Technical Talks :

Quantum Internet

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Quantum Internet: The Big Picture

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Quantum Mechanics → Quantum Computing

Quantum mechanics is all around us...

Quantum technology 1.0

- Smartphones
- Computers
- Semiconductors
- MRI scanners
- Nuclear energy

QUANTUM COMMUNICATION

Development of autonomous metro-area, long distance (>1000 km) and entanglement-based networks, a 'quantum internet'.

Protocols that exploit the novel properties that quantum communication offers.

QUANTUM SIMULATION

Development of autonomous metro-area, long distance (>1000 km) and entanglement-based networks, a 'quantum internet'.

Protocols that exploit the novel properties that quantum communication offers.

QUANTUM COMPUTING

Quantum algorithms that demonstrate quantum speed-up and outperform classical computers.

Quantum 2.0

QUANTUM SENSING AND METROLOGY

Quantum sensors, imaging systems and quantum standards that employ single qubit coherence and outperform classical counterparts (resolution, stability) in a laboratory environment.

Courtesy: Quantum Internet | The internet's next big step, TU Delft 2019

Quantum Internet: Basics

- **Quantum Information:** Uses quantum bits, or qubits, which can be in a superposition of both 0 and 1 at the same time. Qubits can be encoded, for example, in the polarization states of a photon or in the spin states of electrons and atomic nuclei

- **Quantum Internet**: Information is created, stored and moved around in ways that mirror the bizarre behavior of the quantum world

- **Quantum Key Distribution (QKD)**: Qubits are being used for creating secret keys, random strings of 0s and 1s that can then be used to encode classical information

- **Entangled Systems (Qubits)**: Once entangled, both systems are described by a single quantum state, so measuring the state of one system instantly influences the state of the other

- **Quantum Teleportation:** Quantum teleportation works by creating pairs of entangled photons and then sending one of each pair to the sender of data and the other to a recipient

- **Quantum Repeater:** Allows the end to end generation of quantum entanglement, and thus - by using quantum teleportation

Quantum Communication: Entanglement + Teleportation
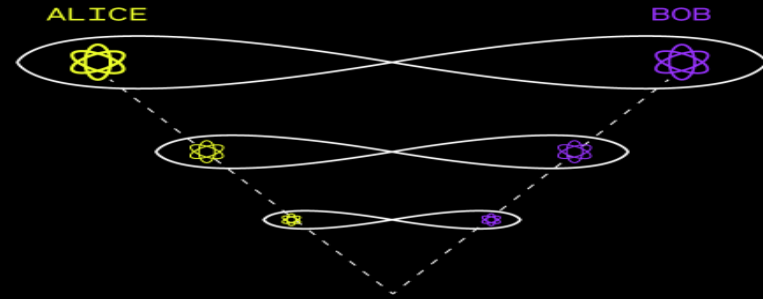
How quantum teleportation works

Figure 1.
Alice and Bob receive pairs of entangled qubits in the form of photons.
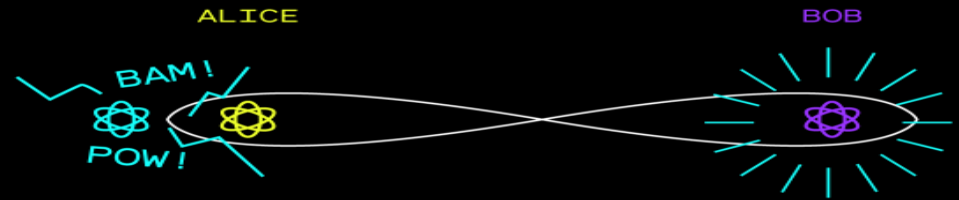
Figure 2.
The photon received by Alice interacts with a qubit of hers that contains quantum data. She measures the state of the entangled photon and this qubit at the same time. This measurement changes the state of Bob's entangled photon.
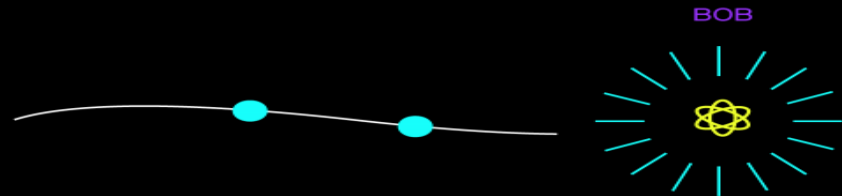
Figure 3.
However, Bob can't tell what's happened to his photon until he receives the result of the measurement. Alice sends this to him in the form of classical bits via fiber-optic cables or other means. With this information, Bob can now work out how his photon has changed and the quantum data that's been teleported to it.

