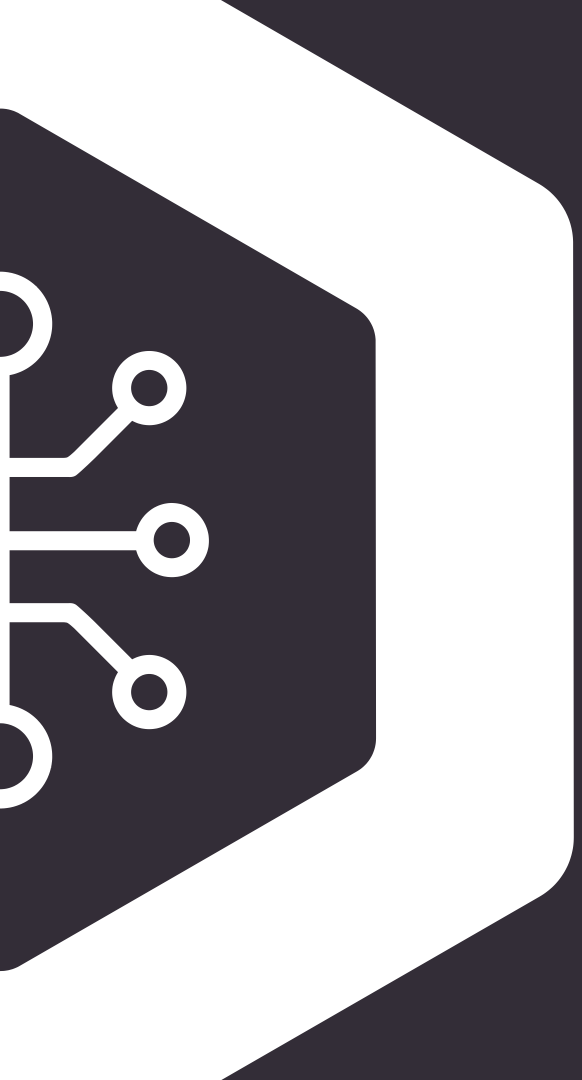

Extending the reach of RISC-V with Renode & Zephyr, on Earth and beyond

Göteborg RISCV Meetup #3, 2024-02-20

Michael Gielda, mgielda@antmicro.com

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ANTMICRO

- Founded in 2009, dedicated to open source in a pragmatic and commercial approach
- Around 130 people (now also in Gothenburg - Citygate), SW-driven company with extensive HW know-how - developing complete systems
- We provide end-to-end engineering services, advanced tooling and platform development and strategic R&D for high-tech products
- Heavily involved in RISC-V, Zephyr, open source hardware/FPGA/ASIC - members of CHIPS Alliance, RISC-V International, Zephyr project

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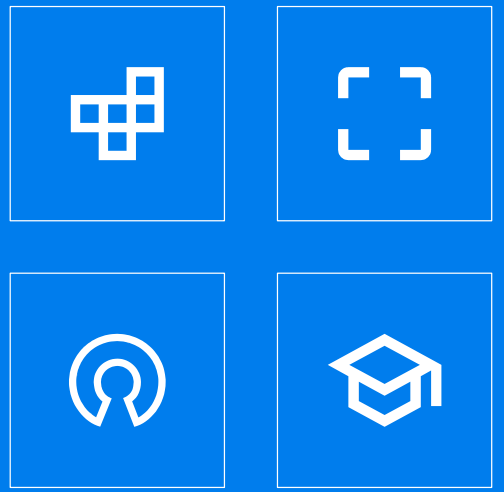
WHY DO PEOPLE PICK RISC-V?

