Building Secure Systems Using RISC-V and Rust

Arun Thomas
arun.thomas@acm.org

RISC-V Workshop Zurich

Talk Overview

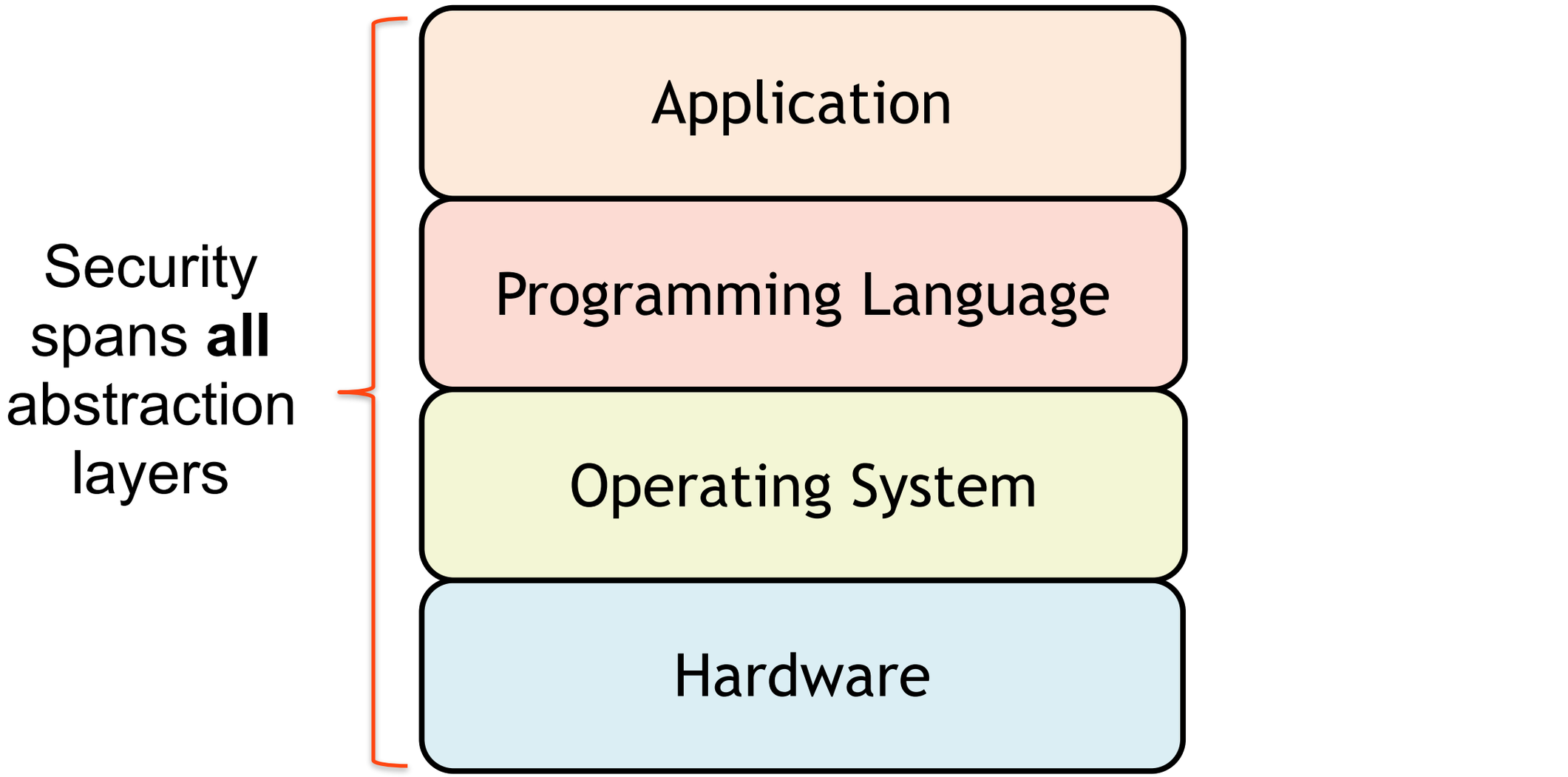
- How do you build a **secure computer system**?
- My take:
  - **RISC-V Hardware**: Openness, Simplicity, and Flexibility
  - **Rust Software**: Safety, Performance, and Productivity

How do you build a secure computer system?

Hint: Antivirus is **not** the answer.

(Ask Project Zero.)

