volatile and temporary files
systemd-tty-ask-password-agent	Process system password requests
telinit	Tells init which run-level to change to
timedatectl	Controls the system time and date
udevadm	Udev management tool
<code>libnss_myhostname</code>	Plugin for the GNU Name Service Switch (NSS) functionality of Glibc, providing hostname resolution for the locally configured system hostname
<code>libsystemd</code>	Support library for systemd
<code>libudev</code>	A library interface to Udev device information.

10.65. D-Bus-1.8.6

D-Bus is a message bus system, a simple way for applications to talk to one another.

10.65.1. Installation of D-Bus

Prepare D-Bus for compilation:

```
./configure --prefix=/usr --sysconfdir=/etc \
  --libexecdir=/usr/lib/dbus-1.0 --localstatedir=/var \
  --with-systemdsystemunitdir=/lib/systemd/system \
  --docdir=/usr/share/doc/dbus-1.8.6
```

Compile the package:

```
make
```

This package does come with a test suite, but it requires several packages that are not included in CLFS. Instructions for running the test suite can be found in the CBLFS wiki at http://cblfs.cross-lfs.org/index.php/D-BUS_Core.

Install the package:

```
make install
```

Move the shared library to `/lib` and recreate the symbolic link.

```
mv -v /usr/lib/libdbus-1.so.* /lib
ln -sfv ../../lib/$(readlink /usr/lib/libdbus-1.so) /usr/lib/libdbus-1.so
```

Create a symlink so that D-Bus and systemd can use the same `machine-id` file:

```
ln -sv /etc/machine-id /var/lib/dbus
```

10.65.2. Contents of D-Bus

Installed programs:	dbus-cleanup-sockets, dbus-daemon, dbus-launch, dbus-monitor, dbus-send, dbus-uuidgen
Installed libraries:	libdbus-1.[a,so]
Installed directories:	/etc/dbus-1, /usr/include/dbus-1.0, /usr/lib/dbus-1.0, /usr/share/doc/dbus-1.8.6, /var/lib/dbus

Short Descriptions

dbus-cleanup-sockets	Cleans up leftover sockets in a directory
dbus-daemon	The message bus daemon
dbus-uuidgen	Utility to generate UUIDs
dbus-monitor	A debug probe that prints message bus messages
dbus-launch	Utility to start a message bus from a shell script
dbus-send	Send a message to a message bus
libdbus-1	Library containing the API for using the message bus

10.66. Tar-1.27.1

The Tar package contains an archiving program.

10.66.1. Installation of Tar

The following patch adds a man page for **tar**:

```
patch -Np1 -i ../tar-1.27.1-manpage-1.patch
```

Prepare Tar for compilation:

```
FORCE_UNSAFE_CONFIGURE=1 ./configure --prefix=/usr \  
--bindir=/bin --libexecdir=/usr/sbin
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

Generate the man page and place it in the proper location:

```
perl tarman > /usr/share/man/man1/tar.1
```

Install the documentation:

```
make -C doc install-html docdir=/usr/share/doc/tar-1.27.1
```

10.66.2. Contents of Tar

Installed programs:	rmt, tar
Installed directory:	/usr/share/doc/tar-1.27.1

Short Descriptions

rmt Remotely manipulates a magnetic tape drive through an interprocess communication connection

tar Creates, extracts files from, and lists the contents of archives, also known as tarballs

10.67. Texinfo-5.2

The Texinfo package contains programs for reading, writing, and converting info pages.

10.67.1. Installation of Texinfo

Prepare Texinfo for compilation:

```
./configure --prefix=/usr
```

Compile the package:

```
make
```

To test the results, issue:

```
make check
```

Install the package:

```
make install
```

10.67.2. Contents of Texinfo

Installed programs:	info, infokey, install-info, makeinfo (link to texi2any), pdftexi2dvi, texi2dvi, texi2pdf, texindex
Installed directory:	/usr/share/texinfo

Short Descriptions

info	Used to read info pages which are similar to man pages, but often go much deeper than just explaining all the command line options. For example, compare man bison and info bison .
infokey	Compiles a source file containing Info customizations into a binary format
install-info	Used to install info pages; it updates entries in the info index file
makeinfo	Translates the given Texinfo source documents into info pages, plain text, or HTML
pdftexi2dvi	Shell script that run texi2dvi --pdf
texi2dvi	Used to format the given Texinfo document into a device-independent file that can be printed
texi2pdf	Used to format the given Texinfo document into a Portable Document Format (PDF) file
texindex	Used to sort Texinfo index files

10.68. Vim-7.4

The Vim package contains a powerful text editor.

10.68.1. Installation of Vim



Alternatives to Vim

If you prefer another editor—such as Emacs, Joe, or Nano—please refer to http://cblfs.cross-lfs.org/index.php/Category:Text_Editors for suggested installation instructions.

The following patch merges all updates from the 7.4 Branch from the Vim developers:

```
patch -Np1 -i ../vim-7.4-branch_update-5.patch
```

Change the default location of the vimrc configuration file to /etc:

```
echo '#define SYS_VIMRC_FILE "/etc/vimrc"' >> src/feature.h
```

Prepare Vim for compilation:

```
./configure \  
  --prefix=/usr --enable-multibyte
```

Compile the package:

```
make
```

To test the results, issue:

```
make test
```

However, this test suite outputs a lot of binary data to the screen, which can cause issues with the settings of the current terminal. This can be resolved by redirecting the output to a log file.

Install the package:

```
make HELPSUBLOC=/usr/share/doc/vim-7.4 install
```

The meaning of the make option:

```
HELPSUBLOC=/usr/share/doc/vim-7.4
```

Tells Vim to install its documentation into /usr/share/doc/vim-7.4 instead of /usr/share/vim/vim74/doc, for better consistency with the documentation location for other packages.

Many users are accustomed to using **vi** instead of **vim**. Some programs, such as **vigr** and **vipw**, also use **vi**. Create a symlink to permit execution of **vim** when users habitually enter **vi** and allow programs that use **vi** to work:

```
ln -sv vim /usr/bin/vi
```

If an X Window System is going to be installed on the CLFS system, you may want to recompile Vim after installing X. Vim comes with a GUI version of the editor that requires X and some additional libraries to be installed. For more information, refer to the Vim documentation and the Vim installation page in CBLFS at <http://cblfs.cross-lfs.org/index.php/Vim>.

10.68.2. Configuring Vim

By default, **vim** runs in vi-incompatible mode. This may be new to users who have used other editors in the past. The “*nocompatible*” setting is included below to highlight the fact that a new behavior is being used. It also reminds those who would change to “*compatible*” mode that it should be the first setting in the configuration file. This is necessary because it changes other settings, and overrides must come after this setting. Create a default **vim** configuration file by running the following:

```
cat > /etc/vimrc << "EOF"
" Begin /etc/vimrc

set nocompatible
set backspace=2
set ruler
syntax on
if (&term == "item") || (&term == "putty")
    set background=dark
endif

" End /etc/vimrc
EOF
```

The *set nocompatible* makes **vim** behave in a more useful way (the default) than the vi-compatible manner. Remove the “no” to keep the old **vi** behavior. The *set backspace=2* allows backspacing over line breaks, autoindents, and the start of insert. The *syntax on* enables vim's syntax highlighting. Finally, the *if* statement with the *set background=dark* corrects **vim**'s guess about the background color of some terminal emulators. This gives the highlighting a better color scheme for use on the black background of these programs.

Documentation for other available options can be obtained by running the following command:

```
vim -c ':options'
```

10.68.3. Contents of Vim

Installed programs: efm_filter.pl, efm_perl.pl, ex (link to vim), less.sh, mve.awk, pltags.pl, ref, rview (link to vim), rvim (link to vim), shtags.pl, tcltags, vi (link to vim), view (link to vim), vim, vim132, vim2html.pl, vimdiff (link to vim), vimm, vimspell.sh, vimtutor, xxd

Installed directories: /usr/share/vim, /usr/share/doc/vim-7.4

Short Descriptions

efm_filter.pl	A filter for creating an error file that can be read by vim
efm_perl.pl	Reformats the error messages of the Perl interpreter for use with the “quickfix” mode of vim
ex	Starts vim in ex mode
less.sh	A script that starts vim with less.vim
mve.awk	Processes vim errors
pltags.pl	Creates a tags file for Perl code for use by vim
ref	Checks the spelling of arguments

rview	Is a restricted version of view ; no shell commands can be started and view cannot be suspended
rvim	Is a restricted version of vim ; no shell commands can be started and vim cannot be suspended
shtags.pl	Generates a tags file for Perl scripts
tcltags	Generates a tags file for TCL code
view	Starts vim in read-only mode
vi	Link to vim
vim	Is the editor
vim132	Starts vim with the terminal in 132-column mode
vim2html.pl	Converts Vim documentation to HypterText Markup Language (HTML)
vimdiff	Edits two or three versions of a file with vim and show differences
vimm	Enables the DEC locator input model on a remote terminal
vimspell.sh	Spell checks a file and generates the syntax statements necessary to highlight in vim . This script requires the old Unix spell command, which is provided neither in CLFS nor in CBLFS
vimtutor	Teaches the basic keys and commands of vim
xxd	Creates a hex dump of the given file; it can also do the reverse, so it can be used for binary patching

10.69. GRUB-2.00

The GRUB package contains the GRand Unified Bootloader.

10.69.1. Installation of GRUB



Note

If you would like use a different bootloader than this one you can go to the following link for alternative bootloaders and the instructions to use them. <http://trac.cross-lfs.org/wiki/bootloaders>



Note

This package is known to have issues when its default optimization flags (including the `-march` and `-mtune` options) are changed. If any environment variables that override default optimizations have been defined, such as `CFLAGS` and `CXXFLAGS`, unset them when building GRUB.

Glibc-2.19 does not declare `gets()`:

```
sed -i -e '/gets is a/d' grub-core/gnulib/stdio.in.h
```

Prepare GRUB for compilation:

```
./configure --prefix=/usr \  
--sysconfdir=/etc --disable-werror
```

Compile the package:

```
make
```

To test GRUB you must have QEMU installed and then, issue:

```
make check
```

Install the package:

```
make install
```

10.69.2. Configuring GRUB

Now that grub is installed, we need to configure the defaults that will be used to generate the configuration after we install the kernel. Create this file with the following:

```
install -m755 -dv /etc/default
cat > /etc/default/grub << "EOF"
# Begin /etc/default/grub

GRUB_DEFAULT=0
#GRUB_SAVEDEFAULT=true
GRUB_HIDDEN_TIMEOUT=
GRUB_HIDDEN_TIMEOUT_QUIET=false
GRUB_TIMEOUT=10
GRUB_DISTRIBUTOR=Cross-LFS

GRUB_CMDLINE_LINUX=" "
GRUB_CMDLINE_LINUX_DEFAULT=" "

#GRUB_TERMINAL=console
#GRUB_GFXMODE=640x480
#GRUB_GFXPAYLOAD_LINUX=keep

#GRUB_DISABLE_LINUX_UUID=true
#GRUB_DISABLE_LINUX_RECOVERY=true

#GRUB_INIT_TUNE="480 440 1"

#GRUB_DISABLE_OS_PROBER=true

# End /etc/default/grub
EOF
```

The meaning of the above options and possible alternate values:

GRUB_DEFAULT=

Write Me

GRUB_SAVEDEFAULT=

Write Me

GRUB_HIDDEN_TIMEOUT=

Write Me

GRUB_HIDDEN_TIMEOUT_QUIET=

Write Me

GRUB_TIMEOUT=

Write Me

GRUB_DISTRIBUTOR=

Write Me

GRUB_CMDLINE_LINUX=

Write Me

GRUB_CMDLINE_LINUX_DEFAULT=

Write Me

GRUB_TERMINAL=

Write Me

GRUB_GFXMODE=

Write Me

GRUB_GFXPAYLOAD_LINUX=

Write Me

GRUB_DEFAULT=

Write Me

GRUB_DISABLE_LINUX_UUID=

Write Me

GRUB_DISABLE_LINUX_RECOVERY=

Write Me

GRUB_INIT_TUNE=

Write Me

GRUB_DISABLE_OS_PROBER=

Write Me

10.69.3. Contents of GRUB

Installed programs:	grub, grub-install, grub-md5-crypt, grub-set-default, grub-terminfo, and mbchk
Installed directories:	/usr/lib/grub, /boot/grub

Short Descriptions

grub	The Grand Unified Bootloader's command shell
grub-install	Installs GRUB on the given device
grub-md5-crypt	Encrypts a password in MD5 format
grub-set-default	Sets the default boot entry for GRUB
grub-terminfo	Generates a terminfo command from a terminfo name; it can be employed if an unknown terminal is being used
mbchk	Checks the format of a multi-boot kernel

10.70. About Debugging Symbols

Most programs and libraries are, by default, compiled with debugging symbols included (with `gcc`'s `-g` option). This means that when debugging a program or library that was compiled with debugging information included, the debugger can provide not only memory addresses, but also the names of the routines and variables.

However, the inclusion of these debugging symbols enlarges a program or library significantly. The following is an example of the amount of space these symbols occupy:

- a bash binary with debugging symbols: 1200 KB
- a bash binary without debugging symbols: 480 KB
- Glibc and GCC files (`/lib` and `/usr/lib`) with debugging symbols: 87 MB
- Glibc and GCC files without debugging symbols: 16 MB

Sizes may vary depending on which compiler and C library were used, but when comparing programs with and without debugging symbols, the difference will usually be a factor between two and five.

Because most users will never use a debugger on their system software, a lot of disk space can be regained by removing these symbols. The next section shows how to strip all debugging symbols from the programs and libraries.

10.71. Stripping

If the intended user is not a programmer and does not plan to do any debugging on the system software, the system size can be decreased by about 200 MB by removing the debugging symbols from binaries and libraries. This causes no inconvenience other than not being able to debug the software fully anymore.

Most people who use the command mentioned below do not experience any difficulties. However, it is easy to make a typo and render the new system unusable, so before running the `strip` command, it is a good idea to make a backup of the current situation.

Before performing the stripping, take special care to ensure that none of the binaries that are about to be stripped are running. If unsure whether the user entered `chroot` with the command given in [If You Are Going to Chroot](#) first exit from `chroot`:

```
logout
```

Then reenter it with:

```
chroot ${CLFS} /tools/bin/env -i \
  HOME=/root TERM=${TERM} PS1='\u:\w\$ ' \
  PATH=/bin:/usr/bin:/sbin:/usr/sbin \
  /tools/bin/bash --login
```

Now the binaries and libraries can be safely stripped:

