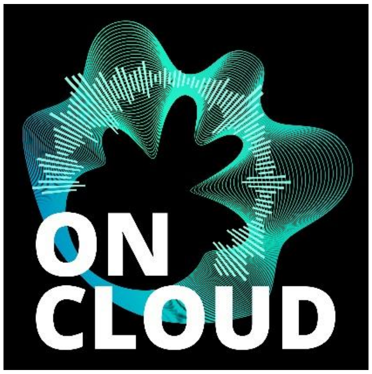

The Deloitte On Cloud Podcast

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Title: **Deloitte's Scott Buchholz takes a deep dive into quantum computing**

Description: In this episode, Deloitte Managing Director Scott Buchholz dives into quantum computing. He explains how it works and how it differs from traditional computing. He also touches on risks and provides sample use cases. However, he cautions that quantum computing capabilities are still experimental and not yet production ready. Nonetheless, he strongly advises that companies educate themselves on quantum computing's power and collaborate with their hyperscalers to plan for a quantum future.

Duration: **00:11:26**

Scott Buchholz:
Welcome back to the On Cloud podcast. I'm Scott Buchholz, and I have the privilege of leading Deloitte's efforts to explore quantum computing. I'll be your host for today's Knowledge Short episode and today we're going to be diving into the world of quantum computing. Many of you will have heard about quantum computers. And the first place I like to start when I'm talking about quantum computing is just helping everybody understand your intuition for what you think a quantum computer might be able to do may not be correct.

I find in a lot of cases that people probably correctly think of quantum computers as super supercomputers. The challenge, though, is that quantum computers are a fundamentally new way of doing computation. They don't work anything like today's classical computers. And so, the ideas that we have, for instance, that we can simply throw lots of data at them and that they will handle it with grace may not be as true as you might think.

So, let me give you an example. A quantum computer is using different principles to solve problems. And maybe the simplest way to explain this is with an analogy. The analogy would be to think about blowing a soap bubble. So, if you think about remembering being a child and you had a little wand and you stick it in the soapy water and you blow bubbles. If we wanted to use math, the way today's classical computers would try to calculate what would happen once you finish blowing, you could do months' or years' worth of computations in order to determine that all the things that are going on are going to cause that soapy film, that soap water, soapy water to actually become a bubble and a sphere. But those spheres form almost instantaneously. So, one of two things has to be true: Either they are mathematical prodigies, the likes of which the world has never seen, or they are working differently.

And the answer is they're doing things differently. They're using physics, not math, to determine their final shape. And the analogy is important because quantum computers, while not using math, using physics instead, really perform calculations differently, which means that they are going to be really good at solving certain problems, the problems that are more tractable to physics than the problems that are perhaps today tractable to math. And we've spent 70 years or so with the smartest minds in the world figuring out what we can solve with math. What we're just on the cusp of starting is figuring out what kinds of problems can we solve for using physics.

So, your question might be, "All right, I get this. My intuition may not be well-tuned. What should I be thinking about? What kinds of problems should I be looking for?" And fundamentally, those problems tend to exist in three spaces. In the space of optimization, so, in the space of machine learning, and in the space of simulation, so, chemistry and material science and other things. The way you can think about optimization is optimization problems are cases where you have a bunch of rules, and you have a right answer. Think about scheduling a workforce, routing trucks and deliveries. Machine learning is where I give you a bunch of examples of something and expect you to learn from those examples. And simulation is all about what happens when I put a bunch of molecules or subatomic particles together. How do they interact with one another? And how might we extrapolate those things to bigger things on larger scales? And so, that's what people are looking at using quantum computers for.

So, the next question might be, okay, what is the state of the art today? The state of the art today is that people are exploring more than half a dozen different ways of building quantum computers, everything from superconducting systems that operate at temperatures a hundred times colder than outer space, to systems where you have hundreds or thousands of atoms that are getting zapped millions of times per second with lasers to precisely control their behavior, to a variety of things in between. And those systems, if you think about what I just described, are fiendishly complicated to build. And so, what we see is those systems today, by and large, are not capable of running production workloads.

