

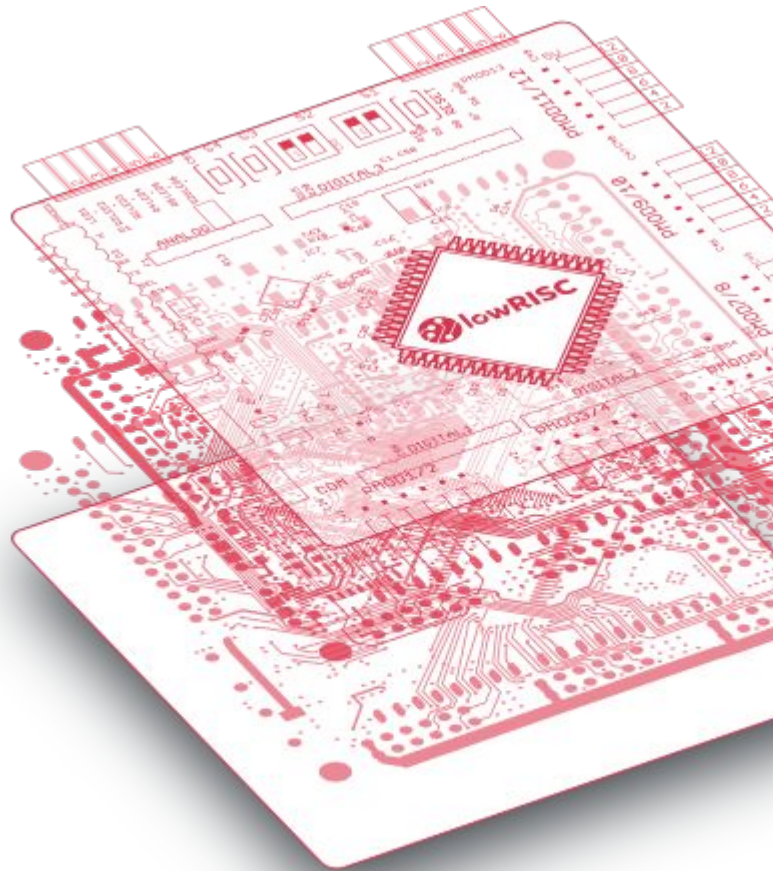


Announcing COSMIC!

The open source 64-bit CHERI powered
application class secure enclave reference
design

lowRISC, Capabilities Limited, Oxford University Innovation (OUI)