```
/tools/bin/find /{,usr/}{bin,lib,sbin} -type f \
  -exec /tools/bin/strip --strip-debug '{} ' ;'
```

A large number of files will be reported as having their file format not recognized. These warnings can be safely ignored. These warnings indicate that those files are scripts instead of binaries.

If disk space is very tight, the `--strip-all` option can be used on the binaries in `/{,usr/}{bin,sbin}` to gain several more megabytes. Do not use this option on libraries—they will be destroyed.

Chapter 11. System Configuration

11.1. Introduction

This chapter details how to finish configuring the base system. This includes some final configuration for systemd as well as locales and a simple bash profile that should be suitable for most users.

11.2. How does Systemd work?



Warning

Please disregard this page until it is complete and verified.

11.2.1. Introduction to Systemd

Systemd is a system management daemon designed exclusively for the Linux kernel API. In the Linux startup process, it is the first process to execute in user land; therefore, it is also the parent process of all child processes in user land.

Systemd's initialization instructions for each daemon are recorded in a declarative configuration file rather than a shell script. For inter-process communication, systemd makes Unix domain sockets and D-Bus available to the running daemons. Because systemd tracks processes using Linux cgroups instead of process identifiers (PIDs), daemons cannot "escape" systemd; not even by double-forking. Systemd is also capable of aggressive parallelization.

Among systemd's auxiliary features are a cron-like job scheduler called systemd Calendar Timers, and an event logging subsystem called journal. The system administrator may choose whether to log system events with systemd or syslog. Systemd's logfile is a binary file. The state of systemd itself can be preserved in a snapshot for future recall.

Systemd provides a replacement for sysvinit, pm-utils, inetd, acpid, syslog, watchdog, cron and atd, and obsoletes ConsoleKit.

11.2.2. Systemctl

systemctl is the main command used to introspect and control systemd.

List running units:

systemctl or **systemctl list-units**

List failed units:

systemctl --failed

List available unit files:

systemctl list-unit-files

Activate a unit immediately:

systemctl start *unit*

Stop a unit immediately:

systemctl stop *unit*

Restart a unit:

systemctl restart *unit*

Reload unit configuration:

```
systemctl reload unit
```

Show status of a unit:

```
systemctl status unit
```

Check if a unit is enabled or disabled:

```
systemctl is-enabled unit
```

Enable a unit to start during boot:

```
systemctl enable unit
```

Disable a unit to not start during boot:

```
systemctl disable unit
```

Reload systemd and scan for new or changed units:

```
systemctl daemon-reload
```

For more information regarding systemd, please refer to the systemd and related man-pages and *Systemd at FedoraProject* for documentation, examples, features, and other information.

11.3. Configuring the system clock

This section discusses how to configure the **systemd-timedated** system service, which configures system clock and timezone.

Systemd provides a **timedatectl** utility which is used to communicate with **systemd-timedated**. It can be used to set the system clock in local time or UTC time, depending on the hardware clock setting. By default, **systemd-timedated** will assume that clock is set to UTC time.

If you cannot remember whether or not the hardware clock is set to UTC, find out by running the **hwclock --localtime --show** command. This will display what the current time is according to the hardware clock. If this time matches whatever your watch says, then the hardware clock is set to local time. If the output from **hwclock** is not local time, chances are it is set to UTC time. Verify this by adding or subtracting the proper amount of hours for the timezone to the time shown by **hwclock**. For example, if you are currently in the MST timezone, which is also known as GMT -0700, add seven hours to the local time.

systemd-timedated reads `/etc/adjtime`, and depending on the contents of the file, it sets the clock to either UTC or local time.

Create the `/etc/adjtime` file with the following contents if your hardware clock is set to local time:

```
cat > /etc/adjtime << "EOF"
0.0 0 0.0
0
LOCAL
EOF
```

If `/etc/adjtime` isn't present at first boot, **systemd-timedated** will assume that hardware clock is set to UTC and adjust the file according to that.

If your clock is set to local time, tell **systemd-timedated** about it by running the following command:

```
timedatectl set-local-rtc 1
```

timedatectl can also be used to change system time and time zone.

To change your current system time, issue:

```
timedatectl set-time YYYY:MM:DD HH:MM:SS
```

Hardware clock will also be updated accordingly.

To change your current time zone, issue:

```
timedatectl set-timezone TIMEZONE
```

You can get list of available time zones by running:

```
timedatectl list-timezones
```



Note

Please note that **timedatectl** command can be used only on a system booted with systemd.

11.4. Configuring the Linux Console

This section discusses how to configure the **systemd-vconsole-setup** system service which configures the virtual console font and console keymap. The **systemd-vconsole-setup** service reads `/etc/vconsole.conf` for configuration information. Decide which keymap and screen font will be used. Various language-specific HOWTO's can help. with this (see <http://www.tldp.org/HOWTO/HOWTO-INDEX/other-lang.html>). Examine **localectl list-keymaps** output for a list of valid console keymaps. Look in `/usr/share/consolefonts` for valid screen fonts.

The `/etc/vconsole.conf` file should contain lines of the form: `VARIABLE="value"`. The following variables are recognized:

KEYMAP

This variable specifies the key mapping table for the keyboard. If unset, it defaults to `us`.

KEYMAP_TOGGLE

This variable can be used to configure a second toggle keymap and is unset by default.

FONT

This variable specifies the font used by the virtual console.

FONT_MAP

This variable specifies the console map to be used.

FONT_UNIMAP

This variable specifies the unicode font map.

An example for a German keyboard and console is given below:

```
cat > /etc/vconsole.conf << "EOF"
KEYMAP=de-latin1
FONT=Lat2-Terminus16
EOF
```

You can change **KEYMAP** value at runtime by using the **localectl** utility:

```
localectl set-keymap MAP
```


**Note**

Please note that **localectl** command can be used only on a system booted with systemd.

You can also use **localectl** utility with the corresponding parameters to change X11 keyboard layout, model, variant and options:

```
localectl set-x11-keymap LAYOUT [MODEL] [VARIANT] [OPTIONS]
```

To list possible values for **localectl set-x11-keymap** parameters, run **localectl** with parameters listed below:

`list-x11-keymap-models`

Show known X11 keyboard mapping models.

`list-x11-keymap-layouts`

Show known X11 keyboard mapping layouts.

`list-x11-keymap-variants`

Show known X11 keyboard mapping variants.

`list-x11-keymap-options`

Show known X11 keyboard mapping options.

**Note**

Using any of the parameters listed above requires *XKeyboard Client* package from CBLFS.

11.5. Device and Module Handling on a CLFS System

In *Installing Basic System Software*, we installed Udev, as one of the components of systemd. Before we go into the details regarding how this works, a brief history of previous methods of handling devices is in order.

11.5.1. History

11.5.1.1. Static Device Nodes

Linux systems in general traditionally use a static device creation method, whereby a great many device nodes are created under `/dev` (sometimes literally thousands of nodes), regardless of whether the corresponding hardware devices actually exist. This is typically done via a **MAKEDEV** script, which contains a number of calls to the **mknod** program with the relevant major and minor device numbers for every possible device that might exist in the world.

11.5.1.2. Devfs

In February 2000, a new filesystem called `devfs`, which dynamically created device nodes as devices were found by the kernel, was merged into the 2.3.46 kernel and was made available during the 2.4 series of stable kernels. Although it was present in the kernel source itself, this method of creating devices dynamically never received overwhelming support from the core kernel developers.

The main problem with the approach adopted by `devfs` was the way it handled device detection, creation, and naming. The latter issue, that of device node naming, was perhaps the most critical. It is generally accepted that if device names are allowed to be configurable, then the device naming policy should be up to a system administrator, not imposed on them by any particular developer(s). The `devfs` file system also suffered from race conditions that were inherent in its design and could not be fixed without a substantial revision to the kernel. It was marked deprecated with the release of the 2.6 kernel series, and was removed entirely as of version 2.6.18.

11.5.1.3. Sysfs

With the development of the unstable 2.5 kernel tree, later released as the 2.6 series of stable kernels, a new virtual filesystem called `sysfs` came to be. The job of `sysfs` is to export a view of the system's hardware configuration to userspace processes. Drivers that have been compiled into the kernel directly register their objects with `sysfs` as they are detected by the kernel. For drivers compiled as modules, this registration will happen when the module is loaded. Once the `sysfs` filesystem is mounted (on `/sys`), data which the built-in drivers registered with `sysfs` are available to userspace processes. With this userspace-visible representation, the possibility of seeing a userspace replacement for `devfs` became much more realistic.

11.5.1.4. Udev Implementation

Shortly after the introduction of `sysfs`, work began on a program called Udev to advantage of it. The `udev` daemon made calls to `mknod()` to create device nodes in `/dev` dynamically, based on the information from `sysfs`, in `/sys`. For example, `/sys/class/tty/vcs/dev` contains the string “7:0”. This string was used by `udev` to create a device node with major number 7 and minor number 0.

Linux kernel version 2.6.32 introduced a new virtual file system called `devtmpfs`, an improved replacement for `devfs`. This allows device nodes to once again be dynamically created by the kernel, without many of the problems of `devfs`. As of version 176, Udev no longer creates device nodes itself, instead relying on `devtmpfs` to do so.

11.5.1.5. Systemd and Eudev

In 2010, development began on `systemd`, an alternate `init` implementation. Starting with Udev 183, Udev's source tree was merged with `systemd`. Several Gentoo developers who disagreed with this merge announced a project fork called Eudev in December 2012, created by extracting the Udev code from `systemd`. One of the goals of Eudev is to allow for easier installation and usage of `udev` without the need for the rest of `systemd`.

11.5.2. Device Node Creation

By default, device nodes created by the kernel in a `devtmpfs` are owned by `root:root` and have `600` permissions. `udev` can modify ownership and permissions of the nodes under the `/dev` directory, and can also create additional symlinks, based on rules specified in the files within the `/etc/udev/rules.d`, `/lib/udev/rules.d`, and `/run/udev/rules.d` directories. The names for these files start with a number, to indicate the order in which they are run, and they have a `.rules` extension (`udev` will ignore files with any other extension). All of the rules files from these directories are combined into a single list, sorted by filename, and run in that order. In the event of a conflict, where a rules file with the same name exists in two or more of these directories, the rules in `/etc` take the highest priority, followed by rules files in `/run`, and finally `/lib`. Any device for which a rule cannot be found will just be ignored by `udev` and be left at the defaults defined by the kernel, as described above. For more details about writing Udev rules, see [/usr/share/doc/systemd-213/udev.html](#).

11.5.3. Module Loading

Device drivers compiled as modules may have aliases built into them. Aliases are visible in the output of the `modinfo` program and are usually related to the bus-specific identifiers of devices supported by a module. For example, the `snd-fm801` driver supports PCI devices with vendor ID `0x1319` and device ID `0x0801`, and has an alias of “`pci:v00001319d00000801sv*sd*bc04sc01i*`”. For most devices, the bus driver exports the alias of the driver that would handle the device via `sysfs`. E.g., the `/sys/bus/pci/devices/0000:00:0d.0/modalias` file might contain the string “`pci:v00001319d00000801sv00001319sd00001319bc04sc01i00`”. The default rules provided by Udev will cause `udev` to call out to `/sbin/modprobe` with the contents of the `MODALIAS` uevent environment variable (that should be the same as the contents of the `modalias` file in `sysfs`), thus loading all modules whose aliases match this string after wildcard expansion.

In this example, this means that, in addition to *snd-fm801*, the obsolete (and unwanted) *forte* driver will be loaded if it is available. See below for ways in which the loading of unwanted drivers can be prevented.

The kernel itself is also able to load modules for network protocols, filesystems and NLS support on demand.

11.5.4. Problems with Loading Modules and Creating Devices

There are a few possible problems when it comes to automatically creating device nodes.

11.5.4.1. A kernel module is not loaded automatically

Udev will only load a module if it has a bus-specific alias and the bus driver properly exports the necessary aliases to `sysfs`. In other cases, one should arrange module loading by other means. With Linux-3.14.13, Udev is known to load properly-written drivers for INPUT, IDE, PCI, USB, SCSI, SERIO and FireWire devices.

To determine if the device driver you require has the necessary support for Udev, run **modinfo** with the module name as the argument. Now try locating the device directory under `/sys/bus` and check whether there is a `modalias` file there.

If the `modalias` file exists in `sysfs`, the driver supports the device and can talk to it directly, but doesn't have the alias, it is a bug in the driver. Load the driver without the help from Udev and expect the issue to be fixed later.

If there is no `modalias` file in the relevant directory under `/sys/bus`, this means that the kernel developers have not yet added `modalias` support to this bus type. With Linux-3.14.13, this is the case with ISA busses. Expect this issue to be fixed in later kernel versions.

Udev is not intended to load “wrapper” drivers such as *snd-pcm-oss* and non-hardware drivers such as *loop* at all.

11.5.4.2. A kernel module is not loaded automatically, and Udev is not intended to load it

If the “wrapper” module only enhances the functionality provided by some other module (e.g., *snd-pcm-oss* enhances the functionality of *snd-pcm* by making the sound cards available to OSS applications), configure **modprobe** to load the wrapper after Udev loads the wrapped module. To do this, add an “install” line to a file in `/etc/modprobe.d`. For example:

```
install snd-pcm /sbin/modprobe -i snd-pcm ; \
    /sbin/modprobe snd-pcm-oss ; true
```

If the module in question is not a wrapper and is useful by itself, configure the **S05modules** bootscript to load this module on system boot. To do this, add the module name to the `/etc/sysconfig/modules` file on a separate line. This works for wrapper modules too, but is suboptimal in that case.

11.5.4.3. Udev loads some unwanted module

Either don't build the module, or blacklist it in `/etc/modprobe.d` file as done with the *forte* module in the example below:

```
blacklist forte
```

Blacklisted modules can still be loaded manually with the explicit **modprobe** command.

11.5.4.4. Udev makes a wrong symlink

This usually happens if a rule unexpectedly matches a device. For example, a poorly-written rule can match both a SCSI disk (as desired) and the corresponding SCSI generic device (incorrectly) by vendor. Find the offending rule and make it more specific, with the help of **udevadm info**.

11.5.4.5. Udev rule works unreliably

This may be another manifestation of the previous problem. If not, and your rule uses `sysfs` attributes, it may be a kernel timing issue, to be fixed in later kernels. For now, you can work around it by creating a rule that waits for the used `sysfs` attribute and appending it to the `/etc/udev/rules.d/10-wait_for_sysfs.rules` file. Please notify the CLFS Development list if you do so and it helps.

11.5.4.6. Device naming order changes randomly after rebooting

This is due to the fact that Udev, by design, handles uevents and loads modules in parallel, and thus in an unpredictable order. This will never be “fixed”. You should not rely upon the kernel device names being stable. Instead, create your own rules that make symlinks with stable names based on some stable attributes of the device, such as a serial number or the output of various `*_id` utilities installed by Udev. See Section 11.6, “Creating custom symlinks to devices” and Networking Configuration for examples.

11.5.5. Useful Reading

Additional helpful documentation is available at the following sites:

- A Userspace Implementation of `devfs`
http://www.kroah.com/linux/talks/ols_2003_udev_paper/Reprint-Kroah-Hartman-OLS2003.pdf
- The `sysfs` Filesystem
<http://www.kernel.org/pub/linux/kernel/people/mochel/doc/papers/ols-2005/mochel.pdf>

11.6. Creating custom symlinks to devices

11.6.1. CD-ROM symlinks

Some software that you may want to install later (e.g., various media players) expect the `/dev/cdrom` and `/dev/dvd` symlinks to exist. Also, it may be convenient to put references to those symlinks into `/etc/fstab`. For each of your CD-ROM devices, find the corresponding directory under `/sys` (e.g., this can be `/sys/block/hdd`) and run a command similar to the following:

```
udevadm test /sys/block/hdd
```

Look at the lines containing the output of various `*_id` programs.

There are two approaches to creating symlinks. The first one is to use the model name and the serial number, the second one is based on the location of the device on the bus. If you are going to use the first approach, create a file similar to the following:

```
cat >/etc/udev/rules.d/82-cdrom.rules << EOF

# Custom CD-ROM symlinks
SUBSYSTEM=="block", ENV{ID_MODEL}=="SAMSUNG_CD-ROM_SC-148F", \
    ENV{ID_REVISION}=="PS05", SYMLINK+="cdrom"
SUBSYSTEM=="block", ENV{ID_MODEL}=="PHILIPS_CDD5301", \
    ENV{ID_SERIAL}=="5VO1306DM00190", SYMLINK+="cdrom1 dvd"

EOF
```

**Note**

Although the examples in this book work properly, be aware that Udev does not recognize the backslash for line continuation. If modifying Udev rules with an editor, be sure to leave each rule on one physical line.

This way, the symlinks will stay correct even if you move the drives to different positions on the IDE bus, but the `/dev/cdrom` symlink won't be created if you replace the old SAMSUNG CD-ROM with a new drive.

The `SUBSYSTEM=="block"` key is needed in order to avoid matching SCSI generic devices. Without it, in the case with SCSI CD-ROMs, the symlinks will sometimes point to the correct `/dev/srX` devices, and sometimes to `/dev/sgX`, which is wrong.

The second approach yields:

```
cat >/etc/udev/rules.d/82-cdrom.rules << EOF

# Custom CD-ROM symlinks
SUBSYSTEM=="block", ENV{ID_TYPE}=="cd", \
    ENV{ID_PATH}=="pci-0000:00:07.1-ide-0:1", SYMLINK+="cdrom"
SUBSYSTEM=="block", ENV{ID_TYPE}=="cd", \
    ENV{ID_PATH}=="pci-0000:00:07.1-ide-1:1", SYMLINK+="cdrom1 dvd"

EOF
```

This way, the symlinks will stay correct even if you replace drives with different models, but place them to the old positions on the IDE bus. The `ENV{ID_TYPE}=="cd"` key makes sure that the symlink disappears if you put something other than a CD-ROM in that position on the bus.

Of course, it is possible to mix the two approaches.

11.6.2. Dealing with duplicate devices

As explained in Section 11.5, “Device and Module Handling on a CLFS System”, the order in which devices with the same function appear in `/dev` is essentially random. E.g., if you have a USB web camera and a TV tuner, sometimes `/dev/video0` refers to the camera and `/dev/video1` refers to the tuner, and sometimes after a reboot the order changes to the opposite one. For all classes of hardware except sound cards and network cards, this is fixable by creating udev rules for custom persistent symlinks. The case of network cards is covered separately in Networking Configuration, and sound card configuration can be found in *CBLFS*.

For each of your devices that is likely to have this problem (even if the problem doesn't exist in your current Linux distribution), find the corresponding directory under `/sys/class` or `/sys/block`. For video devices, this may be `/sys/class/video4linux/videoX`. Figure out the attributes that identify the device uniquely (usually, vendor and product IDs and/or serial numbers work):

```
udevadm info -a -p /sys/class/video4linux/video0
```

Then write rules that create the symlinks, e.g.:

```
cat >/etc/udev/rules.d/83-duplicate_devs.rules << EOF

# Persistent symlinks for webcam and tuner
KERNEL=="video*", SYSFS{idProduct}=="1910", SYSFS{idVendor}=="0d81", \
    SYMLINK+="webcam"
KERNEL=="video*", SYSFS{device}=="0x036f", SYSFS{vendor}=="0x109e", \
    SYMLINK+="tvtuner"

EOF
```

The result is that `/dev/video0` and `/dev/video1` devices still refer randomly to the tuner and the web camera (and thus should never be used directly), but there are symlinks `/dev/tvtuner` and `/dev/webcam` that always point to the correct device.

11.7. The Bash Shell Startup Files

The shell program `/bin/bash` (hereafter referred to as “the shell”) uses a collection of startup files to help create an environment to run in. Each file has a specific use and may affect login and interactive environments differently. The files in the `/etc` directory provide global settings. If an equivalent file exists in the home directory, it may override the global settings.

An interactive login shell is started after a successful login, using `/bin/login`, by reading the `/etc/passwd` file. An interactive non-login shell is started at the command-line (e.g., `[prompt]$/bin/bash`). A non-interactive shell is usually present when a shell script is running. It is non-interactive because it is processing a script and not waiting for user input between commands.

For more information, see **info bash** under the *Bash Startup Files and Interactive Shells* section, and *Bash Startup Files* in CBLFS.

The files `/etc/profile` and `~/ .bash_profile` are read when the shell is invoked as an interactive login shell. Create a base `/etc/profile` that will setup locale information and load any bash auto completion files that may be on the system. This script also sets the `INPUTRC` environment variable that makes Bash and Readline use `/etc/inputrc`.

```
cat > /etc/profile << "EOF"
# Begin /etc/profile

source /etc/locale.conf
for f in /etc/bash_completion.d/*.sh; do source $f; done; unset f
export INPUTRC=/etc/inputrc

# End /etc/profile
EOF
```

11.8. Setting Up Locale Information

The `/etc/locale.conf` below sets some environment variables necessary for native language support. Setting them properly results in:

- The output of programs translated into the native language
- Correct classification of characters into letters, digits and other classes. This is necessary for **bash** to properly accept non-ASCII characters in command lines in non-English locales
- The correct alphabetical sorting order for the country
- Appropriate default paper size
- Correct formatting of monetary, time, and date values

Replace `[LL]` below with the two-letter code for the desired language (e.g., “en”) and `[CC]` with the two-letter code for the appropriate country (e.g., “GB” or “US”). `[charmap]` should be replaced with the canonical charmap for your chosen locale. Optional modifiers such as “@euro” may also be present.

The list of all locales supported by Glibc can be obtained by running the following command:

```
locale -a
```

Locales can have a number of synonyms, e.g. “ISO-8859-1” is also referred to as “iso8859-1” and “iso88591”. Some applications cannot handle the various synonyms correctly, so it is safest to choose the canonical name for a particular locale. To determine the canonical name, run the following command, where `[locale name]` is the output given by **locale -a** for your preferred locale (“en_US.utf8” in our example).

```
LC_ALL=[locale name] locale charmap
```

For the “en_US.utf8” locale, the above command will print:

```
UTF-8
```

This results in a final locale setting of “en_US.UTF-8”. It is important that the locale found using the heuristic above is tested prior to it being added to `/etc/locale.conf`:

```
LC_ALL=[locale name] locale territory
LC_ALL=[locale name] locale language
LC_ALL=[locale name] locale charmap
LC_ALL=[locale name] locale int_curr_symbol
LC_ALL=[locale name] locale int_prefix
```

The above commands should print the language name, the character encoding used by the locale, the local currency, and the prefix to dial before the telephone number in order to get into the country. If any of the commands above fail with a message similar to the one shown below, this means that your locale was either not installed in Chapter 10 or is not supported by the default installation of Glibc.

```
locale: Cannot set LC_* to default locale: No such file or directory
```

If this happens, you should either install the desired locale using the **localedef** command, or consider choosing a different locale. Further instructions assume that there are no such error messages from Glibc.

Some packages beyond CLFS may also lack support for your chosen locale. One example is the X library (part of the X Window System), which outputs the following error message:

```
Warning: locale not supported by Xlib, locale set to C
```

Sometimes it is possible to fix this by removing the charmap part of the locale specification, as long as that does not change the character map that Glibc associates with the locale (this can be checked by running the **locale charmap** command in both locales). For example, one would have to change "de_DE.ISO-8859-15@euro" to "de_DE@euro" in order to get this locale recognized by Xlib.

Other packages can also function incorrectly (but may not necessarily display any error messages) if the locale name does not meet their expectations. In those cases, investigating how other Linux distributions support your locale might provide some useful information.

Once the proper locale settings have been determined, create the `/etc/locale.conf` file:

```
cat > /etc/locale.conf << "EOF"
# Begin /etc/locale.conf

LANG=[ll]_[CC].[charmap][@modifiers]

# End /etc/locale.conf
EOF
```

Note that you can modify `/etc/locale.conf` with systemd's **localectl** utility. To use **localectl** for the example above, run:

```
localectl set-locale LANG="[ll]_[CC][charmap][@modifiers]"
```

You can also specify other language specific environment variables such as `LANG`, `LC_CTYPE`, `LC_NUMERIC` or any other environment variable from **locale** output. Just separate them with a space. An example where `LANG` is set as `en_US.UTF-8` but `LC_CTYPE` is set as just `en_US` is:

```
localectl set-locale LANG="en_US.UTF-8" LC_CTYPE="en_US"
```



Note

Please note that **localectl** command can be used only on a system booted with systemd.

Setting the keyboard layout, screen font, and locale-related environment variables are the only internationalization steps needed to support locales that use ordinary single-byte encodings and left-to-right writing direction. UTF-8 has been tested on the English, French, German, Italian, and Spanish locales. All other locales are untested. If you discover issues with any other locale please open a ticket in our Trac system.

Some locales need additional programs and support. CLFS will not be supporting these locales in the book. We welcome the support for these other locales via <http://cblfs.cross-lfs.org/>.

11.9. Creating the `/etc/inputrc` File

The `/etc/inputrc` file deals with mapping the keyboard for specific situations. This file is the start-up file used by Readline — the input-related library — used by Bash and most other shells.

Most people do not need user-specific keyboard mappings so the command below creates a global `/etc/inputrc` used by everyone who logs in. If you later decide you need to override the defaults on a per-user basis, you can create a `.inputrc` file in the user's home directory with the modified mappings.

For more information on how to edit the `inputrc` file, see **info bash** under the *Readline Init File* section. **info readline** is also a good source of information.

Below is a generic global `inputrc` along with comments to explain what the various options do. Note that comments cannot be on the same line as commands. Create the file using the following command:

```
cat > /etc/inputrc << "EOF"
# Begin /etc/inputrc
# Modified by Chris Lynn <roryo@roryo.dynup.net>

# Allow the command prompt to wrap to the next line
set horizontal-scroll-mode Off

# Enable 8bit input
set meta-flag On
set input-meta On

# Turns off 8th bit stripping
set convert-meta Off

# Keep the 8th bit for display
set output-meta On

# none, visible or audible
set bell-style none

# All of the following map the escape sequence of the
# value contained inside the 1st argument to the
# readline specific functions

"\eOd": backward-word
"\eOc": forward-word

# for linux console
"\e[1~": beginning-of-line
"\e[4~": end-of-line
"\e[5~": beginning-of-history
"\e[6~": end-of-history
"\e[3~": delete-char
"\e[2~": quoted-insert

# for xterm
"\eOH": beginning-of-line
"\eOF": end-of-line

# for Konsole
"\e[H": beginning-of-line
"\e[F": end-of-line
```

```
# End /etc/inputrc
EOF
```

11.10. Creating the /etc/fstab File

The `/etc/fstab` file is used by some programs to determine where file systems are to be mounted by default, in which order, and which must be checked (for integrity errors) prior to mounting. Create a new file systems table like this:

```
cat > /etc/fstab << "EOF"
# Begin /etc/fstab

# file system  mount-point  type  options                dump  fsck
#                                     order

/dev/[xxx]    /             [fff] defaults                1     1
/dev/[yyy]    swap          swap  pri=1                   0     0

# End /etc/fstab
EOF
```

Replace `[xxx]`, `[yyy]`, and `[fff]` with the values appropriate for the system, for example, `sda2`, `sda5`, and `ext2`. For details on the six fields in this file, see **man 5 fstab**.

Chapter 12. Networking Configuration

12.1. Configuring the system hostname

Systemd reads `/etc/hostname` to determine which hostname should be set.

Create the `/etc/hostname` file and enter a hostname by running:

```
echo "[c1fs]" > /etc/hostname
```

`[c1fs]` needs to be replaced with the name given to the computer. Do not enter the Fully Qualified Domain Name (FQDN) here. That information will be put in the `/etc/hosts` file in the next section.

12.2. Customizing the `/etc/hosts` File

If a network card is to be configured, decide on the IP address, fully-qualified domain name (FQDN), and possible aliases for use in the `/etc/hosts` file. The syntax is:

```
<IP address> myhost.example.org aliases
```

Unless the computer is to be visible to the Internet (i.e., there is a registered domain and a valid block of assigned IP addresses—most users do not have this), make sure that the IP address is in the private network IP address range. Valid ranges are:

Private Network Address Range	Normal Prefix
10.0.0.1 - 10.255.255.254	8
172.x.0.1 - 172.x.255.254	16
192.168.y.1 - 192.168.y.254	24

`x` can be any number in the range 16-31. `y` can be any number in the range 0-255.

A valid IP address could be 192.168.1.1. A valid FQDN for this IP could be `www.cross-lfs.org` (not recommended because this is a valid registered domain address and could cause domain name server issues).

Even if not using a network card, a valid FQDN is still required. This is necessary for certain programs to operate correctly.

Create the `/etc/hosts` file by running:

```
cat > /etc/hosts << "EOF"
# Begin /etc/hosts (network card version)

127.0.0.1 localhost
[192.168.1.1] [<HOSTNAME>.example.org] [HOSTNAME] [alias ...]

# End /etc/hosts (network card version)
EOF
```

The `[192.168.1.1]` and `[<HOSTNAME>.example.org]` values need to be changed for specific users or requirements (if assigned an IP address by a network/system administrator and the machine will be connected to an existing network). The optional alias name(s) can be omitted.

If a network card is not going to be configured, create the `/etc/hosts` file by running:

```
cat > /etc/hosts << "EOF"
# Begin /etc/hosts (no network card version)

127.0.0.1 [<HOSTNAME>.example.org] [HOSTNAME] localhost

# End /etc/hosts (no network card version)
EOF
```

12.3. Creating the `/etc/resolv.conf` File

12.3.1. Creating the `/etc/resolv.conf` File

If the system is going to be connected to the Internet, it will need some means of Domain Name Service (DNS) name resolution to resolve Internet domain names to IP addresses, and vice versa. This is best achieved by placing the IP address of the DNS server, available from the ISP or network administrator, into `/etc/resolv.conf`. If at least one of your network interfaces is going to be configured by DHCP then you may not need to create this file. By default DHCPD will overwrite this file when it gets a new lease from the DHCP server. If you wish to manually configure your network interfaces or manually set your DNS using DHCP then create the file by running the following:

```
cat > /etc/resolv.conf << "EOF"
# Begin /etc/resolv.conf

domain [Your Domain Name]
nameserver [IP address of your primary nameserver]
nameserver [IP address of your secondary nameserver]

# End /etc/resolv.conf
EOF
```

The *domain* statement can be omitted or replaced with a *search* statement. See the man page for `resolv.conf` for more details.

Replace *[IP address of the nameserver]* with the IP address of the DNS most appropriate for the setup. There will often be more than one entry (requirements demand secondary servers for fallback capability). If you only need or want one DNS server, remove the second *nameserver* line from the file. The IP address may also be a router on the local network.

12.4. Systemd Networking?

This section only applies if a network card is to be configured. If you do not need to configure a network interface you can skip on to Making the CLFS System Bootable.

There are two different ways you can proceed from this point to configure your network. You can use `systemd`, or install the `CLFS-Network-Scripts`.

To use `systemd` to configure a Network Interface, Follow Section 12.5, “Networking Configuration with `Systemd-networkd`”.

To use `CLFS-network-scripts` to configure a Network Interface, Follow Section 12.6, “`CLFS-Network-Scripts-20140224`”.

12.5. Networking Configuration with Systemd-networkd

12.5.1. Network Interface Configuration



Note

Udev may assign random Network Card Interface names for some network cards such as `enp2s1`. If you are not sure what your Network Card Interface name is, you can always run **ip l** after you have booted your system. It is important that the `Name` variable in `/etc/systemd/network` contain the correct Network Card Interface name (e.g. `Name=enp2s1` or `Name=eth0`) or `systemd` will fail to bring up your network interface.

12.5.1.1. Static Network Interface Configuration

`systemd-networkd` uses `/etc/systemd/network` for configuration files. Refer to `systemd.network(5)` and `systemd.netdev(5)`. Configure a network interface with a config file. Adjust `Name=` as required:

