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THE FEDERAL CATALYST

What Comes After Moore's Law? (episode 5)

Podcast Transcript

Announcer: Welcome to the Federal Catalyst with Accenture Federal Services, the podcast series addressing critical management and technology issues impacting federal leaders. Each episode goes behind the scenes with our experts and others to discuss the latest research, innovations and breakthroughs shaping how federal agencies achieve their mission.

Chris Copeland: Welcome to the Federal Catalyst with Accenture Federal services. I am Chris Copeland, chief technology officer for AFS. In this role, I lead our Accenture federal Technology vision research with our Chief Innovation Officer, Kyle Michael. This is our annual look at how the biggest trends in technology are likely to impact the federal government over the next three years. With the Federal Catalyst Podcast, we've been going behind the scenes with the authors of each trend to further discuss their implications for federal leaders. We conclude our series today with a program on Trend 4, computing the impossible. So, here's the setup for today's program. Moore's law is confronting the laws of physics. The incredible technological advances that we have experienced over the past 50 years might finally begin to level off. However, human progress demands that we continue to grow technologies, capability, and capacity. This raises the question of what's poised to replace the conventional, or binary computing that has defined most of our lives. And for this discussion, I'm joined by two of the report's co-authors. Garland Garris is our quantum security lead and a former FBI technology executive. Mary Lou Hall is our chief data scientist for the defense sector and a former executive and commissioned officer with the US Army. Welcome, Mary Lou. Welcome Garland.

Mary Lou Hall: Thanks, Chris. It's great to be here.

Garland Garis: Thank you, Chris.

Chris Copeland: So, let's start with a baseline. How much has technology progressed during your professional careers?

Garland Garis: So, my earliest exposure to technology when my career began was working with the NCR 9800 mainframe that had 256 megabytes of RAM, 3 gigabytes of storage, and cost about $5 million. This system was connected to dumb terminals which connected with coax cables. Inevitably, these were replaced with PCs, and the thought at the time was people needing or wanting PCs because it was just a foreign concept. This was replaced with Novell IPX SPX-connected workstations and then inevitably TCP came along, and Novell went away. Unix came along, then the Internet became accessible to everyone, and then inevitably, Microsoft, release of Windows 31, Windows 95, Windows 2000 and fast-forward to where we are today.

Mary Lou Hall: So, let me give you a quick example of how much computing power has progressed during my career as an operations research analyst. I coded my first large scale optimization problem at Naval Postgraduate School more than 20 years ago. As a young captain, I was trying to optimally Schedule Army training to align it with seasonal demand, so this scheduling problem was 50,000 variables designed to make best use of training resources. So, not a problem that you could solve by hand or with excel. I solved it on a computer that had a Pentium 3 processor, 200 megabytes of RAM, and leveraged an algorithm called SEAPLEX. It took about nine and a half hours to solve this problem each time. A Pentium 3 processor at that time had nine and a half million transistors. Today's state-of-the-art microprocessors have up to 80 billion transistors. That's 8,421 times the number of transistors, and my laptop that I'm using today has 16 gigabyte of RAM. And the simplex solver, that's the algorithm that was used to solve this, had breakthroughs at the time that even if I had tried to solve this problem one year earlier, it would have taken more than 25 days to solve. And I can assure you that as a graduate student, I would have given up quickly. But here my story taught us a couple of important lessons. Solving these really complex problems requires 3 different things. It requires speed. Speed of compute. It requires memory, and it requires advancements in algorithms. And the quantum supremacy is all about all three of those: better memory, better compute, and better algorithms.

Chris Copeland: So, it's always fun to take that trip down memory lane. I'm sure we could sit here and swap stories on that all day. But let's talk about Moore's law. There's been a lot made out about the demise of Moore's Law, which has really governed a lot of this computing progress over the years. Garland, what's going on with Moore's Law today?

Garland Garis: So, looking back, in 1965 Gordon Moore stated the number of components on processors would double every year. He revised that in 1975 to be every two years and also identified an issue point where advances due to side production would be less effective. So, microprocessors themselves basically have transistors that make up logic gates, and the gates have two poles separated by a space. When those poles become so close, charges can jump from one to the other. And that was the point he was identifying. So, for all intents and purposes, Moore's law no longer applies. And there are other approaches engineering-wise that are being used to increase speed in processors.

Chris Copeland: That was great Garland. Mary Lou, why do we need better computers?

Mary Lou Hall: When I think about increasing computer speed, I ask myself why? Who cares? Well, we care because there are really hard problems that need to be solved. Some problems can be solved fairly easily. They're called polynomial time problems. These are problems that have discrete solutions, but other problems like my scheduling problem and also cryptography problems are NP hard problems. This means nondeterministic polynomial time problem. They're hard to solve, but they're relatively easy to check the solution. So, encryption algorithms are hard to solve, but we use the process of checking that solution every time we use a key to allow secure communications to pass through. It's possible that quantum computers will make it possible to solve what we currently think of as NP hard problems faster.

