A quantum processor is not a quantum computer without classical resources

Quantum real-time

System real-time

Near real-time

Qubits
coherence time

Tracking qubits
parameters

Hybrid
Algorithm iteration

Low latency iterations / feedback

Compute-intense

Real-time Pulse Processor

HPC
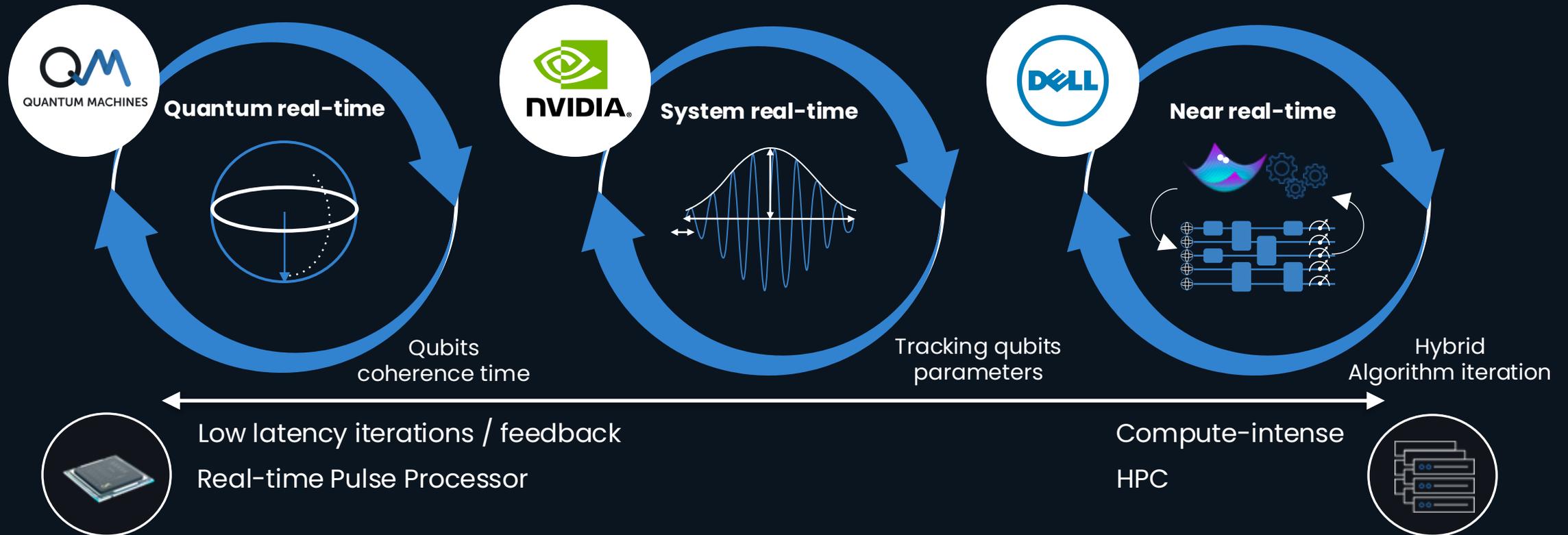
300+ Customers
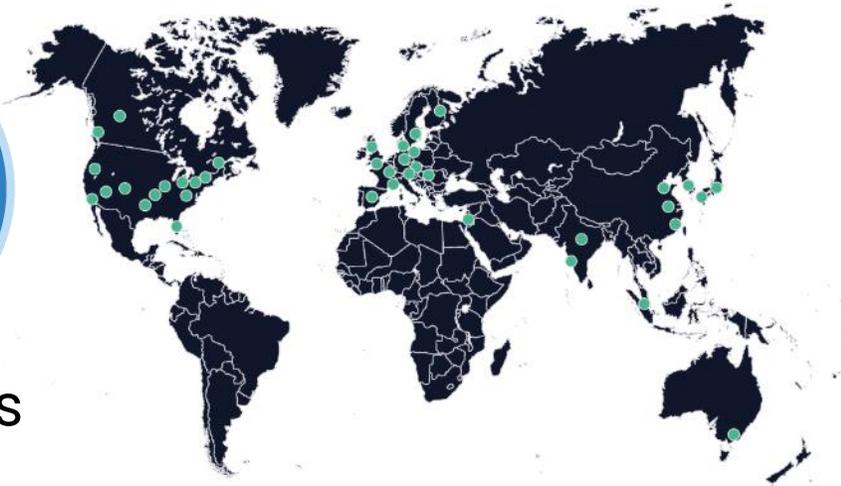
Corporates, startups, national labs, HPC centers, and academic institutions
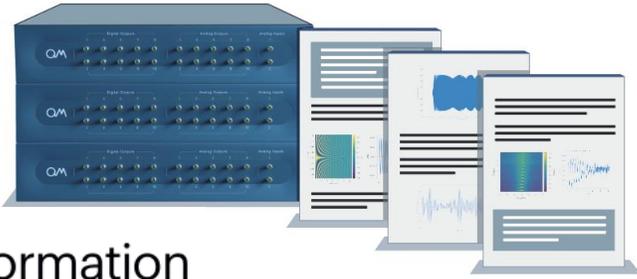
160+ Quantum Physicists & Engineers

