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Let’s Try Out RustSBI!

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Contents

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Complete Secure-Boot Solution

Why Rust for RISC-V SBI firmware and bootloaders?

Systems' Programming Language

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Secure While Efficient

Compiled language, ownership checks and interoperability

Language Primitives

Zero-cost abstractions, proc-macros, modules, generics and async/await

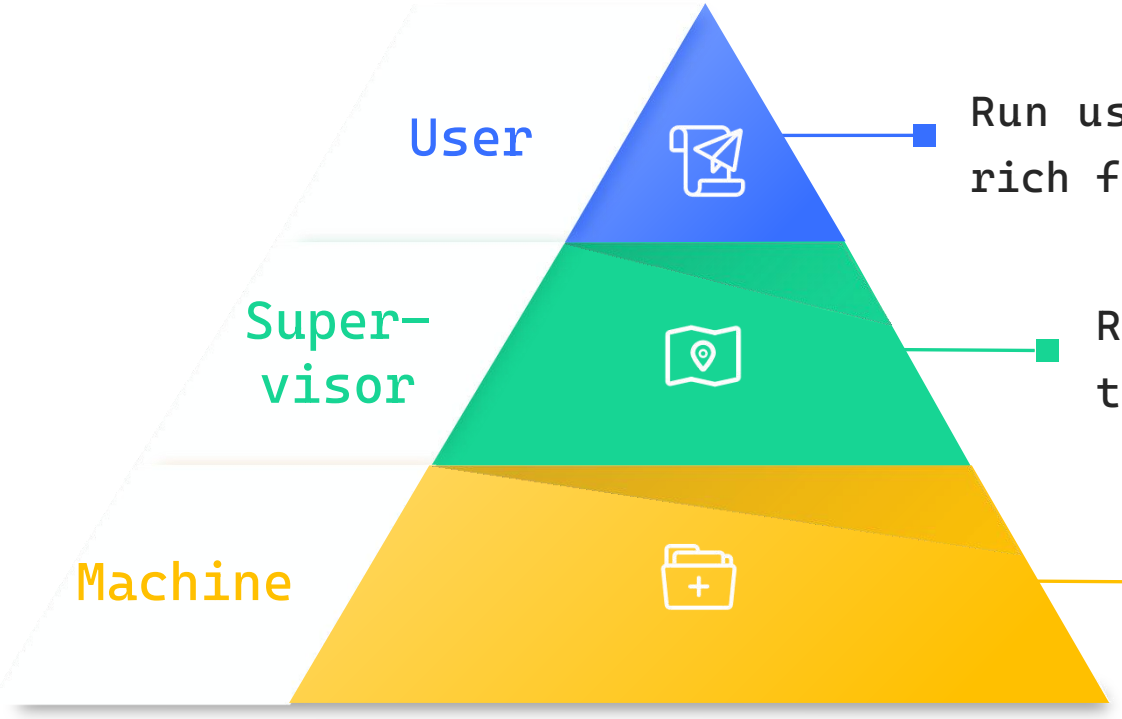
Fearless System Develop.

Concurrency, #[entry], RTOS & embassy, HALs from manufactureres

Rich Ecosystem

Multi-platform, debugging and flashing, IDEs, ecosystem crates

What is RISC-V SBI?



Run user applications with rich features

Run S-mode bootloader with the kernel

- UEFI
- LinuxBoot
- U-Boot (S)

Start kernel and support essiential features → **RISC-V SBI**

SBI Implemented in Rust

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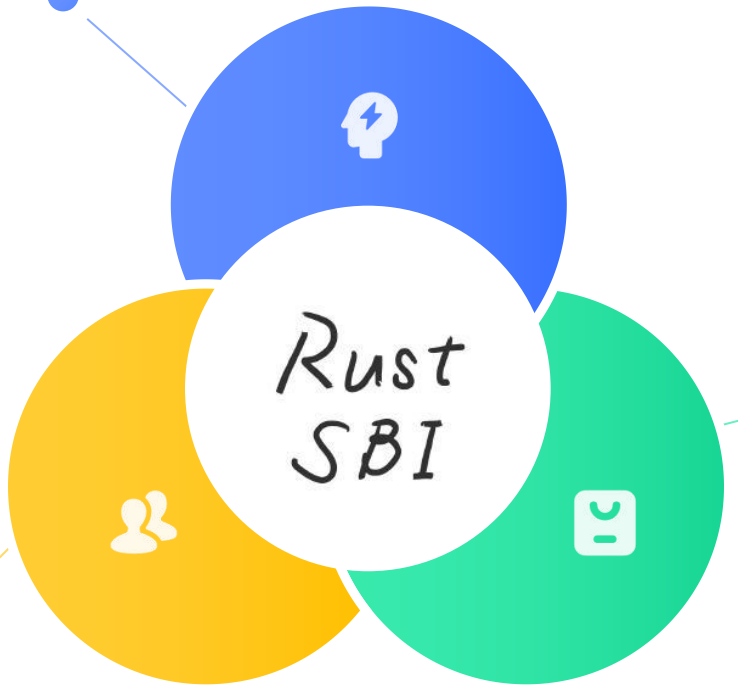
Originated from Shenzhen

