QUANTUM COMPANIES — GUIDE

Quantum computing modalities compared

Compare superconducting, trapped-ion, neutral-atom, photonic, spin-qubit and topological quantum computers by qubit count, fidelity, connectivity and cloud availability.

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Quantum computers use different physical systems to realize qubits. Each modality has distinct trade-offs in qubit count, gate fidelity, connectivity, coherence time, operating temperature and cloud availability.

Modality comparison

| Modality | Leading vendors | Typical qubit count (2024) | 1-qubit fidelity | 2-qubit fidelity | Connectivity | Operating temp | Cloud access | |---|---|---|---|---|---|---|---| | Superconducting | IBM, Google, Rigetti, IQM, OQC | 100–1000+ | 99.9%+ | 99%–99.9% | Fixed, nearest-neighbor | ~15 mK | IBM Quantum, AWS Braket, Azure Quantum, Google Cloud | | Trapped ion | IonQ, Quantinuum, AQT | 25–56 | 99.99%+ | 99.7%–99.9% | All-to-all | Room temp or ~4 K | IonQ Cloud, AWS Braket, Azure Quantum | | Neutral atom | QuEra, Pasqal, Atom Computing | 100–1000+ (arrays) | 99.9%+ | 99%–99.5% | Reconfigurable | Room temp or ~4 K | AWS Braket, Azure Quantum, QuEra Cloud | | Photonic | Xanadu, PsiQuantum, QuiX | 12–216 (modes) | 99%+ | N/A (measurement-based) | All-to-all (via interferometer) | Room temp | Xanadu Cloud | | Spin qubit | Intel, Diraq, Quantum Motion | 2–12 | 99.9%+ | 99%+ | Nearest-neighbor | ~10–100 mK | Limited (research) | | Topological | Microsoft (research) | < 10 (demonstrated) | N/A | N/A | N/A | ~15 mK | Not commercially available | | Quantum annealing | D-Wave | 5000+ (qubits) | N/A | N/A | Sparse, fixed | ~15 mK | D-Wave Leap, AWS Braket |

Key considerations

Superconducting (transmon qubits): Most mature modality. IBM's Condor (1,121 qubits) and Google's Willow (105 qubits) lead on qubit count. Fixed connectivity requires SWAP gates for non-adjacent qubits. Dilution refrigerators required.

Trapped ion: Highest gate fidelities and all-to-all connectivity. IonQ Forte (36 qubits) and Quantinuum H2 (56 qubits) available commercially. Slower gate speeds (~microseconds vs nanoseconds). Laser control systems complex.

Neutral atom: Large arrays (100s–1000s of atoms) with reconfigurable connectivity via optical tweezers. QuEra Aquila (256 qubits) and Pasqal Fresnel (100 qubits) on clouds. Mid-circuit measurement and atom loss are challenges.

Photonic: Room-temperature operation. Measurement-based quantum computing with continuous variables. Xanadu Borealis (216 squeezed modes) demonstrates quantum advantage. Loss and error correction are primary challenges.

Spin qubit: Silicon-based, CMOS-compatible fabrication. Intel Tunnel Falls (12 qubits) and academic devices show promise. Very small footprint enables dense scaling. Requires dilution refrigeration and sophisticated control electronics.

Quantum annealing: D-Wave Advantage2 (5000+ qubits) for optimization and sampling. Not gate-model universal. Available on D-Wave Leap and AWS Braket.

Sources

- IBM Quantum hardware roadmap — fetched 2026-11-01.
- IonQ Forte specifications — fetched 2026-11-01.
- Quantinuum H2 specifications — fetched 2026-11-01.
- QuEra Aquila specifications — fetched 2026-11-01.
- Pasqal Fresnel specifications — fetched 2026-11-01.
- Xanadu Borealis demonstration — Nature, 2022.
- D-Wave Advantage2 specifications — fetched 2026-11-01.
- AWS Braket quantum computers — fetched 2026-11-01.
- Azure Quantum providers — fetched 2026-11-01.

Frequently asked questions

Which modality is best?

No single modality leads on all metrics. Superconducting has the highest qubit counts. Trapped-ion has the highest gate fidelities. Neutral-atom scales to large arrays. Photonic operates at room temperature. Choose based on your workload requirements.

Are qubit counts comparable across modalities?

No. A 100-qubit superconducting processor and a 36-qubit trapped-ion processor may solve different problem sizes. Compare gate fidelity, connectivity, coherence time and error rates, not just qubit count.

Which modalities are available on public clouds?

IBM, Google and Rigetti offer superconducting on their clouds. IonQ and Quantinuum offer trapped-ion on AWS Braket, Azure Quantum and their own clouds. QuEra and Pasqal offer neutral-atom on AWS Braket and Azure Quantum. Xanadu offers photonic on its cloud.