Quantum Queue Utility

Quantum HPC integration tool

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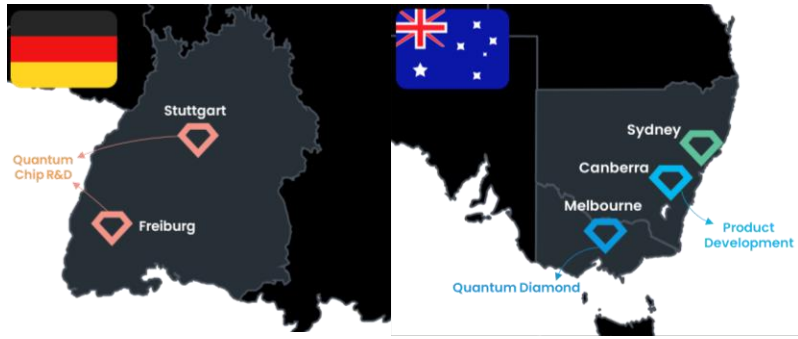
Short introduction about me

QUANTUM BRILLIANCE

Quantum Brilliance Context

Eight leading approaches to build a commercial quantum computer

Reference: https://www.idtechex.com/de/research-article/how-the-quantum-physics-nobel-links-to-a-future-us-21b-market/33858



Quantum utility at room temperature

Research areas / Projects

- quantum sensing
- pulse level access
- multi-NV algorithms
- quantum accelerators
- quantum development kits
- mobile quantum computing

QB Partners & Customers

NVIDIA, Oak Ridge National Laboratory, cyberagentur, Pawsey Supercomputing Centre, L3Harris Fast. Forward., Thales, imec, GlobalFoundries, TNO innovation for life, University of Stuttgart Germany, NEXTDC, LUX PROVIDE, Fraunhofer, CSIRO, Australian National University

QB Investors

Main Sequence, iqt, Moelis Australia, National Reconstruction Fund Corporation, investible, ultratech capital partners, InterValley Ventures, r&mpersand., Jelix, Powerhouse Ventures, Breakthrough Victoria, Brindabella Asset Management

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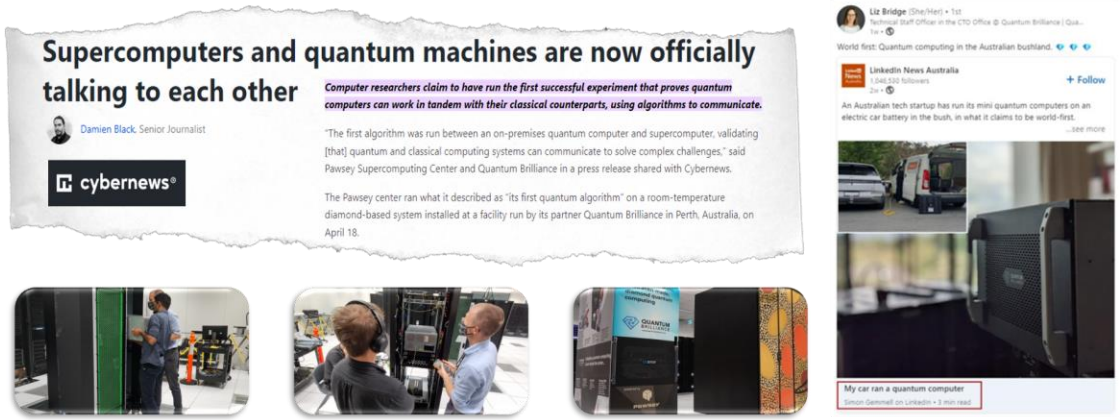
Quantum Brilliance Roadmap



2022

World's 1st Integration inside a Supercomputer

PAWSEY supercomputing centre

2023

World's 1st Mobile Quantum Computing

Fraunhofer

2025

World's 1st Quantum Computer Cluster

OAK RIDGE National Laboratory

Coming in 2028

World's 1st GPU-sized Mobile Quantum computer

cyberagentur

Quantum Queue Utility is currently being used in 3 HPC centers

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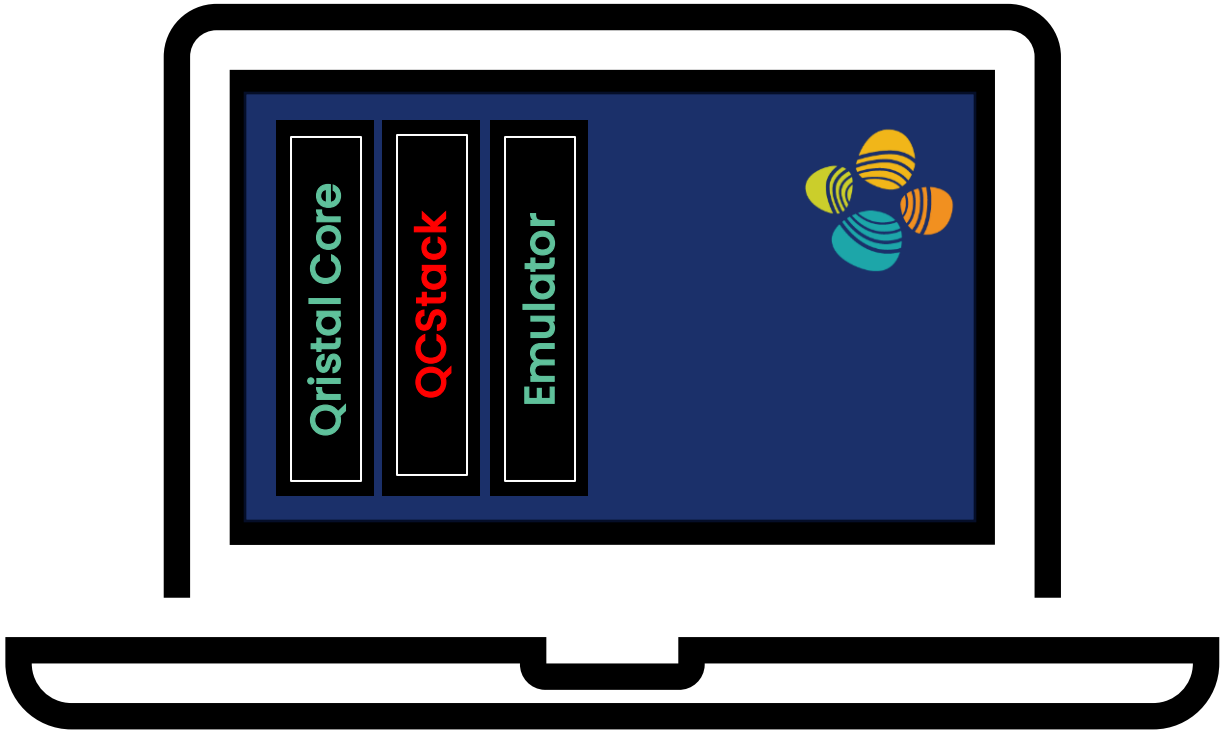
How do you compute?

