The Reproducible Build Zoo

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About reproducible builds

- reproducible-builds.org
- Packages with the same source code, built with the same toolchain, should come out identical.

Source Code

- Source code is readable and writeable by trained ~~monkeys~~ humans
- Computers run binary code
- How do you know the binary code the computer is running was produced from the source code?

Verification

```
$ python -c 'x=1 ; y=1 ; print(x+y)'
2

$ python -c 'x=1 ; y=1 ; print(x+y)' | sha256sum
53c234e5e8472b6ac51c1ae1cab3fe06fad053beb8ebfd8977b010655bfdd3c3  -

$ echo 2 | sha256sum
53c234e5e8472b6ac51c1ae1cab3fe06fad053beb8ebfd8977b010655bfdd3c3  -
```

Independent verification

source code + build environment + build instructions
=
bit-by-bit identical copies
anyone can verify the result
`https://reproducible-builds.org/docs/definition/`

Reproducibility matters

What kind of security implications are we facing?

- CVE-2002-0083: Remote root exploit in OpenSSH, caused by an off-by-one error
- 2015: XcodeGhost: malware variant of Apple's SDK Infected over 4,000 apps in Apple's App store

I Blame u-boot

- u-boot was marked as reproducible
- I knew it was wrong:
  U-Boot SPL 2016.01+dfsg1-3 (Feb 21 2016 - 21:39:10)

timestamps: Please No

There's no timestamps like NO timestamps.

timestamps: SOURCE_DATE_EPOCH

Last resort: SOURCE_DATE_EPOCH
`https://reproducible-builds.org/specs/source-date-epoch/`

locales

- Sort order for C, as spoken in UNIX:

```
$ printf 'a\nB\nb\nA\n' | LC_ALL=C sort
A
B
a
b
```

- Sort order for English, as spoken in USA:

```
$ printf 'a\nB\nb\nA\n' | LC_ALL=en_US.UTF-8 sort
a
A
b
B
```

https://reproducible-builds.org/docs/locales/

file sort order

- Bad Makefile:

```
SRCS = $(wildcard *.c)
tool: $(SRCS:.c=.o)
  $(CC) -o $@ $^
```

- Good Makefile:

```
SRCS = $(sort $(wildcard *.c))
tool: $(SRCS:.c=.o)
  $(CC) -o $@ $^
```

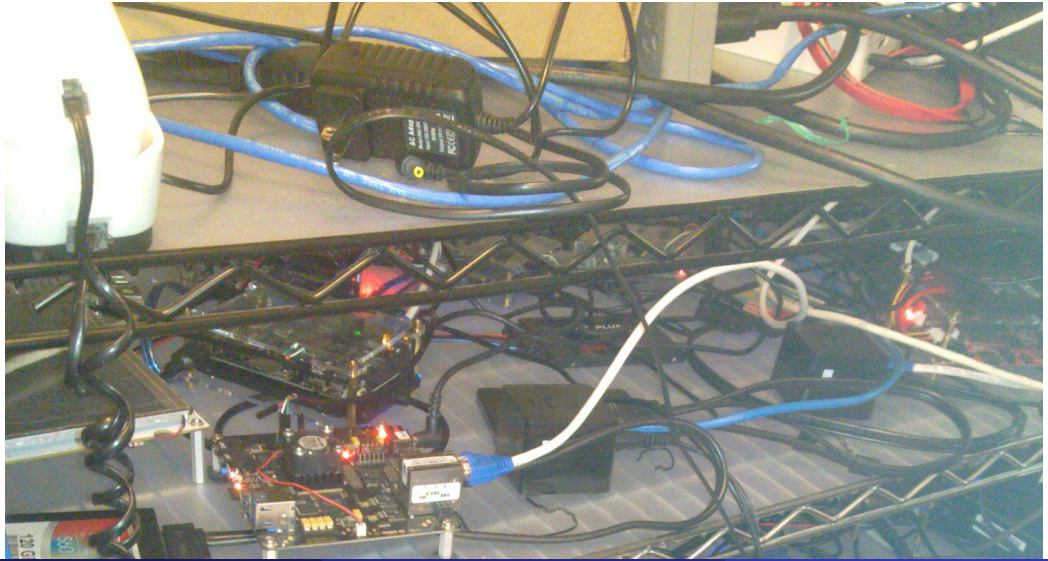
https://reproducible-builds.org/docs/stable-inputs/

