



# BuildRoot

Making Embedded Linux Easy

## What is new?

**Peter Korsgaard, Maintainer**  
**ELCE 2013**

## What is it?

- An **Embedded Linux build** system
  - Cross toolchain
  - Bootloader
  - Linux kernel
  - Rootfs
- All software components of an embedded Linux system



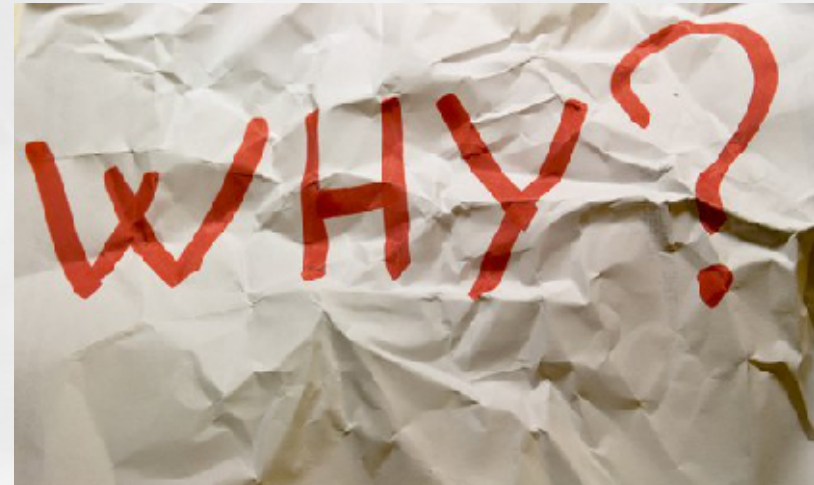
**Build Root**  
Making Embedded Linux Easy

## Alternatives



## Why Buildroot?

- One of the longest running projects
  - Started in 2001 as a way to test & demo uClibc
  - Mature and well documented
- Relatively simple
  - For me, OE fails the easy to understand, quick to setup test. I now use buildroot. -- Kevin Hilman, ARM kernel developer.*
- Regular release schedule
  - Every 3 months + bugfix releases
- Real community project
  - No single company steering direction
  - Active and friendly community



# KISS

- Lots of tradeoffs
  - **Features vs simplicity**
  - **How can it be generalized?**
- Rootfs image, no binary packages!



## How does it work?

- **Kconfig** based interactive configuration tool

- From the Linux kernel
- Tree structure
- Dependencies, conflicts
- Help

```
/home/peko/source/buildroot/.config - Buildroot 2013.11-git-00281-ge9f6011 Conf
Buildroot 2013.11-git-00281-ge9f6011 Configuration
Arrow keys navigate the menu. <Enter> selects submenus ---,
Highlighted letters are hotkeys. Pressing <Y> selects a feature,
while <N> will exclude a feature. Press <Esc><Esc> to exit, <?> for
Help, </> for Search. Legend: [*] feature is selected [ ] feature is

Target options --->
Build options --->
Toolchain --->
System configuration --->
Kernel --->
Target packages --->
Filesystem images --->
Bootloaders --->
Host utilities --->
Legacy config options --->

<Select> < Exit > < Help > < Save > < Load >
```

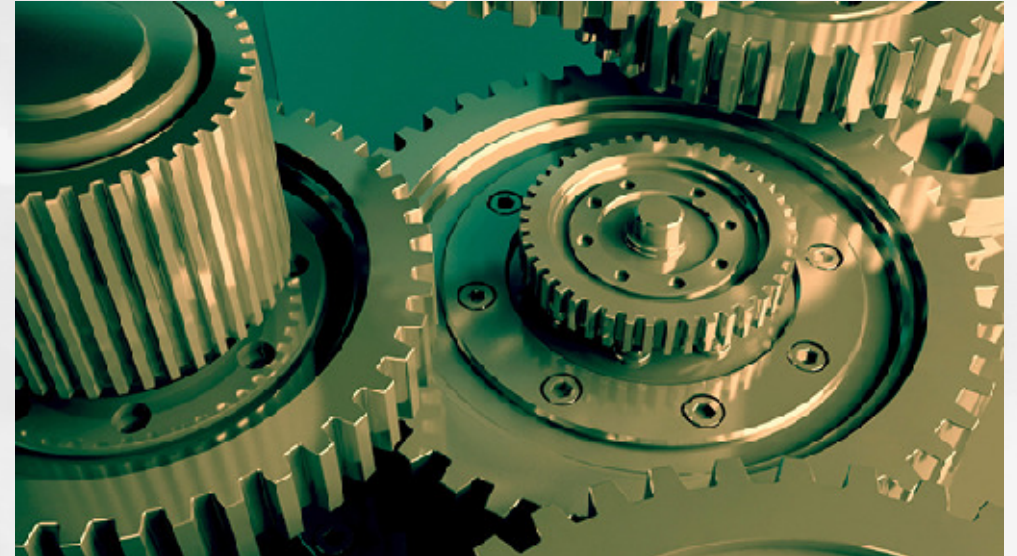
- **Make** based build system

```
(23:15)--
[dell] make menuconfig; make ~/source/buildroot
```

