All Posts

Lior Mishan

10 Key Quantum Computing Predictions: 2024 and Beyond

January 24 | 2024 | 05 min

2023 has been a rollercoaster for quantum computing, filled with breakthroughs and an ever-growing sense of optimism. Major research papers have explored new error correction codes [1] and novel quantum algorithms. We even saw incredible new technological demonstrations [2-3] going up to 48 logical, fully interconnected atomic qubits [4] and the showcasing of quantum advantage in new and exciting fields [5]. This progress lays a path to practical quantum computing, which is steady and fast. Still, many challenges lie ahead.

Quantum computing is entering a crucial phase, shifting from theoretical marvels to tangible solutions. To prepare for the exciting ride ahead, let us peek into the future with ten bold predictions for 2024 and beyond.

Quantum Hardware: Making Leaps

In my attempt to decode the future of quantum computing, I have zoomed in on several key categories, the first being Hardware: the physical advancement of quantum processors. This is where the muscle lies – qubit count (supercharged processing cores), fidelity (how accurate the calculations are), and coherence (keeping those qubits singing in tune). More power, precision, and harmony – it is all about building more efficient quantum processors. My predictions for quantum hardware are:

- **Quality over Quantity:** By 2025, development teams will likely be focusing on qubit precision and performance instead of just raw count.
- **Scaling Up in Powerhouses:** Established quantum-focused countries and full-stack players are expected to maintain substantial investments in pushing the qubit count boundaries until 2025, gradually diverting more resources to qubit quality from 2026.

Software: Composing the Music for Quantum Performance

Let us now focus on algorithms and software. This category is the sheet music that tells our quantum orchestra what to play, paving the way for practical applications. After all, without smooth coding, even the most superpowered processors are just expensive paperweights.

I have two predictions for quantum software:

- **Hybrid Quantum-Classical Applications:** The practical applications of these hybrid algorithms could hit the stage as early as 2025, and their likelihood of success will keep growing from there.
- **Hybrid Algorithms Harmony:** Things are about to get much more exciting! Merging classical and quantum algorithms for enhanced problem-solving will become more common by 2027.

Standardization and interoperability will shape the commercial adoption of quantum technologies. Everyone from programmers to policymakers must play in harmony to make quantum computing a reality.

Here are some predictions for this category:

- **Commercial Investment Soars:** Will we witness a quantum gold rush? Private companies might be much more likely to take an interest in quantum computing by 2025. A surge in funding will accelerate the quantum race.
- **Standardization Takes Root:** Building common protocols and APIs takes collaboration and agreement; it is a gradual process, and we are likely to see more of this by 2026.

Quantum Advantage and Beyond

To what extent will quantum computers outperform classical machines for specific use cases? This category dives into this highly anticipated milestone where tasks previously unattainable via classical computing will be made possible with quantum computing.

Here are my thoughts on the future of quantum advantage:

- **Early Quantum Advantage Glimmers:** We might see the first hints of quantum computers outperforming classical machines for specific tasks by 2025, with that likelihood increasing moderately by 2026.
- **Fault Tolerance Takes Flight:** Building robust, error-free quantum computers is a long-term game. While it is a marathon and not a sprint, techniques for fault-tolerant quantum computers might gain traction by 2027.
- **Broader Quantum Advantage Beckons:** This is the ultimate prize – diverse applications will begin showcasing the true power of quantum computing. The start may be slow, but it will become more likely in 2027.
- **Quantum Usefulness Materializes:** Conquering specific commercial problems with quantum computing might take until the late 2020s or the beginning of the 2030s. But hey, even if it takes some time, the payoff could be huge.

Summing Things Up

Probability of prediction by years (Very low --> Very high)	**2024**	**2025**	**2026**	**2027+**
Quality over Quantity: The industry focuses on qubit fidelity and coherence and less on the number of qubits (size of QPU - quantum processing units	Low	Mid	Very Low	Very Low
Standardization Takes Root: Common protocols and APIs emerge	Very Low	Low	Mid	Very Low
Scaling Up in Powerhouses: Established regions push the qubit count boundaries	Mid	Mid	Very Low	Very Low
Early Quantum Advantage Glimmers: Specific tasks yield clear performance gain	Very Low	Low	Mid	Very Low
Broader Quantum Advantage Beckons: Diverse applications start displaying quantum power	Very Low	Very Low	Low	Mid
Commercial Investment Soars: Private companies flock to unlock quantum solutions	Low	Mid	Low	Very Low
Hybrid Algorithms Harmony: Classical and quantum worlds merge for enhanced problem-solving	Very Low	Low	Mid	Very Low
Hybrid Quantum-Classical Applications Hit the Stage: Practical solutions utilizing hybrid-algorithms emerge	Very Low	Very Low	Low	High
Fault Tolerance Takes Flight: Techniques for robust, error-free quantum computing gain traction	Very Low	Very Low	Low	High
Quantum Usefulness Materializes: Specific problems with commercial value conquered, marking a turning point	Very Low	Very Low	Low	Very High

Back to the (Quantum) Future

These categories can be viewed as a roadmap to the future of quantum computing. Of course, I do not have a magic crystal ball, and the future is never certain. There will be twists and turns, but by keeping our eyes on these key areas, we can get a clearer picture of the advancements that are just around the corner.

becomes undeniable, commercial interest may skyrocket.

Discover More About Quantum Machines

Contact us or *request a demo* to learn more about *OPX+* and its scaled-up version *OPX1000* to better understand how these unique processor-based controllers can accelerate your research.

References

[1] Bravyi, Sergey, et al. "High-threshold and low-overhead fault-tolerant quantum memory." arXiv preprint arXiv:2308.07915 (2023).

[2] Zhou, Xianjing, et al. "Electron charge qubit with 0.1 millisecond coherence time." Nature Physics (2023): 1-7.

[3] Milul, Ofir, et al. "Superconducting cavity qubit with tens of milliseconds single-photon coherence time." PRX Quantum 4.3 (2023): 030336.

[4] Bluvstein, Dolev, et al. "Logical quantum processor based on reconfigurable atom arrays." Nature (2023): 1-3.

[5] Assouly, Réouven, et al. "Quantum advantage in microwave quantum radar." Nature Physics 19.10 (2023): 1418-1422.

Lior Mishan

Lior is the Director of Product Marketing at Quantum Machines.