Centre for Air Power Studies

Centre for Air Power Studies ISSUE BRIEF

07/24

01 March 2024

QUANTUM 2.0 REVOLUTION, INDIA, AND THE MILITARY: KEEPING UP WITH THE INNOVATION AND COMPETITION IN THE QUANTUM COMMUNICATION RACE

Abhishek Sharma

Research Associate, Centre for Air Power Studies

Communication has been considered an essential aspect of warfare since antiquity, holding the power to shift the direction of conflicts and war, just as it does today. In this endeavour, Quantum Communications has recently gained much traction in many countries, including India. Therefore, it is vital to understand the rationale and application of technologies like Quantum Communication to secure the next generation of communication infrastructure.

India and Quantum Communication Technologies: Dual Application with Strategic Benefits

As India grows economically, the digital economy is becoming one of the drivers of India's growth story. Due to this, the protection of its digital infrastructure engaged in financial transactions, banking infrastructure, and communications systems has become vital to safeguard from attacks, disruption, harm, and manipulation. Such heightened security can be promised only with the help of the next generation of secure communication techniques, such as Quantum Communications Quantum Key Distribution (QKD).

In 2020, the government announced a National Mission on Quantum Technologies & Application (NM-QTA) spanned across five years with an allocated budget of Rs 8000 crore.[1] This energised the development of organisations working on Quantum technologies, particularly the Quantum communication ecosystem across academia, government institutions, startups, and industries. In addition, it emphasised the building of a knowledge and patents ecosystem, indigenisation, and a sustainable

funding pipeline. It was followed by the announcement of the National Quantum Mission (NQM) for 2023-2031, aimed 'to seed, nurture, and scale up scientific and industrial R&D and create a vibrant & innovative ecosystem in Quantum Technology.' Under the NQM, the Centre for Development of Telematics (C-DoT) is the nodal organisation that oversees the Quantum Communications projects. The organisation is developing QKD and Post Quantum Cryptography (PQC) solutions to enhance and secure communications.[2]

Military application of Quantum communication brings benefits such as tamper-proof or unbreakable encryption, secure key distribution, and eavesdropping detection for sensitive military operations and communications.

Most quantum technologies, including quantum communications, have dual-use applications— Military and Civilian communication, vital in strengthening the state's national security. From the national security standpoint, the military application is more critical. Military application of Quantum communication brings benefits such as tamper-proof or unbreakable encryption, secure key distribution, and eavesdropping detection for sensitive military operations and communications. Developing such technologies is essential to counter emerging threats to India's communication infrastructure from adversaries with more advanced technology.

In the last few years, we have seen human knowledge and capital investment improving in demonstrating quantum communication technology in India, such as QKD demonstrations. These steps are vital in the backdrop of increasing[3] vulnerability of Indian military communication to Chinese attacks. Demonstration of these capabilities is serious, such as the alleged role of cyber interference in the 2017 Sukhoi crash.[4] However, even civilian infrastructure is critical. For example, attacks on Viasat satellite and disturbing Ukrtelecom internet[5] and Kyivstar,[6] are all tactical choices States make for influencing operations.

India and Quantum Communication

Indian Minister Ashwini Vaishnav, while addressing the International Quantum Communications Conclave, said that 'Quantum is the new frontier of technology for security purposes, [and] for cryptographic purposes.'[7] The introduction of NQM has led to many new initiatives in government and the private sectors, currently in the pipeline, aiming to enhance India's strategic capabilities in the Quantum domain. It started with the government's announcement to bring in a dedicated mission on emerging technologies like Quantum to influence change through a top-down approach. This mirrors the strategy observed in the space startup ecosystem, whereby bringing in policy, easing regulations, and focusing on ease of doing business has helped spur a boom.[8] A replication of this approach would help in two ways: first, it would create an ecosystem that attracts investment in research and innovation in Quantum technologies, and second, it would

help achieve India's objective in the Quantum domain, particularly those related to Quantum communication.

The introduction of NQM has led to many new initiatives in government and the private sectors, currently in the pipeline, aiming to enhance India's strategic capabilities in the Quantum domain.

