Quantum Readiness

Future-Proofing Enterprises for the Age of Hybrid Computing

Executive Summary

Quantum computing is progressing from theoretical promise to strategic inevitability. While universal, fault-tolerant systems remain developmental, domain-specific advantage is emerging in optimisation, simulation, and probabilistic modelling.

Quantum readiness can be described as the deliberate engineering of hybrid architectures, post-quantum security posture, and organisational capability that preserves strategic optionality. Enterprises that prepare early will capture asymmetric advantage as commercial viability matures. Those that delay risk structural exposure in security, capital efficiency, and intellectual property defensibility.

1. The Current State of Play

Quantum hardware today reflects divergent engineering approaches, rather than a unified technological standard. Current leading platforms, including IBM, Google, IonQ, and D-Wave, utilise different physical qubits to achieve computational results.

Contemporary Quantum Hardware Landscape

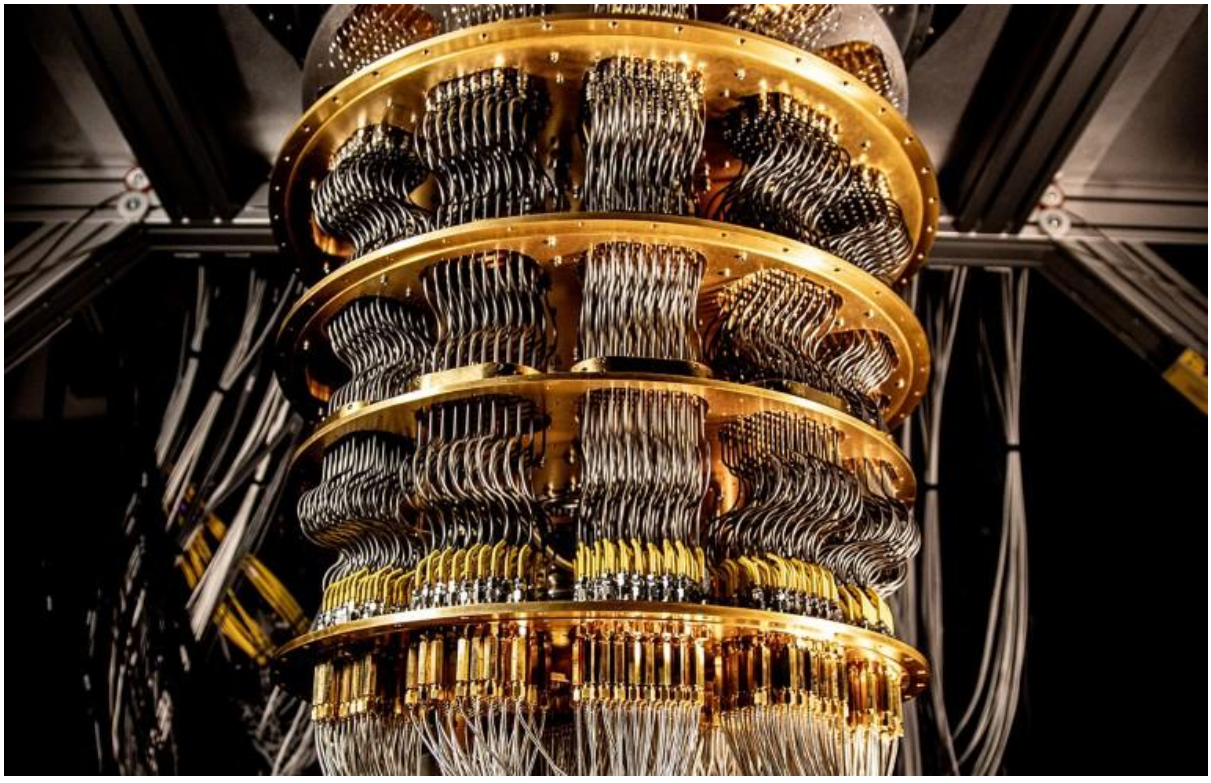

Fig. 1a: Superconducting architectures, such as Google's Quantum AI Willow-era, operate inside dilution refrigerators, cooling the processor to millikelvin temperatures to preserve qubit coherence and gate fidelity. Credit: Google Quantum AI.

