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This is the Quantum Tech Pod brought to you by Inside Quantum Technology, covering industry analysis, data and market forecasting for quantum technology markets worldwide. Now here's your host, Christopher Bishop.

Christopher Bishop:

Hello, everybody, and welcome to the Quantum Tech Pod. I'm delighted you're listening. Good morning. Good afternoon. Good evening. Depending on where you're sitting on the planet. My guest today is Chad Rigetti, who's the founder and CEO of Rigetti Computing. Chad is a quantum computing physicist and the founder and CEO of Rigetti Computing. He's a former researcher in the quantum computing group at IBM and he holds a bachelor's degree in physics from the University of Regina and a PhD in applied physics from Yale. Rigetti is building the world's most powerful computers to help solve humanity's most pressing and important problems. Chad founded the company in 2013 and the company has raised approximately 200 million in venture capital. The superconducting quantum computing systems are available over the cloud via Rigetti Quantum Cloud Services. The company is located in Berkeley and Fremont, California, but employs more than 130 people with offices in the United States, Canada, UK and Australia. Chad, thanks very much for joining me today.

Chad Rigetti:

Great to be here.

Christopher Bishop:

So, Chad, I always like to start the podcast by asking my guests to share a bit about their own personal quantum journey. And my objective is to certainly give our audience a sense of what you did before you founded Rigetti Computing, but more broadly, to orient our audience to the fact that there are many ways and various paths that people have taken to get into the field of quantum information science. So could you please share with our listeners a bit about your background and path so far, things like where you grew up and where you went to school and what you studied? I've talked a little bit about that, but other activities you enjoyed. I saw you were on the varsity wrestling team in college and certainly any insight into companies or organizations where you worked before starting Rigetti.

Chad Rigetti:

I have been interested in quantum computing and really got fascinated with it about 20 years ago. I remember really distinctly I was a junior physics major in college and I was taking both computer science classes as well as a first course on quantum mechanics. And I was frustrated because computer science doesn't really teach you the fundamentals. Early computer science doesn't teach you the basics of how computers work, but that's what I was interested in kind of at the moment. How do computers store and represent information and quantum mechanics separately was also a very challenging and interesting course that I was fascinated by. And around the same time I heard about a field very new and at the time just very exciting within the physics community called quantum computing. And there were early results around that time on really small scale prototype quantum computers based on liquid state NMR. And I just got fascinated with the possibility of building a computer that would encode and represent information in quantum mechanical states of light or matter, and have been working on it in this area through academia, then IBM Research and now at Rigetti over the past close to nine years, ever since. And it's been a really exciting journey. We've kind of grown up with the technology as it's made its way through just incredible, groundbreaking research in academia, across many extraordinary research groups around the world, one of which I got to be a part of at Yale University for my PhD program, and also later a postdoc that I did there through kind of the industrial take up of the effort to build practical quantum computers, heavy government investments in fundamental research, and now more in supporting the build out of quantum powered economies in the US and around the world. I've just been thrilled to be a part of the industry since those early stages and to have a chance to kind of be a part of some of the groundbreaking advances that have taken place.

Christopher Bishop:

Quantum enabled economies or quantum powered economy is fantastic. I'm going to write that down. And listeners, please make a note of that new term for the lexicon. Thank you for sharing that. I want to ask what led you to start Rigetti, so is there a light bulb moment? Were you walking down the street and you got this epiphany or maybe a chance encounter with a colleague or a brainstorm in the lab? What made you decide to start a quantum computing company?

Chad Rigetti:

It's a great question. The story goes back to my PhD program. In fact, when I was at Yale, I was one of the earliest graduate students in our group, and I was very interested. I'm definitely an experimentalist. I like to build things first quantum computers and now companies. But at that in those days, it was really about building qubits. And my thesis was focused on demonstrating two qubit logic gates with supermarket qubits. But as an early graduate student in the lab, we need to first build out the lab and there's buying equipment and installing that equipment. So during that time, when we weren't able to yet really produce the chips that I want to do my experimental measurements on, I ended up doing a lot of theory. And I'm certainly not a theorist. But having that exposure to some of the core concepts in quantum information and quantum error correction gave me just a taste of how interesting and exciting that branch of the field is. And fast forward five or six years at IBM, and what I saw, I just kind of tracked the progress across key vectors of all the things that need to come together to make a viable and high performing quantum computer. Things like enhancements in quantum coherence times, improvements in gate fidelities, and the ability to do single shot, high fidelity readout of superconducting qubits, improvements in error correcting codes, as well as progress in developing quantum algorithms that could really provide value to an end user with less than the kind of million or 10 million qubits or maybe even more that maybe needed to run, say, Shores algorithm, which was almost the founding algorithm of quantum computing, in a sense. So what I saw when I was at IBM was this convergence on the rate of progress and trajectory of ongoing improvements across all those different vectors. And I've been tracking them for some time because of this opportunity I had as a graduate student of being able to explore different things while kind of doing the foundational building, contributing to the building of our lab and facilities. And that was just an extraordinary experience. And what I saw at IBM was that those things, if you would fast forward five or seven years, that it could be foreseen that error correcting codes would reach a more and more tolerable error level and a lower, lower overhead that possibly this kind of redacted region and quantum algorithm space between 100 or a few hundred physical qubits and tens of millions for shorts algorithm would potentially start to be revealed a little bit through ongoing research and progress, and that progress on coherence times and fidelities would continue to improve. And if that all did well, in a few years, it would be viable to produce a fully integrated, true kind of quantum computer, first at a small scale and then potentially at a scale where it would be able to exceed the performance of what a classical computer simulator could do. And at that time, I thought, if this can happen, then it will, because this technology is just too important and the promise is just too great. And I want to be a part of building that, and I want to build a company that builds that technology. And so I left IBM to start Rigetti, and it's been an incredible journey ever since. And that's how we got started.

Christopher Bishop:

Wow, terrific. So segues around qubits, right? So there are lots of options. As we all know.Attempting to find maybe not the ideal solution, but how different cubic configurations might be applied. Rigetti is using superconducting, and you’ve operated quantum computers over the cloud continuously since 2017, which is pretty early to the game, I think. IBM’s first quantum computer in the cloud was also based on superconducting and made available in May 2016. But I wanted to ask you, what made you focus on superconducting as the best solution? Because it’s complex. Right. Dilution refrigerators and wiring harnesses, and it requires more complexity than, say, other qubit solutions. So I just want to get your take on why is superconducting the best solution?

Chad Rigetti:

In the early days, quantum computing really referred to a field of physics research over the past ten years, I would say. And certainly our focus at Rigetti has always been on quantum computing as a field of computing. And in computing, there's a set of performance factors vectors of performance that really kind of shape the end user utility of the technology. And I think over the past several years there's starting to be a little more clarity in the computing industry around this. But there's really the quality of the systems. In other words, how low are the error rates ultimately, there's the scale of the systems, how many qubits can you compute with when you're running algorithms. And then there's the speed with which they can execute those quantum circuits. And we look across those three vectors. Superconducting technology is the one that is, in our view, kind of ready for primetime across all three. And the one also where you can envision substantial ongoing rates of progress across all three vectors in, you know, for the long term as computing technology needs to continue to evolve and improve. So when you look at the speed, the scale, the quality of the systems, we really feel like superconducting is the one that is both furthest along and has the greatest prospects going forward. And it it's not that a technology can be really strong at one of these. In fact, it's got to pass a bar, there's got to be a certain degree of performance on all three vectors simultaneously. And superconducting is in our view, kind of head and shoulders above the other technologies on that overall performance level. Now, I am an absolute quantum optimist. I believe this industry is going to reformulate the, you know, the information technology landscape, the semiconductor industry, the value chains around the world over the next several decades. And ultimately, where I view kind of superconducting technology is likely to be the CMOS of quantum computing, if you will, the predominant technology, maybe the one that kind of sets the tone for the industry. Other approaches, trapped ions, neutral atoms, even photonic quantum computing have real potential to add value in that ecosystem. And certainly this is such an important technology that has the potential to create so much end user value long term that we anticipate that the number of options that are out there that are being pursued are going to continue to grow. But ultimately, superconducting is likely to be the preponderance of the market, if you will, and in the mainstream technology on which other ones are kind of play a niche role or a supporting role.

Christopher Bishop:

Thank you for sharing that perspective, the three vectors. That's fantastic. Appreciate it. Let's talk about manufacturing for a minute. So you have Rigetti fab one which is described as a captive quantum integrated circuit foundry. And you've been doing this since 2016. Wow. You know, many quantum companies have been talking about leveraging best practices that we've learned from, you know, 50 years or so of industrial research fabs and you know, using these learnings to develop and maintain stable processes, of course, and support continuous development, some computing companies, clinical beauty companies have relationships with suppliers, like Global Foundries, for example, for their chip fabrication, but you have you built your own facility. So want to get your take, and what are the advantages. And by the same token, the challenges of owning and managing your own fab, what's that been like?