Single device



All you need is your laptop

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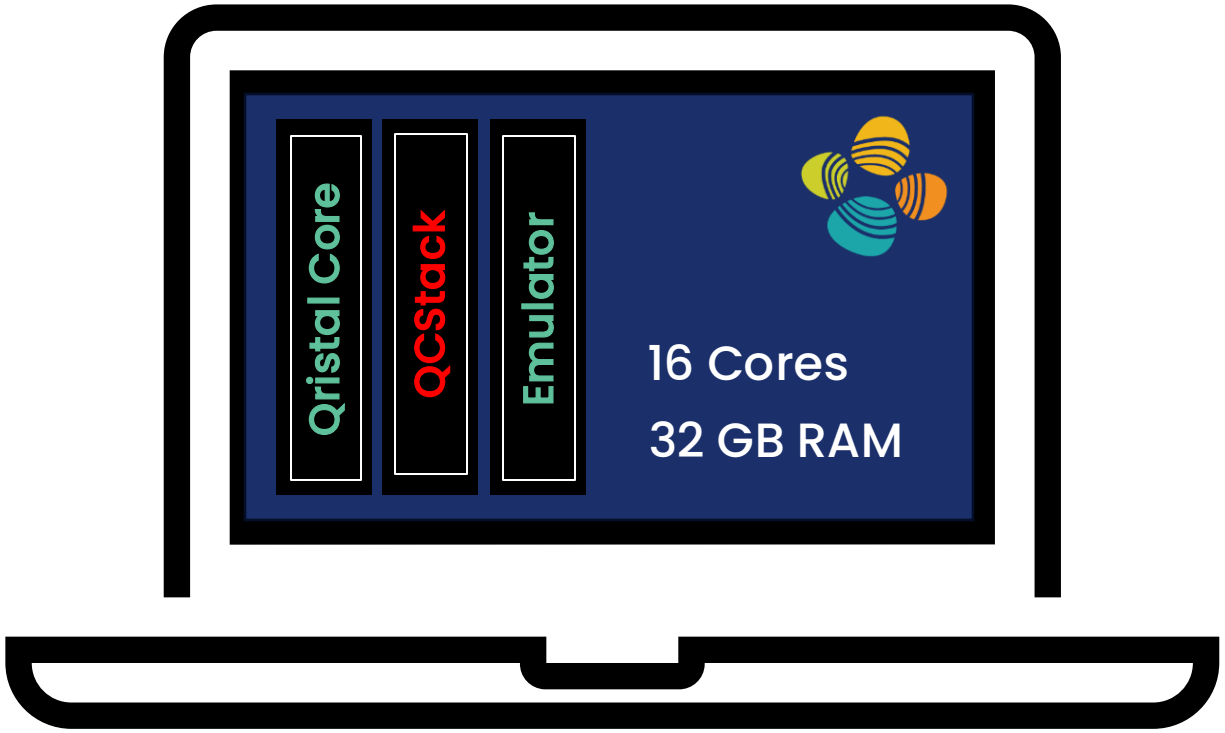
Limits of a single device



A 2-qubit system:

$$|\psi(\theta)\rangle = U(\theta)\,|00\rangle = \begin{pmatrix}\psi_{00}\\ \psi_{01}\\ \psi_{10}\\ \psi_{11}\end{pmatrix} = \psi_{00}\,|00\rangle + \psi_{01}\,|01\rangle + \psi_{10}\,|10\rangle + \psi_{11}\,|11\rangle.$$

Complex numbers
(16 bytes)

You need in memory
16×2^n

A 30-qubit system: 16 GB

Beyond 30 qubits, your laptop will freeze

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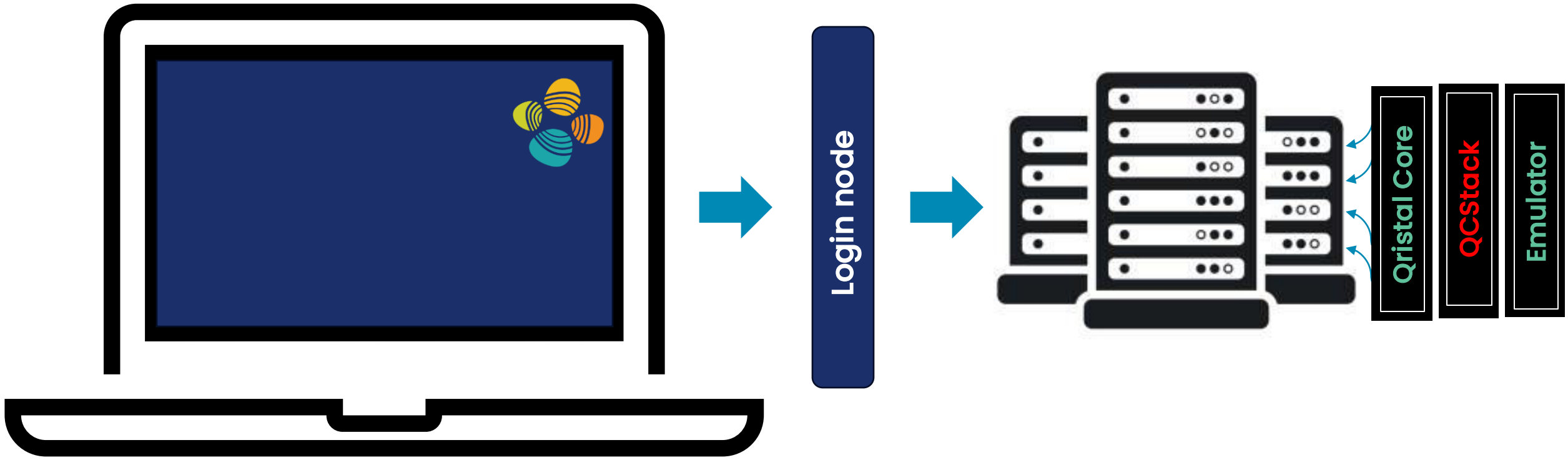
HPC Cluster



