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Quantum Teleportation Algorithm

Предмет:
Оптоинформатика и
квантовая криптография

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Content

1. Precedent

1.1. Is possible teleportation of quantum information?

Teleportation is the technique of transmitting quantum information (quantum state) from one location to another (considering a long distance between both points).

Мария (sender) and Антон (receiver) need to share a qubit each of a Bell State.

2. Bell states and Quantum No-Cloning Theorem

Bell basis

$$|\Phi^+\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |0\rangle_B + |1\rangle_A \otimes |1\rangle_B) \quad (1)$$

$$|\Phi^-\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |0\rangle_B - |1\rangle_A \otimes |1\rangle_B) \quad (2)$$

$$|\Psi^+\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |1\rangle_B + |1\rangle_A \otimes |0\rangle_B) \quad (3)$$

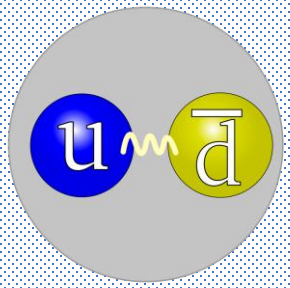
$$|\Psi^-\rangle = \frac{1}{\sqrt{2}}(|0\rangle_A \otimes |1\rangle_B - |1\rangle_A \otimes |0\rangle_B) \quad (4)$$

The Bell's states are specific quantum states of two qubits that represent the simplest (and maximal) examples of quantum entanglement.

Quantum entanglement is the phenomenon that occurs when a group of particles are generated, interact, or share spatial proximity in a way such that the quantum state of each particle of the group cannot be described independently of the state of the others.

2. Bell states and Quantum No-Cloning Theorem

Example of quantum entanglement: An electron and positron both originate from a decaying pi meson [1]



Quantum No-Cloning Theorem: is not possible to find a unitary transformation which will duplicate a given state and write it on to a blank state [2].

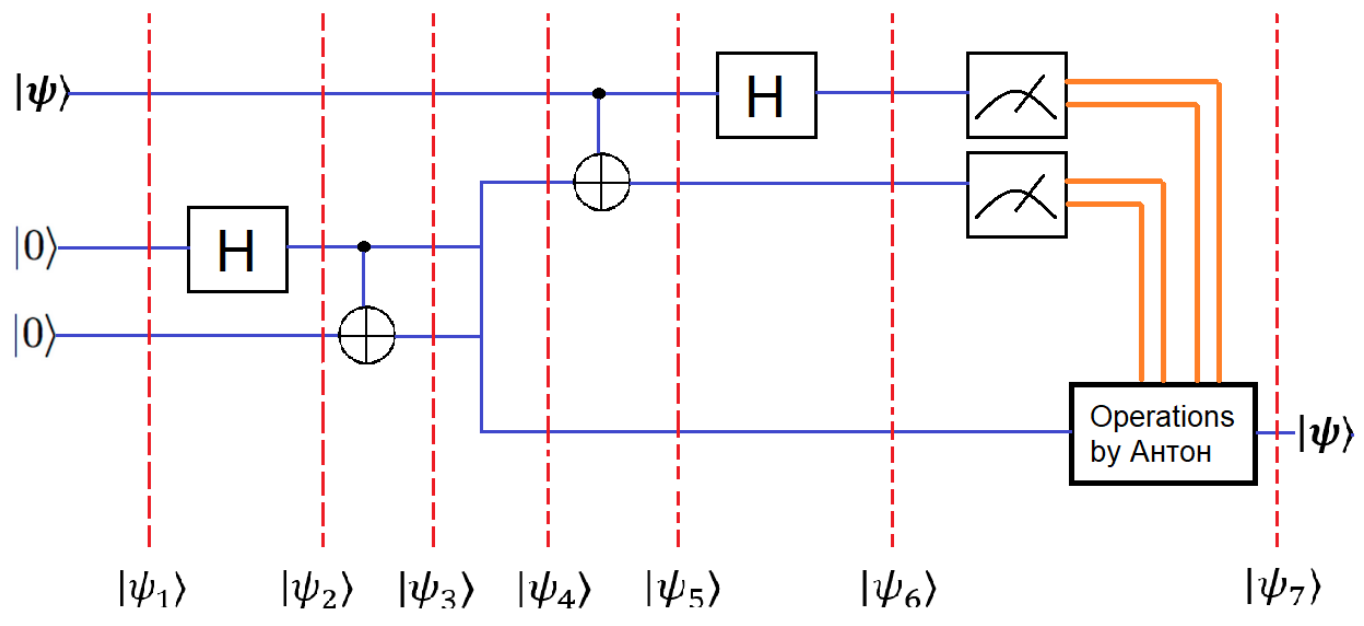
$$|0\rangle \otimes |\psi\rangle \longrightarrow |\psi\rangle \otimes |\psi\rangle = \langle \psi, \phi \rangle^2$$ (No possible)

3. Explanation: Quantum Teleportation circuit by each quantum stages

The Quantum Teleportation of a qubit can be possible using 3 qubits and 2 classical bits.

