Buildroot at 25

A Quarter Century of Making Embedded Linux Easy



ELCE26, Prague

Me

- Peter Korsgaard
- 20+ years of embedded Linux experience
- Buildroot maintainer
- Danish, living in Belgium
- Works for Barco



peter@korsgaard.com
@peterkorsgaard@fosstodon.org

Agenda

- History
- Current status
- Testimonals
- Looking ahead



History

- Once upon a time in a galaxy far far away..

```
commit ffde94bd2ca21542ae0b4518348f8e986b9d92e0 (tag: 0_0)
Author: Eric Andersen <andersen@codepoet.org>
Date:   Sat Dec 22 00:56:11 2001 +0000

    Initial revision
```



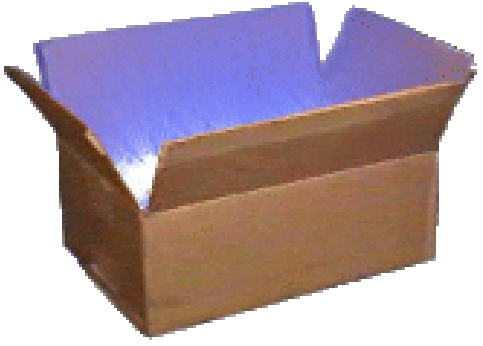
2001



- A **really long time** ago!
  - No git (used CVS)
  - 2.4.x kernel, -rmk patchset
  - Compaq iPAQ just released
    - 206MHz StrongARM, 32MB RAM, 16MB NOR, 320x240 LCD
  - No WRT54G, no Zaurus SL-5500
    - No OpenWRT, no OpenEmbedded
- Buildroot **oldest** active embedded Linux build system

Origin

- Erik worked on uClibc and BusyBox
- Buildroot for easy testing and demo
  - Hosted on buildroot.uclibc.org
  - Only supported uClibc/busybox
  - Shared infrastructure with those



I got involved in 2006

```
commit 9dd69ffbfd8a99c066d84cda4f113fe1c37f3978
Author: Eric Andersen <andersen@codepoet.org>
Date:   Mon Apr 10 23:31:14 2006 +0000

    0000789: New package: ethtool: patch from jacmet
    This little patch adds a target for ethtool to buildroot.
    ethtool is a small utility for examining and tuning your
    ethernet-based network interface.
```

Commit access

```
commit 7bc4ad6e56d2083a3adb71705dbdd236fc352eb5
Author: Peter Korsgaard <jacmet@sunsite.dk>
Date:   Fri Apr 28 19:40:43 2006 +0000

    0000851: toolchain/kernel-headers: Use LINUX_HEADERS_VERSION instead of
    LINUX_VERSION.

    Use LINUX_HEADERS_VERSION instead of LINUX_VERSION as that variable is used
    for the actual kernel version used which might be different than the headers
    version.

    E.G. LINUX_VERSION is set in the target/device/* files. If this version
    doesn't match the selected kernel headers version the patches won't be applied.
```

Too many chefs in the kitchen

- 30 people with commit access
  - No coordination, no agreements on structure
  - Changes for use case 1 would break use case 2
- Erik was no longer active
- No releases



From: Peter Korsgaard <jacmet@uclibc.org>
To: buildroot@busybox.net
Subject: [Buildroot] Buildroot maintainer and stable releases
Date: Mon, **05 Jan 2009 22:18:01 +0100**
Message-ID: <87prj1v4dy.fsf@macbook.be.48ers.dk>

Hi, and happy new year everyone,

The end of the year is a moment to take a step back and take a bigger look at the situation. I have done that for buildroot, and as I see it the two biggest problems we have are:

- **Lack of an active maintainer**. No hard feelings, but lets face it - Erik hasn't really been active in buildroot development for quite some time. This isn't a big deal for day to day development, but it means that there's no one doing stuff like keeping the website up to date, a central contact point for infrastructure issues (like the recent break in), make decisions when there is disagreements among developers (we already lost Bernhard because of that), and:
- **Lack of releases**. It has often been discussed, but nothing has come of it.

I offer to do something about both: **Take over maintainership and get atual stable releases out the door** (if Erik and the other developers agree).

My proposal

- Fixed release schedule, date based versioning
  - <year>.02, <year>.05, <year>.08, <year>.11
  - 2 months development, 1 month stabilization
- Linux / U-Boot style development
  - Single maintainer (committer)
  - Patches and reviews on mailing list
  - Commit after approval (for everyone)

From: Peter Korsgaard <jacmet@uclibc.org>
To: buildroot@busybox.net
Subject: [Buildroot] Buildroot 2009.02 released
Date: **Thu, 12 Feb 2009 10:22:07 +0100**
Message-ID: <87skmkf1s0.fsf@macbook.be.48ers.dk>

Hi,

Buildroot 2009.02 is released - Go download it at:

http://buildroot.uclibc.org/downloads/buildroot-2009.02.tar.gz

or

http://buildroot.uclibc.org/downloads/buildroot-2009.02.tar.bz2

It has been a long time coming, but we finally have a stable buildroot
release. This is not to say that there won't be any bugs, but we have
done a LOT of cleanups and bugfixes these last weeks, and it's IMHO a
good baseline.

As promised earlier, we are moving to a **3 month release cycle** - So
expect the first release candidate of 2009.05 some time in late April,
and the final release mid May.
...

Version control

- Started in CVS
- Migrated to Subversion early 2005
- Migrated to Git for easier collaboration

```
commit e2cac48876e11a29fd7b873dbfe2e5b0138e3fe5
Author: Peter Korsgaard <jacmet@sunsite.dk>
Date:   Sun May 3 22:11:33 2009 +0200

    docs/: announce move to git

    Signed-off-by: Peter Korsgaard <jacmet@sunsite.dk>
```

Single maintainer

- Single committer != dictatorship
- Community of developers
- No features get added without review on ml
  - Also not by maintainer!

Additional maintainers

From: Peter Korsgaard <jacmet@sunsite.dk>
To: buildroot@busybox.net
Subject: [Buildroot] **New temp maintainer** (was Re: pending patches)
Date: Wed, 11 Jul 2012 09:25:00 +0200
Message-ID: <87zk76yd2r.fsf@macbook.be.48ers.dk>

Hi,

 Peter> Hi, Sorry about the low amount of patch review/commits lately,
 Peter> but I'm on antibiotics since Wednesday, and it's only improving
 Peter> very slowly.

