CYBERSECURITY Social Engineering / Corporate Security / Human Vulnerability / AI-Augmented Attacks

The Quantum Race: Google, IBM , and Microsoft vie for Supremacy in a Transformative Technology.

Quantum Computing is one of the most preeminent and becoming the cutting edge in technology today . Classical Computers process the information in binary bits (0s and 1s), on the other side quantum computers use qubits that can exist in different states like confluence and interdependence Basically quantum computing is used to tackle difficult problems like molecular simulations, optimization and encryption , that would take the fastest supercomputers in billion of years .

According to my thinking this "race" doesn't involve only these huge techs but also nations and startups, powered by huge investments.

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The Fundamentals and Challenges

Qubits are disrupted, they can lose quantum states due to outliers, temperature changing or interference are leading to problems. Quantum error correction (QEC) is critical, requiring numerous physical qubits to make one stable "logical" qubit. Scalability is the main hurdle, useful for fault-bearable systems that need millions of qubits. While other challenges include deep-called thermal conditioning needs for quantum coherent systems, massive costs, and need for both combined quantum-classical systems. Along with this, progress in error rates, qubit numbers and architectures has increased.

Goggle's Approach: superconducting qubits and error correction milestone:-

Google quantum has been a leader in proving quantum advantage. Its 2019 sycamore processor popularly performs a random circuit job in 3 minute and 20 seconds that would take a normal supercomputer 10,000 years in december 2024, google revealed the **Willow chip (around 105 qubits),** a major development. Willow achieved "below threshold" error correction; errors reduce gradually as the system expands, a desirable achievement after 30 years of research. It also completed a standard for comparison in under 5 minutes that takes a super computer like frontier 25 septillion (10 ^ 25) years. The approach of Google includes six achievements toward a useful error-corrected quantum computer around year of 2029. The google show strongly engineering hardships where physical obstacles are showed with high impacts on AI, virtual version and beyond.

