

The State of PTXdist



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<https://www.pengutronix.de>

What is PTXdist?

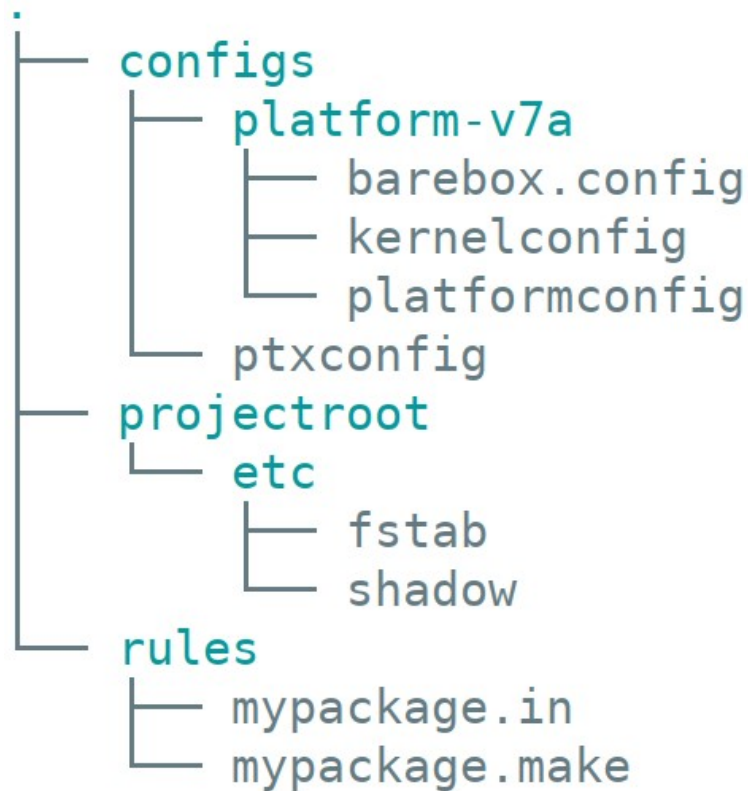
- Build system with focus on building Embedded Linux images from source
- Building blocks:
 - GNU Make
 - Kconfig
 - Bash
 - AWK
- Monthly releases
 - First version from before August 2003
- GPL-2.0 licensed
- <https://www.ptxdist.org>



A Typical BSP

Philosophy

- BSP structure == PTXdist structure
- Overwrite and extend upstream files locally



A First Look

\$ ptxdist menuconfig

```
.config - PTXdist 2020.01.0
PTXdist 2020.01.0
Arrow keys navigate the menu. <Enter> selects submenus
---> (or empty submenus ----). Highlighted letters are
hotkeys. Pressing <Y> includes, <N> excludes, <M>
modularizes features. Press <Esc><Esc> to exit, <?> for

+-----+
| Project Name & Version  ---> |
|-----+ Host Options -----|
| PTXdist Options        ---> |
| Host Tools             ---> |
| Cross Tools            ---> |
| Debug Tools            ---> |
|-----+-----+-----+-----|
| Root Filesystem        ---> |
| Core (libc, locales)   ---> |
|-----+-----+-----+-----|
| Shell & Console Tools   ---> |
| Scripting Languages     ---> |
| Bytecode Engines / VMs  ---> |
| Networking Tools        ---> |
| Disk and File Utilities  ---> |
| Communication Utilities  ---> |
| Applications            ---> |
| Editors                 ---> |
| System Libraries        ---> |
| Security                ---> |
| Middleware              ---> |
| Scientific Apps         ---> |
| Web Applications        ---> |
| Test Suites             ---> |
| Games                  ---> |
| Graphics & Multimedia   ---> |
|-----+-----+-----+-----|
| Bare Metal              ---> |
|-----+-----+-----+-----|
| [ ] Staging              ----|
+-----+

< elect>  < Exit>  < Help>  < Save>  < Load>
```

