

RISC-V v0.2

Introduction to Risc-V for developers

TuxCon, Plovdiv
June, 2022

About me



- Nearly 20 years in IT
- Embedded development mostly
- FreeBSD/Linux
- Security
- Open source, OpenFest & more

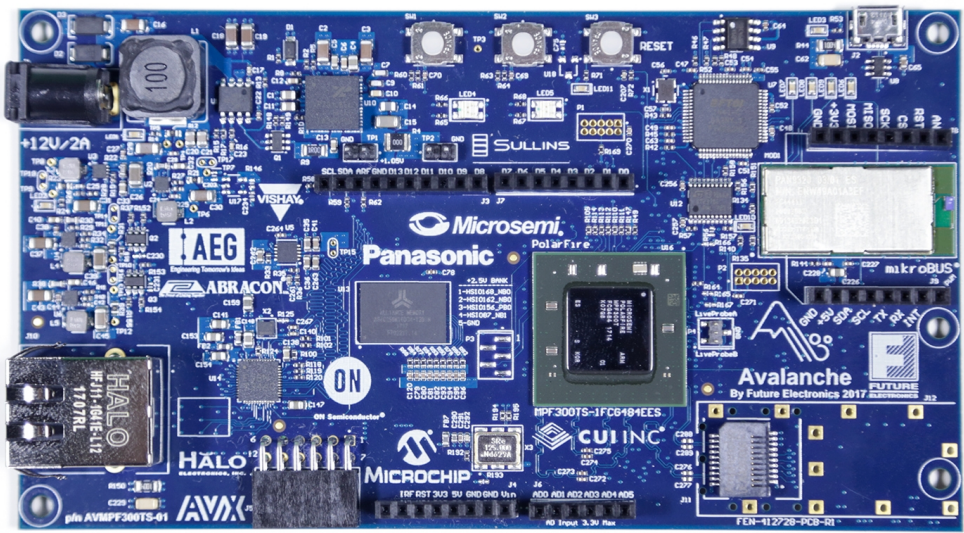
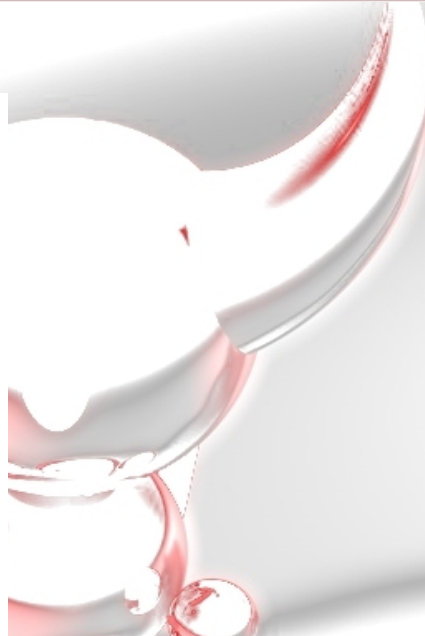
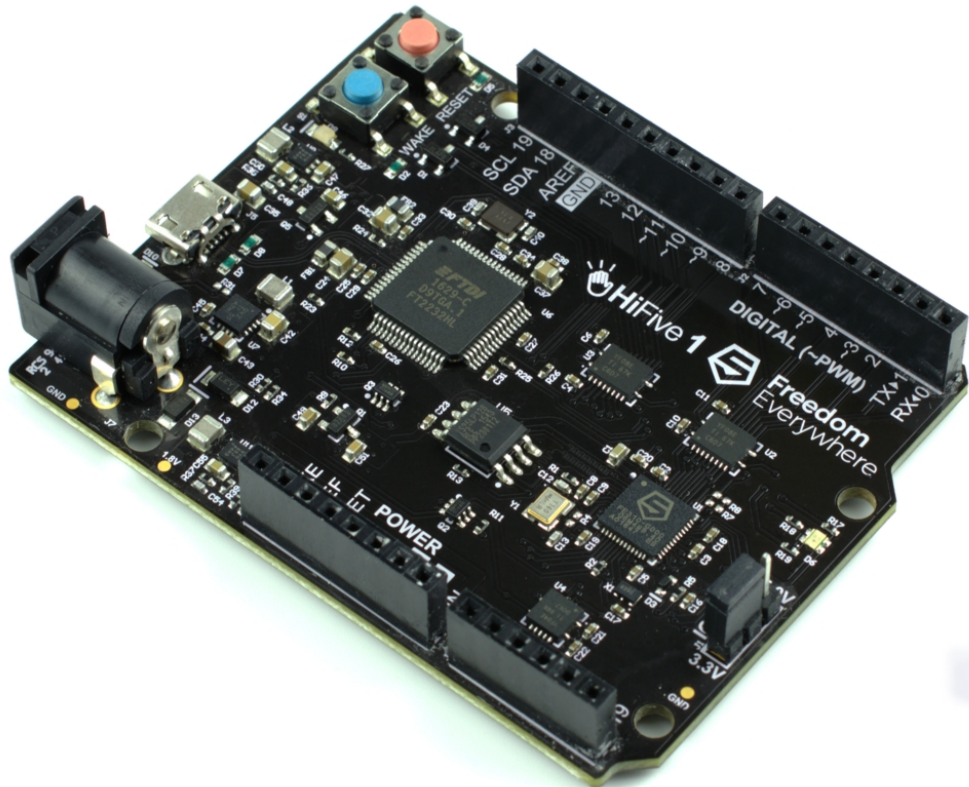
What is RISC-V

