Blogs
May 10, 2023
Today’s Most Disruptive Technologies: Spotlight on Quantum Computing

Welcome to **Today's Most Disruptive Technologies**! We kick things off with a **Spotlight on Quantum Computing**. Artificial intelligence (AI) may be all the buzz today, but the seismic impact that quantum computing could have on the future of technology far exceeds what any of today's classical computers could accomplish within our lifetimes.

What Is Quantum Computing? Quantum computing is an area of computer science or a type of technology that applies principles of quantum mechanics to solve computationally intensive problems.

- **Qubits.** In a paradigm shift from classical computing, quantum computing relies on qubits. Whereas the traditional "bit" of a classical computer stores either a "0" or a "1," a qubit is in a state of flux, simultaneously representing two states, with a certain probability of being a "0" and a certain probability of being a "1."
- **Superposition.** A qubit continues in this "neither 0 nor 1" state, and only when the quantum system "observes" the qubit will the qubit be set as either a "0" or "1." Superposition refers to this ability of a quantum system to represent multiple values simultaneously until measured.
- **Quantum Entanglement.** Quantum entanglement refers to a phenomenon in which two qubits are inextricably linked. Once one qubit goes in one direction, the other qubit goes the opposite. This ability to create a predictable relationship between multiple qubits could spur an exponential growth in computing power.

Why Does Quantum Computing Matter Now? Quantum computing might finally be coming of age. For 90 years, there had been a fierce debate about whether quantum entanglement, that "spooky action at a distance," was real.

- **Nobel Prizes.** Just last year, the Nobel Prize in physics went to three scientists who, over the course of three decades, "laid the foundation for a new era of quantum technology." While the principles of quantum mechanics date as far back as the early 1900s, the notion of a quantum computer did not appear until the 1980s. It was not until 2012, when the Nobel Prize in physics was awarded to two scientists who discovered a way to use photons, or particles of light, to measure and manipulate quantum systems, did the quantum computer become a viable reality.

- **Cybersecurity.** Quantum computing has already caused a stir in the cybersecurity community. Consider RSA-2048, a seemingly unbreakable encryption standard that would take current-day classical computers trillions of years to pierce. Meanwhile, quantum computers are predicted to contain enough computing power to crack the code within hours.
    - **Y2Q.** Y2Q may sound familiar to those who remember the doomsday predictions of Y2K. Y2Q refers to the day when quantum computing becomes capable of breaking most of the public encryption keys used today. While we knew exactly when Y2K would happen (12:00 a.m. on January 1, 2000), no one knows when Y2Q will strike.
    - **National Security.** Cybersecurity experts are ringing alarm bells about nation-states and spy agencies who are warehousing internet data today in the hopes of decrypting that data in the future.
        - **United States.** Recognizing the national security threats posed by quantum computers, President Joe Biden signed the Quantum Computing Cybersecurity Preparedness Act in December 2022, the first U.S. federal law containing the term. The Act directs federal agencies to migrate their systems to "post-quantum cryptography to be resilient against attacks from quantum computers."
        - **Global.** The U.S. is not alone in its concern. The World Economic Forum formed the Global Future Council on Quantum Computing and issued Quantum Computing Governance Principles in January 2022.

What Are the Potential Obstacles for Quantum Computing? When compared to classical computers, quantum computers are not particularly efficient at solving simpler problems or accurately returning the correct output for a given input.

- **Quantum Advantage.** To date, quantum computers have yet to reach the point of quantum advantage. Quantum advantage is the point at which the quantum computer proves itself capable of consistently and accurately solving a real-world problem faster than a classical computer.
- **Quantum Supremacy.** Quantum advantage is not to be confused with quantum supremacy, a milestone scientists reached back in 2019. Quantum supremacy is the point at which a quantum computer performs a task a conventional computer is incapable of completing within a feasible amount of time.

- **Quantum Challenges.** Building a quantum computer with a quantum advantage over classical computers presents a number of issues.
    - **Limited Memory.** First, quantum computers cannot store data. The memory of a quantum computer only lasts a few hundred microseconds.

- **Extreme Conditions.** Second, quantum computers are highly unstable and require very specific operating conditions. Errors can occur due to various natural interferences, such as magnetic forces, temperature, or general system instability.
- **Error Prone.** Third, even in today's state-of-the-art quantum computers, the error rate is as high as one in one thousand operations, a far cry from the less than one in a billionfold rate expected of most applications. Until a reliable, fault-tolerant model can be developed, quantum computers will likely be limited to very specific use cases.

Right now, the reality is that for the vast majority of today's everyday computational problems, classical computers continue to be more efficient, more accurate, and faster than today's quantum computers.

What's Next for Quantum Computing?

- **Quantum Superpowers.** The most promising innovations emerging in this space rely on one or more of these five quantum computing superpowers: (1) simulation, (2) linear systems, (3) optimization, (4) search, and (5) factorization.

- **Emerging Use Cases.**

  - **Enhanced Artificial Intelligence and Machine Learning (AI/ML).** The distinct capability of the quantum computer to process unprecedented amounts of data and simulate huge and numerous neural networks, all at speeds that were previously thought to be unattainable, could revolutionize the already exploding field of AI/ML.
  - **Climate Change, Clean Energy, and Sustainability.** The ability of quantum computers to analyze, simulate, and model multiple and complex scenarios could lead to better weather forecasting, improved climate change studies, cleaner fertilizers, more optimized solar capture, and a host of other solutions toward a better planet.
  - **R&D for Pharmaceuticals and Chemicals.** The simulation, modeling, and optimization potential of quantum computers could lead to unprecedented breakthroughs in our understanding of nature and materials. By supercharging the research and development of materials, energy, and drugs, quantum enthusiasts are hoping for discoveries from better batteries to a cure for cancer.
  - **Manufacturing, Product Development, and Supply Chains.** The power of quantum computers to track multiple parties, items, and processes and measure risk across a breadth of hypothetical and real-life situations could enable them to optimize any number of industrial, supply chain, manufacturing, design, and safety systems, from automotive to logistics.
  - **Stock Market and Financial Modeling.** The ability of quantum computers to factor and model probability distributions and complex correlations could make them uniquely adept at analyzing and predicting stock market performance and portfolio and risk management.

Concluding Thoughts. While today's computers may continue to competently perform simpler calculations, by going beyond the either/or constraints of 0s or 1s, tomorrow's quantum computers could usher in a host of innovative use cases across nearly every industry. With estimates of $2.2 billion invested in the private quantum company market in 2022, $35 billion invested in the total market in 2022, and market projections of $125 billion invested by 2030, the march toward a commercially viable quantum computer is bound to continue.

Follow us on social media @PerkinsCoieLLP, and if you have any questions or comments, contact us here. Learn more about our Digital Media & Entertainment, Gaming & Sports industry group here, and check out our podcast: Innovation Unlocked: The Future of Entertainment.

Authors

Explore more in

Technology Transactions & Privacy Law