Quantum Networking for Scale-Out: Nu Quantum's Entanglement Fabric

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OCP FUTURE TECHNOLOGIES SYMPOSIUM

October 14, 2026
San Jose, California

Scale-Out Is Essential to Quantum Value

Why does it feel like quantum turned a corner in 2025 and into 2026?

- Requirements of quantum algorithms improved by x20
- Overheads of quantum error correction improved by x10-20
- Physical qubit quality improved by x10
- Logical qubits demonstrated









Enter the Logical Era
2025
1 - 10 Logical Qubits
10^{-3} Logical Error Rates

Narrow Scientific Quantum Advantage
2027
100 Logical Qubits
10^{-6} Logical Error Rates
'MegaQuop'

First Commercial Quantum Advantage
2030
1,000 Logical Qubits
10^{-6} Logical Error Rates
'GigaQuop'

RSA-Breaking Machine
2033
6,000 Logical Qubits
10^{-12} Logical Error Rates
'TeraQuop'

Unlock 1 Trillion Dollar Value
2035
10,000+ Logical Qubits
10^{-14} Logical Error Rates

Single QPU scaling
Limited to ~100s logical qubits by interdependent fundamental challenges

Scalability gap to commercial value

Power of many QPUs
A solution to this problem will deliver outsized returns

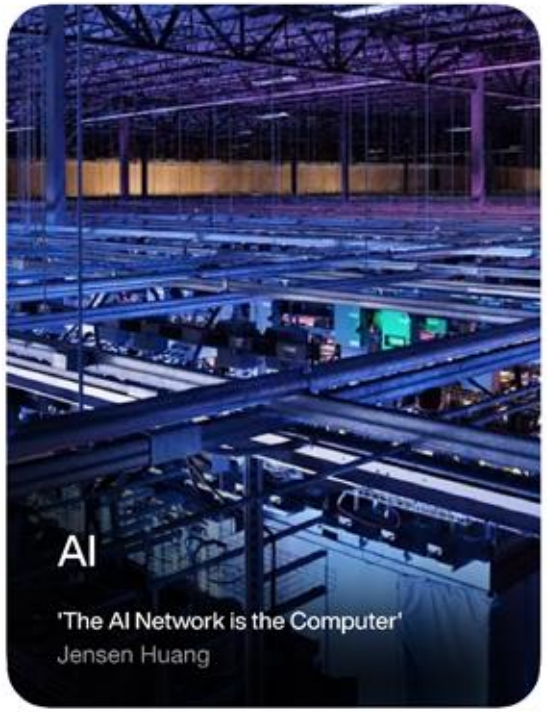
Networking Enables Scale-Out Across Industries

Trillion dollar computing industries exist thanks to scale-out

Networking technology aggregating the power of thousands of CPUs, GPUs, and now, QPUs



$3T projected by 2033
McKinsey



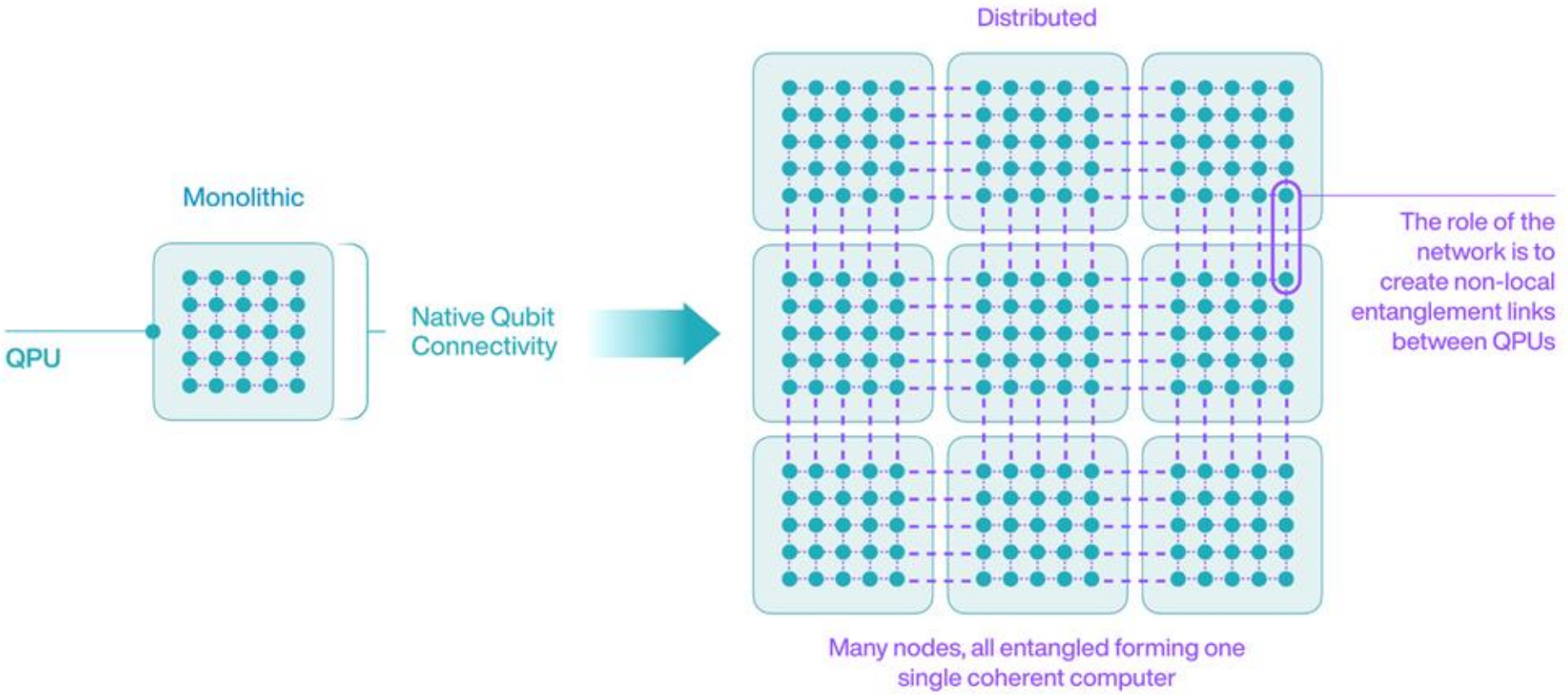
$4.8T projected by 2033
UN Trade & Development



