Embedded Linux Conference
North America

OpenIoTSummit
North America

OpenEmbedded/Yocto on RISC-V

Khem Raj, Comcast

THE LINUX FOUNDATION

Agenda

- Introduction
- What works
- Demo (maybe)
- Work In progress
- Future work

RISC-V

yocto PROJECT

openembedded

RISC-V

“RISC-V: The Free and Open RISC Instruction Set Architecture”

RISC-V

- RISC-V Open ISA
  - pronounced "risk-five”
  - Licensed under BSD License
  - Started with clean slate in 2010
- RISC-V Foundation
  - https://riscv.org/
- RISC-V GitHub
  - https://github.com/riscv
- Several Commercial adopters

Yocto/OpenEmbedded

“The Yocto Project is not an Embedded Linux Distribution. It creates a custom one for You!”

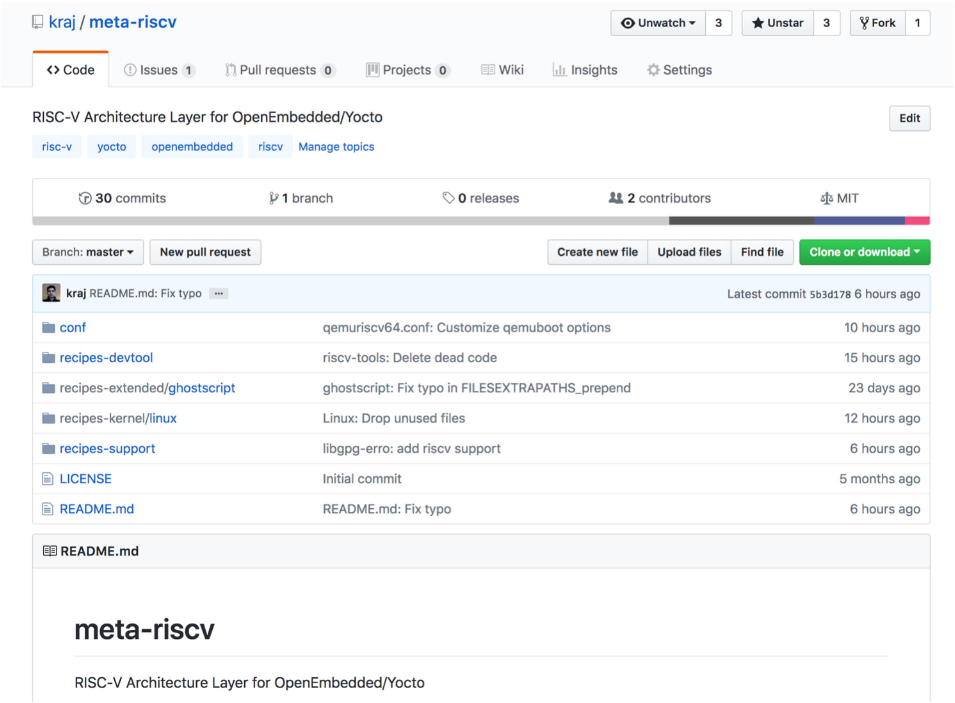
“It is not a single project – its an Ecosystem”

Yocto Project/OpenEmbedded

- Yocto Project uses OpenEmbedded Build system
- Combines Ready to run Linux Distribution with Flexibility to Customize
- System Integration tools
    - Images, SDKs, Extensible SDKs
- Layered Architecture
    - Add only what's needed
    - 1000’s of package recipes available

Porting RISC-V

- A RISC-V Layer
  - Contains RISC-V specific package recipes
  - QEMU machine configuration for RISC-V
    - -machine virt
  - bbapends for packages from other layers
    - Who need a bit of tweaks



kraj / meta-riscv

RISC-V Architecture Layer for OpenEmbedded/Yocto

risc-v yocto openembedded riscv Manage topics

30 commits · 1 branch · 0 releases · 2 contributors · MIT

kraj README.md: Fix typo ... Latest commit 5b3d178 6 hours ago

conf	qemuriscv64.conf: Customize qemuboot options	10 hours ago
recipes-devtool	riscv-tools: Delete dead code	15 hours ago
recipes-extended/ghostscript	ghostscript: Fix typo in FILESEXTRAPATHS_prepend	23 days ago
recipes-kernel/linux	Linux: Drop unused files	12 hours ago
recipes-support	libgpg-erro: add riscv support	6 hours ago
LICENSE	Initial commit	5 months ago
README.md	README.md: Fix typo	6 hours ago