- Customizability and flexibility - can be freely adapted, versatile framework/ecosystem rather than just a “technology”
- Scalability - start with small cores, scale to any use case, including very complex ones
- Openness - share everything freely, no licensing restrictions
- Lack of barrier to entry - experiment without up front investment, meshes well with academia and research, industrial R&D



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WHY DO PEOPLE PICK RISC-V, RENODE AND ZEPHYR

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- Scalability - start with small cores, scale to any use case, including very complex ones
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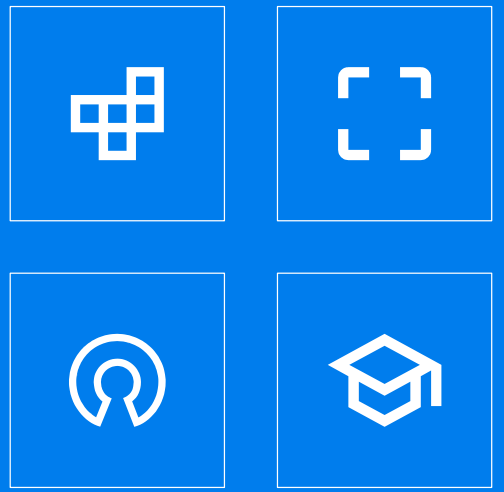
- **As RISC-V, Renode and Zephyr share those qualities, they go along very well!**



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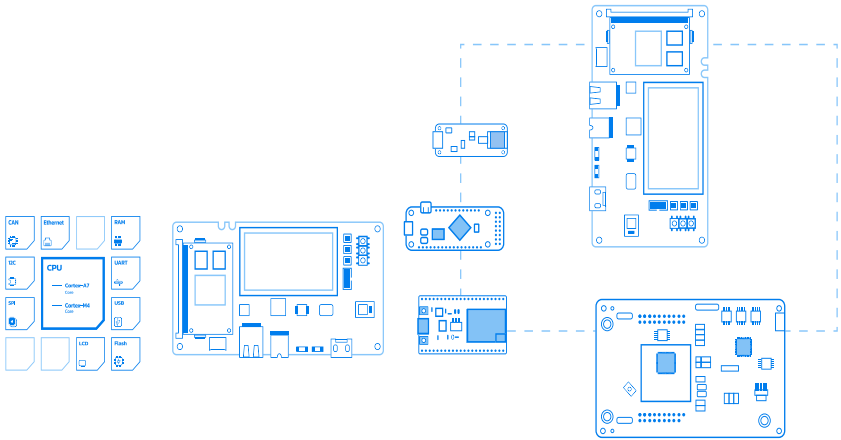
SO WHAT IS RENODE?

- Renode is our flagship open-source system development framework featuring software/hardware/FPGA/ASIC co-simulation capability for the flexible and rapid design of heterogeneous systems
- It supports various CPU and I/O IP, sensor, network building blocks — you can quickly build and simulate entire SoCs/systems before actually implementing them
- We offer commercial support and engineering services around Renode and integrating it into various interactive and CI workflows

RENODE™



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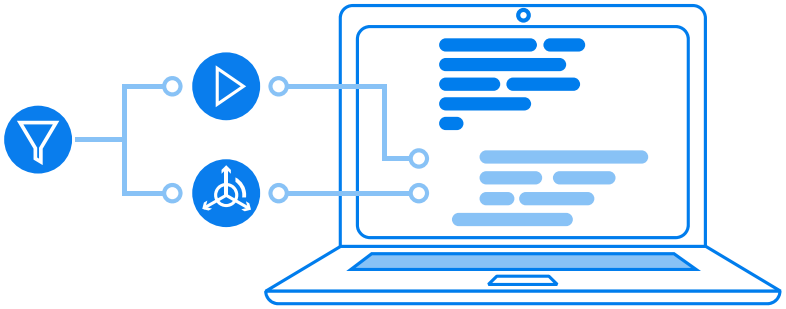
SUPPORTS COMPLEX, MULTI-NODE ENVIRONMENTS

- Renode allows to design and test sophisticated multi-node environments, heterogeneous, multi-ISA; complete products
- Full-system, binary-compatible simulation, software agnostic - but meshes best with open source like Zephyr!
- Full inspection of SW behaviour and robust event tracing mechanisms
- Lets you debug simulated applications with GDB, also for multiple nodes at the same time