$1.3T projected by 2035
McKinsey

What is the role of networking in scale-out?

- Build a dense array of east-west links connecting separate quantum computing cores with **entanglement**



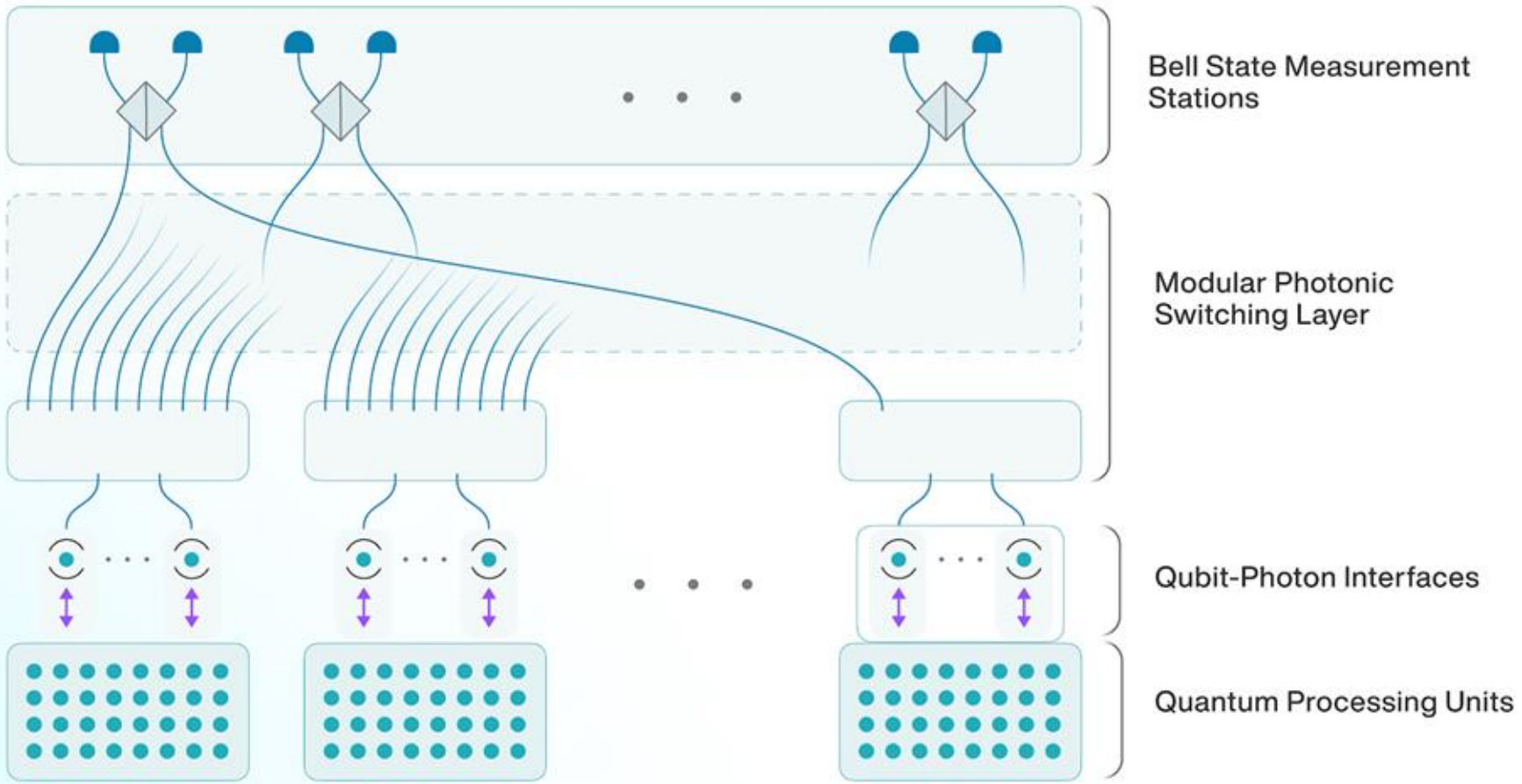
What is required for an entanglement link?