README.md

meta-riscv

RISC-V Architecture Layer for OpenEmbedded/Yocto

Porting RISC-V - Setup

```
mkdir riscv-yocto && cd riscv-yocto
git clone git://git.openembedded.org/openembedded-core
(cd openembedded-core && git clone git://git.openembedded.org/bitbake)
git clone git://github.com/kraj/meta-riscv

. openembedded-core/oe-init-build-env riscv-build
bitbake-layers add-layer ../meta-riscv
```

Porting RISC-V - Build

- Select machine (in local.conf)

```
MACHINE = ”qemuriscv64”
```

- Build

```
bitbake core-image-minimal
```

- Go for lunch ☺

Porting RISC-V - Run

- Run image in QEMU – Use Yocto tooling

```
runqemu nographic
runqemu nographic slirp
```

- Forwards port 22 to 22222 on host
- SSH into RISC-V emulator

```
ssh root@localhost –p 22222
```

RISC-V Porting Status (Core packages)

- Kernel
  - linux-riscv 4.15
- Glibc
  - 2.27 – Upstream
- GCC
  - 7.3 – Upstream
- Binutils
  - 2.30 – Upstream
- GDB
  - riscv-binutils-gdb
- QEMU
  - riscv-qemu
- RISC-V tools
  - bbl, fesvr, spike

What works

- Images

  core-image-minimal
  core-image-base
  core-image-full-cmdline

- SDKs

  bitbake –cpopulate_sdk <image>

- Extensible SDK

  bitbake –cpopulate_sdk_ext <image>

What works

- Init systems
  - Sysvinit
  - Systemd
  - Busybox/mdev

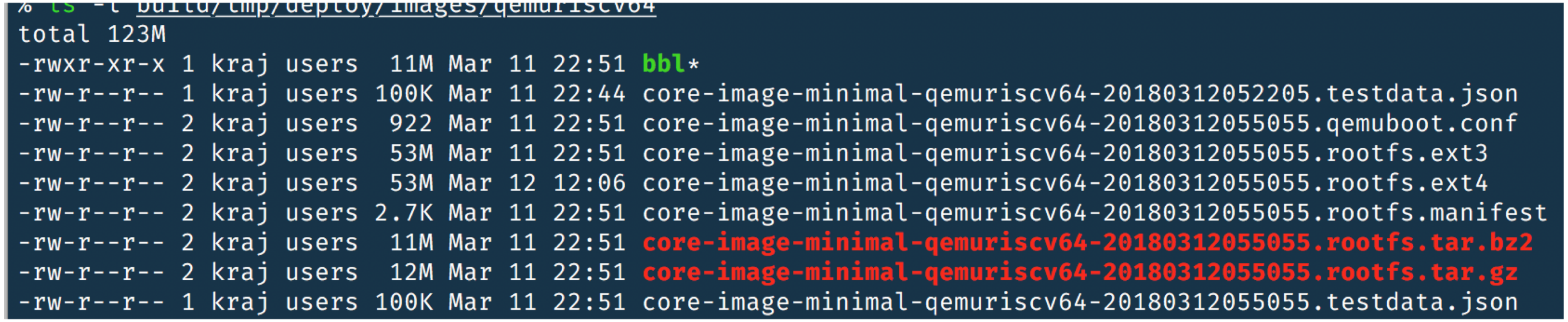
What works

- Running images QEMU
  - runqemu nographic slirp
    - ssh root@localhost –p 22222
  - runqemu nographic
    - Uses tap
    - ssh root@192.168.7.2

