Buildroot: what's new?

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Thomas Petazzoni

- CTO and Embedded Linux engineer at Free Electrons
  - 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://free-electrons.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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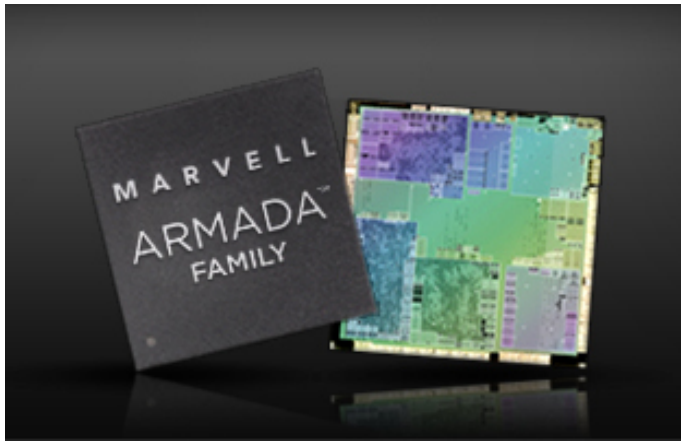
- **Processor vendors**
  - Analog Devices
  - Imagination Technologies
  - Marvell
  - Atmel



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- **Processor vendors**
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  - Imagination Technologies
  - Marvell
  - Atmel
- Many, many **hobbyists** on development boards: Raspberry Pi, BeagleBone Black, etc.

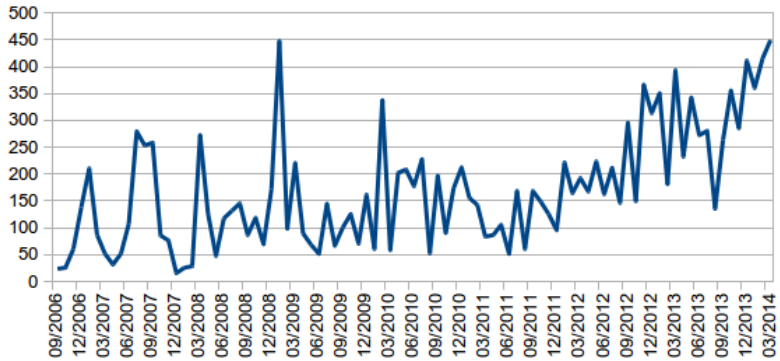
Demonstration

A demonstration is worth many slides!

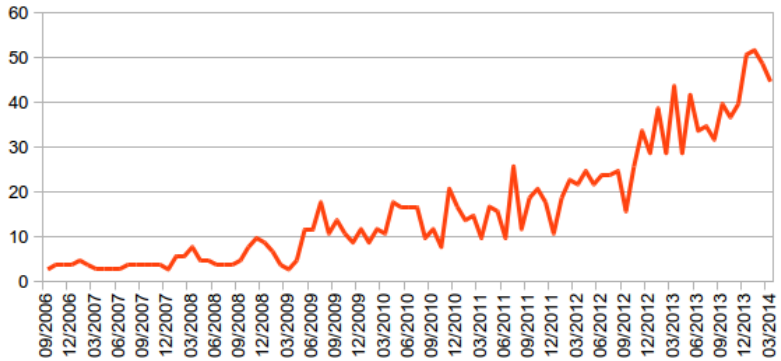
What's new?

