Quantum computing 101

Seven questions corporate executives are asking

What exactly is a quantum computer?

Today's computers encode information into bits represented by a series of zeros and ones. Although they are faster than ever, traditional computers can only perform calculations on one dataset at a time. Quantum computing is based on the principles of quantum physics in which particles, when cooled to almost -460 degrees Fahrenheit, can represent either a zero or a one simultaneously. These quantum bits, called qubits, can therefore perform virtually endless operations in parallel. Quantum computers are an entirely different form of computing and will soon solve problems that are too complex and time-consuming for today's classical computer systems.

Can my business get a quantum computer?

Because of the complex technical requirements to house and stabilize the sensitive components of a quantum computer, it's expected that in the near term manufacturers will maintain them and customers will access their quantum computing capabilities via the cloud. Estimates are that commercial availability of quantum computers is five to ten years away. Some observers even believe that the scope of applications is so narrow that they may never become commercially widespread. Either way, the consensus is that quantum computers will never fully displace classical computer systems, PCs, or laptops.

Are there business applications of quantum computers?

Quantum computing is best suited for advanced operations like cryptography, modeling, and database indexing. It is ill suited for mundane tasks like word processing, spreadsheets, and email. Like many early-stage technologies, however, practical use cases are still being formulated.

What are some potential use cases for quantum computing?

Cross-industry
- –Supply chain optimization
- –Accelerated machine learning
- –Fleet optimization
- –Image and pattern recognition

Aerospace/aviation
- –Airline flight scheduling
- –Accelerated component design
- –Airflow analysis
- –Fuel optimization planning

Transportation
- –Route planning
- –Autonomous vehicle navigation
- –Battery composition/ performance

Financial Services
- –Risk analysis
- –Fraud detection
- –Portfolio performance prediction and optimization
- –Trade settlement optimization

Pharmaceuticals/Chemicals
- –Accelerated drug discovery
- –Molecular simulation
- –Genome mapping
- –Personalized medicine

Energy/Natural Resources
- –Electric grid optimization
- –Cost effective resource extraction

Media
- –Ad revenue maximization
- –Advertising scheduling

Government
- –Weather/climate change prediction
- –Secure communications
- –Traffic modeling
- –Smart cities

Who's leading the way in quantum computing?

The ecosystem surrounding quantum computing covers the spectrum of academia and the public and private sectors. Academia has been exploring the concept of quantum computing since the 1960s, but the field didn't really start gaining momentum until the early 1980s. Given the passage of decades, there are today approximately 100 universities globally that are researching quantum computing. Yet there are even more public and private companies (approximately 130) engaged in developing and commercializing quantum computing. Many of these companies have affiliations or codevelopment ventures with select universities. Finally there are also approximately 30 government and nonprofit agencies that perform research or provide funding for quantum computing. While it appears there are many parties involved in quantum computing, it's probably fair to say there are truly only a few hundred experts worldwide in the field.

What knowledge and skills will be required to leverage quantum computers?

Several universities offer a formal curriculum in quantum information systems. The coursework is typically incremental to the student's core program (engineering, science, information technology [IT], mathematics, etc.) Other institutions and certain companies offer programs and seminars in quantum computing, but it is viewed as helpful if the individual has prior experience in physics, mathematics, and/or computer programming. If quantum computers become commercially available, components will likely evolve so the technology will be accessible to a larger population of users.

How can my company prepare to start leveraging quantum technology?

Assess your business challenges

What problems have you been unable to solve with classical computer systems? How would your business be transformed if you could solve them? Think beyond the use cases already identified. Quantum logic could provide a distinct advantage over non-quantum-using competitors who do not employ this technology.

Embark on the quantum learning curve

Seminars, workshops, online courses, simulators, and software development kits are available now. Charge a team of engineers and programmers within your organization with understanding quantum systems and algorithms and their potential applications.

Evaluate your existing IT architecture

Quantum computers will operate with, but not replace, classical computer systems, PCs, laptops, or other devices. They will work alongside classical computers to focus on the particular calculations where they can excel and outperform. Start looking at how quantum computing could integrate with your existing IT architecture.

Address your ongoing data security

You could be impacted by quantum computing even if you don't plan to leverage it in your business. Current data encryption relies on prime factorization of large datasets, which is highly time-consuming. Quantum computers can perform these calculations almost in real time, crack encryption codes, and breach systems that today are considered virtually unbreakable. They can even unencrypt information that was collected years ago and stored away. Start exploring how you can employ the benefits of quantum computing, while protecting your customer and company data from bad actors who would use quantum computing with malicious intent.

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