



Buildroot: what's new?

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- ▶ CTO and Embedded Linux engineer at Bootlin
 - ▶ Embedded Linux **development**: kernel and driver development, system integration, boot time and power consumption optimization, consulting, etc.
 - ▶ Embedded Linux **training**, Linux driver development training and Android system development training, with materials freely available under a Creative Commons license.
 - ▶ <http://bootlin.com>
- ▶ Contributions
 - ▶ **Kernel support for the Marvell Armada** ARM SoCs from Marvell
 - ▶ Major contributor to **Buildroot**, an open-source, simple and fast embedded Linux build system
- ▶ Living in **Toulouse**, south west of France

Introduction to Buildroot



Buildroot at a glance

- ▶ Is an **embedded Linux build system**, builds from source:
 - ▶ cross-compilation toolchain
 - ▶ root filesystem with many libraries/applications, cross-built
 - ▶ kernel and bootloader images
- ▶ **Fast**, simple root filesystem in minutes
- ▶ **Easy** to use and understand: kconfig and make
- ▶ **Small** root filesystem, default 2 MB
- ▶ More than **1000 packages** available
- ▶ Generates filesystem images, not a distribution
- ▶ Vendor neutral
- ▶ Active community, regular releases
- ▶ Started in 2001, oldest still maintained build system



Who's using Buildroot: a few examples

▶ System makers

- ▶ Google
- ▶ Barco
- ▶ Rockwell Collins





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▶ Processor vendors

- ▶ Analog Devices
- ▶ Imagination Technologies
- ▶ Marvell
- ▶ Atmel





Who's using Buildroot: a few examples

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▶ Processor vendors

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- ▶ Marvell
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- ▶ Many, many **hobbyists** on development boards: Raspberry Pi, BeagleBone Black, etc.





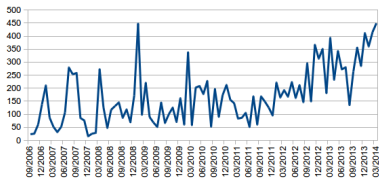
A demonstration is worth many
slides!

What's new?

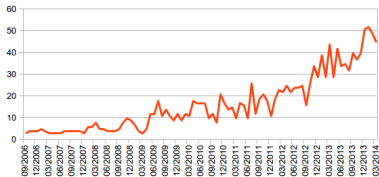


Increased activity

Number of commits per month



Number of contributors per month



Number of e-mails per month





Architecture support

- ▶ Several **new architectures** added
 - ▶ AArch64
 - ▶ ARC, contributed by Synopsys
 - ▶ Blackfin, contributed by Analog Devices
 - ▶ Microblaze
 - ▶ NIOS II
 - ▶ Xtensa, maintained by Tkos
- ▶ **Improved ARM** support: soft-float, softfp, hardfp, NEON, VFP variants
- ▶ **Improved MIPS** support, contributed by Imagination Technologies
- ▶ **Improved noMMU** support



Toolchain support

- ▶ In the **internal toolchain backend**
 - ▶ Support added for *eglibc* and *glibc*
 - ▶ Upcoming support for *musl*
 - ▶ Significant cleanup of the backend
- ▶ In the **external toolchain backend**
 - ▶ Support for many additional external toolchains: Linaro, Sourcery, Analog Devices, etc.
- ▶ Dropped support for the *Crosstool-NG backend*
 - ▶ But toolchains generated by *Crosstool-NG* can still be used as *external toolchains*



New packages

- ▶ Multimedia
 - ▶ GStreamer 1.2, XBMC, Wayland, EFL, Qt5, Pulseaudio, Opus, Linphone, tvheadend, etc.
 - ▶ Lots of OpenGL improvements
- ▶ Scripting
 - ▶ Python 3, nodejs, Lua, Python and PHP modules
- ▶ System
 - ▶ Systemd/udev, eudev
- ▶ Databases
 - ▶ MySQL server, PostgreSQL
- ▶ Development
 - ▶ perf, lttng, trace-cmd, wireshark, etc.
- ▶ 342 packages added since January, 1st 2013.