build path

- Can be normalized in build environment
- Ongoing work to GCC and other major toolchains by Ximin Luo and others:
  - Some patches to GCC accepted, more in progress
  - draft specification: BUILD_PATH_PREFIX_MAP in progress

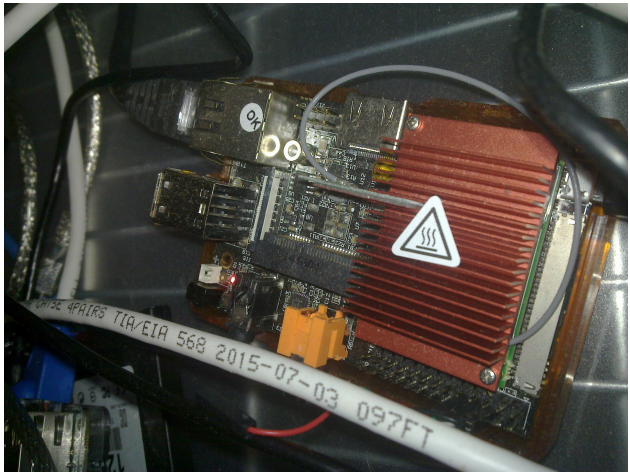
A typical build farm

The Reproducible Build Zoo



Humble Beginnings

- In August of 2015, work was done to enable two dual-core and two quad-core build machines.



Alive and kicking

- In September 2015, the network went live, building around 200 source packages a day.
- With over 25,000 packages in the Debian archive, it would take well over 100 days to build everything in Debian unstable...

BananaPI

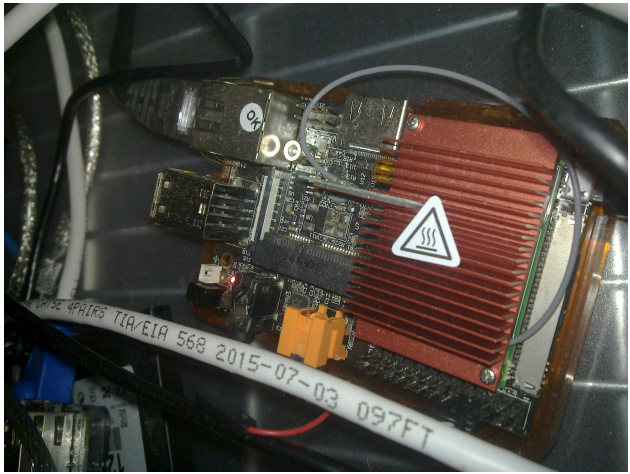
BananaPI

- 74 builds per day
- dual-core Allwinner A20 (cortex-A7)
- 1GB of ram
- Sata
- Donated by LeMaker

HummingBoard i2ex

HummingBoard i2ex

- 89 builds per day
- dual-core imx6 (cortex-a9)
- 1GB of ram
- mSata
- Donated by Solidrun



Wandboard Quad

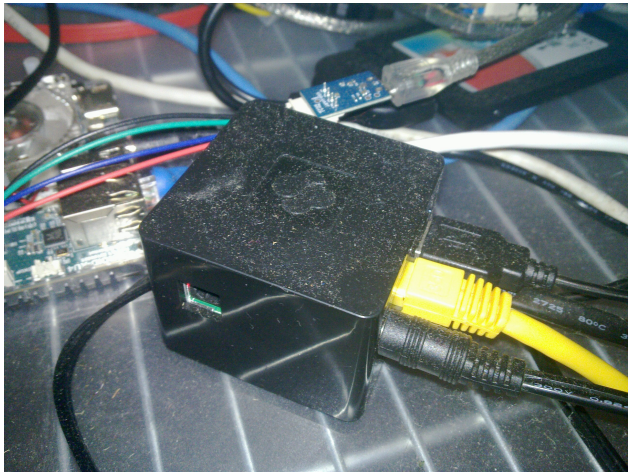
Wandboard Quad

- 184 builds per day
- quad-core imx6 (cortex-a9)
- 2GB of ram
- Sata
- Donated by Aikidev