\$ ptxdist platformconfig

```
.config - PTXdist 2020.01.0
PTXdist 2020.01.0
Arrow keys navigate the menu. <Enter> selects submenus
---> (or empty submenus ----). Highlighted letters are
hotkeys. Pressing <Y> includes, <N> excludes, <M>
modularizes features. Press <Esc><Esc> to exit, <?> for

+-----+
| Target Platform Configuration |
|-----+-----+-----+-----|
| (v7a) platform name          ---> |
| (-${PTXDIST_BSP_AUTOVERSION}) platform version ---> |
| architecture                 ---> |
| -* Linux kernel              ---> |
| [*] Build device tree        ---> |
| -* dtc                       ---> |
| console options               ---> |
| extra kernel                  ---> |
| bootloaders                   ---> |
| bootloader spec entries       ---> |
| image creation options        ---> |
| [ ] Code signing              ----|
+-----+

< elect>  < Exit>  < Help>  < Save>  < Load>
```



Applying Patches

```
.
├── configs/platform-v7a/patches
│   ├── linux-5.5
│   │   ├── 0001-add-frobnicated-flectrospector.patch
│   │   ├── 0002-fix-compilation-with-gcc-9.patch
│   │   └── series
│   └── patches
│       ├── busybox-1.29.3
│       │   ├── 0001-su-c-is-not-using-bin-sh.patch
│       │   └── series
│       └── 
```

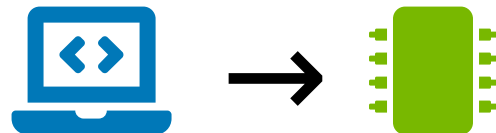
- Automatically applied during the extract stage
- Edit patch queue with *git* or *quilt*



Package Types

Target packages

- Built on the build host for the target architecture
 - e.g: systemd, busybox, coreutils, kernel, bootloader



Host packages

- Built on the host, executed on the host
- Compatible build environment on different host systems
 - e.g.: host-dosfstools, host-python3, host-cmake

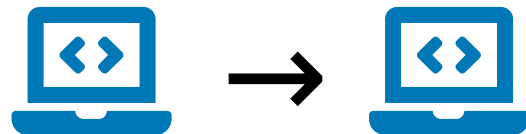


Image packages

- Determine the image format and the list of installed packages
 - e.g.: hdiimage, root.tgz, RAUC bundles



Creating New Package Rules

```
~/projects/my-bsp $ ptxdist newpackage target
```

```
ptxdist: creating a new 'target' package:
```

```
ptxdist: enter package name.....: mypackage
```

```
ptxdist: enter version number.....: 0.1
```

```
ptxdist: enter URL of basedir.....: https://example.org/mypackage
```

```
ptxdist: enter suffix.....: tar.gz
```

```
ptxdist: enter package author.....: Roland Hieber <rhi@pengutronix.de>
```

```
ptxdist: enter package section.....: project_specific
```

```
ptxdist: select option by number:
```

```
ptxdist: [1] autoconf
```

```
ptxdist: [2] cmake
```

```
ptxdist: [3] kconfig
```

```
ptxdist: [4] meson
```

```
ptxdist: [5] perl
```

```
ptxdist: [6] python3
```

```
ptxdist: [7] qmake
```

```
ptxdist: conf tool.....: 2
```

```
generating rules/mypackage.make
```

```
generating rules/mypackage.in
```



Package Definition: rules/mypackage.in

```
## SECTION=project_specific

config MYPACKAGE
  tristate
  select HOST_CMAKE
  select LIBUSB
  prompt "mypackage"
  help
    MyPackage is an example package.
    It is built with CMake and uses libusb at runtime.
```



Package Definition: rules/mypackage.make

```
PACKAGES-$(PTXCONF_MYPACKAGE) += mypackage
```

```
MYPACKAGE_VERSION      := 0.1
MYPACKAGE_MD5          := 68b329da9893e34099c7d8ad5cb9c940
MYPACKAGE              := mypackage-$(MYPACKAGE_VERSION)
MYPACKAGE_SUFFIX       := tar.gz
MYPACKAGE_URL          := https://ftp.example.org/mypackage/$(MYPACKAGE).$(MYPACKAGE_SUFFIX)
MYPACKAGE_SOURCE       := $(SRCDIR)/$(MYPACKAGE).$(MYPACKAGE_SUFFIX)
MYPACKAGE_DIR          := $(BUILDDIR)/$(MYPACKAGE)
MYPACKAGE_LICENSE      := 0BSD
MYPACKAGE_LICENSE_FILES := file://LICENSE;md5=60b725f10c9c85c70d97880dfe8191b3
```