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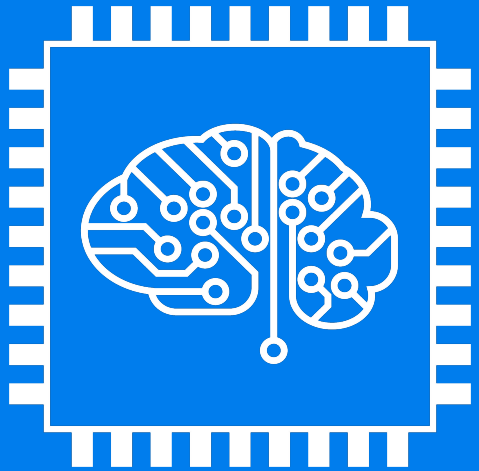
RENODE FOR CUSTOMIZED RISC-V DEVELOPMENT

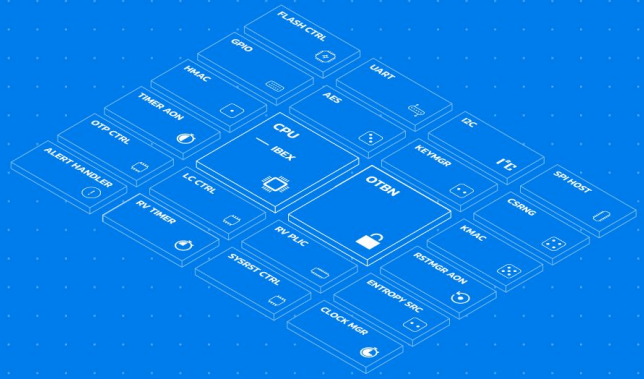
- Renode helps develop end products but also e.g. SoCs, security IP or ML solutions, especially based on RISC-V
- Supports RISC-V Vector extensions
- Many ways of adding RISC-V Custom Instructions - including Python one-liners - and Custom Function Units for HW/SW ML co-development
- Renode together with Kenning enables co-development of RISC-V AI accelerators and testing of ML flows in a fully automated, reproducible and consistent manner - Kenning now **includes Zephyr runtime with TVM!**

RISC-V



RENODE IN RISC-V PROJECTS

- Prominently supports Microchips PolarFire SoC - with Zephyr and complete FPGA co-development flow - see our talk at EOSS/ZDS in Seattle in April (right before LatchUp in Boston)! https://sched.co/1aBFb
- Very good support for SiFive platforms
- Great support for OpenTitan
  - and, as a consequence, Open Se Cura
- (we're also working with Caliptra, which is Microsoft+Google+AMD+NVIDIA, the core is called VeeR, and we just added PMP to it)