- **Qubit-photon interface:** An efficient way of transducing quantum information stored on a matter-based qubit into an optical-frequency photon

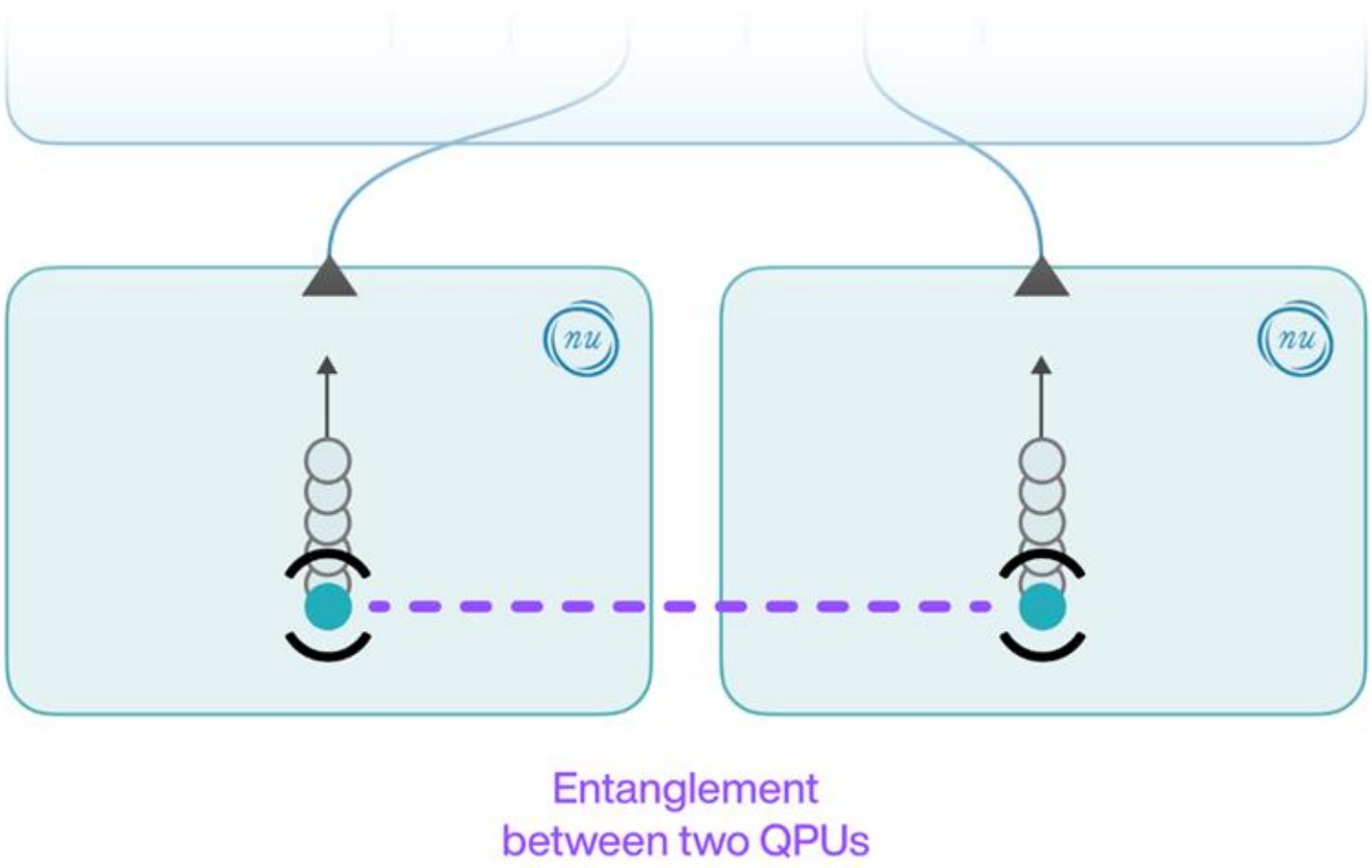
- **Switchable optical network** between quantum end-nodes and a central station, with **low loss**, **high polarization and spatial-mode stability** and **rapid reconfiguration**

- **Low-latency classical communication** channel

Entanglement distribution requires single photon extraction, routing and detection

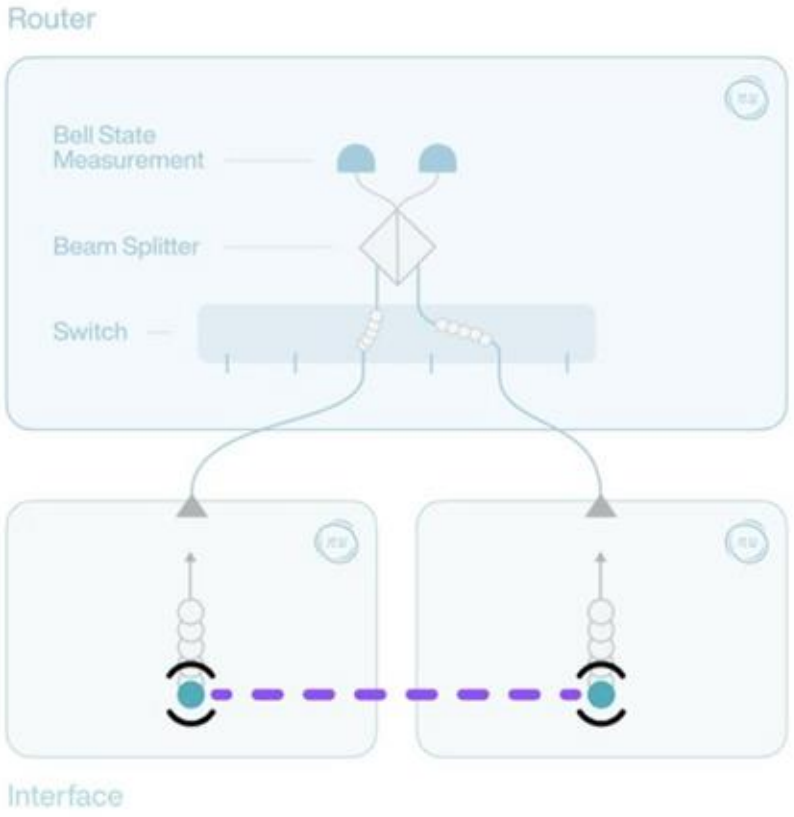


The end result is entanglement between two QPUs



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Fidelity and rate are key figures of merit



