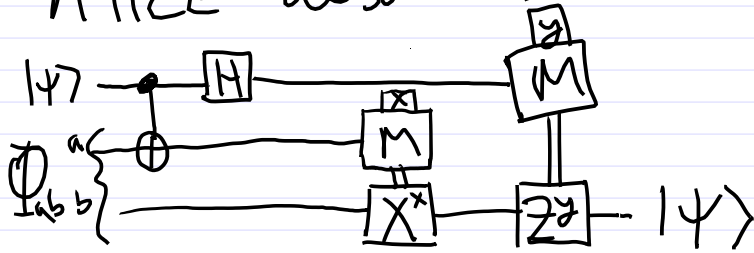


Alice, Bob share a Bell state

$$\Phi_{ab} = \frac{1}{\sqrt{2}} (|00\rangle + |11\rangle)$$

Alice also has some (unknown) $|\psi\rangle$



$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

(See next page)

If Alice measures:

$$x, y = 0, 0$$

$$0, 1$$

$$1, 0$$

$$1, 1$$

To recover $|\psi\rangle$,

Bob needs to apply:

$$I$$

$$X$$

$$Z$$

$$ZX$$

$$|\Psi\rangle_a |\Phi\rangle_b = (\alpha|0\rangle + \beta|1\rangle)_a \frac{1}{\sqrt{2}} (|00\rangle + |11\rangle)$$

apply CNOT \Rightarrow

$$\alpha|0\rangle_a \frac{1}{\sqrt{2}} (|00\rangle + |11\rangle) + \beta|1\rangle_a \frac{1}{\sqrt{2}} (|10\rangle + |01\rangle)$$

$$\frac{|0\rangle + |1\rangle}{\sqrt{2}}$$

apply H
gives:

$$\frac{|0\rangle - |1\rangle}{\sqrt{2}}$$

To correct
Bobs needs
to apply

$$\frac{1}{2} |0\rangle_a |0\rangle_a (\alpha|0\rangle + \beta|1\rangle)_b \quad \vdots \quad 1$$

$$+ \frac{1}{2} |0\rangle_a |1\rangle_a (\alpha|1\rangle + \beta|0\rangle)_b \quad \vdots \quad X$$

$$+ \frac{1}{2} |1\rangle_a |0\rangle_a (\alpha|0\rangle - \beta|1\rangle)_b \quad \vdots \quad Z$$

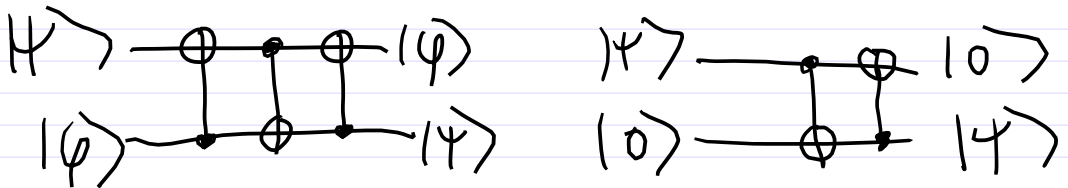
$$+ \frac{1}{2} |1\rangle_a |1\rangle_a (\alpha|1\rangle - \beta|0\rangle)_b \quad \vdots \quad ZX$$



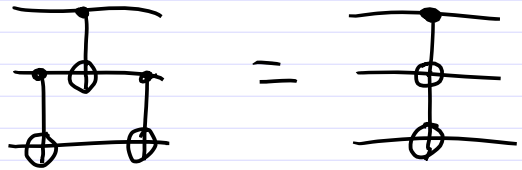
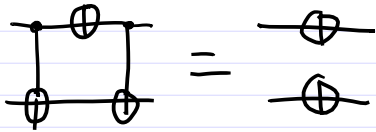
$$|\Psi\rangle_b$$

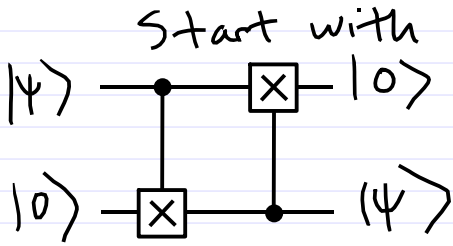
For teleportation, we'll need

General swap circuit reduces for $|\psi\rangle = |0\rangle$ to:



