40 years of x86: 5 things you need to know

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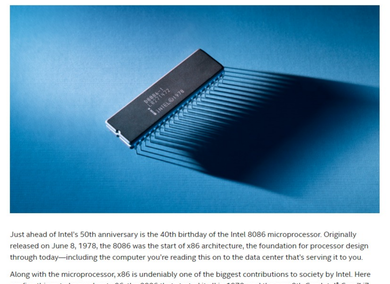
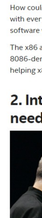


Just ahead of Intel's 50th anniversary is the 40th birthday of the Intel 8086 microprocessor. Originally released on June 8, 1978, the 8086 was the start of x86 architecture, the foundation for processor design through today—including the computer you're reading this on to the data center that's serving it to you.

Along with the microprocessor, x86 is undeniably one of the biggest contributions to society by Intel. Here are five things to know about x86, the 8086 that started it all in 1978, and the new 8th Gen Intel® Core™ i7-8086K that celebrates those original accomplishments.

1. What is x86?



An image of the Intel 8086 die.

The x86 architecture refers to a forward-compatible instruction set for software to run on hardware. The first processor to feature x86 was the Intel 8086.

"It is like the words of a language," explained Reynold D'Sa, VP in the Silicon Engineering Group and GM of the Devices Development Group at Intel. "It created a standard from which anyone in the world could use computing technology to do great things."

Intel Fellow Ronak Singhal agreed, and added, "It has become a universal language that allows software developed once to 'talk' (run) on many generations of hardware and to scale from PCs to data center servers with the same language."

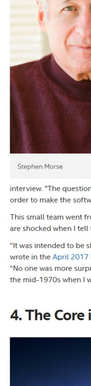
The universality and scaling of x86 has also been critical to many of today's most widely used technologies. "Think about the first servers Google ever built using off the shelf PC parts to what they buy now from us (Xeons), but the language between those points is the same," said Singhal. "But, just as language evolves over time, so has x86 to provide additional capabilities that reflect the key usages today that may not have existed two decades ago or more."

The term x86 comes from the subsequent generations of CPUs that would be backward-compatible with the instruction set, including the 80186, 80286, 80386, 80486, through all Intel CPUs today even without "86" in the name (Pentium, Celeron, Atom, Core, Xeon).

How could a technology developed 40 years ago still be cutting-edge? "The language got more powerful with every generation," D'Sa said. "Intel, with its creativity and innovation, improved x86 and hardware and software with every new generation."

The x86 architecture received a major endorsement from IBM when it released the iconic 5150 PC with an 8086-derived Intel 8088 CPU. The IBM 5150 would be the start of the consumer PC as we know it today, helping x86 to proliferate across the industry.

2. Intel set the x86 standard that even competitors needed to follow



The late Paul Otellini (right) with the late Steve Jobs on stage at MacWorld 2006 to talk about the Mac's switch to Intel processors.

Despite being invented at Intel, x86 design isn't limited to one company; competitors throughout the decades (including AMD with its chips today) licensed x86 from Intel. Having chips that are compatible with the "standard" set by Intel is essentially a requirement for any modern PC. Even Apple switched its Macs to x86 with Intel chips in 2006, after running IBM PowerPC chips since 1994.

So if x86-compatible chips can be purchased from other companies, then why do customers still tend to buy Intel? Singhal said plainly that there's far more to it than just x86: "Just relying on the legacy success of x86 is not enough. Instead, we must continue to be diligent about not just evolving x86 to meet our customer's needs but also provide implementations that are best in class for performance and power efficiency. That, more than anything, will determine which products will win."

Remarkably, x86's backward compatibility with the "standard" means assembly code written for the 8086 four decades ago could still run on any modern CPU—like the new Intel Core i7-8086K limited-edition processor officially revealed at Computex on Tuesday. (Read full coverage of the Computex keynote on Circuit News.)

x86's influence in computing wasn't just luck—Intel supported it during the late 1970s with the largest marketing campaign yet. Called "Operation Crush," over 1,000 employees would be involved, working on committees, seminars, technical articles, sales aids, and sales incentive programs. Having begun with the ambitious goal of landing 2,000 design wins for Intel, the campaign brought in around 2,500—leading the New York Times to characterize the marketing campaign as "legendary." (Read more about Operation Crush on the Intel Newsroom.)

3. The 8086 all started with an Intel software engineer

Stephen Morse

Intel CPUs today are designed with contributions of thousands of employees across multiple business units as well as with input from partners and customers. But the x86 revolution all started with a small team of engineers in 1976 developing the 8086, which was only originally designed as a stopgap solution ahead of the 8800 (released in 1981 as the ill-fated iAPX 432). Noted in the Intelpedia: "Intel's decision to proceed with the 8086/8088 instead of throwing all of its resources into the 432 proved crucial, as the 8086 successfully established a new 16-bit software architecture, and software compatibility became an extremely important strategy in developing the processors that would follow."