Increased activity

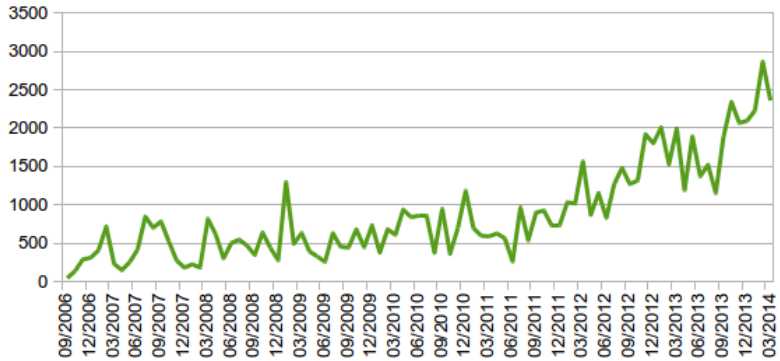
Number of commits per month



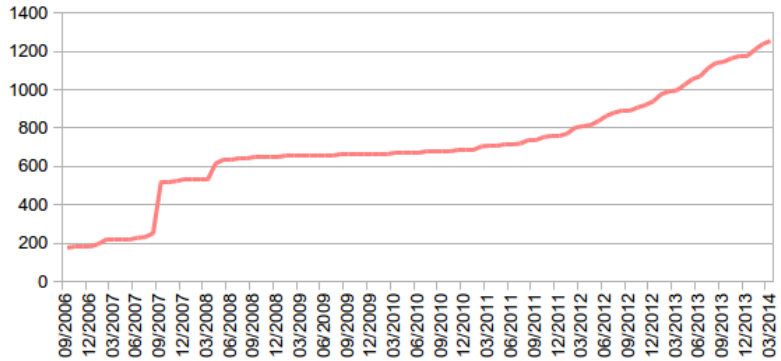
Number of contributors per month



Number of e-mails per month



Number of packages



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.

GSoC and multimedia

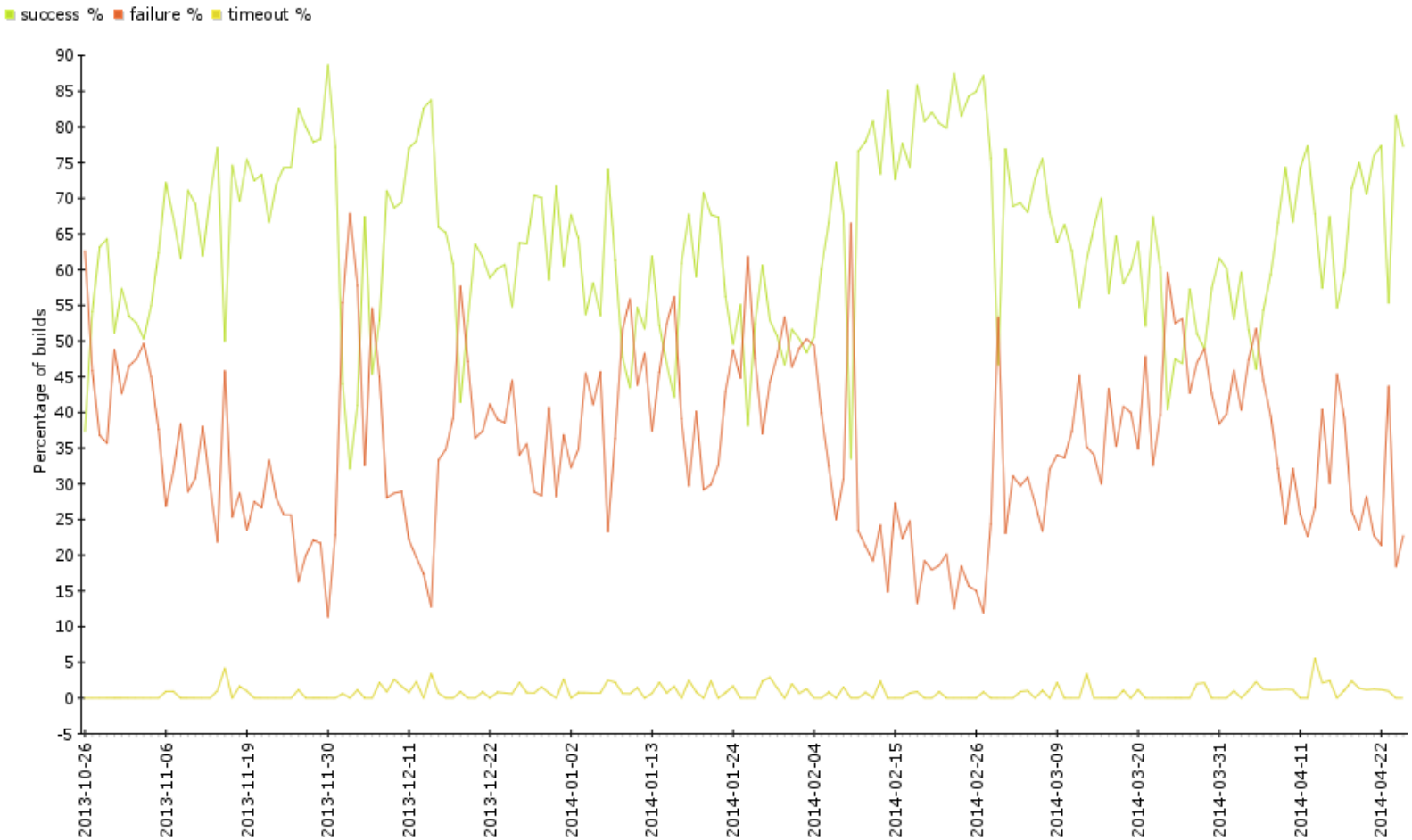
- In 2013, participated to the **GSoC program**. One student, Spenser Gilliland, working on **ARM multimedia support**
- **GPU drivers**: PowerVR for TI, Mali for Allwinner, Vivante on i.MX, RaspberryPi
- **Video acceleration**: CedarX on Allwinner, VPU on i.MX, Gst-omx on RaspberryPi
- Enabling of OpenGL 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)*	mips64el	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)*	nios2	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)*	nios2	ltp-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 *(gcc10)*	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:

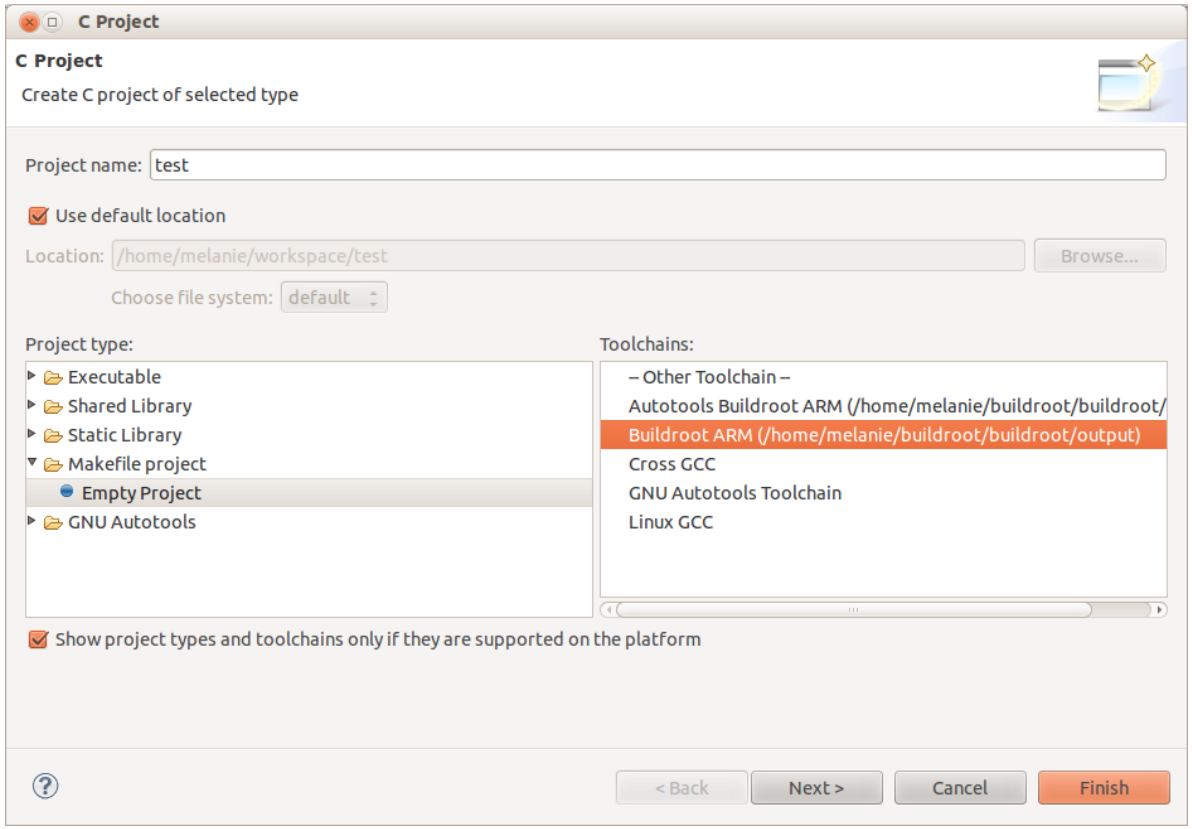
- `buildroot.config`, copy of Buildroot configuration
- `licenses/`, directory with the licenses of each target package
- `licenses.txt`, file with the licenses of all target packages
- `manifest.csv`, CSV file with the description of all target packages
- `sources/`, directory with the tarballs
- Same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