- ▶ In 2013, participated to the **GSoC program**. One student, Spenser Gilliland, working on **ARM multimedia support**
- ▶ **GPU drivers**: PowerVR for TI, Mali for Allwinner, Vivante on i.MX, RaspberryPi
- ▶ **Video acceleration**: CedarX on Allwinner, VPU on i.MX, Gst-omx on RaspberryPi
- ▶ Enabling of OpenGL ES and EGL in several packages: Qt5, Cairo, etc.
- ▶ Ongoing effort with a new GSoC 2014 project **improvement of multimedia support**, with Hadrien Boutteville

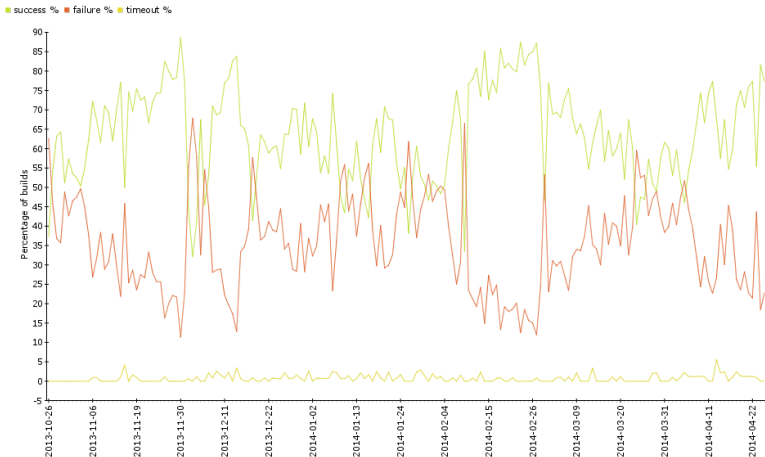


Quality assurance: autobuilders (1)

Buildroot tests						
Date	Status	Commit ID	Submitter	Arch	Failure reason	Data
2014-04-25 21:16:56	NOK	909382c3	Thomas Petazzoni (Free Electrons build server)	mips64c	postgresql-9.3.4	dir, end log, config, defconfig
2014-04-25 21:14:34	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	powerpc	none	dir, end log, config, defconfig
2014-04-25 21:11:39	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	powerpc	none	dir, end log, config, defconfig
2014-04-25 21:02:04	NOK	909382c3	Thomas Petazzoni (Free Electrons build server)	arm	evemu-1.2.0	dir, end log, config, defconfig
2014-04-25 20:56:02	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	arm	none	dir, end log, config, defconfig
2014-04-25 20:38:01	OK	909382c3	Peter Korsgaard (gcc110)	i686	none	dir, end log, config, defconfig
2014-04-25 20:26:04	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	mipsel	none	dir, end log, config, defconfig
2014-04-25 20:02:33	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	xtensa	none	dir, end log, config, defconfig
2014-04-25 19:24:50	NOK	909382c3	Thomas Petazzoni (Free Electrons build server)	mips2	gdb-7.5.1	dir, end log, config, defconfig
2014-04-25 19:17:49	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	arm	none	dir, end log, config, defconfig
2014-04-25 18:53:45	OK	909382c3	Peter Korsgaard (gcc110)	i686	none	dir, end log, config, defconfig
2014-04-25 18:41:14	NOK	909382c3	Thomas Petazzoni (Free Electrons build server)	mips2	hp-testsuite-20140115	dir, end log, config, defconfig
2014-04-25 18:37:47	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	xtensa	none	dir, end log, config, defconfig
2014-04-25 18:26:08	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	arm	none	dir, end log, config, defconfig
2014-04-25 18:22:31	NOK	909382c3	Thomas Petazzoni (Free Electrons build server)	x86_64	cairo-1.12.10	dir, end log, config, defconfig
2014-04-25 18:00:51	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	i686	none	dir, end log, config, defconfig
2014-04-25 17:59:09	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	arm	none	dir, end log, config, defconfig
2014-04-25 17:57:44	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	i686	none	dir, end log, config, defconfig
2014-04-25 17:46:22	OK	909382c3	Peter Korsgaard (gcc110)	arm	none	dir, end log, config, defconfig
2014-04-25 17:28:41	OK	909382c3	Peter Korsgaard (gcc110)	i686	none	dir, end log, config, defconfig
2014-04-25 17:21:34	OK	909382c3	Thomas Petazzoni (Free Electrons build server)	microblazeel	none	dir, end log, config, defconfig
2014-04-25 16:56:59	NOK	909382c3	Thomas Petazzoni (Free Electrons build server)	mipsel	evemu-1.2.0	dir, end log, config, defconfig
2014-04-25 16:32:46	NOK	909382c3	Thomas Petazzoni (Free Electrons build server)	arm	evemu-1.2.0	dir, end log, config, defconfig



Quality assurance: autobuilders (2)





License compliance support (1)

- ▶ Embedded Linux systems integrate dozens of components, each distributed under a given license.
- ▶ Keeping track of the list of all components and their license can be a cumbersome task.
- ▶ Buildroot now has licensing information attached to each package

```
BUSYBOX_LICENSE = GPLv2  
BUSYBOX_LICENSE_FILES = LICENSE
```

- ▶ Given a configuration, such information can be extracted for all the packages used in the generated system.