```
cd /etc/systemd/network &&
cat > static.network << "EOF"
[Match]
Name=enp2s0

[Network]
Address=192.168.1.1/24
Gateway=192.168.1.2
EOF
```

The values of these variables must be changed in every file to match the proper setup.

The `Name` variable defines the interface name, for example, `eth0`. It is required for all network device configuration files.

The `Gateway` variable should contain the default gateway IP address, if one is present. If not, then comment out the variable entirely.

For more information see the `systemd.netdev` man page.

12.5.1.2. Connecting to a network with DHCP

`systemd-networkd` uses `/etc/systemd/network` for configuration files. Refer to `systemd.network(5)` and `systemd.netdev(5)`. Configure a network interface with a config file. Adjust `Name=` as required:

```
cd /etc/systemd/network &&
cat > dhcp.network << "EOF"
[Match]
Name=enp2s0

[Network]
DHCP=yes
EOF
```

systemd-networkd will automatically configure `/run/systemd/network/resolv.conf` when using DHCP. If you did not manually create `/etc/resolv.conf`, create a symlink:

```
ln -sv /run/systemd/network/resolv.conf /etc
```

12.5.2. Using Timesyncd

Systemd includes a simple NTP client daemon, **systemd-timesyncd**, though it is disabled by default. If you want to enable it, you will first need to add a required user and group:

```
groupadd -g 41 systemd-timesync  
useradd -g systemd-timesync -u 41 -d /dev/null -s /bin/false systemd-timesync
```

Then, actually enable **systemd-timesyncd** so that it will run on system boot:

```
systemctl enable systemd-timesyncd
```

You can configure **systemd-timesyncd** by editing `/etc/systemd/timesyncd.conf`.

Continue to Making the CLFS System Bootable.

12.6. CLFS-Network-Scripts-20140224

The CLFS-Network-Scripts package contains a set of scripts to configure the network at bootup and deconfigure it at shutdown.

12.6.1. Installation of CLFS-Network-Scripts

Install the package:

```
make install
```

12.6.2. Contents of CLFS-Network-Scripts

Installed scripts:	ifdown, ifup, ipv4-static
Installed systemd units:	ifupdown@.service, dhcpcd@.service, nscd.service
Installed directories:	/etc/sysconfig, /lib/services, /lib/lsh (symbolic link)

Short Descriptions

ifdown	Stops a network device.
ifup	Initializes a network device.
ipv4-static	Provides the functionality needed to assign a static Internet Protocol (IP) address to a network interface.

12.7. Static Networking Configuration

12.7.1. Creating the Static Network Interface Configuration Files

Which interfaces are brought up and down by the network script depends on the files and directories in the `/etc/sysconfig` hierarchy. This directory should contain a sub-directory for each interface to be configured, such as `ifconfig.xyz`, where “xyz” is a network interface name. Inside this directory would be files defining the attributes to this interface, such as its IP address(es), subnet masks, and so forth.



Note

Udev may assign random Network Card Interface names for some network cards such as `enp2s1`. If you are not sure what your Network Card Interface name is, you can always run `ip l` after you have booted your system. Again, it is important that `ifconfig.xyz` is named after correct Network Card Interface name (e.g. `ifconfig.enp2s1` or `ifconfig.eth0`) or `systemd` will fail to bring up your network interface.

The following command creates a sample `ipv4` file for the `eth0` device:

```
mkdir -pv /etc/sysconfig &&
cd /etc/sysconfig &&
cat > ifconfig.eth0 << "EOF"
IFACE="eth0"
SERVICE="ipv4-static"
IP="192.168.1.1"
GATEWAY="192.168.1.2"
PREFIX="24"
BROADCAST="192.168.1.255"
EOF
```

The values of these variables must be changed in every file to match the proper setup.

The `IFACE` variable defines the interface name, for example, `eth0`. It is required for all network device configuration files.

The `SERVICE` variable defines the method used for obtaining the IP address. The `CLFS-Network-Scripts` package has a modular IP assignment format, and creating additional files in the `/lib/services` directory allows other IP assignment methods.

The `GATEWAY` variable should contain the default gateway IP address, if one is present. If not, then comment out the variable entirely.

The `PREFIX` variable needs to contain the number of bits used in the subnet. Each octet in an IP address is 8 bits. If the subnet's netmask is `255.255.255.0`, then it is using the first three octets (24 bits) to specify the network number. If the netmask is `255.255.255.240`, it would be using the first 28 bits. Prefixes longer than 24 bits are commonly used by DSL and cable-based Internet Service Providers (ISPs). In this example (`PREFIX=24`), the netmask is `255.255.255.0`. Adjust the `PREFIX` variable according to your specific subnet.

For more information see the `ifup` man page.

To configure another DHCP Interface, Follow Section 12.8, “DHCPD-6.3.2”.

12.7.2. Configuring the Network Interface at boot

Enabling of the Network Interface configuration is done per interface. To enable Network Interface configuration at boot, run:

```
systemctl enable ifupdown@eth0
```

To disable previously enabled Network Interface configuration at boot, run:

```
systemctl disable ifupdown@eth0
```

To manually start the Network Interface configuration, run:

```
systemctl start ifupdown@eth0
```

Replace eth0 with the correct Network Interface name as described on the beginning of this page.

12.8. DHCPD-6.3.2

The DHCPD package provides a DHCP Client for network configuration.

12.8.1. Installation of DHCPD

If you wish to configure your network to connect to a DHCP server, you will first need to install a DHCP client. CLFS uses the DHCPD package for this.

Prepare DHCPD for compilation:

```
./configure --prefix=/usr --sbindir=/sbin \
  --sysconfdir=/etc --dbdir=/var/lib/dhcpd --libexecdir=/usr/lib/dhcpd
```

Compile the package:

```
make
```

This package does not come with a test suite.

Install the package:

```
make install
```

12.8.2. Creating the DHCP Network Interface Configuration File

The following is an example for the eth0 interface. Refer to the dhcpd.conf man page for more information. This step may be skipped if default behavior of dhcpd is required.

Create the /etc/dhcpd.conf configuration file using the following commands. Adjust appropriately for additional options:

```
cd /etc &&
cat > dhcpd.conf << "EOF"
# dhcpd configuration eth0 interface
# See dhcpd.conf(5) for details.

interface eth0
# dhcpd-run-hooks uses these options.
option subnet_mask, routers, domain_name_servers

# The default timeout for waiting for a DHCP response is 30 seconds
# which may be too long or too short and can be changed here.
timeout 16
EOF
```

To configure another Static Interface, Follow Section 12.7, “Static Networking Configuration”.

12.8.3. Configuring the Network Interface at boot

Enabling of the Network Interface configuration is done per interface. To enable Network Interface configuration at boot, run:

```
systemctl enable dhcpd@eth0
```

To disable previously enabled Network Interface configuration at boot, run:

```
systemctl disable dhcpd@eth0
```

To manually start the Network Interface configuration, run:

```
systemctl start dhcpd@eth0
```

Replace eth0 with the correct Network Interface name as described on the beginning of this page.

12.8.4. Contents of dhcpd

Installed files: dhcpd

Short Descriptions

dhcpd dhcpd is an implementation of the DHCP client specified in RFC 2131. It gets the host information from a DHCP server and configures the network interface automatically.

Chapter 13. Making the CLFS System Bootable

13.1. Introduction

It is time to make the CLFS system bootable. This chapter discusses building a kernel for the new CLFS system and installing the boot loader so that the CLFS system can be selected for booting at startup.

13.2. Linux-3.14.13

The Linux package contains the Linux kernel.

13.2.1. Installation of the kernel

Building the kernel involves a few steps—configuration, compilation, and installation. Read the `README` file in the kernel source tree for alternative methods to the way this book configures the kernel.

Apply the latest Linux sublevel patch:

```
xzcat ../patch-3.14.13.xz | patch -Np1 -i -
```

Prepare for compilation by running the following command:

```
make mrproper
```

This ensures that the kernel tree is absolutely clean. The kernel team recommends that this command be issued prior to each kernel compilation. Do not rely on the source tree being clean after un-tarring.



Note

A good starting place for setting up the kernel configuration is to run **make defconfig**. This will set the base configuration to a good state that takes your current system architecture into account.

Be sure to enable or disable following features or the system might not work correctly or boot at all. Refer to `/usr/share/doc/systemd-213/README:`

```

General setup --->
  [*] open by fhandle syscalls (CONFIG_FHANDLE)
  [ ] Auditing support (CONFIG_AUDIT)
  [*] Control Group support (CONFIG_CGROUPS)
Processor type and features --->
  [*] Enable seccomp to safely compute untrusted bytecode (CONFIG_SECCOMP)
Networking support --->
  Networking options --->
    <*> The IPv6 protocol (CONFIG_IPV6)
Device Drivers --->
  Generic Driver Options --->
    ( ) path to uevent helper (CONFIG_UEVENT_HELPER_PATH)
    [*] Maintain a devtmpfs filesystem to mount at /dev (CONFIG_DEVTMPFS)
    [ ] Fallback user-helper invocation for firmware loading (CONFIG_FW_LOADER)
File systems --->
  [*] Inotify support for userspace (CONFIG_FSNOTIFY)
  <*> Kernel automounter version 4 support (also supports v3) (CONFIG_AUTOFS4)
Pseudo filesystems --->
  [*] Tmpfs POSIX Access Control Lists (CONFIG_TMPFS_POSIX_ACL)
  [*] Tmpfs extended attributes (CONFIG_TMPFS_XATTR)
Firmware Drivers --->
  EFI (Extensible Firmware Interface) Support --->
    <*> EFI Variable Support via sysfs (CONFIG_EFI_VARS)
-*- Enable the block layer ---> (CONFIG_BLOCK)
  Partition Types --->
    [*] Advanced partition selection (CONFIG_PARTITION_ADVANCED)
    [*] EFI GUID Partition support (CONFIG_EFI_PARTITION)
Kernel Hacking --->
  [*] Collect scheduler debugging info (CONFIG_SCHED_DEBUG)
  [*] Collect scheduler statistics (CONFIG_SCHEDSTATS)

```



Note

While "The IPv6 Protocol" is not strictly required, it is highly recommended by the Systemd developers. "EFI Variable support" and "EFI GUID Partition support" are for UEFI systems. "Collect scheduler debugging info" and "Collect scheduler statistics" is for systemd-bootchart.

Configure the kernel via a menu-driven interface. CBLFS has some information regarding particular kernel configuration requirements of packages outside of CLFS at <http://cblfs.cross-lfs.org/>:

```
make menuconfig
```

Alternatively, **make oldconfig** may be more appropriate in some situations. See the README file for more information.

If desired, skip kernel configuration by copying the kernel config file, `.config`, from the host system (assuming it is available) to the root directory of the unpacked kernel sources. However, we do not recommend this option. It is often better to explore all the configuration menus and create the kernel configuration from scratch.

Compile the kernel image and modules:

```
make
```

If using kernel modules, a configuration file in `/etc/modprobe.d` file may be needed. Information pertaining to modules and kernel configuration is located in the kernel documentation in the `Documentation` directory of the kernel sources tree. Also, `modprobe.d(5)` may be of interest.

Install the modules, if the kernel configuration uses them:

```
make modules_install
```

Install the firmware, if the kernel configuration uses them:

```
make firmware_install
```

After kernel compilation is complete, additional steps are required to complete the installation. Some files need to be copied to the `/boot` directory.

Issue the following command to install the kernel:

```
cp -v arch/x86_64/boot/bzImage /boot/vmlinuz-clfs-3.14.13
```

`System.map` is a symbol file for the kernel. It maps the function entry points of every function in the kernel API, as well as the addresses of the kernel data structures for the running kernel. Issue the following command to install the map file:

```
cp -v System.map /boot/System.map-3.14.13
```

The kernel configuration file `.config` produced by the **make menuconfig** step above contains all the configuration selections for the kernel that was just compiled. It is a good idea to keep this file for future reference:

```
cp -v .config /boot/config-3.14.13
```

It is important to note that the files in the kernel source directory are not owned by `root`. Whenever a package is unpacked as user `root` (like we do inside the final-system build environment), the files have the user and group IDs of whatever they were on the packager's computer. This is usually not a problem for any other package to be installed because the source tree is removed after the installation. However, the Linux source tree is often retained for a long time. Because of this, there is a chance that whatever user ID the packager used will be assigned to somebody on the machine. That person would then have write access to the kernel source.

If the kernel source tree is going to be retained, run **chown -R 0:0** on the `linux-3.14` directory to ensure all files are owned by user `root`.



Warning

Some kernel documentation recommends creating a symlink from `/usr/src/linux` pointing to the kernel source directory. This is specific to kernels prior to the 2.6 series and *must not* be created on a CLFS system as it can cause problems for packages you may wish to build once your base CLFS system is complete.

Also, the headers in the system's `include` directory should *always* be the ones against which Glibc was compiled and should *never* be replaced by headers from a different kernel version.

13.2.2. Contents of Linux

Installed files: `config-[linux-version]`, `clfskernel-[linux-version]`, and `System.map-[linux-version]`
Installed directory: `/lib/modules`

Short Descriptions

<code>config-[linux-version]</code>	Contains all the configuration selections for the kernel
<code>clfskernel-[linux-version]</code>	The engine of the Linux system. When turning on the computer, the kernel is the first part of the operating system that gets loaded. It detects and initializes all components of the computer's hardware, then makes these components available as a tree of files to the software and turns a single CPU into a multitasking machine capable of running scores of programs seemingly at the same time.
<code>System.map-[linux-version]</code>	A list of addresses and symbols; it maps the entry points and addresses of all the functions and data structures in the kernel

13.3. Making the CLFS System Bootable

Your shiny new CLFS system is almost complete. One of the last things to do is to ensure that the system can be properly booted. The instructions below apply only to computers of x86 and x86_64 architecture, meaning mainstream PCs. Information on “boot loading” for other architectures should be available in the usual resource-specific locations for those architectures.

Boot loading can be a complex area, so a few cautionary words are in order. Be familiar with the current boot loader and any other operating systems present on the hard drive(s) that need to be bootable. Make sure that an emergency boot disk is ready to “rescue” the computer if the computer becomes unusable (un-bootable).



Warning

The following command will overwrite the current boot loader. Do not run the command if this is not desired, for example, if using a third party boot manager to manage the Master Boot Record (MBR). In this scenario, it would make more sense to install GRUB into the “boot sector” of the CLFS partition. In this case, this next command would become `grub-install /dev/sda2`.

Instruct GRUB to install itself into the MBR of sda:

```
grub-install /dev/sda
```

Next, we need to generate a configuration for GRUB. In previous versions of grub we could create the configuration manually here, but with GRUB2 we can generate `grub.cfg` automatically. You can do this with the following command:

```
grub-mkconfig -o /boot/grub/grub.cfg
```

Chapter 14. The End

14.1. The End

Well done! The new CLFS system is installed! We wish you much success with your shiny new custom-built Linux system.

It may be a good idea to create an `/etc/clfs-release` file. By having this file, it is very easy for you (and for us if you need to ask for help at some point) to find out which CLFS version is installed on the system. Create this file by running:

```
echo 3.0.0-RC1 > /etc/clfs-release
```

14.2. Download Client

The final system build does not install an FTP or HTTP client for downloading files.

Some suggested clients include:

- Curl <http://cblfs.cross-lfs.org/index.php/Curl>
- Inetutils <http://cblfs.cross-lfs.org/index.php/Inetutils>
- LFTP <http://lftp.yar.ru/>
- Links <http://cblfs.cross-lfs.org/index.php/Links>
- Lynx <http://cblfs.cross-lfs.org/index.php/Lynx>
- NcFTP Client <http://cblfs.cross-lfs.org/index.php/Ncftp>
- Wget <http://cblfs.cross-lfs.org/index.php/Wget>
- BASH - A user can use net redirections (if not disabled when building bash in the final system) to download wget or another program.