Chad Rigetti:

In quantum computing, really the fountainhead of ongoing progress and the acceleration that the industry has seen over the past 5,10 years centers and begins with our ability to design and produce quantum computing chips. This is where you know the kind of the fountainhead of value creation and progress. And at Rigetti in the early stages, we made a strategic decision that given how dynamically expect this industry to be given how much value there is to be created, that we wanted to play at the most fundamental level, where value is being created and captured. And that really includes focusing on owning and driving progress in the design and manufacturing of quantum computer chips themselves. That is that that's led us to a highly vertically integrated approach. We took this decision after really thorough evaluation of what commercial capabilities were out there with respect to the quantum chip architecture that we needed to build to meet the long term challenges of scale, speed and performance. And ultimately, found ourselves in a situation where we felt like we could design a facility to produce the chips that we needed, that would be distinctive, and really have substantial benefits, as well as allowing us to move faster. So ultimately, with our own fab, we've designed the facility to be a rapid design fab to support our rapid design fab test flywheel that we run internally to iterate on chip architectures, and process innovations. We can turn new silicon in between 5 to 15 weeks with the way the semiconductor industry is structured today, first of all, most of the manufacturing has moved overseas. We're starting to see a little bit of that coming back now as part of the, you know, recent trends in the industry. But these are at massive scale. And we were talking about multibillion dollar foundries really and quantum computing simply can't support that at this stage, given the early commercial adoption of the technology. And so we, you know, we we've invested probably about $25 million in the fab over the past five years. And we're able to produce chips in there that are, you know, cutting edge of the, you know, leading cohort within the entire industry. And we're in a position where we're able to drive the rate of progress ourselves through this rapid iteration mindset. We, you know, owning the means of production of the core, you know, the fountainhead of progress in the industry is a real is a key strategic advantage. And ultimately, the core innovations we've made at the chip level have been matched at the fab in the sense that, you know, the fab is designed to produce the chips within the proprietary Rigetti architecture that we've developed to address the scalability challenges. And so we expect this, this approach to really continue going forward and to be a real advantage. Now, that said, the semiconductor supply chain is really, really important. And one of the benefits of superconducting technology is that the technology is actually quite similar to RF MEMS devices and a lot of traditional semi devices. And because of that, we're able to tap into the talent to the supply chains outside of just the chip manufacturing but tooling vendors for example, external vendors that might be providing in like specific processing steps within a within the overall design and manufacturing flow. And that's really important because it allows us to move quickly and tap into that existing capability within the economy today. Another reason why I think we've seen really, you know, good success with this approach is the iteration cycle is impedance matched to the rate of progress in the industry. So with very large foundries and working with an outsourced model. Well, they the capabilities at the you know, in producing very large wafers with high yield can be substantial. They're really quite sharp capabilities and to deviate, or to very those to produce quantum chips require substantial rework and retooling and could only happen with this relatively slow cadence of maybe annual or biannual tape outs, and redesign. And we view that as a real challenge to overcome going forward for that for those alternative strategies. So with a captive foundry, we expect to be able to continue to drive pioneering advances in the chip architecture in the manufacturability. Going forward.

Christopher Bishop:

Yeah, thank you for sharing that. Yeah. Very exciting that, again, sort of controlling, you know, the, the core process, or the core sort of capability. It's great that you have that in house. Right. Let's tease out one of the vectors. You mentioned, scale scalability. So it's been one of the largest hurdles that quantum computer companies face when going to market right. Your latest offering introduced in June last year, called Aspen M, is an 80 qubit processor that consists of two connected 40 qubit chips, right and is available on your quantum cloud services platform I read. Tell me about your multi chip quantum processor and what are the advantages of two connected qubit chips? The implication being how will it scale, right? How do you manage the interaction between them, but then it gives you the ability to sort of build out a multi-chip processor that could deliver you know what, what single chips couldn't do.

Chad Rigetti:

At the high end of computer chip manufacturing, quantum or classical, everything is yield limited. And that applies to the latest NVIDIA GPUs or TP or Google TPUs or the latest AMD chips. For example, having a technology solution to mitigate and reduce the yield challenges going forward was one of the things we set out to develop and deliver in the multi-chip solution. What you're able to do with a multi-chip architecture is to transform what is otherwise an exponential yield challenge. As you pack more and more quantum components onto a single die, more qubits more resonators, more readout, io, more control circuitry onto a single die to build larger and larger quantum computers, you're able to transform that exponential yield challenge into a linear challenge of producing many good copies of say, 100, you know, a die with 100 qubits, and assembling those together to create, say, a system with 1000 or 4000 qubits. Now, if you take that approach, you, you reduce the yield challenges and those yield challenges can be addressed, they is relatively slow, and it's really quite expensive to address them. And our focus is on speed and driving to quantum advantage and other milestones at you know, as leaders in the industry and continuing our pioneering position. And so we wanted to develop an approach that could allow us to do that. And ultimately, the multi-chip solution by translating from exponential to linear in terms of the yield challenge shifts the work into a different approach, which is how do you develop the 3D integration technology to allow yourself to assemble these chips at the wafer or die level to produce a multi-chip quantum processor and that's what Rigetti has been focused on for the past many years. In fact, the technology roots of this go back to 2015, it includes core technologies like the ability to do superconducting die level packaging, superconducting through silicon via process technology for both isolating qubits on a single die, as well as delivering signals to and from qubits through, you know, through 3D signaling. And then the last kind of component that our engineering teams have put in place over the past few years is the ability to do very high quality very fast, two qubit gates directly between qubits disposed on different pieces of silicon. And that last ingredient where you're really able to create a, a single cohesive quantum lattice of qubits across multiple dies, was last piece of the puzzle and the 80Q Aspen M processor, as you said, based on two 40 qubit chips, the critical capability here, you know, there's all these foundational things like the superconducting TSVs is a super interesting die level packaging, other capabilities, but then being able to assemble that processor into operate that 80 qubit system, as if it were a single die processor, from an end user perspective is the is what we've been able to deliver. And I want to distinguish that against some other approaches to scaling. Because in the end, all quantum computing, scaling technologies or approaches are going to require some degree of modularity, the die level modularity or the kind of multi-chip approach to building a single cohesive quantum processor, it's multi chip, but it's single core, if you will. And that approach is really interesting, because it doesn't introduce any network latency, for example, or overhead in slower gates, because of the you know, the gates between dyes being done with a different manner mechanism as the intra chip to keep a gate. So ultimately, this is a really interesting solution. And with our 3d integration technology now, and going forward, we're going to be able to assemble, we anticipate being able to assemble larger, larger quantum computers, simply by using more copies of those core dyes and assembling them out onto the, you know, the cap, the higher the carrier die, that we call it. And that approach is really exciting. We think it's gonna be a substantial acceleration in the rate of scaling at Rigetti and in the industry.

Christopher Bishop:

Wow, very exciting. So you mentioned quantum advantage, just take a step back and talk to the big picture for a moment about the larger question of maybe the difference between quantum supremacy and quantum advantage. So we know that Google claims to achieve quantum supremacy in September 2019, right when they're running that algorithm, and solving in 200 seconds, what would have taken a classical computer 10,000 years to solve? And I guess the Chinese since then have extensively already exceeded that performance level. I also read in October last year, two Chinese teams claimed to have reached quantum advantage. So let's talk about that for a moment. Can you describe for our listeners what the difference is and why Rigetti is particularly focused on advantage. And then by inference with the broader implications are for the industry.

Chad Rigetti:

We tried to be really thoughtful about the right metrics and the right objectives to set for ourselves and recognizing that in many cases, those become objectives for the overall industry. And in kind of 2017 2018, we went through a process and a series of conversations, where does quantum computing technology and ask the question, Where does quantum computing technology really need to get to get to an inflection point to really start unlocking end user value? At that point, we were just starting out on the stage of scaling our production quantum computing systems, we want to set clear goals for the organization going forward and for the industry. Ultimately, we landed on a notion of quantum advantage. And we put some work into what we mean by that, because it's really important to be clear. So quantum advantage ultimately, is when you're able to use quantum computing systems to solve computational problems with some degree of performance benefit, relative to the best available classical alternative, that performance benefit could be faster time to solution, lower cost of solution, or perhaps higher quality or greater accuracy of solution if you're trying to calculate a ground state energy of molecule, for example, and quantum advantage is so so if you focus on that definition of quantum advantage, it means that it's in essence, that kind of customer defined metric. It's about what you're doing for your customers and the end user versus what, what they're, you know, what the systems are doing from an algorithmic perspective, independent of an application. Now, quantum supremacy, the Google achievement of quantum supremacy in 2018, was historic and an incredible accomplishment for the industry, that the definition of supremacy and they're you know, according to Google, which is very, very rigorous one is kind of non-classically reproducible behavior on a porter Thomas sampling experiment. And that definition is really strong because it's rigorous, and it's thorough, and it's quite objective, it is disconnected from any particular customer application, if you will, right. So it's really a little bit like measuring the horsepower of an engine when the engine is on stilts in the garage versus can the car get you to school and back. So it's really strong. It's a different concept than advantage. And so what we're getting has been focused on is delivering quantum advantage with end to end customers. And we think that's really the metric that needs to be hit to achieve an inflection point in the rate of adoption and in the growth of the revenue opportunity for all the participants in the quantum computing industry today. So we've been focused on that corn advantage now, within quantum advantage. Today, Rigetti is in the early the emerging quantum advantage phase. And what that means is today our systems are big enough, fast enough and performant enough that you can earnestly benchmark them against classical alternatives. Or you can, you can run practical use cases on our systems and get relevant information out relevant data. And so in this phase of emerging quant advantage, really for the first time, we're able to truly benchmark against practical use cases and ask the question, are we close to quantum advantage? Are we showing quantum advantage what needs to be true? That isn't true yet, in order to demonstrate Kwan advantage and to hit this inflection point. And you know, going forward, we expect to go through additional stages of kind of narrow quantum advantage where you're first demonstrating it on a specific use case, perhaps, you know, pricing options with a bank or predictive weather modeling through a generative modeling approach. And then from there really through to solving problems that are classically intractable. And at that stage, that would be kind of a broad quantum advantage, because that if you're if you're able to solve an intractable problem, what is classically intractable, there's going to be a broad degree of transferability, and applicability of those results beyond the specific narrow use case and customer that you've worked with. And so you really think of it as emerging QA, and then narrow QA, where you're delivering that value to end users on a specific use case basis, and then broad, we're going to start to see broad adoption and re applicability of specific results from our quantum computing systems.

