QUANTUM COMPANIES — GUIDE

Quantum technology glossary

Plain-language definitions of key terms in quantum computing, sensing, networking, cryptography and components. Updated quarterly.

Updated November 1, 2026

Definitions for buyers, engineers and investors. Terms are grouped by domain.

Quantum computing — core concepts

| Term | Definition | |---|---| | **Qubit** | Quantum bit. Two-level quantum system (|0'é, |1'é) that can exist in superposition ; Ã ~’ ² ²|1'é. Physical realizations: transmon, trapped ion, neutral atom, photon, spin, Majorana. | | **Superposition** | Qubit state that is a linear combination of basis states. Enables quantum parallelism. Collapses to a basis state on measurement. | | **Entanglement** | Non-classical correlation between qubits. Measuring one instantly determines the state of the other(s), regardless of distance. Resource for quantum algorithms and QKD. | | **Gate** | Unitary operation on one or more qubits. Single-qubit: X, Y, Z, H, S, T, Rz. Two-qubit: CNOT, CZ, iSWAP, " iSWAP, MS (Mølmer-Sørensen). Universal set = arbitrary single-qubit + one entangling two-qubit gate. | | **Circuit** | Sequence of gates applied to qubits. Depth = longest path of dependent gates. Width = number of qubits. | | **Measurement** | Projective readout in computational basis (Z-basis). Returns 0 or 1 with probabilities |; Ë"Â Ã²|². Destroys superposition. | | **Fidelity** | Measure of gate/state quality. Process fidelity: overlap between ideal and actual quantum channel. State fidelity: $|\langle \psi_{ideal} | \psi_{actual} \rangle|^2$ …ö–FV Â~’à 1.0 = perfect. | | **Coherence time** | T1 (energy relaxation), T2 (dephasing). Upper bound on circuit depth. Typical: superconducting 50–200 ;Ç0, trapped ion 1–10 s, neutral atom 1–10 s, photonic (photon lifetime). | | **Crosstalk** | Unintended interaction between qubits during gates. Causes correlated errors. Mitigated by frequency allocation, echo sequences, compiler-aware scheduling. | | **Connectivity** | Graph of which qubit pairs support native two-qubit gates. Heavy-hex (IBM), grid (Google), all-to-all (trapped ion), reconfigurable (neutral atom). Affects SWAP overhead. | | **Quantum volume** | Benchmark metric (IBM). Largest square circuit (width = depth = n) that runs successfully. Accounts for qubit count, connectivity, gate fidelity, measurement error, compiler efficiency. | | **NISQ** | Noisy Intermediate-Scale Quantum (Preskill 2018). 50–1000 qubits, no full error correction. Current generation. Algorithms: VQE, QAOA, quantum ML, error mitigation. | | **FTQC** | Fault-Tolerant Quantum Computing. Logical qubits encoded in many physical qubits with active error correction. Threshold theorem: if physical error rate < threshold (~10 {³–10 { t), arbitrary-long computation possible. | | **Logical qubit** | Error-corrected qubit encoded in multiple physical qubits. Surface code: d² physical qubits for distance d. Distance d corrects # (d-1)/2# errors. | | **Error correction (QEC)** | Active syndrome measurement and correction. Surface code, color code, LDPC codes, bosonic codes (cat, GKP). Requires high fidelity, fast feed-forward, low-latency decoding. | | **Error mitigation** | Post-processing to reduce noise impact without full QEC. Zero-noise extrapolation (ZNE), probabilistic error cancellation (PEC), Clifford data regression (CDR), measurement error mitigation (M3). | | **VQE** | Variational Quantum Eigensolver. Hybrid quantum-classical algorithm for ground-state energy. Parameterized ansatz + classical optimizer. NISQ flagship for chemistry. | | **QAOA** | Quantum Approximate Optimization Algorithm. Alternating problem/mixer Hamiltonians. p layers. Approximate combinatorial optimization (MaxCut, scheduling). | | **Quantum advantage** | Solving a useful problem faster/better than best classical

method. Not yet demonstrated commercially (2024). | | **Quantum supremacy** | Solving a contrived sampling problem beyond classical reach. Demonstrated: Google Sycamore (2019), USTC Jiuzhang (2020, 2021), Xanadu Borealis (2022). |