Incubated in Pengcheng Laboratory and rCore community, developed from MeowSBI.



Our RustSBI Team

~15 members, spanning multiple universities including HUST.
Organized ~20 offline open-source events.

Uses 100% Rust

Utilizing Rust to build a secure boot solution specifically for RISC-V.

Our RustSBI Team

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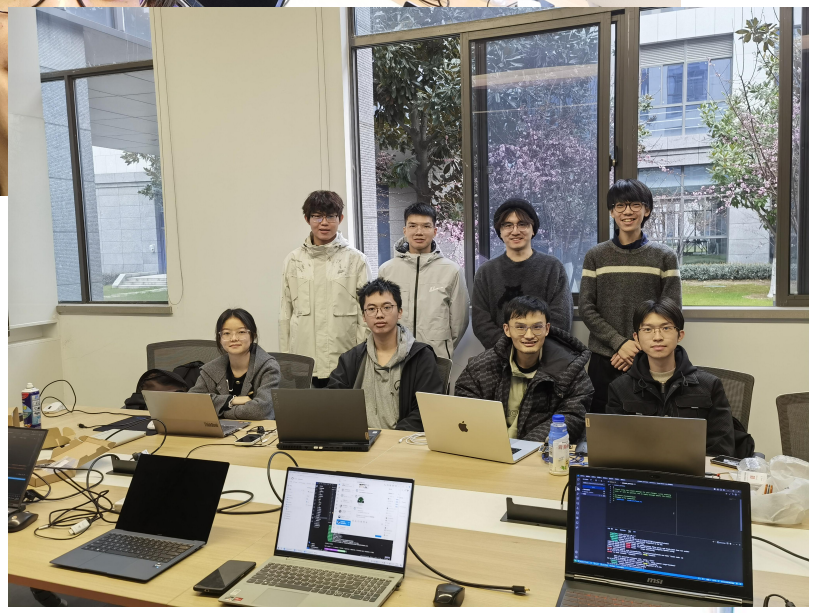

RustSBI Architecture of Today

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Applications

ZSBL

- SyterKit
- Bouffaloader

Machine-Level

- RustSBI Prototyper
- RustSBI-QEMU
- RustSBI-HPM
- RustSBI-K210

Supervisor-Level

- Oreboot
- RROS by BUPT
- Terminus
- Hikami (Hypervisor)
- Hypercraft

Tools

- RISC-V Online
- O1O-Editor Scripts
- RustSBI Agent

Support Packages

Ecosystem Base

- RustSBI (Library)
- sbi-spec
- sbi-rt
- RISCV-Decode
- sbi-testing

HAL Support

- Allwinner-HAL
- Bouffalo-HAL
- HPMicro HPM-HAL
- Sophgo-HAL
- Kendryte-HAL

Projects Maintainted by RustSBI

Ecosystem Projects RustSBI contributes to

Timeline of RustSBI Prototyper

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Run on Emulators

Used as M-mode firmware on QEMU, supporting various distributions such as Ubuntu, Arch Linux, and Fedora.

24 Q4

Broader Market Applications

~2026

Collaborations have been established with several chip manufacturers to adapt Rust bare-metal development and RustSBI booting solutions.

Unified Support Package for Real Hardware

25 Q1

Using front-end software like SyterKit or Bouffalo-HAL Boot, RustSBI is launched to support various kernels in S-mode.

UEFI + RustSBI Firmware Solution

25 Q2

Completes the S-mode bootloader and integrates with M-level RustSBI, forming a UEFI-supported booting scheme. Also supports booting various RTOS's.

