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Quantum Networks Research

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Why can a quantum link catch a spy? Because looking at a quantum signal changes it. India has tested three such links since 2022. A Kolkata team has also found a more efficient way to plan a quantum network.

1 What is a quantum network?

A quantum network is a network of entangled states. These states can carry quantum information from one place to another. Entanglement means two particles stay linked, however far apart they are.

Why does that matter?

Think of two magic coins. Flip one in Delhi and the other in Kolkata always shows a matching result. Nobody can say the result before the flip. Yet the two coins stay linked. Entangled particles behave a little like this pair.

What is the memory hook?

Think “linked particles, far apart”.

> **Quick check 1.** Entangled particles stay linked, however far apart they are. *(True or False?)* See answer ↓

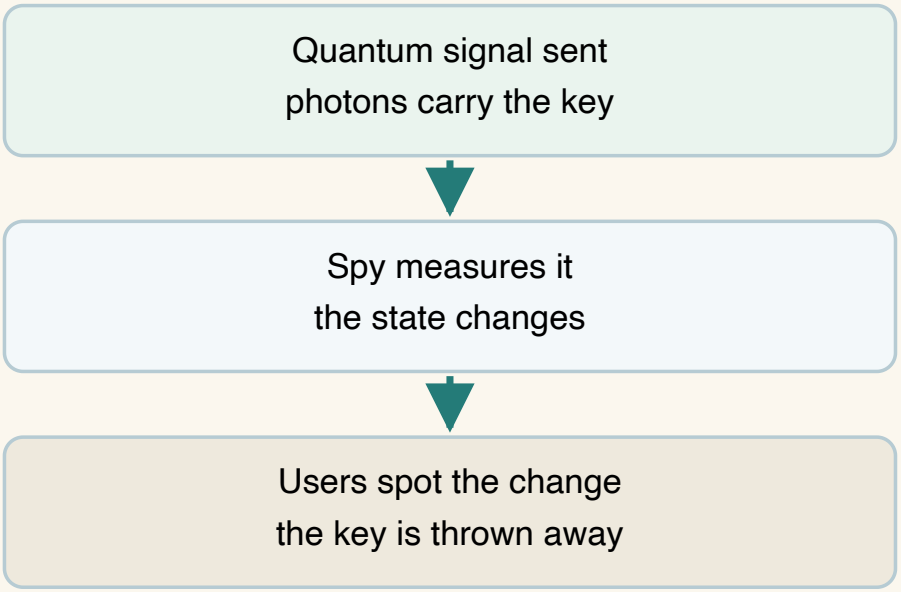
Sources: thequantuminsider.com; journals.aps.org

2 Why can't spies copy QKD?

QKD stands for Quantum Key Distribution. It lets two parties share a secret key. The key then locks and unlocks their messages.

What makes it safe?

Think of a letter sealed with wax. If anyone opens it, the seal is broken. You see the damage at once. A quantum signal works the same way. Measuring it changes its state. The two legitimate users can spot the change.



Look and you leave a mark. Original explanatory diagram.

- Any attempt to intercept the photons disturbs them.
- The users then know a spy is present.
- Device-independent QKD can certify security from test results. This holds only under assumptions, such as protected labs, private randomness and an authenticated classical channel.
- Ordinary implementations must still deal with hardware imperfections.

What is the memory hook?

Think “look and you leave a mark”.

> **Quick check 2.** Measuring a quantum signal leaves no trace for the legitimate users to find. *(True or False?)* See answer ↓

Sources: opengovasia.com; thequantuminsider.com

3 What was the 2022 link?

In February 2022, India showed its first QKD link between two cities. A joint team from DRDO and IIT Delhi built it. DRDO is the Defence Research and Development Organisation.

What were the key facts?

- The link joined Prayagraj and Vindhyachal in Uttar Pradesh.
- The distance was more than 100 kilometres.
- It ran over ordinary commercial-grade optical fibre already laid in the field.
- DRDO announced it on 23 February 2022.
- DRDO said it proved indigenous technology for sharing secure keys.

What is the memory hook?

Think “2022, two cities, fibre”.

> **Quick check 3.** India's first intercity QKD link joined Prayagraj and Vindhyachal over commercial-grade fibre. *(True or False?)* See answer ↓

Sources: tribuneindia.com; aviation-defence-universe.com

4 What is free-space QKD?

Free-space QKD sends quantum signals through open air. It needs no optical fibre. In June 2025, DRDO and IIT Delhi tested it using entanglement.