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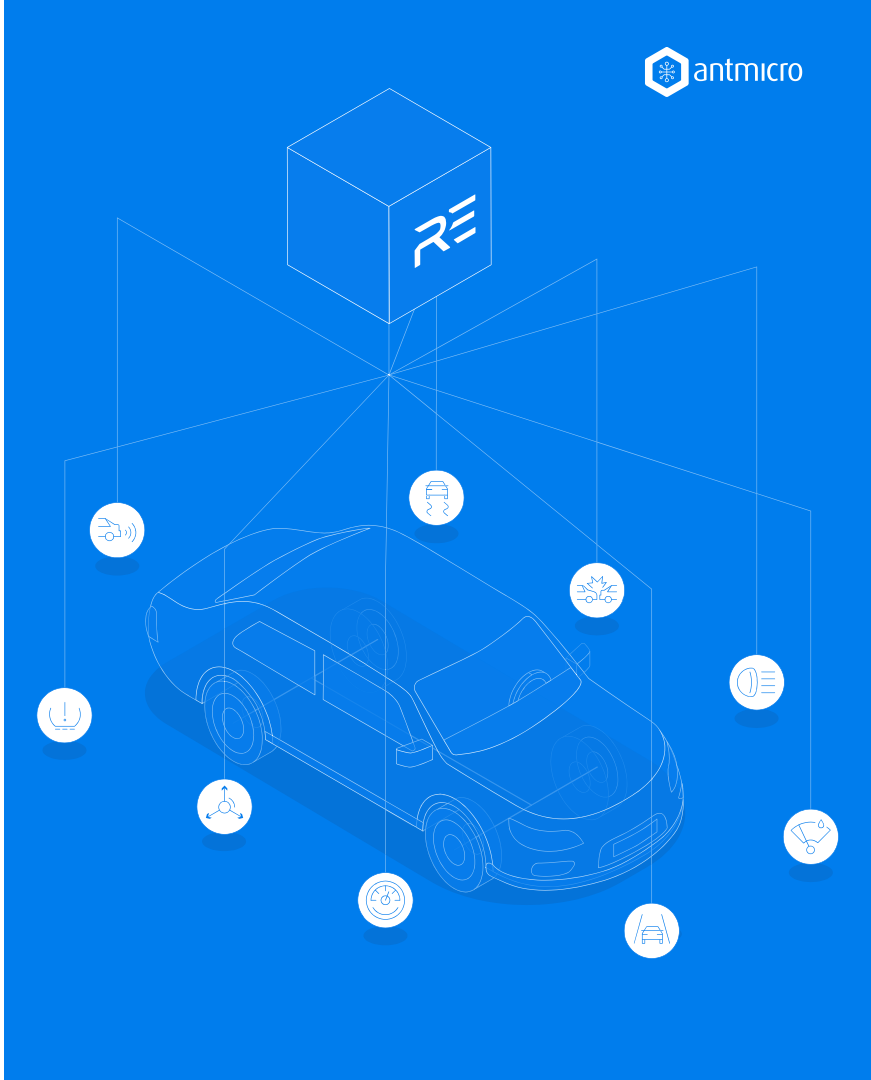
RENODE FOR PROTOTYPING AND HARDWARE DEVELOPMENT

- Renode can co-simulate with Verilator, including simulating CPUs directly from RTL, as well as to emulate with physical peripherals
- Supports DPI to integrate with simulators such as Verilator, Questa, Vivado or VCS
- Despite being an ISS, Renode also supports trace-based augmentation of execution data, useful for pre-silicon HW/SW co-design and performance evaluation
- Broad support for RISC-V but also ARM and other popular platforms

AGENT OF CHANGE: RENODE FOR AUTOMOTIVE

- Renode is gaining traction in new automotive applications, software driven and electric cars
- Key features: ability to mix architectures, simulate multi-node systems, debugging features
- Also agent for Zephyr / open source OS adoption
- Helping build new, tailored silicon devices, evaluate choice of CPUs for specific algorithms
- Used as demonstrator for capabilities of RISC-V product portfolios
- Dedicated blog note: https://antmicro.com/blog/2023/12/multi-node-development-in-renode-for-automotive-use-cases/



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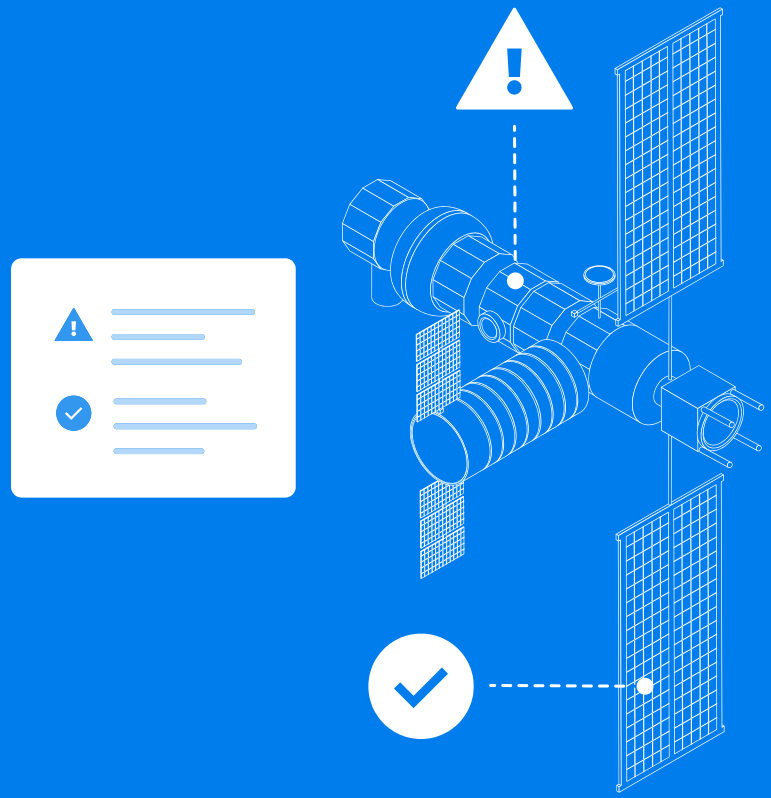
AGENT OF CHANGE: RENODE FOR SPACE

