SECTOR PROFILE
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Digital Economy – Bits, Bytes & Basis Points

A view of where progress on quantum stands, from the top of Rigetti Computing

Summary

Interview with Subodh Kulkarni, the CEO of Rigetti Computing Inc., as part of our Bits, Bytes & Basis Points series. The views expressed by Dr. Kulkarni are his own and not those of Moody's Ratings.

The long promise of quantum computing is now showing momentum. New research indicates quantum computers capable of breaking the encryption that protects most sensitive digital data could arrive earlier than expected, while the US government has declared quantum a strategic national priority. We asked Subodh Kulkarni, CEO of Rigetti Computing, which makes everything from superconducting quantum processors to cloud-accessible quantum computing platforms (and which was recently selected to receive an up to $100 million investment from the US government),[1] for his views on where progress on quantum computing really stands, which sectors will see the most significant changes first, and the cryptographic harvest-now-decrypt-later threat. His responses are set out in question-and-answer format and express his own views, not those of Moody's Ratings. Below is a summary of key points from Dr. Kulkarni's responses to Moody's Ratings' questions.

» Quantum computing systems are still a nascent field because of engineering challenges and will likely not cross the commercial threshold in the next year. The quantum advantage remains an estimated three years away.

» In financial workflows, portfolio optimization, risk aggregation and stress testing, and derivatives pricing are likely to first see the benefits. Quantum will not wholly replace classical computing's infrastructure, but will instead be a hybrid that accelerates specific bottlenecks inside classical workflows.

» A hybrid model of classical, AI and quantum computing will likely prevail for the next decade. Quantum's defensible advantage will lie in problems where the state space grows exponentially with the size of the input.

» Post-quantum cryptography (PQC) challenges are "critical now" as adversaries can collect encrypted data today and decrypt it when cryptographically relevant quantum computers exist. That includes financial infrastructure data from payment systems, clearing and settlement, identity and custody. The systemic vulnerability is the concentration of migration in a narrow window of time. The operational risk during transition will itself become a systemic exposure and will touch every system with public-key cryptography.

» Quantum is emerging as a strategic capability and is being shaped by hardware leadership, talent shortages and competing standards. Countries must invest, collaborate and coordinate to maintain leadership, while financial institutions should prepare for fragmentation, access limits and a more sovereign digital system.

Moody's Ratings: There seems to be significant momentum around scalable quantum systems. What specific technical constraints need to be overcome? Which claims do you believe overstate near-term progress?

Subodh Kulkarni, Rigetti Computing CEO: The constraints on scaling quantum systems are well understood and are overwhelmingly engineering challenges rather than open scientific questions. The fundamental physics is not the bottleneck. What separates today's quantum processors from machines that offer general purpose commercial advantage is the engineering work of improving, reducing gate times,[2] integrating error correction and scaling manufacturing — all difficult, but all tractable.

Though we've made incredible progress in advancing quantum computing technology, we believe there is a misconception about the maturity of the industry. It is still a nascent field. There is no quantum computer on the market today with enough high-quality qubits to outperform the best classical resources on a problem that is part of a commercial production system. We do not believe any quantum computer will cross that threshold in the next year, regardless of what is being claimed. Our view is that quantum advantage — the point at which quantum computers can solve a practical problem that would be physically impossible to solve on a classical computer — is approximately three years away. We believe it will be achieved on a system of 1,000 or more qubits, at two-qubit gate fidelity[3] above 99.9 percent, with gate speeds below 50 nanoseconds, and with integrated quantum error mitigation. Those four parameters are the threshold. Any platform falling materially short of them on any one dimension is unlikely to be capable of quantum advantage.

Moody's Ratings: Which specific financial workflows — portfolio optimization, derivatives pricing, credit risk modeling, fraud detection — are most likely to see meaningful quantum advantage first? What would meaningful advantage actually look like for an institutional user?

Subodh Kulkarni, Rigetti Computing CEO: Financial workflows that map well to near-term quantum computing share a particular mathematical structure: high-dimensional optimization under constraints, simulation of correlated stochastic processes and pattern detection in feature spaces that do not compress well classically. Three categories sit clearly in this domain.

