Quantum computing and the race to commercialisation: Dr. Subodh Kulkarni, CEO of Rigetti Computing, on The Next Big Thing

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Key Takeaways

- Rigetti is one of only three companies in the world, alongside IBM and Google, that has built a working quantum computer with more than 100 qubits, putting it in a very small group of organisations at the true frontier of the technology.
- Rigetti's open modular architecture sets it apart from the closed, mainframe-like approach taken by IBM and Google, allowing it to integrate best-in-class partners across cloud, software and error correction rather than trying to own the entire stack.
- Qubit quality (fidelity) matters far more than qubit quantity. Rigetti has led an industry-wide shift in focus from scaling up the number of qubits to improving the accuracy of each one, which is the real gate to commercial usefulness.
- Quantum computers will not replace classical computers. The future is a hybrid architecture where quantum processing units (QPUs) work alongside CPUs and GPUs in data centres, each doing what they do best.
- Quantum advantage, the point at which quantum computers become genuinely useful in commercial data centres, may be roughly three years away, contingent on reaching around 1,000 qubits, near-99.9% fidelity, faster gate speeds, and real-time error correction.

Classical computers have one constraint that has never changed. The bit is always either a zero or a one. Quantum computing changes that entirely. A qubit can be both at the same time, and when you harness enough of them together, you can tackle problems so complex that no classical machine on earth could solve them in any practical timeframe.

Governments on every continent are now committing billions to the race. A company at the centre of it is Rigetti Computing, one of a very small group of organisations that has actually built a working quantum computer with more than 100 qubits.

That is why we invited Dr. Subodh Kulkarni, President and CEO of Rigetti Computing, on The Next Big Thing. Subodh came to quantum computing from the semiconductor industry, and that background shapes

everything about how he runs Rigetti, from the decision to prioritise qubit quality over quantity, to the belief that getting quantum computing out of the lab and into data centres is fundamentally an engineering challenge.

This blog post summarises some of the key messages from the conversation. To listen to the full episode, follow the link **here** .

What is Rigetti Computing?

Rigetti was founded in 2013 by Chad Rigetti, a physicist who had worked at IBM and believed there were better ways to bring quantum computing to market. The company went public through a SPAC in 2022 (a SPAC, or Special Purpose Acquisition Company, is a listed shell company used as a faster route to market than a traditional initial public offering). Subodh joined as CEO shortly after, brought in by the board because of his deep background in the semiconductor industry. His starting point was that at the heart of superconducting quantum computing is a chip that looks and feels a great deal like a semiconductor chip, built on silicon, using standard equipment. His experience scaling and eventually selling Cyber Optics, a publicly traded sensor company for semiconductor manufacturers, made him a natural fit for what Rigetti needed: an engineer who could take a lab prototype and turn it into something that could reliably live in a data centre.

What is superconducting quantum computing and why does it matter?

There are several competing approaches to building a quantum computer. Rigetti uses superconducting gate-based quantum computing, which is also the approach chosen by IBM and Google, and accounts for more than 90% of global investment in the field. The reason comes down to two things: speed and scalability. Superconducting systems operate using electrons, which means gate speeds (the time it takes to perform an operation on a qubit) in the range of tens of nanoseconds. Competing approaches that use trapped ions or atoms are physically moving particles rather than electrons, making them roughly 10,000 times slower. Superconducting systems also draw on established semiconductor manufacturing techniques, which gives them a clear path to scaling up in ways other approaches cannot match. The trade-off is fidelity (the accuracy of quantum operations), where trapped ion systems currently have a slight edge. Rigetti's position is that the fidelity gap can be closed through engineering, whereas the speed and scale disadvantages of other approaches are much harder to overcome.

What makes Rigetti different from IBM and Google?

Subodh was direct about the competitive landscape. IBM and Google have built their quantum computing stacks like mainframe computers: closed systems where they control everything and allow no meaningful integration with outside parties. Rigetti has taken the opposite approach, building what Subodh calls an open modular architecture. Every layer of the stack, from the chip to the software, is designed so that third-party solutions can slot in. This matters because the best components in the quantum computing ecosystem are not all coming from one company. Rigetti is partnered with Nvidia for distribution layer

software (the software layer that decides which computations go where), with AWS and Microsoft Azure for cloud deployment, with Quanta for control systems, and with Riverlane for error correction. None of those partnerships would be possible if Rigetti had taken the closed approach. The second major differentiator is chiplets. In conventional semiconductors, chiplets (small, stackable chips assembled together rather than built as one large chip) have become standard practice because smaller chips are easier to manufacture consistently. Rigetti was the first to demonstrate chiplets in quantum computing and holds strong intellectual property in the area, particularly around the challenge of allowing qubits to remain entangled (quantum-mechanically connected) across chip boundaries, which has no equivalent in classical computing.