License compliance support (2)

```
$ make legal-info
```

In `output/legal-info/`, generates:

- ▶ `buildroot.config`, copy of Buildroot configuration
- ▶ `licenses/`, directory with the licenses of each target package
- ▶ `licenses.txt`, file with the licenses of all target packages
- ▶ `manifest.csv`, CSV file with the description of all target packages
- ▶ `sources/`, directory with the tarballs
- ▶ Same thing for *host packages*: `host-licenses/`, `host-licenses.txt`, `host-manifest.csv`.



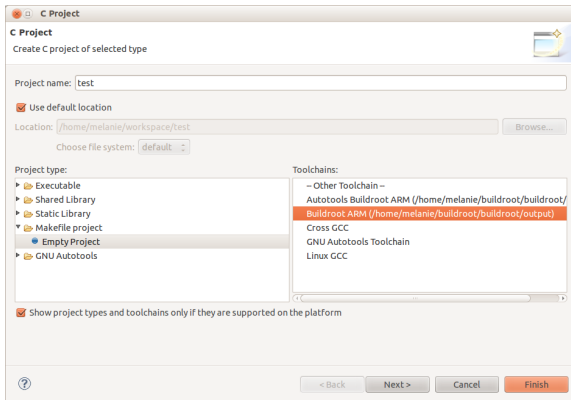
License compliance support (3)

```
$ cat output/legal-info/manifest.csv
"PACKAGE","VERSION","LICENSE","LICENSE FILES","SOURCE ARCHIVE"
"toolchain-external","undefined","unknown","not saved","ia32-..."
"busybox","1.22.1","GPLv2","LICENSE","busybox-1.22.1.tar.bz2"
"i2c-tools","3.1.0","GPLv2+, GPLv2 (py-smbus)","COPYING","i2c-..."
"kmod","17","LGPLv2.1+","libkmod/COPYING","kmod-17.tar.xz"
"lua","5.1.5","MIT","COPYRIGHT","lua-5.1.5.tar.gz"
```



Eclipse plugin

- ▶ An Eclipse plugin facilitates the usage of Buildroot toolchains for library and application development.
- ▶ <https://github.com/mbats/eclipse-buildroot-bundle/wiki>





Configurations for boards

- ▶ Predefined configurations for many popular boards have been added.
 - ▶ RaspberryPi
 - ▶ BeagleBoneBlack
 - ▶ CubieBoard
 - ▶ Altera SOCKit
 - ▶ Wandboard
 - ▶ Zedboard
 - ▶ ...
- ▶ Also lots of pre-defined configurations for QEMU emulated platforms.
- ▶ In total, 63 pre-defined board configurations
- ▶ `make <name>_defconfig && make`



Package infrastructures

- ▶ Buildroot has **package infrastructures** to factorize common logic between package recipes, and simplify the creation of new packages.
- ▶ Buildroot already had: `autotools-package`, `cmake-package` and `generic-package`
- ▶ Over the last year, **several package infrastructures** were added:
 - ▶ `python-package`, with major improvements to the Python support
 - ▶ `perl-package`
 - ▶ `lua-package`

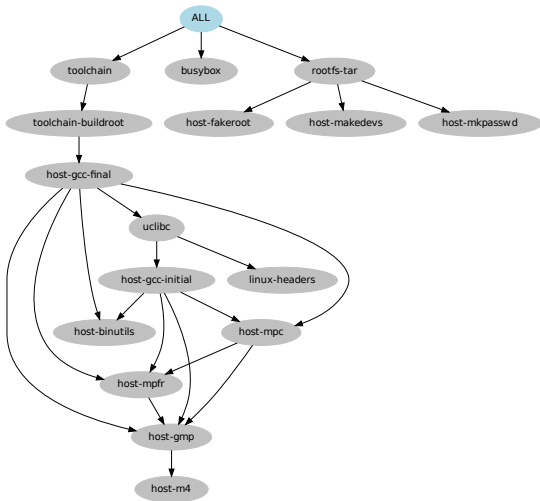


Dependency graphing

- ▶ Addition of a tool to visualize the dependencies between packages
- ▶ Tied to a given configuration
- ▶ Allows to more easily understand why a given package is brought into the build.
- ▶ Usage:
 - ▶ `make graph-depends` for a full dependency graph
 - ▶ `make <pkg>-graph-depends` for the dependencies of one package
 - ▶ `ls output/graphs`