- conceived 2010 in UC Berkeley
- open source processor design, RISC architecture
- an alternative to Intel and ARM
- Risc-V is not a company
- riscv.org
- aims to do the same for semiconductor research & design as Linux for operating systems

Available platforms

- Qemu
- Spike (*)
- SiFive HiFive1/HiFive Unleashed board
- LiteX/VexRiscv on PolarFire FPGA board
- Allwinner, BeagleBoneV est. end of 2021
- Core-V-MCU design on Nexys-A7-100 FPGA board, SoC est. mid 2022
- <https://riscv.org/risc-v-developer-boards/>

Boards



Boards - unverified

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RVBoards-Nezha

RVBoards RISC-V

澎峰(北京)科技有限公司

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RVBoards-Nezha -The first mass-production development board that supports 64 bit RISC-V instruction set and Debian system.

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RISC-V ISA – the basics

- Privilege levels – machine (boot, mandatory), supervisor, user modes (hypervisor mode unspecified/TBD)
- Harts (cores) – id 0 is special
- General purpose registers with load store architecture – x0-x31; CSR instructions
- Mandatory Base Integer ISA – ALU, branches/jumps, load/stores
- Standard extensions – integer multiplication/division, atomic instructions, single-/double-precision floating point
- Compressed instructions & optional extensions

Compilers/bare metal applications

- CLANG/LLVM
- GCC

Just like ISA strings, ABI strings are concatenated together and passed via the `-mabi` argument to GCC. In order to explain why the ISA and ABI should be treated as two separate arguments, let's examine a handful of `-march/-mabi` combinations:

- `-march=rv32imafdc -mabi=ilp32d`: Hardware floating-point instructions can be generated and floating-point arguments are passed in registers. This is like the `-mfloat-abi=hard` argument to ARM's GCC.
- `-march=rv32imac -mabi=ilp32`: No floating-point instructions can be generated and no floating-point arguments are passed in registers. This is like the `-mfloat-abi=soft` argument to ARM's GCC.
- `-march=rv32imafdc -mabi=ilp32`: Hardware floating-point instructions can be generated, but no floating-point arguments will be passed in registers. This is like the `-mfloat-abi=softfp` argument to ARM's GCC, and is usually used when interfacing with soft-float binaries on a hard-float system.
- `-march=rv32imac -mabi=ilp32d`: Illegal, as the ABI requires floating-point arguments are passed in registers but the ISA defines no floating-point registers to pass them in.

Bootloaders



- BBL / Risc-V PK (proxy kernel) - <https://github.com/riscv/riscv-pk>
- Das u-boot

Operating systems

- Real-time – [Zephyr](#), FreeRTOS, ...
- Linux
- BSDs – FreeBSD, [OpenBSD](#), [NetBSD](#)
- ...