Turns out it is worse than first expected. The Xrays show I have
Pneumonia and need to rest as much as possible. Luckily **Thomas Petazzoni**
has agreed to step up and take over maintainership for the 2012.08
release.

I should be **back alive** for the 2012.11 cycle though.

Thanks a lot Thomas!

Maintainer team

- Peter Korsgaard (2009 - ..)
- Thomas Petazzoni (2012 - ..)
- Arnout Vandecappelle (2017 - ..)
- Yann E. Morin (2019 - 2024)
- Romain Naour (2023 - ..)
- Julien Olivain (2024 - ..)
- Marcus Hoffman (2026 - ..)
- Fiona Klute (2026 - ..)



Developer meetings

- First meeting after ELCE 2009 in Grenoble, France



Developer meetings

- 2-3 meetings / year, around conferences
  - FOSDEM in spring
  - ELCE in autumn
  - Around summer (Embedded Recipes, summer camp, ..)
- Maintainers and users
  - Normally 5-10 people
- Discussions about new features and backlog handling
  - Important for “complicated” changes
- Next meeting here after ELCE

Meeting locations

- At companies, hackerspaces, airbnb, hotels,..
- Some fancy, some less so
  - But always fun!


Paris 2018



Edinburgh 2013


Edinburgh 2018


Brussels 2014


Dusseldorf 2014


Brussels 2017


Vienna 2024

Testing

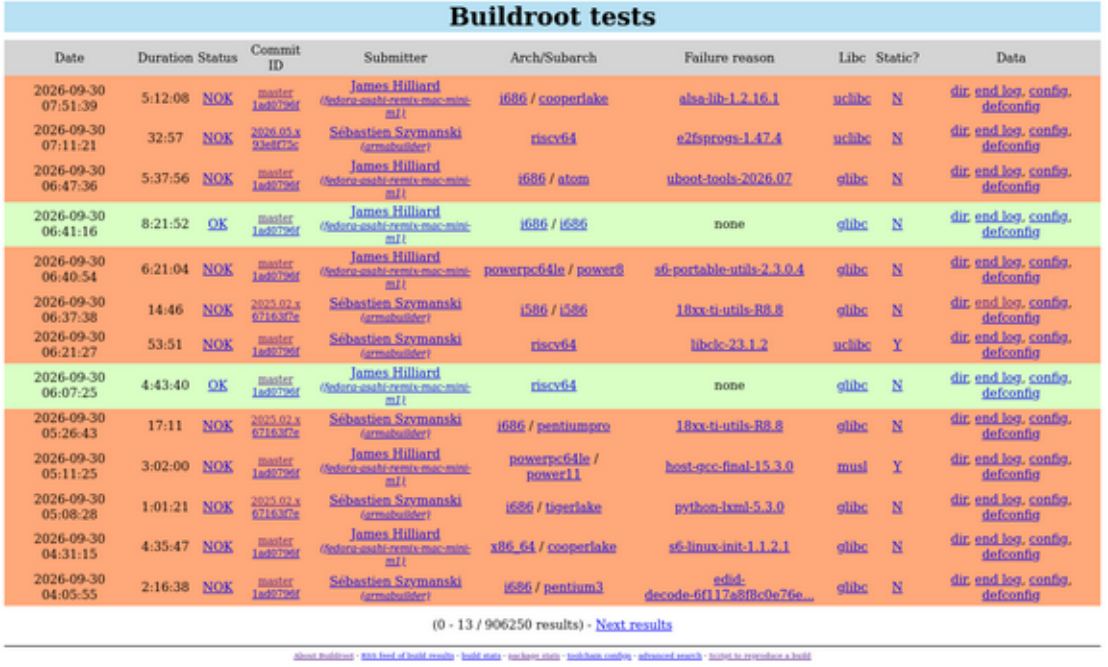
- Really important!
- Not trivial, too many combinations

> The big issue with buildroot quality control is the **mindblowing number** of **configuration combinations** and specialized hardware needed to test. I am therefore convinced we need to leverage **qemu** and agressively deprecate legacy versions / packages + actively work with upstream to keep the number of patches low. I think our users would also be happier with a less ambitious project that **wouldn't break left and right**, instead of the current situation.

From my 2009 “takeover” mail

Autobuilders

- Builders run builds and report results to a central server
- https://autobuild.buildroot.net
- Random configurations
- **Build** and sanity checks
- Daily reports to list



