The Six Five Summit

Patrick Moorhead: Jay, it's great to see you. And thank you so much for kicking off the quantum computing track here at the Six Five Summit 2022.

Daniel Newman: It's great to have you here, Jay. I mean, what a big topic we've added this track to our 2022 slate. We are seeing the momentum for quantum, whether that's been the hyperscalers announcing quantum offering simulations or new entrance into the market, of course, new formulas for calculating who's leading the charge. There's all kinds of things that come out on the regular, but we know that people out there are very interested, they're interested in the practical applications and of course they're interested in hearing about the science and all the fascinating education that's required to understand this particular field.

Jay Gambetta: Sounds great. Just looking forward to the discussion and maybe I can add a little to that.

Daniel Newman: So let's jump off and talk a little bit about the broader history, context of quantum in the IT industry. Maybe provide us a little perspective for us, for our listeners as to kind of how you see quantum similar to or maybe even different than previous major innovations in computing.

Jay Gambetta: So when you think about quantum computing, don't think of it as replacing classical computing, think of it as adding a new processor and this new processor can do math that we could never do with traditional processes.

Patrick Moorhead: Yeah. Jay, one of the only things about getting older and being in this industry for over 30 years that you learn a lot of lessons. And one of those is that tech is really about, it's not about or's, it's about and's. We're going to have classical computing, we're going to have quantum computing. And I can't think of something that has just disappeared. I've seen functions come into devices. Five functions come into devices like the smartphone. But very rarely does something just go away, maybe punch cards and we should all be glad for that.

Hey, one thing that I've been really impressed with in your approach to quantum has been that you put a roadmap out there, I think, three or four years ago. Right. And listen, when it comes to research that's a really high risk thing to do because it's research and it's very difficult. By the way, you have been delivering on it as well, which a lot of folks in the industry, I don't think they can say that. Last week you brought out, at IBM Think a few weeks back, how you're removing bottlenecks of scaling quantum systems. Interestingly enough, similar to the way I spent a few years in microprocessors and I found a lot of similarities that, can you talk about why you're being so open with the roadmap and the importance of these latest milestones you brought out at Think?

Jay Gambetta: Yeah. I want it to be very open with the roadmap because I see quantum much like a building an industry and with an industry we need roadmaps. We need to have the direction we're going so others can intercept. And you touched on it as well, like quantum and classical are going to come together. We're going to build up software stacks. We're going to make application. If we don't write down a roadmap, everyone has to wait until you build that technology before they innovate. So if we want to speed up and bring this as quick as we can to the market, we need to lay out the path we're going. And so for me, the roadmap made sense from the start because I think of how do we make this a industry, not just a technology.

Daniel Newman: I think that's a pretty significant challenge. But we definitely, as analysts, appreciate it when companies like yours provide us that, it's what we kind of need to know. And then it gives us the capabilities, Jay, to sort of assess execution. Pat and I have across many of these particular conversations here for the Summit have mentioned this [inaudible] ratio and different executives call it different things but essentially it's what you tell the customers, what you tell your ecosystem, what you tell the street in terms of both the technology itself, the timing, and then of course, how well do you deliver? And this of course has been a little bit more nascent. I mean quantum is one of these things that if you were in the early days, kind of like AI, there's people that have been studying it for five decades now, and then there's people that think it's brand new. And so this is one of those things that's got a similar sort of trajectory here.

You alluded to something earlier and I just want to kind of zero in on that Jay, and so some of this might be a little bit of repeat of your first answer but I think it's worth digging back into. People sometimes think about these things as mutually exclusive, quantum computing and classical computing. And as I've been trying to break this down, a lot of what we do is try to simplify this to the market because the amount of education you need to succeed in this industry, becoming a quantum physicist is pretty remarkable. But the idea of quantum and classical computing working together is a really important topic. Can you just dig a little bit more into the relationship there and why the two are going to be so powerful together, maybe share a little bit more about kind of how you see that working going forward?

Jay Gambetta: Yeah, sure. So I think it's important to even take a step higher. If we think of a computer, what it does is three things. It has a processor, it has communication and it has storage. And so when we write any program that works on a computer, it takes advantage of all of them. And what we're seeing in the quantum is we're innovating what it means to process information and we're also seeing how we innovate communication. And when I released that roadmap I actually started to talk about processes that will have communication and processing together to allow us to keep scaling.

So at a high level, when you think of a computer, it's about how you innovate on each on them. And so when I write a program and it be anything, it could be an application for drug discovery or a new material. Most of the problem, most of the analyzing of the data is a classical function, like load my data into my computer, process it to find the right information that will go off. It could even go off to an AI algorithm, it could go off to some simple calculation of a function or it can go off to a quantum processor. And so when I think going forward, what quantum does is it does three areas pretty good. One area is simulate nature. So for a long time, we've been trying to model the physics in materials or the physics in chemical reactions, and we just can't do them with a classical computer. When we can do them on a quantum, we can model that much more efficiently. So one area is just trying to simulate nature better, and that was one of the original proposals for quantum.