Entanglement Rate

Success probability given by photon transmission:

$$P_{\text{Success}} = \frac{1}{2}\eta^2$$

and is multiplicative:

$$\eta = \eta_{\text{Interface}} \times \eta_{\text{Router}}$$

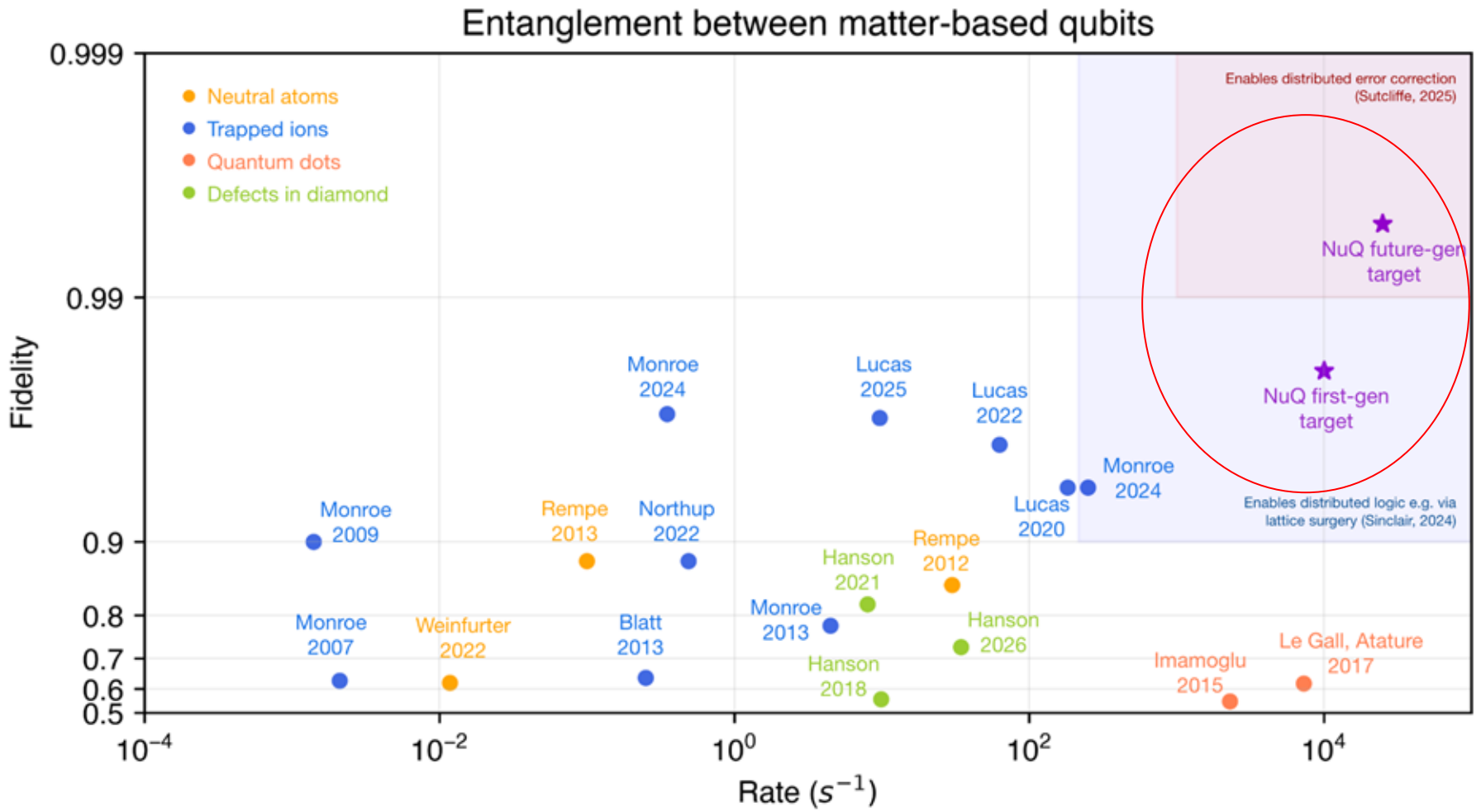
Entanglement Fidelity

Fidelity is related to errors, which are additive:

$$F_{\text{Bell}} = 1 - \epsilon_{\text{Bell}}$$

$$\epsilon_{\text{Bell}} = \epsilon_{\text{Interface}} + \epsilon_{\text{Router}}$$

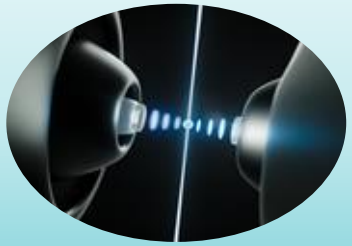
The performance gap: no network can yet meet the needs of DQC