Buildroot tests

Date	Duration	Status	Commit ID	Submitter	Arch/Subarch	Failure reason	Libc	Static?	Data
2026-09-30 07:51:39	5:12:08	NOK	master 1ad0796f	James Hilliard (fedora-asahi-remix-mac-mini-m1)	i686 / cooperlake	alsa-lib-1.2.16.1	uclibc	N	dir, end log, config, defconfig
2026-09-30 07:11:21	32:57	NOK	2026.05.x 93e8f22c	Sébastien Szymanski (armadeus)	riscv64	e2fsprogs-1.47.4	uclibc	N	dir, end log, config, defconfig
2026-09-30 06:47:36	5:37:56	NOK	master 1ad0796f	James Hilliard (fedora-asahi-remix-mac-mini-m1)	i686 / atom	uboot-tools-2026.07	glibc	N	dir, end log, config, defconfig
2026-09-30 06:41:16	8:21:52	OK	master 1ad0796f	James Hilliard (fedora-asahi-remix-mac-mini-m1)	i686 / i686	none	glibc	N	dir, end log, config, defconfig
2026-09-30 06:40:54	6:21:04	NOK	master 1ad0796f	James Hilliard (fedora-asahi-remix-mac-mini-m1)	powerpc64le / power8	s6-portable-utils-2.3.0.4	glibc	N	dir, end log, config, defconfig
2026-09-30 06:37:38	14:46	NOK	2025.02.x 67163f7e	Sébastien Szymanski (armadeus)	i586 / i586	18xx-ti-utils-R8.8	glibc	N	dir, end log, config, defconfig
2026-09-30 06:21:27	53:51	NOK	master 1ad0796f	Sébastien Szymanski (armadeus)	riscv64	libclc-23.1.2	uclibc	Y	dir, end log, config, defconfig
2026-09-30 06:07:25	4:43:40	OK	master 1ad0796f	James Hilliard (fedora-asahi-remix-mac-mini-m1)	riscv64	none	glibc	N	dir, end log, config, defconfig
2026-09-30 05:26:43	17:11	NOK	2025.02.x 67163f7e	Sébastien Szymanski (armadeus)	i686 / pentiumpro	18xx-ti-utils-R8.8	glibc	N	dir, end log, config, defconfig
2026-09-30 05:11:25	3:02:00	NOK	master 1ad0796f	James Hilliard (fedora-asahi-remix-mac-mini-m1)	powerpc64le / power11	host-gcc-final-15.3.0	musl	Y	dir, end log, config, defconfig
2026-09-30 05:08:28	1:01:21	NOK	2025.02.x 67163f7e	Sébastien Szymanski (armadeus)	i686 / tigerlake	python-lxml-5.3.0	glibc	N	dir, end log, config, defconfig
2026-09-30 04:31:15	4:35:47	NOK	master 1ad0796f	James Hilliard (fedora-asahi-remix-mac-mini-m1)	x86_64 / cooperlake	s6-linux-init-1.1.2.1	glibc	N	dir, end log, config, defconfig
2026-09-30 04:05:55	2:16:38	NOK	master 1ad0796f	Sébastien Szymanski (armadeus)	i686 / pentium3	edid-decode-6f117a8f8c0e76e...	glibc	N	dir, end log, config, defconfig

(0 - 13 / 906250 results) - Next results

```
commit a732fb222b8a60076a93d490834d459b0a1c1d6b
Author: Thomas Petazzoni <thomas.petazzoni@free-electrons.com>
Date:   Mon Mar 20 21:36:50 2017 +0100

    support/testing: core testing infrastructure

    This commit adds the core of a new testing infrastructure that allows to
    perform runtime testing of Buildroot generated systems. This
    infrastructure uses the Python unittest logic as its foundation.

    …

    Even though I wrote the original version of this small infrastructure, a
    huge amount of rework and improvement has been done by Maxime
    Hadjinlian, and squashed into this patch. So many thanks to Maxime for
    cleaning up and improving my Python code!

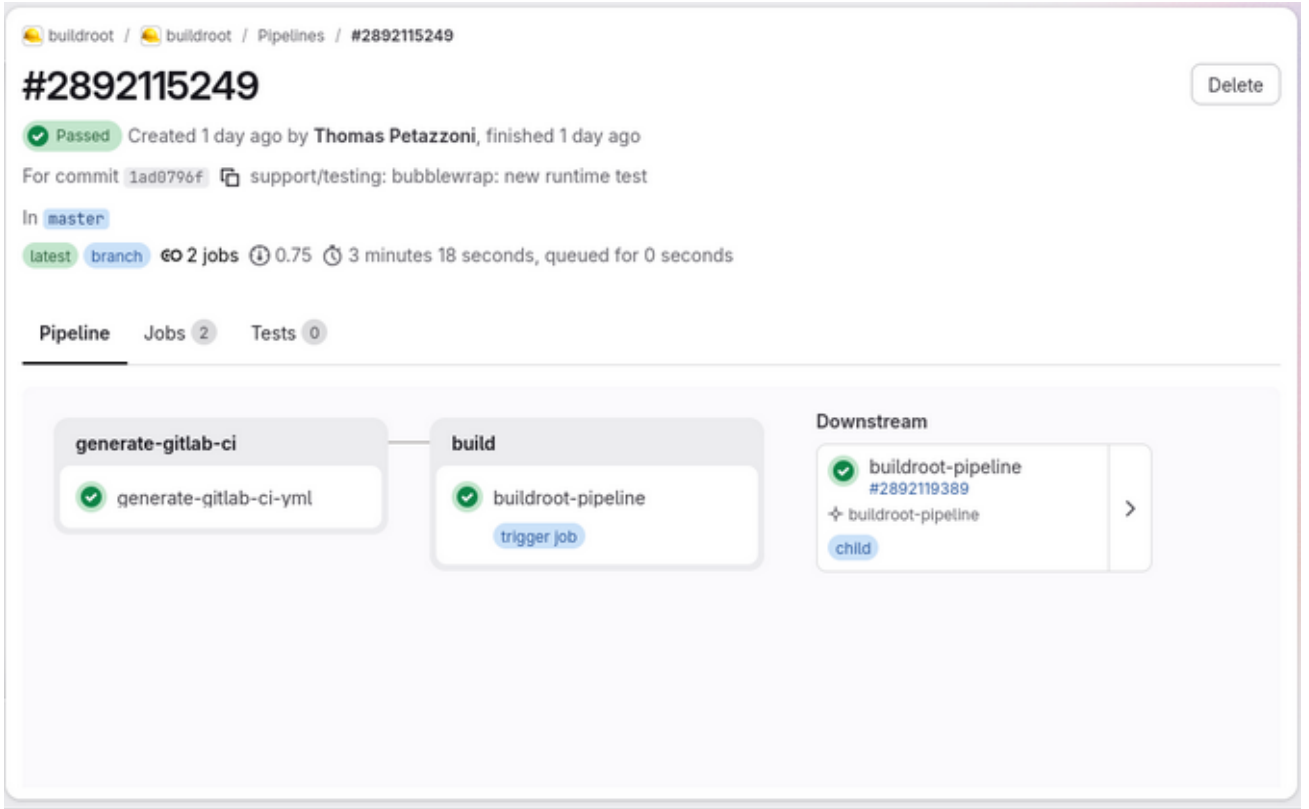
    Signed-off-by: Thomas Petazzoni <thomas.petazzoni@free-electrons.com>
```

Runtime tests

- Test of specific setups / use cases
  - Packages and various infrastructure
- Build and test under QEMU
  - Python based
- Today **800+** tests