Manchester, November 14, 2025



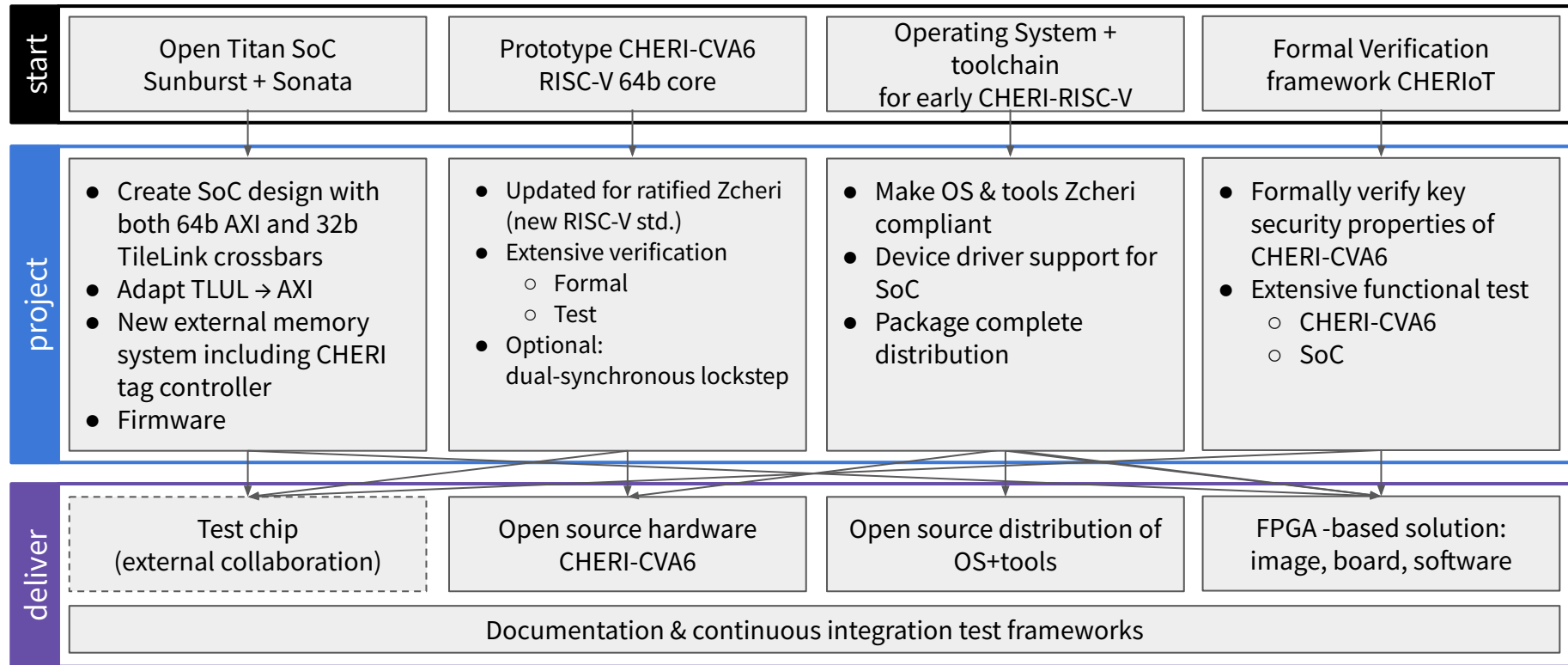
What is COSMIC?

- CHERI for Operational Safety in Memory-Isolated Cores (COSMIC)
- Continuing the CHERI path started with Sunburst and related projects
- 64-bit application class (Linux capable) CHERI core
- Generate a reference open source Secure Enclave design
- Highly verified: with additional formal verification
- Funded by DSIT / Innovate UK. Two stages - S1 until March '26. S2 until March '28

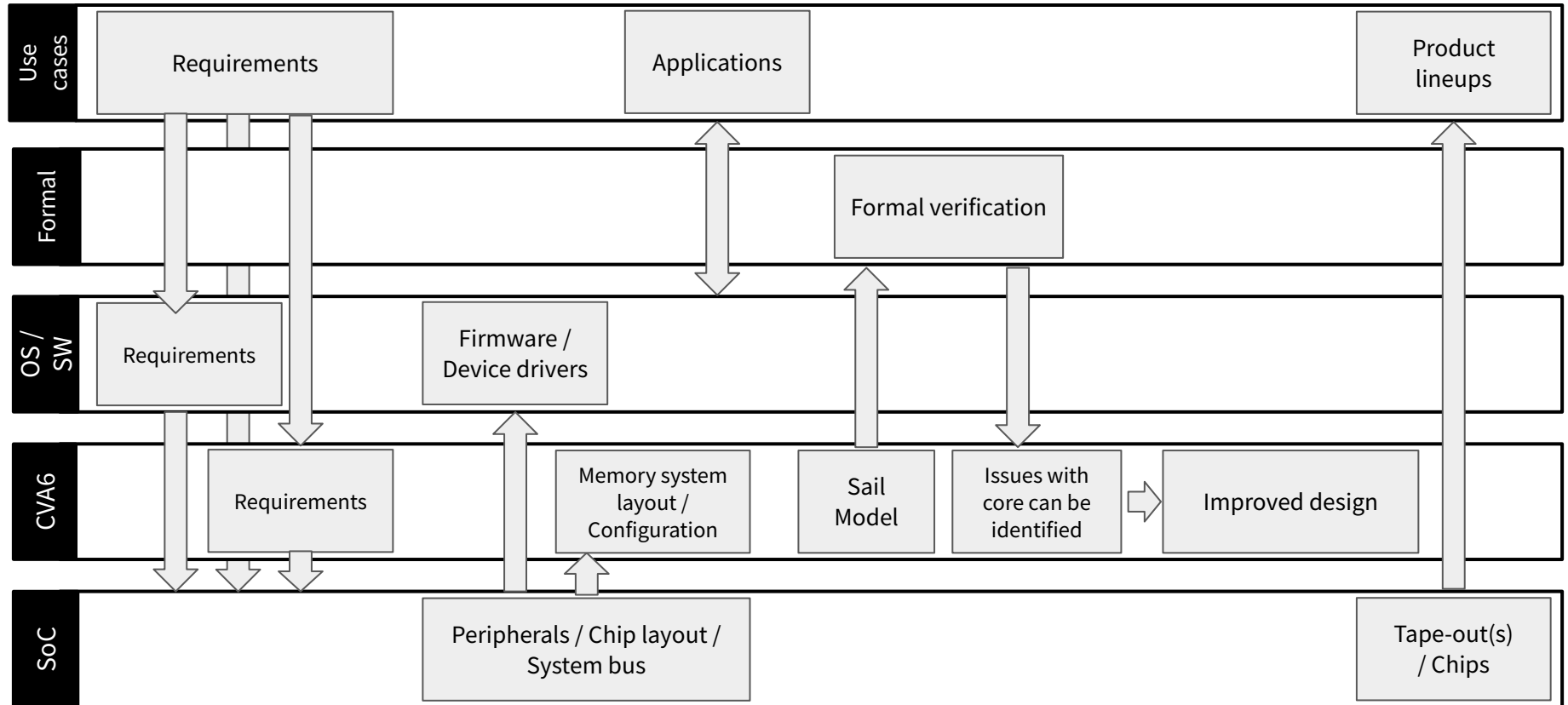
Building on the work from other projects