Entirely focused on quantum Control systems

>60 High Impact Publications In The Last 12 Months

nature physics
nature Science
npj | quantum information

QUANTUM MACHINES

Room Temperature & Cryogenic Solutions

OPX1000
High-density, modular quantum controller

QDAC-II
Ultra-low noise 24 channel DAC

OPX+
Ultra-fast controller
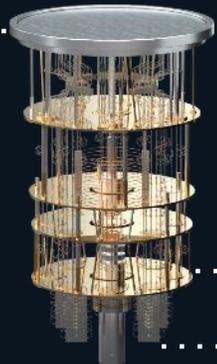
Octave
Up/down converter up to 18GHz

QDAC-II Compact
High-density DAC

QSwitch
Remote-controlled breakout box

Cryogenic Sample Holders, Packaging and Filtering Solutions
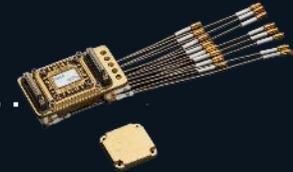
QFilter
Compact multi-stage low-pass cryogenic filter

Room Temperature Quantum Control Solutions to enable Quantum Real Time control

Qcage.64
MW cavity sample holder

QBoard-II
Non-magnetic advanced sample holder

OPX1000

Processor-Based Controller

- ✓ Unmatched quantum-real-time compute and control-flow
- ✓ Ultra-fast feedback: **active reset < 120 ns**

Ease-of-Use

- ✓ Modular: Mix LF/MW modules as needed
- ✓ Intuitive pseudo-like programming
- ✓ Out-of-the-box workflows for ultra-fast calibration and real-time retuning

- ✓ DDS technology up to 10.5 GHz > no mixers/double heterodyne calibration
- ✓ **SFDR > 60 dBc**, over the entire spectrum
- ✓ Low frequency module with up to **16 tones per channel**
- ✓ Microwave frequency module with up to **8 tones around 2 carriers per channel**
- ✓ **2 GSa/s and 4 GSa/s** modes

Cutting-Edge Analog Specs

- ✓ Effortlessly add units with any to-any data-sharing, exceptional phase synchronization, and no software redesign
- ✓ Supports 1000s channels with extremely high density of **26.7 channels/U**
- ✓ **NVIDIA-QM**: Native GPU-quantum HW integration, **roundtrip delay < 4 μs**

