The Classical Infrastructure of Fault-tolerant Quantum Computing

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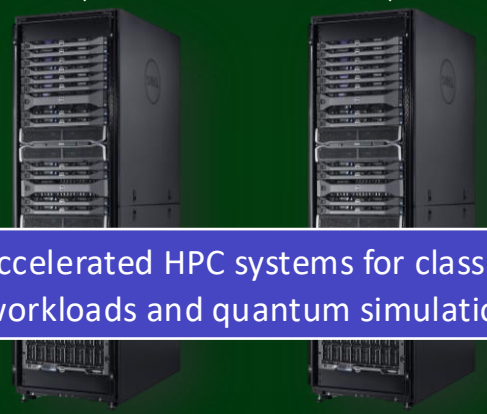
OCP FUTURE TECHNOLOGIES SYMPOSIUM
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San Jose, California

Real-Time QEC Needs Tight Integration



Quantum Hybrid Workload

1. Software solutions to ease quantum workload deployment



4. Accelerated HPC systems for classical workloads and quantum simulation[1]

Quantum Accelerator



Real-time Classical Processing



Pulse Processing



Quantum Processing Unit

2. Infrastructure to integrate quantum accelerators within classical systems

3. Deploying and supporting quantum infrastructure at customer sites

Real-time classical workloads

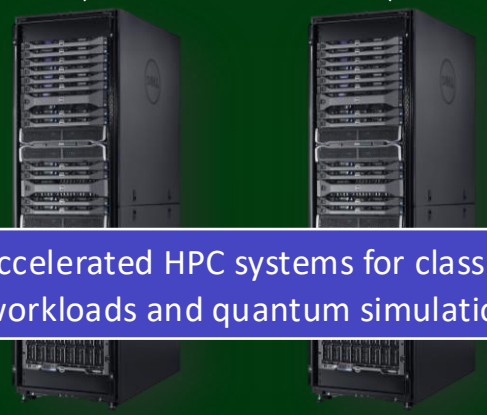
- **Hybrid Applications**: Connecting to and leveraging the QPU as an accelerator for subroutines in larger workflows (ms)
- **Error Correction**: Low latency (~us) access to dedicated FPGA decoders with GPU-equipped classical servers
- **Error Mitigation**: Post-processing plus classical optimization of analog control signals
- **Calibration:** Improvement to fidelity and uptime via extraction of QPU parameters (s to min)

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The three fundamental questions

1

Is it worth it and where does it run?

Route across heterogeneous compute; estimate the resources each workload needs.

2

How does it connect?

Close the quantum–classical loop fast enough for real-time work including decoding.