FreeRTOS on RISC-V

- available ports
 - SiFive QEMU w/ GCC
 - VEGABoard PULP RI5CY w/ GCC/Eclipse
 - RISC-V MiFive M2GL025 w/ GCC
- porting guide -
<https://www.freertos.org/Using-FreeRTOS-on-RISC-V.html>

FreeBSD on RISC-V

- (mini howto run in qemu) - <https://wiki.freebsd.org/riscv>
- Qemu user-mode emulation (*)

```
fetch https://download.freebsd.org/ftp/snapshots/VM-IMAGES/14.0-CURRENT/riscv64/Latest/FreeBSD-14.0-CURRENT-riscv-riscv64.raw.xz  
xz --decompress FreeBSD-14.0-CURRENT-riscv-riscv64.raw.xz
```

```
qemu-system-riscv64 -machine virt -m 2048M -smp 2 -nographic \  
-bios /usr/local/share/opensbi/lp64/generic/firmware/fw_jump.elf \  
-kernel /usr/local/share/u-boot/u-boot-qemu-riscv64/u-boot.bin \  
-drive file=FreeBSD-14.0-CURRENT-riscv-riscv64.raw,format=raw,id=hd0 -device virtio-blk-device,drive=hd0 \  
-netdev user,id=net0,ipv6=off,hostfwd=tcp::8022-:22 -device virtio-net-device,netdev=net0
```

Languages & environments

- C / C++
- Perl
- Python
- Golang – linux/riscv64, [bare-metal](#)
- [Rust](#) - riscv64gc Linux - Tier 1, bare-metal – Tier 2, riscv32gc/riscv64gc FreeBSD - Tier 3
- NodeJS – [“Unofficial build”](#) support
- Others?

Demo



- Running FreeBSD on risc-v in Qemu
- Blinky on FreeRTOS

homework




- Build/run Linux on RISC-V
- <https://peter.quantr.hk/2020/11/running-64-and-32-bit-risc-v-linux-on-qemu/>

questions?

QUESTIONS
FOUND IN GOOGLE AUTOCOMPLETE

WHY DO WHALES JUMP
WHY ARE WITCHES GREEN
WHY ARE THERE MIRRORS ABOVE BEDS
WHY DO I SAY UH
WHY IS SEA SALT BETTER
WHY ARE THERE TREES IN THE MIDDLE OF FIELDS
WHY IS THERE NOT A POKEMON MMO
WHY IS THERE LAUGHING IN TV SHOWS
WHY ARE THERE DOORS ON THE FREEWAY
WHY ARE THERE SO MANY SUSHI STOPS RUNNING
WHY AREN'T THERE ANY COUNTRIES IN ANTARCTICA
WHY ARE THERE SCARY SOUNDS IN MINECRAFT
WHY IS THERE KICKING IN MY STOMACH
WHY ARE THERE TWO SLASHES AFTER HTTP
WHY ARE THERE CELEBRITIES
WHY DO SNAKES EXIST
WHY DO OYSTERS HAVE PEARLS
WHY ARE DUCKS CALLED DUCKS
WHY DO THEY CALL IT THE CLAP
WHY ARE KYLE AND CARTMAN FRIENDS
WHY IS THERE AN ARROW ON AANG'S HEAD
WHY ARE TEXT MESSAGES BLUE
WHY ARE THERE MUSTACHES ON CLOTHES
WHY ARE THERE MUSTACHES ON CARS
WHY ARE THERE MUSTACHES EVERYWHERE
WHY ARE THERE SO MANY BIRDS IN OHIO
WHY IS THERE SO MUCH RAIN IN OHIO
WHY IS OHIO WEATHER SO WEIRD
WHY ARE THERE MALE AND FEMALE BIKES
WHY ARE THERE BRIDESMAIDS
WHY DO DYING PEOPLE REACH UP
WHY AREN'T THERE VARIOUS FRIENDS
WHY ARE OLD FRIENDS DIFFERENT