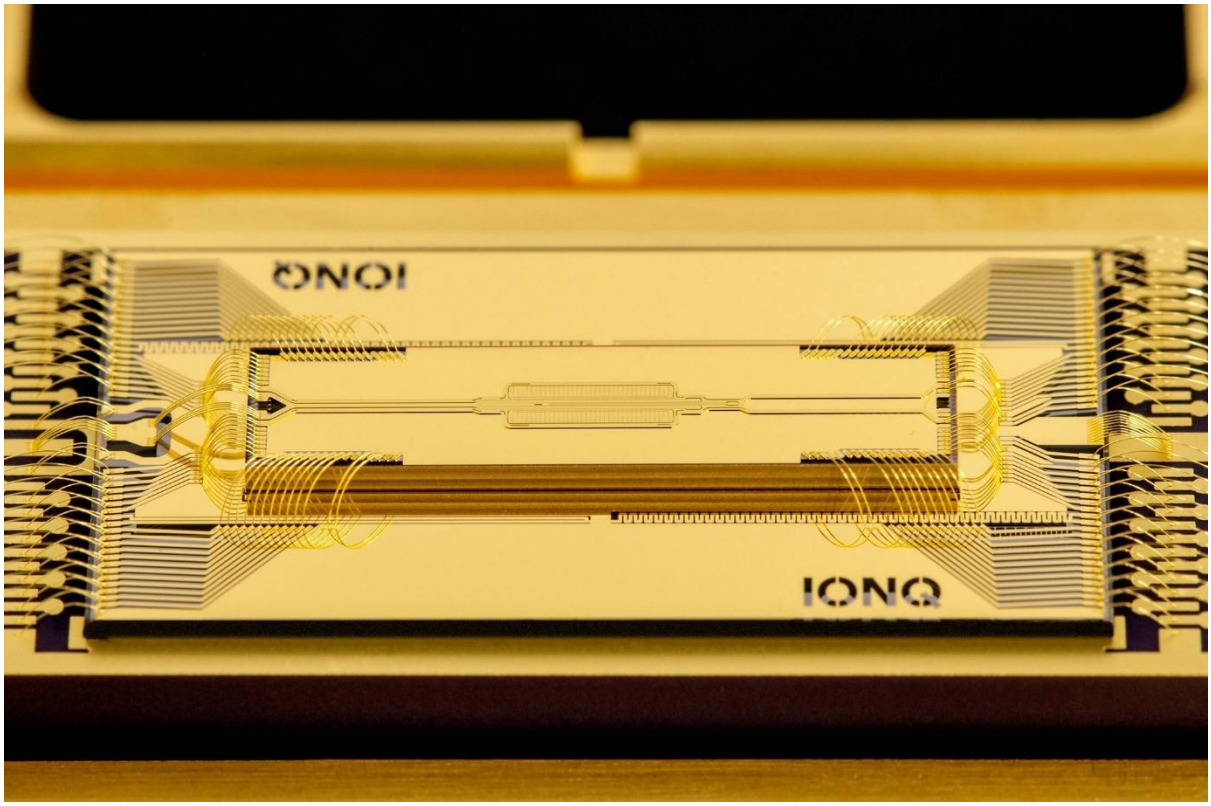

Fig. 1b: Trapped-ion systems utilise electromagnetic fields to isolate individual atoms, offering high-fidelity operations. Credit IonQ 2026 roadmap.

Fig. 1c: IBM's Loon 112-qubit proof-of-concept processor, illustrating continued advances in micro-scale superconducting chip integration within the 2026 hardware roadmap. Credit IBM.

Fig. 1d: IBM Quantum System Two integrates cryogenic infrastructure, control electronics and modular processor units into a scalable commercial full-stack architecture.

Three realities define the landscape:

1. **Fault-tolerant quantum computing** remains under active development.
2. **Commercial advantage** is currently domain-specific, such as in chemistry or logistics.
3. **Cloud accessibility** is accelerating enterprise experimentation without the requirement for massive capital expenditure.