- Renode is also seeing incredible adoption in space
- Good match: multiple ISAs, FPGA co-simulation, multi-node systems, lot of testing!
- RISC-V is a rising star there as well, and Renode is helping establish its footprint
  - ARC, Microblaze, LEON and other proprietary options slowly fading away, replaced with RISC-V
- Seeing a lot of space ROS, looking forward to more Zephyr adoption
- Dedicated blog note: https://antmicro.com/blog/2024/02/developing-and-testing-space-systems-with-renode/



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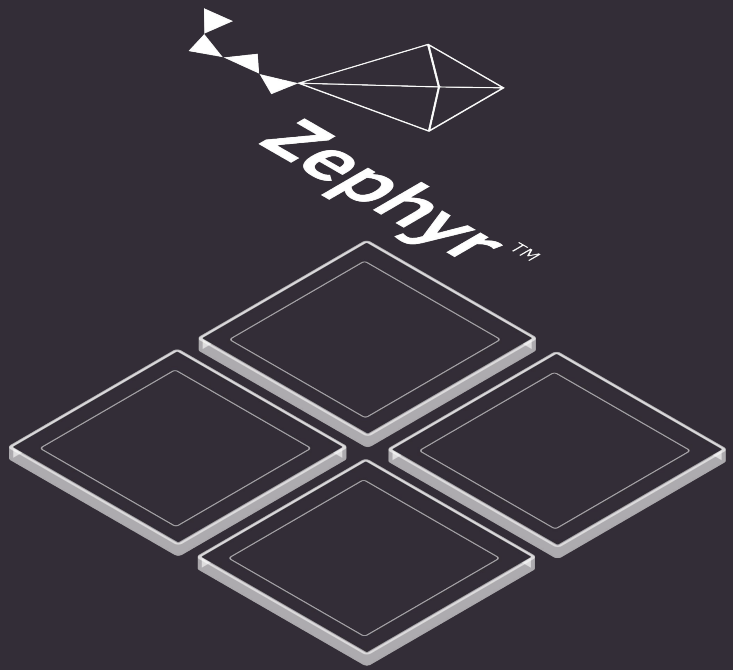
ZEPHYR

- For those of you that don’t know...
- ... where have you been hiding?
- Zephyr RTOS is the world’s fastest growing RTOS, most commits, developers, boards...
- Focused on security, standardization, portability
- Pushing for Zephyr to be the “de-facto” standard for RISC-V (alongside Linux)



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ZEPHYR AND RISC-V

- Antmicro maintains the RISC-V ISA in Zephyr
  - your contributions to SoCs and arch port will likely go through our review
- We're working on improving the ease of use
  - ISA modularity
  - soft CPUs, soft SoCs
- Helping test Zephyr with Renode
  - helps ensure stability and fitness of platforms and drivers (not only cores!)
  - default testing platform for many Zephyr platforms, especially RISC-V