Announcing RustSBI 0.4.0

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- Feature rich and extensible operating system runtime
- Empower support for machines, hypervisors & emulators
- Supports RISC-V SBI specification v2.0 ratified
- Written in Rust, builds under stable Rust
- Capable to develop with other firmware ecosystem projects
- Adapted for operating system kernels on your choice

- Please star us at: https://github.com/rustsbi/rustsbi

Embedded

Rust SBI

RISC-V

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Go Bare-Metal

Bare-Metal Programs, Supported Platforms, and Ecosystem

Opinion: Embedded Rust & Bootloader

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01

Bootloaders and embedded software are both bare-metal applications.

02

RTOS and M-Mode environment can both be initiated by ZSBL.

03

Both bootloaders and IoT rely on network and interconnection software stacks.

Conclusion

Bootloaders, embedded, and operating systems share the same Rust ecosystem!

Execution Environment

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```rust
#[entry] // This macro would initiali
fn main(p: Peripherals, _c: Clocks) {
    // Display the bootloader banner.
    show_banner();

    // Initialize the DRAM.
    let dram_size: usize = syterkit::
    println!("DRAM size: {}M 🐏", dr

    // Dump information about the sys
    clock_dump(&p.ccu);

    // Start boot command line.
    let (command_buffer: [u8; 128], h
```

Synchronous

Blocking based loops and relaxation. Simple and stable.

Async/Await

Scheduling tasks to maximize performance. Efficient and practical.

```rust
#[embassy_executor::main(entry = "hpm_hal::
async fn main(spawner: Spawner) -> ! {
    let p = hal::init(Default::default());

    defmt::info!("Board init!");

    spawner.spawn(blink(p.PE14.degrade(), 1
    spawner.spawn(blink(p.PE15.degrade(), 2
    spawner.spawn(blink(p.PE04.degrade(), 3

    defmt::info!("Tasks init!");