- Capabilities Limited - spin-off from University of Cambridge
 - CVA6 - originally from ETH Zurich + University of Bologna; now with OpenHW / Eclipse Foundation
 - Working on the CVA6-CHERI fork from University of Minho
 - Expertise in CHERI systems development
 - Provided the SAIL formal model of the CHERI 'Y' draft standard
- Oxford University Innovation with assistance from Prof Tom Melham
 - Formal flows helped identify RTL bugs in Microsoft's implementation of CHERIOT-Ibex
 - Continued this into the Sunburst project for unbounded complete proofs of Sail / RTL equivalence
- lowRISC
 - Track record of delivering high quality, highly verified open source designs
 - Dashboards / CI / Regressions - all the systems needed to ensure high quality designs
 - Proven route to commercialisation through partners like Google, Rivos and SCI

Project Overview



Project Interactions



Deliverables + Milestones

- Stage-1
 - Preparing an initial top-level design, CHERI-MOCHA for integrating CVA6 into an SoC design
 - CVA6 CHERI modifications verified; compliance with Zcheri standard
 - Performance analysis for subsequent optimisation during Stage-2
 - Engaging with stakeholders to identify useful Secure Enclave requirements
 - FPGA target for running the design
- Stage-2
 - Customisation of SoC and overall SoC verification ready for commercialisation
 - Performance optimisations for CVA6
 - Work towards multiple possible tape-outs from the technical and commercial side
- All outputs as open source deliverables

