

# Quantum Teleportation Assignment

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## 1 Quantum Teleportation

Quantum teleportation is used to “teleport” the state of one qubit to another without making a copy of the state.

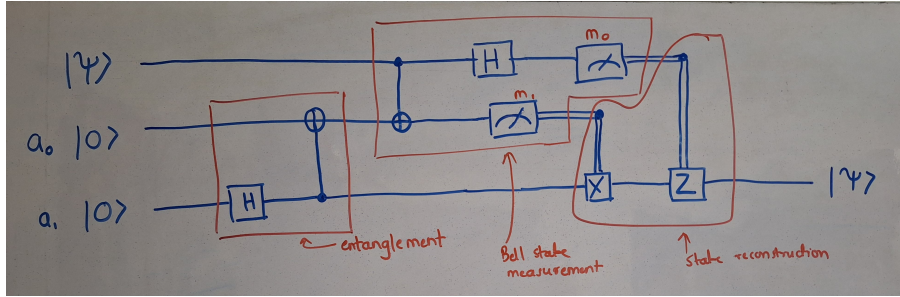


Figure 1: Teleportation circuit

In this, first we need two entangled qubits. These are  $a_0$  and  $a_1$  in the above circuit. These are entangled using the Hadamard gate and CNOT gate as shown in the circuit above. The qubit state to be teleported is in  $|\psi\rangle$  from Alice to Bob. The qubits  $|a_0\rangle$  and  $|\psi\rangle$  are with Alice while  $|a_1\rangle$  is with Bob.

The qubits  $|\psi\rangle$  and  $|a_0\rangle$  are then measured in the Bell basis and the measured values are stored in  $m_0$  and  $m_1$  respectively. Bob uses these values and applies  $Z^{m_0}X^{m_1}$  to his qubit  $|a_1\rangle$  to get the state  $|\psi\rangle$ . Thus, the state in  $|\psi\rangle$  has been teleported to  $|a_1\rangle$ .

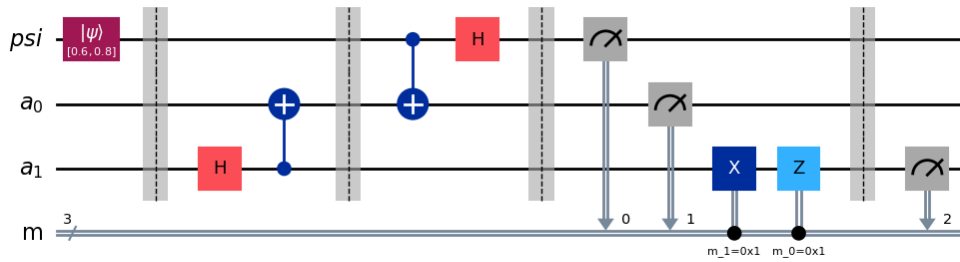


Figure 2: Teleportation circuit drawn using Qiskit in the assignment

## 2 Results

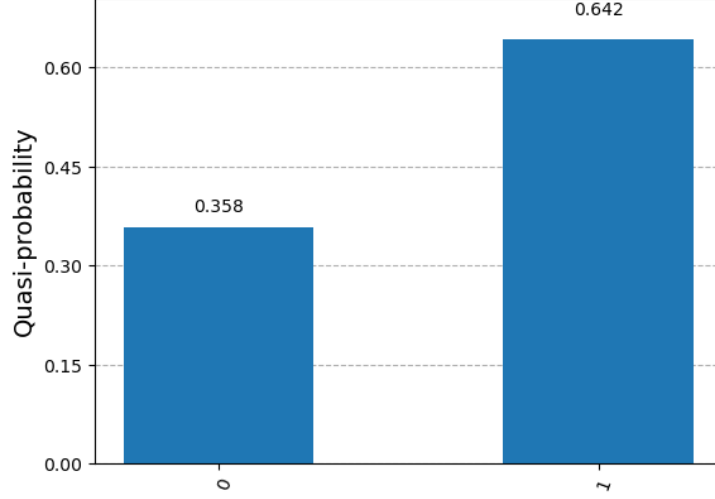


Figure 3: AER plot

The first bit in the registers is for  $a_1$ , i.e Bob's bit. We have to find the state of this qubit at the end of this circuit. So we find out the probabilities of  $a_1$  being  $|0\rangle$  and  $|1\rangle$  which turn out to be very close to 0.36 and 0.64 respectively. Thus,  $a_1$  is in the state  $0.6|0\rangle + 0.8|1\rangle$ . This is the state of the qubit which we wanted to teleport from Alice to Bob. This shows that we have done it successfully.

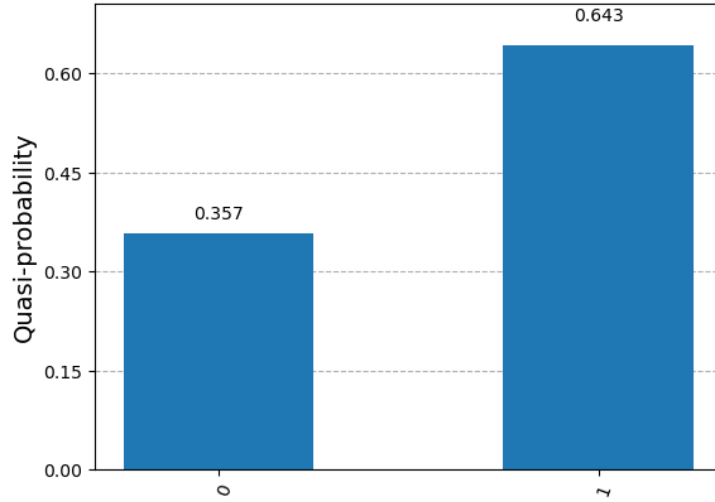


Figure 4: Histogram of the qubit states generated by running the circuit on IBM quantum computer for 4096 shots

With 4096 shots, the state of  $|a_1\rangle$  still is very close to the original state of  $|\psi\rangle$ . Even though a quantum computer might have noise which would give errors in the result, increasing the number of shots seems to make the result more accurate.