Research @ Citi Episode 71: Infleqtion and the Quantum Opportunity

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Transcript:

Rob Rowe (00:03)

Hi, everyone. I'm Rob Rowe, U.S. Regional Director of Research here at Citi. Welcome to our Research @ Citi podcast.

We are really pleased today to have Matthew Kinsella on the podcast with us, who is the CEO of Infleqtion.

First off, Matt, congratulations on your recent IPO. I attended Matthew's Investor Day, and I found a lot of really intriguing developments that you're doing over at Infleqtion. And it also includes a lot to do with quantum computing, which is of a specific interest to me.

And so maybe we can get started talking about quantum computing. Maybe we can talk a little bit about various applications thereof. And then I thought what's also very interesting and I think unique to Infleqtion is the work that you're all doing on sensing and on atomic clocks, because these are quantum solutions for these things which seem to be much needed right now.

Matthew Kinsella (00:59)

Thanks for having me, Rob. I’m really excited for this conversation. This is going to be a blast.

Rob Rowe (01:03)

I don't know if we should start off with the joke that you mentioned at the Investor Day which I thought was really great.

Matthew Kinsella (01:07)

I mean, there's a very small but growing cadre of quantum Dad jokes and I decided to start the analyst day off with one of those. So sure, why don't we kick off the podcast with the joke?

Rob Rowe (01:23)

So why can't you trust an atom?

Matthew Kinsella (01:29)

Oh boy I don't know, Rob . . . why not?

Rob Rowe (01:33)

Because it makes up everything!

That's a great joke, I tell you — that's really great.

In any case, maybe we could start off with the state of quantum computing today. I think everyone has watched from afar to see how this is developing. We all know that one of the big milestones to come up is going to be 100 logical qubits in a default-free environment.

Maybe you can explain what that means. Where is Infleqtion in that process? How are you differentiated in terms of your modality, your neutral atom approach to it? Maybe you can tell us where we are. And I know that obviously a lot of folks in the audience may be familiar that people are most concerned about things like encryption. But give us an idea an understanding of where Infleqtion is, where you feel the industry is.

Matthew Kinsella (02:29)

Sure. Maybe it's helpful for the audience to define some terms very quickly. So “qubit” as you mentioned, is a quantum bit. It's very similar to the bits that are in classical computing, but very different in that it's not a zero or a one; it can be a zero *and* a one, or anything in between. And that is the fundamental power of quantum computing relative to classical computing.

And it doesn't mean that quantum computers are going to do things that classical computers do, but better. It means that there's this class of problems that classical computers just really aren't architected to solve, that because of that difference between a classical bit and a quantum bit, quantum computers can solve. So the way I think about this is it's going to open up a whole new use case for computing that we just haven't really been able to throw compute at in the past. And we can talk about some of those specific use cases later, but just to make sure everyone understands, “What is a qubit?”

Now, to further complicate things, what is a physical qubit vs. a logical qubit? And to answer your question, where are we on that journey to 100 logical qubits? So again, to define a couple terms, a physical qubit is that quantum bit. And in our case, a physical qubit is made up of an atom and either a cesium atom or a rubidium atom. And that joke is very relevant to Infleqtion because literally all of our products — well, I guess everything on earth is made of atoms, other than light — but all of the products that we bring to market are based on atoms and in particular, the quantum properties of atoms.

So in our case, each of our qubits is a rubidium or a cesium atom. And then what we do is we entangle those atoms together and we freeze them by holding them in place such that they're moving so little that they start to exhibit their superposition. We entangle them and then those become the basic building blocks of our computer and how we then perform calculations.

But those atoms are highly prone to errors. And so physical qubits are very error-prone. Logical qubits are clusters of physical qubits that have error-correction software applied to them such that they are now pristine and without error and therefore you can actually use them for computation. It's not dissimilar from how we've dealt with errors in classical computing. If you are buying a hard drive, let's say, you're getting a lot more than the one terabyte that you have bought. You're getting more than that but it's guaranteed that that one terabyte is going to work, because there's competencies built in.

