WHAT I LEARNED THIS WEEK

Excerpt from July 20, 2017

5 China leapfrogs the world to create a "hack-proof" quantum communications network. Can others catch up?

In *WILTW* December 15, 2016, we argued that the rapidly-approaching quantum computing era would ignite massive disruption. Now, driven by domestic security concerns following Edward Snowden's revelations of U.S. internet surveillance, China has taken a commanding lead in a critical new technology—quantum communications.

China is near completion of a 2,000 kilometer (km) "unhackable" fiber communications network, linking Shanghai with Beijing. China also recently succeeded in teleporting "entangled" photons from a quantum satellite 480 km above the earth to two terrestrial stations 1,200 km apart—a distance 10 times greater than anything previously achieved. The breakthroughs are major steps to creating a new internet, free from the risk of cyberattack, and **making it nearly impossible for other governments to intercept Chinese communications.** China ultimately plans to launch a fleet of quantum-enabled satellites creating a global space-based hack-proof internet. By 2020, China aims to deploy a quantum communications network nationwide and between Asia and Europe—developing a global grid by 2030, according to John Costello, a Cybersecurity Fellow for New America, in testimony to the U.S.-China Economic and Security Review Commission.

Source: Financial Times

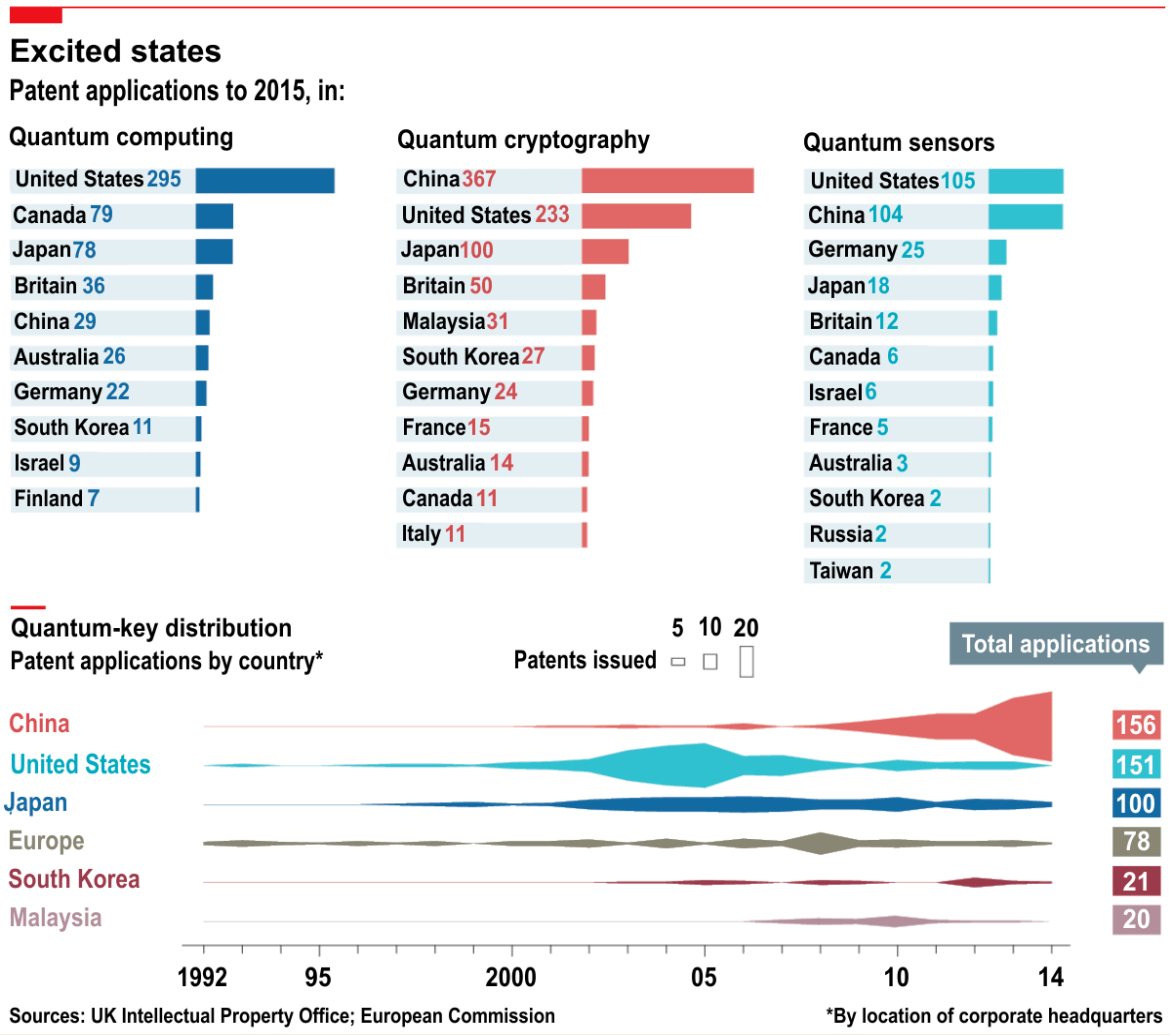
The implications are broad and significant. First, the quantum era will fundamentally rewrite the rules for technology advancement—providing strategic military and security advantage and upending the business models of many incumbents. This is because quantum technologies leverage the unusual behaviors of single atoms and particles. Second, quantum technologies will become pervasive, underscores an analysis in *The Economist*, similar to the way AI is now being incorporated into all manner of products and services. Third, China's innovation in quantum communications provides a cutting edge in quantum science—**potentially setting the stage for it to take a global lead across the technology landscape.** Fourth, leading suppliers of vital quantum-technology components—trading at discounted cash flow multiples—will likely outperform. *Consider the following:*

- **China's quantum communications network provides a technological competitive advantage.** The Beijing-Shanghai quantum network employs quantum key distribution (QKD), which creates shared cryptographic keys that are used to encrypt and decrypt data in the states of individual photons. If a hacker attempts to eavesdrop on a quantum transmission, it creates detectable errors. QKD technology has existed for years, but transmitting photons over long distances has been impossible. For instance, in 2007, Switzerland deployed a QKD network to secure transmission of votes in a Swiss election. Other countries implementing small QKD networks include Austria, Japan, and the U.S.