The second is working with data that has some type of structure. So imagine you're looking for correlations in your data or things like this, and this is why a lot of health and life science are interested and finance businesses are interested as well. If I can find those correlations in those data I can do a lot more. So you imagine sending that part just to the quantum processor. And the third is you can search a little bit faster than we can do classical. And if you can search, you can find many applications in optimization, portfolio and things like that.

So most of the problem will start off classical, it'll do most of the calculation classical and then for that tiny hard bit, it'll send off to the quantum processor. It'll come back, analyze that data, decide what it'll do next, and then either return the answer to the user or run it again. So I see the future of computing, just how we keep innovating and bringing more what it means to process information, communicate information, and eventually store information. And there's going to be information that is classical in nature and information that will be quantum in nature.

Patrick Moorhead: Yeah, it's interesting. I view it very similarly watching the way that we saw GPU compute work out a little bit differently in that the way that you're structuring a problem will be different. But then again if you look at machine learning algorithms that was very different than necessarily the ones we would want to run on a CPU. But interesting nonetheless. The technology is amazing, but I think-

Jay Gambetta: On that point, I think you touching on a really important part. We need to train how to use that information, that quantum part, because you won't send just the classical calculation. So when you make those algorithms, like the GPU, it's a different way of doing it. And so how do we train that workforce, re-skill the workforce in quantum? These all come back to why we want to put our roadmap out and establish that path. In the end I hope for most of the users, like when you say you look on your phone to get from point A to point B, you don't know what computers are doing that. So if we can innovate in quantum in some way, it'll be easy for the users and they won't know. But on the ones developing those algorithms, they need to learn a different way.

Patrick Moorhead: Yeah. Sorry to keep bouncing back and forth here. But one of the reasons we see such algorithm change from year to year, even in machine learning is because we keep learning more and the models keep getting bigger and we just need to do it differently. So we come up with new models and I'm expecting the same thing when it comes to quantum.

I think the good news is about quantum is, we're starting to ask questions about business value and when we can start seeing business value out of it, what that means to me is that we're getting closer to having commercial viability. One fundamental requirement is to make quantum development easier. And I think if we look at, let's say, the last four major compute cycles that ended up being important. So I have two questions for you. The first is what are you doing to make quantum applications easier? And what do you think about the industries and use cases that will have the biggest impact soonest? You did talk a little bit about chemicals, but talk more.

Jay Gambetta: Yeah. So, I think at the moment we got to hit three different types of developers. You've got the developers like myself that still want the physics of these processor and they want to get the most out of them, when I was a developer that was. Then you got the ones that want to start doing algorithms and do what we talked about before between classical and quantum. And then you're going to have to have developers that have the data, the data analyst, the data scientists. And so part of the roadmap we've put out was to also talk about how we're making abstraction lays.

Today I would say most users are still at a very low level. They're sending assembly language to these machines. We just talked about a runtime environment and released that last year which is starting to enable algorithm developers to do. I want to, in 2023, get to the point where we actually bring quantum to some type of software. So you could imagine a chemist would have their software stack, could have their own software stack, and you can imagine various different ones, even AI software stacks, how we would bring quantum into it. So over the next couple of years, it's about abstracting and bringing it to enable a big set of user.

So the first part, to answer your question, is to do that as fast as possible and to make sure that devices work so reliably at the lower levels, that the higher levels can take advantage of [inaudible]. On your second question, the applications, I think it's going to come back to the three I said. So I'm real excited about what we can do in material science. Can we find better batteries? Can we find better catalysts? Can we invent ways of getting energy more efficient and all these type of things. If we can do this by modeling the fundamental equations better, we'll be able to do a lot more going forward. The second area I've seen a lot is in the finance companies and the ones that use a lot of hard math. One of the things you talked about, AI, imagine if I could bring quantum to AI and I could actually extend what I could do in AI. So traditionally AI is about doing more with large data. If we bring quantum, it's not about the more data it's, how do I get more from the data that I already have? So, if we can extend what it means to do AI by bringing quantum calculations to it, you could imagine a lot more that could be done in that space and extend all those areas.

Daniel Newman: Yeah, it seems a lot of that symbiotic relationship we've kind of hit on from question to question between traditional and classical continues to sort of rise to the top. And I think for the audience out there, that's probably a really important takeaway. If there's nothing else that comes, is, hey, that relationship is going to be critical. Especially as it comes to seeing applications go mainstream, start to be utilized every day, we're starting to see little bits and inklings of that. But largely a lot of the biggest and most exciting use cases are still being developed. But it is both we're seeing it commercialized slowly. Your roadmap shows a little bit more of a breadth of how that's going to happen over the next several years, which kind of takes me, Jay, where I wanted to go next, which comes down to measurement.