Continous integration

- Package sanity checks
- Runtime tests
- Defconfig builds
- Using Gitlab CI



```
commit 7e76f904d208e4ef0bf722583897d4044264f546
Author: Luca Ceresoli <luca@lucaceresoli.net>
Date:   Thu May 17 19:33:00 2012 +0200

    legal-info: infrastructure to collect legally-relevant material

    This allows to automatically collect material that may be needed to comply with
    the license of packages that Buildroot prepares for the target device.

    The core of the implementation is made by the following parts:
     - in package/pkg-utils.mk some helper functions are defined for common actions
       such as generating a warning, producing info about a package etc;
     - in package/pkg-gentargets.mk, within the GENTARGETS framework, a new
       <PKG>-legal-info target produces all the info for a given package;
     - Makefile implements the top-level targets:
       - legal-info-prepare creates the output directory and produces legal info
         about Buildroot itself and the toolchain, which mostly means just warning
         the user that this is not implemented;
       - legal-info, the only target that is supposed to be used directly, depends
         on all of the above and finishes things by producing the README files from
         the various pieces.

    Signed-off-by: Luca Ceresoli <luca@lucaceresoli.net>
    Signed-off-by: Thomas Petazzoni <thomas.petazzoni@free-electrons.com>
```

Legal info

- Licensing metadata in packages
- **`make legal-info`**
  - Collects source and license files for compliance
- Extended for SBOM in CycloneDX format in 2025

```
commit a4239f7fd1053c11bf4bb8bbc98cbe4b513f2d47
Author: Thomas Petazzoni <thomas.petazzoni@free-electrons.com>
Date:   Thu Dec 5 20:11:10 2013 +0100

    core: introduce the BR2_EXTERNAL variable

    This commit introduces the BR2_EXTERNAL environment variable, which
    will allow to keep Buildroot customization (board-specific
    configuration files or root filesystem overlays, package Config.in and
    makefiles, as well as defconfigs) outside of the Buildroot tree.

    This commit only introduces the variable itself, and ensures that it
    is available within Config.in options. This allows us to use
    $BR2_EXTERNAL in a 'source' statement in Config.in.

    Following patches extend the usage of BR2_EXTERNAL to other areas
    (packages and defconfigs).

    In details, this commit:

     * Introduces the BR2_EXTERNAL Kconfig option. This option has no
       prompt, and is therefore not visible to the user and also not
       stored in the .config file. It is automatically set to the value of
       the BR2_EXTERNAL environment variable. The only purpose of this
       BR2_EXTERNAL Kconfig option is to allow $BR2_EXTERNAL to be
       properly expanded when used inside Kconfig source statements.
...
```

External trees

- Way to keep local customization outside tree
  - Added clarity
  - Easier upgrades
- Since extended to support multiple trees (2016)



Buildroot association

- We received a bit of money
  - Sponsors, GSoC
- Created a (french) non-profit in 2016
  - Bank account
  - Handle expenses (domain, server, ..)



Signing session 2016

Hosting

- Originally VM shared with BusyBox / uClibc at OSUOSL
- Git (and CI) moved to Gitlab in 2017
- Website/Autobuild/mirror moved to Hetzner in 2024
- Mailing list still at OSUOSL



From: Chris Simmonds <chris@2net.co.uk>
To: buildroot@busybox.net
Subject: [Buildroot] Buildroot LTS?
Date: **Fri, 30 Oct 2015 09:22:38 +0000**
Message-ID: <563336DE.4040809@2net.co.uk>

Hi,

Is there a long term support policy for Buildroot? For example, when the next significant bug like heartbleed or shellshock comes along, how do I best incorporate the fix in my Buildroot project?

Looking through the commit history, I gather that Buildroot is a "rolling release". There are stable releases several times per year, but there are few updates once it is released. So, the way to get security fixes would be to update to the latest stable release: is that correct? The downside is that that will bring in many changes in addition to fixing security bugs and I may have to go through a new QA cycle.

I would be interested in any comments on the above. What do Buildroot users do in practice? Does any 3rd party offer LTS support for Buildroot?

Best regards,
Chris Simmonds

From: Peter Korsgaard <peter@korsgaard.com>
To: buildroot@busybox.net
Subject: [Buildroot] Buildroot 2017.02 released
Date: Tue, 28 Feb 2017 22:19:38 +0100
Message-ID: <871suihv2t.fsf@dell.be.48ers.dk>

Hi,

Buildroot **2017.02** is released - Go download it at:

http://buildroot.net/downloads/buildroot-2017.02.tar.gz

<snip>

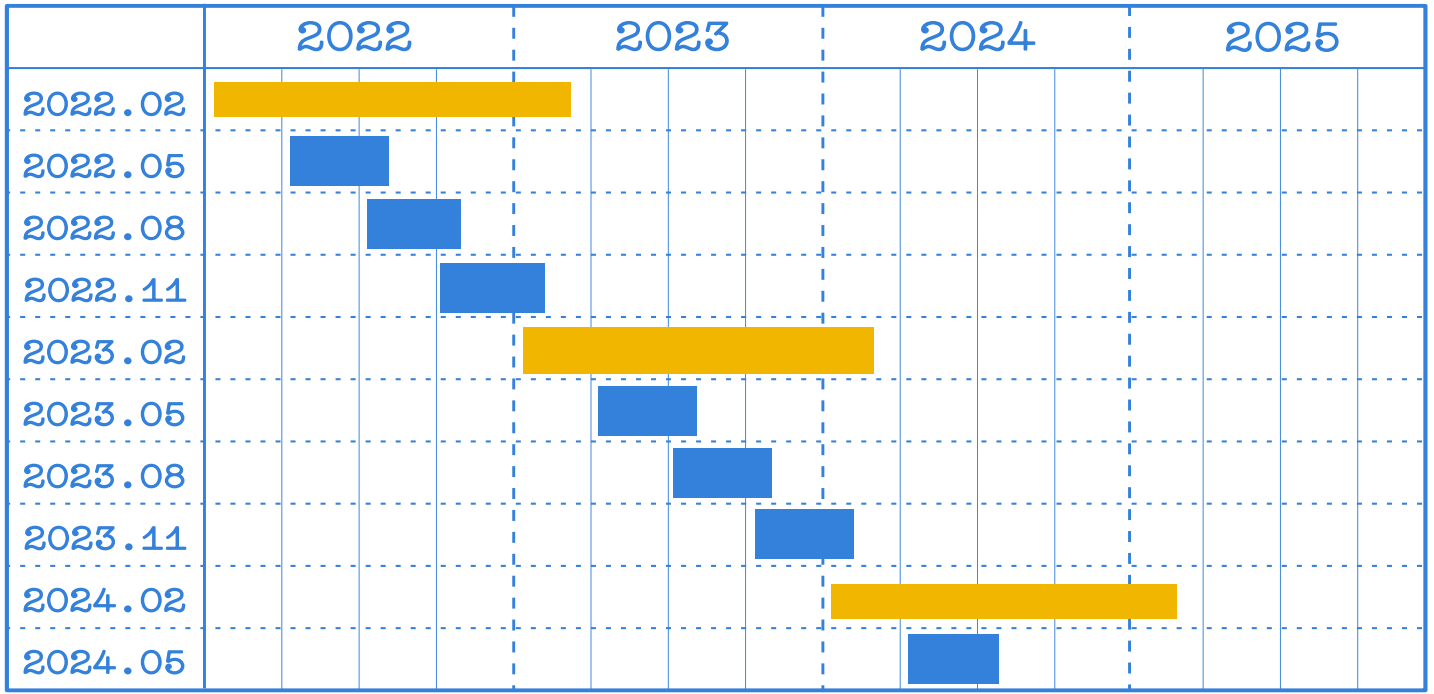
This release will become our first long term support release, which means that we aim to maintain it with security and other important fixes until 2018.02. We will do regular point releases (2017.02.x) within the support period.