Portfolio optimization is the most-discussed example for good reason. Real-world portfolio construction is constrained by transaction costs, regulatory limits, tax considerations and increasingly complex risk factors. Classical solvers produce approximate answers within tractable time budgets; quantum methods offer a different cost-quality trade-off, particularly for portfolios that are large, heavily constrained or rebalanced frequently. Derivatives pricing — particularly path-dependent and high-dimensional instruments — is the second category. Monte Carlo simulation and differential equations are the workhorses of modern derivatives pricing, and they are precisely the kind of workloads where quantum methods can, in principle, deliver speedups. The third category is risk aggregation and stress testing, where simulating correlated tail events across thousands of exposures pushes classical compute to its limits.

What does meaningful advantage actually look like for an institutional user? It looks like running a calculation in a few minutes that today takes overnight — or running a calculation that today is intractable at all. It looks like the ability to incorporate dimensions of risk — counterparty correlation, climate scenarios, regime shifts — that current models truncate because the math becomes too expensive. Crucially, quantum advantage will not be a wholesale replacement of classical infrastructure. It will be a hybrid architecture where quantum subroutines accelerate specific bottlenecks inside classical workflows. That is the model institutions should be designing toward.

The institutions that will benefit first are the ones identifying their compute-bound workloads now, characterizing them in ways that allow quantum benchmarking and building relationships with quantum hardware partners who can co-develop application-specific algorithms. We believe that the competitive gap between firms that have done this work and firms that have not will be visible by the end of the decade.

Moody's Ratings: As classical computing and AI advance rapidly, where do you see quantum delivering a clear and defensible advantage? Where is it likely to remain complementary for the foreseeable future?

Subodh Kulkarni, Rigetti Computing CEO: The right framing is not quantum versus classical — it is quantum with classical. The realistic architecture for the next decade and beyond is hybrid: classical and AI systems handling the workloads they do well, with quantum processors accelerating specific subroutines where the mathematical structure of the problem creates an inherent advantage.

Quantum's defensible advantage is in problems where the state space[4] grows exponentially with the size of the input. That means combinatorial optimization, the simulation of quantum systems themselves (which matters enormously for materials and drug discovery, and increasingly for advanced battery and semiconductor work), certain classes of sampling problems, and a growing set of machine learning problems where data exhibits structure that quantum feature maps[5] capture more efficiently than classical embeddings. These are not edge cases. They sit at the heart of several trillion-dollar industries.

Where quantum is unlikely to displace classical infrastructure is in workloads where classical methods are already efficient: most data processing, most transactional systems, most inference at scale. Quantum will not run your core banking system. It will not replace GPUs for training large language models — or at least not for the foreseeable future. What it will do is sit alongside that infrastructure as a specialized accelerator for the problems that classical methods cannot solve efficiently, in much the same way GPUs sit alongside CPUs today.

There is also an infrastructure story that deserves attention. Data center capacity and electricity availability are emerging as the binding constraints on AI scaling. Quantum processors, particularly superconducting systems, offer significantly different energy and footprint profiles than large-scale GPU clusters for the workloads they are suited to. They can reuse much of the existing data center infrastructure for power and cooling integration, while requiring dedicated R&D centers for the specialized cryogenic and control systems. This is one reason national strategies — in the US, the UK and across allied nations — are increasingly treating quantum computing as critical infrastructure alongside semiconductor manufacturing and AI compute. The investments being made now are not speculative. They are positioning bets on which jurisdictions will host the foundational compute capacity of the next 20 years.

Moody's Ratings: What are the most critical operational and infrastructure challenges in adopting quantum technology at institutional scale? Where could the transition — particularly post-quantum cryptography migration — introduce systemic vulnerabilities across global economies?

Subodh Kulkarni, Rigetti Computing CEO: The operational challenges of adopting quantum technology fall into three layers, and post-quantum cryptography is the layer where the urgency is highest right now.

The first layer is talent and organizational readiness. Quantum is not a technology an institution can buy off a shelf and bolt onto existing operations. It requires people who understand both the physics of the underlying hardware and the mathematics of the workloads being mapped onto it. The talent pool is small and growing slowly relative to demand. Institutions that have not begun building in-house quantum expertise are already behind, and the gap compounds — the firms with internal teams are the ones identifying productive problems, running benchmarks and shaping algorithmic approaches that will make an impact in three to five years.

The second layer is infrastructure integration. Near-term quantum workloads are hybrid by design, which means quantum processors must integrate seamlessly with classical high-performance computing environments, with cloud platforms, and with the data pipelines institutions already operate. This is where adoption succeeds or fails.