Unrivaled Scalability

QUANTUM MACHINES
OPX1000-MW-FEM

QM QUANTUM MACHINES

Accelerated Quantum Supercomputing at NVIDIA

Accelerated Quantum Supercomputers
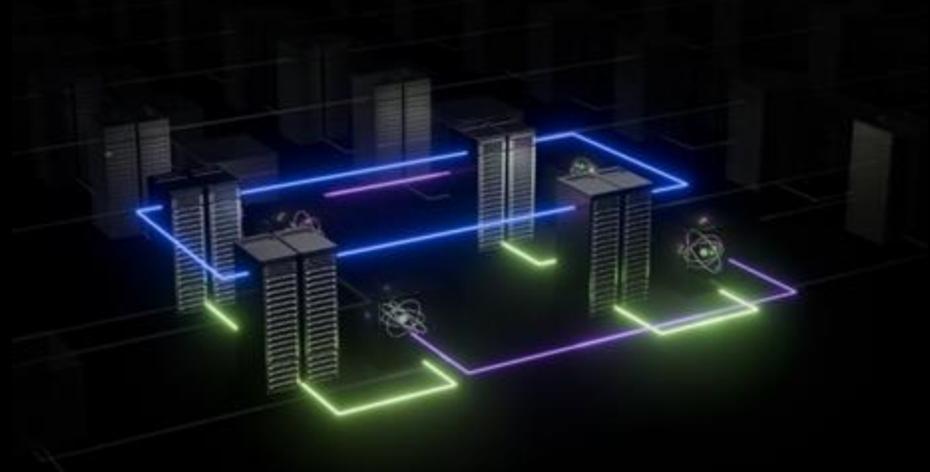
- AI Supercomputers **integrate quantum processing units**

- **Hybrid algorithms** need GPUs and QPUs

- **CUDA-Q software platform** connects applications seamlessly

- **Qubit-agnostic** integration with AI supercomputing

NVIDIA Partner Network

>75%	160+	20/20	18/20
QPUs integrate CUDA-Q	NVIDIA Quantum Partners	Leading startups build on NVIDIA	Leading HPC centers work with NVIDIA

QUANTUM HARDWARE BUILDERS

QUANTUM SIMULATION FRAMEWORKS

CLOUD SERVICE PROVIDERS

SYSTEMS BUILDERS & INTEGRATORS

RESEARCH CENTERS

QUANTUM SOFTWARE AND SYSTEMS

NVIDIA
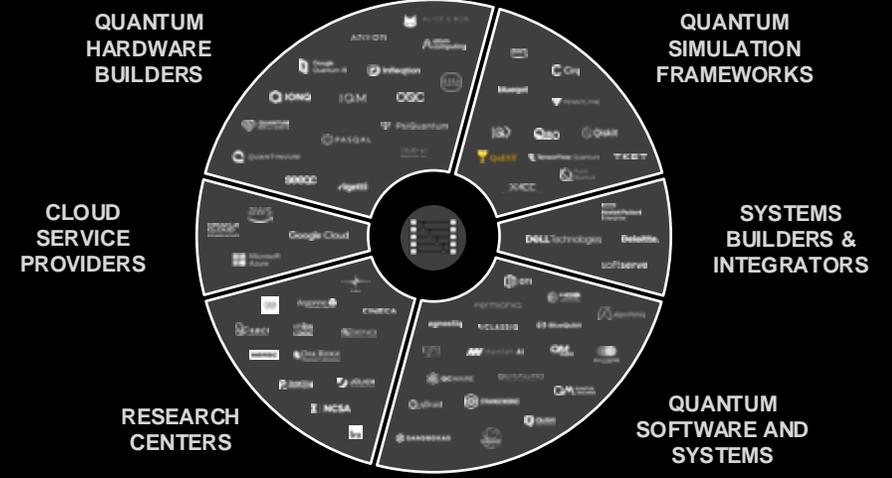
AI Supercomputing Accelerating QC Development
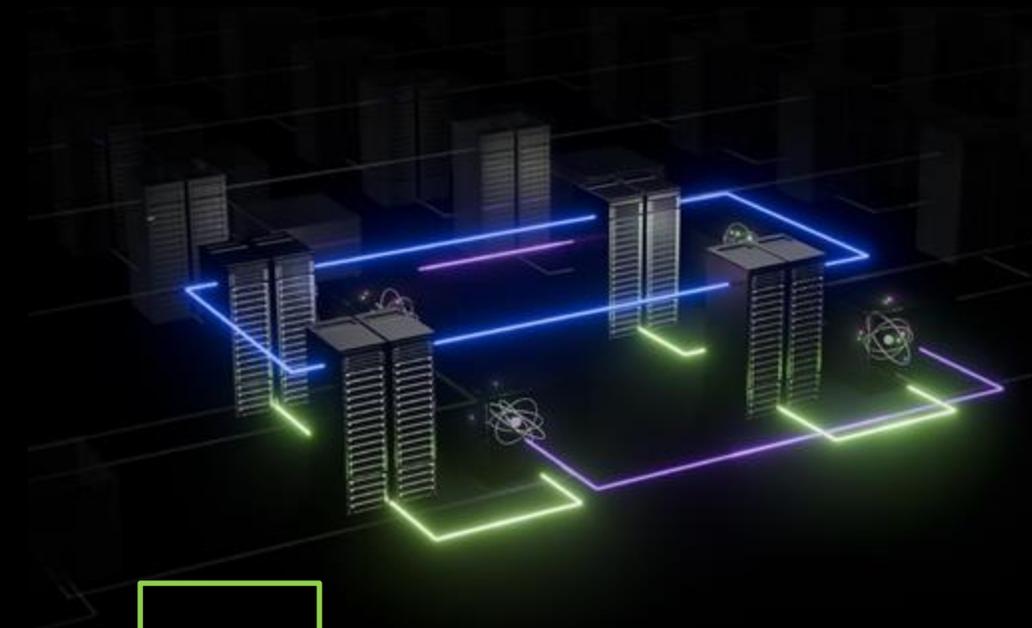
Qubits