Securing Computer Systems

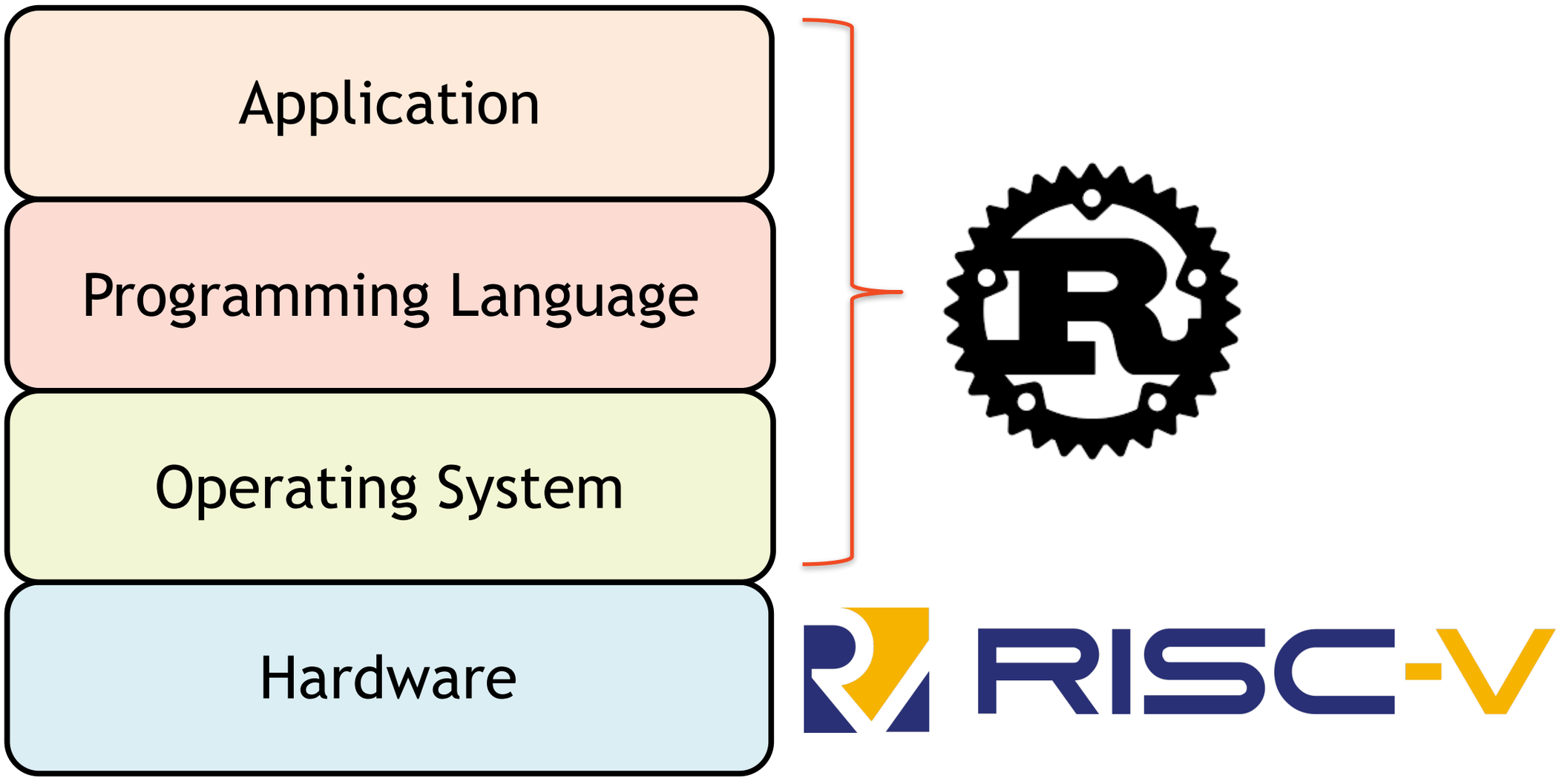


A flaw in **any layer** can compromise system security requirements.

How Are We Doing?

Well, it turns out security is HARD.