CHERI Mocha

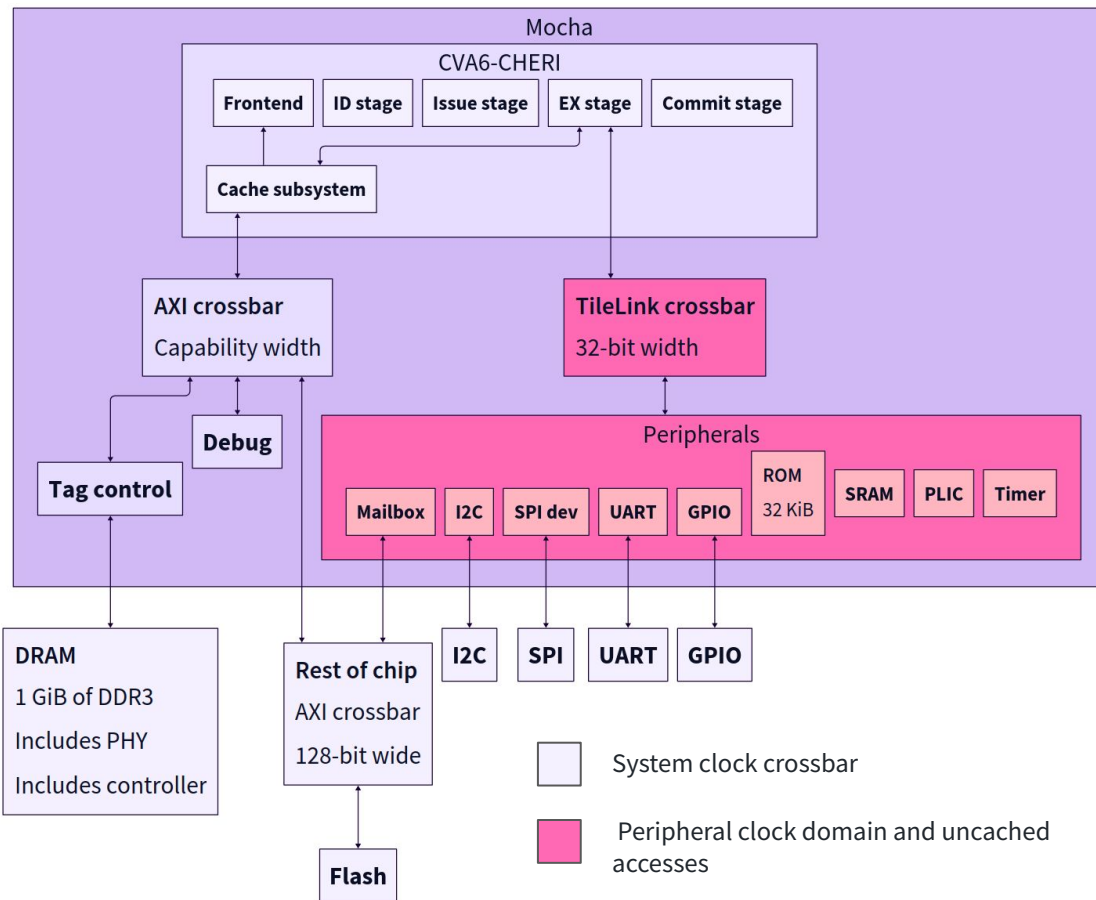
Early days of the architectural design (Subject to change)

Reference SoC open source
(GitHub / Apache 2.0 style)

Improvements to CVA6-CHERI
Core + Software

SoC reference design

Investigate Formal



Exploitation

Tech company exploitation

- Exploring tape-outs based on the CHERI-MOCHA design
- Have a large tech company reviewing this currently

Commercial / Technical exploitation

- BOSCH / Thales / CEA are public about their use of CVA6
- They will be approached to see if they are interested
 - Availability of Zcheri in the RISC-V International Standard is likely to be critical; likely to be completed before end Q2 2026
- Others expected to be involved / interested

THALES



BOSCH

Summary

- Production-grade, highly verified 64b CHERI-RISC-V application-class core
 - Complete distribution available by the end of the project
 - Complete System-on-FPGA building on OpenTitan root-of-trust
 - Documentation and continuous integration
 - Complete RTL design, associated DV, application-class OS and toolchain
- Open source design
 - Usable by anyone without permission or fees to build chips
 - Permissive open source licenses
 - Potential test chip(s) depending on additional collaborations
- Strong team - Track record of delivering on similar projects
 - The CapLtd hardware team developed the original CHERI technology, collaborated with Arm to create Morello, and has developed the CVA6-CHERI prototype
 - lowRISC have collaborated with Google and delivered OpenTitan to market
 - OUI and Tom Melham performed the formal verification of the CHERI_{IoT}-Ibex core with lowRISC

Call for Action

- Open source project - interested if others would be willing to contribute
- Do you know of features or things that you would like in a secure enclave design?
- Do you know of groups / organisations that would be willing to fund a tape-out based on COSMIC?
- Do you have a software stack that you would like to run on COSMIC?
- If interested, please join the COSMIC Technical Interest Group
 - <https://tinyurl.com/cosmic-tig> We will hold monthly Telcos for those interested in learning more