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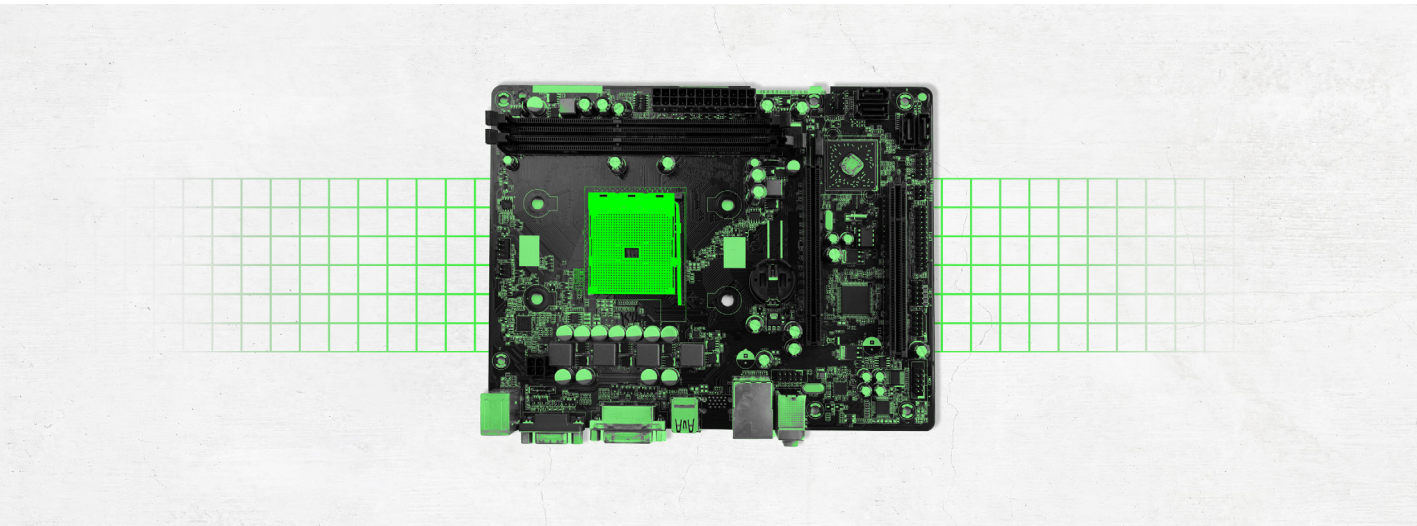

RISC-y business: Could open chip standard RISC-V gain traction against dominant incumbents?

The open-source chip architecture offers lower costs and greater access, but its future in the marketplace is anything but certain

Duncan Stewart, Eiji Kodama, Ariane Bucaille, and Gillian Crossan

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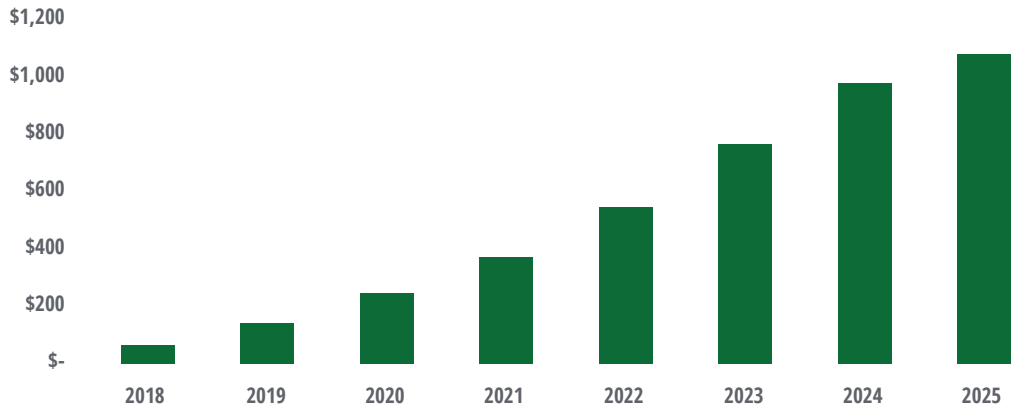
RISC-V (pronounced "risk five"), an open-source instruction set architecture for chip design, is creating ripples that may evolve into the wave of the future. Deloitte Global predicts that the market for RISC-V processing cores will double in 2022 from what it was in 2021—and that it will double again in 2023, as the served addressable market available for RISC-V processing cores continues to expand.[1] Revenue will grow more slowly, as might be expected from an open-source solution. Still, RISC-V revenue will likely reach close to US$800 million in 2023, up from less than US$400 million in 2021, and is expected to approach US$1 billion by 2024.[2]

FIGURE 1

RISC-V revenue is on track for exponential growth

Total RISC-V market revenue, 2018–2025 (US$ millions)



Source: Omdia, *RISC-V Processors Report*, 2019.

RISC-V is making headway—and facing headwinds

Traditionally, processing cores—the best known of which are the central processing units (CPUs) found in computers, data centers, and phones—have been closed and proprietary. Proprietary instruction set architectures (ISAs) from Intel and Arm have made up nearly all CPUs deployed globally in recent years. The open-source nature of RISC-V offers several advantages over proprietary ISAs. For one thing, it's free. This can save companies millions of dollars in license fees, which is especially important for earlier-stage companies. For a second thing, it's sanction-free: Being open-source, RISC-V is also not affected by export restrictions. This makes it appealing to companies, especially in China, that have been affected or fear being affected by those restrictions.

