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Fixed-Frequency Qubits Coupled via a Tunable Bus[1]

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As quantum circuits increase in size there are conflicting design requirements: qubits must be highly coherent and addressable, but also interact strongly with each other on demand. Fixed-frequency superconducting transmon qubits coupled by bus resonators (circuit QED) excel in terms of coherence. However, it is difficult to activate interactions in this architecture because of the limited tuning parameters. To circumvent this limitation, we add tunability to the bus which results in a tunable exchange coupling between qubits. The qubits themselves become only weakly tunable, thus suppressing flux-noise limited coherence. In Ref. [1] we demonstrated a two-qubit iSWAP gate with a fidelity of 98.3% by modulating the tunable bus at the qubit difference frequency which activates a resonant SWAP interaction. In this talk I will discuss our iSWAP gate in detail and present our work utilizing the SWAP interaction to couple four qubits, which is the prototypical surface code unit cell.

1. McKay et al., A universal gate for fixed-frequency qubits via a tunable bus. Arxiv/1604.03076 (2016)

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