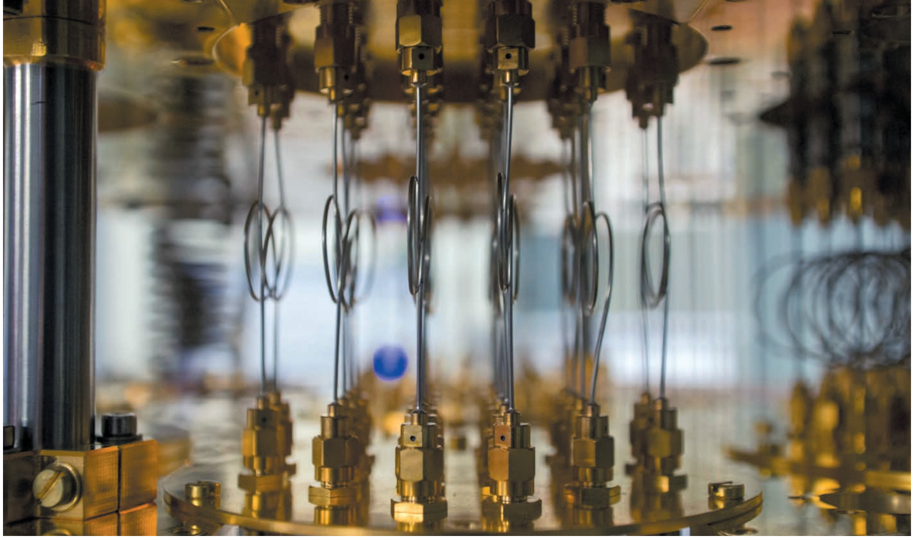

IBM

Superconducting lines for IBM's quantum computer.

QUANTUM COMPUTING

Quantum cloud goes commercial

IBM plans a system aimed at creating a market for the still-immature technology.

BY DAVIDE CASTELVECCHI

Hoping that if you build it, they will come, IBM plans to roll out the world's first commercial 'universal' quantum-computing service some time this year, the company announced on 6 March. Named IBM Q, the system will be accessible over the Internet for a fee.

It will not outperform conventional computers, at least not yet. But the company says that the system will be crucial in developing a market for future quantum machines that can handle complex calculations currently out of reach of classical computers.

The project builds on know-how developed around IBM's existing cloud-computing service: Quantum Experience, which anyone can access for free. That system went online in May 2016. "Having it up for ten months has taught us a lot," says physicist Jerry Chow, who leads the quantum-computing laboratory at IBM's research centre in Yorktown Heights, New York. It has enabled researchers around the world to practise building quantum algorithms without access to their own quantum computer. IBM aims to build "a community and an ecosystem" around its technology, Chow says.

The company will not say when exactly IBM Q will come online, only that it will happen this year. It is also not disclosing how powerful the system will be, or how much it will cost to access. The company says that it already has several commercial partners, which IBM would not identify, that will test and develop their own applications for the machine.

Quantum computers harness the counterintuitive properties of subatomic physics, in which bits of information — called quantum bits, or qubits — can assume multiple states simultaneously, rather than simply representing a 0 or 1, as bits do in classical computing. Starting in the 1990s, theoretical physicists, including some at IBM, have developed qubit-based algorithms that in theory could perform certain tasks exponentially faster than classical computers can.

QUANTUM COMPETITION

But in practice, getting enough qubits to work together to run any such algorithm — in what is known as a universal quantum computer — has proved extremely challenging. Two technologies have emerged as front-runners for handling qubits. One traps individual ions in a vacuum using electric and magnetic fields; the other incorporates qubits into microscopic superconducting circuits kept at a few degrees above absolute zero. IBM has bet heavily on the latter approach.

In recent years, Google has also entered the fray, establishing a superconducting-qubit lab in Santa Barbara, California. Google, IBM and a handful of other companies and academic labs have announced aggressive strategies for building machines that can outperform classical computers. But these machines would need to run on roughly 50 qubits each. The current record is about 20 qubits, barely enough for simple computations.

So when IBM rolled out Quantum Experience — which runs on five superconducting qubits — some did not see the point. "A lot of folks looked at it as a publicity stunt," says physicist Christopher Monroe, who runs an ion-trap laboratory at the University of Maryland in College Park. "But I think it's a really big deal."

Even though it is not a state-of-the-art machine, IBM had to overcome several challenges to get Quantum Experience online and make it usable for researchers who are not necessarily physicists and have never worked on a quantum computer before. That included creating a system that functions without the constant attention of the scientists who built it. "Putting the machine on the cloud is an obvious thing to do," Monroe says. "But it takes a lot of work in getting a system to that level."

Having access to a system such as Quantum Experience or IBM Q also means that researchers around the world could start working on the unique challenges of quantum programming. This is very different from conventional coding, and requires programmers to understand and adapt to the limitations of physical qubits. A five-qubit machine is easy to simulate using a classical computer — even a laptop, Monroe says. But real qubits are not so simple.

ERA OF THE QUANTUM CLOUD

"The real challenge is whether you can make your algorithm work on real hardware that has imperfections," says Isaac Chuang, a physicist at the Massachusetts Institute of Technology in Cambridge.

Chow says that IBM Q will have more qubits than Quantum Experience, but the company has not yet settled on a specific number.

Quantum Experience has so far attracted about 40,000 users from more than 100 countries. They have performed 275,000 experiments and produced about 15 research papers.

Among them is one by Monroe and his collaborators, in which they compared the performance of IBM's superconducting machine with that of a five-qubit ion-trap system at Monroe's lab (N. M. Linke *et al.* Preprint at http://arxiv.org/abs/1702.01852; 2017). The company's system was faster, but Monroe's machine was more precise.

Monroe has co-founded a start-up called IonQ that expects to roll out a cloud-based, trapped-ion quantum service, but he won't speculate on when. Google plans to do the same with its own superconducting-qubit machines, but only after it has made a working 50-qubit computer, says John Martinis, head of the company's quantum-computing laboratory in Santa Barbara.

Meanwhile, D-Wave, a company based in Burnaby, Canada, has had a quantum-computing service on the cloud since 2010. But their machines are not 'universal' computers, and can run only a limited range of quantum algorithms. Nevertheless, several research groups have used the service for their projects. ■