Package Definition: rules/mypackage.make

```
# -----  
# Prepare  
# -----  
  
MYPACKAGE_CONF_TOOL := cmake  
MYPACKAGE_CONF_OPT  := $(CROSS_CMAKE_USR) -DUSB=ON  
  
# -----  
# Target-Install  
# -----  
  
$(STATEDIR)/mypackage.targetinstall:  
    @$(call targetinfo)  
  
    @$(call install_init, mypackage)  
    @$(call install_fixup, mypackage,PRIORITY,optional)  
    @$(call install_fixup, mypackage,SECTION,base)  
    @$(call install_fixup, mypackage,AUTHOR,"Roland Hieber <rhi@pengutronix.de>")  
    @$(call install_fixup, mypackage,DESCRIPTION,missing)  
  
    @$(call install_copy, mypackage, 0, 0, 0755, -, /usr/bin/myprog)  
  
    @$(call install_finish, mypackage)  
  
    @$(call touch)
```



Layer Mechanisms

- Alternative config files
 - Customising config files
- Platforms
 - Different hardware
- Collections
 - Different sets of software packages
- Kconfig diffs
 - Similar kernel/bootloader packages
- Base layers
 - Free-style layering



Alternative Config Files

```
# ptxdist/rules/cups.make
$(STATEDIR)/cups.targetinstall:
# ...
@$(call install_alternative, cups, daemon, lp, 0640, /etc/printcap)
```

Search order (roughly):

1. my-bsp/projectroot/etc/printcap
2. my-bsp/configs/platform-v7a/projectroot/etc/printcap
3. ptxdist/projectroot/etc/printcap
4. /etc/printcap from *cups* install dir
5. /etc/printcap from *cups* build dir