For the development of quantum communication technologies, the NQM states a clear objective: build a satellite-based secure quantum communication system for a 2000 km range within India between ground stations and inter-city and beyond with other countries.[9] Many government organisations are working on this endeavour, particularly Indian Space Research Organisation (ISRO) and C-DoT. ISRO is leading the innovation and research in safe communications through QKD, and the C-DoT is working to facilitate the 'development of telecom and associated technologies by collaborating with Industry.'[10] The latter has focused on ensuring that the broader ecosystem is incorporated in developing these technologies from academia, startups, and industry under the Collaborative Research Program 2022 (CCRP-2022) with a funding pipeline.[11]

In 2020, the Space Application Centre (SAC) successfully demonstrated QKD communication over 300 metres. This success of the experiment motivated the organisation to take a step ahead and launch India's QKD satellite. ISRO chairman said that '[W]e are trying to build payloads that could communicate with each other in space in a closed loop without signal attenuation via QKD' aimed at 'embedding this technology [QKD] in our future launches.'[12]

Furthermore, Raman Research Institute (RRI), an autonomous institution based in Bengaluru, is also working on Quantum technologies. Recently, RRI's Quantum Information and Computing lab successfully conducted an experiment with ISRO's UR Rao Satellite Centre, deploying the Pointing Acquisition and Tracking (PAT) system—technology that 'assists ground-based source in tracking the moving receiver.'[13] This technological development paves the way for secure communications, particularly for 'defence and strategic purposes, [and] enhance cyber security.[14]

Besides focusing on development and innovation, India has also given impetus to hold challenges like hackathons, seminars, and competitions on Quantum technologies. This gives interested startups and students a platform to put forward their products and research, which further helps the industry develop new solutions and security technologies. Organising open quantum communication challenges to break quantum channel encryption and giving incentives helps to attract talent. Last year, the International Quantum Communication Conclave was organised with an open challenge to break quantum channel encryption.[15]

Indian Military and Quantum Computing

India has also given impetus to hold challenges like hackathons, seminars, and competitions on Quantum technologies. This gives interested startups and students a platform to put forward their products and research, which further helps the industry develop new solutions and security technologies.

In recent years, the Indian Armed Forces have paid more attention to the development and modernisation of their systems and structures. For this, they are focusing on the innovation, research, and integration of Critical and Emerging Technologies (CET) into their operations. All three professional uniformed services, the Indian Army, the Indian Navy, and the Indian Air Force, look at the critical importance of emerging technologies—Artificial Intelligence (AI), cyber security, and quantum computing. This emphasises the importance of CET in defence modernisation, mainly focusing on high technologies and learning the lessons from different conflicts and wars in the world. The latter stresses the necessity to develop, invest, and innovate in CET for future Traditional and Irregular warfare. Technologies like Quantum Communication are vital for building the future military communication infrastructure. These are still in development and would take decades to integrate fully.

Apart from India, countries like China, the US, the EU, and Japan are focusing on Quantum Communication technologies; some countries are in a more advanced phase. China, for example, has successfully experimented with satellites to ground station demonstration QKD, making it the first country in the world to do so. It was also the first country to launch a dedicated Quantum communication satellite known as Quantum Science Satellite (QUESS) in 2020.[16] Recently, China and Russia successfully demonstrated Quantum communication spanning 3,800 Km between Moscow in Russia and Urumqi in China from its Mozi satellite.[17]

All Indian armed forces are working to incorporate Quantum technologies, including Quantum communication, in their military functioning. The Indian Navy's Weapons and Electronics Systems Engineering Establishment (WESEE) signed a Memorandum of Understanding (MoU) with RRI's QuIC to develop indigenously 'quantum key distribution techniques' towards securing communications for potential maritime use-cases.[18] The Indian Army is also working on a Quantum secure communications project with its Defence Innovation Organisation (DIO).[19] One startup that stands out in Quantum Communications in India is QNu Labs, considered the only 'quantum communication company in India'[20] with extensive experience.[21] The Indian Navy and Indian Army have collaborated with QNu Labs to 'deploy QKD systems in a hub & spoke configuration across multiple locations with the state-of-the-art systems.'[22]

Similarly, the Indian Space Promotion and Authorization Centre (IN-SPACe) has signed an MoU with QNu Labs 'to develop indigenous satellite QKD products.'[23] The robust military and private sector collaboration is critical for achieving NQM's objectives. The Defence secretary has appreciated the role of iDEX startups in developing indigenous QKD technology and contributing to Aatmanirbhar Bharat's success.[24] Deep tech startups in Quantum communications are critical in developing Quantum technologies.

India is expected to launch a satellite in the future that would further assist its quantum communication capabilities, which are considered essential features of safe and secure strategic military and civilian communication.