Better quantum hardware

Hybrid algorithms

Implementing QEC

Infrastructure challenges

Accelerated Quantum Supercomputers

AI supercomputing

NVIDIA

Quantum Computing Needs Accelerated Computing

GPUs for QC Deployments

Quantum Error Correction

Hybrid algorithms and applications

AI for
- Calibration
- Control
- Readout

GPUs for QC Development

Accelerated application development

AI assisted circuit design

Dynamical simulations

Noise modeling

Practical Post Quantum Cryptography

NVIDIA

DGX Quantum

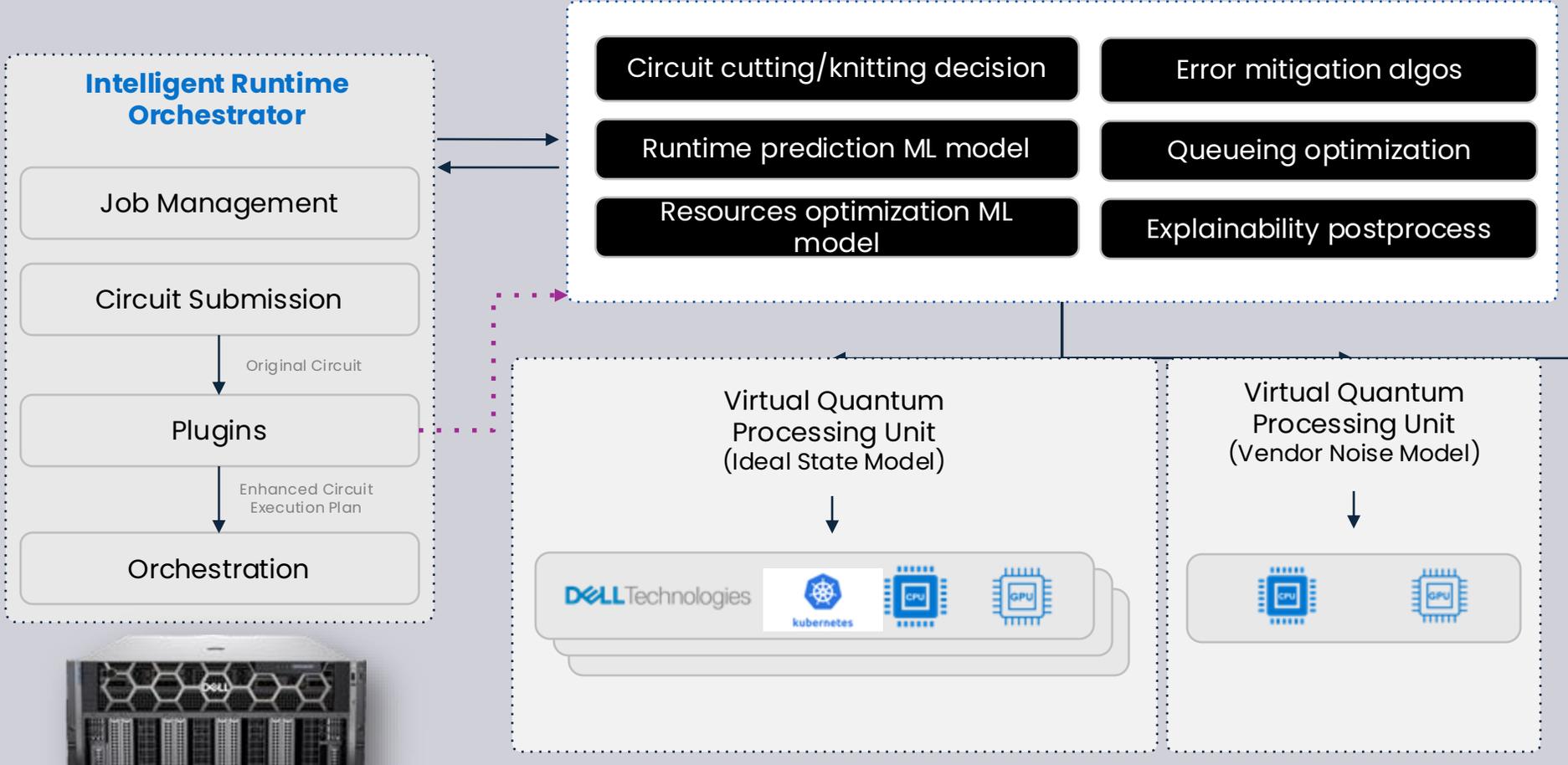## System for Integration of Quantum with AI supercomputing

