Technology Flash...

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Moore's Law is Dead – Or is it?

Over the past several years there has been continuous speculation that Moore's Law is dead. It is true that eventually the physical downsizing of transistors will come to an end as quantum physics will ultimately get in the way. The arrival of large-scale quantum computing elements will allow us to get beyond this barrier and provide a totally new way to advance computing, but that is likely at least 5-10 years away. So does the eventual end of Moore's Law as we know it mean that we should worry about no longer seeing all the gains in processing power and cost reduction the market has grown accustomed to? Is Moore's Law really dead?

Is Moore's Law really only about process nodes and transistor counts?
Moore's Law was never really about just transistor counts and nanometers. It was about what the benefits of new processes and new designs meant for PCs, data centers, cloud services, embedded products, mobile devices, etc. Going forward, the real challenge is, can chip vendors like Intel (and ultimately the rest of the industry) maintain the kinds of performance, cost and technology improvements we have all come to expect over the past 60+ years?

That's not to say that Moore's Law is dead yet. We still have at least the 10 and 7 nm process nodes to go through, and probably more beyond that. It may take somewhat longer to get to each new step than originally predicted by Moore's Law, but as the design and process has gotten more complex, the time has also stretched out. That is to be expected, and not really a breakdown of Moore's Law. More complex systems just take longer to develop.

It's time to acknowledge that many of the newest/latest tech improvements powering "things" are not a direct result of pushing the leading edge of Moore's Law, and consequently will continue to make advances accordingly. In fact a very large number of chips deployed today aren't even close to pushing the edge of Moore's Law as we currently know it. Many utilize older 20nm, 24nm, and even 40nm process technology. They don't need to be leading edge to be successful at their tasks. Indeed, "consumer meaningful" measurements, like expecting the battery life to continue to improve per generation, new memory tech to improve performance and reduce power, a continued march in improved graphics to a future of AR/VR, moving to the forefront of the communications revolution with 5G and beyond, etc., are not always process node dependent.

Redefining "next generation"
We expect the benefits of Moore's Law to continue for many years, even as we change the fundamental understanding of the current Moore's Law parameters. But the greatest change will come from "reuse and recycle" of existing sub-components that have proven capability, but do not need to be implemented in the newest processes. This not only saves scarce design resources, but can substantially speed time to production as only those components that can take maximum advantage of new processes are redesigned. It also means that proven subsystems will create

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fewer defects in manufacturing, ultimately improving yields and lowering defects. And it gives chip makers the ability to get an increased return and/or higher margins than they could get by going the fully monolithic approach

Based on this premise, there are a number of things chip makers need to do to keep the promise of Moore's Law moving forward.

- First is the realization that not everything needs to be built into a monolithic chip. Very high performance chips (e.g., data center processors) may need all parts of the chip to be maximized. But for most designs a more component-based approach moves beyond the process node restrictions to be more equalized across all of the subsystems in the chip, not all of which need or can take advantage of the most recent process node. This provides Intel and other chip makers with the ability to reuse existing components/IP that work well now and could work equally well as the next node is reached. It means concentrating on updating only those high performance subsystems that can most benefit without having to expend scarce resources on redesigning all the parts of new chips.
- The key to making this work is implementation of very high speed interconnects on silicon to enable subsystem interactions to closely approach the speeds of monolithic chips. Such technologies already exist, and can be used to great advantage in connecting all the building blocks for new designs.
- This gets vendors like Intel beyond the "latest node at any cost" option required to stay ahead of the competition. Only those parts of the chip that benefit most by scaling will be upgraded while those parts of the solution that don't need to be can be carried forward "as-is". This allows much greater utilization of design and process resources. Keeping older processes in production longer can drastically reduce overhead costs for silicon vendors.
- With the increase in heterogeneity necessary for specialized function, like AI/ML, AR/VR, video, etc., it's increasingly important to utilize "best of breed" capability. Traditionally vendors like Intel used only Intel IP, but now can incorporate components that are not necessarily their own for specialized circuits or lower volume devices. This provides much more flexibility to build SoCs that couldn't be built due to volume constraints and design restrictions.
- Increasingly this requires a chip design and process design interdependency. Semiconductor companies' expertise in all aspects of architecture and design/process means they can "fine tune" to meet different processor needs, from high end multiprocessing and graphics, down to embedded IoT and communications/5G. Overall benefits are not a result only of Moore's Law's original assumptions, but also of the improvements in overall chip design. Companies like Intel that has its own fabs have an advantage.

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Ultimately this is not about outdoing the competition in the most advanced process technologies with the most transistors. Rather, it's about creating truly beneficial architectures and designs that combine process, technology, and functional design elements to maximize consumer benefits for newer generations of processors.

Bottom Line: We expect Intel to make significant efforts to implement some of these new approaches in the coming 1-2 years, with others to follow. This is not an abandonment of the Moore's Law node scaling. It will actually accelerate the ability to move to new design nodes faster since there will be less of the chip to redesign, and also makes it more likely that no significant problems will arise since the older IP is already proven. But this is only possible through on-chip interconnect that gives performance almost equivalent to a monolithic integrated chip. For Intel, this gives it maximum flexibility to serve new markets, and is not a response to failing Moore's Law or pressure from competing fabs that claim they have caught up in process.

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