- Both **familiar** technologies to developers

# Packages

- Buildroot is structured around **packages**
  - **Each with a number of steps**
    - Download, Extract, Patch, Configure, Build, Install
- A build executes all **enabled** packages
  - **With the chosen options**
  - **In the correct order**
- **Meta** build system
  - **Source code is downloaded**
  - **Build system is driven by Buildroot**



## Anatomy of a package

- Config.in with options
  - In the kconfig language

```
config BR2_PACKAGE_GZIP
```

```
bool "gzip"
```

```
depends on BR2_USE_WCHAR
```

```
help
```

```
Standard GNU compressor. Provides things like gzip,  
gunzip, gzcat, etc...
```

```
http://www.gnu.org/software/gzip/gzip.html
```

```
comment "gzip requires a toolchain with WCHAR support"
```

```
depends on !BR2_USE_WCHAR
```



## Anatomy of a package

- Package.mk with build steps
  - **Sensible defaults for packages using autotools or cmake**

```
GZIP_VERSION = 1.6  
GZIP_SOURCE = gzip-$(GZIP_VERSION).tar.xz  
GZIP_SITE = $(BR2_GNU_MIRROR)/gzip  
  
$(eval $(autotools-package))
```

## Anatomy of a package

- Finally include it in package/Config.in under the right sub option

menu “Compressors and decompressors”

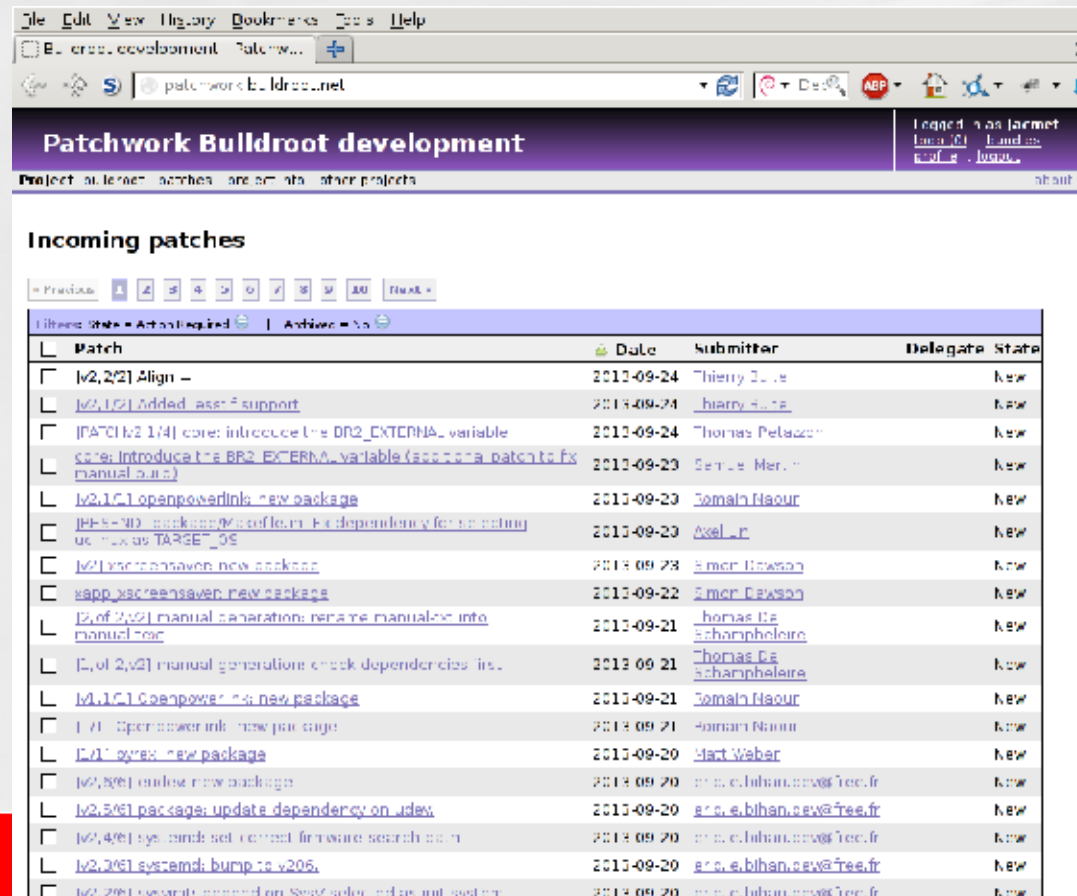
..