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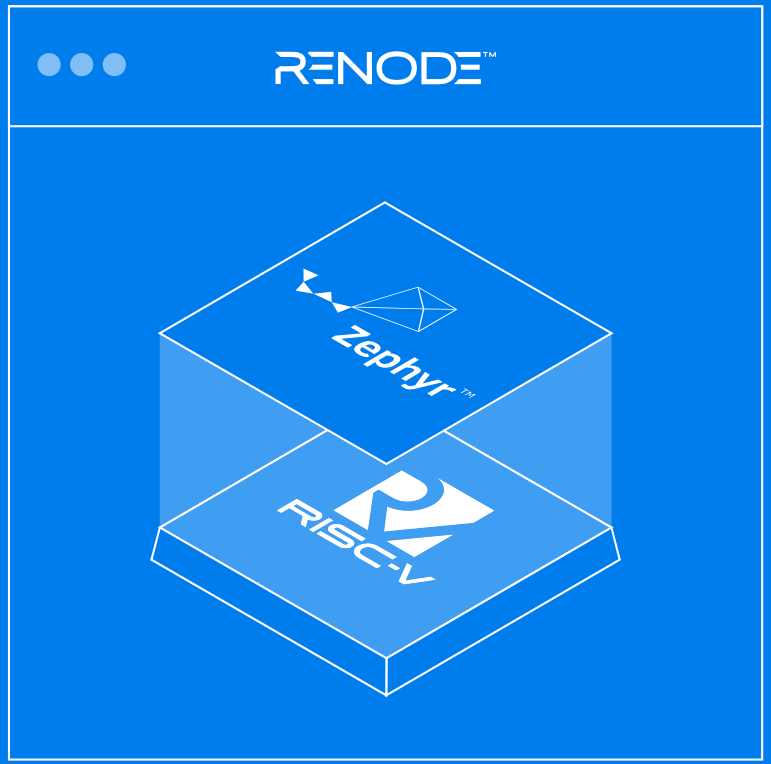
RENODE HELPS RISC-V IN ZEPHYR

- Co-developing support for RISC-V both in Zephyr and Renode
  - ISA strings added as part of DTS for all RISC-V platforms in Zephyr
  - improved platform descriptions for better consistency and analyzability
  - improved a range of peripheral models
- Renode-specific virtual target contributed by Meta, for increased ease of use and modularity comparing to other simulators