The next release will be 2017.05. Expect the first release candidate at the beginning of May and the final release at the end of the month.

Long term support

- The first release of the year becomes LTS
  - <year>.02
- Monthly point releases
  - <year>.02.<n>
- Backports of (security) bugfixes from master
  - Best effort
- Support for ~1 year
  - Goes EOL when <year+1>.02.1 is released
  - Effort goes up a lot as master evolves

LTS


2022
2023
2024
2025
2022.02
2022.05
2022.08
2022.11
2023.02
2023.05
2023.08
2023.11
2024.02
2024.05

From: Arnout Vandecappelle via buildroot <buildroot@buildroot.org>
To: buildroot@buildroot.org
Subject: [Buildroot] Sponsoring Buildroot LTS: talk to your managers!
Date: **Wed, 11 Sep 2024 16:50:10 +0200**
Message-ID: <11df1d27-7fd8-4f6c-bdbe-786f46a75c24@mind.be>

Hi all,

This message is targetted at people who use Buildroot in a **professional** environment, and who believe Buildroot is a good thing and should get better support.

Currently, if you use Buildroot to build a product, you're not getting great security updates. There is an LTS branch, but it is only maintained **for a year**. This means you need to do a major Buildroot update every year, which is more frequent than most people are willing to do. In addition, the "maintenance" is not very thorough: it's just the security updates that Peter happens to stumble upon, or that other people contribute.

This situation exists because it's a completely **voluntary effort**, and Peter is the only volunteer who steps up, and that is the best he can do.

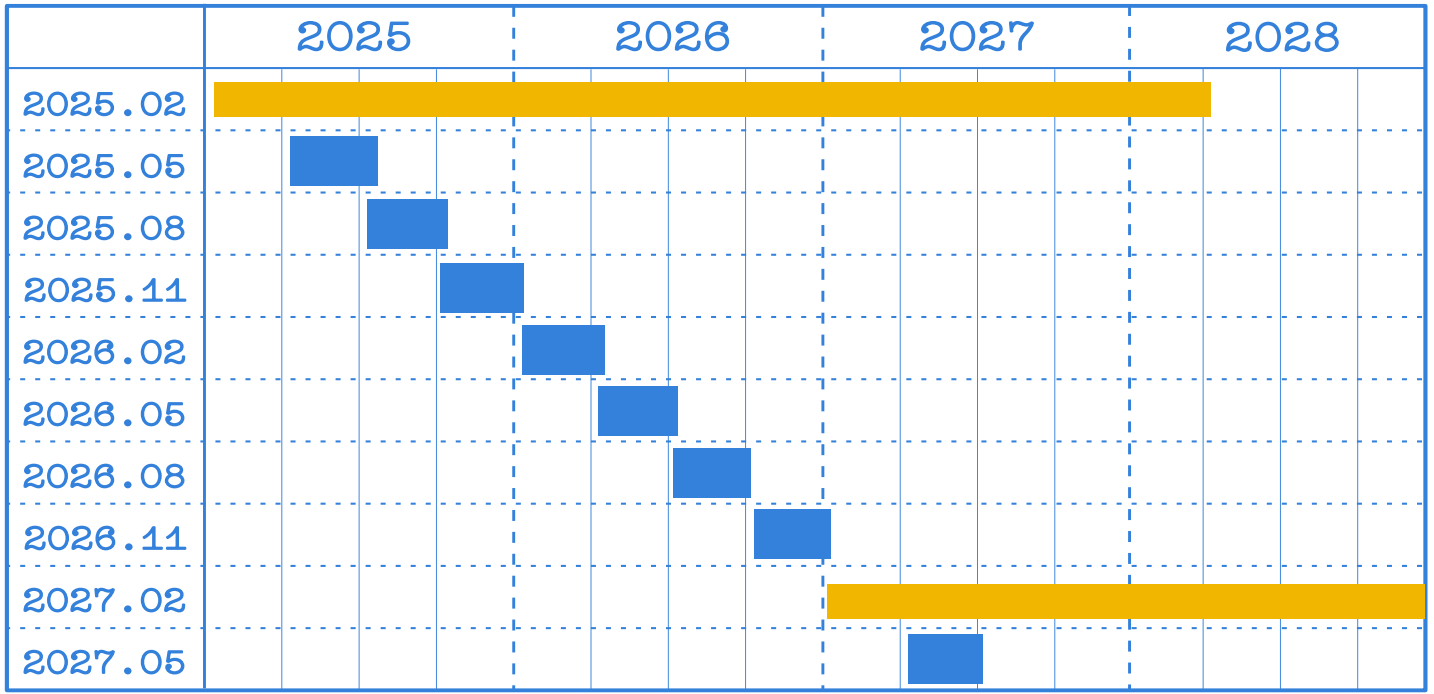
<snip>

LTS-ng

- Request for longer/better LTS support
  - 3 years of support, new release every 2 years
  - Monthly point releases
- Requires real sustained **EFFORT**, not “fun”
- Sponsorship
  - Handling money is difficult
  - Mind.be offered to handle LTS-ng
- Talk earlier today
  - Buildroot LTS in the CRA Era: 18 Months of Keeping a 3-Year Branch Secure