    loop {
        defmt::info!("tick");
```


ZSBL: Take SyterKit as an Example

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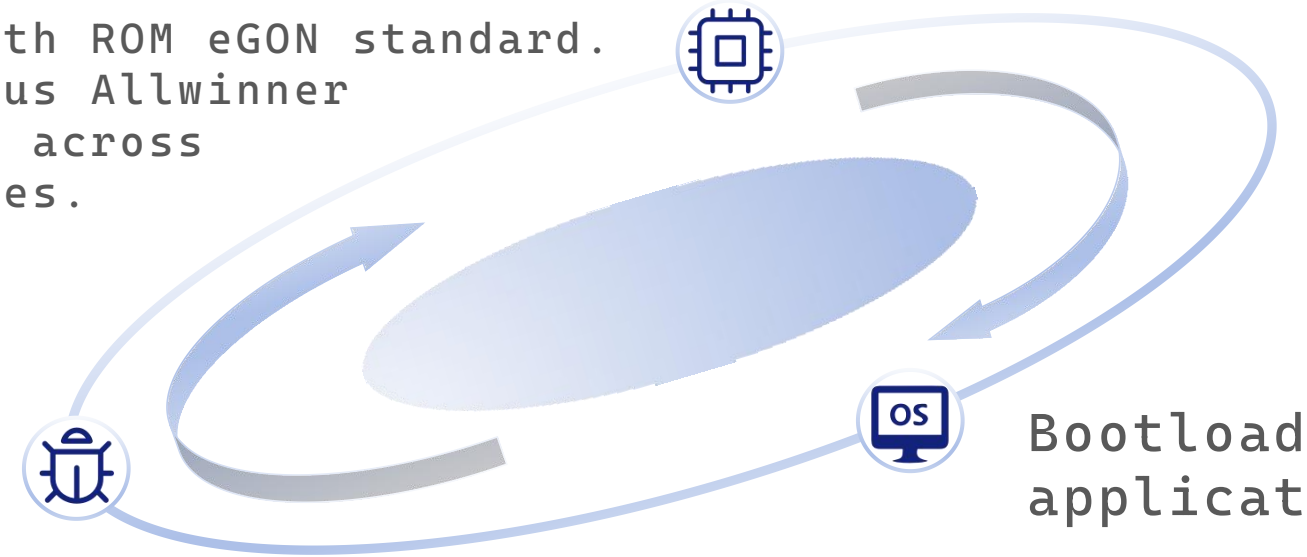
Allwinner ROM bootloader

Complies with ROM eGON standard. Boots various Allwinner chip series across architectures.



Bootload Machine-mode applications

Boots M-mode Linux from flash or SD.Configured via DTB (Device Tree Blob).

Low-level debugging

Basic debug for low-level drivers.Operates within 128-KiB SRAM.

ZSBL: Syterkit Rust support

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[board] Rust serial output example and light up led on 100ask-d1-h #129

Merged luojia65 merged 1 commit into YuzukiHD:main from Placebo27:placebo27/helloworld 3 weeks ago

Conversation 1 Commits 1 Checks 2 Files changed 4

Placebo27 commented 3 weeks ago Contributor ··· Reviewers

[board] support the xtask burn commands cargo make and cargo flash on 100ask-d1-h #128

Merged YuzukiTsuru merged 1 commit into YuzukiHD:main from Placebo27:placebo27/xtask 3 weeks ago

Conversation 1 Commits 1 Checks 0 Files changed 5

