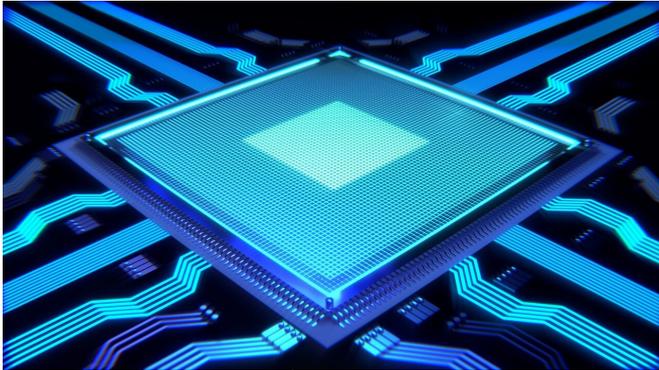


Intel and Softbank beware. Open source is coming to the chip business

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After revolutionizing software, the open-source movement is threatening to do same to the chip industry.

Big technology companies have begun dabbling with RISC-V, which replaces proprietary know-how in a key part of the chip design process with a free standard that anyone can use. While it's early days, this could create a new crop of processors that compete with Intel Corp. products and whittle away at the licensing business of Arm Holdings Plc.

In December, about 2,000 people packed into a Silicon Valley conference to learn about RISC-V, a new set of instructions that control how software communicates with semiconductors. In just a few years, RISC-V has grown from a college teaching tool into an open-source standard being explored by industry giants including Google, Samsung Electronics Co., Alibaba Group Holding Ltd., Qualcomm Inc. and Nvidia Corp.

"Most of the major companies are putting substantial efforts into RISC-V," said Krste Asanovic, a computer scientist at the University of

California, Berkeley, who was part of the team that developed the standard. He's co-founder of SiFive Inc., a startup that sells chip designs based on RISC-V (pronounced "risk five").

Open source harnesses the contributions of multitudes, not just the proprietary ideas of a few companies. New code is shared, so anyone can see it, improve it and build their own contributions on top of it. After being dismissed by giants like Microsoft Corp. in the 1990s, this expanding body of work has become the foundation of the internet, smartphones and many software applications. Last year, IBM bought open-source pioneer Red Hat in the biggest software deal in history. Even Microsoft got on board, acquiring GitHub, the largest repository of open-source code.

Opening up even small parts of the chipmaking process is anathema to many in the \$400 billion industry. But if enough companies commit to an open-source approach, that could create a shared pool of knowledge that may be hard for Intel and Arm to keep up with.

Early developments focus on instruction sets, which govern the basic functions of processors. Only two have mattered for years. One is Intel's X86, which dominates computer processors. Buying a chip from Intel or licensee Advanced Micro Devices Inc. is the only real way to use this instruction set. And Intel is the only [company](#) that can change it. The other instruction set is the basis of all major smartphone components. It is owned by Arm, a unit of Softbank Group Corp. This can be licensed for a fee, so other companies use it to design their own chips. But again, only Arm can alter the fundamentals. This has left the rest of the industry relying on the innovation of just two companies. That was not a problem for decades because most processors were general-purpose components that got faster and more efficient each year through production advances. Those industry axioms are unraveling, though. The steady march of chip

miniaturization has bumped up against the laws of physics, while artificial intelligence and a flood of data from the internet and smartphones require new ways of processing information. A fresh set of instructions will help create better chips to power driverless cars, speech recognition and other AI tasks, RISC-V's backers say.

Google is using RISC-V in its OpenTitan project, which is developing security chips for data center servers and storage devices. "There are a range of other computational tasks, such as machine learning, that could benefit from an open computing architecture," said Urs Holzle, who has overseen the technical infrastructure of Google's massive data centers for years.

Samsung said it will use SiFive designs in chips it's making for mobile phone components. RISC-V has appeared in microcontrollers – a basic form of a processor – that are part of more complex chips sold by Qualcomm and Nvidia. Western Digital Corp., one of the largest makers of data-storage devices, plans to use the technology in some products and has open-sourced its designs. Alibaba has announced a chip based on RISC-V and several universities have published open-source designs.

There are 200 Chinese members of the RISC-V Foundation, a non-profit group created in 2015 to promote the use of the instruction set. An Indian project developed six processors using the technology.

RISC-V specifications are developed, ratified and maintained by the foundation's technical committee, made up of engineers and other contributors from several member companies. Proposed revisions are posted on GitHub. RISC-V designs can either be free or licensed. While there's no strict requirement to stick to the official specifications, members have an incentive to make their designs compatible. This gives [chip](#) customers multiple options for the blueprints they need to design components that communicate properly with the software, according to backers of the project.

It's still very early days, though. In terms of actual chips created, sold and used, RISC-V is nowhere.

Arm's technology is in almost all the 1.4 billion smartphones made each year. More than 200 million PCs sold annually are based on Intel's X86 instruction set.

One criticism of RISC-V is that it won't end up saving money because there's more work involved in using open standards. This echoes complaints raised about Linux and other [open-source](#) software when they were gaining ground decades ago.

Arm said the idea that RISC-V reduces costs doesn't make sense. "Innovation goes far beyond an instruction set," said Tim Whitfield, a vice president of strategy at the company. "Arm's IP is highly configurable and provides our partners with the flexibility to innovate and differentiate where they can add real value while minimizing risk and cost."

Martin Fink, Western Digital's former chief technology officer who still advises the CEO, said it's about spurring innovation in a crucial field that's still locked down, rather than saving money. "It's free as in freedom not as in free beer," he added. "It's about community and collaboration."

Other RISC-V backers argue that the more-collaborative process will eventually reduce the cost of creating chips, especially for data center operators and other companies that are increasingly designing their own processors, according to David Patterson, a former Berkeley professor and a distinguished engineer at Google. "Companies all over the world are collaborating to develop because it saves them money," he said.

Pressure on the incumbents to step up their game might be the biggest immediate impact of RISC-V. Last year, Arm announced a try-before-you-buy plan with a much lower fee so smaller companies and academic institutions could do exploratory work using its instruction set.

Intel said it is adding new instructions that will help with AI processing and other new areas. "Intel engineers have continually advanced the X86 architecture standard, providing best-in-class performance," the company added in a statement.

Qualcomm, one of Arm's biggest customers, sees room for multiple approaches, including RISC-V, according to Keith Kressin, a senior vice president of product management at Qualcomm.

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