Platforms vs. Userland

userland

- ☒ systemd
- ☒ busybox
- ☒ cups

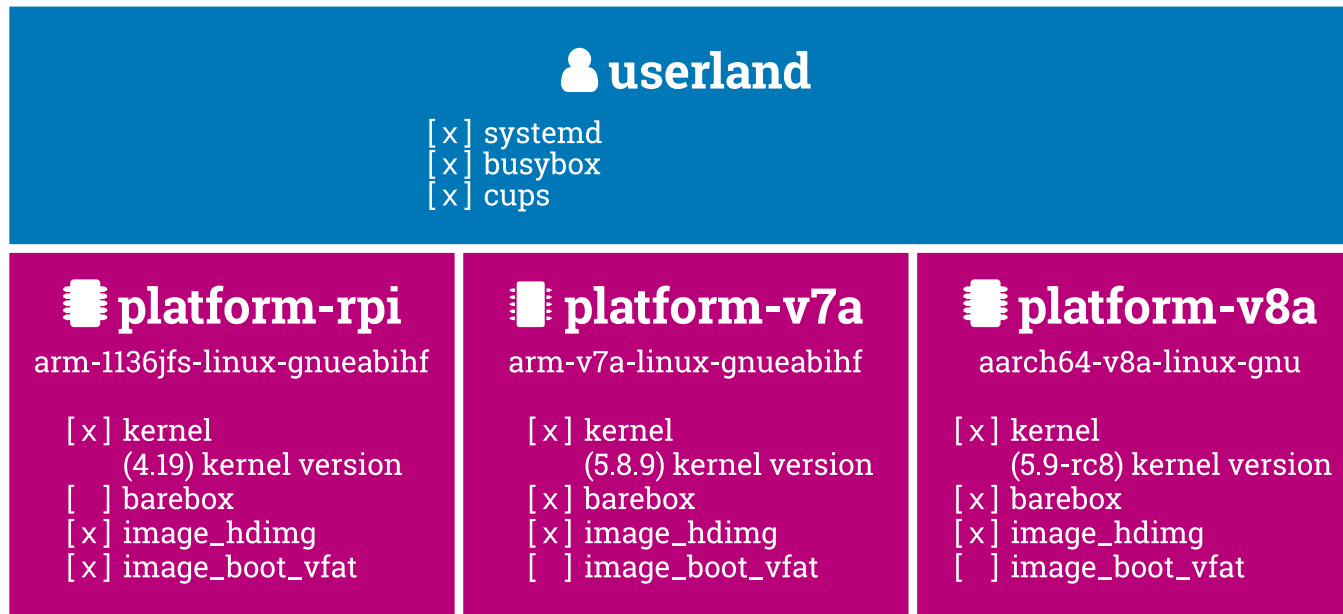
platform-rpi

arm-1136jfs-linux-gnueabi

- ☒ kernel
(4.19) kernel version
- ☐ barebox
- ☒ image_hdimg
- ☒ image_boot_vfat



Platforms vs. Userland



Collections

debug collection

☒ gdb
☒ strace
☒ stress-ng

release collection

☐ gdb
☐ strace
☐ stress-ng

userland

☒ systemd
☒ busybox
☒ cups

☐ gdb
☐ strace
☐ stress-ng

platform-rpi

arm-1136jfs-linux-gnueabi

☒ kernel
 (4.19) kernel version
☐ barebox
☒ image_hdimg
☒ image_boot_vfat

platform-v7a

arm-v7a-linux-gnueabi

☒ kernel
 (5.8.9) kernel version
☒ barebox
☒ image_hdimg
☐ image_boot_vfat

platform-v8a

aarch64-v8a-linux-gnu

☒ kernel
 (5.9-rc8) kernel version
☒ barebox
☒ image_hdimg
☐ image_boot_vfat



Collections: Scenarios

1) Collection used by image

```
IMAGE_DEBUG_TGZ      := image-debug-tgz
IMAGE_DEBUG_TGZ_DIR  := $(BUILDDIR)/$(IMAGE_DEBUG_TGZ)
IMAGE_DEBUG_TGZ_IMAGE := $(IMAGEDIR)/debug.tgz
IMAGE_DEBUG_TGZ_PKGS = $(call ptx/collection, $(call ptx/in-path, \
                                         PTXDIST_PATH_LAYERS, configs/debug.collection))
```

2) Collection selected by user

- All images will use this collection (unless scenario 1.)

```
~/projects/my-bsp $ ptxdist collection configs/debug.collection
info: selected collectionconfig:
      'configs/debug.collection'
```

```
~/projects/my-bsp $ ptxdist -q -j -k images
```



Kconfig Diffs

```
# configs/platform-v7a/rules/kernel-debug.make
PACKAGES-$(PTXCONF_KERNEL_DEBUG) += kernel-debug
KERNEL_DEBUG_VERSION      := 5.4
# ...
KERNEL_DEBUG_CONFIG       := $(call ptx/in-platformconfigdir, kernelconfig-debug)
KERNEL_DEBUG_REF_CONFIG   := $(call ptx/in-platformconfigdir, kernelconfig)
```

```
~/projects/my-bsp $ ptxdist menuconfig kernel-debug
# [... enable debug options ... ]
```

```
~/projects/my-bsp $ ls -l configs/platform-v7a/kernelconfig*
configs/platform-v7a/kernelconfig
configs/platform-v7a/kernelconfig-debug
configs/platform-v7a/kernelconfig-debug.diff
```

```
~/projects/my-bsp $ cat configs/platform-v7a/kernelconfig-debug.diff
1cdfdb2da785381a41fdd7320b37cd3d
CONFIG_DMA_API_DEBUG=y
CONFIG_DMA_API_DEBUG_SG=y
```