Booting in QEMU

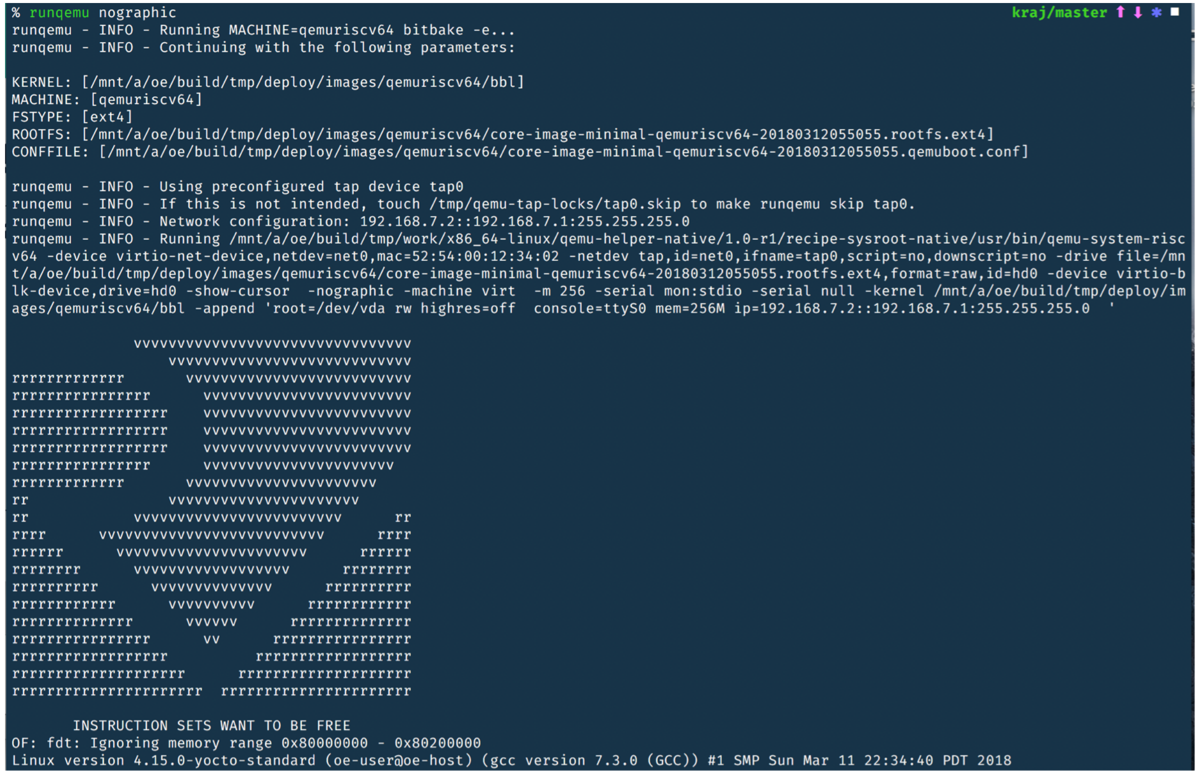
- Kernel
  - Proxy kernel - Bundled with bbl (Berkley bootloader)
  - BBL - meta-riscv/recipes-devtool/riscv-tools/riscv-pk.bb
  - Final kernel image is called ‘bbl’ in DEPLOYDIR
- Rootfs
  - Ext4 image

$ runqemu nographic



```
% ls -l build/tmp/deploy/images/qemuriscv64
total 123M
-rwxr-xr-x 1 kraj users  11M Mar 11 22:51 bbl*
-rw-r--r-- 1 kraj users 100K Mar 11 22:44 core-image-minimal-qemuriscv64-20180312052205.testdata.json
-rw-r--r-- 2 kraj users  922 Mar 11 22:51 core-image-minimal-qemuriscv64-20180312055055.qemuboot.conf
-rw-r--r-- 2 kraj users  53M Mar 11 22:51 core-image-minimal-qemuriscv64-20180312055055.rootfs.ext3
-rw-r--r-- 2 kraj users  53M Mar 12 12:06 core-image-minimal-qemuriscv64-20180312055055.rootfs.ext4
-rw-r--r-- 2 kraj users 2.7K Mar 11 22:51 core-image-minimal-qemuriscv64-20180312055055.rootfs.manifest
-rw-r--r-- 2 kraj users  11M Mar 11 22:51 core-image-minimal-qemuriscv64-20180312055055.rootfs.tar.bz2
-rw-r--r-- 2 kraj users  12M Mar 11 22:51 core-image-minimal-qemuriscv64-20180312055055.rootfs.tar.gz
-rw-r--r-- 1 kraj users 100K Mar 11 22:51 core-image-minimal-qemuriscv64-20180312055055.testdata.json
```