Modalities

| Term | Definition | |---|---| | **Superconducting (transmon)** | Josephson junction shunted by capacitor. Anharmonic oscillator. Fixed frequency or tunable (fluxonium). IBM, Google, Rigetti, IQM, OQC, Alice & Bob. | | **Trapped ion** | Individual ions (Yb z, Ca z, Ba z) confined in Paul trap. Laser-driven gates. All-to-all connectivity. IonQ, Quantinuum, AQT, Oxford Ionics. | | **Neutral atom** | Alkali/alkaline-earth atoms (Rb, Sr, Yb) in optical tweezers. Rydberg blockade for entanglement. Reconfigurable geometry. QuEra, Pasqal, Atom Computing, Infleqtion. | | **Photonic** | Qubits encoded in photons (polarization, path, time-bin, continuous variable). Measurement-based QC. Room temp. Xanadu, PsiQuantum, QuiX, Quandela. | | **Spin qubit** | Electron/hole spin in quantum dot (Si/SiGe, GaAs) or donor (P in Si). CMOS-compatible. Intel, Diraq, Quantum Motion, UNSW. | | **Topological** | Non-Abelian anyons (Majorana zero modes) in nanowire/superconductor heterostructures. Intrinsic error protection. Microsoft, academic. | | **Quantum annealing** | Adiabatic evolution of Ising Hamiltonian. Ground state = solution to optimization. D-Wave. Not universal gate model. |

Performance metrics

| Term | Definition | |---|---| | **1q fidelity** | Single-qubit gate fidelity (randomized benchmarking). Target > 99.9%. | | **2q fidelity** | Two-qubit gate fidelity (RB or cycle benchmarking). Target > 99% (superconducting), > 99.7% (trapped ion). | | **Readout fidelity** | Probability of correct |0'é/|1'é assignment. Target > 99%. | | **SPAM** | State Preparation and Measurement error. Includes readout, initialization, measurement crosstalk. | | **Gate time** | Duration of gate pulse. Superconducting: 20–50 ns (1q), 100–300 ns (2q). Trapped ion: 1–10 ;Ç2 ƒ ’Â c ¼s (2q). | | **Circuit layer operations per second (CLOPS)** | IBM metric: layers of random circuit executed per second. Includes compilation, queue, execution, readout. | | **Azure Quantum Token / HQC / eHQC** | Azure Quantum Token (IonQ billing on Azure Quantum), Hardware Quantum Credit (Quantinuum), emulator HQC. Provider-specific billing units. Note: AQT also names Alpine Quantum Technologies, a trapped-ion hardware vendor. |

Cloud & software

| Term | Definition | |---|---| | **Qiskit** | IBM open-source SDK. Terra (circuits), Aer (simulators), Runtime (managed execution), Primitives (Estimator, Sampler). | | **Cirq** | Google open-source SDK. Focus on NISQ, hardware-aware compilation, noise models. | | **PennyLane** | Xanadu open-source SDK. Differentiable programming, ML integration, device agnostic. | | **Braket SDK** | AWS SDK. Unified interface to IonQ, Rigetti, IQM, QuEra, AQT, simulators. Hybrid Jobs, managed notebooks. | | **Azure Quantum SDK** | Microsoft SDK. Access to IonQ, Quantinuum, Pasqal, Rigetti, Q# language, QIR. | | **Q#** | Microsoft domain-specific language for quantum. Classical host + quantum operations. Compiles to QIR. | | **OpenQASM 3** | Open Quantum Assembly Language. Standard IR for circuits. Classical control flow, subroutines, timing. | | **QIR** | Quantum Intermediate Representation. LLVM-based. Language-agnostic, hardware-agnostic. | | **CUDA-Q** | NVIDIA C++/Python platform. GPU-accelerated simulation, hybrid quantum-classical, multi-QPU. | | **Hybrid job** | Parameterized circuit batch with classical optimization loop. Managed by cloud (Braket Hybrid Jobs, Qiskit Runtime, Azure Quantum Jobs). | |

Primitive | Qiskit Runtime abstraction: Estimator (expectation values), Sampler (quasi-probabilities). Versioned, hardware-optimized. |