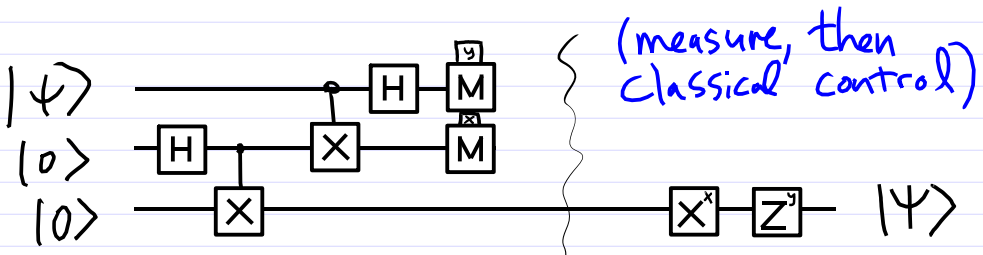
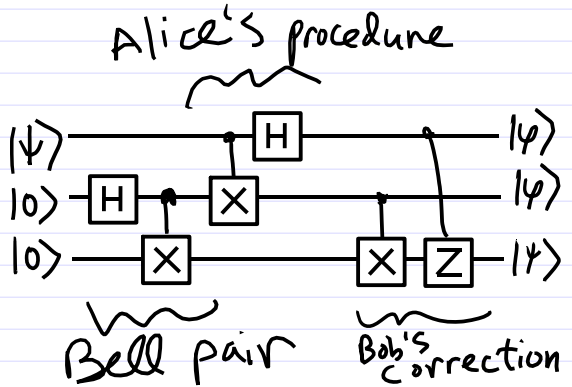
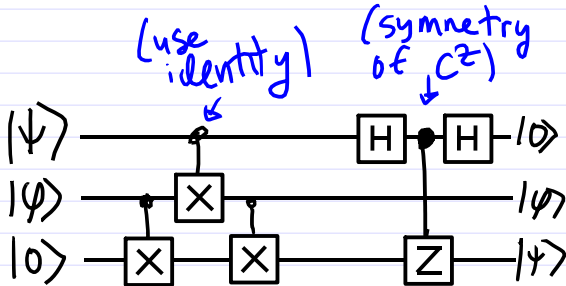
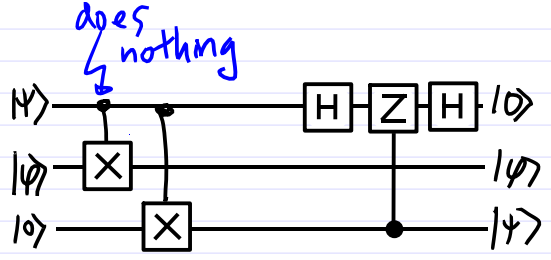
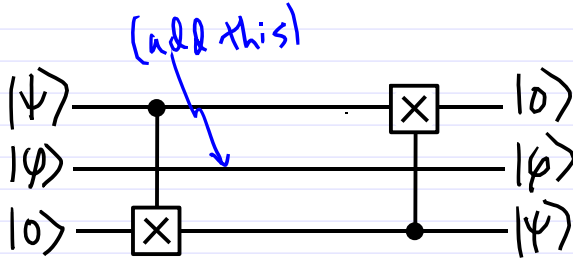
Also recall: implies the controlled circuit identity