Development covers three technical areas

Qubit Photon Interface

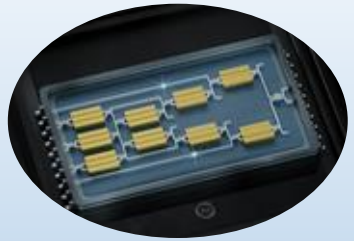
extracts light from qubits using optical microcavity technology



- Increase photon extraction probability and rate
- Improve fidelity through qubit-photon entanglement protocol development

Quantum Networking Unit

hosts photonic technology to distribute entanglement across processors



- Provide high-transmission optical circuit switches with ultra-fast reconfiguration
- Maintain fidelity through the optical system
- Detect single photons with near-unity efficiency

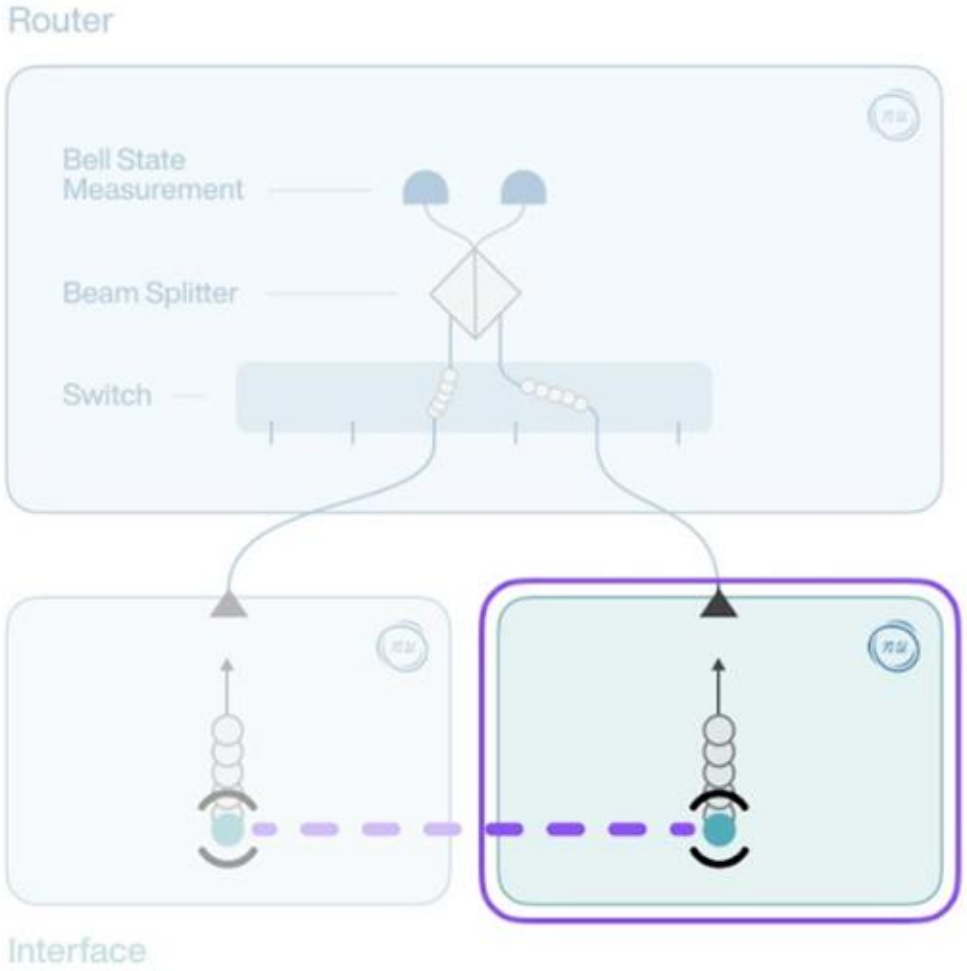
Distributed Quantum Error Correction

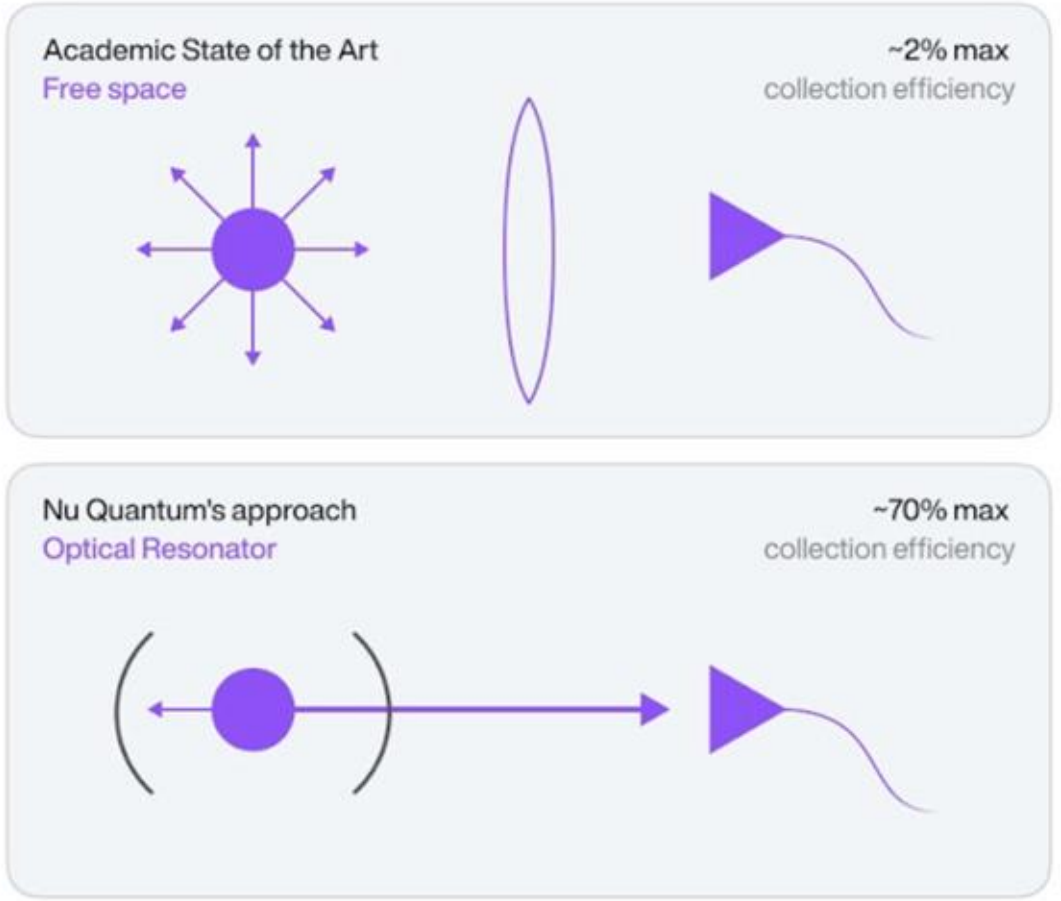
more efficient codes tailored to networked systems