Christopher Bishop:

Yeah, thank you for sharing that respect. I think it's key at tying two use cases real world applicability, right? Advantage. That's, that's the key ultimately, right? I have to take a moment to ask you about qutrits. So again, a new term to be added to the quantum lexicon. I read that by adding just one additional state, you can turn your qubits into qutrits, which not only increases the amount of information encoded in a single element, but also enables techniques that can dramatically decrease readout errors. So can you tell our listeners more about how this works?

Chad Rigetti:

The concept of qutrits has been around for a long time almost as long as qubits and in fact, encoding information and, you know, 0, 1, or two, maybe the three lowest line energy states of our qubits is an established concept. Now, at Rigetti we'd like to take, we like to be a pioneer. We'd like to push the envelope from a research and development perspective and introduce new concepts to the industry by demonstrating the ability to leverage more than two computational states. It's really building around this core concept of what a quantum computer is. A quantum computer ultimately encodes and represents information in quantum mechanical states, the transmon qubits we use have additional states, and those states can be very well behaved and can be manipulated. So by introducing this concept of qutrits, we've accomplished a few things. Broadly speaking, it's a rich sandbox really, for exploring how quantum computing concepts can be incrementally expanded and applied to new use cases in that pursuit of quantum advantage. Ultimately, a practical use cases one specific application is really decreasing readout errors. So if you use 0, 1, and two states as all kind of as viable computational states in each qubit, you can then allocate those two playing a specific role in the computation, whether that's for running specific error correction tests, or parody measurements, or even detecting when a readout error may have occurred, or qubit error may have occurred. And we think there's a really interesting and exciting research paradigm to open up with multistate delivering multiple different states beyond just the two qubits within our technology. Now that's got to be coupled with and paired with a software capability to actually manipulate the states. And one of the really interesting things about Rigetti quantum cloud services is we provide to end users the tools to do pulse level programming to kind of to manipulate these multiple states and this is a capability that is really enabled by our core software on our stack. It's an exciting development.

Christopher Bishop:

Qutrits. Yeah, so I, it's new to me, I guess I'm guilty as charged, I have to investigate further thank you for explaining that. There's, of course an ongoing discussion about how much classical computation is required to make quantum computers viable. And I read that Rigetti offers the hybrid quantum classical computation solution with its quantum cloud services platform QCS. And you're able to support ultra-low latency connectivity less than one millisecond between, say, a customer's high performance classical hardware, and Rigetti's QPUs, using high density flexible circuits must be more to it, I'm sure, can you tell me a bit about how you managed to achieve this. And by inference the importance of better interoperability between classical and quantum devices.

Chad Rigetti:

Our vision for quantum computing has from, from the very early days in 2013, in 2014, centered on really viewing the quantum computer as a component in a or the, the quantum processor itself as a component in a broader computing system in a, in a little way, kind of in an analogy to a, you know, a nuclear reactor where there's the core that generates all the, all the, the raw power, if you will, or the heat, um, or the energy, but then there's an entire ecosystem or infrastructure of kind of non-quantum technologies around it to allow you to, to leverage and apply that to reduce power electricity. And the quantum computer can, you know, conceptually can be taken in a similar way. So we've really viewed, uh, and pioneered this notion of hybrid quantum classical computing, where the quantum processor is delivered in a manner where it's meant to solve problems in tandem with best available classical computing. One of the reasons, and one of the benefits of doing is that, Hey, classical computing is Moore's law is, is grinding to a halt for sure Amdahl's law is, is also kind of at point of, uh, of diminishing returns. Uh, but there are architectural innovations happening in classical computing that are going to continue to drive progress in classical computing. And so, uh, our strategy is to really, uh, couple and partner with classical advanced classical computing technology through our QPUs to deliver to an end user, not an either or quantum or classical, but the, the availability to run on the leading QPU technology, as well as in tandem, in, in a tightly integrated approach, the leading classical computing technology, uh, at that point in time. And, uh, we're able to do that through our cloud services platform. Uh, we've been able, we've been focused on this hybrid approach of quantum classical computing for a long time. We've got an extensive patent portfolio around this, this technology, and have, uh, developed some of the core concepts, for example, Quil, which is, uh, an instruction language that really for the first time put quantum logic instructions and classical logic instructions on the same footing within a single instruction set, uh, uh, a kind of a precursor to a, to a fully realized notion of hybrid quantum classical computing and what this enables is a again, a kind of sandbox for the quantum algorithm developer and the customer to explore this very rich, uh, uh, platform of quantum classical computing to solve their problems from a very pragmatic point of view. Uh, this can enable, for example, the development of hybrid quantum classical neural networks, because the, a tight integration of the hardware that represents both of the components of those, uh, of such a network on hardware, uh, we're just really excited about the direction that this can lead going forward. We've been pioneering it for a long time. And I think one of the things you've really started to see is a broad adoption of this concept across the industry. As people have recognized the importance of this, of this idea, um, now going forward, uh, one of the most important concepts is gonna start to take hold over the next 5 to 10 years in the industry as a notion of fault tolerance and, uh, to run full scale error correction, to deliver truly fault tolerant quantum computers requires substantial classical compute capability, uh, effectively delivered in real time in with a quantum processor. And so we expect that our pioneering role in our, in our leadership, in the hybrid computing technology is going to translate smoothly into leadership in the quantum error correction fault tolerance phase because of the necessary ingredients. Really what we've built so far is a, is a subset of the broader requirements for a truly, fault tolerant quantum computer. Uh, but we've done it from a very practical lens. And so we're really excited about what this means about our roadmap going forward as well.

Christopher Bishop:

I wanna turn to the perennial question. I've been casting this as a $64,000 question based on a quiz show that was on TV in the sixties, but for younger guests, they've never heard of that show. So I'm calling it now the perennial question, but anyway, Chad, do you have clients, right? Um, I read that Rigetti is partnering with Deloitte and Strangeworks among others to explore quantum applications in areas like material simulation, optimization and machine learning. Can you share a little bit of detail about these engagements or who you're working with, uh, even at a meta level, certainly don't want you to share any confidential or proprietary information or give away competitive advantage for your clients, but people always wanna know, you know, where is this going on and how are people using it?

Chad Rigetti:

We do, Rigetti is working today with a broad range of customers in both the public and private sector. We've taken the view towards building the business and the revenue side of the organization, a bit like the technology where, um, you, you're not gonna turn on a hundred million a year revenue engine overnight. You need to build that up over time. Uh, Rigetti reported 6.9 million in revenue for the first three quarters of 2021. Um, and you know, up significantly from, from both prior years. So we're continuing to grow the business and we've got good traction with a broad set of customers. Now, the strategy and approach we take on this is quantum computing is gonna be transformative for substantially any organization, public sector, private sector that uses advanced computing as part of its core operations, or as part of its strategic advantage. And we seek out and partner with leading organizations within their domain that have the use cases that can be accelerated with quantum computing, where we can provide substantial value to them over the medium term. And we can pursue quantum advantage, uh, demonstrations together, and then work to get quantum advantage capabilities in production with them and for them, uh, that has led to a set of deep technology partnerships, ultimately allowing us to accelerate our, our kind of full stack technical innovation from chip design all the way through to kind of software compiler technology. Um, as well as, you know, engaging with, with a, with, with a set of cloud distribution channels, whether it's AWS, uh, that we've been with since they launched Braket service in 2019, we recently announced a, an agreement to bring Rigetti quantum computers, to Microsoft's Azure quantum platform as well, increasing the accessibility of our, of our systems to a, a broader set of users and end customers, we also have, uh, established relationships and, and contracts with some of the leading operators of high performance computing systems. So obviously in the United States, the Department of Energy really takes the lead on a lot of the, you know, high, high end high performance computing systems. Uh, and, uh, and we've really focused on building strong relationships and, and partnerships with, with some of the, those labs as well, uh, in, in driving our, our technology to this, uh, advantage milestone and, and, and, you know, bringing it to the applications and use cases that it can benefit.

