ISC High Performance
The HPC Event.

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A Critical Look at the State of Quantum Software Stack

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whoami

Mobile phones
RESTful web services
Location based services
AR/VR services
Medical software
RegOps/MLOps
Quantum computing

2001
Nokia

2008
Nokia Research

2015
Nokia Tech

2018
CompliancePal
University of Helsinki

2023
University of Jyväskylä

theoretical
applied

QUANTUM INFORMATION AND COMPUTATION

Information Theory
Algorithms
Software

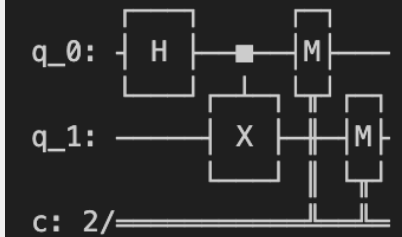
The quantum software Hello World

1 pip install qiskit

2
```python
from qiskit import QuantumCircuit, transpile
from qiskit_aer import Aer, AerSimulator

def demo_function(shotsAmount=1000):
    simulator = AerSimulator(method="statevector", device="GPU")

    circuit = QuantumCircuit(2, 2)
    circuit.h(0)
    circuit.cx(0, 1)
    circuit.measure([0, 1], [0, 1])

    compiled_circuit = transpile(circuit, simulator)
    job = simulator.run(compiled_circuit, shots=shotsAmount)
    result = job.result()
    counts = result.get_counts()

    print("Total count for 00 and 11 are:", counts)
    print(circuit)

result = demo_function(2000)
```