Cubox-i4pro

Cubox-i4pro

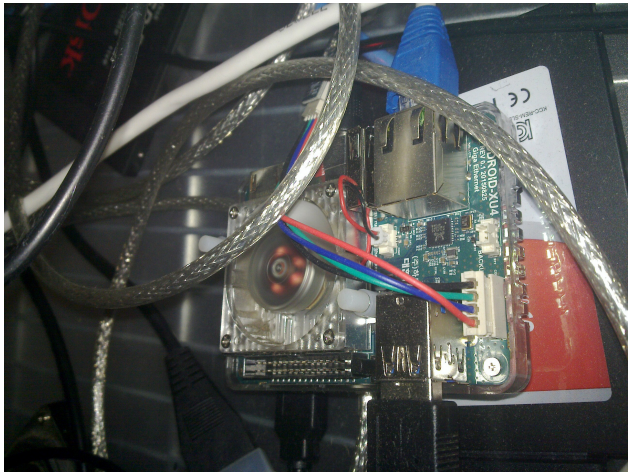
- 165 builds per day
- quad-core imx6 (cortex-a9)
- 2GB of ram
- eSata
- Donated by Aikidev



Odroid-XU4

Three Odroid-XU4

- 192-228 builds per day
- octa-core exynos 5422 (cortex-a15/a7)
- 2GB of ram
- USB3
- Running linux 4.7 due to USB issues
- firmware blob
- Donated by Aikidev/Debian



Wandboard Dual

Wandboard Dual

- 78 packges per day
- dual-core imx6 (cortex-a9)
- 1GB of ram
- USB2
- Donated by TechNexion

Raspberry PI 2b

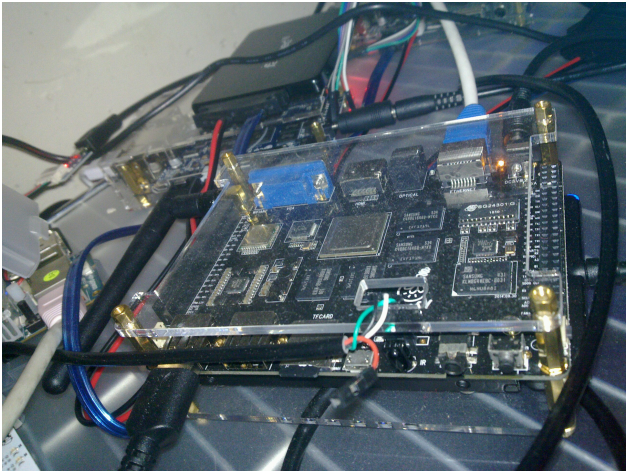
Two RaspberryPI 2b

- 86-92 builds per day
- quad-core bcm2836 (cortex-a7)
- 1GB of ram
- USB2
- firmware blob
- Donated by Aikidev/Debian

Firefly

Two Firefly

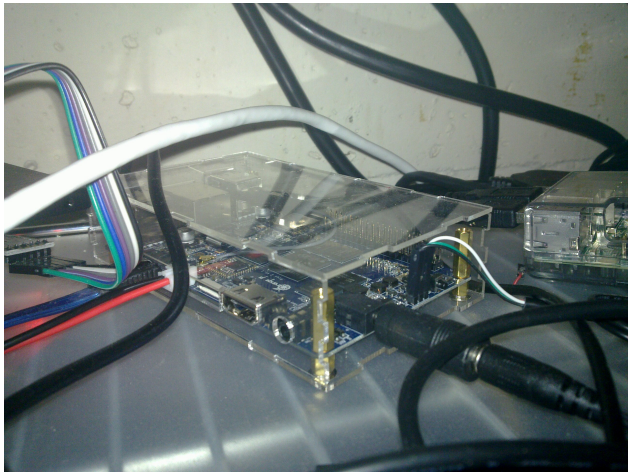
- 178-181
- quad-core Rockchip rk3288 (cortex-a17)
- 2GB of ram
- USB2
- Donated by Debian