include “package/gzip/Config.in”

```
~/home/peko/source/buildroot/.config - Buildroot 2013.11-git-00589-gf0801fa Conf
i
                                     Compressors and decompressors
Arrow keys navigate the menu. <Enter> selects submenus --->.
Highlighted letters are hotkeys. Pressing <Y> selects a feature,
while <N> will exclude a feature. Press <Esc><Esc> to exit, <?> for
Help, </> for Search. Legend: [*] feature is selected [ ] feature is
[ ] bzip2
[*] gzip
[ ] infozip
+ (+)
<Select> <Exit> <Help> <Save> <Load>
```

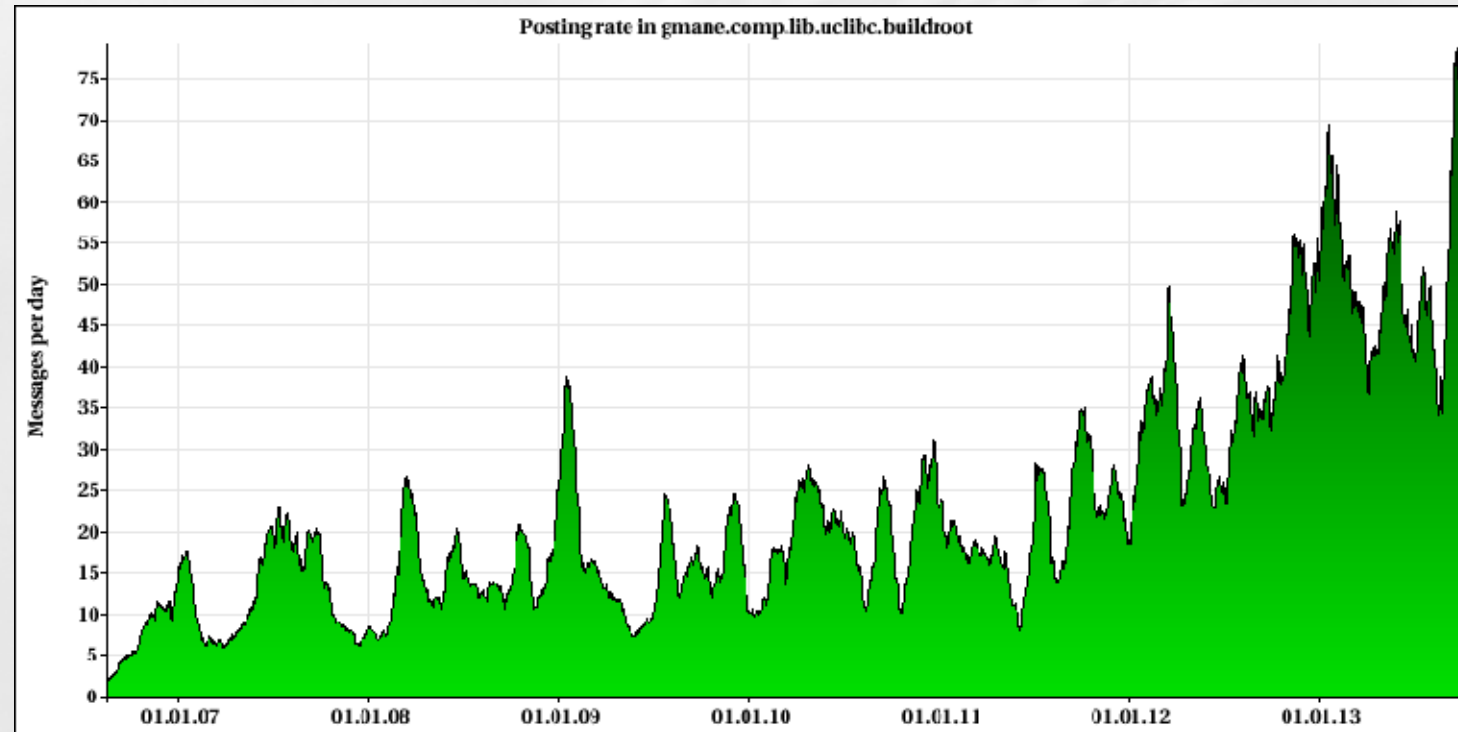
# Source code

- Git managed similar to Linux kernel, only maintainer has commit access
- Patches gets posted and reviewed on mailing list
  - 200-300 patches get integrated each month
- Patch queue managed in Patchwork



