Always Completing Your Journey
Take back control. Be seen and heard when you force through your noise cancelling headset.
SHOP NOW
BOSE

The Race Is On to Protect Data From the Next Leap in Computers. And China Has the Lead.

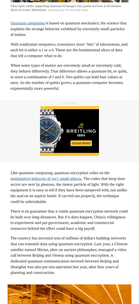
Eric Ang of Singapore's Institute of Photonics Technologies with the network illustration and Nevanji, Another start-up exploring quantum encryption in Quebec. Ang Hong Jun for The New York Times

By Cade Metz and Raymond Zhong

Dec. 4, 2021

中国简体中文 繁體中文

"China has a very deliberate strategy to own this technology," said Duncan Earl, a former researcher at Oak Ridge National Laboratory who now heads a quantum start-up in Canada. It is a technology that is exploring quantum encryption. "If we think we can wait four or 10 years before jumping on this technology, it is going to be too late."



Fiber optic cables supporting Quantum Xchange's encryption services at its Hudson Street Center Manhattan. Ang Hong Jun for The New York Times

Quantum cryptography is based on quantum mechanics, the science that explains the strange behavior exhibited by extremely small particles of matter.

With traditional computers, transistors store "bits" of information, and each bit is either 1 or a 0. These are the fundamental slices of data that tell a computer what to do.

When some types of matter are extremely small or extremely cold, they behave differently. That difference allows a quantum bit, or qubit, to store a combination of 1 and 0. Two qubits can hold four values at once. As the number of qubits grows, a quantum computer becomes exponentially more powerful.

A quantum research facility at the University of Chicago, which is exploring devices, known as quantum repeaters, that could extend the range of encryption. Ang Hong Jun for The New York Times

Like quantum computing, quantum encryption relies on quantum mechanics. Quantum bits, or qubits, can be used to keep data secure and sent by photons, the tiniest particles of light. With the right equipment it is easy to tell if they have been tampered with, not unlike the seal on an opened bottle. It cannot be copied, so the technology could be unbreakable.

It is so powerful that a viable quantum encryption network could be built over long distances. But if it does happen, China's willingness to experiment and get government, academic and commercial resources behind the effort could have a big payoff.

The country has invested tens of billions of dollars in building networks that can transmit data using quantum encryption. Last year, Chinese researchers used a satellite to send quantum-encrypted messages from one cell between Beijing and Vienna using quantum encryption. A dedicated quantum communication network between Beijing and Shanghai was also put into operation last year, after four years of planning and construction.

Devices that could be used to extend the range of quantum encryption. Ang Hong Jun for The New York Times

For now, quantum encryption works only over a limited distance. The satellite link between Beijing and Vienna stretched this limit to a record 4,600 miles. On the ground, using optical fiber, the cutoff is about 250 miles.

Among China's investments in quantum encryption, the Micius satellite has received the most attention. The University of Science and Technology of China, the government-backed university that helped launch Micius, led the construction of the ground network, which stretched 2,000 miles — perhaps a lot of quantum distance for classic improvement.

The governments of Anhui and Shandong Provinces, through which the fiber-optic network passes, together invested 800 million in the project. Like all major infrastructure projects in China, the plans have had high-level support from the Chinese government.

Nevanji, Another start-up exploring quantum encryption in Quebec. Ang Hong Jun for The New York Times

This main line is being extended to other cities and regions. The goal by 2030 is a Chinese-built network for sharing quantum encryption keys across the globe.

Some security experts question the effectiveness of quantum encryption. Because it is so new, it has not been put through anywhere close to the rigorous testing that would give it a stamp of approval from skeptical cryptographers.

But Chao-Yang Lu, a professor of physics at the University of Science and Technology of China, said the Beijing-Shanghai quantum network was a significant upgrade.

Derek Kavelmann oversees most of the University of Chicago's quantum research facility. Ang Hong Jun for The New York Times

With communications seen by traditional means, eavesdroppers can intercept the data stream at every point along a fiber-optic line. A government could say that the just about anywhere. Quantum encryption can be another of cybersecurity tools in the Beijing-Shanghai line is just a few dozen across 1,200 miles, Professor Lu said.

