



lowRISC CIC is a not-for-profit company with an independent, full stack engineering team based in Cambridge, UK. We bring together some of the world's largest companies and the broader open source community to address some of the hardest problems in silicon.

Spun out from the Cambridge University Computer Lab (CUCL) five years ago, lowRISC is committed to bringing the benefits of the open source software movement - with its proven distributed collaboration practices - to the hardware world.

lowRISC was originally co-founded by:

- Dr Rob Mullins, co-founder of the Raspberry Pi Foundation, and Senior Lecturer in Computer Architecture at CUCL, with a research focus on machine learning accelerators;
- Dr Gavin Ferris (CEO), CUCL alum, co-founder of RadioScape, former software lead at DreamWorks SKG and CIO of Aspect Capital (a multi-billion \$ computational hedge fund);
- Alex Bradbury (CTO), CUCL alum, former Linux lead developer for Raspberry Pi, current backend code owner for RISC-V on the LLVM compiler project.

Prof Andy Hopper CBE FRS FREng (Research Director of Acorn at the time the ARM processor was created) has recently joined as our chair.

The future of collaborative silicon development

Non-profit, collaborative engineering orgs like **lowRISC** are ideally placed to act as the prime for future state funded development projects, as they can:

- bring the necessary focus on quality, execution and commercial relevance often missing in the academic domain;
- act as trusted broker between commercial entities, academia and the broader open-source ecosystem; yet
- do not suffer from the conflict of interest issues that for-profit primes often face.

Furthermore, IP created through this kind of cross-domain approach - when made publicly available through permissive, open source licensing - can trigger a cascade of positive economic outcomes (leverage by for-profit startups, input for new academic research, locus of training / knowledge transfer etc.), which can straightforwardly be directed to specific geographic regions, where desired.



Although relatively new, the paradigm already has demonstrable, real-world proof points, e.g.:

- the Raspberry Pi Foundation - of which lowRISC's Dr. Rob Mullins was a co-founder - has been a runaway success (over 30m units shipped to date); and
- lowRISC CIC has successfully partnered with the tech giant Google, the academics at ETH Zurich, and other for-profit companies like Western Digital, to create OpenTitan - the world's first open-source silicon root of trust (<https://opentitan.org>).

For more details of our projects and methodology, please see overleaf.

Source Code: github.com/lowRISC

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With the end of Moore's Law, the growth in low-power, highly-connected devices, and many emergent machine learning applications, the demand for custom SoCs is increasing rapidly.

Open silicon significantly lowers the barriers to producing such high-quality SoC designs, making them cheaper, faster and easier to create. As with open source software, open silicon minimizes vendor lock-in and enables greater procurement agility, in addition to creating opportunities for new market entrants and fostering widespread grassroots innovation. Its open nature also provides inherent auditability: a distinct commercial advantage in an age of ever more advanced security threats. Shared technology investment permits a focus on product differentiation, with amortized costs and substantially reduced overall risk.



lowRISC uses collaborative, open source engineering to create high quality, secure and flexible IP, in both the hardware and software domains. We work closely with our major project partners, including Google, G+D Mobile Security, Western Digital and Nuvoton, as well as some of the world's premier academic institutions, such as the University of Cambridge Computer Lab and ETH Zürich.

Our output includes verified, open source silicon designs, and the tools to develop, test and maintain these. We are committed to upstreaming our work wherever possible, and establishing best practice models of governance for the projects we host.

Find out more at www.lowRISC.org



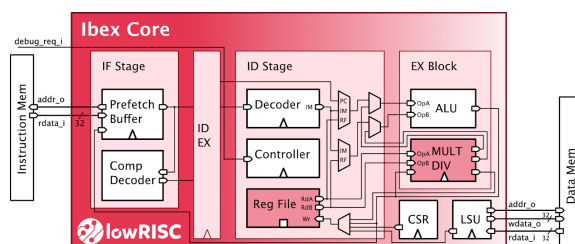
The world's first open source silicon root of trust project, **OpenTitan** is stewarded by lowRISC in partnership with Google, ETH Zürich, G+D Mobile Security, Nuvoton Technology and Western Digital. We are setting a new bar for transparency in trusted silicon, and lowRISC is proud to serve as both a trusted not-for-profit engineering contributor and home for OpenTitan.

The silicon root of trust increases trust in the integrity of the infrastructure on which software runs. Open sourcing the silicon design makes it more transparent, trustworthy, and ultimately, secure. Find out more: www.opentitan.org

Open source 64-bit SoC

Currently Rocket-based, we're also adding support for Ariane, a 64-bit core from ETH Zurich. We offer an FPGA-ready SoC distribution, with open source peripherals such as SD and Ethernet, together with documentation and tutorials. We use this as a testbed for new ideas (such as tagged memory and 'minion' I/O controllers), and aim to deliver a high quality, complete design which can be used as a basis for production SoCs.

Ibex is a fully open source small 32-bit RISC-V core. Evolved from ETH Zürich's *zero-riscy* core, independent development now continues under lowRISC stewardship. With its two-stage pipeline and support for the RV32IMC instruction set Ibex is ideally suited as a control core in many embedded scenarios. Ibex is a high-quality core: together with the RTL, we provide full UVM-based verification and extensive documentation for easy integration into designs.



LLVM compiler infrastructure

lowRISC leads the upstream RISC-V LLVM effort.

Providing a high quality software stack is a vital complement to our work on open source hardware, novel security mechanisms, and post-design flexibility.