Requirements

- Мария and Антон they need to be in separate places.
- Мария needs a qubit with its quantum state, that will be send to Антон.
- A classical communication line between Мария and Антон needs to be needs to be set to transmit the 2 classical bits.

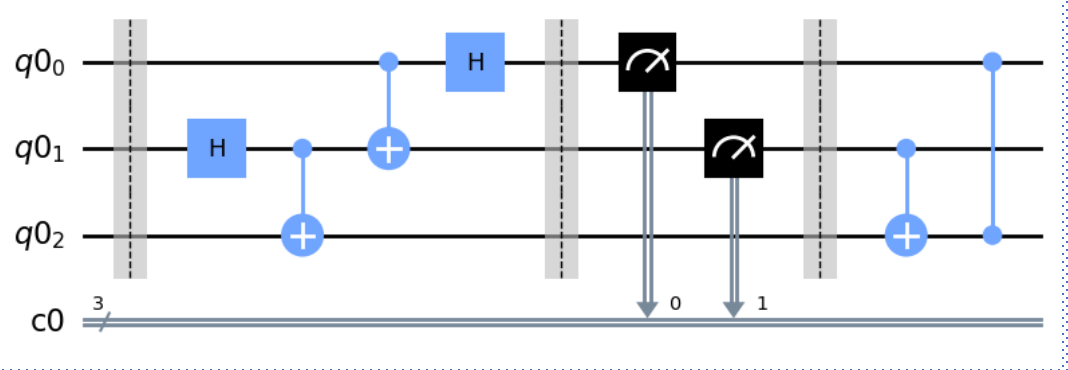


4. Example

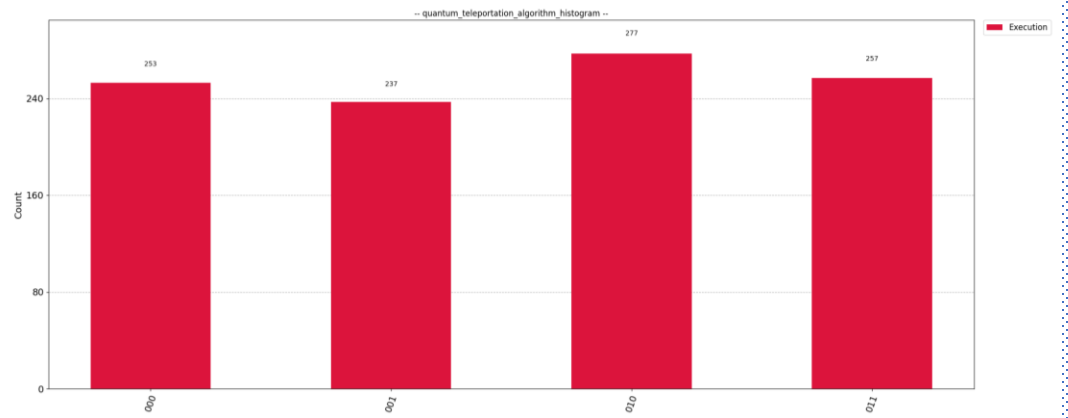
The examples are given during the presentation.
The examples are made on the platform «$Q|$Политех$\rangle$».

Example:
Мария decided to transmit the 0 state of her qubit to Антон.

Quantum circuit



Histogram



5. Conclusion

The transmission of the quantum information is possible with the described quantum circuit. Мария is going to lose the quantum state of her first qubit. Антон will need to do certain operations to acquire the quantum information in his qubit.

6. Bibliography

[1] Pion (2023). Pion. Wikipedia. (Date of consultation: 17.04.2023). Link: https://en.wikipedia.org/wiki/Pion.

[2] EECS Instructional and Electronics Support (2005). No Cloning, Teleportation. C/CS/Phys C191, Fall 2005, Lecture 6. (Date of consultation: 17.04.2023). Link: https://inst.eecs.berkeley.edu/~cs191/fa05/lectures/lecture6_fa05.pdf