```
cat > download.sh << "EOF"
#!/bin/bash

WGET_VERSION='1.14'
WGET_HOSTNAME='ftp.gnu.org'
exec {HTTP_FD}<>/dev/tcp/${WGET_HOSTNAME}/80
echo -ne "GET /gnu/wget/wget-${WGET_VERSION}.tar.xz HTTP/1.1\r\nHost: "\
${WGET_HOSTNAME}'\r\nUser-Agent: '\
'bash/'${BASH_VERSION}'\r\n\r\n' >&${HTTP_FD}
sed -e '1,/^.$/d' <&${HTTP_FD} >wget-${WGET_VERSION}.tar.xz
EOF
```

- GAWK

```
cat > gawkdl.sh << "EOF"
#!/bin/bash

gawk 'BEGIN {
    NetService = "/inet/tcp/0/mirror.anl.gov/80"
    print "GET /pub/gnu/wget/wget-1.14.tar.xz" |& NetService
    while ((NetService |& getline) > 0)
        print $0
    close(NetService)
}' > binary

gawk '{q=p;p=$0}NR>1{print q}END{ORS = ""; print p}' binary > wget-1.14.tar.xz

rm binary
EOF
```

- PERL with HTTP::Tiny (Included with final system PERL install).

```
cat > download.pl << "EOF"
#!/usr/bin/perl

use HTTP::Tiny;
my $http = HTTP::Tiny->new;
my $response;

$response = $http->mirror('http://ftp.gnu.org/gnu/wget/wget-1.14.tar.xz', 'wget');
die "Failed!\n" unless $response->{success};
print "Unchanged!\n" if $response->{status} eq '304';
EOF
```

Or use this:

```
perl -MHTTP::Tiny -E 'say HTTP::Tiny->new->get(shift)->{content}' "http://ftp.gnu.org/pub/gnu/wget/wget-1.14.tar.xz"
perl -e 'local $/; $_ = <>; s/\n$//; print' binary > wget-1.14.tar.xz
rm binary
```

- PERL with LWP: Run **cpan** and manually configure the client. Run **install LWP** while in the CPAN shell. Refer to <http://www.bioinfo-user.org.uk/dokuwiki/doku.php/projects/wgetpl> for wgetpl.

14.3. Rebooting the System

If you built your final system using the boot method, just run **shutdown -r now** to reboot again, using your newly-built kernel instead of the minimal one currently in use. If you chrooted, there are a few more steps.

The system you have created in this book is quite minimal, and most likely will not have the functionality you would need to be able to continue forward. By installing a few extra packages from CBLFS while still in our current chroot environment, you can leave yourself in a much better position to continue on once you reboot into your new CLFS installation. Installing a text mode web browser, such as Lynx, you can easily view the CBLFS website in one virtual

terminal, while building packages in another. The GPM package will also allow you to perform copy/paste actions in your virtual terminals. Lastly, if you are in a situation where static IP configuration does not meet your networking requirements, installing packages such as Dhcpcd or PPP at this point might also be useful.

Now that we have said that, lets move on to booting our shiny new CLFS installation for the first time! First exit from the chroot environment:

```
logout
```

Then unmount the virtual file systems:

```
umount ${CLFS}/dev/pts

if [ -h ${CLFS}/dev/shm ]; then
    link=$(readlink ${CLFS}/dev/shm)
    umount -v ${CLFS}/$link
    unset link
else
    umount -v ${CLFS}/dev/shm
fi

umount ${CLFS}/dev
umount ${CLFS}/proc
umount ${CLFS}/sys
```

Unmount the CLFS file system itself:

```
umount ${CLFS}
```

If multiple partitions were created, unmount the other partitions before unmounting the main one, like this:

```
umount ${CLFS}/usr
umount ${CLFS}/home
umount ${CLFS}
```

Now, reboot the system with:

```
shutdown -r now
```

Assuming the boot loader was set up as outlined earlier, *CLFS 3.0.0-RC1* will boot automatically.

When the reboot is complete, the CLFS system is ready for use and more software may be added to suit your needs.

14.4. What Now?

Thank you for reading this CLFS book. We hope that you have found this book helpful and have learned more about the system creation process.

Now that the CLFS system is installed, you may be wondering “What next?” To answer that question, we have compiled a list of resources for you.

- Maintenance

Bugs and security notices are reported regularly for all software. Since a CLFS system is compiled from source, it is up to you to keep abreast of such reports. There are several online resources that track such reports, some of which are shown below:

- Freecode (<http://freecode.com/>)

Freecode can notify you (via email) of new versions of packages installed on your system.

- *CERT* (Computer Emergency Response Team)

CERT has a mailing list that publishes security alerts concerning various operating systems and applications. Subscription information is available at <http://www.us-cert.gov/cas/signup.html>.

- Bugtraq

Bugtraq is a full-disclosure computer security mailing list. It publishes newly discovered security issues, and occasionally potential fixes for them. Subscription information is available at <http://www.securityfocus.com/archive>.

- Community Driven Beyond Linux From Scratch

The Community Driven Beyond Linux From Scratch wiki covers installation procedures for a wide range of software beyond the scope of the CLFS Book. CBLFS is designed specifically to work with the CLFS book, and has all the necessary information to continue the builds in the same manner that CLFS uses. This is a community driven project, which means anyone can contribute and provide updates. The CBLFS project is located at <http://cblfs.cross-lfs.org/>.

- CLFS Hints

The CLFS Hints are a collection of educational documents submitted by volunteers in the CLFS community. The hints are available at <http://hints.cross-lfs.org/index.php/>.

- Mailing lists

There are several CLFS mailing lists you may subscribe to if you are in need of help, want to stay current with the latest developments, want to contribute to the project, and more. See Chapter 1 - Mailing Lists for more information.

- The Linux Documentation Project

The goal of The Linux Documentation Project (TLDP) is to collaborate on all of the issues of Linux documentation. The TLDP features a large collection of HOWTOs, guides, and man pages. It is located at <http://www.tldp.org/>.

Part VI. Appendices

Appendix A. Acronyms and Terms

ABI	Application Binary Interface
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
ATA	Advanced Technology Attachment (see IDE)
BIOS	Basic Input/Output System
bles	manipulate a filesystem so that OF will boot from it
BSD	Berkeley Software Distribution
CBLFS	Community Driven Beyond Linux From Scratch
chroot	change root
CLFS	Cross-Compiled Linux From Scratch
CMOS	Complementary Metal Oxide Semiconductor
COS	Class Of Service
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Service
EGA	Enhanced Graphics Adapter
ELF	Executable and Linkable Format
EOF	End of File
EQN	equation
ext2	second extended file system
ext3	third extended file system
ext4	fourth extended file system
FAQ	Frequently Asked Questions
FHS	Filesystem Hierarchy Standard
FIFO	First-In, First Out
FQDN	Fully Qualified Domain Name
FTP	File Transfer Protocol
GB	Gigabytes
GCC	GNU Compiler Collection
GID	Group Identifier
GMT	Greenwich Mean Time
HTML	Hypertext Markup Language
IDE	Integrated Drive Electronics

IEEE	Institute of Electrical and Electronic Engineers
IO	Input/Output
IP	Internet Protocol
IPC	Inter-Process Communication
IRC	Internet Relay Chat
ISO	International Organization for Standardization
ISP	Internet Service Provider
KB	Kilobytes
LED	Light Emitting Diode
LFS	Linux From Scratch
LSB	Linux Standard Base
MB	Megabytes
MBR	Master Boot Record
MD5	Message Digest 5
NIC	Network Interface Card
NLS	Native Language Support
NPTL	Native POSIX Threading Library
OF	Open Firmware
OSS	Open Sound System
PCH	Pre-Compiled Headers
PID	Process Identifier
PTY	pseudo terminal
QA	Quality Assurance
QOS	Quality Of Service
RAM	Random Access Memory
RPC	Remote Procedure Call
RTC	Real Time Clock
SCO	The Santa Cruz Operation
SATA	Serial ATA
SGR	Select Graphic Rendition
SHA1	Secure-Hash Algorithm 1
TLDP	The Linux Documentation Project
TFTP	Trivial File Transfer Protocol
TLS	Thread-Local Storage
UID	User Identifier
umask	user file-creation mask

USB	Universal Serial Bus
UTC	Coordinated Universal Time
UUID	Universally Unique Identifier
VC	Virtual Console
VGA	Video Graphics Array
VT	Virtual Terminal

Appendix B. Dependencies

Every package built in CLFS relies on one or more other packages in order to build and install properly. Some packages even participate in circular dependencies, that is, the first package depends on the second which in turn depends on the first. Because of these dependencies, the order in which packages are built in CLFS is very important. The purpose of this page is to document the dependencies of each package built in CLFS.

For each package we build, we have listed three types of dependencies. The first lists what other packages need to be available in order to compile and install the package in question. The second lists what packages, in addition to those on the first list, need to be available in order to run the test suites. The last list of dependencies are packages that require this package to be built and installed in its final location before they are built and installed. In most cases, this is because these packages will hardcode paths to binaries within their scripts. If not built in a certain order, this could result in paths of `/tools/bin/[binary]` being placed inside scripts installed to the final system. This is obviously not desirable.

ACL

Installation depends on: Attr, Bash, Binutils, Coreutils, Glibc, GCC, Gettext, Grep, Libtool, Make, Sed
Test suite depends on: No test suite available
Must be installed before: Coreutils, Gettext, Libcap, Sed, Systemd

Attr

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Gettext, Grep, Libtool, Make, Sed
Test suite depends on: No test suite available
Must be installed before: ACL, Coreutils, Gettext, Libcap, Sed, Systemd

Autoconf

Installation depends on: Bash, Coreutils, Gawk, Grep, M4, Make, Perl, Sed, Texinfo
Test suite depends on: Automake, Binutils, Diffutils, Findutils, GCC, Libtool
Must be installed before: Automake

Automake

Installation depends on: Autoconf, Bash, Binutils, Coreutils, Gawk, Grep, M4, Make, Perl, Sed, Texinfo
Test suite depends on: Bison, Bzip2, DejaGNU, Diffutils, Expect, Findutils, Flex, GCC, Gettext, Gzip, Libtool, Tar, XZ Utils. Can also use several other packages that are not installed in CLFS.
Must be installed before: None

Bash

Installation depends on: Bash, Bison, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, Make, Ncurses, Patch, Readline, Sed, Texinfo
Test suite depends on: None
Must be installed before: None

Bc

Installation depends on: Bash, Binutils, Bison, Coreutils, Glibc, GCC, Grep, Make, , Readline
Test suite depends on: Gawk
Must be installed before: None

Binutils

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, File, Gawk, GCC, Grep, Make, Perl, Sed, Texinfo, Zlib
Test suite depends on: DejaGNU, Expect
Must be installed before: None

Bison

Installation depends on: Bash, Binutils, Coreutils, Glibc, Gawk, GCC, Grep, M4, Make, Sed
Test suite depends on: Diffutils, Findutils, Gawk
Must be installed before: Flex, Kbd, Tar

Bzip2

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Make
Test suite depends on: Diffutils
Must be installed before: None

CLFS-Boot-scripts

Installation depends on: Bash, Coreutils, Make, Sed
Test suite depends on: None
Must be installed before: None

Check

Installation depends on: GCC, Grep, Make, Sed, Texinfo
Test suite depends on: None
Must be installed before: None

CLooG

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, GMP, ISL, Make, MPC, MPFR, Sed, Texinfo
Test suite depends on: None
Must be installed before: GCC

Coreutils

Installation depends on: ACL, Attr, Bash, Binutils, Coreutils, Glibc, Gawk, GCC, GMP, Grep, Libcap, Make, Patch, Perl, Sed, Texinfo

Test suite depends on: Diffutils, E2fsprogs, Findutils, Util-linux

Must be installed before: Bash, Diffutils, Findutils, Man

D-Bus

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Expat, Gawk, GCC, Gettext, Grep, Make, Man, Pkg-config, Sed, Texinfo

Test suite depends on: None

Must be installed before: Systemd

DejaGNU

Installation depends on: Bash, Coreutils, Diffutils, GCC, Grep, Make, Sed

Test suite depends on: None

Must be installed before: None

DHCPD

Installation depends on: Bash, Coreutils, GCC, Make, Sed

Test suite depends on: No test suite available

Must be installed before: None

Diffutils

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Patch, Sed, Texinfo

Test suite depends on: No test suite available

Must be installed before: None

Glibc

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Gawk, GCC, Gettext, Grep, Gzip, Make, Perl, Sed, Texinfo

Test suite depends on: None

Must be installed before: None

Eudev

Installation depends on: Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, Make, Sed

Test suite depends on: No test suite available

Must be installed before: Systemd

Expat

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, GCC, Grep, Make, Sed

Test suite depends on: None

Must be installed before: D-Bus, XML::Parser

Expect

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, GCC, Grep, Make, Patch, Sed, Tcl

Test suite depends on: None

Must be installed before: None

E2fsprogs

Installation depends on: Bash, Binutils, Coreutils, Glibc, Gawk, GCC, Gettext, Grep, Gzip, Make, Pkg-config-lite, Sed, Texinfo, Util-linux

Test suite depends on: Bzip2, Diffutils

Must be installed before: None

File

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, Make, Sed, Zlib

Test suite depends on: No test suite available

Must be installed before: None

Findutils

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Sed, Texinfo

Test suite depends on: DejaGNU, Diffutils, Expect

Must be installed before: None

Flex

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, M4, Make, Sed, Texinfo

Test suite depends on: Bison, Diffutils, Gawk

Must be installed before: IPRoute2, Kbd, Man

Gawk

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Sed, Texinfo

Test suite depends on: Diffutils

Must be installed before: None

Gcc

Installation depends on: Bash, Binutils, CLoog, Coreutils, Diffutils, Glibc, Findutils, Gawk, GCC, GMP, Grep, ISL, Make, MPFR, Patch, Perl, Sed, Tar, Texinfo

Test suite depends on: Check, DejaGNU, Expect

Must be installed before: None

GDBM

Installation depends on: Bash, Binutils, Coreutils, Diffutils, GCC, Grep, Make, Sed

Test suite depends on: None

Must be installed before: None

Gettext

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Findutils, Gawk, GCC, Grep, Make, Sed, Texinfo

Test suite depends on: Tar, Tcl

Must be installed before: Automake

GMP

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, M4, Make, Sed, Texinfo

Test suite depends on: None

Must be installed before: MPFR, GCC

Gperf

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Sed, Texinfo

Test suite depends on: Intltool

Must be installed before: Systemd

Grep

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Patch, Sed, Texinfo

Test suite depends on: Diffutils, Gawk

Must be installed before: Man

Groff

Installation depends on: Bash, Binutils, Coreutils, Glibc, Gawk, GCC, Grep, Make, Perl Sed, Texinfo

Test suite depends on: No test suite available

Must be installed before: Man, Perl

Gzip

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Sed, Texinfo

Test suite depends on: Diffutils

Must be installed before: Man

lana-Etc

Installation depends on: Coreutils, Gawk, Make

Test suite depends on: No test suite available

Must be installed before: Perl

Intltool

Installation depends on: Binutils, Coreutils, Glibc, GCC, Make, Perl Sed, XML::Parser
Test suite depends on: No test suite available
Must be installed before: None

IProute2

Installation depends on: Bash, Binutils, Bison, Coreutils, Glibc, Findutils, Flex, GCC, Make, Linux Headers, Sed
Test suite depends on: No test suite available
Must be installed before: None

IPutils

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Libcap, Make
Test suite depends on: No test suite available
Must be installed before: None

ISL

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, GMP, Make, MPC, MPFR, Sed, Texinfo
Test suite depends on: None
Must be installed before: GCC

Kbd

Installation depends on: Bash, Binutils, Check, Coreutils, Glibc, Gawk, GCC, Gzip, Make
Test suite depends on: No test suite available
Must be installed before: None

KMOD

Installation depends on: Bash, Binutils, Bison, Coreutils, Glibc, Flex, Gawk, GCC, Gettext, Gzip, Make, Pkg-config-lite, Sed, XZ Utils, Zlib.
Test suite depends on: No test suite available
Must be installed before: Systemd

Less

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Ncurses, Sed
Test suite depends on: No test suite available
Must be installed before: None

Libcap

Installation depends on: Attr, Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make

Test suite depends on: No test suite available
Must be installed before: Coreutils, IPutils, Systemd

Libpipeline

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Gawk, GCC, Glibc, Grep, Make, Sed, Texinfo
Test suite depends on: Check
Must be installed before: Man-DB

Libtool

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Findutils, Gawk, GCC, Grep, Make, Sed, Texinfo
Test suite depends on: Autoconf
Must be installed before: None

Linux Headers

Installation depends on: Binutils, Coreutils, Findutils, GCC, Grep, Make, Perl, Sed
Test suite depends on: No test suite available
Must be installed before: None

Linux Kernel

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Findutils, GCC, Grep, Gzip, Make, KMOD, Ncurses, Perl, Sed
Test suite depends on: No test suite available
Must be installed before: None

M4

Installation depends on: Bash, Binutils, Coreutils, Glibc, Gawk, GCC, Grep, Make, Sed, Texinfo
Test suite depends on: Diffutils
Must be installed before: Autoconf, Bison

Make

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Sed, Texinfo
Test suite depends on: Perl, Procps-ng
Must be installed before: None

Man-DB

Installation depends on: Bash, Binutils, Bzip2, Coreutils, Glibc, Gawk, GCC, Grep, Groff, Gzip, Less, XZ Utils, Make, Sed
Test suite depends on: No test suite available
Must be installed before: D-Bus

Man-Pages

Installation depends on: Bash, Coreutils, Make

Test suite depends on: No test suite available

Must be installed before: None

MPC

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, GMP, Make, MPFR, Sed, Texinfo

Test suite depends on: None

Must be installed before: GCC

MPFR

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, GMP, Make, Sed, Texinfo

Test suite depends on: None

Must be installed before: GCC

Ncurses

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, Make, Sed

Test suite depends on: No test suite available

Must be installed before: Bash, GRUB, Inetutils, Less, Procps-ng, Psmisc, Readline, Texinfo, Util-linux, Vim

Patch

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Sed

Test suite depends on: No test suite available

Must be installed before: None

Perl

Installation depends on: Bash, Binutils, Coreutils, Glibc, Gawk, GCC, Grep, Make, Sed

Test suite depends on: Gzip, Iana-Etc, Procps-ng, Tar

Must be installed before: Autoconf

Pkg-config-lite

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Gawk, GCC, Grep, Make, Sed

Test suite depends on: None

Must be installed before: E2fsprogs, Systemd, Util-linux

Procps-ng

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Make, Ncurses

Test suite depends on: No test suite available

Must be installed before: None

Psmisc

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Ncurses , Sed

Test suite depends on: No test suite available

Must be installed before: None

Readline

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Ncurses, Patch, Sed, Texinfo

Test suite depends on: No test suite available

Must be installed before: Bash

Sed

Installation depends on: ACL, Attr, Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Sed, Texinfo

Test suite depends on: Diffutils, Gawk

Must be installed before: E2fsprogs, File, Libtool, Shadow

Shadow

Installation depends on: ACL, Attr, Bash, Binutils, Coreutils, Diffutils, Glibc, Findutils, Gawk, GCC, Gettext, Grep, Make, Sed

Test suite depends on: No test suite available

Must be installed before: None

Systemd

Installation depends on: ACL, Attr, Bash, Binutils, Coreutils, D-Bus, E2fsprogs, Glibc, Findutils, Gawk, GCC, GPerf, Grep, Intltool, Libcap, Make, Perl, Pkg-config, Sed, Util-linux, XML::Parser

Test suite depends on: No test suite available

Must be installed before: None

Tar

Installation depends on: Bash, Binutils, Bison, Coreutils, Glibc, GCC, Grep, Make, Sed, Texinfo

Test suite depends on: Diffutils, Findutils, Gawk, Gzip

Must be installed before: None

Tcl