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Chris Copeland: And that's what trend for computing the impossible is really all about. We're looking at several emerging computing models, not viewing them as replacements for conventional binary computing that we all use everyday, but rather complements that may outperform it in very specific use cases. Quantum is a big focus in this area, and in brief, how does quantum differ from conventional computing?

Garland Garis: Unlike classical computing, which stores information in bits, essentially zeros and ones, column computing makes use of qubits, which can store 0 or one or both at the same time. Instead of needing 10 to the 12th power bits to store a TB of data, you only need 40 qubits. That's one point. So, another is conventional computing is linear. One action or process flows on another. Quantum computing, on the other hand, can perform many computations simultaneously, which has obvious benefits to AI and machine learning.

Chris Copeland: So, there's a perception out there that this is science fiction, this is theoretical. This is something that we won't really see or consume or use as a practical computing model in the near term. Is that true? Is quantum computing real, and will it become mainstream?

Garland Garis: It is. It's been quite an evolution. So, since the 90s the brightest scientific minds agreed that it would be impossible for all intents to create a quantum computer. Ten years later it was agreed that it would be possible but incredibly difficult, and today anyone can actually access a quantum computer with their browser through a cloud service provider. Google D, wave, Intel, IBM, others expose these that you can actually access from that browser and quantum computers are good at solving specific types of problem. Currently they're focused or used primarily for optimization problems, and I think it was three years ago Google achieved quantum supremacy with a 53-qubit system. So, what quantum supremacy is? This is using a quantum computer to crack a problem faster than the largest supercomputer can, and in that example it was able to solve a problem in 200 seconds that would have taken 2.6 days for the world's largest supercomputer to solve. So, that being said, it's going to be a while before your average person will be using a quantum computer thinking back to mainframe days, which for me doesn't seem that long ago, but back then, it wasn't envisioned that a person would need or want a personal computer, and 16 megabytes of RAM seemed excessive. Probably 20 or 30 years. There might be practical applications for your everyday person. But even then, quantum computers are good at solving specific types of problems that return one result. They're not good at solving problems that return multiple results, such as sorting problems.

Chris Copeland: So, it's fair to say that our traditional binary computers are going to be around for a while and be complemented by quantum computing for very specific, very targeted, perhaps very complex use cases in the future. So, Marylou, for me, it's challenging to talk about any new technology imperative or movement without thinking about the human side of it. Quantum computing seems to be a paradigm shift in skills and a whole different mindset of how to actually accomplish these mission goals with technology. How can federal leaders build competency around quantum computing? How do they foster and build that demand?

Mary Lou Hall: Well, you know, whether it's emerging technologies today or quantum computing tomorrow, it all comes back not to the technology, but rather to the unique challenges facing each organization's own mission space. So, the first thing federal leaders need to do is evaluate how these technologies will shape operations within their own enterprise. What insurmountable problem is simply considered the cost of doing business today? How would it reshape your agency if you could solve it? And then we need to help find ways to experiment with next generation computing capabilities that are accessible through as a service offerings and design use cases to show how these new capabilities work for the organization and for its workforce.

Chris Copeland: So, pivoting back a bit with quantum computing, there's an often discussed, you know, risk around its ability to defeat or hack current encryption models. Garland, you've been very focused on this topic. How worried should federal agencies be and what steps can they take to protect their digital assets in there?

Garland Garis: Unfortunately, there's a perception now that this is not a now problem, and that's wrong for a few reasons. First, agencies have spent a decade adopting Hpde 12. There are 20 plus billion devices that have to be moved to quantum save algorithms, which is going to take a bit of time, obviously. Crystal Kyber, which NIST approved for general cryptography, can't be implemented in a forklift fashion. The cryptographic algorithms which we have used for the last four decades work quite well. They're very fast and algorithms have been developed to replace them. The key sizes are significantly larger, and you can end up with issues such as timeout for TLS connections, SSH and so on. So, it's going to take a while to integrate this within agencies' existing cryptosystems and that's one of the reasons that we are promoting a crypto agility approach to doing so. Another point is that given that NIST has approved Khyber for general cryptography, data can be future proofed now by using this crypto agility approach. As far as how worried we should be, I would say very. And the reason is because the amount of invest that is going into quantum information science globally has increased drastically. Last year, $24 billion in research investment was put into quantum information science, with the US government accounting for about 1 billion of that, China accounting for about 10 billion of that. There's a race that's going on between nation states scrambling to get an edge before their competitors do. Another salient point is that unlike Y2K, when you knew when the thing you were fighting against was going to occur, estimates vary for when Y2Q or when quantum computers will be able to crack modern cryptography will actually happen, but what is consistently happening is those estimates are moving to the left because of investment and because of innovations that are occurring. And another factor to consider is technology is pervasive throughout our life. We use it in when we log into our computer at work, when we log into our bank, when we check our credit card statements. It's used to provision our utilities, water, electric and so on. So, it affects every aspect of our lives and everything we do. When we get to that point that quantum computers actually poses a threat today to cryptography. When you think of 10 to 20 years out, that's not really that long.