Quantum sensing

| Term | Definition | |---|---| | **NV center** | Nitrogen-vacancy defect in diamond. Electron spin S=1. Optically detected magnetic resonance (ODMR). Room-temp magnetometer. | | **SERF / OPM** | Spin-Exchange Relaxation-Free / Optically Pumped Magnetometer. Alkali vapor (Rb, Cs, K). Femtotesla sensitivity. Requires ;ÅB 6†–VÆF–3Ò | | **SQUID** | Superconducting Quantum Interference Device. Josephson junction loop. Flux-to-voltage transduction. Requires cryogenics (4 K). | | **Atom interferometry** | Matter-wave interferometer using cold atoms (Rb, Cs). Measures acceleration, rotation, gravity. Space-compatible. | | **CSAC** | Chip-Scale Atomic Clock. Coherent Population Trapping (CPT) in MEMS vapor cell. 10 {^{11}–10 {^{12} stability. < 20 cm^3, < 120 mW. | | **Quantum gravimeter** | Absolute gravity measurement via atom interferometry. µGal (10 { x m/s^2) sensitivity. Drone/aircraft deployable. |

Quantum networking & QKD

| Term | Definition | |---|---| | **QKD** | Quantum Key Distribution. BB84 (prepare-and-measure), E91 (entanglement-based), MDI-QKD (measurement-device-independent), CV-QKD (continuous variable). | | **Quantum repeater** | Entanglement swapping + purification to extend distance beyond fiber loss limit (~100 km). Requires quantum memory. | | **Quantum memory** | Stores photonic qubit (ensemble, rare-earth, NV, trapped ion). Efficiency, fidelity, storage time, multiplexing. | | **QRNG** | Quantum Random Number Generator. Photon shot noise, vacuum fluctuations, phase noise. NIST SP 800-90B validated. | | **Trusted node** | Classical relay in QKD network. Decrypts/re-encrypts keys. Security assumption: node is physically secure. | | **Satellite QKD** | Free-space QKD via satellite (Micius, QEYSSat). Global key distribution. Daytime background noise challenge. |

Post-quantum cryptography

| Term | Definition | |---|---| | **PQC** | Post-Quantum Cryptography. Classical algorithms resistant to quantum attacks. Lattice, hash, code, multivariate, isogeny. | | **ML-KEM** | Module-Lattice-Based Key Encapsulation Mechanism (CRYSTALS-Kyber). FIPS 203. IND-CCA2 secure. | | **ML-DSA** | Module-Lattice-Based Digital Signature (CRYSTALS-Dilithium). FIPS 204. EUF-CMA secure. | | **SLH-DSA** | Stateless Hash-Based Digital Signature (SPHINCS+). FIPS 205. No structured hardness assumption. Larger sigs. | | **CNSA 2.0** | Commercial National Security Algorithm Suite 2.0 (NSA). Mandates ML-KEM-1024 and ML-DSA-87 for NSS. New acquisitions must support it from January 1, 2027; mandatory December 31, 2031. | | **Crypto-agility** | Ability to swap cryptographic algorithms without system redesign. Hybrid certificates, dual signatures, algorithm negotiation. | | **Harvest now, decrypt later** | Adversary records encrypted traffic today, decrypts when CRQC exists. Motivates early PQC migration. |

Components & supply chain

| Term | Definition | |---|---| | **Dilution refrigerator** | ^{3}He/ tHe mixing chamber. Base temp 10–15 mK. Cooling power ~1 ;År B Ô^{2}à Bluefors, Oxford Instruments, Cryomech, Leiden. | | **Pulse-tube cooler** | Pre-cooling stage (4 K, 50 K). No moving parts at cold head. Sumitomo, Cryomech, Brooks. | | **AWG** | Arbitrary Waveform Generator. 10–100 GS/s, 14–16 bit, multi-

channel. Keysight, Tektronix, Zurich Instruments, Qblox, Quantum Machines. | | **FPGA / RFSoC** | Xilinx Zynq UltraScale+ RFSoC, Versal. Integrated DAC/ADC + FPGA fabric. Sub-;Ç2 Æ FVæ7•. | | **Ultra-stable laser** | Linewidth < 1 Hz (diode + reference cavity). Toptica, Menlo Systems, Stable Laser Systems. | | **Frequency comb** | Mode-locked laser spectrum. Optical clock reference, microwave generation. Menlo Systems, IMRA. | | **UHV** | Ultra-High Vacuum (< 10 {¹ p mbar). Ion pumps, NEG, titanium sublimation. Required for trapped ion, neutral atom. | | **Optical tweezers** | Focused laser beams trapping individual atoms. AOD/SLM for dynamic reconfiguration. 1064 nm typical. |