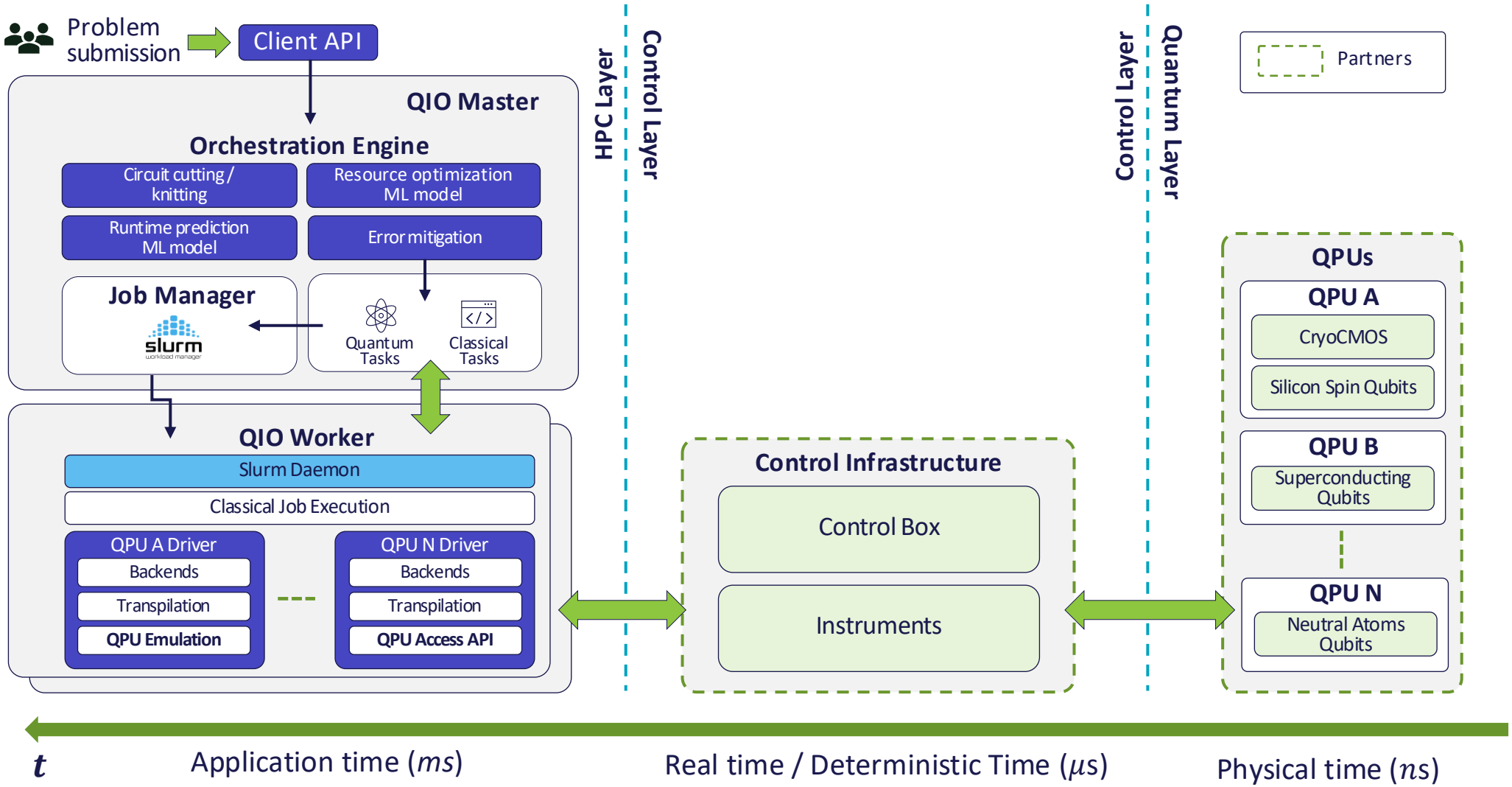
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Can I trust the answer?