We Can Do Better



Building Secure Systems in the 21st Century:
RISC-V Hardware and Rust Software


RISC-V

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- Several open RISC-V implementation exist
  - LowRISC, PULP, Chips Alliance, OpenHW, …
- Industry and academia can collaborate more effectively
  - **No NDAs needed.** Just clone a git repo
  - Critical for making progress on solving hard security problems

*The RISC-V community has an **historic opportunity to "do security right"** from the get-go with the benefit of up-to-date knowledge.*

-RISC-V Foundation

RISC-V as a Platform for Security Research

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- Several groups exploring new security ideas on RISC-V
  - Tagged Architectures (LowRISC, PIPE)
  - Hardware enforced capabilities (CHERI)
  - Formally verified RISC-V implementations (Kami)
  - Secure enclaves (Keystone, MI6)

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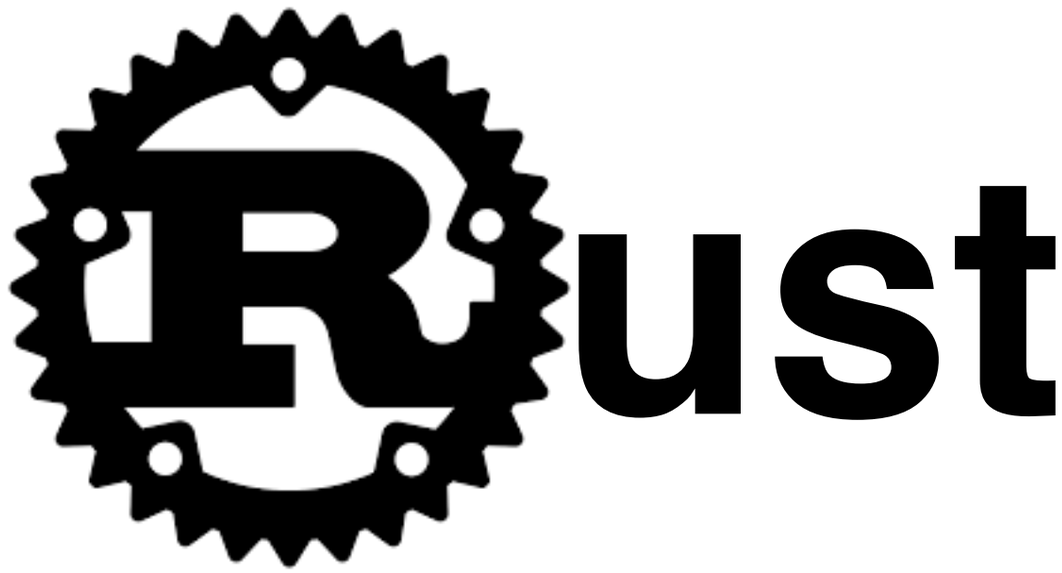
- More interesting work in the security session (post-break)


Rust

On Systems Programming

*[A] systems programmer has seen the **terrors** of the world and understood the **intrinsic horror** of existence*

-James Mickens, The Night Watch

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- Usually written in C or C++ for performance reasons
  - BUT C and C++ are **not memory-safe**
- **Memory corruption vulnerabilities** abound (and are exploited)
  - Microsoft study estimates 70% of security bugs are due to memory safety issues

It turns out programming languages have **evolved** in the last **50 years**.

Rust is a **safe,**
performant systems
programming language.

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  - **Oxidization** is Mozilla's term for "Rusting out" components
- Rust code has improved Firefox's security and performance
  - **Security**: Safe parsers (e.g., New MP4 metadata parser replaced libstagefright)
  - **Performance**: New parallel CSS engine speeds up page loads

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- Rust’s type system enforces memory/thread safety at compile time
- Excellent package manager and productive developer environment

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- Projects exploring Rust OS components for Linux kernel, FreeBSD kernel, seL4, and Fuchsia OS

Rust/RISC-V

Rust/RISC-V (RV32)

- RISC-V 32-bit support (rust-embedded/wg#36, rust-lang/rust#52787, rust-lang/rust#53822) released in Rust 1.30

Closed **RISCV Arch Support** #36

dvc94ch opened this Issue on Aug 21, 2017 · 39 comments

japaric commented on Aug 3, 2018 — Member

RISCV support is now available in the latest nightly. You can compile crates for RISCV using the `riscv32imac-unknown-none-elf` target and Cargo:

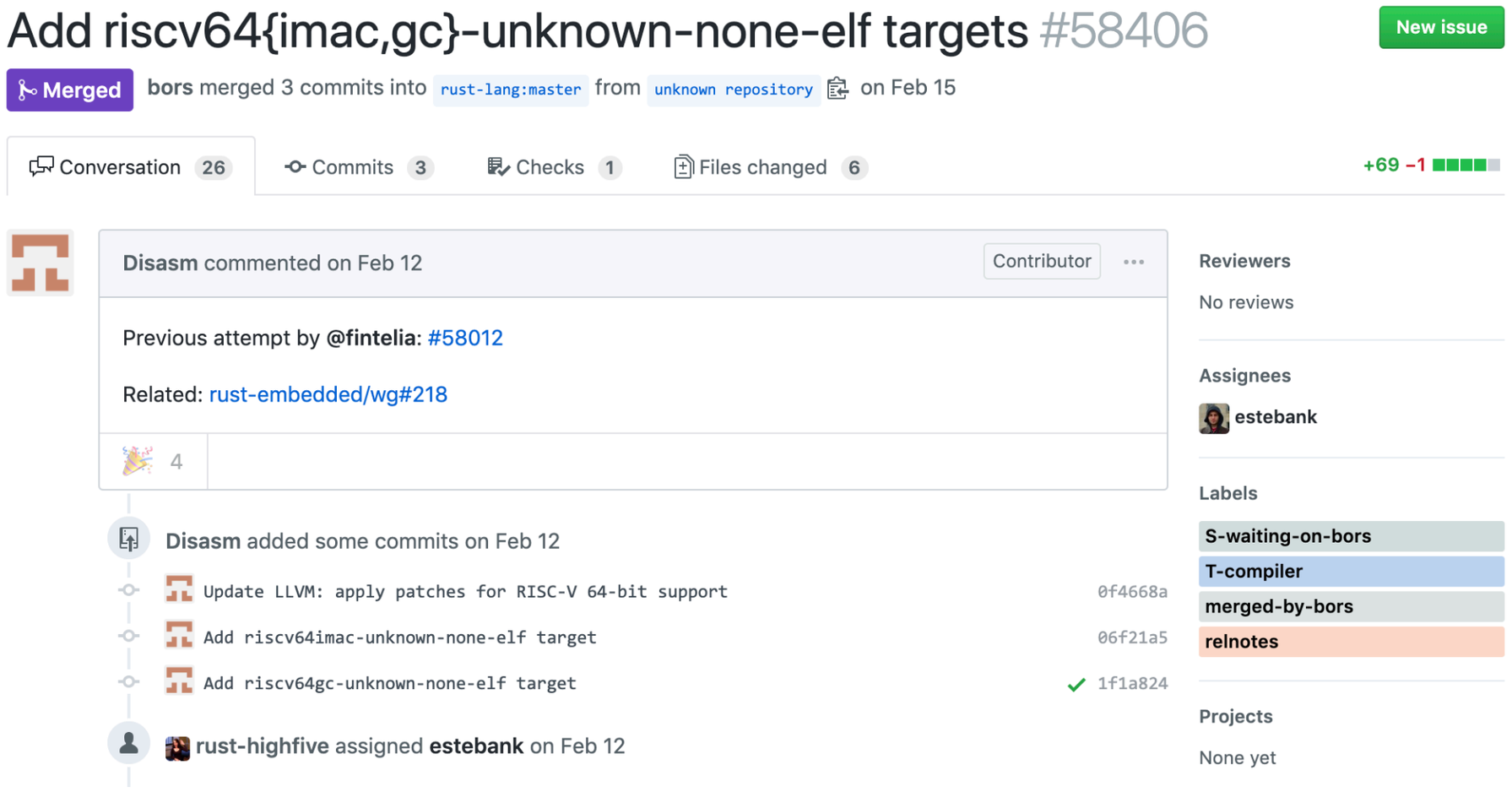
```
$ cargo new --lib foo
$ cd foo
$ cat src/lib.rs
```

```
#![no_std]

#[no_mangle]
pub fn foo(x: u32, y: u32) -> u32 {
    x + y
}
```

```
$ rustup target add riscv32imac-unknown-none-elf
$ cargo build --target riscv32imac-unknown-none-elf --release
$ cargo install cargo-binutils
$ cargo objdump -- -arch-name=riscv32 -d -no-show-raw-insn target/riscv32imac-unknown-none-elf/relea
target/riscv32imac-unknown-none-elf/release/libfoo.rlib(foo-5f01dd28752961b9.foo0-d59093d565f158ef2f

Disassembly of section .text.foo:
foo:
       0:       add     a0, a1, a0
       4:       ret
```

Rust/RISC-V (RV64)

- RISC-V 64-bit support (rust-embedded/wg#218, rust-lang/rust#58406) released in Rust 1.34



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- See my Oxidize ’19 talk for more details

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- Help Wanted

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- Tock microcontroller OS port in progress
  - Tock is written in Rust and provides a secure foundation for IoT devices

Summary

- **RISC-V and Rust provide a strong foundation for building secure systems by combining:**
  - Safety, performance, and productivity of Rust
  - Openness, simplicity, and flexibility of RISC-V