Placebo27 commented 3 weeks ago Contributor ··· Reviewers

[board] refactor directory, add init-dram case macro module for 100ask-d1-h-rs #130

Merged luojia65 merged 3 commits into YuzukiHD:main from Placebo27:placebo/ddrinit 3 weeks ago

Conversation 1 Commits 3 Checks 2 Files changed 12

Placebo27 commented 3 weeks ago • edited Contributor ··· Reviewers

[rust] complete `clock_dump` fuction for syterboot #134

Merged luojia65 merged 1 commit into YuzukiHD:main from Placebo27:placebo27/syterboot 2 weeks ago

01.Peripheral Adaptation

- Adapted Allwinner-HAL crate for DRAM controller and other peripherals.

02.Build and Flash

- Utilize xtask for building and flashing with the xfel program.

03.Example Programs

- Demonstrated with LED control, serial output, and DRAM initialization.

04.Bootloading Interface

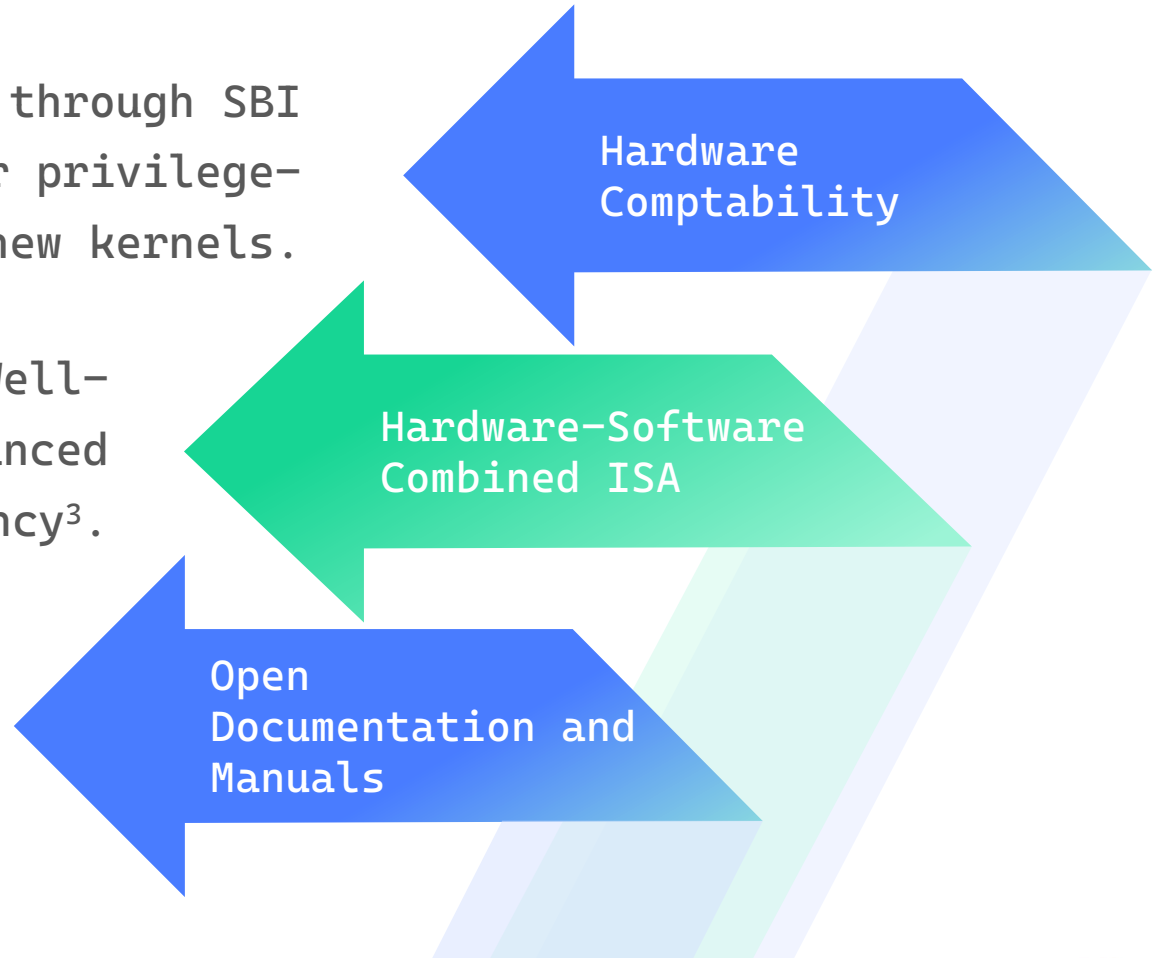
- Features a command-line menu with autocomplete, history, and help command.

Prolong Life of Existing Silicon

Software features[1] implemented through SBI firmware (RustSBI) allows older privilege-level hardware to run new kernels.