  China's innovation is to create a daisy chain of individual quantum "repeater" links, or "trusted nodes" to carry the signals 2,000 km.

Each "trusted node" is a potential weak link, as the quantum key must be converted back into non-quantum data, before re-encrypting and sending it to the next "trusted node." However, the approach is a major improvement over traditional communications, where every point along the network could be intercepted. "We plan to use the network for national defense, finance and other fields, and hope to spread it out as a pilot that if successful, can be used across China and the whole world," highlights Zhou Fei of the Jinan Institute of Quantum Technology.

China is investing aggressively in quantum cryptography, with an expanding margin in patent applications:



Source: The Economist

- **China's emerging edge in quantum information science could provide an asymmetric military advantage.** Since the 1990s, China has developed "counter-intervention" capabilities (see *WILTW* August 4, 2016)—emerging as a global leader in unmanned systems, hypersonic weapons, AI, and, now, quantum-information science. Quantum technologies have the potential to undermine critical aspects of U.S. technological dominance in information warfare, including its intelligence apparatus, satellites, secure communications, and stealth technologies. China believes that **quantum technologies could transform warfare,** concludes a recent StrategyBridge.org report, with a strategic significance on par with nuclear weapons.

- **China's quantum communications breakthrough marks an inflection point for the quantum technologies era.** Satellite quantum systems will be a crucial technology for future global communication networks, highlights a Phys.org review. Quantum systems will help solve communications capacity bottlenecks from congested radio frequencies, and can transmit with higher-power efficiency, using smaller and lighter satellites and terminals. Quantum communication networks could be a key enabling technology for the quantum era. Transformative new quantum technologies include:

  √ **Quantum gravity sensors** – can precisely map geological features, improving efficiencies in geological surveying, oilfield services, and the construction industry—where one-third of all building projects are late due to underground surprises. Military applications include the ability to spot moving masses underwater, such as submarines or torpedoes, potentially eliminating the deterrent effect of nuclear submarines.

  √ **Quantum simulators** – can mimic real physical systems to expedite design solutions. Quantum-simulating a new material such as a stiffer or lighter alloy for use in aerospace or satellites would be faster and cheaper than manufacturing and testing the material itself. "The promise of quantum technologies is in engineering terms a step up in performance—not of 20%, but of a couple of orders of magnitude," underscores Paolo Bianco of Airbus.

  √ **Universal quantum computers** – Google is testing a 20-qubit chip quantum computer and expects to complete a 49-qubit machine by

yearend—making it the first to build a quantum computer capable of solving problems beyond the ability of ordinary computers. (Rather than using transistors that switch on and off the zeros and ones that represent bits of information, quantum computers use quantum bits—qubits—that can represent all combinations of zeros and ones simultaneously.) Universal quantum computing promises to supercharge AI, accelerate drug discovery, create new, better materials, develop biomimicry-based energy systems, leveraging processes of nature, and help solve highly complex problems, such as climate change.

- **China's quantum communications breakthrough will start an "arms race" across a range of quantum technologies.** For instance, Japan's National Institute of Information and Communications Technology (NICT) is working on free-space quantum cryptography. The U.S. National Science Foundation also recently allocated $12 million to spur innovations in quantum information science to engineer a secure quantum communications system on a chip.

- **Suppliers of critical components used in quantum communication networks could emerge as huge winners. Lenovo Group** (992 HK) and Huawei helped develop China's quantum satellite, Micius. **Alibaba** (BABA) has also created a public-private partnership with the Chinese Academy of Sciences—called the Alibaba Quantum Computing Lab—to develop a quantum simulator and computer. Several Chinese startups are also players, including China Quantum Technologies, which is instrumental in the building and operation of the nation's emerging quantum-communication networks. QuantumCTek is also the first to provide multi-protocol network security products based on quantum technologies.

  Although Japan's **Toshiba** (6502 JP) has faced challenges in recent months, the company has one of the largest quantum IP portfolios in the world and has developed a quantum key distribution system. The company is also collaborating with BT Corp to build the U.K. Quantum Network, facilitating quantum-secured communications between Cambridge, Bristol, London, and Adastral Park.

Two key Japanese and Korean leaders also well-positioned to benefit, are:

√ **Mitsubishi Electric** (6503 JP, 1645.50 JPY) – has developed an advanced encryption technique for mobile phones, and is using it in a project with Japan's NICT agency for testing mobile communications over a quantum network. Mitsubishi trades at 13.7x free cash flow and 7x consensus EV/EBITDA.

√ **SK Telecom** (017670 KS, 263000 KRW) – has launched five different national test networks for quantum communications, covering 256 kilometers. The company's Quantum Cryptography System is considered one of the most secure encryption methods available. SK Telecom trades at 9.5x free cash flow and 5.5x consensus EV/EBITDA.