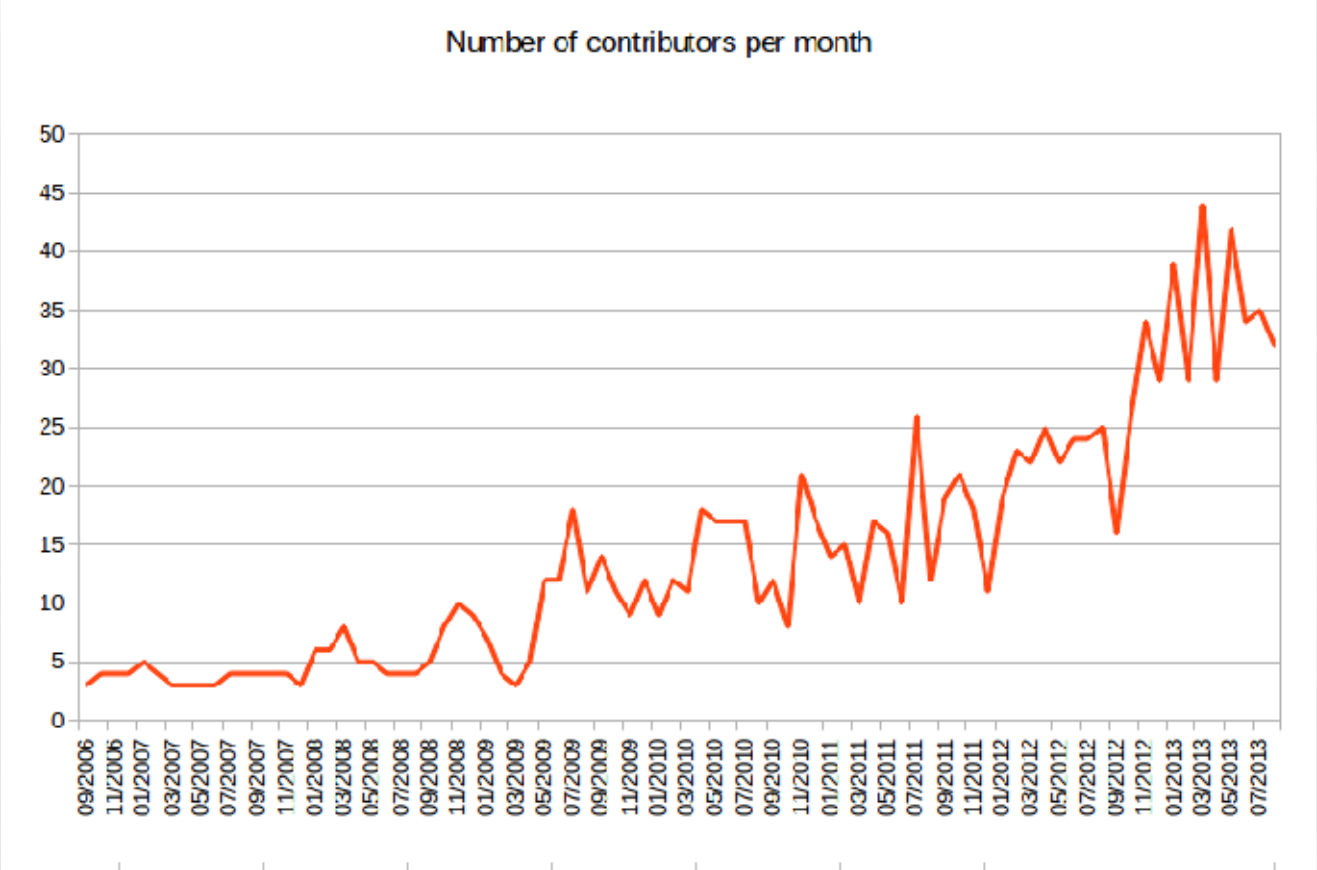
## Mailing List

- User support and development
- 1000+ subscribers, ~2000 mails / month



# Contributors

- 30 – 40 contributors each month



## Developer Days

- 2x / Year
  - Around FOSDEM and Embedded Linux Conference Europe
- Sponsored by companies using Buildroot
  - Thanks!