Strategic implication: Advantage will emerge first in high-dimensional optimisation and simulation workloads where classical systems plateau.

2. Strategic Misjudgements

Three executive errors recur:

- **2.1 Overestimating Immediacy:** Universal supremacy is not imminent across general workloads. Capital discipline remains essential; focus should remain on specific high-value use cases.
- **2.2 Underestimating Cryptographic Disruption:** Shor's algorithm presents a long-term threat to RSA and elliptic curve cryptography. The **"Harvest Now, Decrypt Later" (HNDL)** threat means that sensitive data stolen today could be decrypted in the future, making immediate cryptographic migration a matter of current data longevity.
- **2.3 Treating Quantum as an IT Experiment:** Quantum capability influences intellectual property creation, risk modelling precision, and capital allocation efficiency. It is a core strategic variable, and not a peripheral technical one.

3. Post-Quantum Security as Governance

Post-quantum cryptography (PQC) is a contemporary governance imperative. Advancing quantum power compromises the public-key infrastructures central to global digital trust. The roadmap to a quantum-resilient state includes:

Classical Public-Key Infrastructure

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Exposure to Quantum Algorithms (HNDL Risk)

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Lattice-Based Cryptography

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Enterprise Migration Roadmap

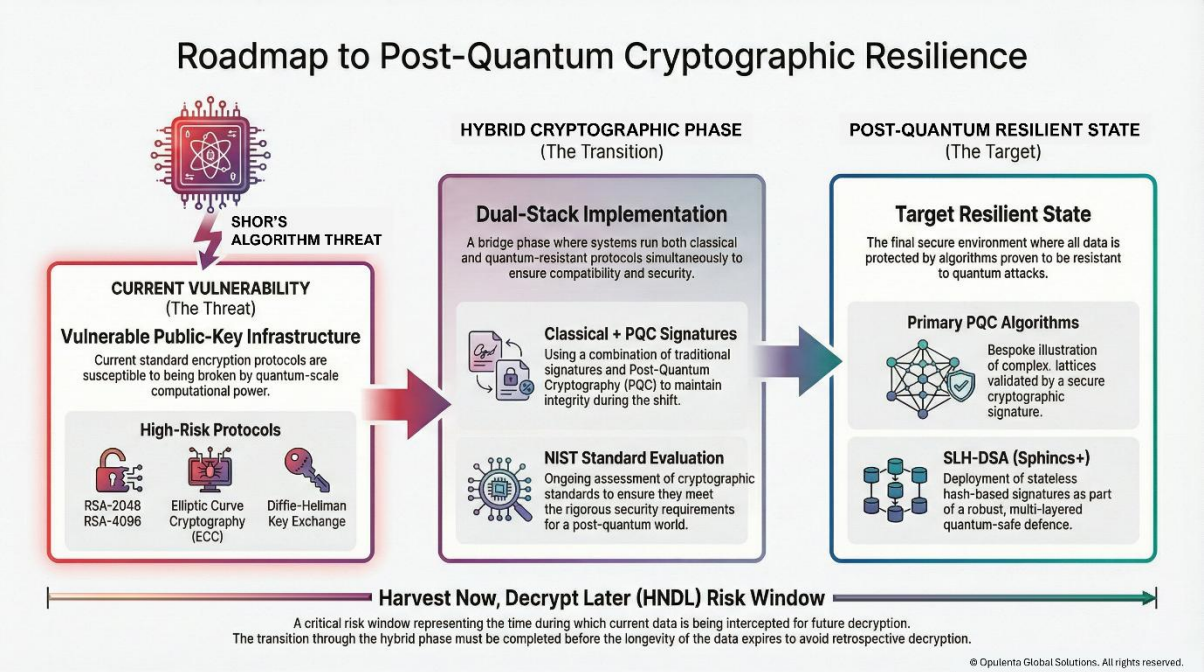

Fig. 2 outlines the structural migration from classical public-key systems to post-quantum cryptographic (PQC) standards.

The National Institute of Standards and Technology (NIST) has selected lattice-based algorithms for PQC standardisation.