You don't need your laptop

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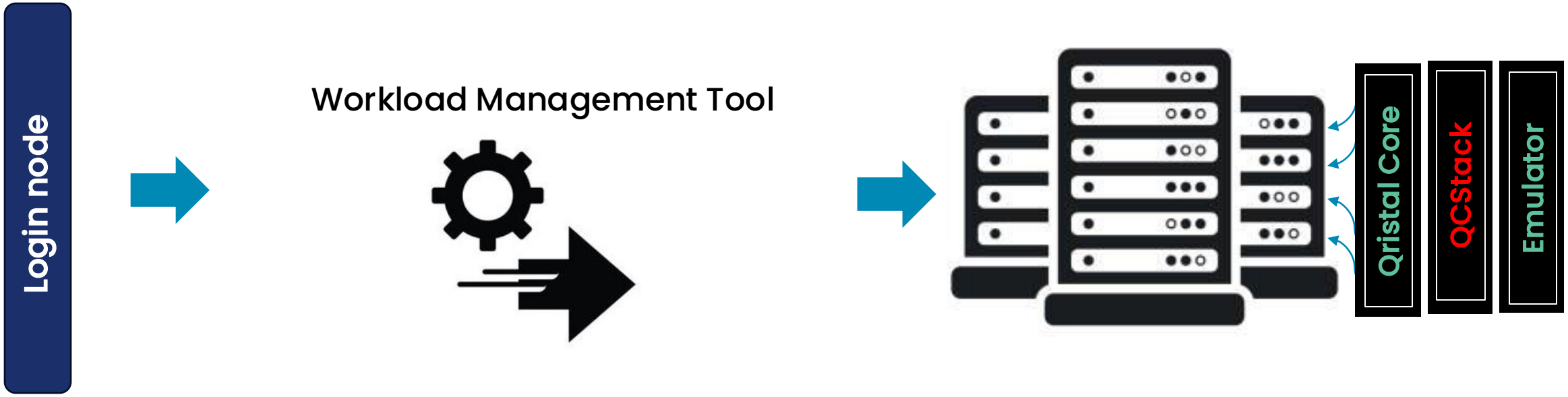
How do you manage the compute resources?



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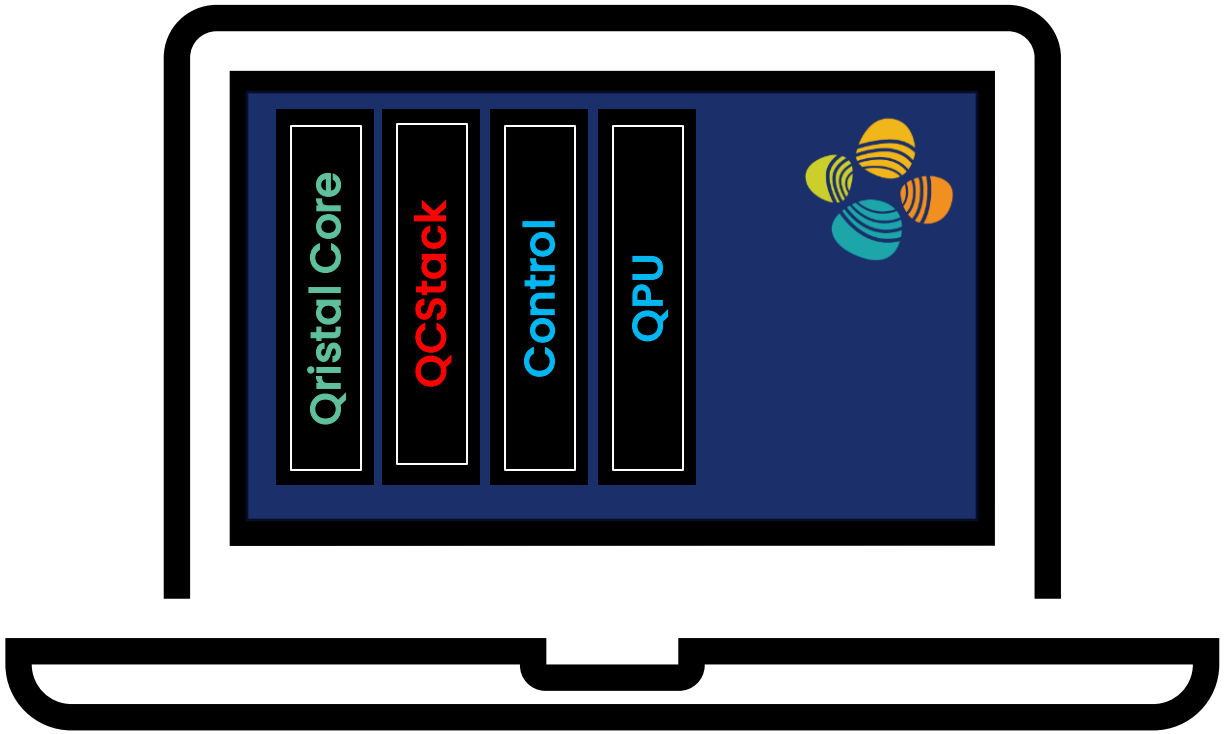
How do you compute...
in a quantum device?

Single device?



All you need is your laptop...? Not yet possible

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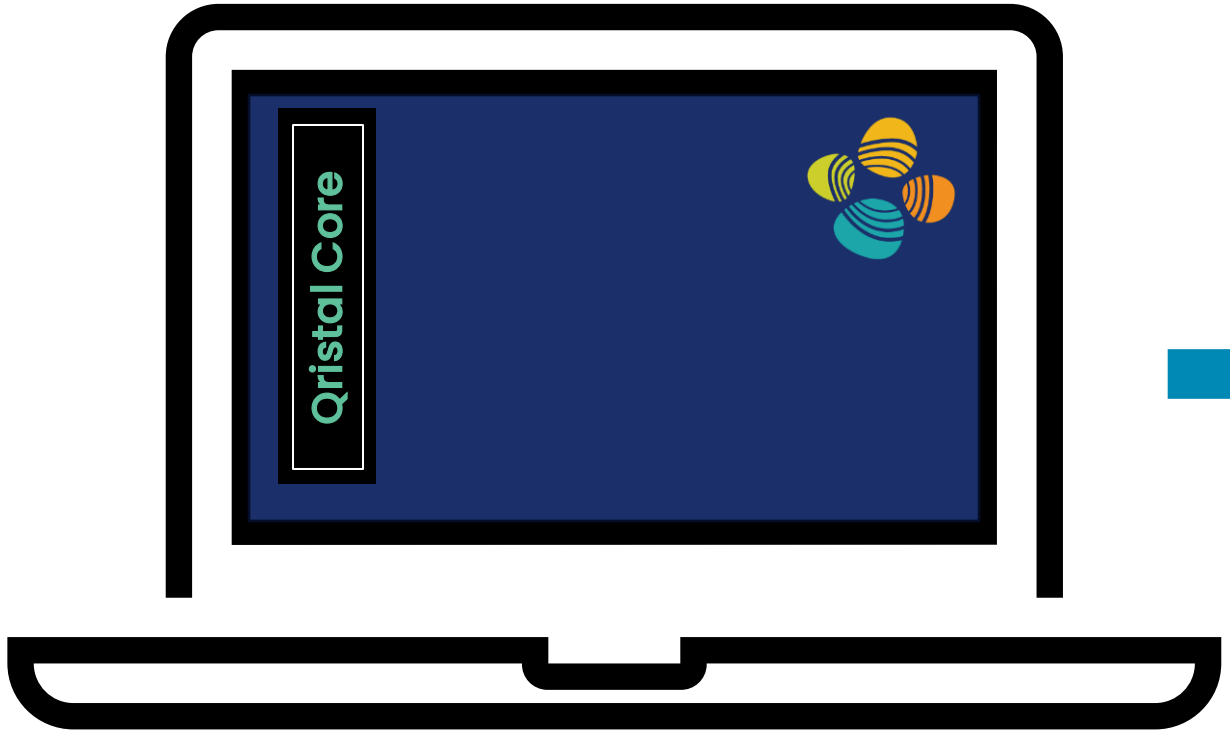
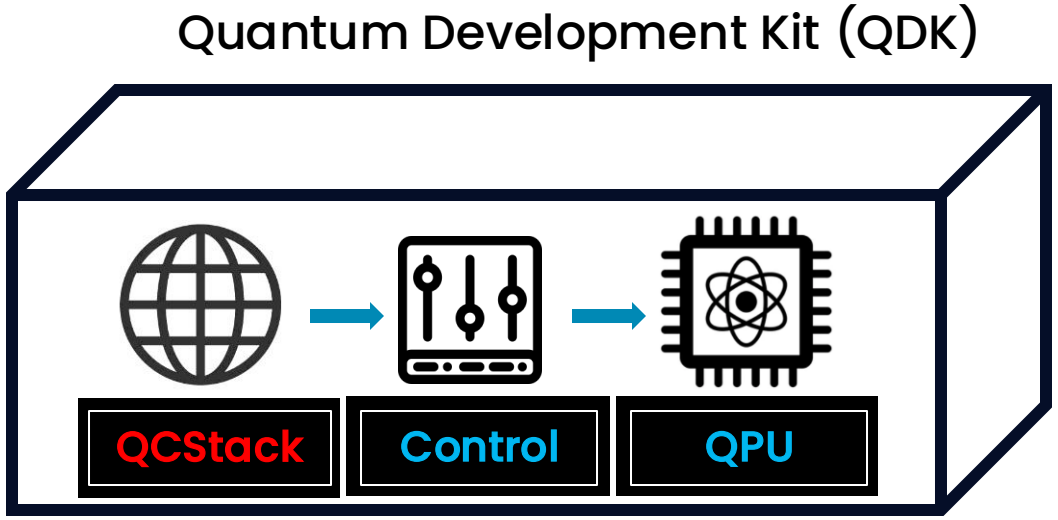
Quantum Development Kit