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, GCC, Grep, Make, Sed

Test suite depends on: None

Must be installed before: None

Texinfo

Installation depends on: Bash, Binutils, Coreutils, Glibc, Gawk, GCC, Grep, Make, Ncurses, Sed

Test suite depends on: Diffutils, Gzip

Must be installed before: None

Util-linux

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Grep, Make, Ncurses, Pkg-config-lite, Sed, Texinfo, Zlib

Test suite depends on: No test suite available

Must be installed before: E2fsprogs, Systemd

Vim

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Findutils, Gawk, GCC, Gettext, Grep, Make, Ncurses, Perl, Sed

Test suite depends on: Gzip

Must be installed before: None

XML::Parser

Installation depends on: Coreutils, Expat, Make, Perl

Test suite depends on: None

Must be installed before: Intltool

XZ Utils

Installation depends on: Bash, Binutils, Coreutils, Diffutils, Glibc, Findutils, Gawk, GCC, Grep, Make, Sed

Test suite depends on: None

Must be installed before: None

Zlib

Installation depends on: Bash, Binutils, Coreutils, Glibc, GCC, Make, Sed

Test suite depends on: None

Must be installed before: File, KMOD, Util-linux

Appendix C. x86 Dependencies

This page contains dependency information for packages specific to x86 Pure64.

Appendix D. Package Rationale

CLFS includes many packages, a number of which might not necessarily be required for a "minimal" system, but still considered very useful. The purpose of this page is to list the reasoning for each package's inclusion in the book.

- ACL

The ACL package allows usage and setting of POSIX Access Control Lists. It can be used by several other packages in CLFS, such as Coreutils and Systemd.

- Attr

Attr allows setting and viewing extended attributes of filesystem objects. It is required by Systemd.

- Autoconf

The Autoconf package contains programs for producing shell scripts that can automatically configure source code. This is useful for software developers, as well as anyone who wants to install packages that don't come with a configure script, such as some of the packages in CBLFS.

- Automake

The Automake package contains programs for generating Makefiles for use with Autoconf. This can be useful to software developers.

- Bash

This package contains the Bourne-Again SHell. A shell is an important component of a Linux system, as there must be some way of allowing the users to enter commands.

- Bc

This package contains a precision calculator. The Linux kernel uses Bc to render the timeconst header.

- Binutils

This package contains programs for handling object files. The programs in this package are needed for compiling most of the packages in CLFS.

- Bison

This package contains programs that are required by several packages in CLFS.

- Bzip2

The programs in this package are useful for compressing files to reduce size. They are also needed to uncompress tarballs for many CLFS packages.

- CLFS-Boot-scripts

This package contains a number of scripts that run at boottime, performing essential tasks such as mounting/checking filesystems and starting the network interface.

- Check

This package contains a test harness for other programs. It is used for some packages' test suites.

- CLooG

This package is used by GCC to enable its Graphite loop generation code.

- Coreutils

This package contains many basic command-line file-management tools, required for installation of every package in CLFS.

- D-Bus

D-Bus is a message bus system, which allows applications to communicate to each other. It is used by Systemd.

- DejaGNU

This package is needed for the test suites of several packages, especially GCC and Binutils.

- DHCPD

This package allows for automatic configuration of network interfaces from a DHCP server. It (or some other package providing a DHCP client is needed to connect to a DHCP server.

- Diffutils

This package contains programs to compare files, and can also be used to create patches. It is required by the installation procedures of many CLFS packages, and used by many packages' test suites.

- Eudev

This is a package that allows for dynamic creation of device nodes. It is a fork of Udev, which is now part of Systemd. It is still used for the "Boot" method in the temp-system, as Systemd is not needed there.

- Expect

This package is needed for the test suites for several packages.

- E2fsprogs

The programs in this package are used for the creation and maintenance of ext2/3/4 filesystems.

- File

This package contains a program that determines the type of a given file. It is needed by some CLFS packages.

- Findutils

This package contains programs for finding files based on certain criteria, and optionally performing commands on them. These programs are used by the installation procedures of many CLFS packages.

- Flex

This package contains a tool for generating text scanners. It is used by multiple packages in CLFS

- Gawk

This package contains programs for manipulating text files, using the AWK language. It is used by the installation procedures of many packages in CLFS.

- Gcc

This package contains a C compiler, which is required to compile most of the packages in CLFS.

- GDBM

This package contains the GNU Database Manager library. Man-DB requires either GDBM or Berkeley DB, though it prefers GDBM.

- Gettext

A tool that allows programmers to easily implement i18n (internationalization) in their programs. It is a required dependency for a number of packages

- Glibc

Any dynamically-linked C program (nearly every package in CLFS has these) needs a C library to compile and run.

- GMP

This package is required by GCC.

- Gperf

This package is required by Systemd.

- Grep

This package contains programs for searching for text in files. These programs are required by many packages in CLFS.

- Groff

This package is required by Man-DB.

- Gzip

Useful for compressing files to reduce size. It is also needed to uncompress tarballs for many CLFS packages

- Iana-Etc

This package provides the `/etc/services` and `/etc/protocols` files. These files map port names to port numbers as well as protocol names to their corresponding numbers. These files are essential for many network based programs to work properly.

- Intltool

This package is required by Systemd.

- IProute2

This package contains programs for administering network interfaces.

- IPutils

This package contains several basic network-management tools.

- ISL

This package is required by CLOoG.

- Kbd

Contains keytable files and keyboard utilities compatible with the Linux kernel. These can be used to change the display font and keyboard layout.

- Kmod

This package contains programs that assist in loading an unloading kernel modules.

- Less

A program that lets you view text files one page at a time. It is also used by Man-DB for displaying manpages.

- Libcap

This package is required by Systemd.
- Libpipeline

The Libpipeline package contains a library for manipulating pipelines of subprocesses in a flexible and convenient way. It is required by the Man-DB package.
- Libtool

The Libtool package contains the GNU generic library support script. It is used by some CLFS packages.
- Linux Headers

This package consists of santized headers from the Linux Kernel. These headers are required for Glibc to compile.
- Linux Kernel

The Linux operating system.
- M4

This package contains a macro processor. It is required by several CLFS packages, including Bison.
- Make

This is required for installation of most CLFS packages
- Man-DB

This package contains programs for finding and viewing man pages, and has superior internationalization capabilities compared to the Man package.
- Man-Pages

A number of useful manpages, not supplied by other packages
- MPC

This package is required by GCC.
- MPFR

This package is required by GCC.
- Ncurses

Needed by several packages in CLFS, such as Vim, Bash, and Less
- Patch

Used for applying patches in several CLFS packages
- Perl

The Perl package contains the Practical Extraction and Report Language. It is required by several CLFS packages.
- Pkg-config-lite

Several packages in CLFS, and many others outside of CLFS, use **pkg-config** to locate dependencies.
- Procps-ng

Provides a number of small, useful utilities that give information about the `/proc` filesystem.

- Psmisc

Provides more utilities that give information about the `/proc` filesystem.

- Readline

The Readline library provides a set of functions for use by applications that allow users to edit command lines as they are typed in. This is essential for input in programs like **bash** to work properly.

- Sed

This package contains a stream editor. It is used in the installation procedures of most CLFS packages.

- Shadow

This package contains programs that assist in the administration of users and groups, and passwords.

- Systemd

Systemd provides the init daemon for the system, as well as Udev, which dynamically creates device nodes.

- Tar

Required to unpack the tar archives in which all CLFS packages are distributed

- Tcl

Needed for the test suites of several packages

- Texinfo

This package contains programs for viewing, installing and converting info pages. It is used in the installation procedures of many CLFS packages.

- Util-linux

The Util-linux package contains miscellaneous utility programs. Among them are utilities for handling file systems, consoles, partitions, and messages. It also includes libraries that are required by E2fsprogs.

- Vim

The Vim package contains a text editor. Users may substitute Nano, Joe, Emacs, or whatever other editor they prefer.

- XML::Parser

This Perl module is required by Intltool.

- XZ Utils

Useful for compressing files to reduce size. Also needed to uncompress tarballs for many CLFS packages

- Zlib

The Zlib package contains compression and decompression routines used by some programs.

Appendix E. Open Publication License

v1.0, 8 June 1999

I. REQUIREMENTS ON BOTH UNMODIFIED AND MODIFIED VERSIONS

The Open Publication works may be reproduced and distributed in whole or in part, in any medium physical or electronic, provided that the terms of this license are adhered to, and that this license or an incorporation of it by reference (with any options elected by the author(s) and/or publisher) is displayed in the reproduction.

Proper form for an incorporation by reference is as follows:

Copyright © <year> by <author's name or designee>. This material may be distributed only subject to the terms and conditions set forth in the Open Publication License, vX.Y or later (the latest version is presently available at <http://www.opencontent.org/openpub/>).

The reference must be immediately followed with any options elected by the author(s) and/or publisher of the document (see section VI).

Commercial redistribution of Open Publication-licensed material is permitted.

Any publication in standard (paper) book form shall require the citation of the original publisher and author. The publisher and author's names shall appear on all outer surfaces of the book. On all outer surfaces of the book the original publisher's name shall be as large as the bridgehead of the work and cited as possessive with respect to the bridgehead.

II. COPYRIGHT

The copyright to each Open Publication is owned by its author(s) or designee.

III. SCOPE OF LICENSE

The following license terms apply to all Open Publication works, unless otherwise explicitly stated in the document.

Mere aggregation of Open Publication works or a portion of an Open Publication work with other works or programs on the same media shall not cause this license to apply to those other works. The aggregate work shall contain a notice specifying the inclusion of the Open Publication material and appropriate copyright notice.

SEVERABILITY. If any part of this license is found to be unenforceable in any jurisdiction, the remaining portions of the license remain in force.

NO WARRANTY. Open Publication works are licensed and provided "as is" without warranty of any kind, express or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose or a warranty of non-infringement.

IV. REQUIREMENTS ON MODIFIED WORKS

All modified versions of documents covered by this license, including translations, anthologies, compilations and partial documents, must meet the following requirements:

1. The modified version must be labeled as such.
2. The person making the modifications must be identified and the modifications dated.

3. Acknowledgement of the original author and publisher if applicable must be retained according to normal academic citation practices.
4. The location of the original unmodified document must be identified.
5. The original author's (or authors') name(s) may not be used to assert or imply endorsement of the resulting document without the original author's (or authors') permission.

V. GOOD-PRACTICE RECOMMENDATIONS

In addition to the requirements of this license, it is requested from and strongly recommended of redistributors that:

1. If you are distributing Open Publication works on hardcopy or CD-ROM, you provide email notification to the authors of your intent to redistribute at least thirty days before your manuscript or media freeze, to give the authors time to provide updated documents. This notification should describe modifications, if any, made to the document.
2. All substantive modifications (including deletions) be either clearly marked up in the document or else described in an attachment to the document.
3. Finally, while it is not mandatory under this license, it is considered good form to offer a free copy of any hardcopy and CD-ROM expression of an Open Publication-licensed work to its author(s).

VI. LICENSE OPTIONS

The author(s) and/or publisher of an Open Publication-licensed document may elect certain options by appending language to the reference to or copy of the license. These options are considered part of the license instance and must be included with the license (or its incorporation by reference) in derived works.

A. To prohibit distribution of substantively modified versions without the explicit permission of the author(s). "Substantive modification" is defined as a change to the semantic content of the document, and excludes mere changes in format or typographical corrections.

To accomplish this, add the phrase `Distribution of substantively modified versions of this document is prohibited without the explicit permission of the copyright holder.' to the license reference or copy.

B. To prohibit any publication of this work or derivative works in whole or in part in standard (paper) book form for commercial purposes is prohibited unless prior permission is obtained from the copyright holder.

To accomplish this, add the phrase 'Distribution of the work or derivative of the work in any standard (paper) book form is prohibited unless prior permission is obtained from the copyright holder.' to the license reference or copy.

OPEN PUBLICATION POLICY APPENDIX

(This is not considered part of the license.)

Open Publication works are available in source format via the Open Publication home page at <http://works.opencontent.org/>.

Open Publication authors who want to include their own license on Open Publication works may do so, as long as their terms are not more restrictive than the Open Publication license.

If you have questions about the Open Publication License, please contact David Wiley at dw@opencontent.org, and/or the Open Publication Authors' List at opal@opencontent.org, via email.

To **subscribe** to the Open Publication Authors' List: Send E-mail to opal-request@opencontent.org with the word "subscribe" in the body.

To **post** to the Open Publication Authors' List: Send E-mail to opal@opencontent.org or simply reply to a previous post.

To **unsubscribe** from the Open Publication Authors' List: Send E-mail to opal-request@opencontent.org with the word "unsubscribe" in the body.

Index

Packages

- ACL: 156
- Attr: 155
- Autoconf: 189
- Automake: 190
- Bash: 192
 - temporary system: 68
- Bc: 194
 - boot: 91
- Binutils: 149
 - cross tools: 48
 - temporary system: 64
- Bison: 148
- Boot-scripts: 92
- Bzip2: 195
 - temporary system: 70
- Check: 71
- CLooG: 144
 - cross tools: 47
 - temporary system: 62
- Coreutils: 175
 - temporary system: 72
- D-Bus: 231
- DejaGNU: 122
- DHCPCD: 261
- Diffutils: 197
 - temporary system: 73
- E2fsprogs: 171
 - boot: 94
- Eudev: 100
- Expat: 220
- Expect: 121
- File: 198
 - cross tools: 38
 - temporary system: 74
- Findutils: 200
 - temporary system: 75
- Flex: 146
- Gawk: 199
 - temporary system: 76
- GCC: 152
 - cross tools, final: 54
 - cross tools, static: 50
 - temporary system: 65
- GDBM: 184
- Gettext: 201
 - temporary system: 77
- Glibc: 130
 - cross tools: 52
- GMP: 139
 - cross tools: 43
 - temporary system: 58
- Gperf: 203
- Grep: 204
 - temporary system: 78
- Groff: 205
- GRUB: 237
 - boot: 104
 - bootable: 268
 - configuring: 238
- Gzip: 209
 - temporary system: 79
- Iana-Etc: 180
- Intltool: 222
- IPRoute2: 182
- IPutils: 210
- ISL: 143
 - cross tools: 46
 - temporary system: 61
- Kbd: 211
- Kmod: 223
 - boot: 95
- Less: 208
- Libcap: 174
- Libpipeline: 213
- Libtool: 181
- Linux: 264
 - boot: 102
- Linux Headers: 128
 - cross tools: 39
- M4: 138
 - cross tools: 40
- Make: 217
 - temporary system: 80
- Man-DB: 214
- Man-pages: 129
- MPC: 142