Board-level actions should include:

- **Cryptographic Audit:** Identifying where high-value data is encrypted with vulnerable algorithms.
- **Dual-Stack Implementation:** Testing classical and PQC standards in parallel to ensure stability.
- **Vendor Roadmap Verification:** Ensuring third-party providers have a robust PQC transition plan.

4. AI as the Orchestration Layer

Artificial intelligence functions as the practical bridge between classical and quantum systems. Within hybrid architectures, AI performs three critical roles:

- **Dimensionality Reduction:** AI compresses problem complexity before quantum execution to conserve "qubit time."
- **Economic Routing:** Machine learning models determine if a problem requires a quantum processor, or if it can be solved more cost-effectively by a classical GPU or TPU.
- **Output Interpretation:** AI interprets the probabilistic "noisy" outputs of current-generation quantum machines into deterministic, decision-grade data.

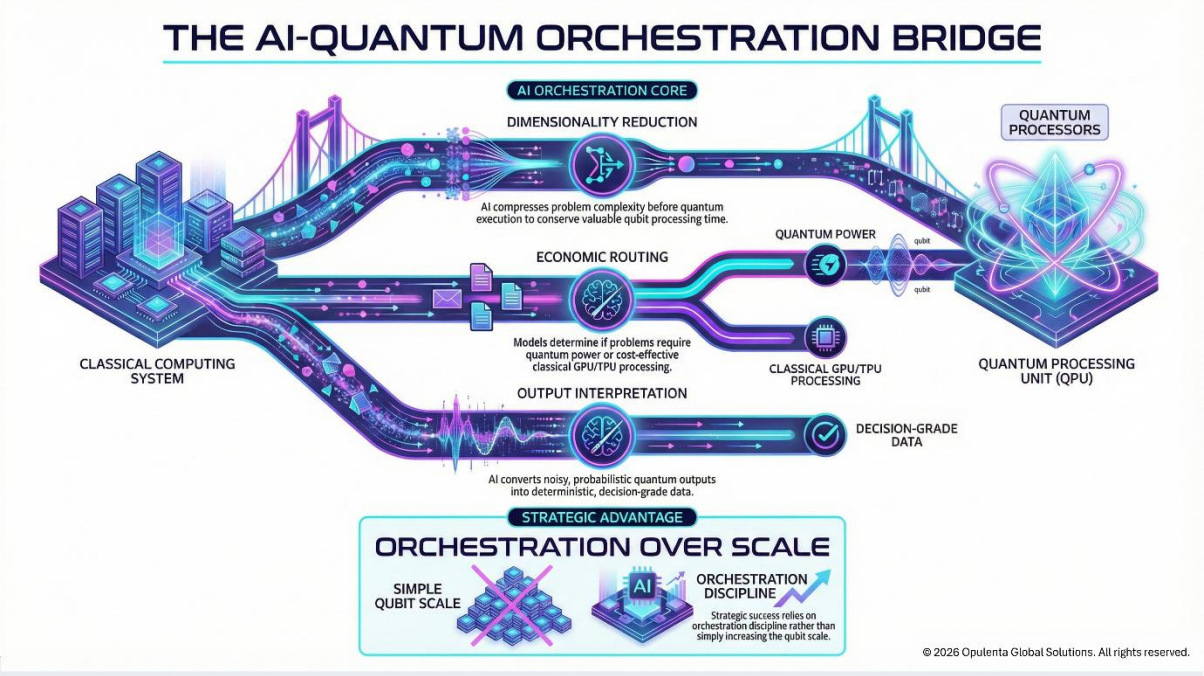

Fig. 3: Illustrates the hybrid architecture required to translate classical enterprise data into quantum-ready workloads

AI serves as the orchestration layer, managing dimensionality reduction and economic routing to ensure that expensive quantum resources are utilised only for high-complexity computational bottlenecks.

The strategic advantage lies in orchestration discipline, rather than qubit scale.

5. Domains of Early Advantage

In these domains, even incremental accuracy translates into material economic impact:

- **Finance:** Portfolio optimisation, tail-risk modelling, and complex derivatives pricing.
- **Life Sciences:** Materials simulation for pharmaceuticals and advanced composites.
- **Logistics & Energy:** Energy grid optimisation and global routing under constraints.