All you need is your laptop and the QDK in the same network



Problems:

- What if multiple users want to use the QPU?
- What if you want to run hybrid calculations?

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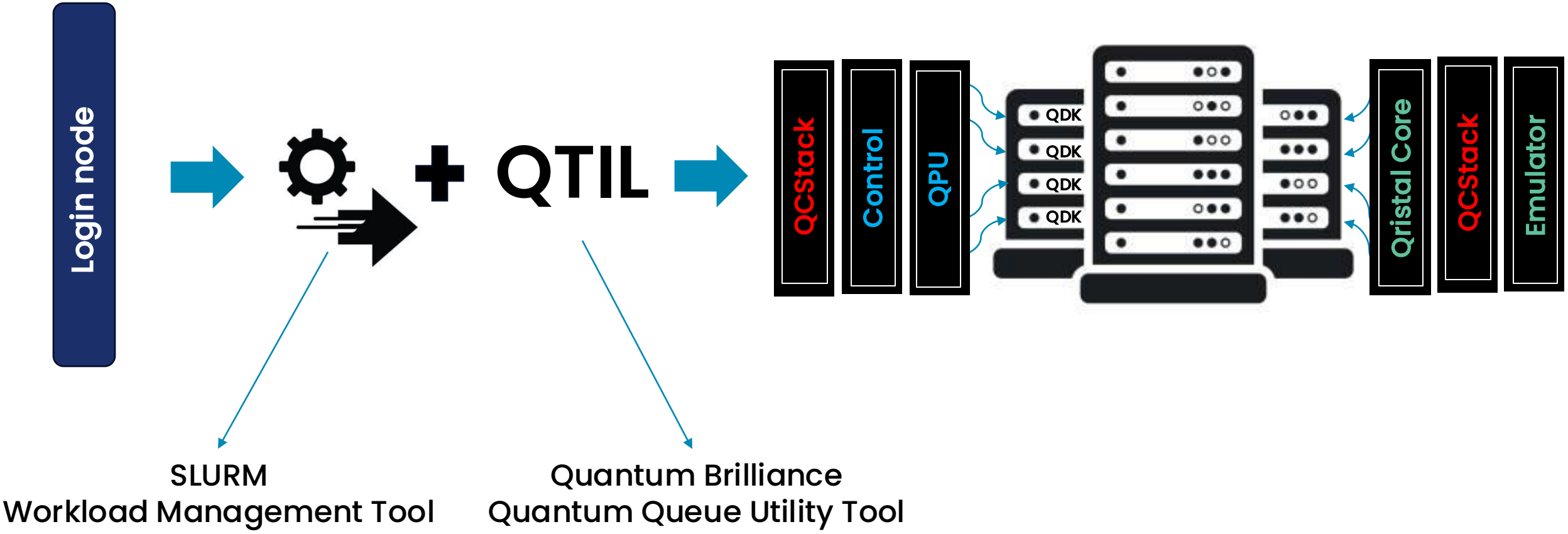
How do you manage quantum resources in a cluster?



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Quantum-HPC integration

What is next?

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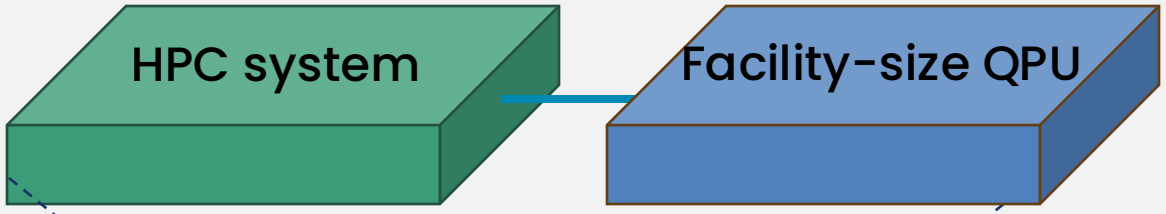
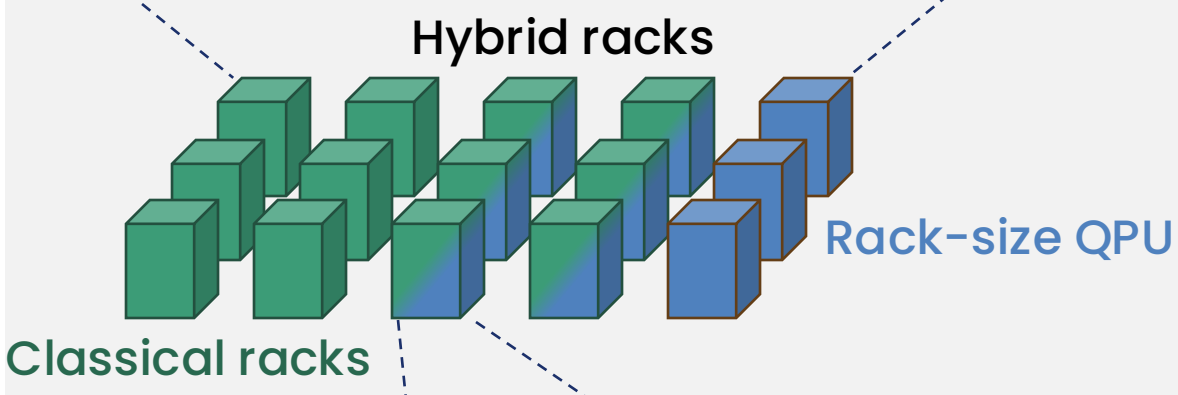
Quantum Brilliance's point of view