- Reduce resource requirements and limit connectivity requirements
- Find approaches that are well-suited to systems with noisy long-range links
- Take full advantage of the benefits of modular systems

The Qubit-Photon Interface is the gateway





Different QPI technologies required for different qubits

Qubit-Photon Interfaces

Connects processors to network

→ Critical to System Performance

→ Active R&D

Optical micro-cavities integrated with comms qubit

Microwave-to-optical transduction integrated with comms qubit

Trapped Ion Qubits

QUANTINUUM · AQT · National Quantum Computing Centre · Universal Quantum · IONQ · oxford ionics



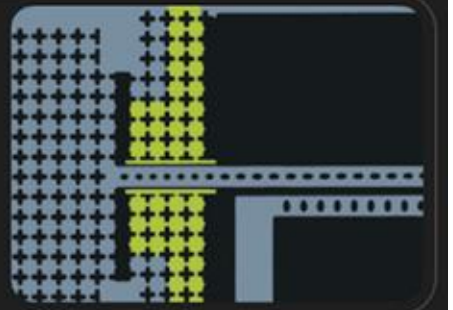
Neutral Atom Qubits

QuEra Computing Inc. · Infleqtion · atom computing · Pasqal



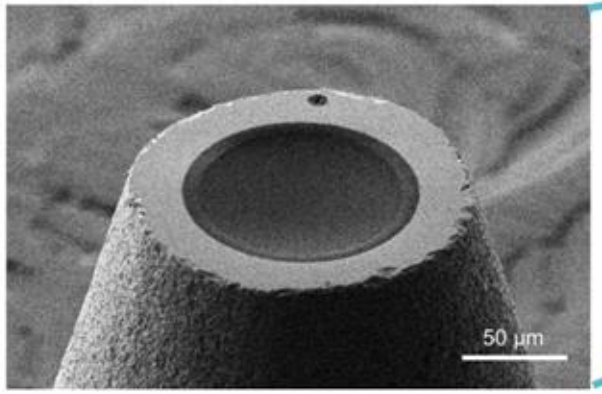
Superconducting Qubits
Silicon Spin Qubits

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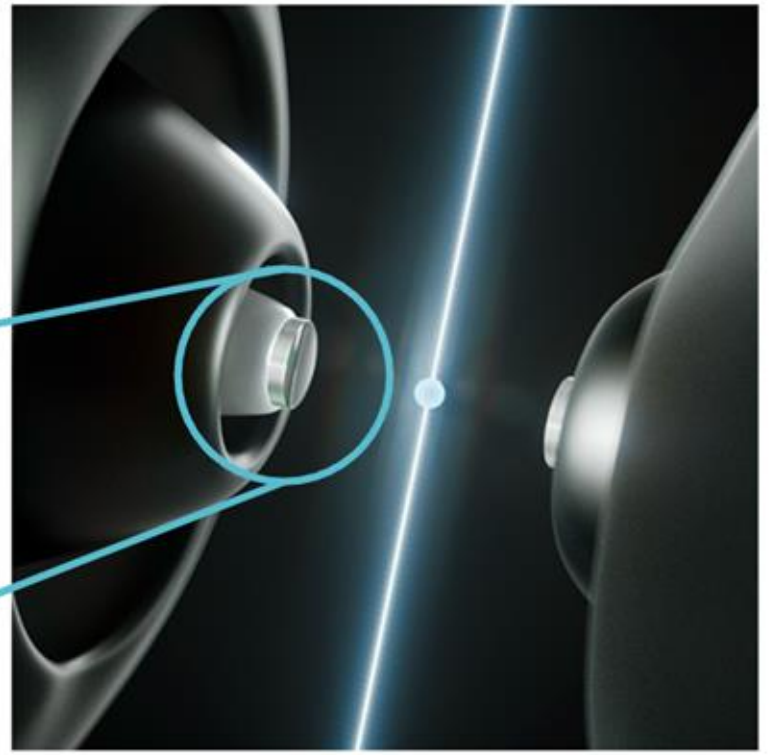