Key Issues in Quantum Networking: Entanglement & Teleportation
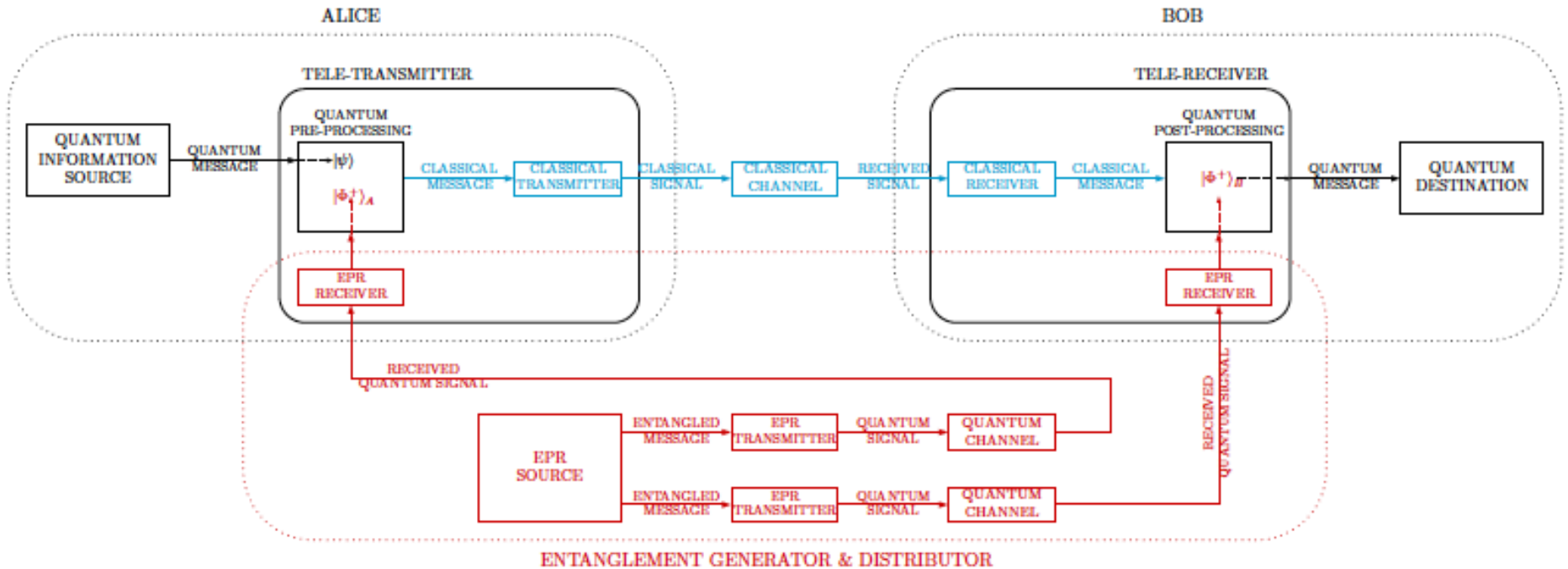
Angela Sara Cacciapuoti et al., "When Entanglement Meets Classical Communications: Quantum Teleportation for the Quantum Internet, IEEE Trans. Communications, 2019: University of Naples Federico II, Italy

Research work at School of I.T., University of Calcutta

- **The present research activities in the area of quantum computing are as follows** :
  - **Quantum Machine Learning**
  - **Designing of new quantum circuits for quantum algorithms**
  - **New circuit optimization techniques**
    - Template based
    - Heuristic based
  - **Development of CAD tools for quantum circuit design, optimization and simulations**
  - **Quantum Cryptography Multi-valued logic and quantum computing**
- **International Collaborations**
  - Department of Computer Engineering, Princeton University, USA
  - Dept. of Computer Science & Engineering and Department of Physics, New York State University at Buffalo, USA
  - Iwate Prefecture University, Japan
  - University of Bremen, Germany
  - University Linz, Austria
  - Nanyang Technological University, Singapore