- Tightly integrates Quantum with GPU Supercomputing

- Qubit Agnostic – Supports different qubit modalities

- Reduces GPU-QPU latency by 1-2 orders of magnitude

- Enables GPU Acceleration of Quantum Error Correction, Calibration, and Hybrid Algorithms
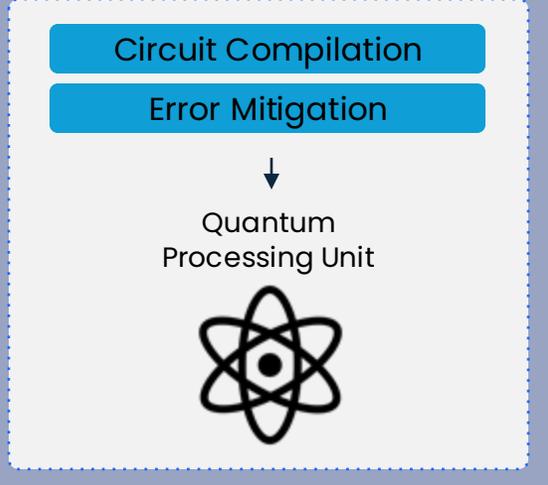
- Scalable for more GPU compute and larger QPUs

NVIDIA.

QM QUANTUM MACHINES

NVIDIA.

Dell Hybrid Quantum Computing leverages your on-prem classical compute

Classical Computing Control Plane for Quantum Accelerator

Intelligent Runtime Orchestrator

- Job Management
- Circuit Submission
  - *Original Circuit*
- Plugins
  - *Enhanced Circuit Execution Plan*
- Orchestration

- Circuit cutting/knitting decision
- Error mitigation algos
- Runtime prediction ML model
- Queueing optimization
- Resources optimization ML model
- Explainability postprocess

Virtual Quantum Processing Unit (Ideal State Model)

DELL Technologies · kubernetes · CPU · GPU

Virtual Quantum Processing Unit (Vendor Noise Model)

CPU · GPU

Quantum Computing (pulse processor, fridge, QPU)