Christopher Bishop:

So you announced at the end of last year, you're gonna go public using a SPAC and merging with Supernova Partners. Can you give us an update on that, you know, more importantly, really, how will you and the company use this new funding to advance the business model to develop your ongoing, innovative roadmap, you know, and, and develop, uh, share, share your vision of where we're getting might be in three to five years?

Chad Rigetti:

Uh, our, our goal is to build, uh, one of leading companies in what we expect is gonna be a very large and important, uh, industry and market going forward to continue to be the technology pioneer in the space and to be the pioneer in driving towards practical use cases, quantum advantage, uh, and getting that into production, uh, with end customers, we're really excited to take Rigetti public, through our SPAC merger with Supernova Partners. It's been incredible working with them through the process over the past several months. We're very excited about this and the next stages for the company. Ultimately, our goal is to continue to advance our technology, to invest in our, you know, to fully invest in our technology and product roadmap going forward, and to be able to fully invest in the research and development partnerships with customers and partners to deliver quantum computing, you know, and to realize the full vision and potential of the technology and going public is gonna be a, a really exciting step forward for Rigetti and for the industry overall, uh, as we complete the transaction.

Christopher Bishop:

Yeah. Do you have a target date, um, in mind, or I guess, I mean, there are a lot of processes involved to get, to get to.

Chad Rigetti:

Uh, we're making good progress and.

Christopher Bishop:

Okay. I'm not gonna press you too much. And congratulations. Fantastic, exciting news. Um, my congrats on the Microsoft, uh, relationship as well. Terrific. So we're coming to the end. I always like to ask about workforce, right? It's a, it's an area of passion for me as a nonlinear multimodal careerist self. Um, I wanted to ask you what the challenges are facing a company like Rigetti and finding talent, you know, how do you go about recruiting for your company? Uh, do you have affiliations with universities perhaps, or national labs? You mentioned relationships with some of those, are you poaching from corporate, R&D uh, you know, based on your colleagues' network at IBM, just curious how you, how you find out it's a, you know, it's a rapidly growing space and high demand for, uh, talent across disciplines, right. So I just wanna get your take on that.

Chad Rigetti:

It’s interesting. I think, uh, I don’t know if there’s ever been an industry that has been founded and created in the early years by hundreds of physicists and quantum computing is really that kind of industry. I’m not sure if you’ve ever seen that before potentially you really, the nuclear industry could have been that, but obviously subject to really substantial, uh, regulation. It puts it in a very different class. And so the opportunity for this industry to grow and flourish based, and just the, the incredible individuals that have been, um, engaged in the industry over the past decade. And there’s so many, uh, uh, incredible people in quantum computing today, first and foremost, it makes me just very bullish about the industry as a whole and the impact it’s gonna have, um, the success that the companies are gonna have. And, and also, I think it, it creates a path for individuals that are early on, maybe they’re in college or they’re in high school that, uh, are really interested in STEM. They’re really interested in science or physics or engineering. Uh, maybe they don’t want to, maybe they don’t want to a, a career in pure research, but they want to have an impact on building products and technology that customers use. And I think quantum computing continues to emerge as an industry where that industry, it is hungry for talent, um, because there’s, uh, there, there, there’s always more challenges, uh, than there are people to solve them. But I think it’s creating a visible path for people early on in their careers to say, that’s something I would want to do, and I wanna prepare myself for a career there. Uh, so I think that’s having a really positive impact overall, uh, we continue to grow. I think one of the things that’s gonna happen through going public and fully capitalizing the balance sheet is that we’re gonna, you know, we expect to grow substantially and we continue to attract and, and have just an incredible team, incredible workforce. Everything that we’ve talked about, everything that the company has accomplished is because of the incredible individuals that have, that have driven that work over the past, you know, 5, 6, 7 years at Rigetti. And, and we’re really bullish on, on, on the future. Um, we do have, uh, you, you know, kind of thinking about talent pipelines and workforce as a consideration of different things, we do, um, some of our partnerships with the Department of Energy, for example, Rigetti is the lead industrial partner on one of the five United States national quantum initiative, uh, research centers, the SQMS center led by Fermilab. Uh, and as part of that, uh, where is just an interweaving of the, of the, of the talent base, if you will, across, uh, major institutions, all the institutions involved there, they get exposure to Rigetti. Rigetti gets exposure to them. And I think things like this can be really healthy for the broad talent markets, cause it creates a little more transparency and visibility about what the different career paths maybe like ultimately, and people can, can ultimately select into the, you know, the paths that make sense for them. So I think that’s having a really positive impact as was the intent ultimately of the national quantum initiative. And we’ve started to see really, uh, really, really, really good impact from it.

Christopher Bishop:

Yeah. Great. So University of Chicago, the Fermi, is that an affiliation with Chicago quantum exchange?