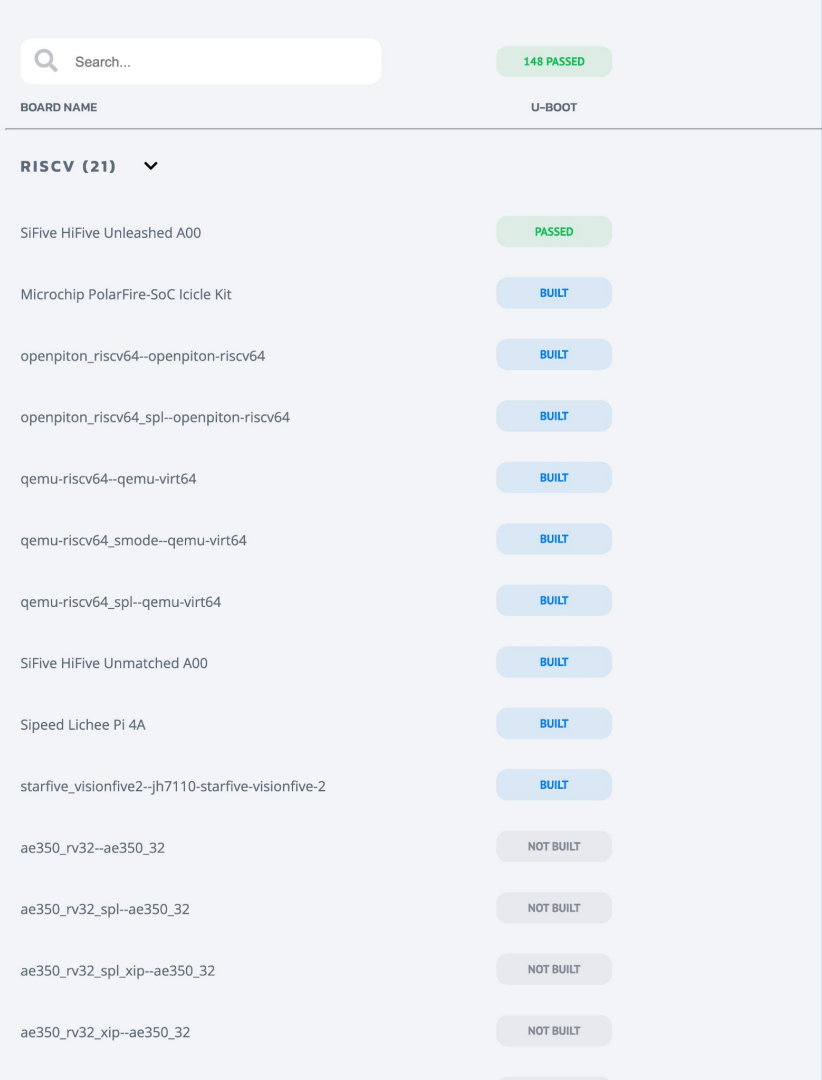


ZEPHYR + RENODE = DASHBOARD

- A great example of the power of Zephyr and Renode used together for testing at scale:
- zephyr-dashboard.renode.io
- Presents auto-generated Zephyr examples and tests passing on >430 platforms in Renode
- Visualizes the data in a matrix view and allows for easy local reproduction
- Leverages device trees used in Zephyr to describe build targets
- Helps improve RISC-V HW descriptions in Zephyr!

UBOOT DASHBOARD

- Similarly to the Zephyr Dashboard, the U-Boot Dashboard applies this concept for boards supported in U-Boot
- u-boot-dashboard.renode.io
- Great source of extra data, especially for boards that are also supported in Zephyr
- Proves the approach is generic and can be expanded to other types of software