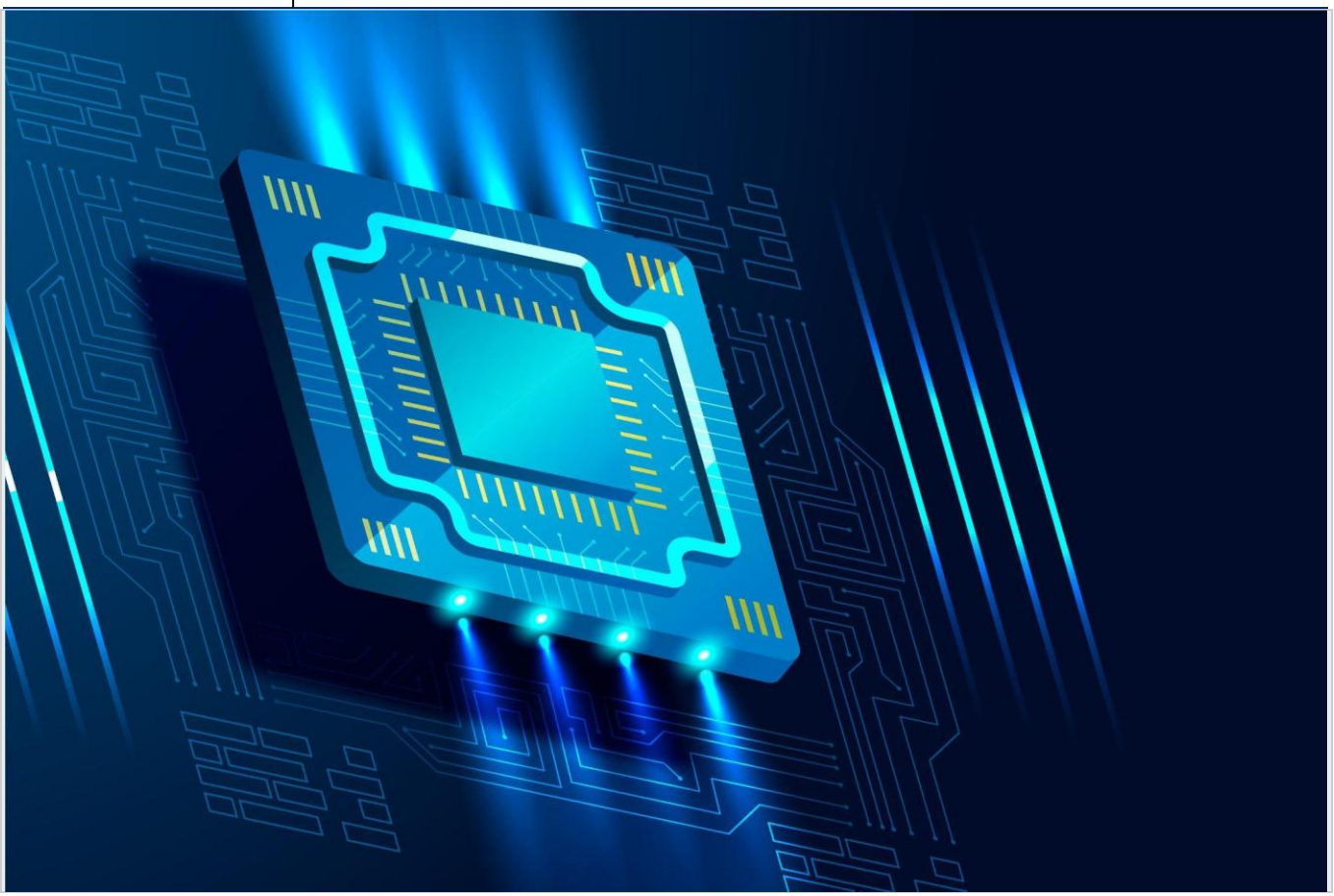

Figure 1: The Quantum Chip —using logical qubits in supercomputers. Credit: Madeeha Shoaib / PakTech Today

IBM'S strategy, modular scaling and quantum-centric supercomputing

IBM has done a systematic, hardware focused way with a public roadmap extending to 2033. IBM deployed systems along its quantum network and cloud storage, accentuating practical utility.

Key processors include:

- Eagle (107 qubits).
- Heron (133 - 156 qubits with improved error rates).
- Experiments with large platforms like Londer (1121 qubits).

In my thoughts, IBM targets quantum pros by the end of 2026 along with its night hawk processor (near about 120 qubits) goal for authentic speed ups up to 7500+ gates. It organizes a plan of fault-tolerant systems in 2029 and large-scale quantum supercomputers deploying quantum, classical and HPC resources altogether.

IBM's modular approach and focus on error improving software tools, position it good for hybrid systems that includes quantum, classical and HPC resource. It pressurize industrial industrial-scale systems by the end of decade, having applications with simulation, optimization and AI.

In short IBM works in ecosystem building, accessibility from cloud and long-term projects that makes it favourite for experiments

Microsoft's bold bet: topological qubits for scalability

Microsoft uses a different principle with topological qubits based on Majorana 0 modes in top conductors. These topological qubits have information of more robust, strongly requiring fewer physical qubits for error correction. In Feb 2025, Microsoft azure introduced Majorana one, that claims the world's first quantum processor that is using topological qubits. It claims that this could increase. The life of practical quantum computers from decades to years, with a scalability of millions qubits on a chip. The design of protected hardware aims for tiny, faster, more controlling qubits that are integrated into azure data centres.

This kind of approach is researched for about two decades and it is highly rewarded Microsoft integrated this approach to Azure quantum that offers cloud access tools and different hybrid problems solutions. The strength of Microsoft Azure is its software expertise and have the ability for disruptive hardware with topological qubits.

The Broader Race And Future Outlook

The race of quantum extends to AWS, IonQ, Quantum, PsiQuantum means different startups and nations like China and America. Nations invested in it that exceeds ten's of billions, in 2025 seen increase in fundings.

Near-term 2025-2027: it is expected from quantum advantage to be expended as Quantum as a Service i n narrow application, hybrid AI quantum workflows and quantum safe encryption urgency.

Medium-term 2028-2035: it will be seen as fault-tolerant systems that have many of logical qubits could simulate molecules accurately, new batteries, superconductors, finance and logistics. McKinsey estimates that quantum computing could generate $28-72 billion near 2035

Longer-term: in longer-term they estimates that a quantum internet, exponential AI advance via better synthetic data and breakthroughs in fundamental science. Room temperature or alternative qubit tech could be broad adoption in future.

Risk includes security threats, ethical problems and uneven global excess. Post quantum cryptography is already under the process with Google eyeing 2029 timelines. Not a single company has emerged: Google leads in error correction, IBM in scalable system and ecosystem and Microsoft leads in unique architecture.

Conclusion: A New Computing Era Dawns

The quantum race is entering in its decisive phase that starts moving from proofs of physics to engineering and commercialization. IBM, Google, and Microsoft are touching boundaries with strengths to superconducting performance and topological robustness. For researchers, the message is clear: First to do experiments via cloud platforms, then invest in talents and hybrid workflows and then prepare it for any disruption or breakage.

In short, Quantum computing can't replace classical computers but they will augment them by solving complex problems and using innovations across the industries. The future is Quantum – and it's closer than ever. The next few years will determine the leaders and researchers with the first transformative applications that reshape or change the world.

About the Author

Madeeha Shoaib is an Agentic AI Engineer and Machine Learning and Deep Learning expert currently doing her degree in Computer Science. She works at the convergence of artificial intelligence and cybersecurity, with a

particular focus on social engineering defence systems. Her work spans both the offensive and defensive dimensions of the AI-security intersection, giving her a practitioner's understanding of how the same technical capabilities can be weaponised and defended against. She is committed to elevating the cybersecurity conversation in Pakistan's technology community to match the sophistication of the threats the sector faces.

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