Chad Rigetti:

Fermilab, Northwestern is the lead, one of lead academic institutions. There's, there's more than 20, institutions across the SQMS center. Um, and there are five of these centers across United States, all led by Department of Energy entities. So overall I think it's really having a positive impact on the, on the, on the US workforce in quantum computing.

Christopher Bishop:

Chad that brings us to the end. Um, thank you much. I've really enjoyed our conversation. Uh, it's been very enlightening for me and I hope our listeners enjoy it. I wanna invite people to follow you and the company Rigetti Computing on LinkedIn. I wanna point them to their website, rigetti.com. They're also social media channels. They're two handles on Twitter at Chad Rigetti and Rigetti, and there's a YouTube channel for Rigetti Computing as well. Thanks Chad, for joining me today and thanks to all of you for listening, please share this podcast on social media channels to increase the impact of my conversation with Chad and listen to my other podcast episodes. If you haven't already quantum tech pod and feel free to connect with me on LinkedIn.

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About Rigetti Computing

Rigetti Computing is a pioneer in full-stack quantum computing. The Company has operated quantum computers over the cloud since 2017 and serves global enterprise, government and research clients through its Rigetti Quantum Cloud Services platform. The Company's proprietary quantum-classical infrastructure provides ultra-low latency integration with public and private clouds for high-performance practical quantum computing. Rigetti has developed the industry's first multi-chip quantum processor for scalable quantum computing systems. The Company designs and manufactures its chips in-house at Fab-1, the industry's first dedicated and integrated quantum device manufacturing facility. Rigetti was founded in 2013 by Chad Rigetti and today employs more than 140 people with offices in the United States, U.K. and Australia. Learn more at www.rigetti.com.

About Supernova

Supernova is led by Michael Clifton, who was most recently a technology investor at The Carlyle Group; Robert Reid, a long-time senior partner at Blackstone; Spencer Rascoff, a serial entrepreneur who co-founded Hotwire, Zillow, dot.LA and Pacaso and who led Zillow as CEO for nearly a decade; and Alexander Klabin, founder and CEO of Ancient and former managing partner, co-CIO and co-founder of Senator Investment Group.

Additional Information and Where to Find It

Supernova has filed a registration statement on Form S-4 (as amended, the "Form S-4") with the Securities Exchange Commission (the "SEC"), which includes a proxy statement/prospectus, that will be both the proxy statement to be distributed to holders of Supernova's common shares in connection with its solicitation of proxies for the vote by Supernova's shareholders with respect to the proposed business combination and other matters as may be described in the registration statement, as well as the prospectus relating to the offer and sale of the securities to be issued in the business combination. After the registration statement is declared effective, Supernova will mail a definitive proxy statement/prospectus and other relevant documents to its shareholders. This communication does not contain all the information that should be considered concerning the proposed business combination and is not intended to form the basis of any investment decision or any other decision in respect of the business combination. Supernova's shareholders and other interested persons are advised to read, when available, the preliminary proxy statement/prospectus included in the registration statement and the amendments thereto and the definitive proxy statement/prospectus and other documents filed in connection with the proposed business combination, as these materials will contain important information about Rigetti, Supernova and the business combination. When available, the definitive proxy statement/prospectus and other relevant materials for the proposed business combination will be mailed to shareholders of Supernova as of a record date to be established for voting on the proposed business combination. Shareholders will also be able to obtain copies of the preliminary proxy statement, the definitive proxy statement and other documents filed with the SEC, without charge, once available, at the SEC's website at www.sec.gov, or by directing a request to Supernova's secretary at 4301 50th Street NW, Suite 300 PMB 1044, Washington, D.C. 20016, (202) 918-7050.

Participants in the Solicitation

Supernova and its directors and executive officers may be deemed participants in the solicitation of proxies from Supernova's shareholders with respect to the proposed business combination. A list of the names of those directors and executive officers and a description of their interests in Supernova is contained in Supernova's prospectus dated March 3, 2021 relating to its initial public offering, which was filed with the SEC and is available free of charge at the SEC's website at www.sec.gov. To the extent such holdings of Supernova's securities may have changed since that time, such changes have been or will be reflected on Statements of Change in Ownership on Form 4 filed with the SEC. Additional information regarding the interests of such participants will be contained in the proxy statement/prospectus for the proposed business combination when available. Rigetti and its directors and executive officers may also be deemed to be participants in the solicitation of proxies from the shareholders of Supernova in connection with the proposed business combination. A list of the names of such directors and executive officers and information regarding their interests in the proposed business combination will be included in the proxy statement/prospectus for the proposed business combination when available.

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