LTS-ng


2025
2026
2027
2028
2025.02
2025.05
2025.08
2025.11
2026.02
2026.05
2026.08
2026.11
2027.02
2027.05

Current LTS-ng sponsors

Gold Sponsors







Silver Sponsors





Bronze Sponsors



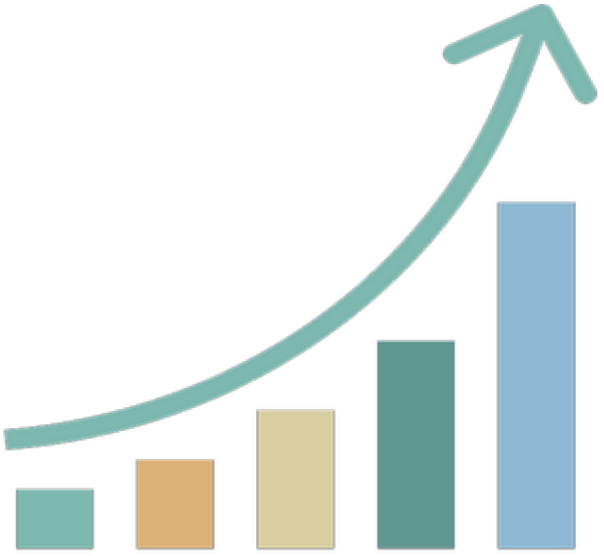


Thanks!

Current Status

Activity

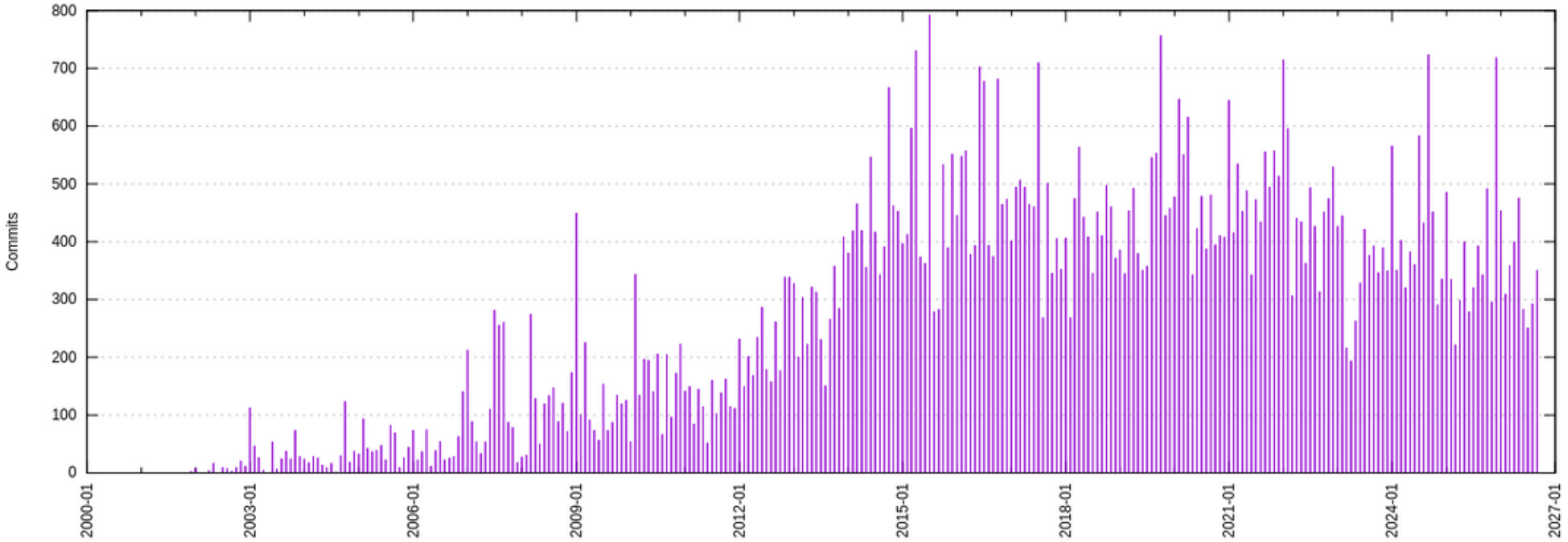
- Fairly active project
  - Git commits
  - Releases
  - Mailing list activity



25 year git statistics

- ~**85K** commits overall, currently ~**5K/year**
- **~9** commits/day avg
- Activity on **80%** days
- ~**1600** unique contributors
- ~**15K** files, ~**600K** lines of code