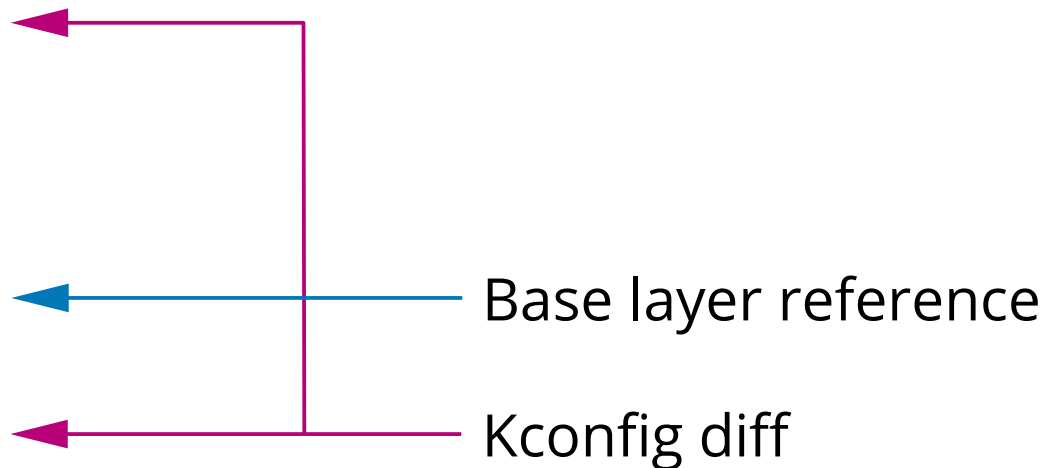
← MD5 sum of ref config



Base Layers

```
distrokit/  
├── configs  
│   ├── platform-v7a  
│   │   ├── kernelconfig  
│   │   └── platformconfig  
│   └── ptxconfig  
└── rules  
    ├── datapartition.in  
    └── datapartition.make
```

```
my-bsp/  
├── base -> ../distrokit/  
├── configs  
│   ├── ptxconfig  
│   └── ptxconfig.diff  
└── rules  
    ├── mypackage.in  
    └── mypackage.make
```



Base Layers: Caveats

```
~/projects/my-bsp $ cat configs/ptxconfig.diff  
105d4dcf6b0783e7fe428f27eac0f43e  
PTXCONF_VIM=y
```

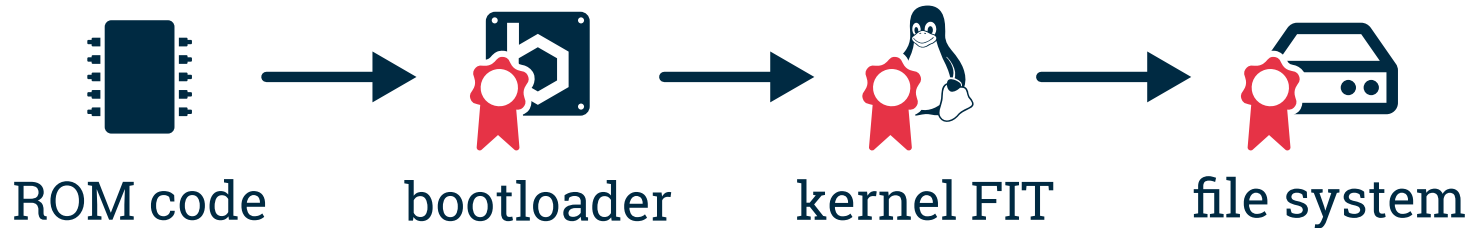
- Layer dependencies are static
 - Kconfig diffs are pinned down via MD5
 - ptxdist oldconfig synchronises diffs
 - Solve update conflicts early
- PTXdist is always implicitly the lowest layer



Code Signing Infrastructure

Use Cases

- Verified Boot / High Assurance Boot



- Signed update bundles

Different signature providers

- Development phase (e.g. SoftHSM)
- Release phase (e.g. NitroKey HSM, Cloud service)