The third layer is governance — how to validate quantum results, how to handle the security of data passed to quantum systems and how to manage vendor concentration risk.

Post-quantum cryptography is the area where these challenges have moved from "important eventually" to "critical now." The harvest-now-decrypt-later risk is real: Adversaries can collect encrypted data today and decrypt it once cryptographically relevant quantum computers exist. For financial infrastructure — payment systems, clearing and settlement, identity, custody — the data being collected now has multi-decade sensitivity. Migration to post-quantum standards is not a single project. It is a multi-year program touching every system that uses public-key cryptography, which is to say nearly everything.

The systemic vulnerability is concentration of migration in a narrow window of time. If the financial sector waits for definitive standards and then attempts to migrate in parallel, the operational risk during transition will itself become a systemic exposure. The institutions and jurisdictions that begin sequenced, governed migration now — with clear crypto-agility roadmaps and prioritization of long-lived sensitive data — will navigate the transition with much less risk. This is also where allied-nation coordination matters most. Standards fragmentation across the US, UK, EU and allied jurisdictions would multiply migration complexity for any institution operating globally. There is a strong shared interest among allies in aligning on standards and migration timelines, and the work being done now to bolster the US and its allies' quantum capabilities — both offensive and defensive — is foundational to financial stability over the next decade.

Moody's Ratings: If quantum becomes a strategic capability, how do you see geopolitical competition shaping access to infrastructure, standards and talent? What risks does this create for globally interconnected markets?

Subodh Kulkarni, Rigetti Computing CEO: Quantum is now a sovereign capability in the same category as advanced semiconductors and AI compute. The competition is real and it is structured around three things: the underlying hardware platforms and intellectual property, the talent pool and the standards that will govern how quantum systems interoperate with the rest of the digital economy.

On hardware, the leading platforms are concentrated in a small number of jurisdictions. The US and its allies — particularly the UK, Canada, Australia, the EU, South Korea, Singapore and Japan — hold a meaningful lead in superconducting and several other platform approaches. Maintaining that lead requires sustained government investment, including direct funding of R&D, infrastructure and procurement that allows domestic and allied vendors to scale. The countries treating quantum as critical infrastructure now are the ones that will host the capacity in 2030. This is one area where I would be direct: Government funding to keep the US and allied nations ahead of adversaries is not optional. It is the cost of remaining technologically sovereign in a category where the lead is durable but not permanent.

On talent, the bottleneck is more significant than most institutions realize. There are perhaps a few thousand people globally with deep quantum engineering experience. That number grows slowly because the training pipeline is long — a useful quantum engineer typically has graduate-level physics or engineering training plus years of hands-on system experience. Institutions that wait to begin recruiting and building internal expertise will find the talent simply unavailable when they need it. This is true for hardware vendors, for financial institutions and for governments. Partnerships between hardware providers, universities and national labs in allied countries are one of the few mechanisms that meaningfully expand the pool, and the firms participating in those partnerships have a structural advantage.

On standards and globally interconnected markets, the vision of a fully integrated global digital economy is in tension with the reality of strategic competition around quantum. We will see some degree of fragmentation — divergent standards in some jurisdictions, restricted access to certain platforms, export controls on critical components. The question is not whether fragmentation occurs, but whether it is managed. The best outcome is tight coordination among allied nations on shared standards, mutual access and joint development, with a clear-eyed understanding that some capabilities will not be shared with adversaries. That is not a retreat from globalization. It is the reality of digital sovereignty in this decade, and financial institutions designing for the next 10 years should plan accordingly.

Endnotes

1 See: Department of Commerce Announces Letters of Intent With 9 Companies for $2 Billion to Accelerate U.S. Leadership in Quantum Computing

2 In quantum computing, gate time refers to the duration it takes to apply a particular logic gate to a qubit or a set of qubits. It is considered a critical parameter that affects the efficiency and success of quantum algorithms.

3 Gate fidelity is a measure of how accurately a quantum gate is implemented in hardware. The measure reflects the overlap between ideal operations and actual operations, where 1.0 is perfect and values below 0.99 are generally considered poor for fault-tolerant computing.

4 In quantum computing, the state space is a high-dimensional amplitude space where a system simultaneously occupies many possible configurations — and computation reshapes that space.

5 A function that encodes classical data into a quantum state so a quantum model can process it.

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