Or if you're receiving a Wi-Fi signal, you're getting more than the amount of megabytes that you're receiving. Real time, you're getting more than those but there's some loss. And the error-correction software takes care of that.

So you can think of that the classical analog to logical qubits. So, they're error-corrected clusters of physical qubits. And we believe that when we get to 100 logical qubits, which our roadmap calls for by the end of 2028, that's when we'll start to be able to do useful things, maybe call them minimum viable useful things on quantum computing.

And we currently announced in October of last year that we are at 12 logical cubits at Infleqtion. Our roadmap calls for us getting to 30 logical qubits by the end of 2026, and then 100 logical qubits by the end of 2028, and then 1,000 logical qubits by the end of 2030.

Rob Rowe (05:35)

And how can you go from 100 to 1,000 in less time?

Matthew Kinsella (05:40)

So, to put things in historical context, the world didn't even have a single logical qubit until 2023. And so in 2023, humanity got our first logical qubits — we finally figured out how to error-correct physical qubits — and going from zero to one logical qubit was actually the hardest leap. And so we've been able to go from one to two in 2024, from two to 12 in 2025. We'll go from 12 to 30 in 2026, and then again, the target of 100 in 2028.

How do you get there? Basically, the basic formula for logical qubits is a lot of physical qubits at very high-quality levels, and the quality is measured by something called gate fidelities in the quantum-computing world. And then very strong error-correction codes. That’s what basically the three ingredients are.

And so how do we get to our 100 logical qubits faster? It's not really about building more physical qubits, because our modality of neutral atoms actually is very scalable. So, we've already demonstrated 1,600 physical qubits inside one of our QPUs. It's really been — at least again for neutral atoms — about increasing the quality of those qubits.

And again, to put some of this into historical perspective, before I was the CEO, I was the first investor in Infleqtion back in 2028. Our gate fidelity is, again, that measure of quality.

Rob Rowe (7:00)

2018.

Matthew Kinsella (7:01)

2018, yes. Wow! This is the quantum world!

Rob Rowe (07:04)

It's the quantum world! You could have possibly got into the future!

Matthew Kinsella (07:08)

But yes. Sorry, 2018. You're absolutely right.

And our gate fidelities were somewhere in the 50% to 60% range. So the improvement has been astounding in that we've gone from 50% to 60% to 99.73% gate fidelities, ultimately getting to three, four, five 9s.

So, the fastest way for us to increase the time to get to 100 logical qubits is to continue to increase our gate fidelity, and then take those large qubit counts, paired up with high quality, and then we already have very good error-correction software. And that'll ultimately determine when we get to the 100 logical qubits.

Rob Rowe (07:42)

And Matt, let's talk a little bit about what you said: When we get to 100 logical qubits, there are meaningful things that we can do. There are things that a quantum computer can do now, right?

Matthew Kinsella (07:55)

Yes.

Rob Rowe (07:56)

And there are things that it will be capable of doing in the future, I think, when it scales up and when you get more improvement in algorithms. Is that correct? What are those things you're doing now vs. some of the things you can do in the future, when you get to this milestone? And is that milestone more to do with the fact that then quantum computers can do things that a classical computer cannot do?

Matthew Kinsella (08:21)

That's basically the right way to think about it, Rob. And so you're right that quantum computers can do things now. They just aren't — and I really try to be intellectually honest about this when I talk about it — they're just not commercially useful yet. A Citigroup probably wouldn't take tens of millions of dollars off of your balance sheet and purchase a quantum computer today, because they thought that they could earn a high return on investment.

And so I often say that we'll know we have quantum advantage when you see a lot of companies doing just that, right? That they found a use case that is high return to their shareholders and they're willing to deploy capital to purchase a quantum computer or purchase time on a quantum computer to start to do those types of things.

So we are not there yet, but we are solving problems that a physicist would find very useful, right? There's a lot of things that we do in physics, and we also do things that are … call them the basic versions or the precursors of the things we're going to do at 100 logical qubits and beyond, that will be commercially useful.

And the way I think about this is when we get to 100 or so logical qubits … and 100 is not the exact number, it's not like 99 it's useless and at 100 it becomes useful. It's just a rough number target, and around there is when we'll start to see commercial viability.