There are some nuanced exceptions that aren't worth getting into right here, but simply know that by and large when you read about quantum computers today those things are not currently capable of running production workloads. Depending on whose roadmap you believe, those may be a handful of years in the future. But the other thing to keep in mind is that quantum information science, a lot like data science, is a discipline that takes people a couple of years to master, or at least to learn, let alone start mastering. And as a result, you really need to think about getting started sooner, so that you can try to shoot the curl such that, when the hardware gets to the point where we can start running production workloads, your quantum information scientists are ready to run those workloads and that you have identified the problems that are tractable to those systems.

Then we get to things that are more interesting. When those first quantum production workloads are available, are they likely to be solving every problem in optimization and every problem in machine learning? Likely not. Likely, where we're going to see those things originate and start is actually smaller problems in machine learning, or perhaps problems in machine learning where accuracy is more important than time to solution. You can think about certain types of fraud detection in financial institutions, or in insurance companies, where you have time to make a decision but making the best decision is more important than making the decision instantaneously.

We've talked a little bit about why quantum computers are different, maybe our intuition isn't right, what sorts of places we might be able to look, how we can think about things, how people are trying to build them.

The next question is how do I get access to these machines? A lot of these machines are accessible through the cloud. There are dozens of different vendors trying to build quantum computers and quantum computing hardware across the world today. The good news is that your favorite hyperscaler or cloud provider can generally provide you access to one or more of these different technologies, enabling you to get access to some of the latest technology to be able to explore, to test, to run, test workloads, to see how these things are different. The good news is a lot of the programming tools are actually open-source. And there's a myriad of different ways that you can get started, that you can learn a little bit more about what's going on, that you can get educated on the topic, and certainly a lot of organizations out there are, are willing to help you figure out how to get from here to there and how to get started and ready. So, that's a lot of what we see going on in quantum computing in general.

The other thing you might learn as you start to read more and learn more about quantum computing is that an as-yet-theoretical, that is to say not-yet-built quantum computer, which is probably at least a decade off, give or take, is likely to be able to decrypt the majority of the encrypted information in the world today. So, to be able to get access to bank accounts and health records and all manner of other things. This is based on an algorithm that was discovered years ago called Shor's algorithm, and the idea is that a sufficiently powerful quantum computer can basically, because it computes differently, run an algorithm that would allow us to decrypt much of today's encrypted information. And what's going on today at the moment as we speak is the National Institute of Standards and Technology in the US, along with a number of international standards bodies, are working to define new standards for encryption that we will all need to adopt in order to replace the way that we've been encrypting information today.

The good news is we've done this before. We've had to upgrade encryption standards before, although it's been a number of years. The bad news is that we've rolled out encryption at scales that haven't necessarily existed in the past. All of us are going to need to take this into account. We will need to hold our cloud providers responsible, our other technology providers responsible to helping us do this, and we'll all have to manage that process as we go through. It's important to know that these new standards for encryption, and also for digital signatures, are likely to be released sometime this summer, and that's going to cause a lot of us to have to look really hard at the things that are going on. The good news is if you look around, you'll see that a number of vendors have already started implementing these standards into browsers and messaging systems and other places, and so that's our opportunity to be able to see how those adoptions go and use that as some of our plan as well.

So, I've told you a lot. The good news is if you want to learn more, there are plenty of resources available on the web. The good news is that you can access the quantum computers of today through cloud providers.

If your question for me is, “When will all of these things be ready to run production workloads?” the thing I would remind everybody is some of the challenges that we're facing are engineering challenges and we can predict engineering evolution. Some of the challenges we're facing are research breakthroughs. Those are much harder to predict and that's sometimes why it's hard to give precise timelines. Sorry, we're doing our best. But in the meantime, I believe that everybody should be spending time getting to understand what quantum computers might change in our organizations, what they might mean for us, where they might be useful, and how we should think about getting ready for them.

So, with that, I want to thank you for listening to this week's Knowledge Short on quantum computing. If you enjoyed this podcast, please make sure to like us, rate us, and subscribe. You can also check out our past episodes at deloittecloudpodcast.com, all one word. Until next time, thanks for having me, and stay safe, everyone.

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