What is fidelity and why is it the key metric?

One of Subodh's most important contributions since joining Rigetti has been to shift the industry conversation from the number of qubits to the quality of qubits. Fidelity, specifically two-qubit gate fidelity, is a measure of how accurately information is transferred from one qubit to another (think of it as the error rate of each operation: a fidelity of 99% means 1 in every 100 operations introduces an error). When Subodh arrived in 2022, Rigetti's two-qubit gate fidelity was around 95%, which he described as simply not good enough for anything practical. Even a million-qubit machine at 95% fidelity would produce results no better than a fifty-qubit machine. The company refocused almost entirely on fidelity improvement, and is now in the mid-99s, around 99.5 to 99.6%. The target for commercial viability is 99.7 to 99.8%. It sounds like a small gap. The engineering required to close it is enormous, but Subodh's view is that it is an engineering problem, which means it can be solved.

What is the wiring challenge and how does Rigetti plan to solve it?

This was one of the most technically illuminating parts of the conversation. Each qubit requires roughly three to four wires to operate. At 100 qubits, that is manageable using standard coaxial cables, and Rigetti, IBM and Google are all doing exactly that. But the quantum computers of the future require thousands, eventually millions, of qubits. At that scale, coaxial cables simply run out of physical space, particularly inside the dilution refrigerators that cool quantum chips to around 10 milliKelvin, colder than outer space. Rigetti's roadmap addresses this in stages. In the next one to two years, the plan is to move to superconducting flex cables, which pack far more connections into the same space. For systems beyond 10,000 qubits, the answer is optical fibre, converting the microwave signals used in superconducting quantum computing into light signals that travel through fibre. Optical fibre gives another order-of-magnitude improvement in density over flex cables, and Rigetti is already publishing research in this area with partners including Qphox in the Netherlands. The path to a million-qubit quantum computer runs through coax to flex cable to optical fibre, each transition unlocking the next scale threshold.

What is the hybrid computing future and when does it arrive?

Subodh was very clear that quantum computers will not replace classical ones. The question is how they fit together. Today's data centres already use CPUs and GPUs side by side: CPUs handle sequential tasks like database sorting; GPUs handle parallel workloads. Subodh's argument is that a third tier is coming, the QPU (quantum processing unit), which will handle what he calls simultaneous computing, the class of problems where multiple parallel streams have to interact with each other. That interaction is what creates the enormous processing overhead in generative AI today, and it is where quantum computers offer a genuine advantage. The software layer that manages this trifurcation, deciding in real time which computation goes to which processor, will likely evolve from Nvidia's compute unified device architecture (CUDA) platform, and Rigetti is already partnered with Nvidia on exactly this. Rigetti has also announced a collaboration with HPE to build a hybrid system at the Pittsburgh Supercomputing Center, a joint venture between Carnegie Mellon University and the University of Pittsburgh funded by the National Science Foundation (NSF), which Subodh expects to be available for public use within a year. His estimate is that hybrid quantum-classical systems will start entering commercial data centres in around three years.

What is quantum advantage, and how far away is it?

Subodh defined quantum advantage simply as the point at which a data centre manager looks at a quantum computer and sees a clear return on investment. He identified four things that need to happen together: a minimum of around 1,000 physical qubits; two-qubit gate fidelity of at least 99.8%; gate speeds better than 40 nanoseconds (currently at 60); and real-time error correction. Rigetti is currently at around 100 qubits and mid-99s fidelity, so the gap is real. His estimate is roughly three years, though he was careful to acknowledge this could be two and a half or four. He was also notably direct about some of the more ambitious claims being made elsewhere in the industry, pointing out that claiming quantum advantage today while also saying meaningful revenue is four years away is internally contradictory. His position is that the industry is still firmly in research and development, and that being honest about that is what builds credibility with the people who will eventually be deciding whether to put quantum computers in their data centres.

Final thought

The big takeaway from this conversation is that quantum computing is real, it is progressing, and the companies working on it are making genuine engineering advances. But it is also still a few years away from commercial data centres.

What makes Rigetti interesting is the combination of engineering rigour, a distinctive open modular approach that allows it to punch above its weight against much larger competitors, and a clear, specific roadmap for how the technology gets from where it is today to where it needs to be for commercialisation. The race is on for developing a quantum computer and Rigetti is one of a very small number of companies that has earned its place at the starting line.

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