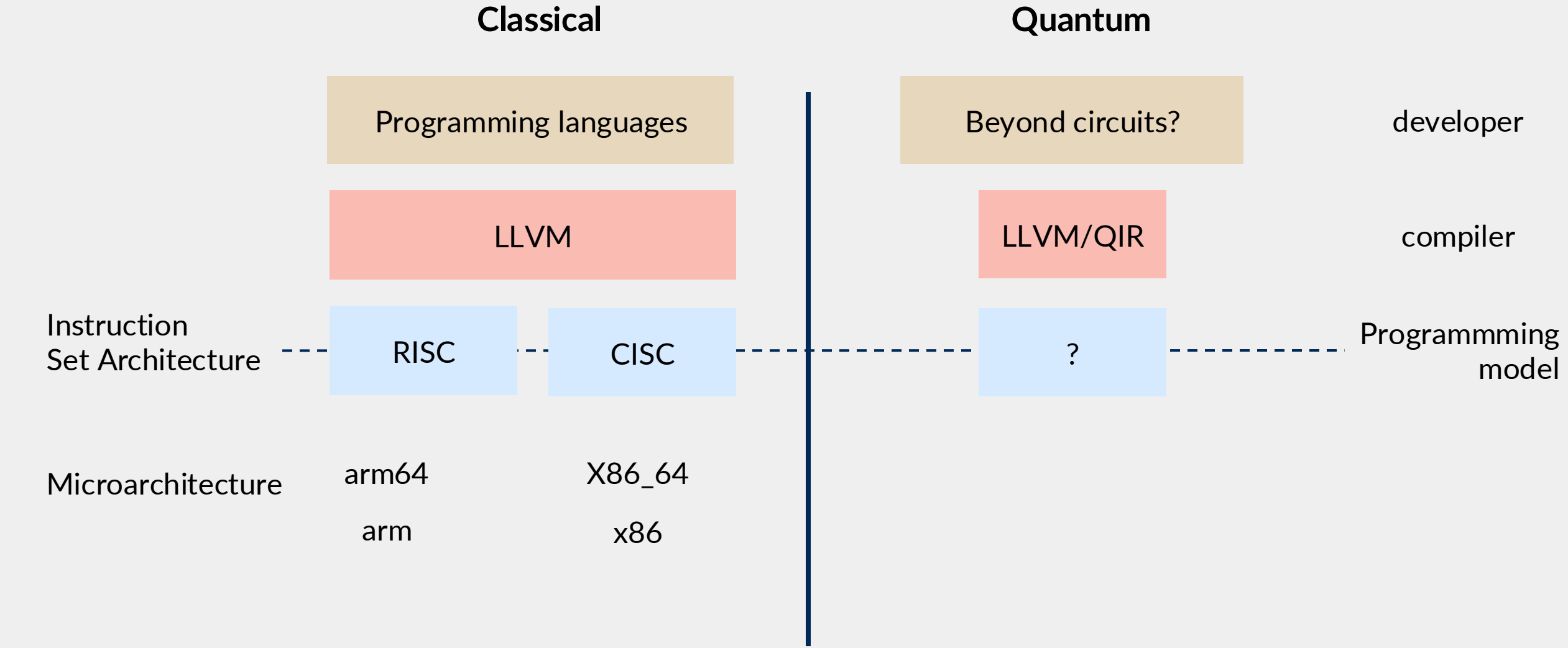
3 python app.py

4
```
Total count for 00 and 11 are: {'11': 1007, '00': 993}
```

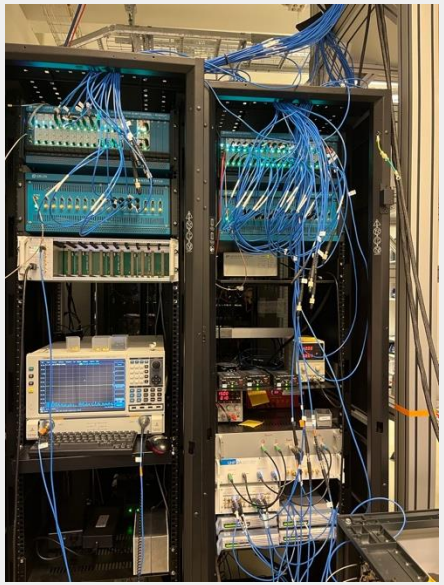


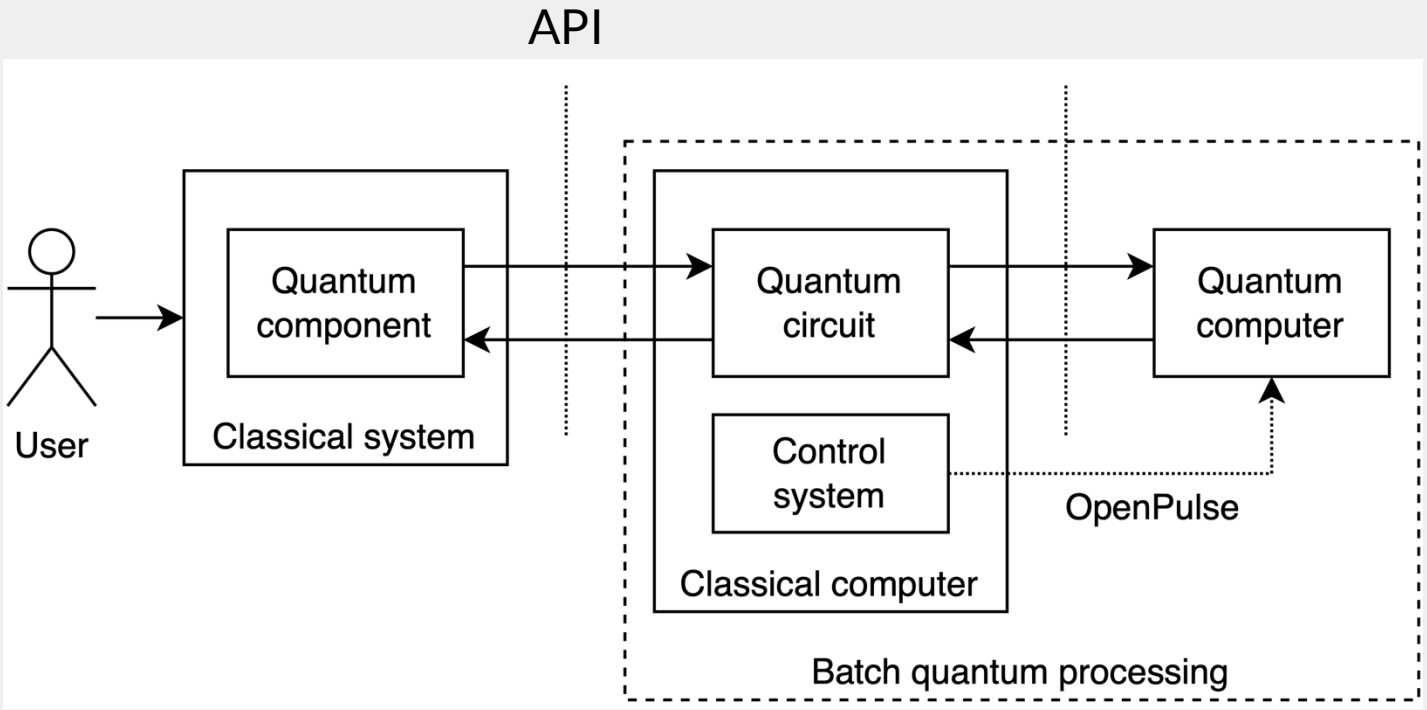
@VladStirbu

Thoughts on quantum programmming model…



Quantum Execution = distributed computing





Targets

- **Simulators**
- CPU for small circuits
- **GPU for large circuits**
- **Noisy qubits**
- **Actual hardware**