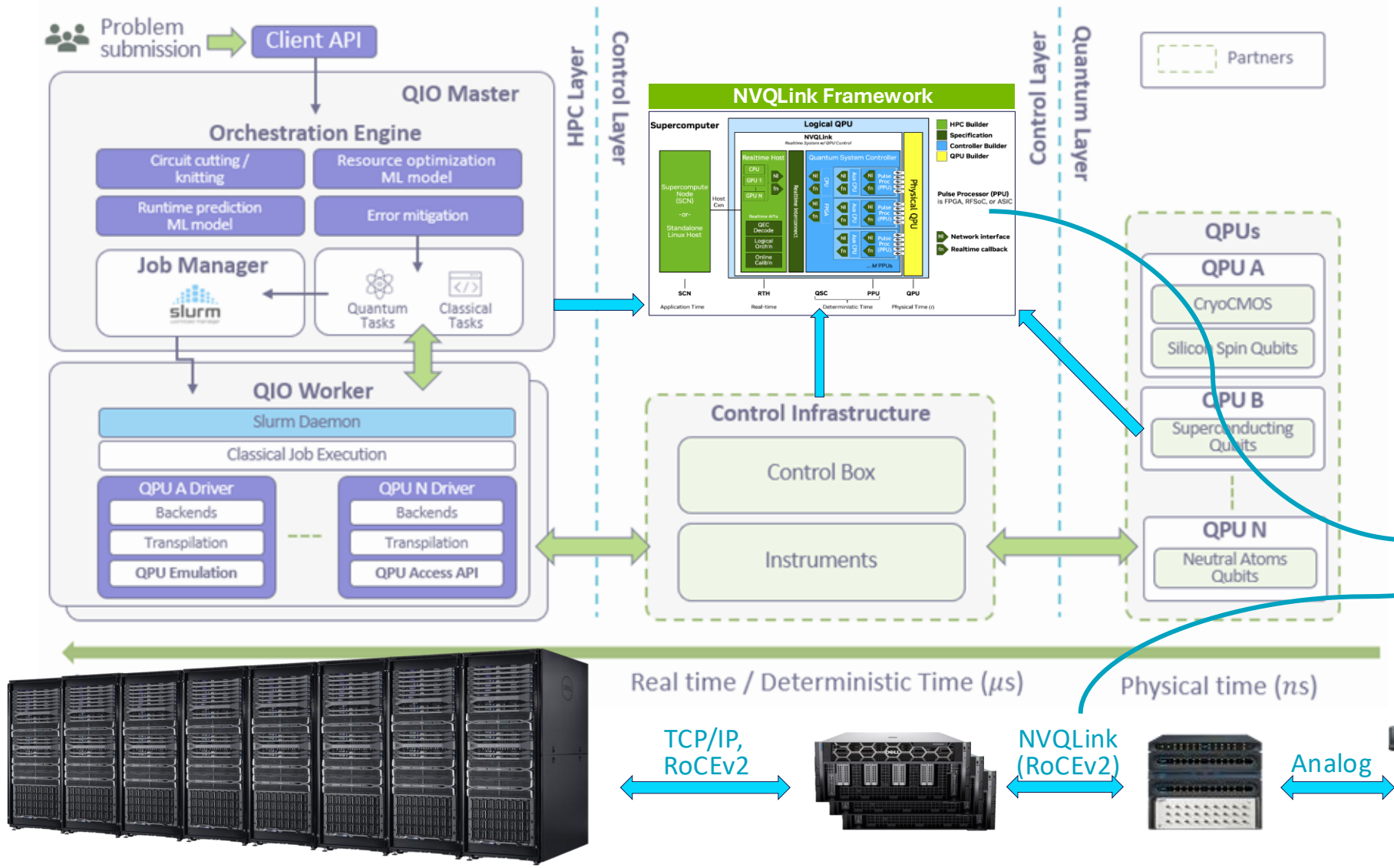
Get usable results off noisy hardware today; build toward correction tomorrow.