Focus on Long-term Play

India cannot compete with countries like the US and China on capital expenditure; hence, it becomes essential to allocate its resources wisely to projects that would be commercially viable and strategically beneficial for economic growth and national security. In this context, the recent 10,000 crore budget announcement is a welcome step, particularly for Deep tech startups.[25] This would require a focus on dedicated projects and, more importantly, a continuity in research and innovation. A whole of system approach is needed for better inter-ministerial and department coordination between agencies like ISRO, the Defence Research and Development Organisation (DRDO), and the Department of Science and Technology (DST), with industries, academia, and start-ups that are working in the space. India can leverage its collective resources by working with large corporations already working on Quantum technologies' specific use cases. Strategic applications for the military are also an important part of the mission. India is expected to launch a satellite in the future that would further assist its quantum communication capabilities, which are considered essential features of safe and secure strategic military and civilian communication.

India must move toward establishing a quantum-safe network nationwide under the NQM in a phased manner through a multi-stakeholder approach, which would help it to join international networks later for commercial purposes. India must invest more in hard infrastructure, funding, and developing human resources and skills to foster better innovation and research. Expertise in Artificial Intelligence and Cloud computing will also need to be developed simultaneously to avail the benefits of the technology entirely. On the International level, India has already signed agreements with major countries like the US and the European Union on Quantum technologies. However, this partnership must be strengthened and cultivated further through joint projects between start-ups, academia, and industry. Another vital area that demands better cooperation with international partners is the standard for Quantum technologies application, which is essential for better collaboration and interoperability going forward. India must also

develop new relationships on Quantum technologies and standardisation with countries such as South Korea, Singapore, Russia, Finland, and Japan. Overall, India's goal should be to achieve its written objectives rather than engage in any global competition along the lines of our space mission. India needs to play the long game, which requires precise focus in areas where we have the best knowledge and capabilities while building capacities in new areas.

Another vital area that demands better cooperation with international partners is the standard for Quantum technologies application, which is essential for better collaboration and interoperability going forward.

Notes:

[1] Ministry of Science and Technology, Government of India, "Budget 2020 announces the largest ever science mission: A 8000 cr National Mission on Quantum Technologies & Applications," *Press Information Bureau*, February 1, 2020, https://pib.gov.in/PressReleseDetailm.aspx?PRID=1601563. Accessed on January 10, 2024.

[2] Ministry of Communications, Government of India, "Two-day 1st International Quantum Communication Conclave, to learn latest advancements in quantum tech, concludes," *Press Information Bureau*, March 28, 2023, https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1911634. Accessed on January 10, 2024.

[3] Rahul Singh, "Chinese hackers can disrupt Indian Army's communication network: Report," *Hindustan Times*, January 20, 2017, https://www.hindustantimes.com/india-news/security-flaws-report-warns-chinese-malware-could-bring-indian-army-to-a-standstill/story-H2ckzU6xpZSIOTaHyldu6K.html. Accessed on February 10, 2024.

[4] Abhinandan Mishra, "Concerns deepen about cyber attack on Su 30, IAF starts inquiry," *The Sunday Guardian,* June 4, 2017, https://sundayguardianlive.com/investigation/9670-concerns-deepen-about-cyber-attack-su-30-iaf-starts-inquiry. Accessed on February 10, 2024.

[5] Daryna Antoniuk, "Meet the frontline workers keeping the internet online in Ukraine," *Recorded Future,* April 1, 2022, https://therecord.media/meet-the-frontline-workers-keeping-the-internet-online-in-ukraine. Accessed on February 10, 2024.

[6] Daryna Antoniuk, "Ukraine's largest telecom operator shut down by cyberattack," *Recorded Future*, December 12, 2023, https://therecord.media/kyivstar-cyberattack-telecom-shutdown-ukraine. Accessed on February 10, 2024.

[7] Yuthika Bhargava, "Govt launches ''quantum communication' network with a dare: Rs 10L for ethical hackers who can break encryption," *The Print,* March 27, 2023, https://theprint.in/india/govt-launches-quantum-communication-network-with-a-dare-rs-10l-for-ethical-hackers-who-can-break-encryption/1476283/. Accessed on February 10, 2024.

[8] Indian Space Research Organisation, "Opening Up Indian Space Sector for Private Sector -Reforms," https://www.isro.gov.in/Reforms.html. Accessed on February 10, 2024.