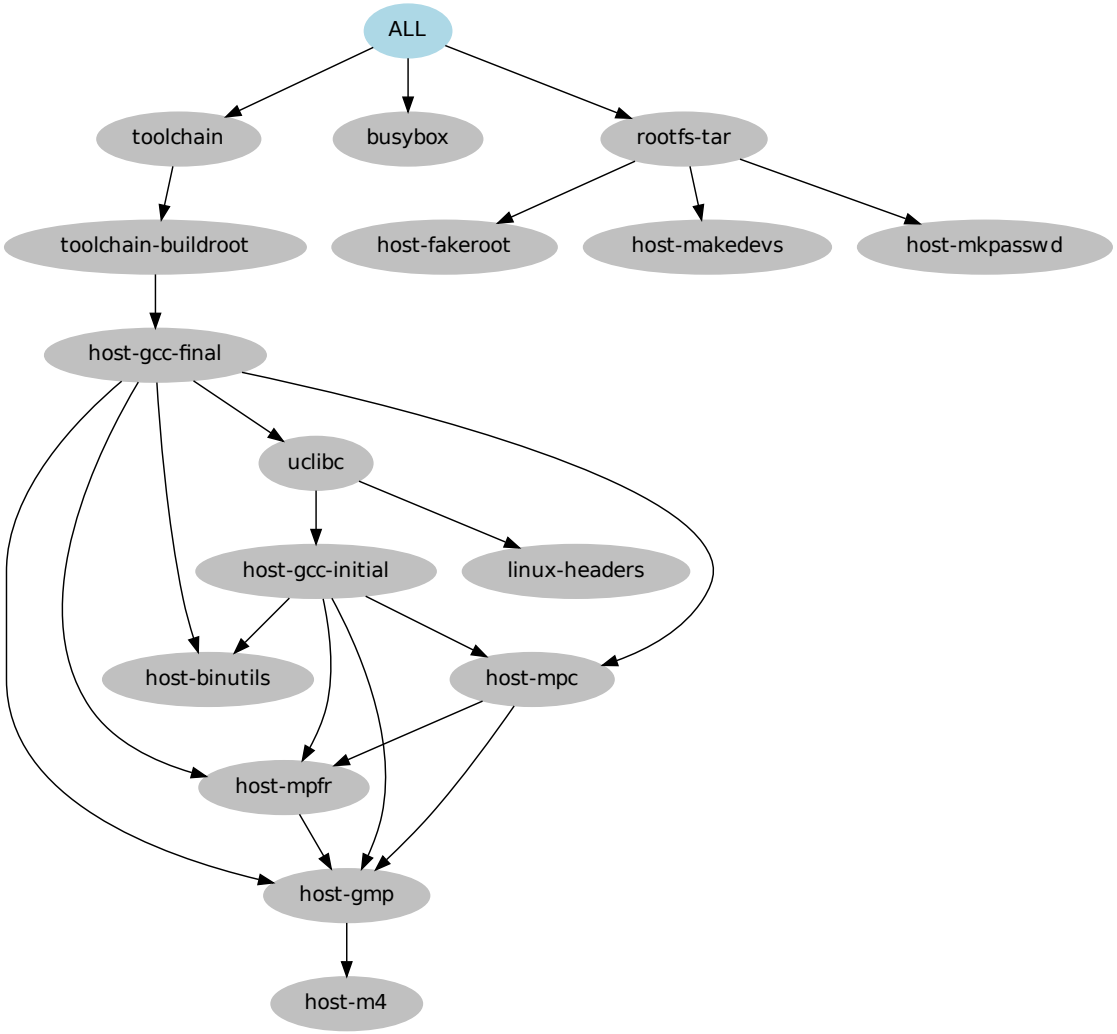
Package infrastructures

- 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`

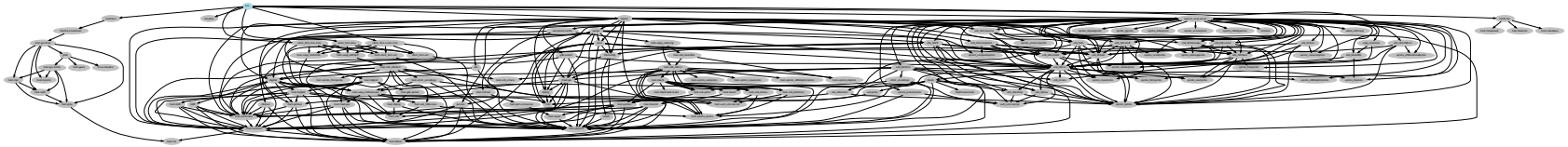
Dependency graphing

- 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`

