



# Quantum Technology for Securing Maritime Communications

**For Prelims:** Indian Navy, Quantum mechanics, Semiconductor, [Internet-of-Things](#), machine learning, [Robotics](#), [Artificial intelligence](#).

**For Mains:** [Quantum Technology](#), Significance and Challenges.

## Why in News?

RRI (Raman Research Institute) has inked a **Memorandum of Understanding (MoU)** with the [Indian Navy](#) on [Quantum Technologies](#) to develop secure maritime communications.

- RRI is an autonomous institute of the Department of Science and Technology (DST).
- Under this agreement, RRI's Quantum Information and Computing (QIc) lab will lead the research efforts towards **developing [Quantum Key Distribution \(QKD\)](#) techniques** that the Indian Navy could leverage in the nation's efforts towards securing free space communications.

## Note

- **Quantum Technology** is a field of science and engineering that deals with the study and **application of quantum mechanics principles**.
  - Quantum mechanics is the branch of physics that describes the behavior of matter and energy at the atomic and subatomic level.
- There are **Four domains of Quantum Technology**:
  - **Quantum communication**
  - Quantum simulation
  - [Quantum computation](#)
  - Quantum sensing and metrology

## What is Quantum Communication?

- **Quantum Communication:**
  - Quantum communication is a **subfield of quantum technology** that focuses on the development of secure communication systems that use the principles of quantum mechanics.
  - Quantum communication uses a **fundamentally different approach to encryption**.
    - The most common example of quantum communication is **QKD**, which allows two parties to generate an **encryption key that is virtually uncrackable**.
- **Mechanism of Quantum Communication:**
  - **Encoding Information:** Information is encoded onto quantum bits (qubits), which can exist in **multiple states simultaneously**.

- This property is known as **superposition**.
- **Transmitting Information:** The encoded **qubits are transmitted over a quantum communication channel**, such as a [fiber optic cable](#) or a **free-space link**.
  - The qubits are **typically transmitted one at a time**.
- **Receiving Information:** The receiving party measures the qubits using a quantum measurement device.
  - The measurement **process collapses the superposition state of the qubit to a single state**, revealing the encoded information.
- **Detecting Eavesdropping:** One of the key features of quantum communication is that any **attempt to eavesdrop on the communication will disturb the quantum state of the qubit**, making it immediately detectable.
  - This is known as the "**no-cloning theorem**" and is a **fundamental principle** of quantum mechanics.
- **Establishing a Secret Key:** By exchanging a sequence of qubits, the transmitting and receiving parties can **establish a secret key that can be used for secure communication**.
  - This key can be used with conventional encryption algorithms to **ensure the confidentiality and integrity** of transmitted information.

## How Can Quantum Technology be useful In Maritime Communication?

- **Secure Communication:**
  - Quantum **encryption can be used to ensure secure communication between ships and shore stations**, making it difficult for hackers to intercept or eavesdrop on the communication.
- **High-speed Communication:**
  - Quantum technology can enable **faster communication between ships and shore stations** by using quantum entanglement to transmit information instantaneously over long distances.
    - This could be **particularly useful for communication in remote areas** where traditional communication methods are limited.
- **Precision Navigation:**
  - Quantum sensors can be used to improve navigation accuracy by measuring the **Earth's magnetic field with high precision**.
  - This could help ships **navigate through narrow channels**, avoid obstacles, and improve overall safety.
- **Improved Weather Forecasting:**
  - Quantum computers can be used to **run complex simulations of weather patterns**, which can provide accurate and timely information to mariners about impending storms or other dangerous weather conditions.

## Way Forward

- **Implementing quantum communication technologies**, such as QKD at scale is a **major challenge** as they are still in the early stages of development and implementation.
  - **Pilot projects can be established** to test the technology in real-world settings and refine the implementation process.
- Quantum communication technologies are **expensive to develop and deploy**. **Adequate funding for R&D** could lead to more cost-effective solutions.
- **Quantum communication technologies are not yet standardized**, making it difficult for different systems to communicate with each other.
  - **Standards and protocols can be developed** to enable different quantum communication systems to communicate with each other

[Source: PIB](#)