Booting In QEMU



```
% runqemu nographic                                                                                          kraj/master ⬆ ⬇ ✱ ■
runqemu - INFO - Running MACHINE=qemuriscv64 bitbake -e...
runqemu - INFO - Continuing with the following parameters:

KERNEL: [/mnt/a/oe/build/tmp/deploy/images/qemuriscv64/bbl]
MACHINE: [qemuriscv64]
FSTYPE: [ext4]
ROOTFS: [/mnt/a/oe/build/tmp/deploy/images/qemuriscv64/core-image-minimal-qemuriscv64-20180312055055.rootfs.ext4]
CONFFILE: [/mnt/a/oe/build/tmp/deploy/images/qemuriscv64/core-image-minimal-qemuriscv64-20180312055055.qemuboot.conf]

runqemu - INFO - Using preconfigured tap device tap0
runqemu - INFO - If this is not intended, touch /tmp/qemu-tap-locks/tap0.skip to make runqemu skip tap0.
runqemu - INFO - Network configuration: 192.168.7.2::192.168.7.1:255.255.255.0
runqemu - INFO - Running /mnt/a/oe/build/tmp/work/x86_64-linux/qemu-helper-native/1.0-r1/recipe-sysroot-native/usr/bin/qemu-system-risc
v64 -device virtio-net-device,netdev=net0,mac=52:54:00:12:34:02 -netdev tap,id=net0,ifname=tap0,script=no,downscript=no -drive file=/mn
t/a/oe/build/tmp/deploy/images/qemuriscv64/core-image-minimal-qemuriscv64-20180312055055.rootfs.ext4,format=raw,id=hd0 -device virtio-b
lk-device,drive=hd0 -show-cursor  -nographic -machine virt  -m 256 -serial mon:stdio -serial null -kernel /mnt/a/oe/build/tmp/deploy/im
ages/qemuriscv64/bbl -append 'root=/dev/vda rw highres=off  console=ttyS0 mem=256M ip=192.168.7.2::192.168.7.1:255.255.255.0  '

              vvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv
                  vvvvvvvvvvvvvvvvvvvvvvvvvvvv
rrrrrrrrrrrrr       vvvvvvvvvvvvvvvvvvvvvvvvvv
rrrrrrrrrrrrrrrr      vvvvvvvvvvvvvvvvvvvvvvvv
rrrrrrrrrrrrrrrrrr    vvvvvvvvvvvvvvvvvvvvvvvv
rrrrrrrrrrrrrrrrrr    vvvvvvvvvvvvvvvvvvvvvvvv