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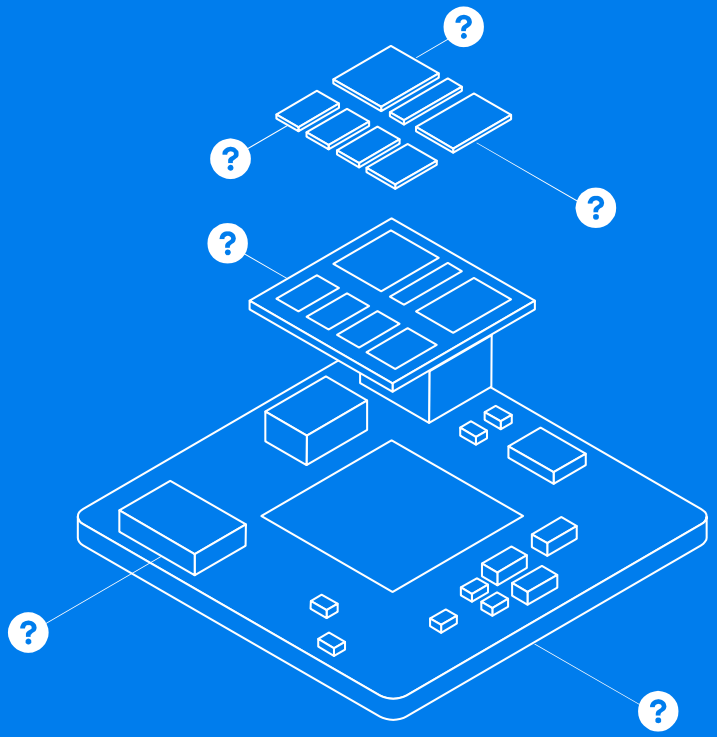
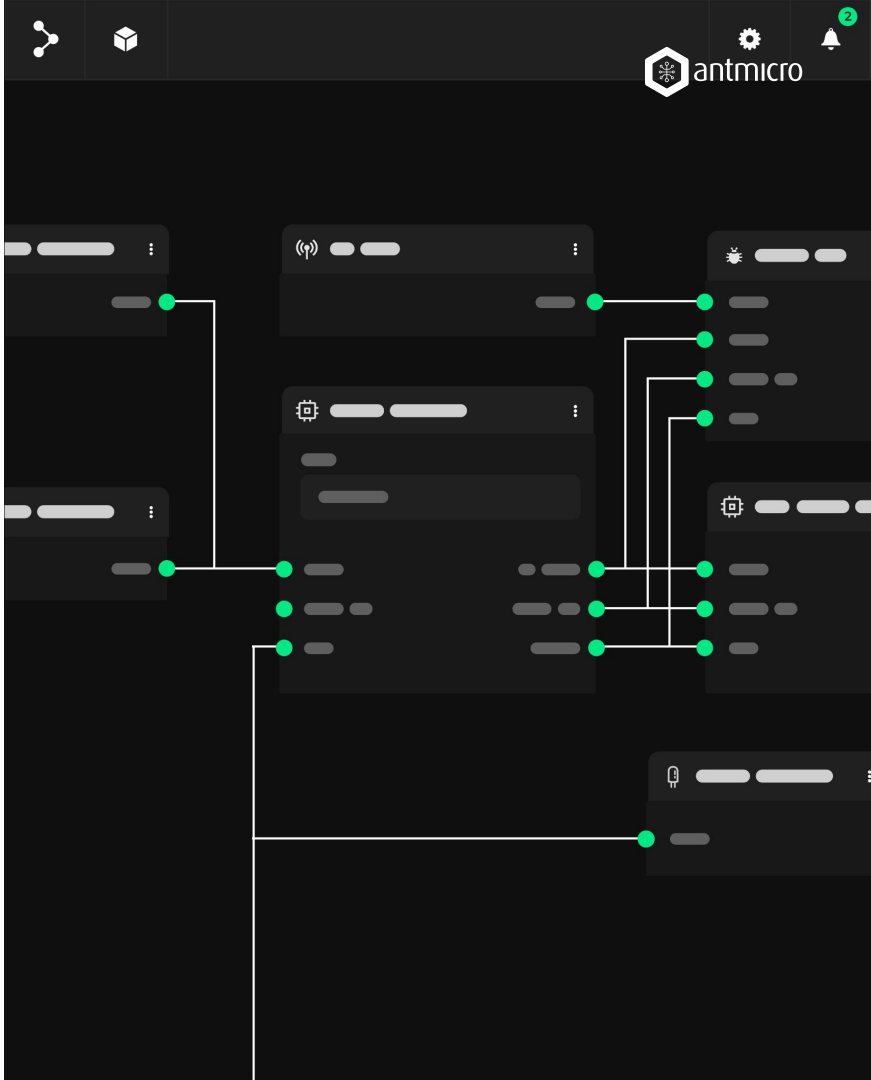
RENODEPEDIA

- Renodepedia - Antmicro's encyclopedia of hardware - SoCs, boards, IP blocks
- Cataloging HW ecosystem, exposing structure - especially great for open source hardware and RISC-V ecosystem
- Based on automated data e.g. device trees from our Zephyr Dashboard CI:
  - Discover connections between components
  - Navigate dependencies
  - Show commonalities and SW payloads
  - Simulate in Renode



VISUAL SYSTEM DESIGNER

- An open source tool, based on Antmicro's open source component and platform database, using Pipeline Manager, visual diagramming tool for AI
- Visual System Designer enables a visual, formalized way to build embedded systems from defined building blocks - and generating Zephyr firmware and tests from the system description!
- Design hardware block diagrams that use a unified specification file containing different component types
- Co-develop hardware and software for Machine Learning scenarios with RISC-V features



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PREDICTING THE FUTURE

- Always a bad idea but I'll try anyway
- Systems will converge around Zephyr (and Linux) and other open options (of course will never get close to 100% adoption, diversity is good)
- RISC-V will continue to grow rapidly, alongside ARM for the foreseeable future, custom architectures will go away except extreme niches
- More software-driven chips!
- Hoping for even more Renode adoption - start using it today (and talk to me tonight)!

THANK YOU
FOR YOUR ATTENTION!