- Circuit Compilation
- Error Mitigation

Quantum Processing Unit

Quantum <u>doesn't work</u> without classic infrastructure

Input

Quantum Processing

Output

Servers, Storage, and Networking

Host Processor

Emulation, testing, development, "hello world" applications

Accelerated vQPU Servers

Pulse Processor

Actual Quantum Utility

Environmental Controls

pQPU

Accelerated Servers or HPC
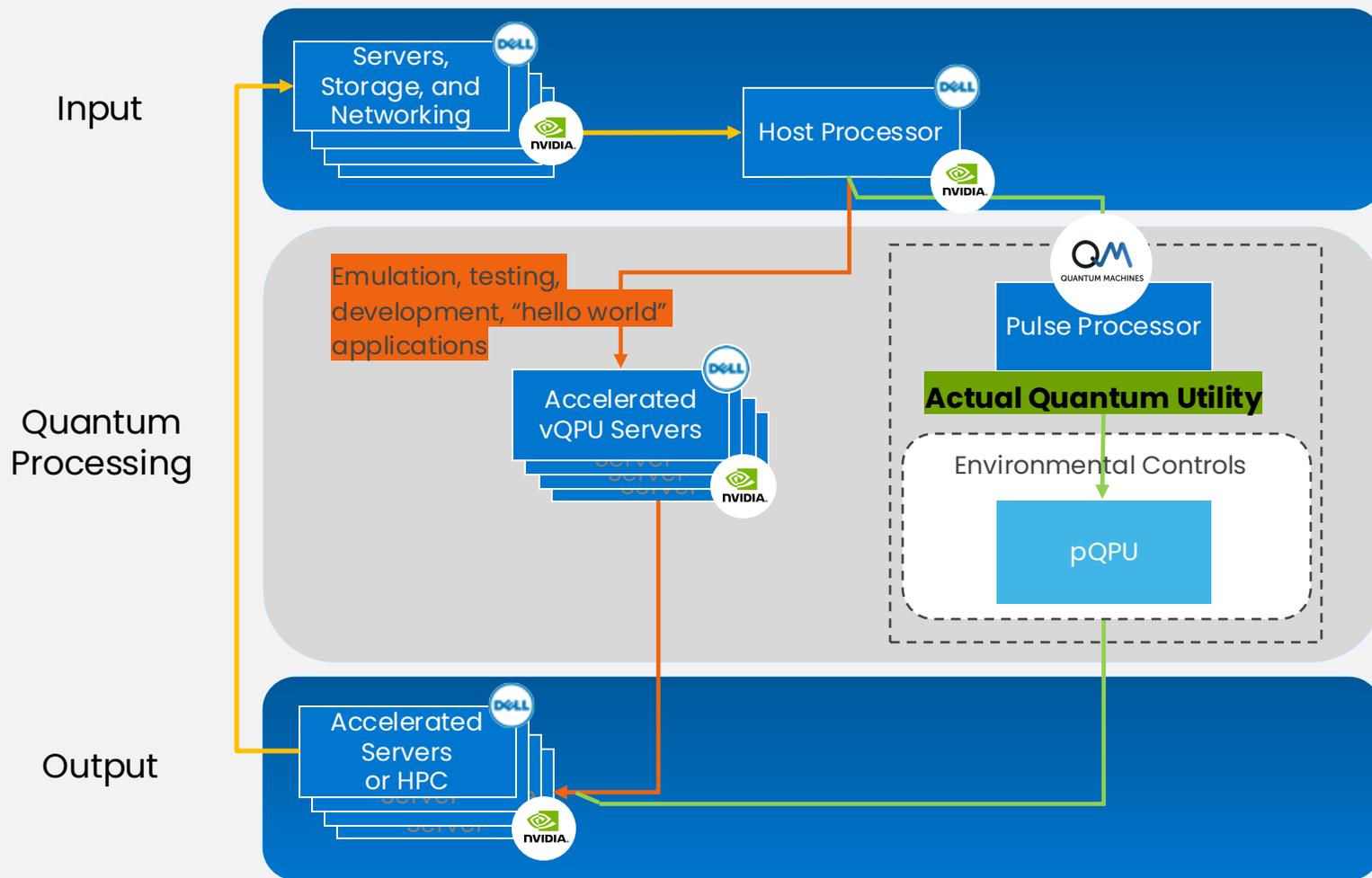
- As the capabilities of QPUs grow (e.g., more qubits), more classic infrastructure is needed to support it!