RISC-V implements some CSRs by software. Well-designed SBI firmware would include advanced features[2] and enhance system efficiency[3].

When documentation is open, the open-source community can unleash endless productivity!



[1] Those features include replacing satp/sptbr, simulating sfence, and simulating page faults.
[2] e.g. H-extension emulation by @DramForever [3] One example: https://github.com/rustsbi/prototyper/pull/8

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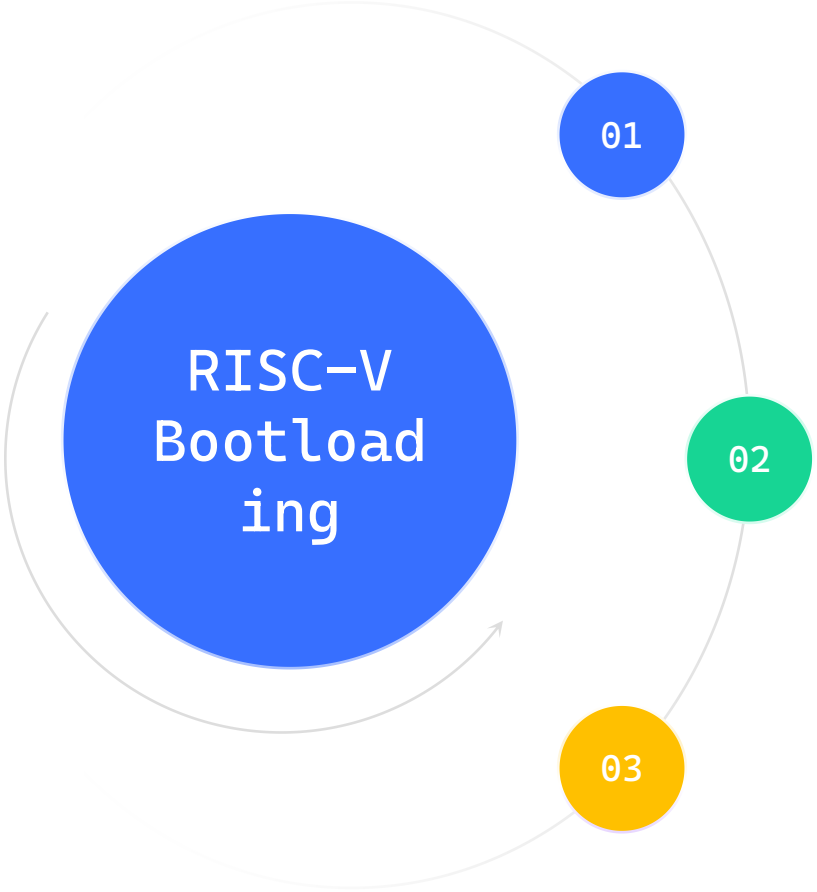
Bootload and Support Systems

How Linux distributions and new kernels dependd on the underlying bootloader environment?

SBI, LinuxBoot and UEFI



Bare SBI

M-mode firmware directly launches various S-mode kernels. Fastest boot speed and best customizability.

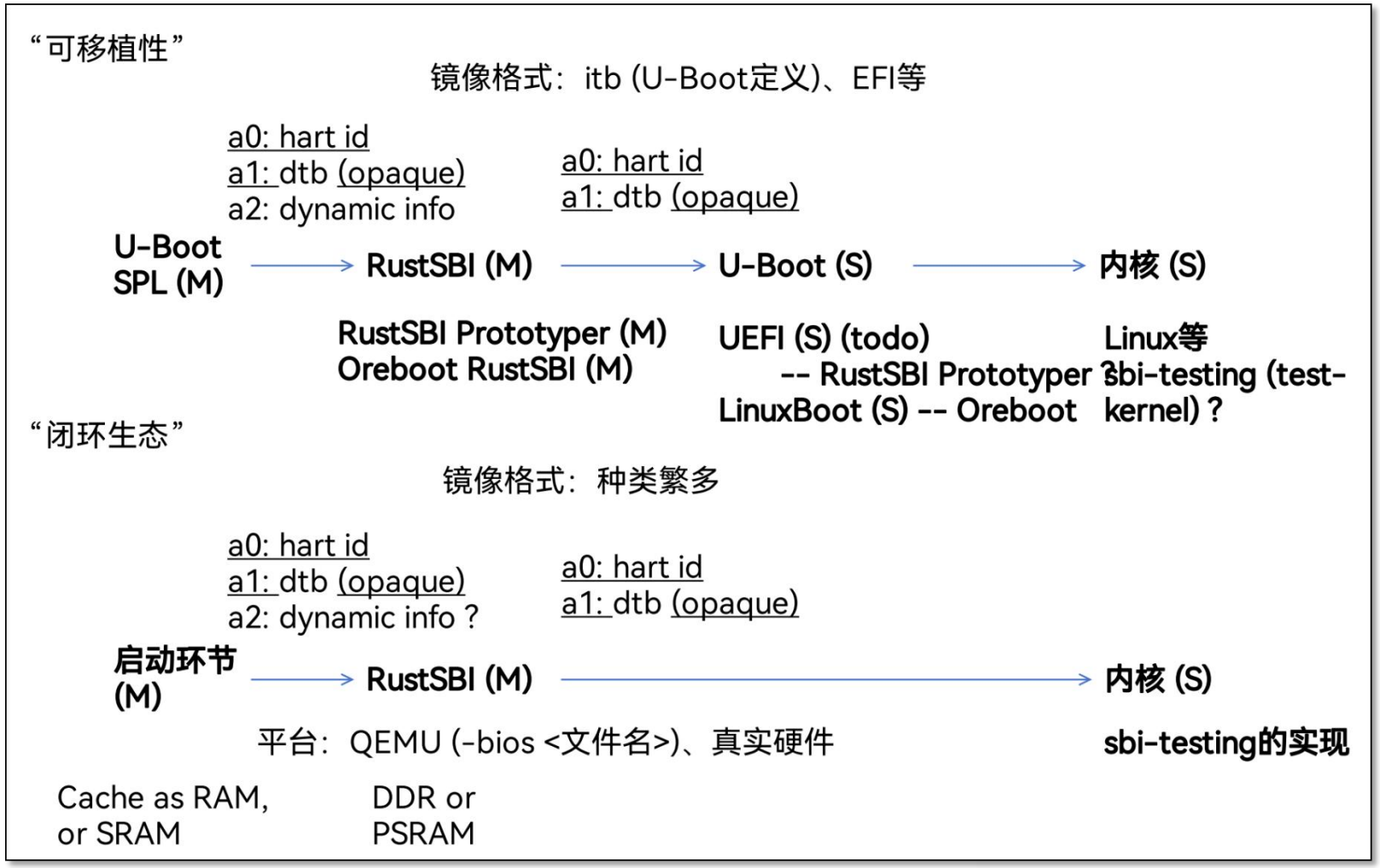
LinuxBoot

Packages tailored Linux with SBI and rootfs into the firmware, launching true Linux via kexec. Reuses Linux drivers, minimizing development effort.

UEFI

Mature commercial standards, providing complete device list through ACPI or DT. Portability and level of productization are the best among the three.