Quantum
Classical

Level 1

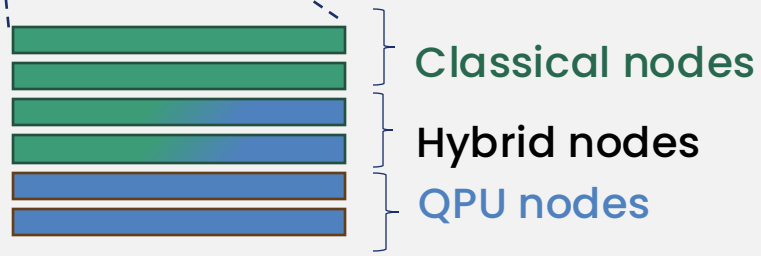


Level 2



- High speed infiniband / ethernet. High level protocols
- Ab initio chemistry, optimization applications
- EM isolation, vibrational isolation, cryogenics

Level 3



- Bus level communication (PCIe, NVLink, CXL)
- Molecular dynamics, ML applications
- Classical compute infrastructure

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Quantum Community point of view

XANADU

Q-CTRL

MUNICH QUANTUM SOFTWARE COMPANY

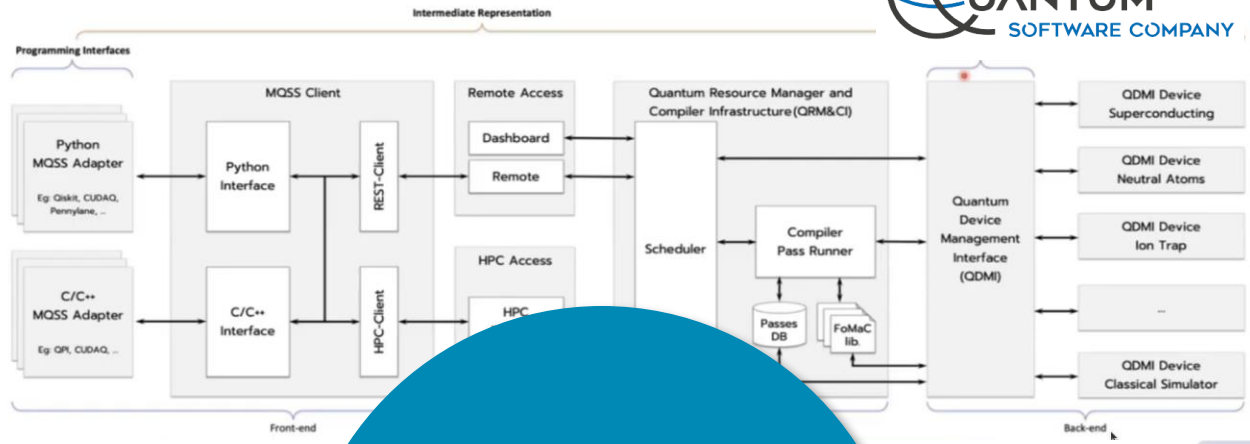
IONQ

ALICE & BOB

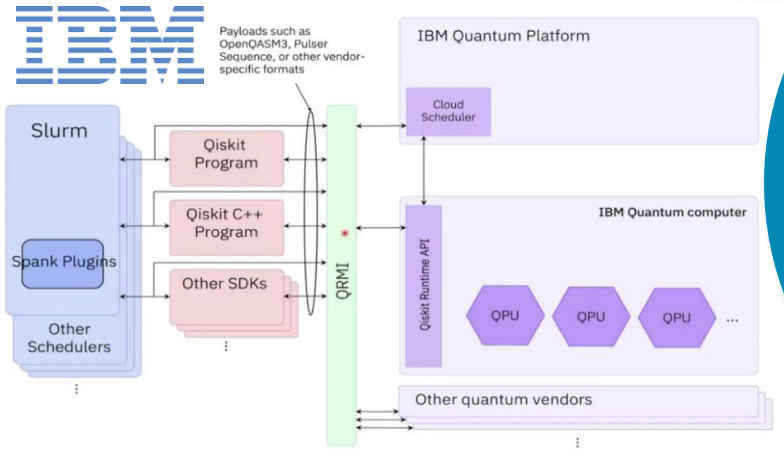
aws

RIKEN

SLURM + QDMI

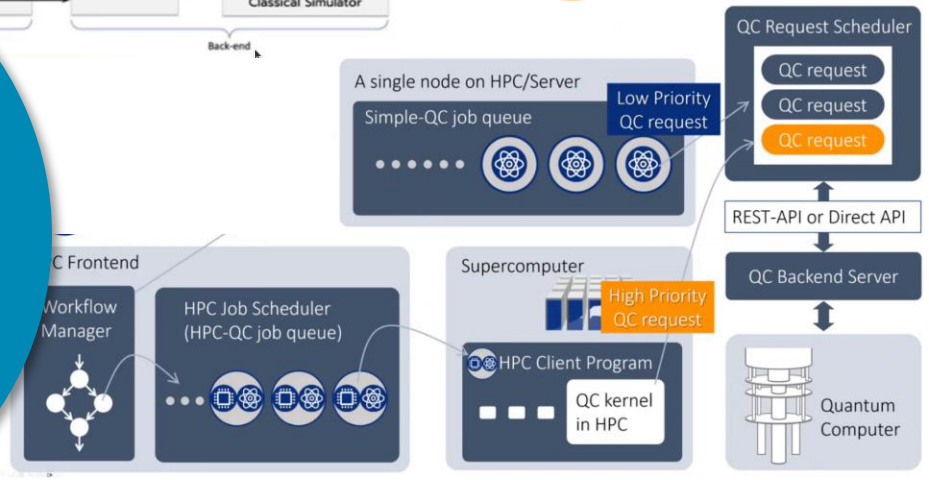


SLURM + QRMI



Open QSE

Open Quantum Software Ecosystem



REX Job Submitter

Develop an open, modular ecosystem to define standard specifications that enable seamless integration between high-performance computing (HPC) and quantum computing through interoperable, vendor-neutral technologies