- A 'full-stack' that includes emulation (vQPU) and physical QPUs (pQPU)

- Multi-Vendor system with location independence

Classic Infrastructure — Emulation

Classic Electronics — Quantum Computer

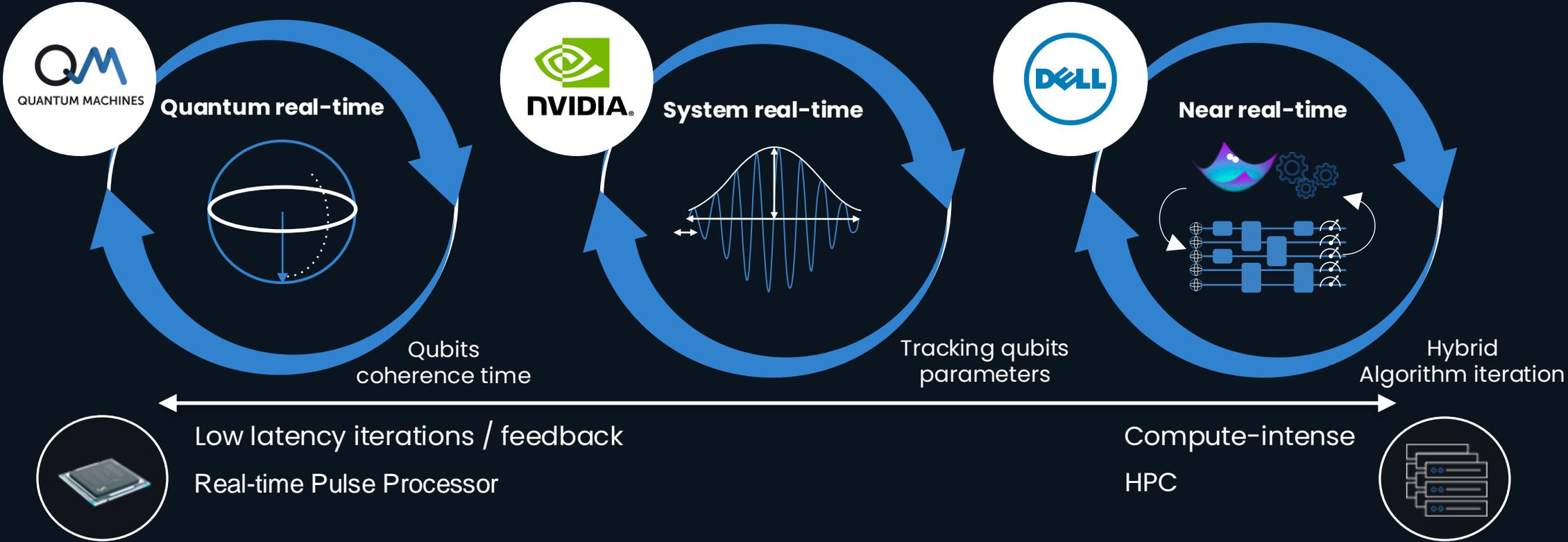Quantum Infrastructure — HPC Infra

DELLTechnologies
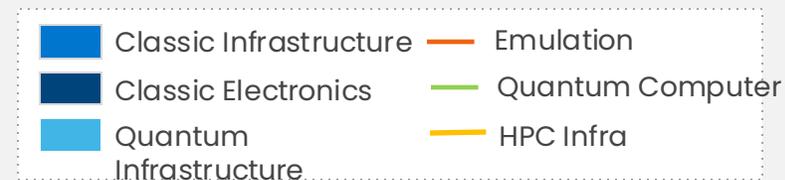
Dell Hybrid Classical–Quantum Computing
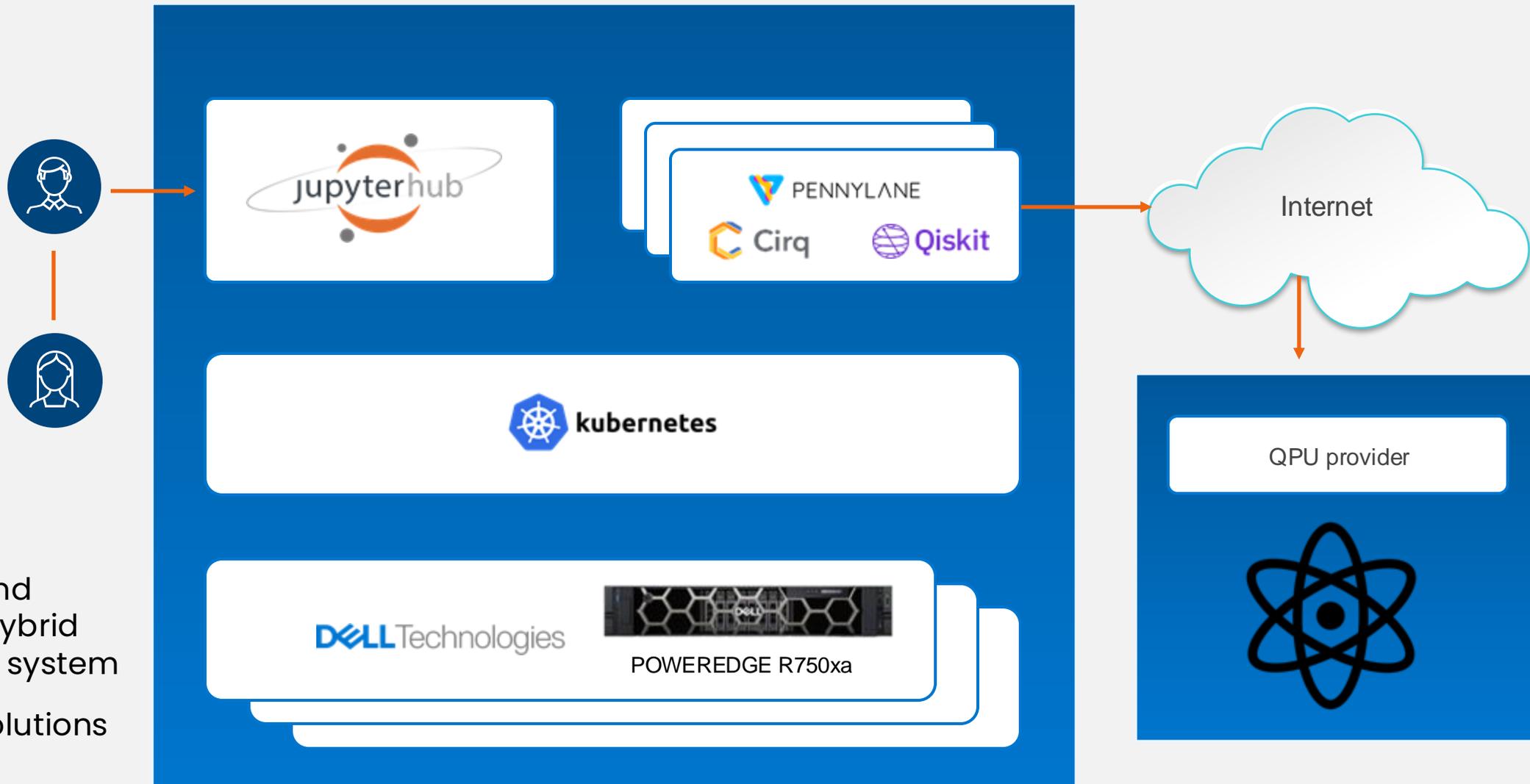
- End to end managed classical and quantum hybrid computing system
- Scalable solutions for various application needs

We provide the classical resources to enable the essential time scales of a quantum computer

Quantum real-time

System real-time

Near real-time

Qubits coherence time

Tracking qubits parameters

Hybrid Algorithm iteration

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Real-time Pulse Processor

HPC