[9] "National Quantum Mission (NQM)," *Department of Science and Technology,* Government of India, https://dst.gov.in/national-quantum-mission-nqm. Accessed on February 10, 2024

[10] Centre for Development of Telematics, Government of India, "C-DOT Collaborative Research Program (CCRP)," https://cdot.in/cdotweb/assets/docs/collaborativePrograms/CCRP_2022_CDOT_Collaborative_R&D_Policy.pdf. Accessed on February 10, 2024

[11] Ibid.

[12] 'Ahmedabad to lead India's quantum communication efforts: Isro Chief,' *The Times of India*, June 23, 2023, https://timesofindia.indiatimes.com/city/ahmedabad/ahmedabad-to-lead-indias-quantum-communication-efforts-isro-chief/articleshow/101204266.cms. Accessed on February 10, 2024.

[13] Chetan Kumar, "RRI moves step closer to ground-to-satellite-based secure quantum communications," *The Times of India,* April 1, 2023, https://timesofindia.indiatimes.com/home/science/rri-moves-step-closer-to-ground-to-satellite-based-secure-quantum-communications/articleshow/99167615.cms?from=mdr. Accessed on February 10, 2024

[14] Ibid.

[15] Yuthika Bhargava, 'Govt launches ''quantum communication' network with a dare: Rs 10L for ethical hackers who can break encryption,' *The Print,* March 27, 2023, https://theprint.in/india/govt-launches-quantum-communication-network-with-a-dare-rs-10l-for-ethical-hackers-who-can-break-encryption/1476283/. Accessed on 10 February, 2024.

[16] Jacob Aron, "China launches world's first quantum communications satellite," *NewScientist,* August 16, 2016, https://www.newscientist.com/article/2101071-china-launches-worlds-first-quantum-communications-satellite/. Accessed on February 10, 2024.

[17] Schrodinger, "China and Russia Successfully Test 'Hack-Proof' Quantum Communication Link, Paving Way for BRICS Network," *Quantum Zeitgeist,* January 1, 2024, https://quantumzeitgeist.com/china-and-russia-successfully-test-hack-proof-quantum-communication-link-paving-way-for-brics-network/#. Accessed on February 10, 2024.

[18] Department of Science and Technology, Government of India, "DST Institute to partner Indian Navy in developing secure maritime communications using Quantum Technology," https://dst.gov.in/dst-institute-partner-indian-navy-developing-secure-maritime-communications-using-quantum-technology. Accessed on February 10, 2024.

[19] "Bengaluru-based startup QNu Labs shortlisted for Army procurement," *The Times of India*, August 16, 2022, https://timesofindia.indiatimes.com/city/bengaluru/qnu-labs-shortlisted-for-army-procurement/articleshow/93581002.cms. Accessed on February 10, 2024.

[20] "India's National Quantum Mission: A Step Forward," QNu Labs, August 28, 2023, https://www.qnulabs.com/national-quantum-mission-india/. Accessed on February 10, 2024.

[21] *The Times of India,* n. 19.

[22] "QNu Labs bags contract from Indian Navy for quantum encryption systems," *The Economics Times*, June 6, 2023, https://economictimes.indiatimes.com/news/defence/qnu-labs-bags-contract-from-indian-navy-for-quantum-encryption-systems/articleshow/100796060.cms. Accessed on February 10, 2024.

[23] Sidharth MP, "Indian start-up partners with ISRO to develop satellite-based QKD secure communication," *World is One News*, December 20, 2022, https://www.wionews.com/science/indian-start-up-partners-with-isro-to-develop-satellite-based-qkd-secure-communication-544849. Accessed on February 10, 2024.

[24] *The Times of India,* n. 19.

[25] Amitabh Sinha, "Why the Union Budget's plans for deep tech and research funding are significant," *The Indian Express*, February 8, 2024, https://indianexpress.com/article/explained/explained-sci-tech/why-budget-plans-for-deep-tech-and-research-funding-matter-9149783/. Accessed on February 10, 2024.

Centre for Air Power Studies

The Centre for Air Power Studies (CAPS) is an independent, non-profit think tank that undertakes and promotes policy related research, study and discussion on defence and military issues, trends, and development in air power and space for civil and military purposes, as also related issues of national security. The Centre is headed by Air Marshal Anil Chopra PVSM AVSM VM VSM (Retd).

Centre for Air Power Studies
P-284, Arjan Path, Subroto Park, New Delhi 110010
Tel: +91 11 25699130/32, Fax: +91 11 25682533

Editor: Dr Shalini Chawla e-mail: shaluchawla@yahoo.com
Formatting and Assistance: Ms Radhey Tambi, Ms Khyati Singh and Mr Rohit Singh