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Quantum Queue Utility – QTIL

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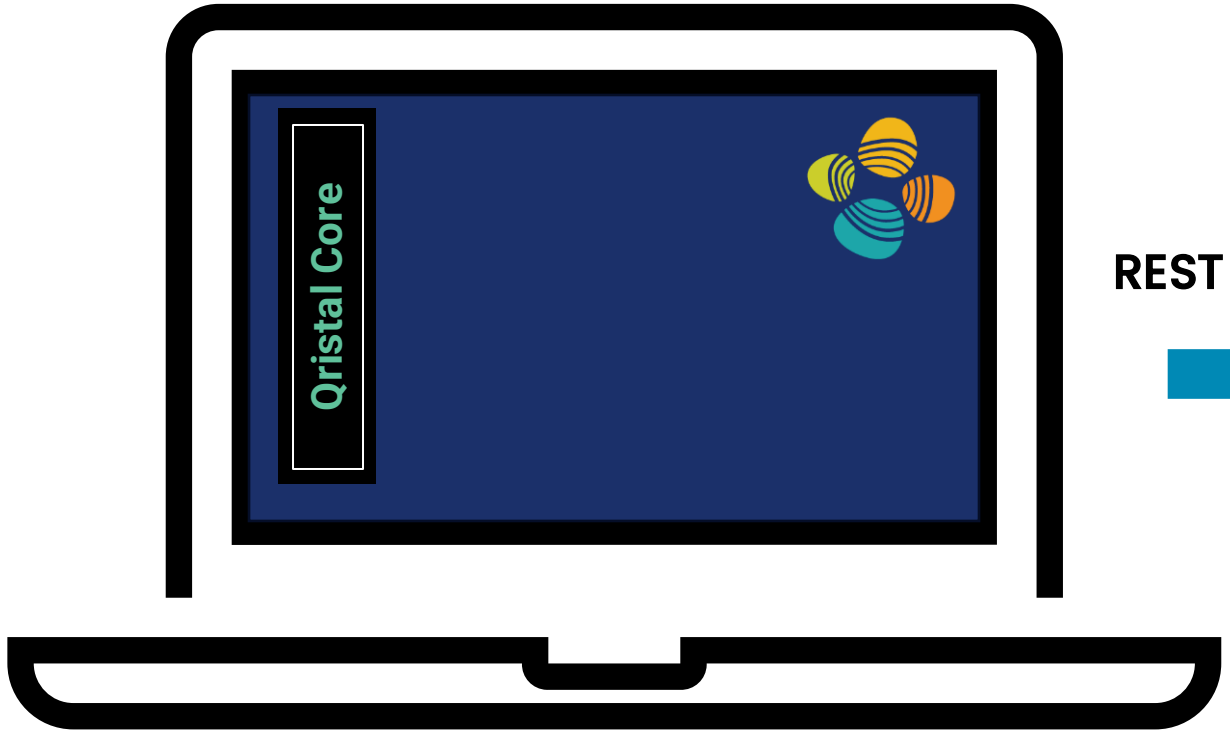
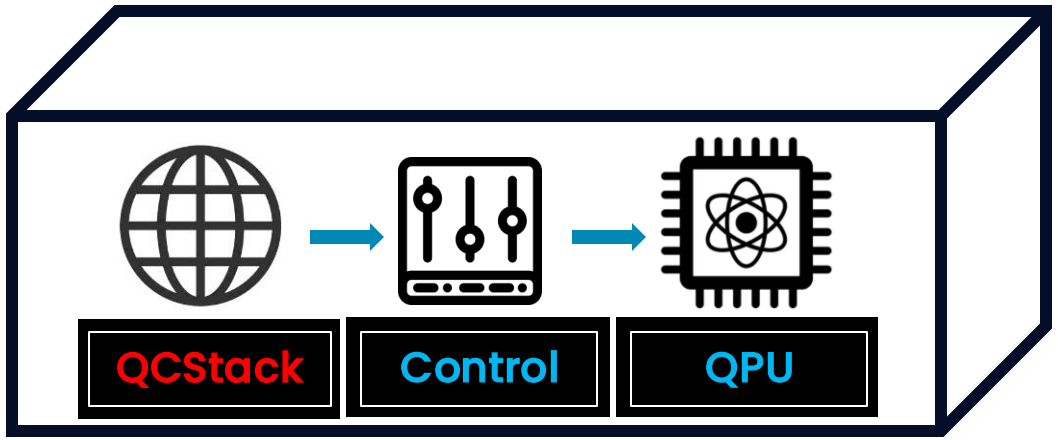
Quantum development Kit



REST API

Quantum Development Kit (QDK)



QCStack talks to the quantum chip via our Control system (RFSoC, sensors, actuators, EM sources, etc...)

- transpilation
- optimization
- calibration
- reservation
- **scheduling**
- web-server
- waveforms

