technology today

Alan Pierce
pierceaj@techtoday.us; on Twitter @ TechToday_US

The IBM Q is a Working 50 Qubits Quantum Computer

During CES 2018 I observed a beautiful gold-colored object that looked like it could hang in someone's dining room. It was hanging from a fixture above a mass of reporters busily photographing the object from different angles. Without yet knowing what I was looking at I joined in (Photo 1). It was clear from

Photo 1—For this quantum computer to operate properly it must be cooled down to almost absolute zero.

Photo 2—For the IBM dilution fridge to cool the qubits quantum processor to operating temperatures it is sealed into the container shown in this photo.

Photo courtesy IBM

its prominent location in an area reserved for the conference's award-winning technologies that this was something functional as well as beautiful to look at.

It turned out to be IBM's new Quantum Computer (IBM Q). Many of the systems that are visible in Photo 1 are part of a cryogenic cooling sys-

tem that allows the computer's processor to operate at near absolute zero temperatures (−459.67° F). When the IBM Q is operational what you see is totally encased in the enclosure shown in Photo 2. This allows its cryogenic refrigeration system to keep the qubits processor at its working temperature. The cold

temperatures in combination with the vibration isolation stand that it is hanging from are necessary to keep the qubits in their quantum state.

The machine that was on display at CES 2018 was more than just a prototype—on March 6, 2018, IBM announced that production of the IBM Q will soon begin. It is not clear

if any of the actual machines will eventually be sold or if scientists will have to access the Q using IBM's Cloud Services.

The race for quantum computer chip supremacy is already heating up. On the same day that IBM made their announcement Google announced that their engineers had just created a 72 qubits quantum chip. This is a fast-moving story and companies such as IBM, Google, Intel, and Microsoft are feverishly working to create the fastest quantum computer.

The dream of building a new type of computer that harnesses the properties of quantum physics has been the dream of some scientists for at least 46 years; quantum theory itself is over 100 years old. This IBM Q has a processor with just 50 qubits; even with this low number it can run some simulations and break some "unbreakable" security codes that are beyond the capacity of a conventional supercomputer.

When a quantum computer qubits chip has enough qubits to surpass the processing power of a conventional supercomputer in every way, the dream of quantum superiority will be achieved. Exactly how many qubits it will take to reach quantum superiority is unclear but it is clear from my research for this column that it is still difficult to keep the quantum state of a qubits processor running error free.

The big problem is if there are undetected vibrations or if cooling is slightly off, referred to as noise, the calculations performed by a quantum computer could be riddled with errors. They now check the accuracy of a quantum computer by using problems that can still be solved on a conventional supercomputer.

For a good explanation of the basic principles behind qubits and the differences between conventional

Alan Pierce, Ed.D., CSIT, is a technology education consultant. Visit www.technologytoday.us for past columns and teacher resources.

Quantum Computing 101

What does "quantum" mean?

Quantum theory, developed in the early 1900's, revolutionized physics and chemistry by successfully explaining the weird behavior of tiny particles like atoms and electrons. In the late twentieth century it was discovered that it applied not just to these particles, but to information itself. This led to a revolution in the science and technology of information processing, making possible previously unimagined kinds of computing and communication.

What is a quantum computer?

A quantum computer is a device able to manipulate delicate quantum states in a controlled fashion, the way an ordinary computer manipulates its bits.

What is a qubit?

A qubit is the quantum version of a bit, and its quantum state can take values of $|0>$, $|1>$, or both at once, a phenomenon known as superposition. The half angle bracket notation $|>$ is conventionally used to distinguish qubits from ordinary bits.

What is a superposition?

A superposition is a weighted sum or difference of two or more states; for example, the state of the air when two or more musical tones are sounding at once. Ordinary, or "classical," superpositions commonly occur in everyday phenomena involving waves.

How are quantum superpositions different?

Quantum theory predicts that a computer with N qubits can exist in a superposition of all $2N$ of its distinct logical states $|00...0>$ through $|11...1>$. This is exponentially more than a classical superposition. Playing N musical tones at once can only produce a superposition of N states.

How is superposition different from probability?

A row of N coins, each of which might be heads or tails, has $2N$ possible states, but it actually is in only one of them—we just don't know which. For this reason, quantum superposition is a more powerful resource than classical probabilism.

---

computer processing and quantum computer processing, check out youtube.com/watch?v=lypnkNm0B4A. IBM also offers detailed tutorials that explain quantum basics with hands-on activities, divided so it can meet the level of sophistication of the user. You will find it all online at: tinyurl.com/td-ibmq

The commercial viability of the IBM Q is significant because it has the computing power to solve some problems that are too numerically complex to be solved on a traditional supercomputer. Biotechnologists could use this computing power to run simulations on the possible positive or negative outcomes if certain genes in plants, insects, or animals are altered to suppress or enhance certain species features. Material scientists could use this computing power to run designer material simulations to determine what would be the physical outcome if one combines the atoms of different basic materials.

My March 2017 column "Material Science Breakthroughs" described how scientists have already accomplished this type of atomic structure merging. The column is available online at www.technologytoday.us/columnPDF/Recent_Material_Science_Breakthroughs.pdf.

It is fascinating to ponder what new medicines, chemicals, artificial intelligence breakthroughs, improvements in the logistical movement of people and materials, and even the optimization of all kinds of systems that might be possible, in the near future, using the processing power of quantum computers. This computer power also has a dark side since it could be used to break all current security codes that our society uses to protect us from hackers trying to gain access to government, banking, manufacturing, public utilities, and consumer computer systems to disrupt society or just steal our identities.

Taking It a Step Further

IBM invites you to explore the world of quantum computing! Visit https://quantumexperience.ng.bluemix.net/qx/experience to check out user guides and interactive demos to learn more about quantum principles. You can also create and run algorithms on real quantum computing hardware, using the Quantum Composer and QISKit software developer kit. td

Video courtesy of IBM

To hear The Sounds of IBM: IBM Q, go here: https://www.youtube.com/watch?v=o-FyH2A7Ed0#action=share