WHY ARE THERE SQUIRRELS


WHY IS PROGRAMMING SO HARD
WHY IS THERE A Q ON ROSSBORO
WHY DO PERSONS HATE SOCCER
WHY DO RHYMES SOUND GOOD
WHY DO TREES DIE
WHY IS THERE NO SOUND ON OWN
WHY AREN'T POKEMON REAL
WHY AREN'T BULLETS SHARP
WHY DO DREAMS SEEM SO REAL

WHY DO TESTICLES MOVE
WHY ARE THERE PSYCHICS
WHY ARE HATS SO EXPENSIVE
WHY IS THERE CAFEINE IN MY SHIRT
WHY DO YOUR BOOBS HURT

WHY AREN'T THERE DINOSAUR GHOSTS
WHY DO IGUANAS DIE
WHY AREN'T ECONOMISTS RICH
WHY DO AMERICANS CALL IT SOCCER
WHY ARE MY EARS RINGING
WHY ARE THERE SO MANY AVENGERS
WHY ARE THE AVENGERS FIGHTING THE X MEN
WHY IS WOLVERINE NOT IN THE AVENGERS

WHY ARE THERE FEMALE MR NIMES
WHY ARE THERE GHOSTS


WHY ARE THERE SLAVES IN THE BIBLE
WHY DO TWINS HAVE DIFFERENT FINGERPRINTS
WHY ARE AMERICANS AFRAID OF DRAGONS
WHY IS HTTPS CROSSED OUT IN RED
WHY IS THERE A LINE THROUGH HTTPS
WHY IS THERE A RED LINE THROUGH HTTPS ON FACEBOOK
WHY IS HTTPS IMPORTANT
WHY AREN'T MY ARMS GROWING


WHY ARE THERE LEECHES
WHY DO I FEEL DIZZY
WHY ARE THERE SO MANY CROWS IN ROCHESTER
WHY IS PSYCHIC WEAK TO BUG
WHY DO CHILDREN GET CANCER
WHY IS POSEIDON ANGRY WITH ODYSSEUS
WHY IS THERE ICE IN SPACE
WHY ARE DOGS AFRAID OF FIREWORKS
WHY IS THERE NO KING IN ENGLAND

WHY ARE THERE ANTS IN MY LAPTOP
WHY IS EARTH TILTED
WHY IS SPACE BLACK
WHY IS OUTER SPACE SO COLD
WHY ARE THERE PYRAMIDS ON THE MOON
WHY IS NASA SHUTTING DOWN

WHY IS THERE AN OWL IN MY BACKYARD
WHY IS THERE AN OWL OUTSIDE MY WINDOW
WHY IS THERE AN OWL ON THE DOLLAR BILL
WHY DO OWLS ATTACK PEOPLE
WHY ARE AK 47s SO EXPENSIVE
WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE
WHY ARE THERE GODS
WHY ARE THERE TWO SPOOKS
WHY ARE MY BOOBS ITCHY
WHY ARE CIGARETTES LEGAL
WHY ARE THERE DUCKS IN MY POOL
WHY IS JESUS WHITE
WHY IS THERE LIQUID IN MY EAR
WHY DO Q TIPS FEEL GOOD
WHY DO GOOD PEOPLE DIE