Around that 100 logical qubit, the first use cases, I believe, will be in the material-science world. And we can talk about what some of those are in particular. And then as we approach 1,000, I think we start to see use cases in the drug-discovery world. And then as we get beyond that, you'll start to see some implications to cryptography, which you alluded to in the opening comments about one of the things that people often associate with quantum computing: its ability to break cryptography.

But let's talk about those different use cases and the 100 vs. 1,000 vs. beyond logical qubits needed to achieve them.

So when I say the term “material science” — I almost feel like I need to use a different term because it sounds very niche-y — it's actually a massive swath of global GDP.

It's literally like anything physical you see, there is material science behind that. And could we find better ways to build materials, which is ultimately what it is?

And the reason why that's a challenging use case for classical computers is because as you're combining atoms or molecules, the interaction of the electrons in those combinations is quantum mechanical in nature. And so what that means is that the range of outcomes of what may happen approaches infinity. And those are the types of problems that classical computers have a very challenging time working on.

At the analyst day, I put up a caffeine molecule, right? It's a pretty simple molecule, a very important molecule to me and many people in the world.

Rob Rowe (10:57)

And me!

Matthew Kinsella (10:59)

But to actually model the quantum mechanical interactions of the various atoms that make up that molecule — and again, it's a pretty basic molecule — would require a computer the size of the planet Jupiter. It would require a number of bits that would exceed the number of atoms on the planet Earth. And that is because the quantum mechanical interactions of the electrons as those atoms are combining are infinite.

It is quantum mechanical. And so, as you start to take even the limited number of variables and as you start to combine them in different ways, that starts to approach infinity for the different types of outcomes that can occur. And those are the types of problems that quantum computers can simulate very quickly because of the superposition nature of their qubits.

And so what we are doing now is working on very basic algorithms that are precursors to useful material-science type applications. Maybe a good example of that is something we did with NVIDIA several months ago — we published a paper on this with them — and that was, we did something called the Anderson Impurity Model. And so, the Anderson Impurity Model is a very basic photovoltaic model, but you can think of it as the precursor to, “How do you build a better battery?”

We did not build a better battery yet, but we did some things that would help you get to the ability to build a better battery. What we did was we worked hand in hand — and this is really important because I believe this is the way the quantum computing world will evolve — we worked hand in hand with NVIDIA, and a lot of the Anderson Impurity Model was solved on their GPUs, but that electron modeling and the quantum mechanical aspects of that problem were kicked over to our logical qubits on our QPU, and then you recombined it to have the answer to the algorithm.

And I believe that's how you're going to see this grow. And once our computers get powerful enough, around that 100 logical qubit level, they'll be able to do useful electron modeling. And then we can actually do things like figure out how to use material science to build a battery. And let's see, you know, your iPhone could last a year vs. a day. Or build better jet fuels, or better materials to build spaceships out of, or better materials to build buildings out of.

If you want to create the Citigroup tower but entirely out of glass, can you create something that's as translucent as glass but as strong as steel? Those are the types of things that quantum computers will enable the ability to do because you can actually model those quantum mechanical interactions.

So those will be the things that we can do early on with quantum computers at that 100 logical qubit and beyond level. And then moves into drug discovery and then factoring, and all for very similar reasons. And we can get into more of those, but I'll pause there.

Rob Rowe (13:36)

And so two things there, Matt. So, currently some folks are buying these computers — you've sold a few. Is it mostly on this experimental side that they're using the computers, number one? And number two, do you think the first phase of this will be sort of a hybrid solution between classical and quantum computing? It sounds like quantum computing does a lot of the front work of producing data that we have yet to be aware of, right? Because the solutions on the molecular, will be essentially almost IP, right? It's data that will be very valuable, but then a classical computer can then use to adopt a solution. Is that the way you see it going?

Matthew Kinsella (14:19)

Yes. I think if you look at the buyers of quantum computers today, they are largely the national labs, governments, nation states, academic institutions. And usually those dollars have been earmarked by a government somewhere to buy quantum computers, right?