Orange PI Plus2

Three OrangePi Plus2

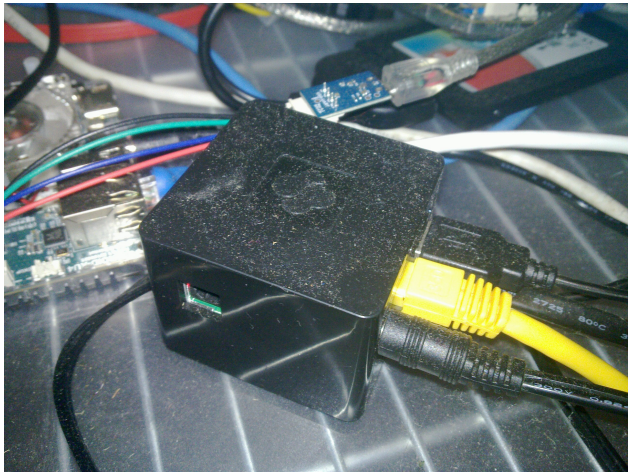
- 162-165 builds per day
- quad-core Allwinner H3 (cortex-a7)
- 2GB ram
- USB2
- Ethernet not supported, using USB adapter
- Donated by Debian



Cubox-i4x4

Two Cubox-i4x4

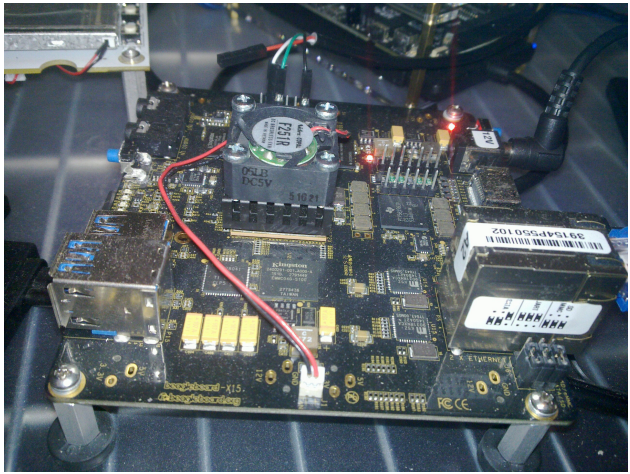
- 195-196 builds per day
- quad-core imx6 (cortex-a9)
- 3.8GB ram
- eSata
- patched u-boot for full ram
- Donated by Debian



BeagleBoard-X15

BeagleBoard-X15

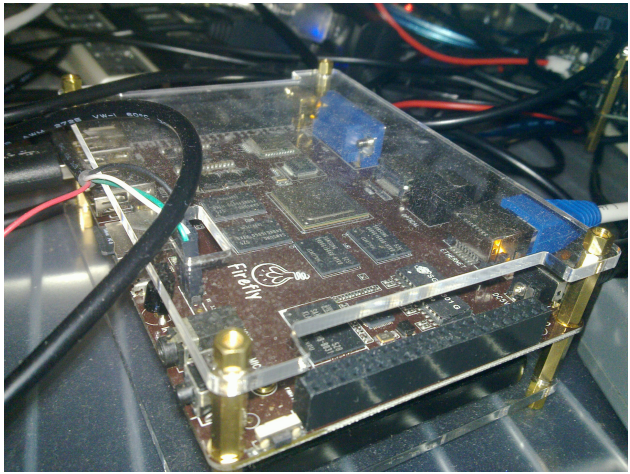
- 200 builds per day
- dual-core TI AM5728 (cortex-a15)
- 2GB ram
- eSata
- Donated by Beagleboard.org



Firefly with 4GB of ram!