## Companies using Buildroot

- Use in products
  - Barco
  - Google (fiber)
  - Rockwell Collins
- Use as SDK
  - Atmel
  - Cadence
  - Imagination Technologies
  - Synopsys



.. And a bunch of others that don't tell us about it

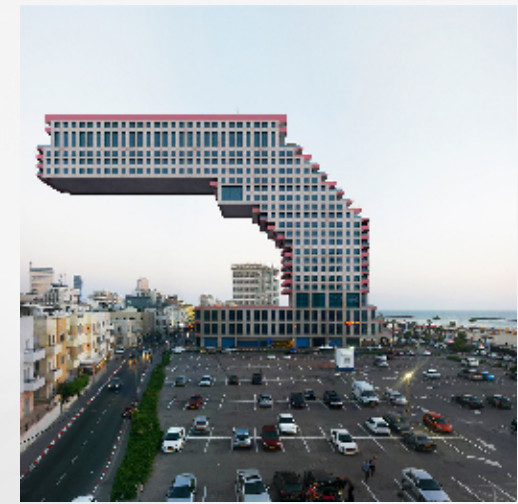
# What is new?





# Architecture Support

- New Architectures
  - Aarch64, ARC, Blackfin, Microblaze, Nios II, Xtensa
  - ARC/Bfin/Xtensa contributed by Synopsys/Analog/Cadence
- Improved variant support
  - ARM soft/hard/hardfp, NEON, VFP variants
- Improved NOMMU support
  - Package annotation
  - FLAT/FDPIC selection