And there's a couple of reasons why. One, basic science. They are highly useful for basic science and experiments. But more importantly, it's really to start to learn how to use quantum computers and start to pair them up with classical GPU clusters to really recreate what the National Labs did with Titan a decade ago where they started to build GPU clusters, right?

And look what's happened over the course of the last several years. The National Labs were the first movers alongside NVIDIA realizing that GPUs were actually going to be a very, very powerful computing modality outside of graphics. And it really gave rise to the large language models and the AI world we're living in today.

The National Labs are starting to do that with quantum computers as well. And they'll be paired up with GPUs. And that's why NVIDIA is really, I think, quite excited about quantum because they view it as a way to sell more GPUs. We're not going to get into what GPUs do well, or really what CPUs do well. We're going to expand the types of possibilities that we can actually throw compute at.

And what are those? We talked about the material-science use case, but you also mentioned a really good one: Quantum computers are a great way to just open up a whole new swath of data about the world that we just aren't able to capture with classical computing. And so, if we're running out of data to train our models on, and the models are only as good as the data they're trained on, we can open up a whole new world down at the quantum level of data to train models on.

And these world models that are out there today are really just approximations. We can actually get these — the world works in quantum, the universe works in quantum — we can actually get the way the world really works into these models.

Rob Rowe (16:07)

Yeah, I had a really good question for Caitlin — for the audience, Caitlin Carnahan is one of the physicists with Infleqtion — about whether this is an analog revolution or a digital revolution that's going on in quantum computing.

Matthew Kinsella (16:21)

It's like a nature revolution honestly, right?

Rob Rowe (16:26)

It is. It's like a nature revolution. There's a certain level of it that's analog — in other words, not digital — and then there's a version of this that that becomes digital in the end in a way that's kind of interesting.

I do want to segue to sensing and atomic clock because I think what's really fascinating is this is a quantum computer revolution. I think the innovation, as you stated, is maybe more groundbreaking than AI is. We'll leave that to the judges, but I do think it's a bigger innovation. The real question, though, is that there's a lot of other real-time quantum solutions going on that may be using this technology. It's not related to the computer, but it's really effective, and it's a real-time solution now.

Maybe you can comment on sensing and also how it's a great solution for GPS right now, along with the atomic clock. That, I think, is really fascinating.

Matthew Kinsella (17:17)

Yeah, absolutely.

So, going back to when I first invested in Infleqtion back in 2018, what I saw at that time was this very flexible quantum technology. And again, our technology is called neutral atoms.

And what makes it so flexible is that it doesn't require large refrigeration units. So many of the audience may have seen pictures of quantum computers, and usually the most popular types of pictures you see are these sort of almost golden-chandelier-looking devices.

Rob Rowe (17:41)

Yeah, that's right. Superconducting.

Matthew Kinsella (17:43)

They're beautiful, right? Yeah, these superconducting machines. They get dipped into these large refrigeration units, and that's because they have to be cold. But what neutral atoms allow you to do is do this at room temperature. And a lot of that has to do with, “What's the definition of cold?” Cold is the lack of motion in atoms. At the end of the day, we just fold our atoms in place with lasers such that they're moving so little that we can actually take advantage of their quantum properties. But the system itself is at room temperature.

It allows them to address a much larger swath of potential products. And so, there is the computing aspect of it, which we just spent time talking about. But then there's the whole sensing aspect of quantum that you just asked about. And neutral atoms are uniquely suited to be able to address both.

And importantly, whereas I believe we'll get to quantum advantage in computing in late 2028, we're already there on sensing. We can build, to your point, atomic clocks. We can build quantum RF antenna and broadly quantum sensors that can perform with precision levels that are 10, 100, 1000 times more precise than classical analogs.

And it's all based on the same underlying technologies, the way we build our computers. You can almost think of it as like a continuum of complexity where the quantum computers are the most complex thing you can build, with neutral atoms, and you work backwards. And sensors are the next most complex, and then clocks are the least complex thing you can build. Still very complex, but in the scale of quantum, less complex.

