

Ridgeway Briefing:

Quantum Links: Lessons from China’s rollout of quantum communication infrastructure

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Ridgeway Briefings offer 2000-word analyses of emerging issues in international relations, security, and development, prepared by Ridgeway's team of open-source analysts, linguists, and subject-matter experts.

At a glance

- Quantum communication technology purports to offer heightened information security, with any attempt at eavesdropping immediately apparent;
- China is currently the furthest advanced in rolling out quantum communications infrastructure;
- Quantum communication could reshape how global communication systems operate, and who controls them.

The "Second Quantum Revolution"

Quantum physics is a fundamental theory in physics that describes the behaviour of nature at and below the scale of atoms. Quantum phenomena were initially discovered in the early 20th century and the theory of quantum mechanics developed gradually over the following decades, bringing significant improvements in the fields of electronics, computing, materials science, and telecommunications.

A "second quantum revolution" is now underway and has spurred a wave of research into practical applications of the quantum phenomena discovered throughout the twentieth century.

Three fields in which quantum-enhanced technologies could be deployed in the near term are computing, remote sensing and communication. Quantum computing has the potential to drastically enhance current computing power, with applications in cryptography, genetics and fundamental physics. Quantum sensing offers the possibility to detect the subtlest of changes in the earth's gravitational and magnetic fields to enable improved navigation, notably in environments where GPS technology cannot function, including in space. Quantum communication relies on the principles of quantum physics to transmit information in a highly secure manner.

One of the key technologies behind quantum communications is quantum-key distribution (QKD). QKD enables quantum-secured transmission of security keys, with any attempt at eavesdropping made evident to the receiver. The protocol underlying this technology, BB84, was first articulated in 1984. The scientists involved, Bennett and Brassard, stated that it could provide "a communications channel on which it is impossible in principle to eavesdrop" without a "high probability" of being detected.

The promise of quantum communication is total information security. Banks, militaries and research institutions are already trialling these technologies. As cybersecurity threats increase and geopolitical tensions rise, such a capability could provide a crucial strategic advantage.

China's Quantum Rollout

While several local quantum communication networks were established and tested in the early 2000s, implementation of the technology did not take off in earnest until the early 2010s. China has been at the forefront of the technology since this time.

China began building its first long-distance quantum network in 2015. Completed in 2017, the Beijing-Shanghai, or Jing-Hu, Trunk Line, is a 2,000-kilometre network connecting Beijing, Jinan, Hefei and Shanghai. Speaking at the time, Chen Yu'ao, a professor from the University of Science and Technology of China (USTC) and Chief Designer for the project, said: "The changes will take place unnoticed; people will enjoy absolute information security without even realizing it."

The investment in this emerging technology is proving fruitful. One of the long-standing challenges facing developers of QKD infrastructure was the prevention of signal loss over long distances. In recent years, Chinese researchers have announced multiple breakthroughs in the development of the enabling technologies, in particular trusted-node repeaters, that permit communication over thousands of kilometres.

In 2025, China unveiled a further expansion of its domestic quantum communications network. The China Quantum Communication Network (CN-QCN) stretches over 10,000km and links 80 cities across the country through 20 metropolitan networks. In addition to its extent, CN-CQN also demonstrates other major advancements in QKD-

technology, notably increased network reliability and security. Within its metropolitan networks, numerous companies in China's banking, finance and research sectors are already testing QKD-technology. This points to an emerging gap between China and the rest of the world in the real-world deployment of quantum-enabled technologies.

The next hurdle was the rollout of inter-state quantum communications, and here again China is demonstrating success. Under the project, "Quantum Experiments at Space Scale" (QUESS), China **launched** MICIUS, the world's first "quantum satellite." In 2020, MICIUS successfully **established** a satellite-to-ground link with China's ground-based network. At the time, Anton Zeilinger, Nobel Laureate in Physics, **noted** that the launch of MICIUS "represents the first step on the way to worldwide quantum communication."

