Superdense Coding Solutions

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1 Superdense Coding

The task of superdense coding is to send two classical bits of information by sending only one qubit. This is done by using entanglement and quantum gates. The protocol is as follows:

1. Alice and Bob share an entangled pair of qubits. The state of the pair is given by: $|\psi\rangle = \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$

2. If Alice wishes to send 00, she does nothing to her qubit. If she wishes to send 01, she applies the Z gate to her qubit. If she wishes to send 10, she applies the X gate to her qubit. If she wishes to send 11, she applies the iY gate to her qubit.

3. Since the Bell states form an orthonormal basis, Bob can determine the classical bits by performing a Bell basis measurement on the two qubits.

2 Limitations of Transmitting Information

We cannot use a single qubit to send more than two classical bits of information. The maximum number of distinct quantum states which can be created by applying operations on a single qubit is 4, and this limits the number of classical bits that can be sent using a single qubit to 2.