What did the test show?

- The link covered more than 1 kilometre on the IIT Delhi campus.
- The secure key rate was nearly 240 bits per second.
- The quantum bit error rate (QBER) was under 7%. QBER is the share of key bits that arrive wrong.
- The DRDO-Industry-Academia Centre of Excellence (DIA-CoE) at IIT Delhi ran the test.
- The research group of Prof Bhaskar Kanseri led the work.

Why is no fibre useful?

Laying cable is costly. It is also hard across rough ground. A beam through air skips that work.

What is the memory hook?

Think “air, not cable”.

> **Quick check 4.** The June 2025 IIT Delhi demonstration needed new optical fibre to be laid. *(True or False?)* See answer ↓

Sources: evertiq.com; thequantuminsider.com

5 What happened in September 2026?

QNu Labs, BISAG-N and IIT Gandhinagar ran a free-space QKD link over 5.56 kilometres. It was India’s first such link at this distance. BISAG-N is the Bhaskaracharya National Institute for Space Applications and Geo-informatics.

What were the key facts?

- The trial ran overnight on 27-28 September 2026.
- It linked BISAG-N and IIT Gandhinagar through open air.
- The QBER stayed below 5%.
- The secure key rate was 230 to 260 bits per second.
- That is about one fresh 256-bit key every second.

Where did the keys go?

The keys went into BISAG-N’s Vedic Kavach platform. It uses post-quantum cryptography (PQC). PQC means ordinary maths-based codes built to resist quantum computers. So hardware and software protection worked together.

What is the memory hook?

Think “5.56 km, night, Vedic Kavach”.

> **Quick check 5.** India's first 5.56 km free-space QKD link was shown by QNu Labs, BISAG-N and IIT Gandhinagar. *(True or False?)* See answer ↓

Sources: circuitdigest.com; quantumcomputingreport.com

6 What is the GCP protocol?

GCP stands for General Concurrence Percolation. Two Bose Institute scientists, Dr Deep Nath and Prof Soumen Roy, proposed it. The Bose Institute is an autonomous institute under the Department of Science and Technology.

What problem does it solve?

Entanglement is hard to keep strong over long distances. Older methods tried to fix this by removing some intermediate stations. That wastes resources and changes the network.

How does GCP differ?

- It uses geometric routing and removes no nodes.
- It strengthens entanglement along the shortest available paths.
- Computer simulations showed it lowers the entanglement needed to connect the whole network.
- It is a theory result. It is not a working hardware link.

When was it published?

The paper is in Physical Review A, volume 114, article 012440. The journal published it on 16 July 2026. News reports followed in August 2026.

What is the memory hook?

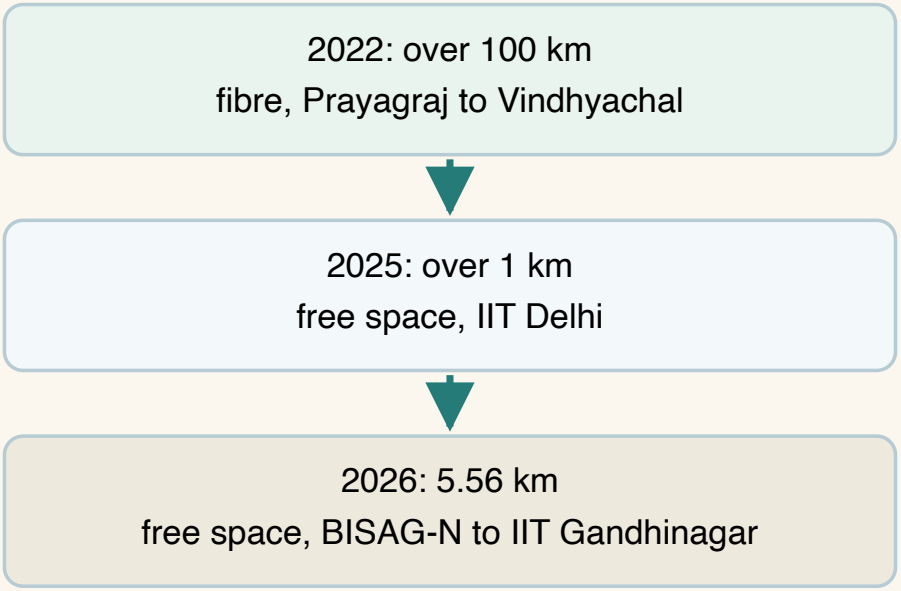
Think “route smartly, remove nothing”.