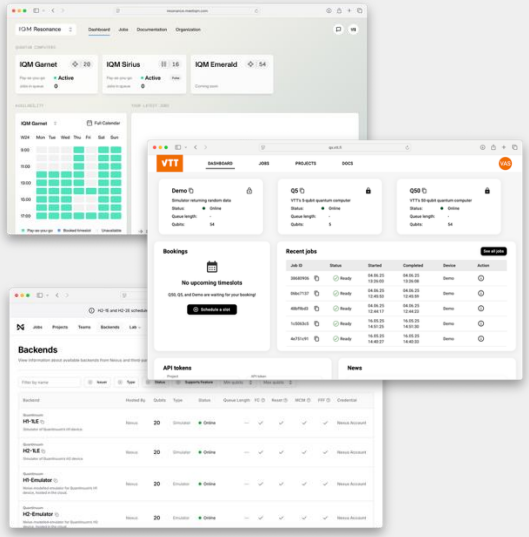
Handling the distributed nature of the system

Common Object Request Broker Architecture

Open MPI

Quantum-classical computing integration paradigms

HTTP API



HPC

Resource intensive

Quantum Computing

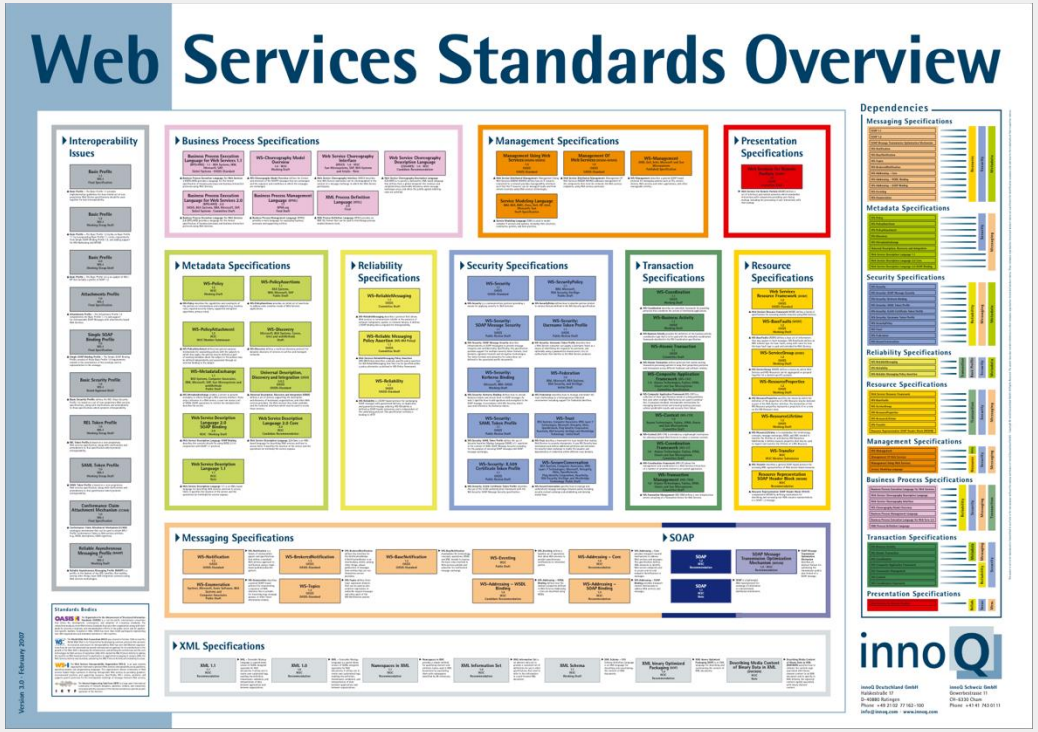
On demand

Cloud-native

EuroHPC Joint Undertaking

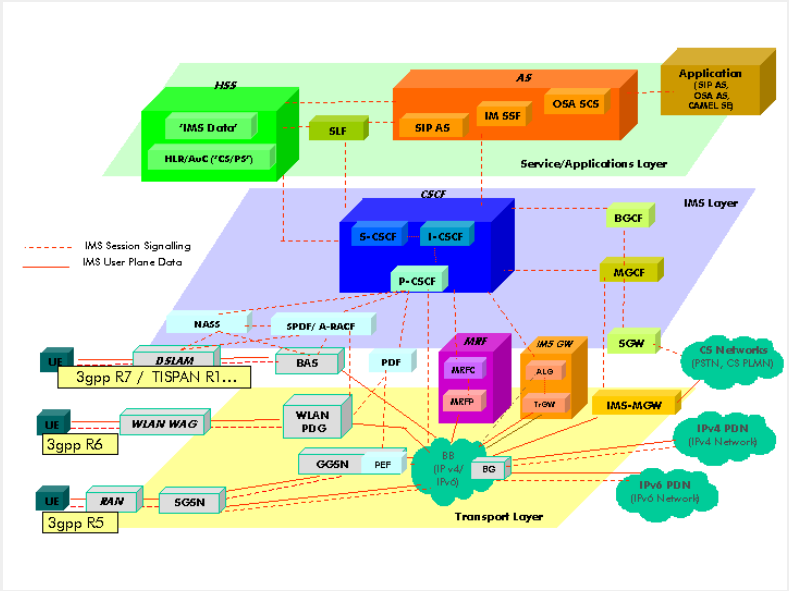
Epic failures from classical computing

SOAP



https://www.innoq.com/resources/ws-standards-poster/

SIP



https://en.wikipedia.org/wiki/IP_Multimedia_Subsystem

And the winner is Web 2.0 and HTTP

Not always seamless integration

QMIO: A tightly integrated hybrid HPCQC system

