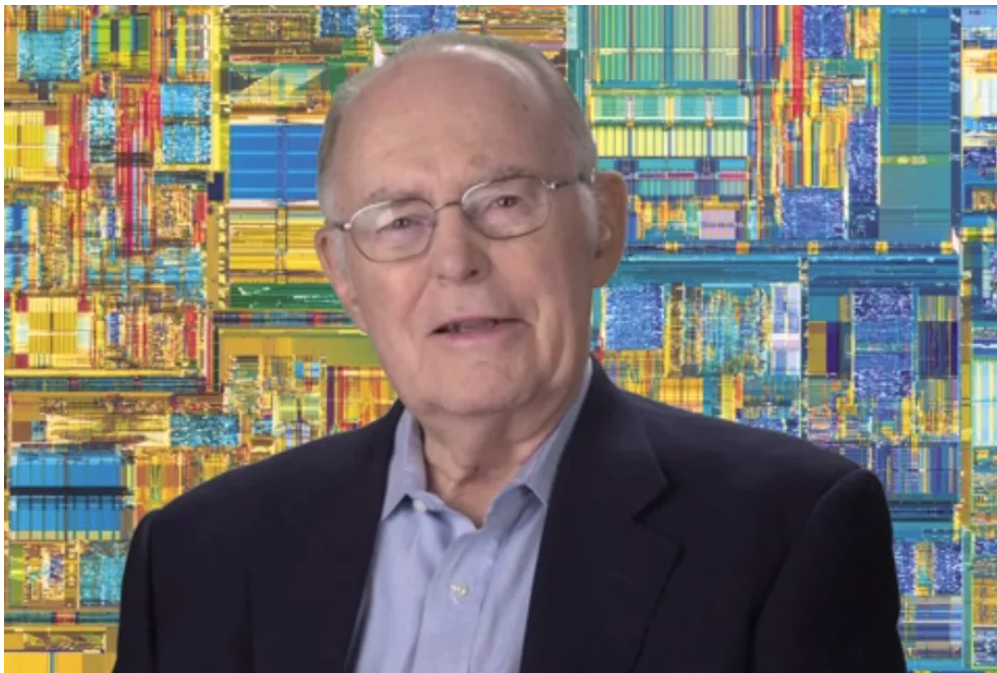


Global Chip Industry Readies for a Future Beyond Moore's Law

After 50 years, a fundamental assumption about the march of progress in computing is evolving into something new.

By **Arik Hesseldahl** | Feb 15, 2016, 1:50pm EST



Screenshot from the Chemical Heritage Foundation

It hasn't even been a year since the world's technology elite paused to observe the 50th anniversary of Moore's Law, and the long knives are already out in force to deny it a 51st.

Next month the global semiconductor industry will release its latest biennial assessment of the technological road ahead for making computer chips. As reported by the journal Nature, for the first time, the look ahead will be crafted without the key assumption of the "law," central in all previous reports: That chipmaking technology

pace.

The new forecast, called the International Roadmap for Devices and Systems, is an evolution of what has since 1998 been called the International Technology Roadmap for Semiconductors. For the first time, its outlook will be based less on the view that applications will inevitably follow improvements in raw computing speed and power, but instead that chip advances will be developed with applications in mind: Smartphones, wearable devices and machines running in data centers and so on. Moore's Law will no longer be considered central to the roadmap.

Moore's Law isn't really a law of science, but rather an informal observation made about the apparent progress of what was in 1965 a very young chip industry. That year Gordon Moore — who later co-founded Intel — wrote up his thoughts in a paper for the April 1965 edition of Electronics Magazine. He proved remarkably prescient, suggesting that by 1975 a single chip could contain a then-unimaginable 75,000 transistors. The transistor counts of today's mainstream chips number in the billions.

Practically every form of computing and electronics has derived a direct benefit from the unremitting efforts of semiconductor engineers who have repeatedly scaled seemingly impassable barriers in the electrical and materials sciences. The advances have had a monumental long-term effect on society's ability to process information and to make it faster and easier to access: Every new generation of chip is smaller than and at least as powerful a computing engine as the one that came before it, but less expensive to make.

Until now, practically every time doubting wags, including myself, have argued that the time had come for Moore and his law to ride off into the sunset, the engineers in bunny suits have figured out new ways to maintain control of the electrons flowing on a chip.

This time is different. As I argued in an essay for Re/code last year, the chip industry is running up against some truly fundamental limits that are causing a lot of people who know a lot more about this than I do to conclude that the time has come to reconsider how we think about improvements in computing.

It comes down to this: You can only shrink a chip so much before the physics fails.

this sentence, were it printed on paper, would be about one million nanometers. At 14 nanometers, the individual parts that make up that chip are smaller than a typical virus particle and similar in size to the outer cell wall of an individual germ. It has gotten so expensive and complicated to manufacture at this scale that only four companies are considered to be on today's leading edge, down from 18 a decade ago: Intel, Samsung, Taiwan Semiconductor Manufacturing Corp. and GlobalFoundries.

The next logical steps in the semiconductor roadmap take us to 10 nanometers, which, depending on whom you ask, may appear in commercial chips this year. Beyond that lies seven nanometers — due about 2018 or 2019. Intel can see ahead about that far. TSMC says it will reach seven nanometers sometime next year and is now working to get to five.

Generally speaking it's at the five-nanometer juncture — due maybe in 2021, give or take — that the outlook has tended to get incomprehensibly fuzzy. At that size, elements on the chip would be about twice the size of a strand of DNA.

Smaller than that, the design features on a chip become no bigger than 10 individual atoms. At that scale, electrons start to behave unreliably: The laws of classical physics give way to the infamously uncertain rules of the quantum scale. Remember Heisenberg (and I don't mean the one from "Breaking Bad")? This is his territory. You might be able to make chips at that size, but there's no guarantee they'd work.

So what's it all mean? Potentially a much more complex view of the progress of chip technology as we head into the future. As Daniel Reed, a computer scientist at the University of Iowa who was quoted in the Nature essay, says, today's Boeing 787 doesn't fly much faster than a Boeing 707 did in the 1970s, but a lot of other innovation has come in aircraft since then, including improved fuel efficiency, lighter airframes and electronic navigation systems.

The road ahead will diverge from one into many with different destinations and different milestones along the way. Some indeed may lead nowhere, but others will lead into unexpected territory that we haven't foreseen. I don't know about you, but to me that seems kind of cool.

This article originally appeared on Recode.net.



Millions turn to Vox to understand what's happening in the news. Our mission has never been more vital than it is in this moment: to empower through understanding. Financial contributions from our readers are a critical part of supporting our resource-intensive work and help us keep our journalism free for all. Please consider making a contribution to Vox today to help us keep our work free for all.

Sign up for The Weeds

Get our essential policy newsletter delivered Fridays.

Email (required)

SUBSCRIBE

By signing up, you agree to our Privacy Notice and European users agree to the data transfer policy. For more newsletters, check out our newsletters page.