Acronyms

| Acronym | Expansion | |---|---| | AQT | Alpine Quantum Technologies (trapped-ion hardware vendor); also Azure Quantum Token (IonQ billing on Azure Quantum) | | BB84 | Bennett-Brassard 1984 (QKD protocol) | | BQP | Bounded-Error Quantum Polynomial Time (complexity class) | | CNOT | Controlled-NOT (two-qubit gate) | | CLOPS | Circuit Layer Operations Per Second | | CV-QKD | Continuous-Variable QKD | | CQC | Coherent Quantum Control / Cambridge Quantum Computing (Quantinuum) | | CSAC | Chip-Scale Atomic Clock | | CPT | Coherent Population Trapping | | DD | Dynamical Decoupling | | E91 | Ekert 1991 (entanglement-based QKD) | | ECCN | Export Control Classification Number | | EUF-CMA | Existential Unforgeability under Chosen Message Attack | | FTQC | Fault-Tolerant Quantum Computing | | GKP | Gottesman-Kitaev-Preskill (bosonic code) | | HQC | Hardware Quantum Credit (Quantinuum) / Hamming Quasi-Cyclic (KEM candidate) | | HSM | Hardware Security Module | | IND-CCA2 | Indistinguishability under Adaptive Chosen Ciphertext Attack | | ITAR | International Traffic in Arms Regulations | | LDPC | Low-Density Parity-Check (code) | | MDI-QKD | Measurement-Device-Independent QKD | | MPS | Matrix Product State | | NISQ | Noisy Intermediate-Scale Quantum | | NSS | National Security Systems | | ODMR | Optically Detected Magnetic Resonance | | OPM | Optically Pumped Magnetometer | | PEC | Probabilistic Error Cancellation | | PQC | Post-Quantum Cryptography | | QEC | Quantum Error Correction | | QKD | Quantum Key Distribution | | QPU | Quantum Processing Unit | | QRNG | Quantum Random Number Generator | | QVM | Quantum Virtual Machine (Rigetti simulator) | | RB | Randomized Benchmarking | | Rydberg | Highly excited atomic state (large dipole moment) | | SERF | Spin-Exchange Relaxation-Free | | SLH-DSA | Stateless Hash-Based Digital Signature Standard | | SPAM | State Preparation and Measurement | | SQUID | Superconducting Quantum Interference Device | | SWAP | Qubit swap gate (3 CNOTs) | | T1 / T2 | Relaxation / Dephasing time | | UHV | Ultra-High Vacuum | | VQE | Variational Quantum Eigensolver | | ZNE | Zero-Noise Extrapolation |

Sources

- NIST PQC Standards — fetched 2026-11-01.
- IBM Quantum Glossary — fetched 2026-11-01.
- Qiskit documentation — fetched 2026-11-01.
- IBM Quantum Learning — fetched 2026-11-01.
- QED-C Glossary — fetched 2026-11-01.
- IEEE Quantum Glossary — fetched 2026-11-01.
- NIST Quantum Information Glossary — fetched 2026-11-01.

Frequently asked questions

What is the difference between a qubit and a bit?

A classical bit is 0 or 1. A qubit can be in a superposition of 0 and 1 simultaneously, enabling quantum parallelism. Measurement collapses the superposition to 0 or 1 with probabilities determined by the quantum state.

What does NISQ mean?

Noisy Intermediate-Scale Quantum. Devices with 50–1000 qubits that lack full error correction. Current generation (2024). NISQ algorithms (VQE, QAOA) are designed to work despite noise.

What is quantum advantage vs quantum supremacy?

Quantum supremacy: a quantum device solves a contrived problem faster than any classical computer (Google 2019, USTC 2020, Xanadu 2022). Quantum advantage: a quantum device solves a useful, real-world problem faster or better than classical methods. Not yet achieved commercially.

What is T1 and T2?

T1 (relaxation time): time for an excited qubit to decay to ground state. T2 (dephasing time): time for qubit superposition to lose phase coherence. T2 "d 2×T1. Longer is better. Typical superconducting: T1 ~100 ;Ç0, T2 ~100 ;Ç0. Trapped ion: T1 > 1 s, T2 ~1–10 s.