rrrrrrrrrrrrrrrrrr    vvvvvvvvvvvvvvvvvvvvvvvv
rrrrrrrrrrrrrrrr      vvvvvvvvvvvvvvvvvvvvvv
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rrrr      vvvvvvvvvvvvvvvvvvvvvvvvvv      rrrr
rrrrrr      vvvvvvvvvvvvvvvvvvvvvv      rrrrrr
rrrrrrrr      vvvvvvvvvvvvvvvvvv      rrrrrrrr
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rrrrrrrrrrrrrrrrrrrrrr  rrrrrrrrrrrrrrrrrrrrrr

       INSTRUCTION SETS WANT TO BE FREE
OF: fdt: Ignoring memory range 0x80000000 - 0x80200000
Linux version 4.15.0-yocto-standard (oe-user@oe-host) (gcc version 7.3.0 (GCC)) #1 SMP Sun Mar 11 22:34:40 PDT 2018
```
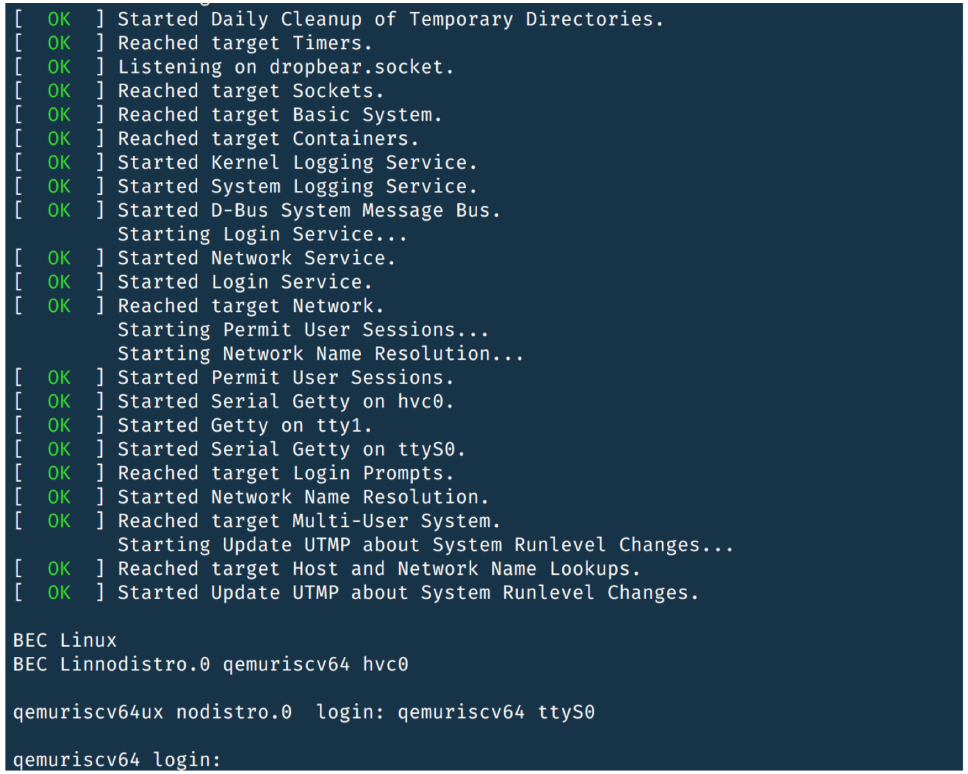
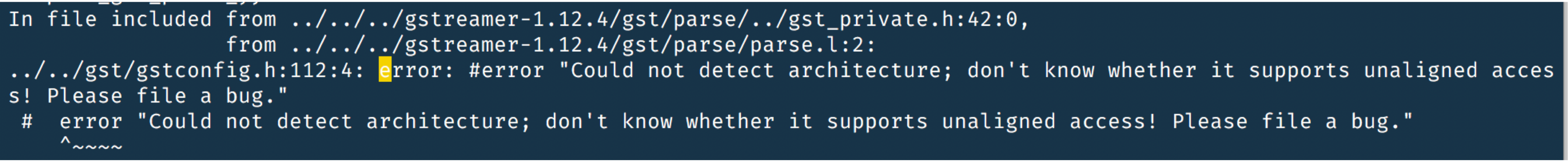



```
[  OK  ] Started Daily Cleanup of Temporary Directories.
[  OK  ] Reached target Timers.
[  OK  ] Listening on dropbear.socket.
[  OK  ] Reached target Sockets.
[  OK  ] Reached target Basic System.
[  OK  ] Reached target Containers.
[  OK  ] Started Kernel Logging Service.
[  OK  ] Started System Logging Service.
[  OK  ] Started D-Bus System Message Bus.
         Starting Login Service...
[  OK  ] Started Network Service.
[  OK  ] Started Login Service.
[  OK  ] Reached target Network.
         Starting Permit User Sessions...
         Starting Network Name Resolution...
[  OK  ] Started Permit User Sessions.
[  OK  ] Started Serial Getty on hvc0.
[  OK  ] Started Getty on tty1.
[  OK  ] Started Serial Getty on ttyS0.
[  OK  ] Reached target Login Prompts.
[  OK  ] Started Network Name Resolution.
[  OK  ] Reached target Multi-User System.
         Starting Update UTMP about System Runlevel Changes...
[  OK  ] Reached target Host and Network Name Lookups.
[  OK  ] Started Update UTMP about System Runlevel Changes.

BEC Linux
BEC Linnodistro.0 qemuriscv64 hvc0

qemuriscv64ux nodistro.0  login: qemuriscv64 ttyS0

qemuriscv64 login:
```