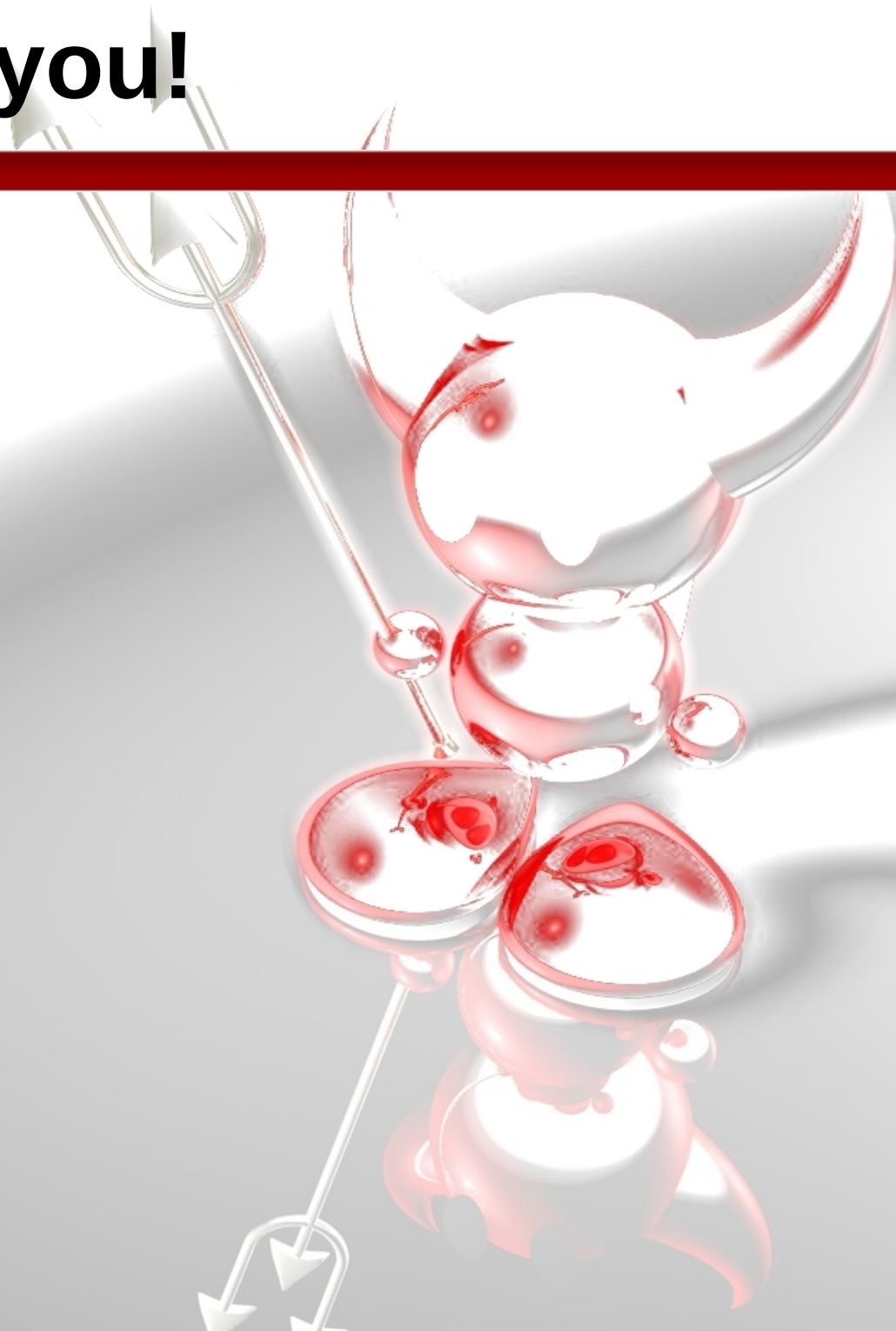
WHY IS MT VESUVIUS THERE
WHY DO THEY SAY T MINUS
WHY ARE THERE OBELISKS
WHY ARE WRESTLERS ALWAYS WET
WHY ARE OCEANS BECOMING MORE ACIDIC
WHY IS ARWEN DYING
WHY AREN'T MY QUAIL LAYING EGGS
WHY AREN'T MY QUAIL EGGS HATCHING
WHY AREN'T THERE ANY FOREIGN MILITARY BASES IN AMERICA

WHY IS SEX SO IMPORTANT


WHY AREN'T THERE GUNS IN HARRY POTTER


WHY ARE ULTRASOUNDS IMPORTANT
WHY ARE ULTRASOUND PROBED EXPENSIVE
WHY IS STEALING WRONG

thank you!



references

- <https://riscv.org/technical/specifications/>
- https://passlab.github.io/ITSC3181/notes/lectureXX_RISCV_ISA.pdf
- <https://github.com/openhwgroup/core-v-mcu/>
- <https://risc-v-getting-started-guide.readthedocs.io/en/latest/index.html>
- <https://www.sifive.com/blog/all-aboard-part-1-compiler-args>
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