Bootloading Linux Distributions



SBI Firmware Boosts Kernel Performance

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When refreshing ≥ 4 pages, prioritize using global refresh instructions.

Page Refresh Optimization[1]

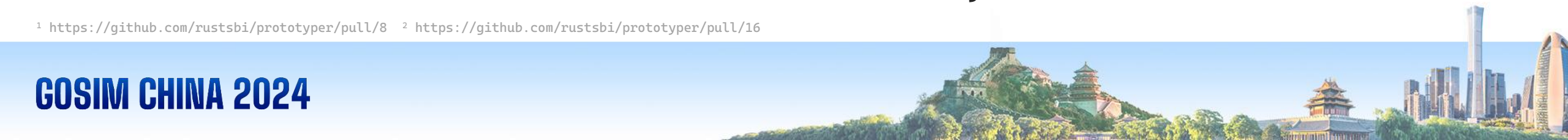
Query hart state from SBI HSM as a primitive for asynchronous multi-core startup, reducing wait times.

Asynchronous Startup

Fence Queue[2]

Queue remote fence commands, allowing remote fence SBI calls to return immediately.

[1] https://github.com/rustsbi/prototyper/pull/8 [2] https://github.com/rustsbi/prototyper/pull/16



Security Demands of Operating Systems

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Secure Boot

Layered verification would establish the trustworthiness of the systems software.

TEE

Run isolated code, protect passwords and biometric information.

Fast Cipher

Scheduling proprietary hardware to meet cryptographic needs.

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Outlook: TEEs & AI

RISC-V CoVE SBI and the RustSBI Agent project

CoVE SBI: Future of RISC-V TEE

