It's time to take note of quantum computing

Research labs, government agencies (NASA) and tech giants like Microsoft, IBM and Google are all focused on developing quantum theories first put forward in the 1970s. What's more, a growing start-up quantum computing ecosystem is attracting hundreds of millions of investor dollars. Given this scenario, Forrester believes it is time for IT leaders to pay attention.

Brian Hopkins, vice president and principal analyst at Forrester Research

"We expect CIOs in life sciences, energy, defence, and manufacturing to see a deluge of hype from vendors and the media in the coming months. Financial services, supply-chain, and healthcare firms will feel some of this as well. We see a market emerging, media interest on the rise, and client interest trickling in. It's time for CIOs to take notice," states Forrester's Brian Hopkins, VP, principal analyst serving CIOs and lead author of a report: *A First Look at Quantum Computing*.

What can it do?

The Forrester report gives some practical applications for quantum computing which helps contextualise its potential:

• Security could massively benefit from quantum computing. Factoring very large integers could break RSA-encrypted data, but could also be used to protect systems against malicious attempts.

• Supply chain managers could use quantum computing to gather and act on price information using minute-by-minute fluctuations in supply and demand

- Robotics engineers could determine the best parameters to use in deep-learning models that recognise and react to objects in computer vision

- Quantum computing could be used to discover revolutionary new molecules making use of the petabytes of data that studies are now producing. This would significantly benefit many organisations in the material and life sciences verticals – particularly those trying to create more cost-effective electric car batteries which still depend on expensive and rare materials.

How is quantum different?

Forrester believes CIOs should apply themselves to understanding quantum computing if they hope to realise its potential in their spheres of influence.

Everything is much smaller, and much more powerful

Unlike its mainstream cousin, quantum computing vendors talk about qubits rather than 1s and 0s. Freed of a limited binary value, a qubit is a much richer unit of information that can work simultaneously on huge information spaces. Using quantum effects, qubits can deliver correct answers from many possible solutions almost instantaneously. However, qubits require a whole new field of computer science, software and hardware, relying on subatomic physics.

No standard unit of measurement

Classical computing uses bits and hertz as standards by which to measure a computer's power, which proves useful when comparing vendors. However, a quantum computer's power is more complex to measure. IBM has made the suggestion of 'quantum volume' as a benchmark, but Forrester has cautioned that this has not been universally accepted.

Programming challenges

Vendors are currently providing specialised quantum computers with algorithms that use small-scale quantum logic to solve domain-specific problems. The challenge is to build a scalable universal quantum computer which can, like today's classical computers, be programmed to solve almost any problem. IBM and Microsoft have set themselves to the task, but Forrester warns they (and others) will face engineering challenges such as scaling the hardware, error correction and improving coherence time.

How long from proof point to reality?

The report advises CIOs to track the advancements between proof points and specialisation as the quantum computing ecosystem grows in funding and support. Accelerating quantum software development and cloud services could see the gap between proof point and specialised solution narrow to just 24 months.

As with all new fields in technology, vendors will be battling to be first to cross new finish lines. Some are focusing on the notion of 'quantum supremacy' – where an actual quantum computer can solve a theoretical problem better than a classical computer.

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Others are focusing in quantum advantage – where an actual quantum computer can solve a real-world problem more effectively than a classical computer, or solve a problem that today's best classical computers cannot. Many others, including startups, are focusing on a hybrid quantum-classical solution as a practical means to deliver shorter-term value. This includes the ability to allow programmers to plug quantum computers into their software using existing languages such as Python, C++ and even Java.

Given the technical complexity of the hardware required by quantum computing (one solution involves supercooling computers to near absolute zero), Forrester believes the cloud is an ideal way for vendors to let clients time-share hardware and call new quantum algorithms through APIs.

With many complex engineering challenges still to be solved, Forrester acknowledges that progress may still be slow for some time. However, since quantum computers grow exponentially in potential power as hardware scales, rather than linearly as digital computers do, the Forrester report describes quantum computing as "…a bullet train that is accelerating."

"In the race to digital, even a 1% advantage - for example, in energy production costs or customer acquisition costs - can help a company overwhelm the competition. Using specialised quantum processors available through the cloud, a few first movers will seize advantages to achieve these smaller but significant gains over the next five years," explains Hopkins.

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