CLAIMS

1. A quantum system, comprising:

a qubit array comprising a plurality of qubits;

a bus resonator coupled between at least one pair of qubits of the plurality of qubits in the qubit array; and

a switch coupled between the at least one pair of qubits, wherein:

the switch comprises a coupling resonator having a Josephson Junction (JJ);

the switch is integrated with a bus resonator; and

the switch comprises a gate that is coupled to an electron system that is tunable by a voltage on the gate.

2. The quantum system of claim 1, wherein the electron system is configured to change an inductance based on the voltage on the gate.

3. The quantum system of claim 1, wherein the gate is configured to tune the electron system between (i) a low inductance state with a first critical current and (ii) a high inductance state with a second critical current, wherein the second critical current is lower than the first critical current.

4. The quantum system of claim 1, wherein:

the switch has a first state that supports a supercurrent; and

the switch has a second state that supports a high resistance and no supercurrent.

5. The quantum system of claim 1, wherein the voltage on the gate is configured to change an inductance of the JJ.

6. The quantum system of claim 1, wherein the switch comprises two or more superconductors that are separated by the electron system.

7. The quantum system of claim 6, wherein the electron system comprises graphene.

8. The quantum system of claim 1, wherein the switch is a voltage-controlled super current switch.

9. The quantum system of claim 1, further comprising, for at least one qubit of the qubit array, a second switch coupled between the at least one qubit and a readout resonator of the qubit array.

10. The quantum system of claim 9, wherein a combination of switches between given qubit pairs and qubits and readout resonators, is configured to multiplex individual qubits in the qubit array such that each qubit in the qubit array is individually controlled and independent of qubit frequency.

11. A quantum system, comprising:

a qubit array comprising a plurality of qubits;

a bus resonator coupled between at least one pair of qubits in the qubit array; and

a switch coupled between the at least one pair of qubits,

wherein:

the qubit array is part of a plurality of qubit arrays in a first layer; and

the plurality of qubit arrays of the first layer are each isolated by one or more additional switches.

12. The quantum system of claim 11, wherein the quantum system comprises a plurality of layers, each having at least one qubit array separated by the one or more additional switches from adjacent layers.

13. The quantum system of claim 12, wherein there is asymmetry in the qubit arrays between at least two layers of the plurality of layers.

14. The quantum system of claim 1, wherein two or more qubits in the qubit array have a similar qubit frequency.

15. The quantum system of claim 11, wherein multiple layers comprising the first layer and a second layer are stacked on top of one another by way of bump bonding.

16. A method of controlling quantum system, comprising:

providing a qubit array having a plurality of qubits;

coupling a bus resonator between each pair of qubits in the qubit array;

at least one of:

separating at least one qubit pair of the qubit array by way of a Josephson Junction (JJ) switch; or

separating at least one qubit of the qubit array from a readout resonator by way of a second JJ switch; and

changing an inductance of an electron system by applying a voltage on a gate of the JJ switch.

17. A method of controlling quantum system, comprising:

providing a qubit array having a plurality of qubits;

coupling a bus resonator between each pair of qubits in the qubit array;

at least one of:

separating at least one qubit pair of the qubit array by way of a Josephson Junction (JJ) switch; or

separating at least one qubit of the qubit array from a readout resonator by way of a second JJ switch; and

separating two or more superconductors by the electron system of the JJ switch.

18. The method of claim 16, further comprising multiplexing individual qubits of the qubit array by a plurality of switches including the JJ switch and the second JJ switch in the qubit array, such that each qubit in the qubit array is individually controlled and independent of qubit frequency.

19. The method of claim 16, further comprising:

stacking a plurality of qubit arrays on a plurality of layers; and

individually controlling each qubit of the plurality of layers by a plurality of switched and independent of qubit frequency.

20. A quantum system, comprising:

a qubit array comprising a plurality of qubits;

a bus resonator coupled between each pair of adjacent qubits in the qubit array; and

at least one of:

a switch coupled between each qubit pair of the qubit array; or

for at least one qubit of the qubit array, a switch between the at least one qubit and a readout resonator of the qubit array, wherein:

the switch is integrated with a coupling resonator having a Josephson Junction (JJ);

each switch comprises a gate that is coupled to an electron system that is tunable by a voltage on the gate; and

the electron system is configured to change an inductance of the JJ based on a voltage on the gate.

21. The quantum system of claim 20, wherein a combination of switches between given qubit pairs, and qubits and readout resonators, is configured to multiplex individual qubits in the array such that each qubit in the qubit array is individually controlled independent of qubit frequency.