6. Quantum Readiness Maturity Model

Quantum resilience requires a fundamental shift in enterprise capability and strategic foresight. A tiered maturity model transforms technological threats into a structured roadmap for competitive advantage. The staged progression levels for enterprise readiness are:

- **Level 3 – Embedded Quantum Strategy:** Dedicated quantum lead, enterprise-wide PQC, and intellectual property alignment.
- **Level 2 – Hybrid Experimentation:** Cloud-based quantum access, AI preprocessing pipelines, and targeted optimisation pilots.
- **Level 1 – Strategic Awareness:** Executive education, cryptographic audit, and workflow identification.

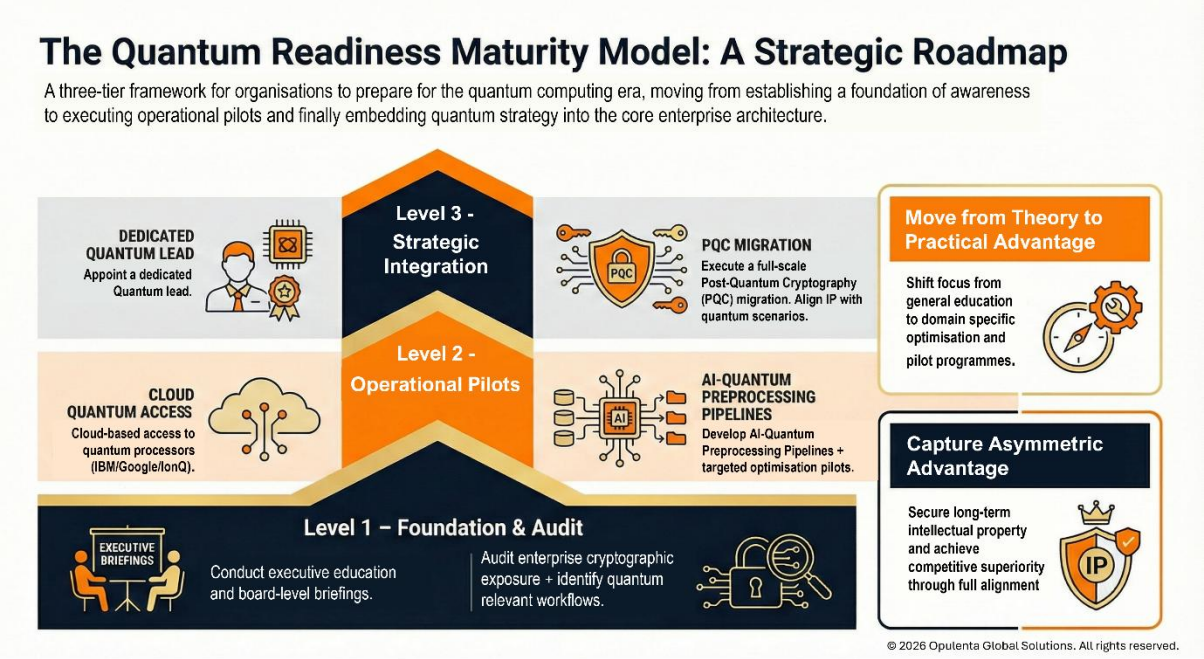

Fig. 4: Presents a staged progression model for structured enterprise readiness.

A staged approach prevents speculative overcommitment while preserving strategic flexibility.

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7. Frontier Scenario: Fintech Case Study

Consider a fintech operating amid geopolitical volatility. A hybrid architecture ingests macroeconomic signals, AI models isolate volatility drivers, and a quantum processor simulates correlated portfolio outcomes in minutes. Risk adjustments previously requiring days are executed within hours. The speed differential appears incremental, yet the compounded impact across quarters is decisive.

8. Leadership Imperative

Quantum computing will not displace classical systems overnight. It will generate selective advantage in constrained domains first. The decisive question is not whether quantum becomes universal, but whether the enterprise is positioned to capture advantage at first emergence.

Optionality compounds. Inertia does not.

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