 - cross tools: 45
 - temporary system: 60
- MPFR: 141
 - cross tools: 44

temporary system: 59
 Ncurses: 158
 cross tools: 41
 temporary system: 67
 Network-Scripts: 258
 Patch: 225
 temporary system: 81
 Perl: 185
 temporary tools: 127
 Pkg-config-lite: 160
 cross tools: 42
 Procps-ng: 169
 Psmisc: 226
 Readline: 188
 Sed: 157
 temporary system: 82
 Shadow: 161
 boot: 96
 configuring: 162
 Systemd: 227
 configuring: 228
 usage: 241
 Sysvinit: 97
 configuring: 97
 Tar: 232
 temporary system: 83
 Tcl: 120
 Texinfo: 233
 temporary system: 84
 Udev
 usage: 244
 Util-linux: 164
 temporary system: 85
 Vim: 234
 temporary system: 86
 XML::Parser: 221
 XZ Utils: 218
 temporary system: 88
 Zlib: 145
 temporary system: 63

Programs

a2p: 185, 186
 accessdb: 214, 216
 aclocal: 190, 190
 aclocal-1.14: 190, 190
 addftinfo: 205, 205

addpart: 164, 165
 addr2line: 149, 150
 afmtodit: 205, 205
 agetty: 164, 165
 apropos: 214, 216
 ar: 149, 150
 as: 149, 150
 ata_id: 100, 100
 attr: 155, 155
 autoconf: 189, 189
 autoheader: 189, 189
 autom4te: 189, 189
 automake: 190, 190
 automake-1.14: 190, 190
 autopoint: 201, 201
 autoreconf: 189, 189
 autoscan: 189, 189
 autoupdate: 189, 189
 awk: 199, 199
 badblocks: 171, 172
 base64: 175, 176
 basename: 175, 176
 bash: 192, 192
 bashbug: 192, 193
 bc: 194, 194
 bigram: 200, 200
 bison: 148, 148
 blkdiscard: 164, 165
 blkid: 164, 165
 blockdev: 164, 165
 bootctl: 227, 229
 bootlogd: 97, 98
 bridge: 182, 182
 bunzip2: 195, 195
 busctl: 227, 229
 bzip2: 195, 195
 bzip2: 195, 196
 bzdiff: 195, 196
 bzegrep: 195, 196
 bzfgrep: 195, 196
 bzgrep: 195, 196
 bzip2: 195, 196
 bzip2recover: 195, 196
 bzless: 195, 196
 bzip2: 195, 196
 c++: 152, 153
 c++filt: 149, 150

c2ph: 185, 186
cal: 164, 165
capsh: 174, 174
captain: 158, 159
cat: 175, 176
catchsegv: 130, 135
catman: 214, 216
cc: 152, 153
cdrom_id: 100, 100
cfdisk: 164, 165
chacl: 156, 156
chage: 161, 162
chattr: 171, 172
chcon: 175, 176
chcpu: 164, 165
checkmk: 71, 71
chem: 205, 205
chfn: 161, 162
chgpasswd: 161, 162
chgrp: 175, 176
chmod: 175, 176
chown: 175, 176
chpasswd: 161, 163
chroot: 175, 176
chrt: 164, 165
chsh: 161, 163
chvt: 211, 212
cksum: 175, 176
clear: 158, 159
clfskernel-[linux-version]: 264, 267
clockdiff: 210, 210
cloog: 144, 144
cmp: 197, 197
code: 200, 200
col: 164, 165
colcrt: 164, 165
collect: 100, 100
colrm: 164, 165
column: 164, 165
comm: 175, 176
compile: 190, 190
compile_et: 171, 172
config.charset: 201, 201
config.guess: 190, 190
config.rpath: 201, 201
config.sub: 190, 190
config_data: 185, 186
corelist: 185, 186
cp: 175, 176
cpan: 185, 186
cpan2dist: 185, 186
cpanp: 185, 186
cpanp-run-perl: 185, 186
cpp: 152, 153
create_floppy_devices: 100, 100
csplit: 175, 176
ctrlaltdel: 164, 165
ctstat: 182, 182
cut: 175, 176
cytune: 164, 165
date: 175, 176
dbus-cleanup-sockets: 231, 231
dbus-daemon: 231, 231
dbus-launch: 231, 231
dbus-monitor: 231, 231
dbus-send: 231, 231
dbus-uuidgen: 231, 231
dc: 194, 194
dd: 175, 176
deallocvt: 211, 212
debugfs: 171, 172
delpart: 164, 165
depcomp: 190, 190
depmod: 223, 223
df: 175, 176
diff: 197, 197
diff3: 197, 197
dir: 175, 176
dircolors: 175, 177
dirname: 175, 177
dmesg: 164, 165, 164, 165
du: 175, 177
dumpe2fs: 171, 172
dumpkeys: 211, 212
e2freefrag: 171, 172
e2fsck: 171, 172
e2image: 171, 172
e2initrd_helper: 171, 172
e2label: 171, 172
e2undo: 171, 172
e4defrag: 171, 172
echo: 175, 177
edd_id: 100, 100
efm_filter.pl: 234, 235

efm_perl.pl: 234, 235
 egrep: 204, 204
 elfedit: 149, 150
 enc2xs: 185, 186
 env: 175, 177
 envsubst: 201, 201
 eqn: 205, 205
 eqn2graph: 205, 205
 ex: 234, 235
 expand: 175, 177
 expect: 121, 121
 expiry: 161, 163
 expr: 175, 177
 factor: 175, 177
 faillog: 161, 163
 fallocate: 164, 165
 false: 175, 177
 fdformat: 164, 165
 fdisk: 164, 165
 fgconsole: 211, 212
 fgrep: 204, 204
 file: 198, 198
 filefrag: 171, 172
 find: 200, 200
 find2perl: 185, 186
 findfs: 164, 165
 findmnt: 164, 165
 firmware.sh: 100, 101
 flex: 146, 146
 flex++: 146, 146
 flock: 164, 166
 fmt: 175, 177
 fold: 175, 177
 frcode: 200, 200
 free: 169, 169
 fsck: 164, 166
 fsck.cramfs: 164, 166
 fsck.ext2: 171, 172
 fsck.ext3: 171, 172
 fsck.ext4: 171, 172
 fsck.ext4dev: 171, 172
 fsck.minix: 164, 166
 fsfreeze: 164, 166
 fstab-decode: 97, 98
 fstab_import: 100, 101
 fstrim: 164, 166
 fuser: 226, 226
 g++: 152, 153
 gawk: 199, 199
 gawk-4.1.1: 199, 199
 gcc: 152, 153
 gcov: 152, 153
 gdbmtool: 184, 184
 gdbm_dump: 184, 184
 gdbm_load: 184, 184
 gdiffmk: 205, 205
 gencat: 130, 135
 genl: 182, 182
 getcap: 174, 174
 getconf: 130, 135
 getent: 130, 135
 getfacl: 156, 156
 getfattr: 155, 155
 getkeycodes: 211, 212
 getopt: 164, 166
 getpcaps: 174, 174
 gettext: 201, 201
 gettext.sh: 201, 201
 gettextize: 201, 201
 gpasswd: 161, 163
 gperf: 203, 203
 gprof: 149, 150
 grap2graph: 205, 205
 grcat: 199, 199
 grep: 204, 204
 grn: 205, 205
 grodvi: 205, 205
 groff: 205, 205
 groffer: 205, 205
 grog: 205, 206
 grolbp: 205, 206
 grolj4: 205, 206
 grops: 205, 206
 grotty: 205, 206
 groupadd: 161, 163
 groupdel: 161, 163
 groupmems: 161, 163
 groupmod: 161, 163
 groups: 175, 177
 grpck: 161, 163
 grpconv: 161, 163
 grpunconv: 161, 163
 grub: 237, 239
 grub-install: 237, 239

grub-md5-crypt: 237, 239
 grub-set-default: 237, 239
 grub-terminfo: 237, 239
 gunzip: 209, 209
 gzexe: 209, 209
 gzip: 209, 209
 h2ph: 185, 186
 h2xs: 185, 186
 halt: 227, 229
 halt: 97, 98
 head: 175, 177
 hexdump: 164, 166
 hostid: 175, 177
 hostname: 175, 177
 hostname: 201, 201
 hostnamectl: 227, 229
 hpftodit: 205, 206
 hwclock: 164, 166
 iconv: 130, 135
 iconvconfig: 130, 135
 id: 175, 177
 ifcfg: 182, 182
 ifnames: 189, 189
 ifstat: 182, 182
 igawk: 199, 199
 indxbib: 205, 206
 info: 233, 233
 infocmp: 158, 159
 infokey: 233, 233
 infotocap: 158, 159
 init: 227, 229
 init: 97, 98
 insmod: 223, 223
 install: 175, 177
 install-info: 233, 233
 install-sh: 190, 190
 instmodsh: 185, 186
 intltool-extract: 222, 222
 intltool-merge: 222, 222
 intltool-prepare: 222, 222
 intltool-update: 222, 222
 intltoolize: 222, 222
 ionice: 164, 166
 ip: 182, 182
 ipcmk: 164, 166
 ipcrm: 164, 166
 ipcs: 164, 166
 isosize: 164, 166
 join: 175, 177
 journalctl: 227, 229
 json_pp: 185, 186
 kbdinfo: 211, 212
 kbdrate: 211, 212
 kbd_mode: 211, 212
 kernel-install: 227, 229
 kill: 164, 166
 killall: 226, 226
 killall5: 97, 98
 kmod: 223, 223
 last: 164, 166
 lastb: 164, 166
 lastlog: 161, 163
 ld: 149, 150
 ld.bfd: 149, 150
 ldattach: 164, 166
 ldconfig: 130, 135
 ldd: 130, 135
 lddlibc4: 130, 135
 less: 208, 208
 less.sh: 234, 235
 lessecho: 208, 208
 lesskey: 208, 208
 lex: 146, 146
 lexgrog: 214, 216
 libnetcfg: 185, 186
 libtool: 181, 181
 libtoolize: 181, 181
 link: 175, 177
 lkbib: 205, 206
 ln: 175, 177
 lnstat: 182, 183
 loadkeys: 211, 212
 loadunimap: 211, 212
 locale: 130, 135
 localectl: 227, 229
 localedef: 130, 135
 locate: 200, 200
 logger: 164, 166
 login: 161, 163
 loginctl: 227, 229
 logname: 175, 177
 logoutd: 161, 163
 logsave: 171, 172
 look: 164, 166

lookbib: 205, 206
losetup: 164, 166
ls: 175, 177
lsattr: 171, 172
lsblk: 164, 166
lscpu: 164, 166
lslocks: 164, 166
lsmod: 223, 224
lzcat: 218, 218
lzcmp: 218, 218
lzdiff: 218, 218
lzegrep: 218, 218
lzfgrep: 218, 218
lzgrep: 218, 218
lzless: 218, 218
lzma: 218, 219
lzmadec: 218, 219
lzmainfo: 218, 219
lzmore: 218, 219
m4: 138, 138
machinectl: 227, 229
make: 217, 217
makedb: 130, 135
makeinfo: 233, 233
man: 214, 216
mandb: 214, 216
manpath: 214, 216
mapscrn: 211, 212
mbchk: 237, 239
mcookie: 164, 166
md5sum: 175, 177
mdate-sh: 190, 190
mesg: 164, 166
missing: 190, 190
mkdir: 175, 177
mke2fs: 171, 172
mkfifo: 175, 177
mkfs: 164, 166
mkfs.bfs: 164, 166
mkfs.cramfs: 164, 166
mkfs.ext2: 171, 172
mkfs.ext3: 171, 172
mkfs.ext4: 171, 172
mkfs.ext4dev: 171, 172
mkfs.minix: 164, 166
mkinstalldirs: 190, 190
mklost+found: 171, 173
mknod: 175, 177
mkswap: 164, 166
mktemp: 175, 177
mk_cmds: 171, 172
mmroff: 205, 206
modinfo: 223, 224
modprobe: 223, 224
more: 164, 166
mount: 164, 166
mountpoint: 164, 166
msgattrib: 201, 201
msgcat: 201, 202
msgcmp: 201, 202
msgcomm: 201, 202
msgconv: 201, 202
msgen: 201, 202
msgexec: 201, 202
msgfilter: 201, 202
msgfmt: 201, 202
msggrep: 201, 202
msginit: 201, 202
msgmerge: 201, 202
msgunfmt: 201, 202
msguniq: 201, 202
mtrace: 130, 135
mv: 175, 177
mve.awk: 234, 235
namei: 164, 166
ncursesw5-config: 158, 159
neqn: 205, 206
newgrp: 161, 163
newusers: 161, 163
nggettext: 201, 202
nice: 175, 177
nl: 175, 177
nm: 149, 150
nohup: 175, 177
nologin: 164, 167
nproc: 175, 177
nroff: 205, 206
nscd: 130, 135
nsenter: 164, 167
nstat: 182, 183
numfmt: 175, 177
objcopy: 149, 151
objdump: 149, 151
od: 175, 177

oldfind: 200, 200
openvt: 211, 212
partx: 164, 167
passwd: 161, 163
paste: 175, 178
patch: 225, 225
pathchk: 175, 178
path_id: 100, 101
pcprofiledump: 130, 135
pdfroff: 205, 206
pdftexi2dvi: 233, 233
peekfd: 226, 226
perl: 185, 186
perl5.20.0: 185, 186
perlbug: 185, 186
perldoc: 185, 186
perlivp: 185, 187
perlthanks: 185, 187
pfbtops: 205, 206
pg: 164, 167
pgawk: 199, 199
pgawk-4.1.1: 199, 199
pgrep: 169, 170
pic: 205, 206
pic2graph: 205, 206
piconv: 185, 187
pidof: 169, 170
ping: 210, 210
pinky: 175, 178
pivot_root: 164, 167
pkg-config: 160, 160
pkill: 169, 170
pl2pm: 185, 187
pldd: 130, 135
pltags.pl: 234, 235
pmap: 169, 170
pod2html: 185, 187
pod2latex: 185, 187
pod2man: 185, 187
pod2text: 185, 187
pod2usage: 185, 187
podchecker: 185, 187
podselect: 185, 187
post-grohtml: 205, 206
poweroff: 227, 230
poweroff: 97, 98
pr: 175, 178
pre-grohtml: 205, 206
preconv: 205, 206
printenv: 175, 178
printf: 175, 178
prlimit: 164, 167
prove: 185, 187
prtstat: 226, 226
ps: 169, 170
psed: 185, 187
psfaddtable: 211, 212
psfgettable: 211, 212
psfstriptime: 211, 212
psfxtable: 211, 212
pstree: 226, 226
pstree.x11: 226, 226
pstruct: 185, 187
ptar: 185, 187
ptardiff: 185, 187
ptargrep: 185, 187
ptx: 175, 178
pwcat: 199, 199
pwck: 161, 163
pwconv: 161, 163
pwd: 175, 178
pwdx: 169, 170
pwunconv: 161, 163
py-compile: 190, 191
ranlib: 149, 151
raw: 164, 167
rdisc: 210, 210
readelf: 149, 151
readlink: 175, 178
readprofile: 164, 167
realpath: 175, 178
reboot: 227, 230
reboot: 97, 98
recode-sr-latin: 201, 202
ref: 234, 235
refer: 205, 206
rename: 164, 167
renice: 164, 167
reset: 158, 159
resize2fs: 171, 173
resizecons: 211, 212
resizepart: 164, 167
rev: 164, 167
rm: 175, 178

rmdir: 175, 178
 rmmmod: 223, 224
 rmt: 232, 232
 roff2dvi: 205, 206
 roff2html: 205, 206
 roff2pdf: 205, 206
 roff2ps: 205, 206
 roff2text: 205, 206
 roff2x: 205, 206
 routef: 182, 183
 routel: 182, 183
 rpcgen: 130, 135
 rtacct: 182, 183
 rtcwake: 164, 167
 rtmon: 182, 183
 rtpr: 182, 183
 rtstat: 182, 183
 runcon: 175, 178
 runlevel: 227, 230
 runlevel: 97, 99
 runttest: 122, 122
 rview: 234, 236
 rvim: 234, 236
 s2p: 185, 187
 script: 164, 167
 scriptreplay: 164, 167
 scsi_id: 100, 101
 sdiff: 197, 197
 sed: 157, 157
 seq: 175, 178
 setarch: 164, 167
 setcap: 174, 174
 setfacl: 156, 156
 setfattr: 155, 155
 setfont: 211, 212
 setkeycodes: 211, 212
 setleds: 211, 212
 setmetamode: 211, 212
 setsid: 164, 167
 setterm: 164, 167
 setvtrgb: 211, 212
 sfdisk: 164, 167
 sg: 161, 163
 sh: 192, 193
 sha1sum: 175, 178
 sha224sum: 175, 178
 sha256sum: 175, 178
 sha384sum: 175, 178
 sha512sum: 175, 178
 shasum: 185, 187
 showconsolefont: 211, 212
 showkey: 211, 212
 shred: 175, 178
 shtags.pl: 234, 236
 shuf: 175, 178
 shutdown: 227, 230
 shutdown: 97, 99
 size: 149, 151
 slabtop: 169, 170
 sleep: 175, 178
 sln: 130, 135
 soelim: 205, 206
 sort: 175, 178
 sotruss: 130, 135
 splain: 185, 187
 split: 175, 178
 sprof: 130, 135
 ss: 182, 183
 stat: 175, 178
 stdbuf: 175, 178
 strings: 149, 151
 strip: 149, 151
 stty: 175, 178
 su: 161, 163
 sulogin: 164, 167
 sum: 175, 178
 swapon: 164, 167
 swapon: 164, 167
 swapoff: 164, 167
 swapon: 164, 167
 switch_root: 164, 167
 symlink-tree: 190, 191
 sync: 175, 178
 sysctl: 169, 170
 systemctl: 227, 230
 systemd: 227, 230
 systemd-analyze: 227, 230
 systemd-ask-password: 227, 230
 systemd-cat: 227, 230
 systemd-cgls: 227, 230
 systemd-cgtop: 227, 230
 systemd-coredumpctl: 227, 230
 systemd-delta: 227, 230
 systemd-detect-virt: 227, 230
 systemd-inhibit: 227, 230

systemd-machine-id-setup: 227, 230
systemd-notify: 227, 230
systemd-nspawn: 227, 230
systemd-run: 227, 230
systemd-stdio-bridge: 227, 230
systemd-tmpfiles: 227, 230
systemd-tty-ask-password-agent: 227, 230
tabs: 158, 159
tac: 175, 178
tail: 175, 178
tailf: 164, 167
tar: 232, 232
taskset: 164, 167
tbl: 205, 206
tc: 182, 183
tclsh: 120, 120
tclsh-version: 120, 120
tcltags: 234, 236
tee: 175, 178
telinit: 227, 230
telinit: 97, 99
test: 175, 178
texi2dvi: 233, 233
texi2pdf: 233, 233
texindex: 233, 233
tfmtodit: 205, 207
tic: 158, 159
timedatectl: 227, 230
timeout: 175, 178
tload: 169, 170
toe: 158, 159
top: 169, 170
touch: 175, 178
tput: 158, 159
tr: 175, 179
tracepath: 210, 210
tracepath6: 210, 210
traceroute6: 210, 210
troff: 205, 207
true: 175, 179
truncate: 175, 179
tset: 158, 159
tsort: 175, 179
tty: 175, 179
tune2fs: 171, 173
tzselect: 130, 136
udevadm: 227, 230
udevadm: 100, 100
udevvd: 100, 100
ul: 164, 167
umount: 164, 167
uname: 175, 179
uncompress: 209, 209
unexpand: 175, 179
unicode_start: 211, 212
unicode_stop: 211, 212
uniq: 175, 179
unlink: 175, 179
unlzma: 218, 219
unshare: 164, 167
unxz: 218, 219
updatedb: 200, 200
uptime: 169, 170
usb_id: 100, 101
useradd: 161, 163
userdel: 161, 163
usermod: 161, 163
users: 175, 179
utmpdump: 164, 167
uuuid: 164, 167
uuidgen: 164, 167, 164, 168
v4l_id: 100, 101
vdir: 175, 179
vi: 234, 236
view: 234, 236
vigr: 161, 163
vim: 234, 236
vim132: 234, 236
vim2html.pl: 234, 236
vimdiff: 234, 236
vimm: 234, 236
vimspell.sh: 234, 236
vimtutor: 234, 236
vipw: 161, 163
vmstat: 169, 170
w: 169, 170
wall: 164, 168
watch: 169, 170
wc: 175, 179
whatis: 214, 216
whereis: 164, 168
who: 175, 179
whoami: 175, 179
wipefs: 164, 168

write: 164, 168
 write_cd_rules: 100, 101
 write_net_rules: 100, 101
 xargs: 200, 200
 xgettext: 201, 202
 xmlwf: 220, 220
 xsubpp: 185, 187
 xtrace: 130, 136
 xxd: 234, 236
 xz: 218, 219
 xzcat: 218, 219
 xzcmp: 218, 219
 xzdec: 218, 219
 xzdiff: 218, 219
 xzegrep: 218, 219
 xzfgrep: 218, 219
 xzgrep: 218, 219
 xzless: 218, 219
 xzmore: 218, 219
 yacc: 148, 148
 yes: 175, 179
 ylwrap: 190, 191
 zcat: 209, 209
 zcmp: 209, 209
 zdiff: 209, 209
 zdump: 130, 136
 zegrep: 209, 209
 zfgrep: 209, 209
 zforce: 209, 209
 zgrep: 209, 209
 zic: 130, 136
 zipdetails: 185, 187
 zless: 209, 209
 zmore: 209, 209
 znew: 209, 209
 zsoelim: 214, 216

Libraries

ld.so: 130, 136
 libacl: 156, 156
 libanl: 130, 136
 libasan: 152, 154
 libasprintf: 201, 202
 libatomic*: 152, 154
 libattr: 155, 155
 libbfd: 149, 151
 libblkid: 164, 168

libBrokenLocale: 130, 136
 libbz2*: 195, 196
 libc: 130, 136
 libcap: 174, 174
 libcheck.{a,so}: 71, 71
 libcidn: 130, 136
 libcloog-isl: 144, 144
 libcom_err: 171, 173
 libcrypt: 130, 136
 libcursesw: 158, 159
 libdbus-1: 231, 231
 libdl: 130, 136
 libe2p: 171, 173
 libexpat: 220, 220
 libexpect-5.43: 121, 121
 libext2fs: 171, 173
 libfl: 146, 146, 146, 147
 libformw: 158, 159
 libg: 130, 136
 libgcc*: 152, 154
 libgcov: 152, 154
 libgdbm: 184, 184
 libgdbm_compat: 184, 184
 libgettextlib: 201, 202
 libgettextpo: 201, 202
 libgettextsrc: 201, 202
 libgmp: 139, 140
 libgmpxx: 139, 140
 libgomp: 152, 154
 libhistory: 188, 188
 libiberty: 152, 154
 libieee: 130, 136
 libisl: 143, 143
 libitm*: 152, 154
 libltdl: 181, 181
 liblto_plugin: 152, 154
 liblzma: 218, 219
 libm: 130, 136
 libmagic: 198, 198
 libman: 214, 216
 libmandb: 214, 216
 libmcheck: 130, 136
 libmemusage: 130, 136
 libmenuw: 158, 159
 libmount: 164, 168
 libmpc: 142, 142
 libmpfr: 141, 141

libmudflap*: 152, 154
 libncursesw: 158, 159
 libnsl: 130, 136
 libnss: 130, 136
 libnss_myhostname: 227, 230
 libopcodes: 149, 151
 libpanelw: 158, 159
 libpcprofile: 130, 136
 libpipeline: 213, 213
 libprocps: 169, 170
 libpthread: 130, 136
 libquadmath*: 152, 154
 libquota: 171, 173
 libreadline: 188, 188
 libresolv: 130, 136
 librpcsvc: 130, 136
 librt: 130, 136
 libSegFault: 130, 136
 libss: 171, 173
 libssp*: 152, 154
 libstdbuf: 175, 179
 libstdc++: 152, 154
 libsupc++: 152, 154
 libsystemd: 227, 230
 libtcl-version.so: 120, 120
 libtclstub-version.a: 120, 120
 libthread_db: 130, 136
 libtsan: 152, 154
 libudev: 227, 230
 libudev: 100, 101
 libutil: 130, 136
 libuuid: 164, 168
 liby.a: 148, 148
 libz: 145, 145
 preloadable_libintl.so: 201, 202

Scripts

checkfs: 92, 92
 cleanfs: 92, 92
 clock
 configuring: 242
 console
 configuring: 243
 udev: 92, 93
 functions: 92, 92
 halt: 92, 92
 hostname

 configuring: 254
 ifdown: 258, 258
 ifup: 258, 258
 ipv4-static: 258, 258
 localnet: 92, 92
 /etc/hosts: 254
 mountfs: 92, 92
 mountkernfs: 92, 92
 network
 /etc/hosts: 254
 configuring: 255
 rc: 92, 93
 reboot: 92, 93
 sendsignals: 92, 93
 setclock: 92, 93
 swap: 92, 93

Others

/boot/config-[linux-version]: 264, 267
 /boot/System.map-[linux-version]: 264, 267
 /dev/*
 boot: 107
 /etc/clfs-release: 269
 /etc/default/grub: 238
 /etc/fstab
 boot: 109
 system config: 253
 /etc/group
 boot: 107
 chroot: 115
 /etc/hosts: 254
 /etc/inittab: 97
 /etc/inputrc: 251
 /etc/ld.so.conf: 134
 /etc/locale.conf: 249
 /etc/localtime: 133
 /etc/login.defs: 161
 /etc/nsswitch.conf: 133
 /etc/os-release: 228
 /etc/passwd
 boot: 107
 chroot: 115
 /etc/profile: 249
 /etc/protocols: 180
 /etc/resolv.conf: 255
 /etc/services: 180
 /etc/udev: 100, 101

/etc/vimrc: 235
/lib/udev: 100, 101
/usr/include/{asm,linux}/*.h: 128, 128
dhcpcd: 261
man pages: 129, 129