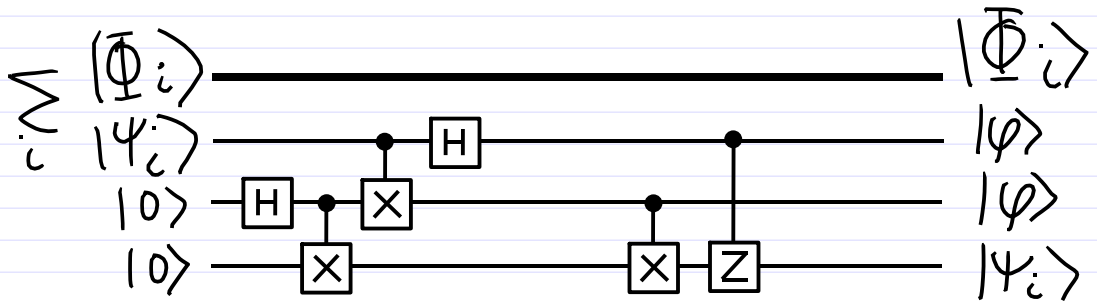
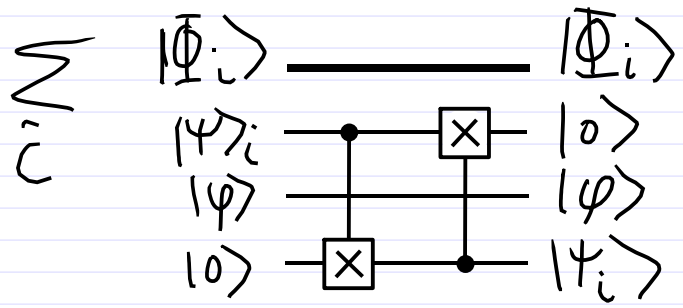


$$|\phi\rangle = H|0\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$$

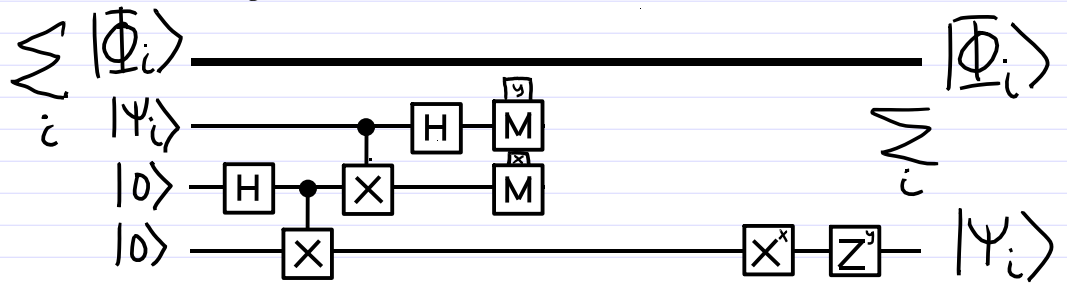
$$X|\phi\rangle = |\psi\rangle$$



Now consider Alice's qubit is in some entangled state $\sum_i |\Psi_i\rangle_a |\Phi_i\rangle_{n-1}$.



(Same argument teleports entanglement)



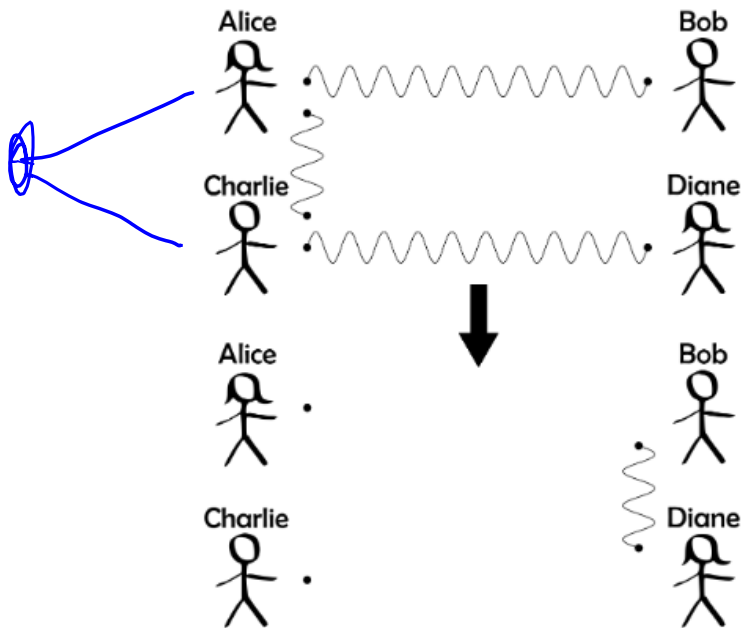


Figure 10.3: Entanglement swapping procedure depicted. Initially Alice and Bob share a Bell pair, as do Charlie and Diane and Alice and Charlie. Following a pair of teleportations from Alice to Bob and from Charlie to Diane we find that Bob and Diane now share a Bell pair (even though they never interacted directly).