Firefly

- 202 builds per day
- quad-core Rockchip rk3288 (cortex-a17)
- 4GB of ram
- USB2
- Donated by Debian



Odroid-U3

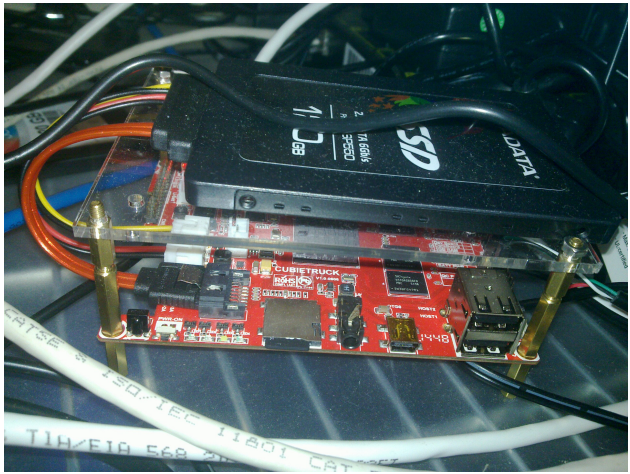
Odroid-U3

- 234 builds per day
- quad-core exynos 4412 (cortex-a9)
- 2GB of ram
- USB2
- firmware blob
- Donated by Debian

Cubietruck

Cubietruck

- 75 builds per day
- dual-core Allwinner A20 (cortex-a7)
- 2GB of ram
- SATA
- Donated by Debian



Jetson-TK1

Jetson-TK1

- 232 builds per day
- quad-core tegra-k1 (cortex-a15)
- 2GB of ram
- SATA
- installation of firmware difficult
- on-board ethernet issues
- Donated by Nvidia

Pine64+

Two Pine64+

- 95-106 builds per day
- quad-core Allwinner A64 (coretex-a53)
- 2GB of ram
- USB2
- Ethernet not supported, using USB adapter
- firmware blob
- Running kernel from linux-next
- Donated by Aikidev

Troublesome boards

- Cubieboard4
- Cubietruck Plus
- Odroid-c1+
- Odroid-c2
- LeMaker HiKey

Upstream Linux support

- Debian's modular kernel configuration

Upstream U-boot support

- distro bootcmd
- Patches in Debian packages

Bootstrapping

- debootstrap or qemu-debootstrap
- install and configure kernel & initial user
- Ansible

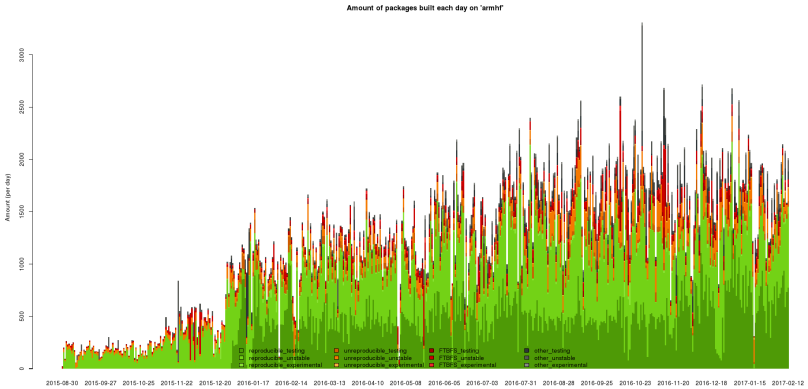
Managing build jobs

`https://tests.reproducible-builds.org`

- runs jenkins
- executes shell scripts on nodes
- results of builds copied to server for comparison

Current capacity

- 98 cores
- 46.8 GB of ram
- under 225 watts
- 1700+ builds per day



Thanks

- Core Infrastructure Initiative
- LeMaker
- TechNexion
- SolidRun
- Debian
- BeagleBoard.org
- Nvidia
- The Reproducible Builds folks

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