Inside a microcavity-based QPI

- Nu Quantum optical microcavities consist of two microfabricated curved mirrors held less than 1 mm apart
- **Rate** and **fidelity** hinge on design choices and system performance



Cavity mirror (SEM)



The Quantum Networking Unit connects QPUs

Quantum Networking Unit

Datacenter-scale entanglement distribution

- → Modular
- → Performant
- → Upgradable
- → Qubit Adaptable



Gen 1 [2025]

Supports up to

99.7% Entanglement fidelity

MHz Entanglement attempt rate

300 ns Control system latency

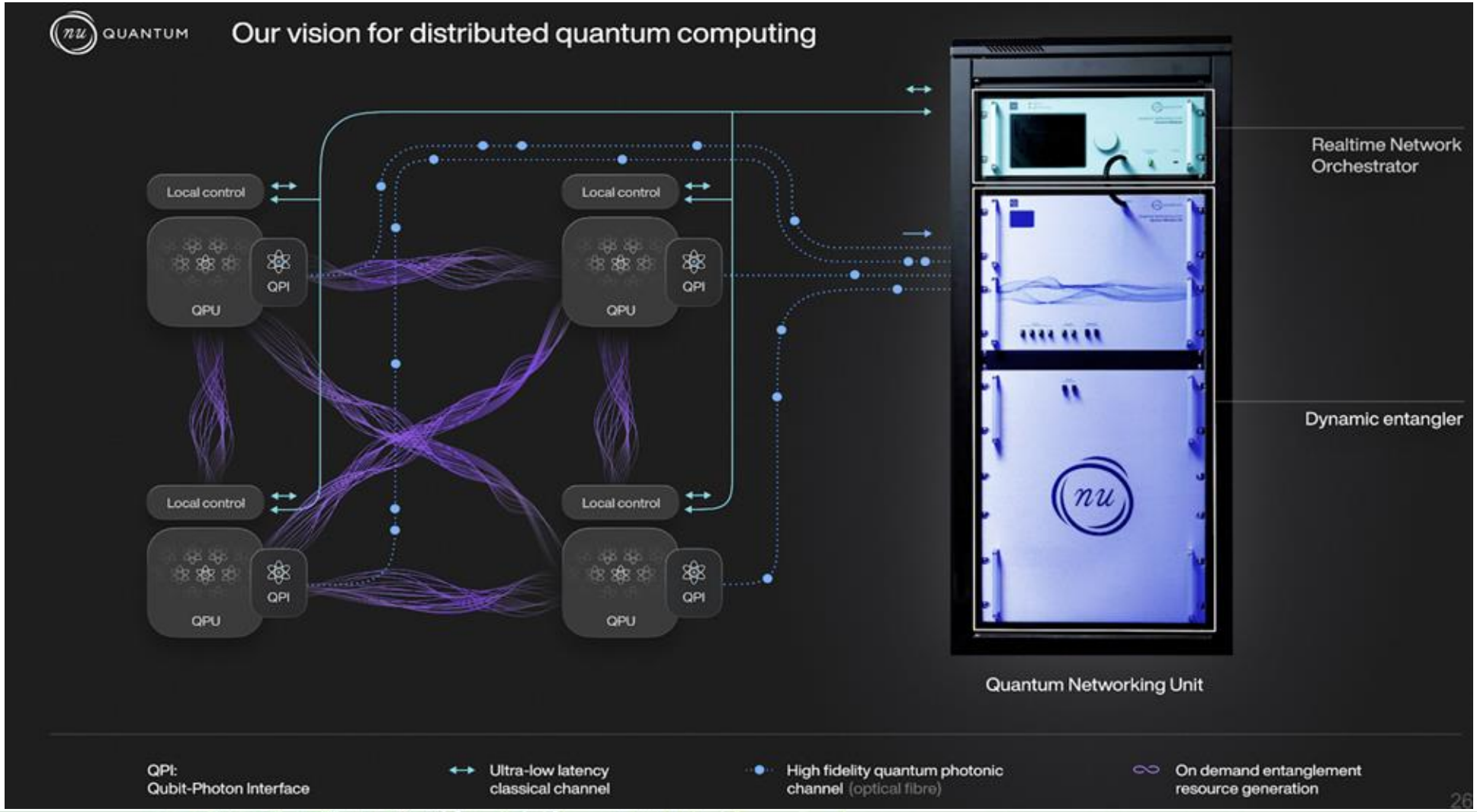
Gen 2 [2027]



Proprietary switching technology

- → Lower loss
- → Higher speed
- → Higher fidelity
- → Higher node count

Layout of a 4-node quantum network



Quantum Error Correction for logical architectures

Logical Architectures

Efficient, Error Corrected Scale-out

Network delivers:

→ Non-local connectivity

→ Reconfigurability

Therefore Enables:

→ Efficient, high-rate codes

→ Modularity

→ Resilience

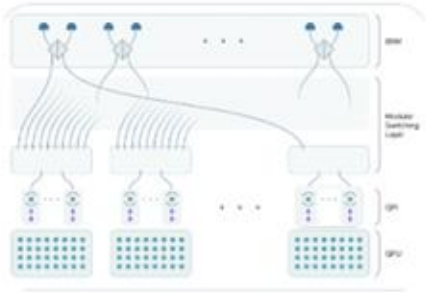
→ Elasticity

Distributed Quantum Error Correction based on Hyperbolic Floquet Codes

2025 IEEE International Conference on Quantum Computing and Engineering (QCE)

Authors: Evan Sutcliffe, Bhargavi Jonnadula, Claire Le Gall, Alexandra E. Moylett, Coral M. Westoby