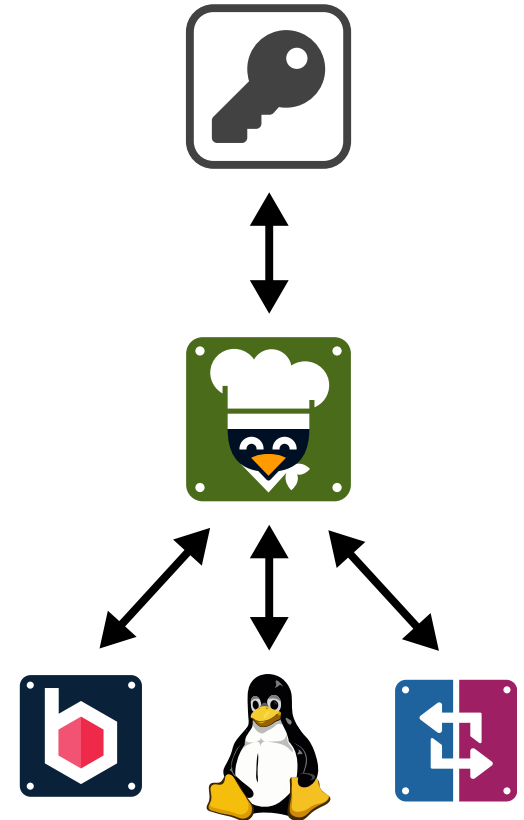
Code Signing Infrastructure

Providers

- Handles communication with HSM
- Selected in `platformconfig` menu
 - e.g. `host-devel-code-signing`, `host-release-code-signing`
- `ptxdist newpackage code-signing-provider`

Consumers

- Package recipes
 - e.g. `barebox`, `kernel-fit`, `image-rauc`



BSP Info

```
~/projects/my-bsp $ ptxdist bsp-info
```

```
-----  
target: bsp-info  
-----
```

```
vendor:      ACME  
project:     MyBSP  
version:     -
```

```
platform:    v7a  
platform version: -
```

```
BSP:         /home/rohieb/projects/my-bsp  
PTXdist:     /usr/local/lib/ptxdist-2020.01.0
```

```
ptxconfig:   my-bsp/configs/ptxconfig  
platformconfig: my-bsp/configs/platform-v7a/platformconfig
```

```
images:      image-hdimg  
              image-kernel  
              image-root-ext  
              image-root-tgz
```

```
finished target bsp-info
```



Package Info

```
~/projects/my-bsp $ ptxdist package-info busybox
```

```
-----  
target: busybox.package-info  
-----
```

```
package:    busybox  
version:    1.31.1
```

```
license:    GPL-2.0-only  
files:      file://LICENSE;md5=de10de48642ab74318e893a61105afbb
```

```
source:     /usr/src/busybox-1.31.1.tar.bz2  
md5:        70913edaf2263a157393af07565c17f0  
url:        https://www.busybox.net/downloads/busybox-1.31.1.tar.bz2
```

```
src dir:    my-bsp/platform-v7a/build-target/busybox-1.31.1  
build dir:  my-bsp/platform-v7a/build-target/busybox-1.31.1  
pkg dir:    my-bsp/platform-v7a/packages/busybox-1.31.1
```

```
rule file:  ptxdist-2020.09.0/rules/busybox.make  
menu file:  ptxdist-2020.09.0/rules/busybox.in
```

```
patches:    ptxdist-2020.09.0/patches/busybox-1.31.1
```

```
finished target busybox.package-info
```



License Report

```
PACKAGES-$(PTXCONF_MYPACKAGE) += mypackage
```

```
MYPACKAGE_VERSION      := 0.1
```

```
MYPACKAGE_MD5          := 68b329da9893e34099c7d8ad5cb9c940
```

```
MYPACKAGE              := mypackage-$(MYPACKAGE_VERSION)
```

```
MYPACKAGE_SUFFIX       := tar.gz
```

```
MYPACKAGE_URL          := https://ftp.example.org/mypackage/$(MYPACKAGE).$(MYPACKAGE_SUFFIX)
```

```
MYPACKAGE_SOURCE       := $(SRCDIR)/$(MYPACKAGE).$(MYPACKAGE_SUFFIX)
```

```
MYPACKAGE_DIR          := $(BUILDDIR)/$(MYPACKAGE)
```

```
MYPACKAGE_LICENSE      := 0BSD
```

```
MYPACKAGE_LICENSE_FILES := file://LICENSE;md5=60b725f10c9c85c70d97880dfe8191b3
```