"We admit that it is not mathematically unbreakable," he said. "It is not the final solution. But it's already a huge improvement in terms of security."

In the United States, the government and industry have viewed quantum encryption as little more than a science experiment. Instead, researchers have focused on using quantum mechanics to build new forms of encryption that can stand up to a quantum computer. This technology would require new infrastructure.

Devices that could be used to extend the range of quantum encryption. Ang Hong Jun for The New York Times

But now, spurred by activity in China and recent advances in quantum research, some in the United States are playing catch-up.

Quantum, a Southern California start-up, is working to secure power grids in Tennessee using the technology. A second start-up, Quantum Xchange, is building a network of fiber-optic cables in Manhattan, hoping to serve Wall Street banks and other business. Researchers at Stony Brook University on Long Island are preparing a third network.

Small start-ups like Qubitekk are unlikely to match the millions of dollars in infrastructure already created in China for quantum encryption. But many experts believe the more important work will happen in research labs, and the Department of Energy is funding a test network in Chicago that could eclipse the kind of systems deployed in China.

Derek Kavelmann oversees most of the University of Chicago's quantum research facility. Ang Hong Jun for The New York Times

The Los Alamos and Oak Ridge National Laboratories are working on a network that connects power grids with quantum technology, and Southern Company is entering quantum into the Hudson Street, the Chicago Mercantile Exchange hub, which now serves as an interim hub for Lower Manhattan.

Quantum Xchange is building a quantum encryption link between Manhattan and Newark, with plans to extend the link eventually to the two cities. Eventually, it hopes to extend this network up and down the East Coast.

At places like the University of Chicago, researchers hope to go step further, exploring what are called quantum repeaters — devices that could extend the range of quantum encryption.

Subscribe to Amazon, eBay, Walmart, Etsy The New York Times for just $1 a week. SUBSCRIBE
The New York Times
Join The New York Times for just $1 a week.
SUBSCRIBE
SIGN IN / CREATE ACCOUNT
Related Coverage
Nov. 22, 2021 The New York Times Shortage Question Computer Manufacturers
Nov. 22, 2021 Yale Professors Ross Google and IBM in the First Quantum Computer
Nov. 22, 2021 As China Matches Forward on A.I., the White House Is Silent
Interested in All Things Tech?
The We newsletter will keep you updated on the latest from Silicon Valley and the technology industry.
SIGN UP
Enter your email address
By signing up, you agree to receive promotional emails from The New York Times and its affiliates.

More in Technology
A Top Finance Executive Is Arrested in Canada for Extradition to the U.S.
Facebook Emails Show Its Fear of Rivals Shaping Mergers and Crushing Competition
Microsoft Acquisition Would Make Xbox a Leader for Years of Streaming Subscriptions
Facebook Lured People's Data in Faux Contest Purchases and Punish Rivals, Documents Show
I Tried to Make My Dog an Instagram Celebrity. I Failed.
Cancer Pushes New York's Vice Cultivated, Tumbls Lea, Dina Perlmutter Stage
Trending
A Top Finance Executive Is Arrested in Canada for Extradition to the U.S.
Microsoft Acquisition Would Make Xbox a Leader for Years of Streaming Subscriptions
In Funeral Flying and Parade Protest, Trump Forward to Corrupt Rush
The Women Who Overcame Odds, 200 Miles at a Time
The Best Movies of 2020
Opinion: Trump Gets It All Wrong
Coronavirus Can Emerge Accelerate Like a Speeding Freight Train in 2020
Opinion: Why We Miss the Wright
Some Words Only Translators Angela Michel Discuss Why
Video and Full Transcript of George W. Bush's Eulogy for His Father
Editor's Picks
Oh Rudy, We Relived the Wheel for a Week Before Thanksgiving Ever Was. The Hell Is Us.
Opinion: Trump Is Not Alone
Sections
HOME
OPINION
ARTS
LIVING
LISTENING & WATCHING
Subscribe
Log In
Account
Help
Contact Us
Gift Articles
Manage My Account
Site Feedback
Site Map
Site Index
© 2020 The New York Times Company
Privacy Notice
Cookies
Terms of Sale
Terms of Service
Do Not Sell My Info
Ad Choices