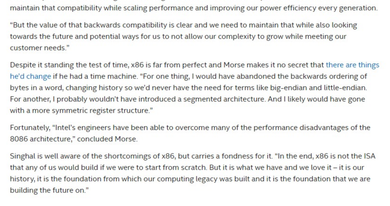
Interestingly, the designer of the 8086, Stephen Morse, was a software engineer—all previous CPU design at Intel was led by hardware engineers. Morse reportedly earned the trust of management after a critique of the 8800. Other key members of the 8086 team included Bill Pohlman, Jim McKevitt, and Bruce Ravenel. (Read the original IEEE paper from the 8086 team: "Intel Microprocessors: 8008-8086.")

"For the first time, we were going to look at processor features from a software perspective," Morse told PC World in a 2008 interview. "The question was not 'What features do we have space for?' but 'What features do we want in order to make the software more efficient?'"

This small team went from design in 1976 to shipment on June 8, 1978—about 18 months. "People today are shocked when I tell them the schedule," recalled McKevitt, one of the lead engineers.

"It was intended to be short-lived and not have any successors, but that's not how things turned out," Morse wrote in the April 2017 issue of Computer magazine. On the longevity of his underlying design, Morse wrote, "No one was more surprised by this turn of events than I was. I never could have predicted this outcome in the mid-1970s when I wrote the architectural specifications for the 8086."

4. The Core i7-8086K: a CPU 40 years in the making



To celebrate the 40th birthday of the 8086, Intel is releasing the Core i7-8086K, a commemorative desktop processor aimed at enthusiasts for performance gaming, advanced content creation, and productivity.

Based on the "Coffee Lake" architecture, the Core i7-8086K packs 6-core, 12-threads on Intel's refined 14nm++ process technology. It has a 4 GHz base frequency but will crank itself up to 5 GHz in single-core turbo. The Intel Core i7-8086K processor also comes fully unlocked for overclocking to even higher frequencies. In short, this is the best desktop gaming chip from Intel yet.

While Intel was already working on an anniversary product to commemorate this major milestone, David Schor, an engineer and analyst with Wikichip, pontificated a similar line of thinking in a tweet from January:

That tweet stirred up enough excitement to confirm that a new 8086 CPU would be the way to go.

Learn more about the new Intel Core i7-8086K from the News Byte on the Intel Newsroom.

5. Intel will continually improve x86

A 1978 photo shows an Intel 8086 in its package form.

There are few other technologies that are 40 years old yet continue to push the boundaries—the original design at the time along with all the innovation throughout the decades is a monumental achievement that Intel should be proud of. Even 36 years removed from Intel, Morse displays a humility that is characteristic of this company.

"I was only doing my job and did what any number of Intel engineers could have done. It wasn't until years later that I, and others, realized the significance of that work," Morse told Circuit News. "I was just lucky enough to be in the right place at the right time."

Morse had two stints at Intel; his first from 1975 to 1979 and the second from 1981 to 1982. In his time since, Morse developed genealogy tools and these days lectures both domestically and abroad.

As has been done in every new generation of CPU, Intel engineers will continue to advance x86—and it's no easy task, as evidenced by the ever growing R&D into increasing performance and efficiency.

"Backwards compatibility is hard," said Singhal. "It takes a lot of effort to ensure that software sees essentially no difference from generation to generation in the functionality of our CPUs. And we must maintain that compatibility while scaling performance and improving our power efficiency every generation.

"But the value of that backwards compatibility is clear and we need to maintain that while also looking towards the future and potential ways for us to not allow our complexity to grow while meeting our customer needs."

Despite it standing the test of time, x86 is far from perfect and Morse makes it no secret that there are things he'd change if he had a time machine. "For one thing, I would have abandoned the backwards ordering of bytes in a word, changing history so we'd never have the need for terms like big-endian and little-endian. For another, I probably wouldn't have introduced a segmented architecture. And I likely would have gone with a more symmetric register structure."

Fortunately, "Intel's engineers have been able to overcome many of the performance disadvantages of the 8086 architecture," concluded Morse.

Singhal is well aware of the shortcomings of x86, but carries a fondness for it. "In the end, x86 is not the ISA that any of us would build if we were to start from scratch. But it is what we have and we love it – it is our history, it is the foundation from which our computing legacy was built and it is the foundation that we are building the future on."