License Report

\$ ptxdist make license-report

Contents

20 dosfstools	42
20.1 COPYING	42
20.2 src_fsck.fat.c	54
21 e2fsprogs	55
21.1 NOTICE	55
21.2 lib_uuid_gen_uuid.c	71
22 expat	72
22.1 COPYING[automatically found]	72
23 gcclibs	73
23.1 COPYING3	73
23.2 COPYING.RUNTIME	85
24 gdbserver	87
24.1 COPYING	87
24.2 COPYING3	93
24.3 COPYING.LIB	105
24.4 COPYING3.LIB	114
25 glib	118
25.1 COPYING[automatically found]	118
26 glibc	128
26.1 COPYING	128
26.2 COPYING.LIB	134
26.3 LICENSES	143

53 openssh

Package: openssh 8.3p1

License: BSD AND BSD-2-Clause AND BSD-3-Clause AND MIT AND Beerware AND ISC

Flags: attribution

URL: <https://ftp.halifax.rwth-aachen.de/openssh/OpenSSH/portable/openssh-8.3p1.tar.gz>
<https://mirror.hs-esslingen.de/pub/OpenBSD/OpenSSH/portable/openssh-8.3p1.tar.gz>

MD5: 68d7527bf2672153ca47402f6489a1af



Figure 53.1: Dependency tree for openssh

53.1 LICENCE

This file is part of the OpenSSH software.

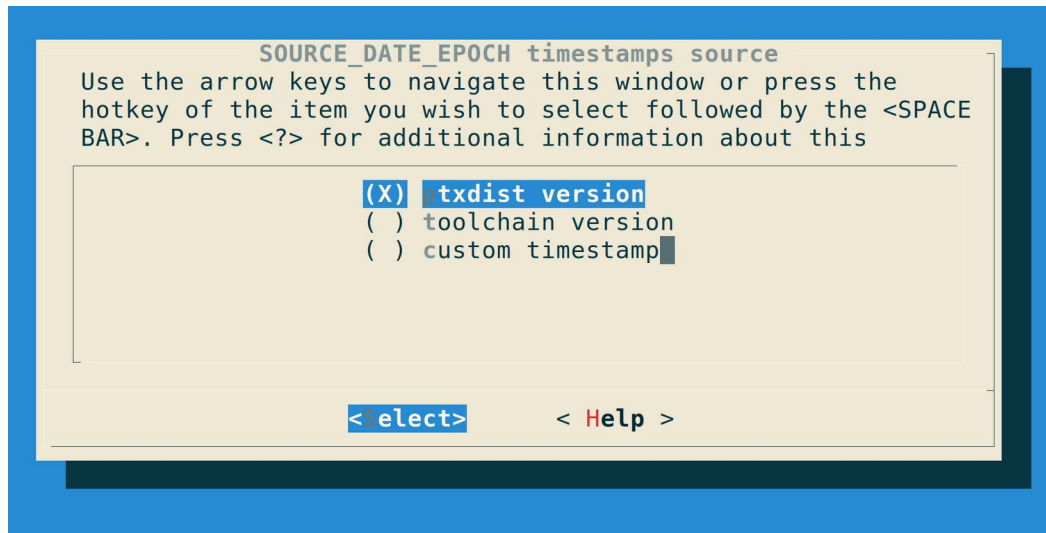
The licences which components of this software fall under are as follows. First, we will summarize and say that all components are under a BSD licence, or a licence more free than that.