> **Quick check 6.** The GCP protocol works by removing intermediate network stations. *(True or False?)* See answer ↓

Sources: ddindia.co.in; journals.aps.org

7 What are the common exam traps?

Four mix-ups come up again and again.



Fibre first, then air, then longer air. Original explanatory diagram.

What are the traps?

- **Fibre or air?** The 2022 link used fibre. The 2025 and 2026 links used open air.
- **Which distance?** The 2022 link was over 100 km. The 2025 link was over 1 km. The 2026 link was 5.56 km.
- **Which team?** DRDO and IIT Delhi did 2022 and 2025. QNu Labs, BISAG-N and IIT Gandhinagar did 2026.
- **Link or theory?** GCP is a simulated protocol. The other three are field tests.

How do you remember them?

Think “fibre first, then air, then theory”.

> **Quick check 7.** The Bose Institute's GCP protocol is a working hardware quantum link. *(True or False?)* See answer ↓

Sources: tribuneindia.com; evertiq.com; circuitdigest.com

Practice MCQs

1. What fundamental property of quantum measurement makes Quantum Key Distribution (QKD) secure against eavesdropping?

A. Quantum computers cannot be hacked by definition

B. Measuring or intercepting a quantum signal disturbs it, alerting legitimate users

C. QKD uses passwords that change every second

D. Quantum signals travel faster than classical ones

See answer ↓

2. Which two places did India's first intercity QKD link, shown in February 2022, connect?

A. Hyderabad and Bengaluru

B. Prayagraj and Vindhyachal

C. Delhi and Jaipur

D. Mumbai and Pune

See answer ↓

3. What secure key rate did the June 2025 DRDO and IIT Delhi free-space entanglement test reach?

A. Nearly 240 bits per second

B. Nearly 24 bits per second

C. About 240 kilobits per second

D. About 2,400 bits per second

See answer ↓

4. Which platform received the keys from India's 5.56 km free-space QKD link of September 2026?

A. BISAG-N's Vedic Kavach

B. ISRO's NavIC network

C. UPI payment network

D. Aadhaar authentication system

See answer ↓

5. What do older methods do that the Bose Institute's GCP protocol avoids?

A. Publish in a journal

B. Use computer simulations

C. Remove intermediate network nodes

D. Use entangled states

See answer ↓

Answer Key

1. **B.** The answer is that measuring or intercepting a quantum signal disturbs it. This change alerts the two legitimate users to a spy. Quantum signals do not travel faster than classical ones. QKD does not use passwords that change every second. Quantum computers are not unhackable by definition; the safety comes from physics. Memory hook: look and you leave a mark. ↑ Q1
2. **B.** The answer is Prayagraj and Vindhyachal in Uttar Pradesh. DRDO and IIT Delhi built the link over more than 100 km of commercial-grade optical fibre. The other city pairs were not part of this test. Memory hook: 2022, two cities, fibre. ↑ Q2
3. **A.** The answer is nearly 240 bits per second. The quantum bit error rate stayed under 7% over more than 1 km. The other rates are ten or a thousand times off. Memory hook: air, not cable, about 240. ↑ Q3
4. **A.** The answer is BISAG-N's Vedic Kavach. It is a post-quantum cryptography platform. Test messages were encrypted and decrypted end to end with the keys. The other three systems were not part of the trial. Memory hook: 5.56 km, night, Vedic Kavach. ↑ Q4
5. **C.** The answer is removing intermediate nodes. Older methods disconnected some stations to strengthen links, which wastes resources. GCP uses geometric routing and keeps every node. Entangled states and simulations are used by both approaches. Memory hook: route smartly, remove nothing. ↑ Q5

Quick-check answers

1. **True.** This link is what a quantum network uses. ↑ 1
2. **False.** it is false. Measuring changes the signal, so a spy is noticed. ↑ 2
3. **True.** The distance was more than 100 km. ↑ 3
4. **False.** it is false. It used a free-space link through open air. ↑ 4
5. **True.** The trial ran overnight on 27-28 September 2026. ↑ 5
6. **False.** it is false. GCP uses geometric routing and removes no nodes. ↑ 6
7. **False.** it is false. It is a protocol tested in computer simulations. ↑ 7

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