At a more technical level, RISC-V designs are easier to modify than traditional ISAs, allowing for greater flexibility. They are also compatible with a wide range of applications. Even though a few doubters continue to argue that RISC-V could face challenges across ecosystems, companies are tapping into RISC-V cores for all of artificial intelligence (AI) image sensors, security management, AI computing, and machine control systems for 5G. Other companies are planning on using it for different storage, graphics, and machine-learning applications. Even Intel's foundry services division is partnering with RISC-V player SiFive.[3]

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To be clear, the technology is still relatively new, and RISC-V is not yet suitable for all markets or customers. The technology has disadvantages as well as benefits: It is relatively new, has few high-profile design wins, lacks some of the features of Arm or x86 ISAs, and doesn't have the same level of support for designers. Additionally, fabricating a RISC-V chip at a foundry is not materially easier, faster, or different from making a traditional closed ISA-based chip: The manufacturing technology is

the same. Even by 2025, sales of chips from Intel (particularly its x86 chip) and Arm will likely be many times larger than the new kid on the block.

So, who cares about RISC-V? The answer differs depending on the stakeholder:

China cares. As a result of recent US sanctions, Chinese manufacturers have lost or fear losing access to x86 or Arm ISAs. Even if trade policies change, Chinese companies would remain aware that, at any future point, the "ISA rug" could get pulled out from under them. Going the RISC-V route could give them a way around that possibility, helping China meet its aggressive goals for reducing reliance on chip imports. The country has been trying to become more self-sufficient in making chips for years, although this has seen some challenges.[4] About a third of RISC-V organization members are from China, and multiple large Chinese companies have announced RISC-V chips already.

Startups care. In the three years between 2020 and 2022, venture capitalists (VCs) will invest about US$22 billion into startup chip companies of all kinds. To put this into perspective, that's more than the US$21 billion they invested in the entire 11 years between 2005 and 2016.[5] All that money means more chips being made—but startups usually must make them on a budget. A million-dollar license fee may not matter to one of the world's largest smartphone companies, but it does matter for a startup that has relatively little cash and a monthly burn rate. It's not surprising that, according to a 2020 study, more than 23% of new ASIC (application-specific integrated circuit) and FPGA (field-programmable gate array) chips from startups incorporated at least one RISC-V processor.[6]

AI cares. A number of new AI chip designs appear to be using RISC-V. Interestingly, expectations were that the technology would not be used in data centers in the near term, but some speculate that AI chips may allow RISC-V to break into the data center market earlier than expected.[7]

The automotive and IoT markets care. The served addressable market (SAM) for RISC-V in automotive was 4 million cores in 2020, forecast to rise to 150 million cores in 2022, and to 2.9 billion cores by 2025.[8] Supporting that potential, a leading RISC-V company and a leading automotive chipmaker announced a strategic partnership in 2021 targeting multiple auto applications with high-end solutions.[9] The chips in autos tend to be less powerful than personal computer or data center CPUs, so success in vehicles could augur well for RISC-V doing well in other Internet of Things markets.

PC chipmakers care less, at least for now. The PC market is unlikely to shift in a large way to RISC-V in the near term. Although there is a Chinese initiative to use the technology to build laptops that support various open-source browsers, the goal is to build 2,000 laptops by the end of 2022,[10] compared to a global annual market of roughly 300 million PCs in 2020. There is also a Russian initiative, but its goal of selling 60,000 systems by 2025 is similarly modest.[11] That said, the SAM opportunity for RISC-V in laptops is large—just under 300 million processing cores in 2022.[12]

Foundries care a bit. Although ISAs don't matter much to those who actually make the chips, it is possible that RISC-V, with its lower cost and greater flexibility, could lead to a Cambrian-style explosion in new chip designs. Hundreds or thousands of new chips may need to be manufactured by foundries, in low volumes at first, but any potential boom in new chip designs would be a tailwind for semiconductor manufacturers.

THE BOTTOM LINE

For now, large traditional chipmakers likely have little reason to worry that RISC-V will eat into their business. The cost of licensing an ISA from Arm may be rising,[13] but it is usually "only" a few million dollars at most. And though the cost of a license to Intel's x86 is unknown, largely because Intel has historically not licensed its chips except to AMD and Via, it is probably also in the single-digit millions as well.[14]

Millions of dollars may seem like a lot, but in the context of a new chip design for a popular smartphone or other application where chip volumes are measured in the millions, reducing the ISA license cost alone is unlikely to be a material consideration. Chipmaking entails multiple costs: design, verification, validation, software, manufacture, having to respin if the first design contains a mistake, and so on. All in, making a new chip of a relatively leading-edge design will likely cost more than US$500 million in 2022,[15] and a few million dollars out of that for licensing fees is just a drop in the bucket.

In the future, it will be interesting to see if RISC-V will take hold in an industry dominated by two large incumbents. It's worth remembering that there have been nearly 50 different ISAs over the years[16] … and Arm and Intel accounted for nearly 100% of the market in 2020. A few, such as MIPS, ARC, and Tensilica, still have niche roles, but the rest of Arm and Intel's competitors are just plain gone. Not because their chips were bad, or expensive, or didn't work; instead, there seems to be a technology industry imperative toward ISAs consolidation, as there is in other technology spaces. Two major players seem likely for the next decade; for those following RISC-V, the hope is that there's room for a third too.

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