OpenSSH contains no GPL code.

```
1)
* Copyright (c) 1995 Tatu Ylonen <ylo@cs.hut.fi>, Espoo, Finland
* All rights reserved
*
* As far as I am concerned, the code I have written for this software
* can be used freely for any purpose. Any derived versions of this
* software must be clearly marked as such, and if the derived work is
* incompatible with the protocol description in the RFC file, it must be
* called by a name other than "ssh" or "Secure Shell".
```



Reproducible Builds

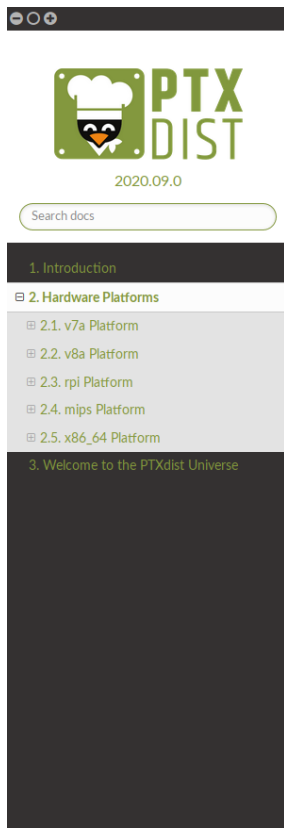


- Ideally: same source input == same binary output
- Set SOURCE_DATE_EPOCH variable during build
 - Packages's build systems need to support it

BSP Documentation

- reStructuredText + sphinx
- HTML and PDF output

```
~/projects/distrokit $ ls -l doc
guru.rst
hardware_mips_qemu.rst
hardware_rpi_raspil.rst
hardware.rst
hardware_v7a_beaglebone_black.rst
hardware_v7a_beaglebone_white.rst
hardware_v7a_nitrogen6x.rst
hardware_v7a_qemu.rst
hardware_v7a_raspi2.rst
hardware_v7a_raspi3.rst
hardware_v7a_riot.rst
hardware_v7a_udoo_neo.rst
hardware_v8a_espressobin.rst
hardware_x86_64_qemu.rst
index.rst
intro.rst
```



Development Helpers

NFS Root

- Export the BSPs sysroot on the devel host via NFS
 - Set correct access rights etc.
- Use vim on the devel host instead of the target :-)
- No rebuilding, reflashing, and rebooting needed

```
~/projects/my-bsp $ ptxdist nfsroot
```

```
Mount rootfs with nfsroot=/root,v3,tcp,port=2049,mountport=2049
```



Development Helpers

GDB Wrapper

- Use with gdbserver or coredumps
- Debug on the host, not on the target

```
~/projects/my-bsp $ ptxdist gdb -quiet platform-v7a/root/usr/bin/mount
Reading symbols from platform-v7a/root/usr/bin/mount...
Reading symbols from platform-v7a/root/usr/lib/debug/.build-id/16/7c142341573f764667b5d22f6ba14aa9e78f15.debug...
(gdb) print main
$1 = {int (int, char **)} 0x2618 <main>
(gdb) list main
574             return 0;
575         return ret;
576     }
577
578     int main(int argc, char **argv)
579     {
580         int c, rc = MNT_EX_SUCCESS, all = 0, show_labels = 0;
581         struct libmnt_context *cxt;
582         struct libmnt_table *fstab = NULL;
583         char *srcbuf = NULL;
(gdb) █
```



Summary

- Menu interface
- Stable and known technology under the hood
- Focus on reproducibility
 - Pin down variable space as much as possible
 - Solve conflicts early
- Code Signing Infrastructure
- Development helpers (NFS root, GDB)



Trying It Out

Pengutronix

DistroKit

```
OSELAS(R)-DistroKit-2019.12.0-00013-ga194771d1638 / v7a-2019.12.0-00013-ga194771d1638  
ptxdist-2020.01.0/2020-02-01T12:42:15+0100
```

DistroKit login:

DistroKit

- preconfigured BSP for a variety of dev boards (and qemu)
- <https://git.pengutronix.de/cgit/DistroKit>



References

Icons

- FontAwesome (<https://fontawesome.com>), CC BY 4.0

Tux Logo

- Attribution: Larry Ewing <lewing@isc.tamu.edu> and The GIMP

Thanks for listening!

Questions?