25 year git statistics



- Source: https://gitstats.buildroot.org

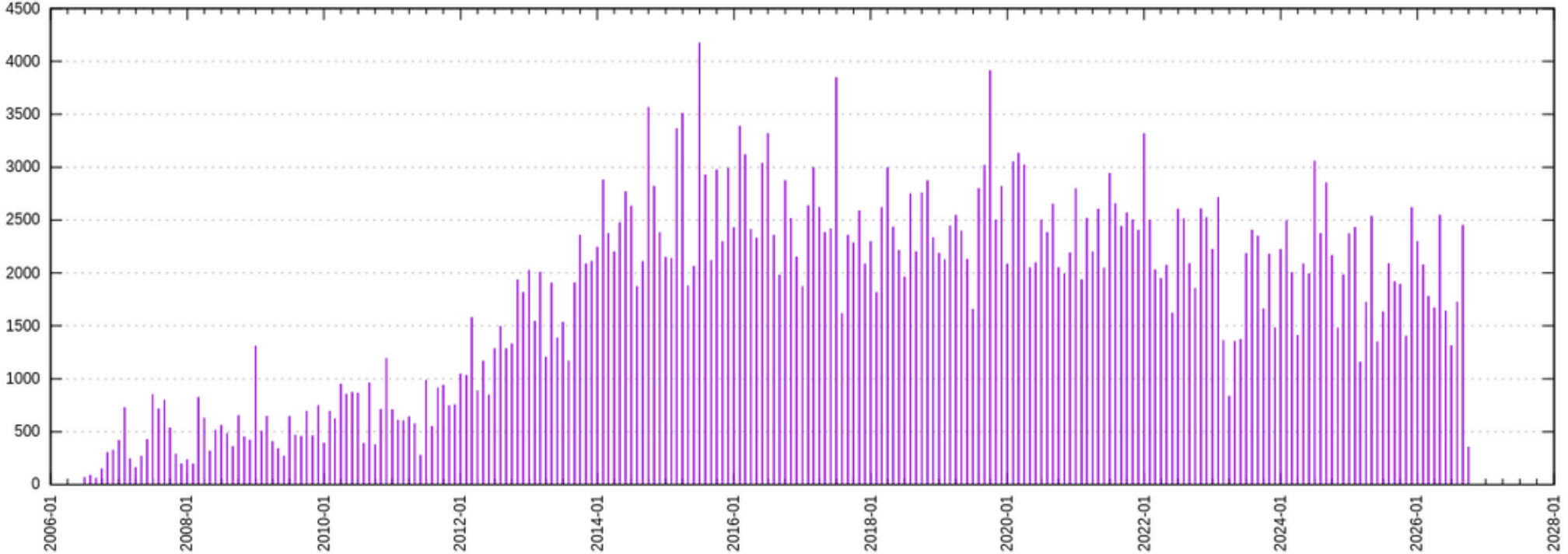
Releases

- Monthly releases
  - Current version
  - Current LTS version(s)
  - Quarterly feature releases
  - **286** releases so far
- Feature releases
  - ~**1000** commits, ~**100** contributors

Mailing list

- Main list:
  - ~**2K** mails/month, ~**60**/day
  - ~**1600** subscribers
- Recently added a `buildroot-users@` list
  - For people where the above is a bit too much

Mailinglist activity



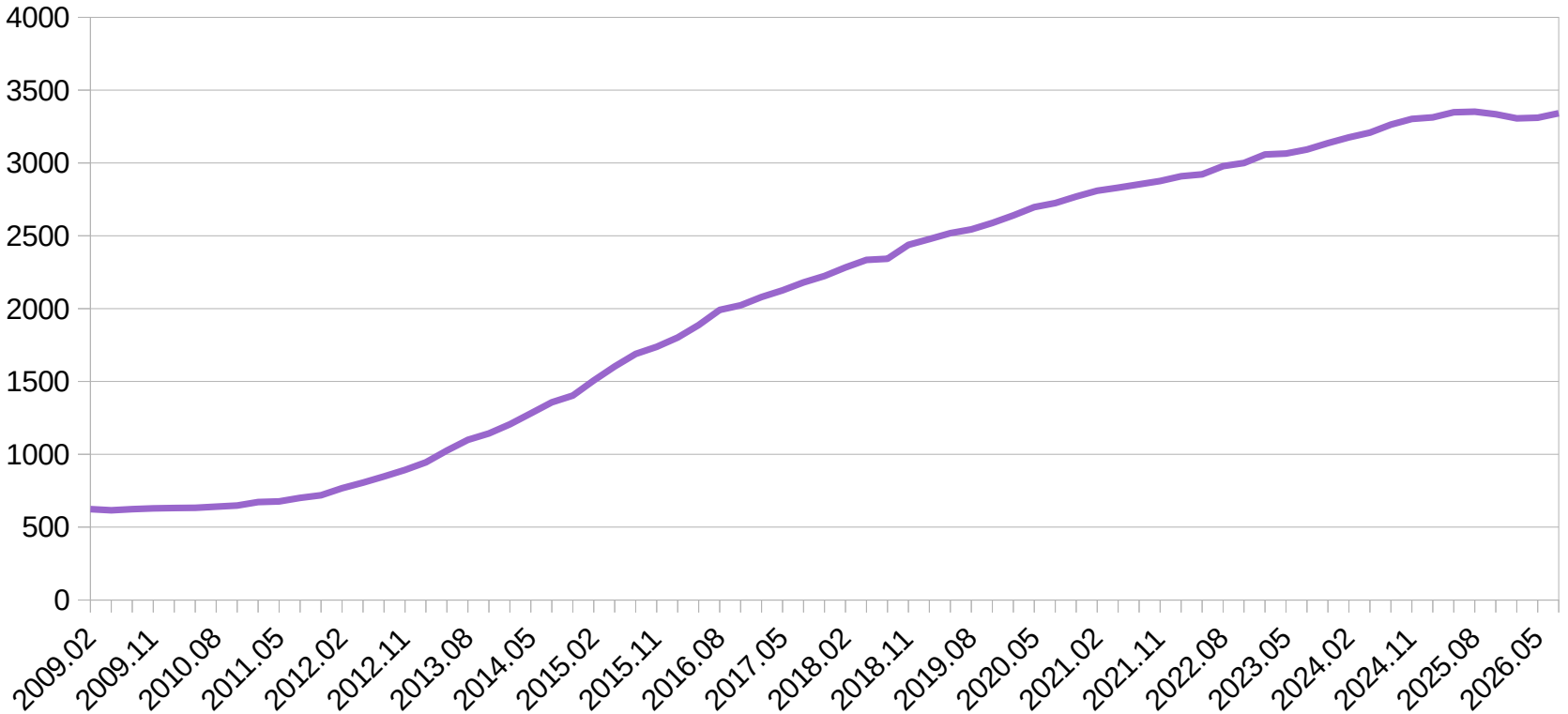
Source: https://mlstats.buildroot.org

Packaging infrastructure

- Originally per-package logic for download, extract, patch, configure, build, install steps
- Now shared infrastructure for:
  - Autotools
  - Cmake
  - Erlang rebar
  - Generic
  - Go
  - Hare
  - Kernel modules
  - Luarocks
  - Meson
  - Perl
  - Python
  - Qmake
  - Rust cargo
  - Waf



Packages



2029.02 includes **624**, 2026.08 **3341** packages

Testimonals

Buildroot users

- Who uses Buildroot?
  - Hard to know
  - Only a small subset contributes
  - So I asked..