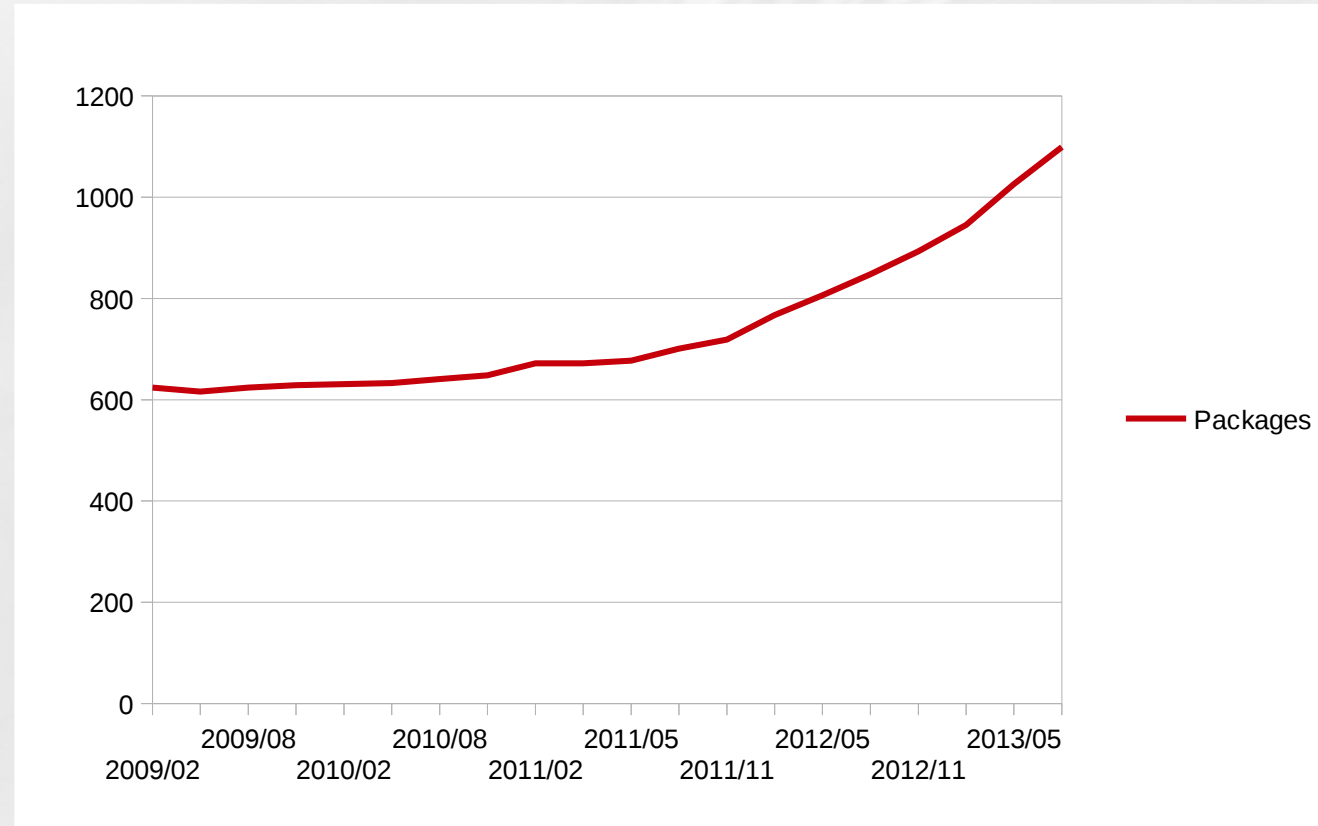
## Toolchains

- C library options for internal toolchain
  - **EGlibc, Glibc, uClibc**
- External toolchain support
  - **Preconfigs for CodeBench, Linaro**
  - **Musl libc support**



## Lots of new packages

- 30% more packages since last year

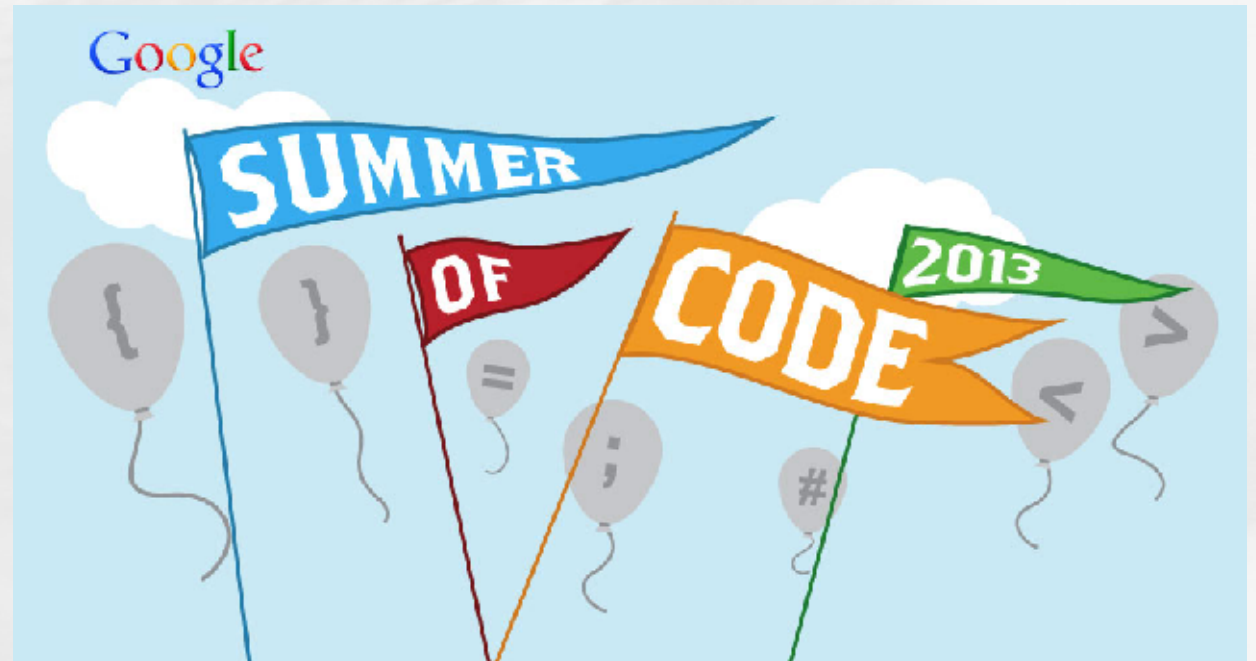


# Packages

- Multimedia
  - Gstreamer 1.2, Wayland, EFL, Qt5, Pulseaudio, Opus, Linphone, tvheadend ..
- Scripting
  - Python3, nodejs, ..
- System
  - Flashbench, systemd, ..
- Development
  - Perf, lttng, trace-cmd, wireshark, ..

## Google Summer of Code

- Improved support for multimedia features of popular ARM SoCs
  - **Spenser Gilliland with Thomas Petazzoni as mentor**
- GPU drivers
  - **PowerVR on TI**
  - **Mali on Allwinner**
  - **Vivante on i.MX**
  - **RPi**
- Video acceleration
  - **Cedarx on Allwinner**
  - **VPU on i.MX**
  - **Gst-omx on RPi**



# Quality assurance



- Development cycle splitup
  - 2 months of feature development
  - 1 month of stabilization
    - Bugfix release if critical issues are found post release
- Continuous regression tests
  - Randpackageconfig
  - 4 servers 24/7