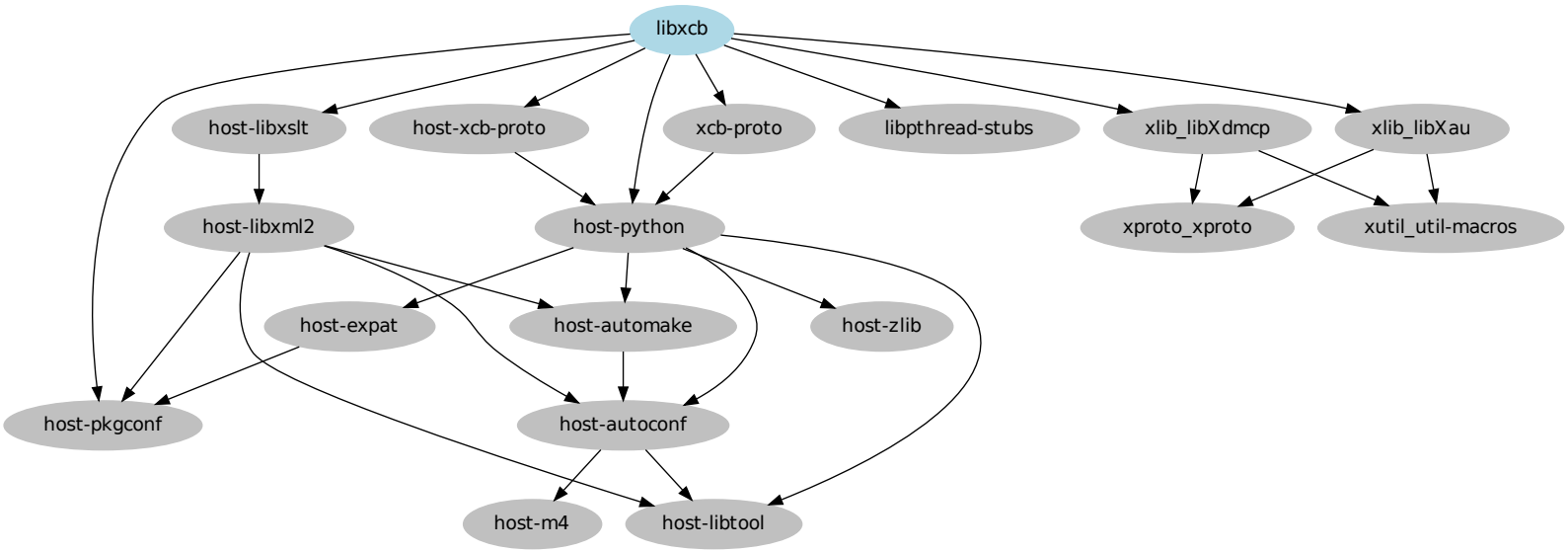
Dependency graphing: example 1



Dependency graphing: example 2



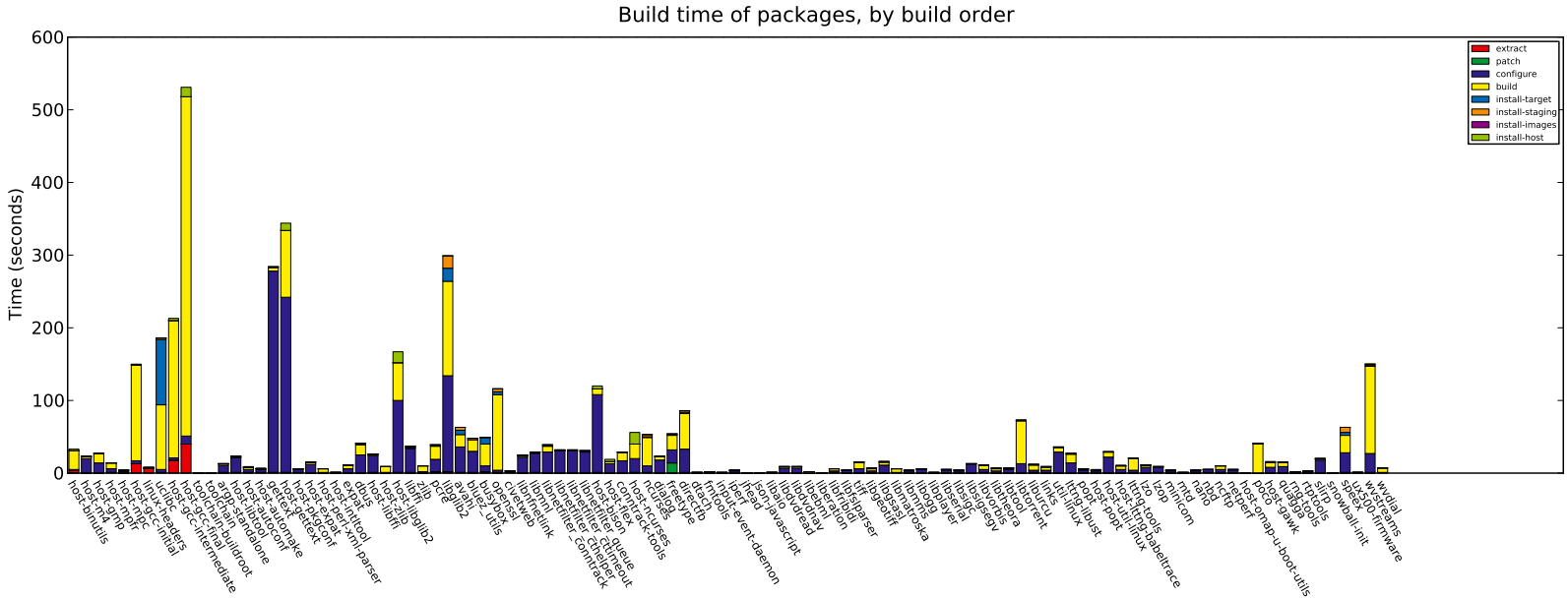
Dependency graphing: example 3



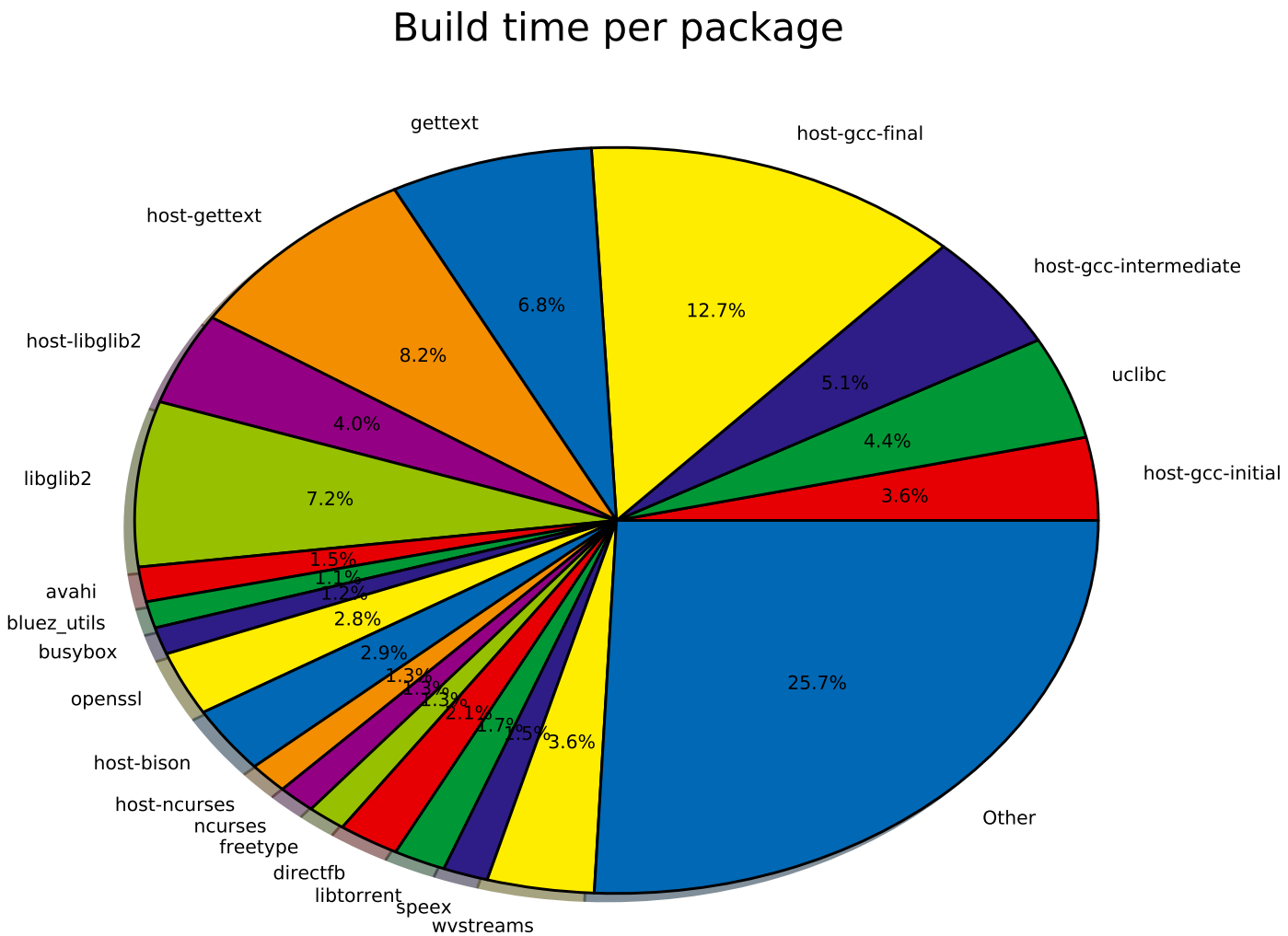
Build time graphing