Having verified the feasibility of satellite quantum communications with MICIUS, in 2022 Chinese researchers launched **Jinan-1**, the world's first quantum micro-satellite. The payload of Jinan-1 weighs only 23 kilograms, representing a reduction exceeding an order of magnitude compared to the payload mass of the MICIUS satellite. The researchers behind Jinan-1 envision an eventual "quantum constellation."

Together, MICIUS and Jinan-1 have enabled China to incorporate other nations into its QKD-network. Russian and Chinese scientists **succeeded** in sending two encoded images secured by quantum keys 3,800km between a ground station close to Moscow and another near Urumqi. In March last year, Chinese researchers successfully **established** a QKD-link with South Africa. As BRICS nations **increase collaboration** on quantum and other emerging tech, norms and standards on communication security could emerge with little to no input from Washington or Brussels.

Russia's Quantum Railways

Elsewhere, long-range quantum communication networks are under development but have not achieved the scale or scope of China's. **South Korea** is a notable example, with 48 government departments connected over an 800-km quantum network.

The EU's **European Quantum Communication Infrastructure project** (EuroQCI) began its implementation phase in January 2023. The EU is also working with the European Space Agency (ESA) on delivering a constellation of quantum-capable satellites. In the UK, where rollout of long-distance QKD infrastructure has been slow, researchers have made notable breakthroughs, including **the successful demonstration of entanglement distribution.**

The approach of the United States offers a cautionary note for the outlook of quantum communication. The NSA's website **states** that it "does not support the usage of QKD or Quantum Cryptography (QC) to protect communications in National Security Systems, and does not anticipate certifying or approving any QKD or QC security products for usage by NSS customers unless these limitations are overcome." Instead, the NSA is focusing its effort on quantum-resistant, or post-quantum, cryptography. But a **deal** signed in October between the US Air Force and Qunnect, a New York based firm developing QKD technology, indicates an emerging interest in leveraging the demonstrated gains of the technology.

The Rest of the World

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Communications, Computing, and Standards

The **first successful demonstration of quantum-key distribution** took place in 1994. Then, researchers could transmit a key a mere 32 centimetres. In just over thirty years, large-scale quantum communication networks have been established, connecting cities and nations across thousands of kilometres. Studying the examples of China and others can provide important insights about this coming technological revolution.

China's success demonstrates that the pairing of nascent quantum capabilities with existing technologies can produce significant near-term advantages. In sensing, quantum-enhanced gravitometers and magnetometers have already been demonstrated to enhance existing capabilities. There is still work to be done to improve performance and reliability, but the fact remains that these tools are being **tested**, and will be deployed.

One of the major factors motivating the rollout of quantum communication is, conversely, quantum computing. The increased computational power of quantum computers poses a **significant threat** to traditional methods of cryptography and cybersecurity. Defence and security analysts have warned that countries may already be collecting secure information with the intention of decrypting it once necessary advancements in quantum computing have been made, in a practice labelled **"harvest now, decrypt later."**

As China, Russia and the US vie for supremacy in quantum computing, the impetus for states to implement quantum communication, or other post-quantum cryptographic measures, will only increase. This interplay has the potential to intensify an already underway technological race in the field.

The development of standards to regulate quantum technologies will play a major role in their eventual rollout. Individual nations have started creating domestic standards for this technology, and as in other areas like 5G, Small Modular Reactors (SMRs), and AI, they will each seek to impart their preferences on global standards.

The impact of quantum communication and other quantum technologies on the defence and security sectors is still far from understood. If an actor could communicate with complete secrecy, it could disrupt crisis management and raise the risk of escalation. Further work is needed to better articulate the near-term impacts of quantum technologies in this area.

While China's achievements in quantum communication are significant, they represent merely the first applications of a technology whose ultimate use cases are far from understood. Quantum key distribution is just the first of a number of quantum-enabled secure communication systems. Other more advanced mechanisms utilizing other features of quantum mechanics are in development and here again, China is demonstrating **technological leadership**. Even if the US has other priority technologies it is focusing on, understanding the implications of China's dominance in quantum communications is vital.

Find out more

Email: info@ridgeway-information.com

Telephone: +44 (0) 2039 101 902

Website: www.ridgeway-information.com

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