From: Peter Korsgaard <peter@korsgaard.com>
To: buildroot@buildroot.org, buildroot-lts-sponsors@buildroot.org
Subject: [Buildroot] **Request for testimonals from users** for Buildroot 25y talk
Date: Sun, 13 Sep 2026 22:40:40 +0200
Message-ID: <87a4pkx4tz.fsf@dell.be.48ers.dk>

Hi,

Buildroot turns 25! And to celebrate, we are doing a talk about the
history at the Embedded Linux Conference in Prague, October 9th:

https://osselceu2026.sched.com/event/2Ragq/buildroot-at-25-a-quarter-century-of-making-embedded-linux-easy-peter-korsgaard-barco?

For this talk it would be interesting to give some examples and
testimonals from companies or projects using Buildroot, E.G.:

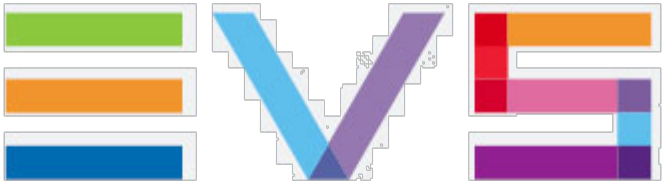
- **Name of company / project**
- **What product(s), ideally with a picture**
- **How long have you used Buildroot for this?**
- **Any additional notes or testimonals, why Buildroot?**

Please reply to the list (or me directly if you prefer), then I will
collect the responses together and pick a selection for the talk.

Thanks in advance!



"Open source has long been central to software development on Arm. For 25 years, Buildroot has offered developers a **straightforward** way to build Linux systems, supporting the Arm architecture from its earliest days to today's platforms. Its **longevity** demonstrates how an engineering-led open source project can **evolve** across generations while continuing to **solve practical problems** for developers," said Mark Hambleton, SVP, Software, Arm.



Buildroot gives us the **flexibility** we need to develop Linux-based systems for a wide range of EVS products. The build system is **powerful** yet **easy to work with**, allowing us to tailor each system to the specific requirements of its target application.
With Buildroot, we can cover a broad range of use cases, from very small embedded systems based on BusyBox to full-featured systems relying on systemd. We also use it across **many hardware architectures**, including Nios II, x86, x86-64, Arm, and AArch64.
The Buildroot **LTS** initiative is also a key element for us, particularly in the context of the **EU Cyber Resilience Act**.



Home Assistant OS

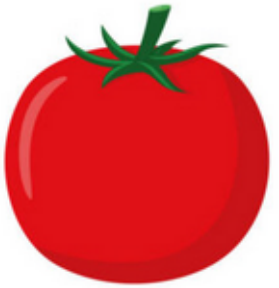
We’ve been using Buildroot for Home Assistant OS since **2018**, and we really value how **simple and approachable** it is: it uses familiar Makefiles, which makes it easy to work with, while keeping up with new releases remains very manageable. We also appreciate how **straightforward and fast** the upstream patch process is. Buildroot now provides the foundation for Home Assistant’s open smart home platform across roughly **2 million** deployments.





Within that portfolio, Buildroot has emerged as the distribution of choice for the **broadest segment** of our general-purpose customer base—the engineers who need a working, maintainable embedded Linux system without taking on the full operational burden of a larger framework. This is **not a niche** use case. It describes the **majority** of embedded product development.

Tomato64



I started using Buildroot in 2022 for my **router project** called Tomato64, a port of Tomato Firmware to x86_64. Tomato at that point had been locked to proprietary Broadcom chipsets, with no clear path forward to newer and more powerful hardware in a world where gigabit+ internet speeds are becoming commonplace. The existing Tomato build system was just a bunch of Makefiles and not a very pleasant thing to deal with.

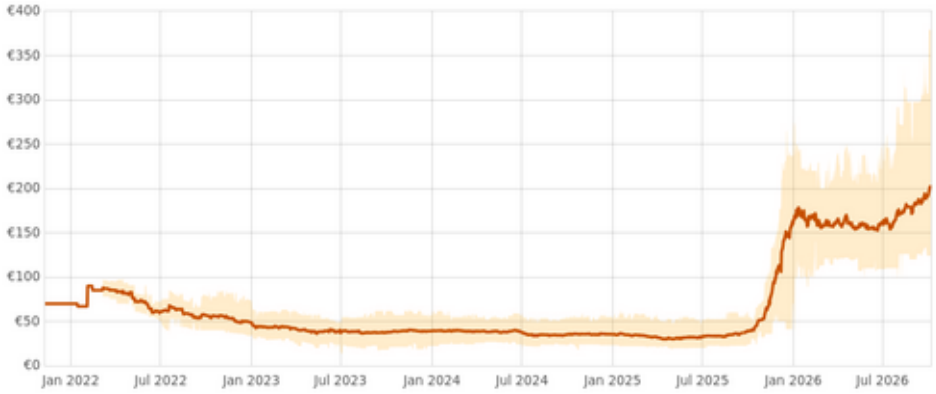
I'm glad to say it's been a **great success**. I started with an x86_64 UEFI build, then a live ISO build, then a legacy BIOS build. Since I use a **br2-external** tree, I just plug in the latest Buildroot version as it comes out and seamlessly get all the package updates. That's a huge relief in itself. On legacy Tomato, half your effort went to updating packages, but now, with packages being updated in every Buildroot release, I have much more time to focus on the things that really push the project forward, like new features and targets.

Looking Ahead

Small is beautiful

- We will stick to our core values:
  - Easy to use
  - Easy to understand
  - Easy to contribute to
  - Can generate small images
    - Important with current RAM and storage prices

8GB DDR5 price



Future

- I have no crystal ball
- Buildroot is a mature project
  - No big roadmap
  - More of the same
  - Whatever gets contributed by **you**!



Thank you!

Contributors, sponsors, users, you!