- 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 1



Build time graphing: example 2



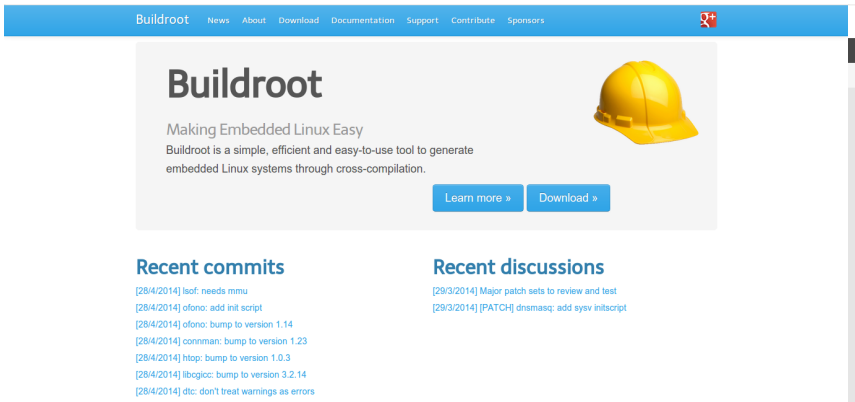
Support for customization

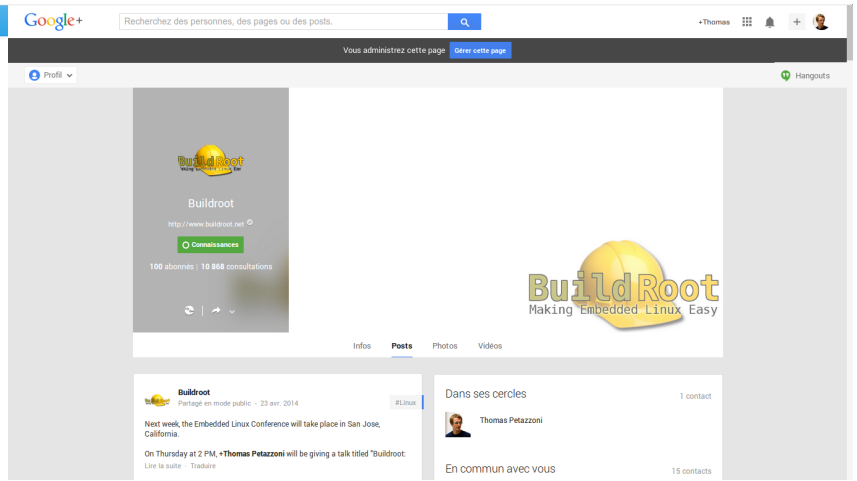
Lots of improvements to help customizing the Buildroot build

- `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





Questions?

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http://free-electrons.com/pub/conferences/2014/elc/petazzoni-buildroot-whats-new/