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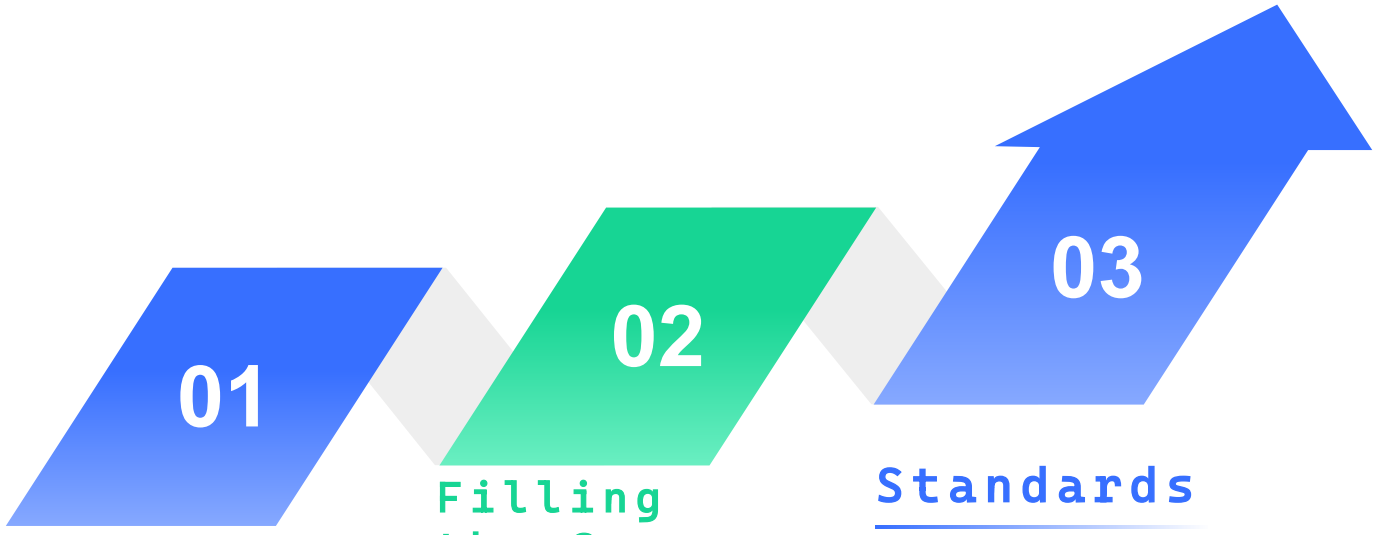

AP-TEE

TCB and Non-TCB code isolation standards

Filling the Gaps

... between architecture and security requirements

Standards

Privilege levels, H instruction set, IOMMU, etc.

Introduction of RustSBI Agent

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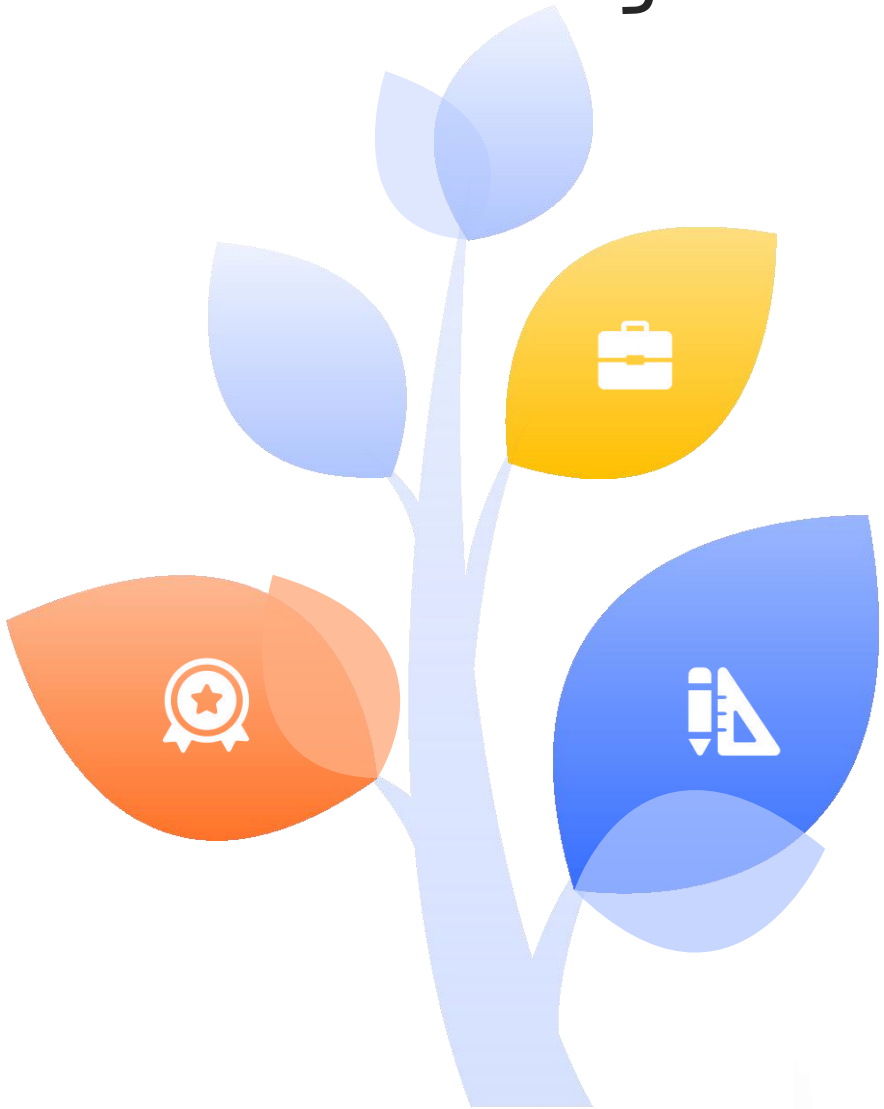
Developer's AI Assistant

A chatbot with expertise in RustSBI, RISC-V, and chip manuals.



Saves Development Time

RustSBI developers spend 3/5 of their time querying documentation—this can be reduced!

Relevant AI Fields

RAG, prompt engineering, are key components of the RustSBI Agent.

Acknowledgments

- We appreciate the speaking opportunity provided by GOSIM and RustCC.
- Special thanks to our project mentors: Professor Wei Zhou, Professor Dongliang Mu, and Professor Jie Wang.
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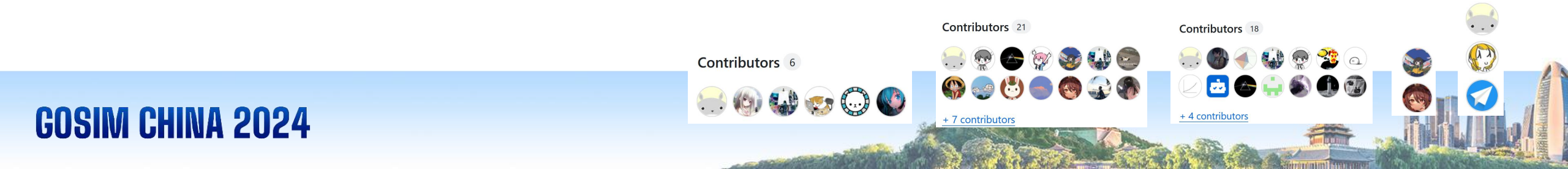
- Finally, we extend our gratitude to the PLCT Laboratory for their significant support.



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THANK YOU