Date	Status	Commit	Submitter	Arch	Failure reason	Data
2013-08-23 16:19:05	OK	<a href="#">a9550e02</a>	Thomas Perazzoni (Free Electrons build server)	mips64	none	<a href="#">dir_end_log</a> , <a href="#">config</a> , <a href="#">defconfig</a>
2013-08-23 15:31:17	OK	<a href="#">b9550e02</a>	Thomas Perazzoni (Free Electrons build server)	x86_64	none	<a href="#">dir_end_log</a> , <a href="#">config</a> , <a href="#">defconfig</a>
2013-08-23 15:07:12	NOX	<a href="#">a9550e02</a>	Thomas Perazzoni (Free Electrons build server)	arm	cive.web-1.0	<a href="#">dir_end_log</a> , <a href="#">config</a> , <a href="#">defconfig</a>
2013-08-23 14:51:58	OK	<a href="#">a9550e02</a>	Peter Korsgaard (post10)	i686	none	<a href="#">dir_end_log</a> , <a href="#">config</a> , <a href="#">defconfig</a>
2013-08-23 14:42:07	OK	<a href="#">b9550e02</a>	Thomas Perazzoni (Free Electrons build server)	mipsel	none	<a href="#">dir_end_log</a> , <a href="#">config</a> , <a href="#">defconfig</a>
2013-08-23 14:15:10	OK	<a href="#">a9550e02</a>	Thomas Perazzoni (Free Electrons build server)	arm	none	<a href="#">dir_end_log</a> , <a href="#">config</a> , <a href="#">defconfig</a>
2013-08-23 14:11:18	NOX	<a href="#">b9550e02</a>	Thomas Perazzoni (Free Electrons build server)	xtensa	lmod 15	<a href="#">dir_end_log</a> , <a href="#">config</a> , <a href="#">defconfig</a>
			Thomas			<a href="#">dir_end</a>

## License compliance support

- Buildroot itself is **GPLv2+**, many packages also copyleft
- Packages are annotated with their license

```
GZIP_LICENSE = GPLv3+  
GZIP_LICENSE_FILES = COPYING
```

- **make legal-info** generates
  - A manifest listing enabled packages, their version and license info
  - A copy of the license files
  - A copy of the source code tarballs
  - Buildroot configuration
- Notice that this is **to support** legal compliance, further work may be needed
  - Proprietary application linking to GPL libraries
  - License conflicts (E.G. OpenSSL vs GPL)



# Eclipse CDT Plugin



**C Project**

Create C project of selected type

Project name:

Use default location

Location:

Choose file system:

Project type:

- Executable
- Shared Library
- Static Library
- Makefile project
- GNU Autotools
  - Empty Project**
  - Hello World ANSI C Autotools Project
  - Autotools Shared Library Project

Toolchains:

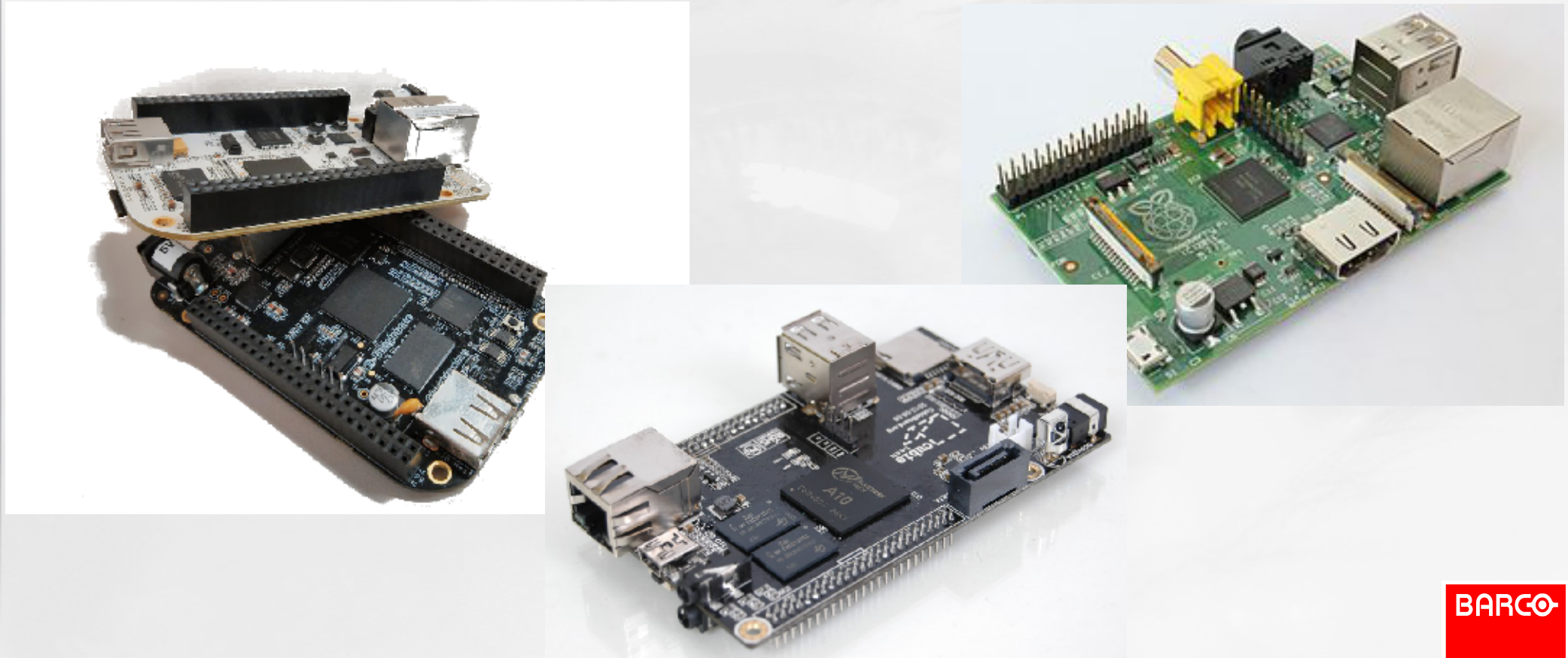
- Autotools Buildroot ARM (/home/melanie/buildroot/buildroot/**
- GNU Autotools Toolchain