When it comes to people looking at quantum and its potential, a lot of people want to hear, how are we measuring the success? Some of it's been things like quantum volume, we've seen the race for quantum supremacy and those are pretty neat in the academic and in the enterprise fields, in the competition level. But, when users are kind of trying to think about, well, how is this going to affect my life? I think they're looking maybe for some different measurements. So talk a little bit about how IBM is reflecting on this, both, A, being marketing itself and its leadership and its technology leadership. And then B, getting to business value, which is something that's always been really core to IBM.

Jay Gambetta: Yeah. So with quantum, until we can do something we can't do classically it gets hard to measure it. But to answer your question, I would say, if I can do something cheaper, faster, or more accurate than I could do with classical alone than we've succeeded with quantum. The truth is the hardware is just approaching that point at the moment. And so when you're just approaching that point, it gets really hard to measure it by something. Can I do this cheaper, can I do it more faster or can I get a better accuracy at this time or problem? And so what we have at the moment are metrics that try and measure are we getting to that point when we can do cheaper, faster, more accurate. And they are typically three different things, like, can I do something with more quality? And what I mean by that is, we are sure that it's using quantum mechanics not classical. Can I do something on a larger size? Is it using more of the qubits, we call that scale. The third is, am I running the quantum instructions faster and faster through a quantum processor? And we call that speed. What we've seen is metrics over those three develop.

But as we go forward and we get that final answer, it will be, can I do something cheaper than I did with classical? Can I do it more accurate, like, can I find a chemical simulation with accuracy I couldn't have done classical? Or can I do it faster, a calculation faster than I could have done with classical alone? And so what I see is from the business value, the one that we are starting with at the moment is defining how do we develop a model for bringing that compute to the user? And can we actually work out how we determine an economic value of, if I can do more compute people are willing to buy more of it? And so I would say at this point in time, it's about compute and how do we bring compute to the users. As we go forward and we get a more higher stack it might morph into a solution where you imagine software and applications and you bring a solution that you couldn't have done classically. And so I see metrics measuring compute at the moment and then we'll transition into a period of time when I do something with more accuracy or I do something a little bit faster than classical. And then you understand, well, how do I bring that to my client and user and that represents the value.

Patrick Moorhead: So, Jay, I always find one positive sign of the maturation of measures of merit, benchmarks, metrics, as we're getting closer to reality. And so this is the good news. So, I wanted to let you know that here.

One thing that I wanted to talk to you about though, was your ecosystem, right? It does take a village and I may have seen the 500 partner slide that you put up during IBM Think, was impressive. But can you talk to the audience about your overall strategy, long term vision for your partnerships in countries like Germany, Japan, and Korea?

Jay Gambetta: Yeah, I think we touched a little, like if you're going to create an industry versus just a technology, that industry needs users and also needs people that are contributing to it. So at the moment when we build these machines, we have to build the electronics, we have to build all the other component trees that go into it. That doesn't happen classically. So if you really want to get it as an industry, you need to have partnerships where you can enable the whole ecosystem to contribute to it. So how do we actually build out the hardware ecosystem? How do we build out the componentry? How do we build out the software stack? How do we build out the users that can explain quantum computing, explain how it will impact businesses? And then ultimately, how can we actually build out the amount of users and clients that are using this as a tool?

So for me, it's very important that we look at this as an ecosystem that covers all of these areas, from research, access to the best hardware, workforce, re-skilling, training, and finally creating economic development and an industry side of this as we go forward. And so from the start, it's been our strategy to make sure that we would get these ecosystems using our access. And ultimately bringing to us as well, like I'm seeing now in Japan and Germany where we have the first two, we see so many users using it, we see software getting developed on top of it. And we're starting to see local industries asking, oh, can we build circulators, they used to be supplying these component trees for the mobile phone industry, then that they're asking, can I supply those technologies for the quantum computing industry?

And yes, it's a different area, it's a different temperature, it's different specifications, but ultimately this is the only way you're going to build an industry and enable us to go faster is for us to be able to focus on what we do good, build the processes. But how you get those processes working in the whole form of computing requires a lot more industries that are going to come together to create this. And so from day one, it's always been, we want to build this industry as fast as we can. And so we've focused on open source, we've focused on open communities and we've focused on partnerships that leverage all those four elements, research, workforce access, and industry, to make this journey go as quick as we can.

Patrick Moorhead: Yeah, Jay, I think it's a good place to end. I really appreciate you coming on and kicking off the Six Five Summit 2022 quantum computing track. Your words and wisdom, I'm sure will go very much noticed. So thank you so much.

Jay Gambetta: Thank you so much.