All you need is your **laptop** and the **QDK** in the **same network**

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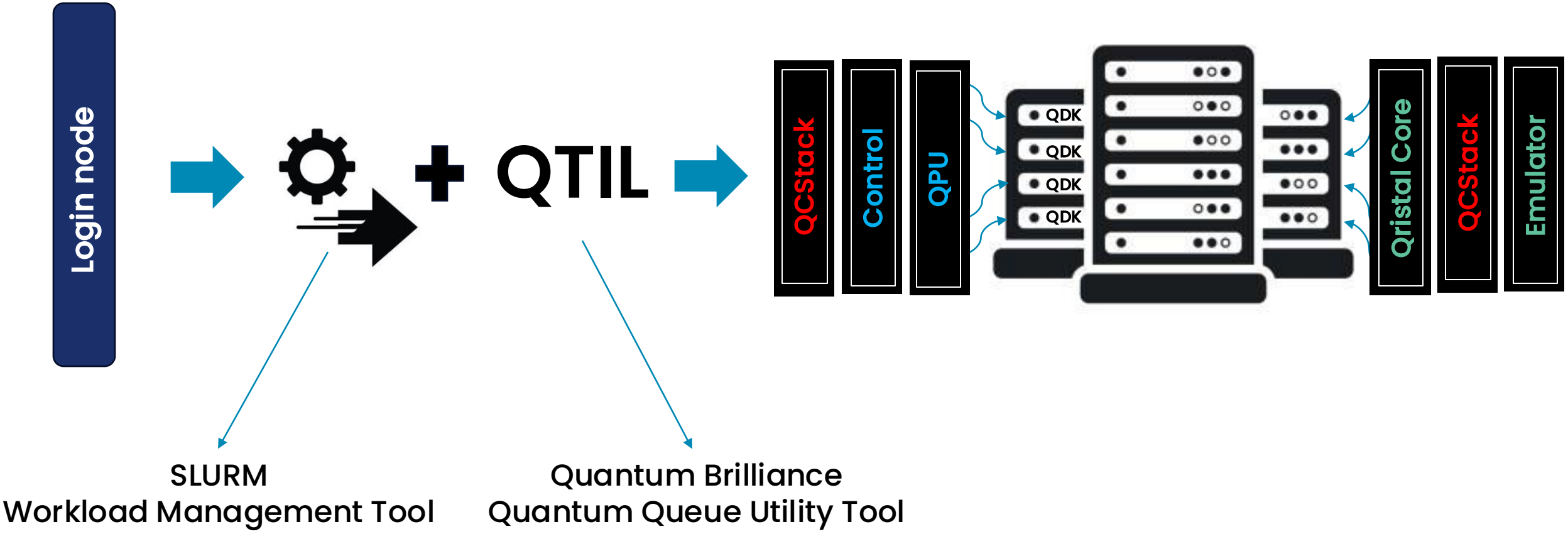
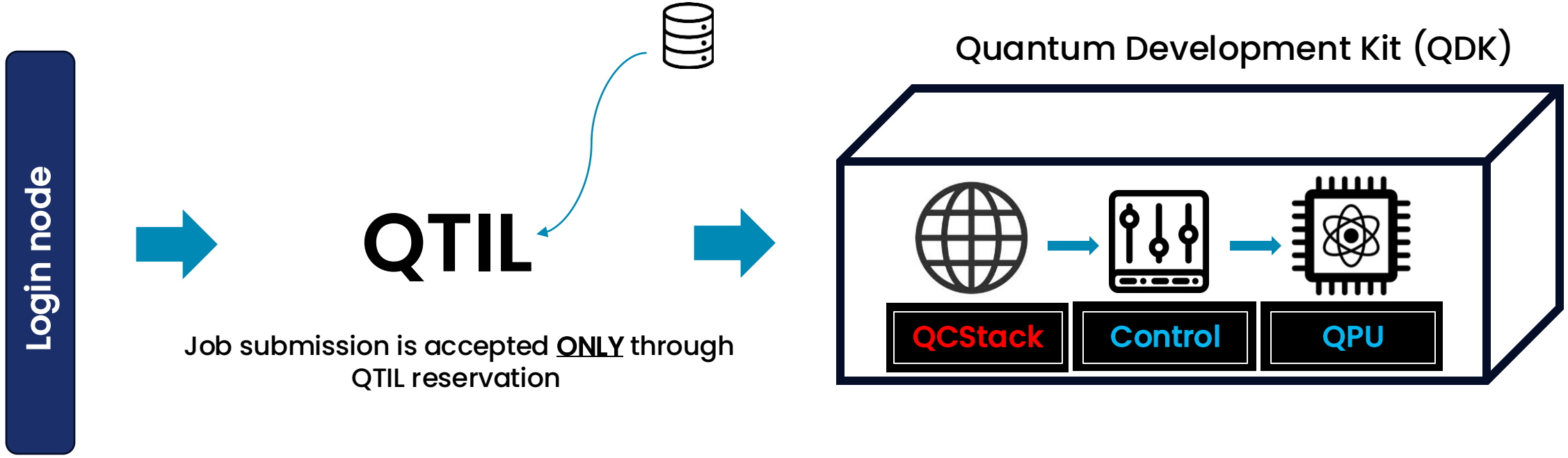
How do you manage quantum resources in a cluster?



QUANTUM BRILLIANCE

How do you manage JUST a quantum resource?

SIMPLIFIED



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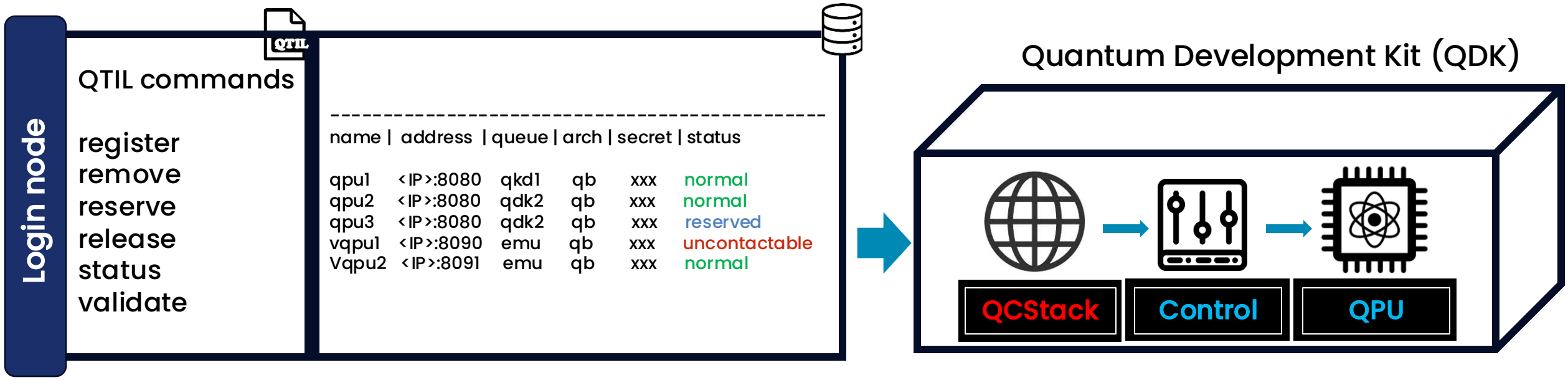
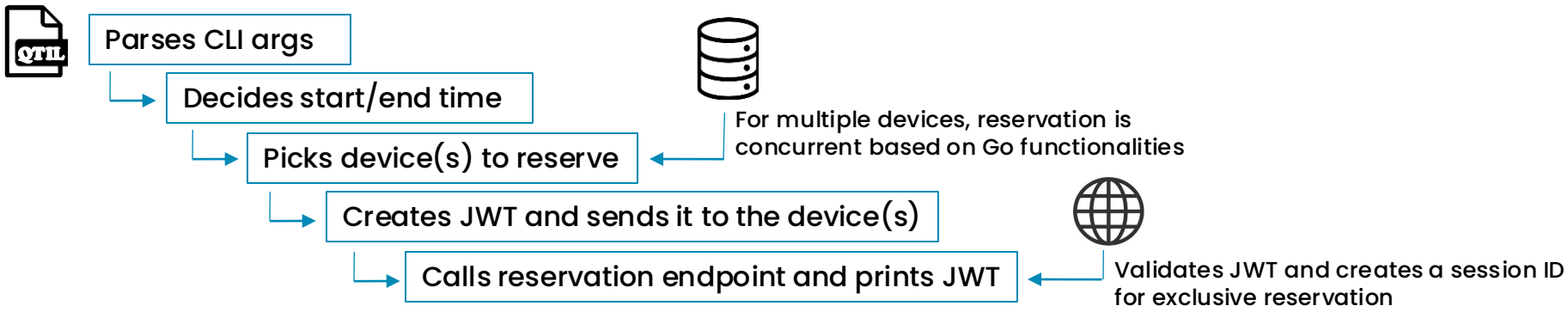
How QTIL works?