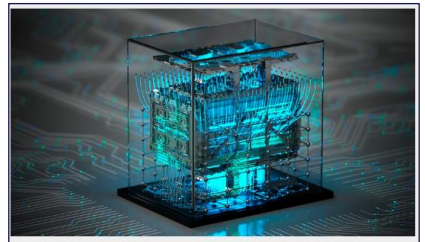


Quantum Intelligent Orchestrator (QIO)



Dell HQCC: Built for the Real-Time Loop



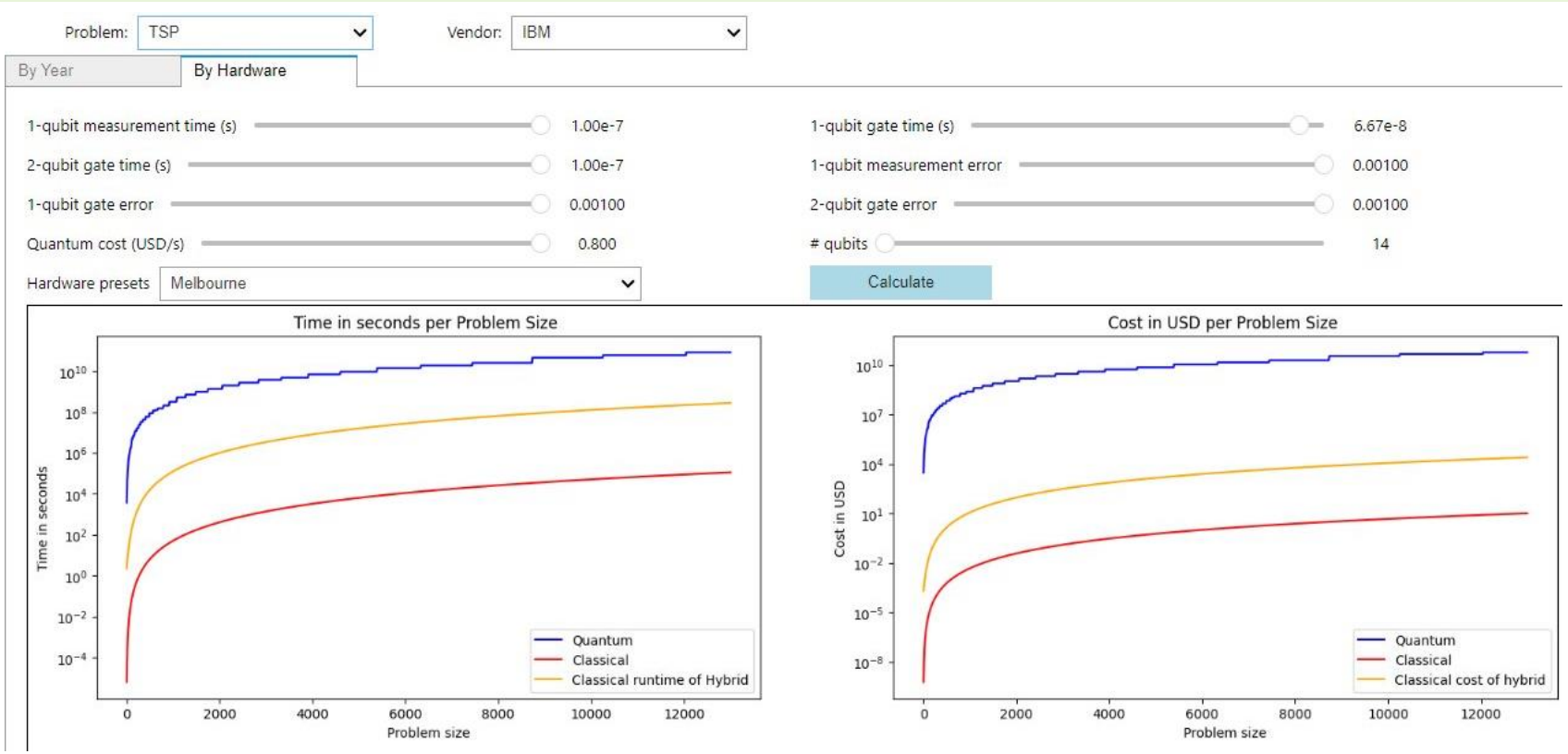


Dell and NVIDIA: breaking the latency barrier

Quantum computing requires classical systems that can react in microseconds, and Dell and NVIDIA demonstrated they can reliably meet that on NVQLink and PowerEdge infrastructure.

<4 usec roundtrip latency

Quantum Advantage Calculator



Comprehensive tool incorporating AI and broader range of variables to deliver reliable results

Predict quantum hardware costs with respect to classical approach for a given problem type and size

Paredes Quinones, et al., "An ML-Based Quantum Advantage Calculator," in 2025 IEEE International Conference on Quantum Computing and Engineering (QCE), Albuquerque, NM, USA, 2025, pp. 376-377, doi: 10.1109/QCE65121.2025.10353.

AI for Quantum Error Mitigation (QEM)

- Dell Developed the first solution (to our knowledge) for QEM using GenAI.
- The solution is based on Diffusion Models, a SOTA technique for image generation that has also been applied to other modalities (e.g., audio and time series).
- Diffusion models are implemented as a denoising mechanism, which makes a direct conceptual connection with QEM.
- Testbed: Dell IQM's Garnet



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- Quantum Intelligent Orchestrator
- Resource estimation intelligence

2

How does it connect?

Close the quantum-classical loop fast enough for real-time work including decoding.

- Dell HQCC architecture
- NVQLink interconnect

3

Can I trust the answer?

Get usable results off noisy hardware today; build toward correction tomorrow.

- QPERT, Quantum XAI
- IQM + Dell whitepaper on QEM

Success Stories

Dell's journey: agnostic HQCC system innovator/integrator

2016
- OCTO QC Research kick-off

2021
- Dell Runtime for IBM Qiskit created

2022
- DQCS: Dell **R740xd** + IonQ
- **QIO** (Quantum Intelligent Orchestrator)

2023
- Dell + EY applied QUBO quantum annealing to address portfolio optimization

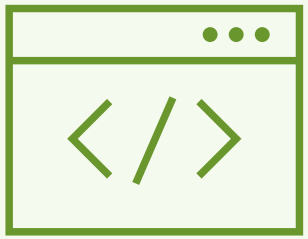
2024
- Dell-internal Supply Chain QUBO work deployed on **R750xa**

2025
- **SC25:** HQCC video demo Dell **R760xa** + QIO + QuEra
- Joined Diraq for DARPA QBI

2026
- **DTW:** *Live* HQCC demo (Dell **R770** + QIO + Equal1)
- **IEEE QW:** HQCC real-time QEC demo (QIO + Qblox)

Get Quantum ready

- We aim to lower the barrier to entry for adopting hybrid quantum-classical stacks.
- Join in our working group on Runtime & Scheduling.
- How to get involved with this community? Join the OCP Future Technologies Initiative community (Jonathan Burnett & Boniface Yogendran)



Dell.com/quantum-computing



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