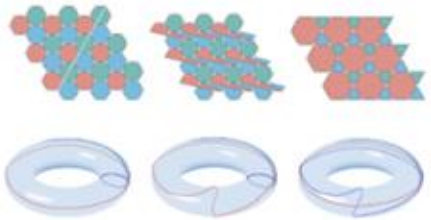
→ January 2025



Logical Gates on Floquet Codes via Folds and Twists

Authors: Alexandra E. Moylett, Bhargavi Jonnadula

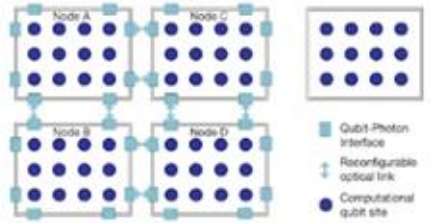
→ December 2025



Tolerating Device Failure in Distributed Quantum Computing

Authors: Evan Sutcliffe, Coral M. Westoby

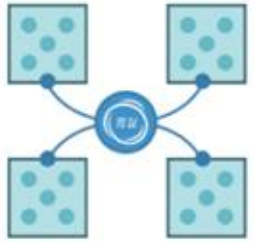
→ May 2026



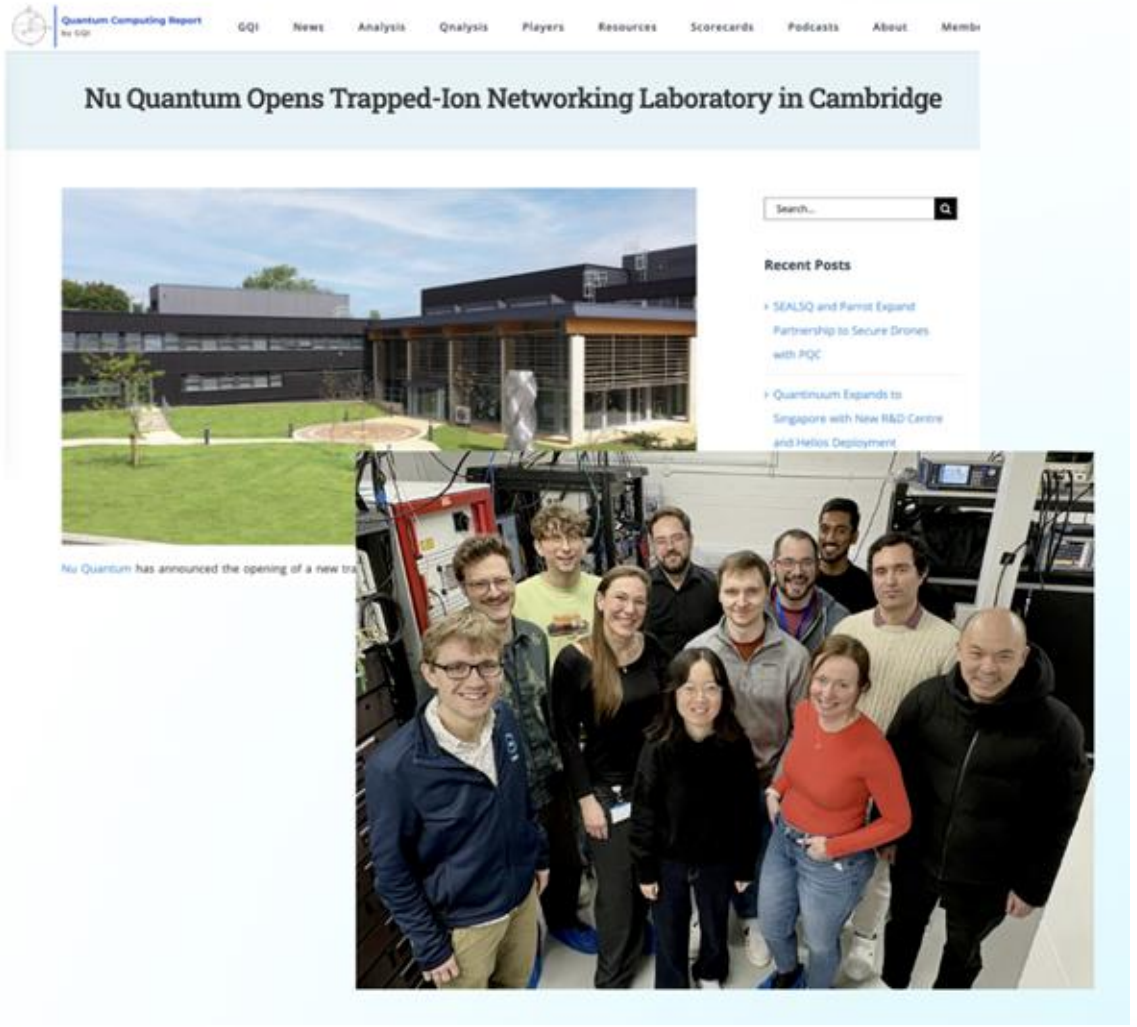
The outlook for Nu Quantum's technology

Quantum Network Testbed

- 50x in entanglement rate,
- State-of-the-art Fidelity (>97%)
- Autonomous Operation







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