Mary Lou Hall: Garland, I couldn't agree more. The ability of quantum to one day decode today's cryptographic algorithms, that fateful day we call CUDA, poses a national security risk. It's a high stakes arms race and we need to pay attention, as you mentioned to near peer competitor investments in quantum, the President recently signed the National Security Memorandum 10 promoting United States leadership in quantum computing while mitigating risks to vulnerable cryptographic systems. This is a call to migrate vulnerable cryptographic systems to quantum-resistant cryptography over the next several years.

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Chris Copeland: So, I think we've established that quantum is not science fiction, that it's here today, it's a now problem, Garland, as you mentioned, but that there's action that can be taken today. Let's switch gears a bit and look at the broader problem set that these technologies may address. Even with these advances, we still risk being overwhelmed by the data that we produce daily. IDC predicts data creation and replication growth is exceeding the installed storage capacity. That's a huge challenge for federal agencies, given their security and compliance requirements. How can federal leaders get ahead of this data tsunami?

Mary Lou Hall: It really comes down to a disciplined approach to data LED transformation, and we're starting to see this both in industry and in go Vermant, but we need to take a really rigorous and disciplined approach to it. It starts with defining a data strategy. We need to define data-driven strategies and map future initiatives to quantifiable business outcomes powered by proven methodologies. Data management is so important, leveraging modern methods for data governance, architecture, and compliance to structure data assets and provide effective ongoing management in modern ways. I can't emphasize that enough. And finally, the data is of no use if you can't disk over it, we need to help federal agencies and industry gain strategic and operational control with dashboards, with predictive analytics, and through simulation and modeling capabilities.

Garland Garis: Hey, Chris, just adding on to that, there's been more changes in US cyber policy in the past year than in history. So, with 14028 and 2209 and other memos that have come out since, they move agencies to adopt zero trust and cloud-first approaches. However, they also increase the amount of data agencies must retain and replicate. M 2131 by itself will result in a marked increase in log retention. A couple of points regarding that. So, logs are useless if they're not surfaced for security purposes, one, and, second, there's a potential for agencies focusing on compliance rather than security.

Chris Copeland: Those are excellent points by both of you. And even with all this data, we still are looking for more and more insights. I know this is your focus, Marylou. What steps can agency leaders take today to not just generate more insights, but actually maximize the data inputs to generating those mission LED insights?

Mary Lou Hall: Yes, Chris, it's so true. Data analytics, artificial intelligence and machine learning represent perhaps the biggest untapped value opportunities in government and industry today. You can't run a business or a government organization if you don't understand how it's working or where it's going. So, of course it's nothing new to track business operations and use that data to gain insights. But one thing is clear. The power of artificial intelligence and machine learning are the biggest untapped value opportunities for business and government. Today, the combination of vast data resources, more computing power than ever before, and emerging capabilities for analytics, data mining, machine learning and artificial intelligence make it real, make the opportunity to take real advantage of the opportunities to drive business value and mission outcomes. Organizations need to enable three things to capitalize on this. The first one is ensuring that organizational data is well managed, governed, accessible, standardized, and can be trusted. Number 2 is powering insight generation in a graduated way. Start with operational reporting. Move up the ladder of complexity and computational demand to advanced analytics, machine learning and artificial intelligence. This will enable tangible and realizable business value and mission outcome. And Number 3 is all about people.

Organizations have to enable and empower innovation within their workforce, enable people with processes so they may rapidly innovate and foster a culture where data and analytic-driven decision making is not just a trusted norm, but essential for growth. These three components, data management, powering insight generation and fostering a culture of data and analytic decision making, are leadership imperatives for generating more insight.

Chris Copeland: And I think on that where we're at here, Mary Lou Garland, I thank you both. That was great conversation and insight.

Garland Garis: Thank you, Chris. It's great to be here.

Mary Lou Hall: Thank you.

Chris Copeland: And thank you for joining us today. I encourage you to explore our Accenture Federal Technology Vision. You can find it online at www.accenturefederal.com and connect with me, Chris Copeland on LinkedIn to let me know what you found most insightful. Thank you for listening.

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