1. Register devices in the database with their own API secret keys (admin)



2. Reserve device, e.g., **qtil reserve –q qdk2 –d 60** -> only qpu2 and qpu3, if available, for 60 s



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QTIL with SLURM

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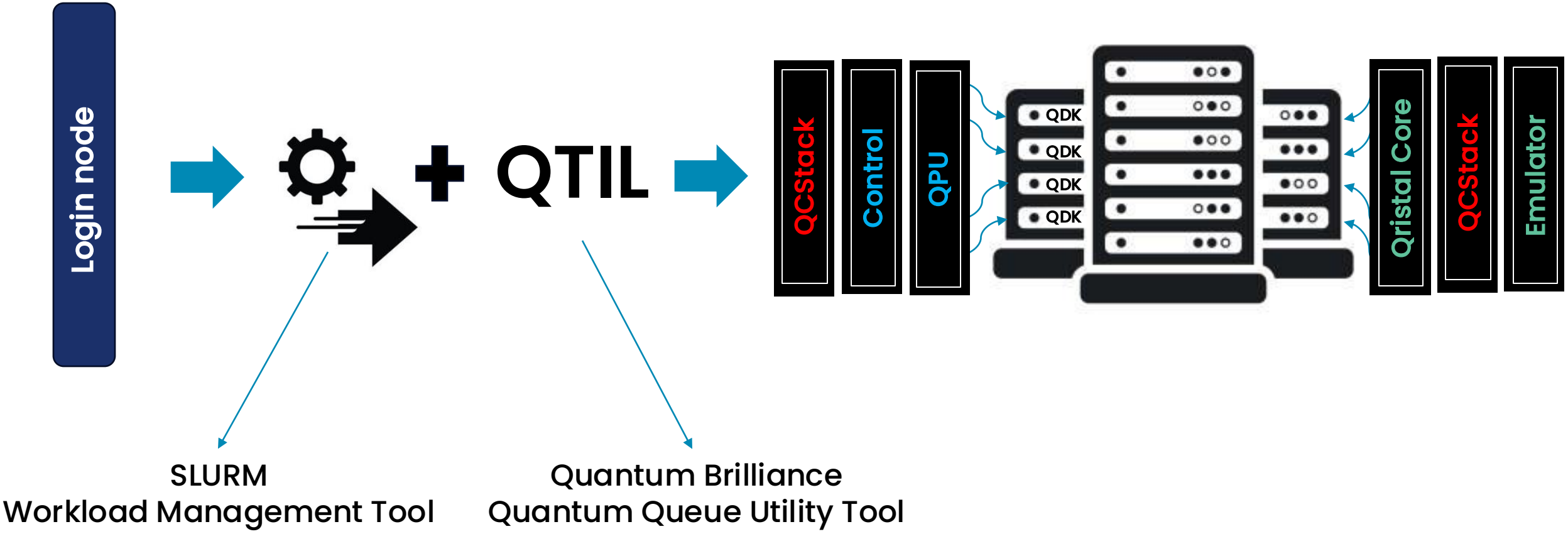
How do you manage quantum resources in a cluster?



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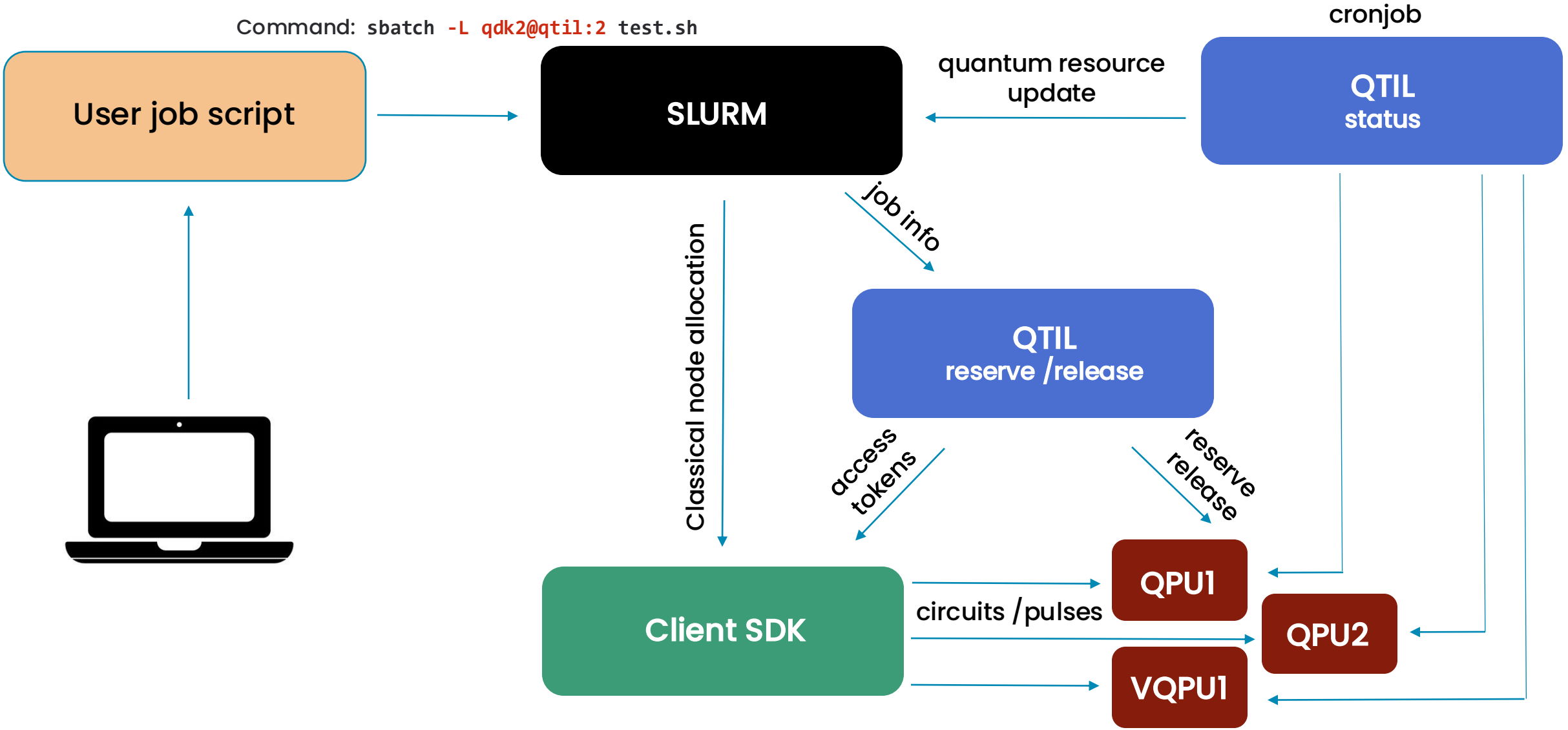
QTIL + SLURM in a nutshell



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Thanks!

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