And so we can field-deploy those technologies today, and we already are selling a lot of our clocks and a lot of our sensors to the commercial markets as well as the national-security markets. And one of the main drivers for that is GPS.

And so what is GPS? GPS is a position, navigation and timing system. It comes to us from satellites in space: We receive the GPS signal, which really is a timing signal, and you can tri-laterate your location based upon what time it was when you were here and what time it is when you're there, and you use the speed of light based upon the precise clocks, that are distributing the time from GPS. And all the services that we know so well from GPS are based upon that.

The problem is that GPS is becoming more spoofed and more denied. We're reading about that every day in the Strait of Hormuz. It's happening over in Europe and happening increasingly here in the U.S. as well.

And what our quantum technologies can do is provide better-than-GPS timekeeping, better-than-GPS navigation in terms of precision, but locally in an un-spoofable, un-jammable manner. So you can really recreate the experience of GPS from both position navigation and timing, but locally in a way that you're not having to access a third-party reference point like a satellite.

So it becomes very important from a redundancy perspective in a world in which GPS isn't working, but also orders of magnitude more precise. And so, I like to say — we don't have this yet — but whereas your Uber can come get you within a few meters, with quantum tech you could have precision to the centimeter level. So it could be like you're walking down the street in the morning and a drone delivers a cup of coffee to your hand, right? That's the type of precision that you can have with quantum sensing.

Rob Rowe (20:40)

And how is that? I know that you may be involved with Golden Dome. I assume it's a sensing product that would be involved with that. How would that work here?

Matthew Kinsella (20:50)

Golden Dome is the system that the United States military is putting into place, really to protect us from hypersonic missiles and drone attacks. Ultimately, what is Golden Dome? Well, it's a network of sensors, but it's almost as importantly, the synchronization of those sensors. And they have to be in complete sync over large, large distances.

The amount of time that you would have to intercept a ballistic missile that was launched at the United States would be measured in minutes. Ten minutes, we'd have a lot of time to be able to take it out. A hypersonic missile — which is probably what would be a threat to the United States — you have 10 seconds from launch. Because they're moving at Mach Whatever.

So what you need is the ability to detect the vibrations that occur when a hypersonic missile is launched somewhere not in the U.S., and those will emit a signal that you would not be able to pick it up with anything other than quantum technologies. So you can actually identify when something has happened.

And then in order to actually intercept a hypersonic missile? Because of the speed at which it's moving, it would require a picosecond-level synchronization between all of the sensors that are tracking it, as well as the device that's being used to take it out. And the only way you're going to get picosecond-level synchronization is with the precision of timing that our clocks can provide.

So, there are a number of different ways that Infleqtion and quantum will play a role in the Golden Dome system, or could play a role in the Golden Dome system, ranging from timekeeping for synchronization to detection of threats to tracking the missile as it's flying through the air because of the emissions that it's making, and then ultimately shooting the missile out of the sky to help protect us and our allies.

And then ultimately, quantum computing will also play a big role in this as well, because it'll be able to simulate the types of outcomes of this missile that's moving very rapidly and unclear as to what it's going to do in the air. And that was one of those very similar to quantum mechanical problems where the range of outcomes is approaching. You can simulate those with a computer.

Rob Rowe (22:51)

Wow! Matthew, we've run out of time. I could talk to you about this for like days. This is exciting. I wish you Godspeed on developing Golden Dome. That'd be great.

Matthew Kinsella (23:06)

I would say it's a very motivating reason to get out of bed and go to work every morning.

Rob Rowe (23:10)

For sure. Thank you so much for being here. I’m sure our audience has learned a lot today — I certainly have. And we look forward to catching you up with you again at some point.

Matthew Kinsella (23:20)

Love to do that, Rob.

Rob Rowe (23:22)

Maybe we'll do it we'll do it when you hit the 100 qubit.

Matthew Kinsella (23:25)

There you go! Yeah that's right, exactly! Well, it was great chatting with you, Rob.

Rob Rowe (23:29)

Thanks so much.

Disclaimer (23:30)

This episode was recorded on March 13, 2026.

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