PALO ALTO, Calif. — Moore's Law -- the ability to pack twice as many transistors on the same sliver of silicon every two years -- will come to an end as soon as 2020 at the 7nm node, said a keynoter at the Hot Chips conference here.

While many have predicted the end of Moore's Law, few have done it so passionately or convincingly. The predictions are increasing as lithography advances stall and process technology approaches atomic limits.

"For planning horizons, I pick 2020 as the earliest date we could call it dead," said Robert Colwell, who seeks follow-on technologies as director of the microsystems group at the Defense Advanced Research Projects Agency. "You could talk me into 2022, but whether it will come at 7 or 5nm, it's a big deal," said the engineer who once managed a Pentium-class processor design at Intel.

Moore's Law was a rare exponential growth factor that over 30 years brought speed boosts from 1 MHz to 5 GHz, a 3,500-fold increase. By contrast, the best advances in clever architectures delivered about 50x increases over the same period, he said.

Exponentials always come to an end by the very nature of their unsustainably heady growth. Unfortunately, such rides are rare, Colwell said.

"I don't expect to see another 3,500x increase in electronics -- maybe 50x in the next 30 years," he said. Unfortunately, "I don't think the world's going to give us a lot of extra money for 10 percent [annual] benefit increases," he told an audience of processor designers.

Colwell poured cold water on blind faith that engineers will find another exponential growth curve to replace Moore's Law. "We will make a bunch of incremental tweaks, but you can't fix the loss of an exponential," he said.

DARPA tracks a list of as many as 30 possible alternatives to the CMOS technology that has been the workhorse of Moore's Law. "My personal take is there are two or three promising ones and they are not very promising," he said.

DARPA's microsystems group has "a fair amount of money chasing" two programs. One is exploring approximate computing in a program called Upside; another is exploring the effects of spin-torque oscillators to settle on partial solutions at relatively low power.

Colwell ticked off a list of other routes to improving chips post-CMOS, including 3D stacking, new architectures and apps, new switching technologies, better human interfaces, and just
plain creative marketing. "You laugh, but you will see this," he said, citing Intel's dolls of fab workers.

Colwell called out a few specifics, such as work building devices at the level of a hundred to a thousand atoms. In addition, "there's a lot of work in brain-machine interfacing -- people who figure out better interfaces will win," he said.

As the end approaches, "when Moore's Law stops it will be economics that stops it, not physics, so keep your eye on the money," he said.

That said, new opportunities will emerge to nudge chips forward, so engineers need to "keep designing our heads off," but at the same time plan for the future because it's not that far off," he said.

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