Dependency graphing: example 1



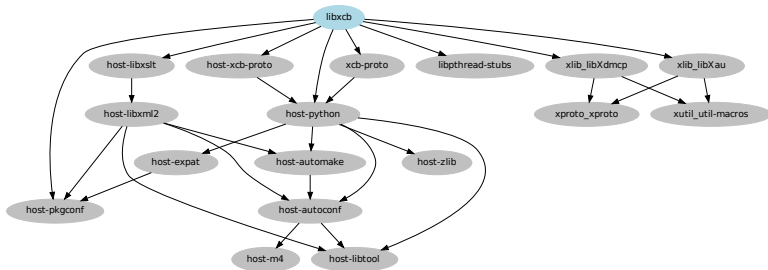


Dependency graphing: example 2





Dependency graphing: example 3





Build time graphing

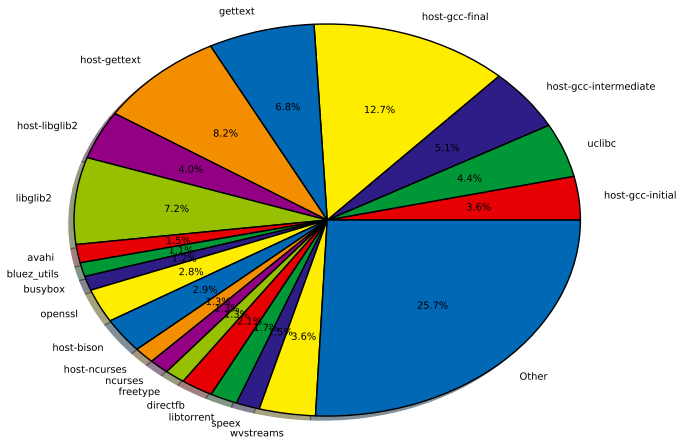
- ▶ Buildroot records the duration of each step for each package: extract, patch, configure, build, install, etc.
- ▶ Using this information, it can produce graphs to help analyze the build duration.
- ▶ Useful to understand what is taking the longest to build, and where build time optimizations should be made.
- ▶ After a build, generate a graph with:
 - ▶ `make graph-build`
 - ▶ `ls output/graphs`





Build time graphing: example 2

Build time per package





Support for customization

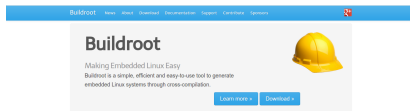
Lots of improvements to help customizing the Buildroot build

- ▶ **BR2_EXTERNAL**: can point to a directory that contains additional package recipes and *defconfigs*
 - ▶ Useful to separate the open-source components (in the core Buildroot) from proprietary/company-specific packages
 - ▶ `make BR2_EXTERNAL=../foobar`
 - ▶ `foobar/package`, `foobar/board`, `foobar/configs`
- ▶ **Rootfs overlay**: a directory copied over the root filesystem after all packages are built, but before the root filesystem image is created.
- ▶ **Hook scripts**: **post-build** and **post-image** scripts can be called to tweak the root filesystem and/or the images.



Entering the 21st century

Finally, a new web site, and a Google+ page

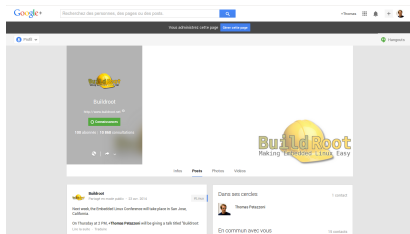


Recent commits

[5842014] kati: needs kmeta
[5842014] ether: add test script
[5842014] ether: bump to version 1.14
[5842014] version: bump to version 1.23
[5842014] http: bump to version 1.5.3
[5842014] debug: bump to version 1.2.14
[5842014] etc: don't trust warnings as errors

Recent discussions

[5832014] Major patch sets to review and test
[5832014] [PATCH] downloading: add open-embedded



Questions?

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Slides under CC-BY-SA 3.0

<http://bootlin.com/pub/conferences/2014/elc/petazzoni-buildroot-whats-new/>