Show project types and toolchains only if they are supported on the platform



# Defconfigs

- Preconfigured setups for popular boards
  - Beaglebone, cubieboard, nitrogen6x, rpi, sheevaplug, wandboard, ..
  - A bunch of QEMU variants



## System users

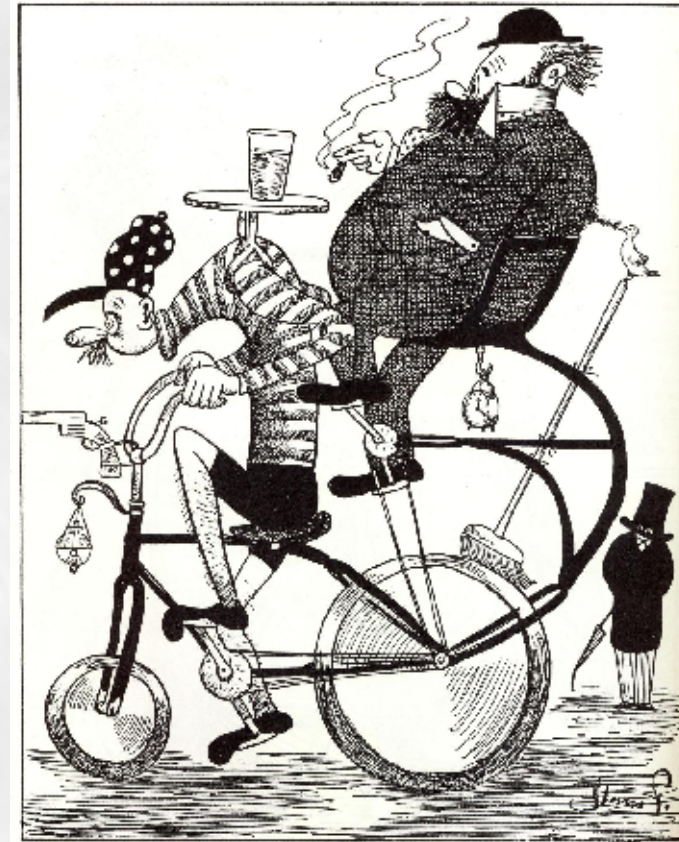
got root?

- Packages can now add system users:

```
# user uid group gid pass homedir shell groups comment
define TVHEADEND_USERS
tvheadend -1 tvheadend -1 * /home/tvheadend - video TVHeadend
endif
```

# Customization

- System configuration menu in menuconfig
  - Hostname, banner, password, init system, getty, ..
- Rootfs overlays
  - For adding extra files
- Hook scripts to tweak
  - Post-build (after all rootfs packages have been built)
  - Post-image (after Buildroot is done)
- Custom packages



## Upcoming work

- Package overlays (external packages)
- SELinux support
- Updated systemd/udev
- ... + What else gets submitted

Questions?



# Build Root

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<http://buildroot.org>