Work In Progress

- Graphical images
  - core-image-sato
  - core-image-x11
  - core-image-weston



```
In file included from ../../../gstreamer-1.12.4/gst/parse/../gst_private.h:42:0,
                 from ../../../gstreamer-1.12.4/gst/parse/parse.l:2:
../../gst/gstconfig.h:112:4: error: #error "Could not detect architecture; don't know whether it supports unaligned acces
s! Please file a bug."
 #  error "Could not detect architecture; don't know whether it supports unaligned access! Please file a bug."
    ^~~~~
```

Work In Progress

- _REENTRANT missing in risc-v gcc

```
% gcc -dumpspecs | grep REENTRANT
%{posix:-D_POSIX_SOURCE} %{pthread:-D_REENTRANT}

% ./build/tmp/work/riscv64-bec-linux/liburcu/0.10.1-r0/recipe-sysroot-native/usr/bin/riscv64-bec-linux/riscv64-bec-linux-gcc  --sysroot=/mnt/a/oe/build/tmp/work/riscv64-bec-linux/liburcu/0.10.1-r0/recipe-sysroot -dumpspecs| grep _REENTERANT
??
```

Work In Progress

- Profiling packages (LTTng)

```
#error "Cannot build: unrecognized architecture detected."
```

☺

- GCC Sanitizers

Work In Progress

- QEMU auto Testing
  - do_testimage_auto
- Enabling Testing

```
INHERIT += "testimage”
DISTRO_FEATURES_append = " ptest”
EXTRA_IMAGE_FEATURES_append = " ptest-pkgs”
TEST_SUITES = "auto”
TEST_IMAGE_qemuall = "1”
TEST_TARGET_qemuall = "qemu"
```

Work In Progress

- Core layer support for RISC-V
  - Targeted for Upstream Yocto 2.5 release (April 2018)

Work In Progress

- Cross Prelink
  - Used in Few places during build
    - Detect library deps using prelink-rtld in cross environment.
  - Patches submitted
    - https://lists.yoctoproject.org/pipermail/yocto/2018-March/040254.html
- libatomic-ops
  - Support in master upstream
  - Openembedded uses releases

Work In Progress

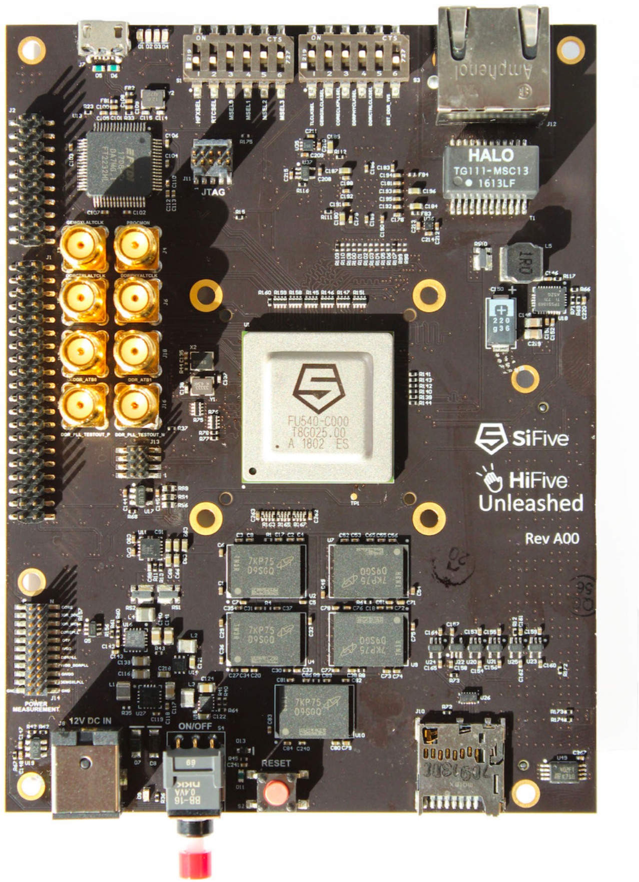
- Upstreaming patches
  - some packages e.g libffi, nspr, libgpg-error
  - Carrying local patches for RISC-V support in meta-riscv

Future

- Make RISC-V core supported architecture
    - Few steps until reaching that point
    - GDB not up-streamed yet
    - MUSL support
    - Golang support
    - A QEMU Release supporting RISC-V
        - upstream in QEMU master already

Future

- BSP layers for RISC-V based boards
  - SiFive Freedom Platform
  - SiFive Freedom U540 SoC
- RISC-V 32-bit
  - Needs 32bit glibc



RISC-V Resources

- https://riscv.org/
- https://github.com/riscv/
- https://github.com/sifive
- IRC #riscv on freenode
- Mailing lists
    - https://riscv.org/mailing-lists/
    - Software Development (sw-dev@groups.riscv.org)

Yocto Project Resources

- http://git.openembedded.org
- http://git.yoctoproject.org/
- https://www.yoctoproject.org/
- https://www.openembedded.org/wiki/Main_Page
- IRC #yocto and #oe on freenode
- Mailing lists
  - https://www.openembedded.org/wiki/Mailing_lists
  - https://lists.yoctoproject.org/listinfo

That’s All for Today

Thank you

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