Javier Cacheiro[1 [0000−0001−5864−283X]], Álvaro C Sánchez[2 [0000−0003−2354−4572]], Russell Rundle[3 [0000−0001−8292−1329]], George B Long[3 [0000−0002−1787−9539]], Gavin Dold[3 [0000−0002−6155−3800]], Jamie Friel[3 [0000−0002−1328−9961]], and Andrés Gómez[1 [0000−0001−7272−8488]]

[1] Galicia Supercomputing Center (CESGA), Santiago de Compostela, Spain
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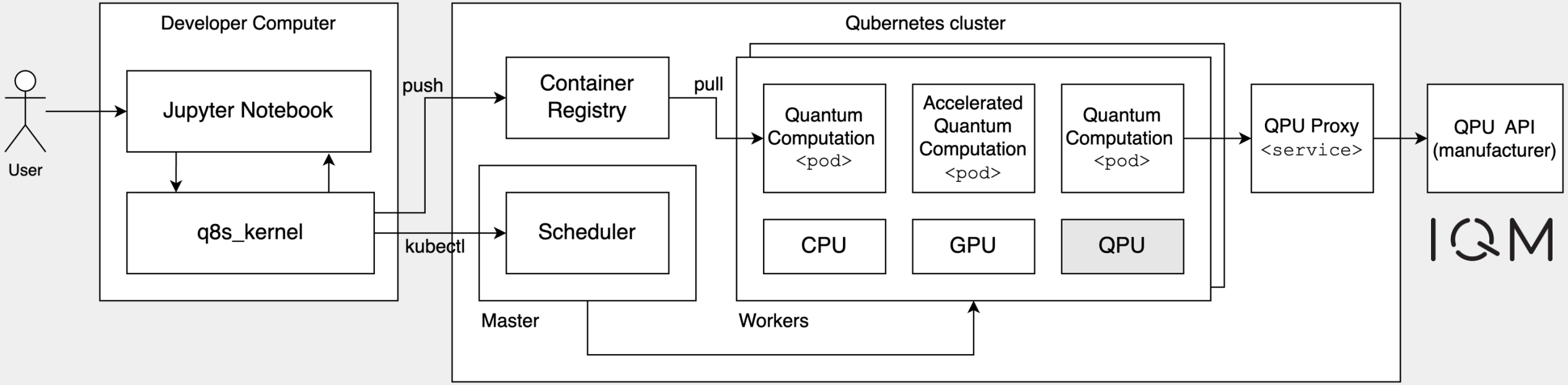
https://arxiv.org/abs/2505.19267

The main issue with this approach was that, each time the Qiskit or PyTket backend internally submitted a quantum circuit job to SLURM, it incurred a significant overhead—between 1 and 3 seconds—because the SLURM resource manager is not intended to run jobs of less than a second of duration. This prompted us to explore alternative approaches.

Qubernetes jobs on quantum hardware

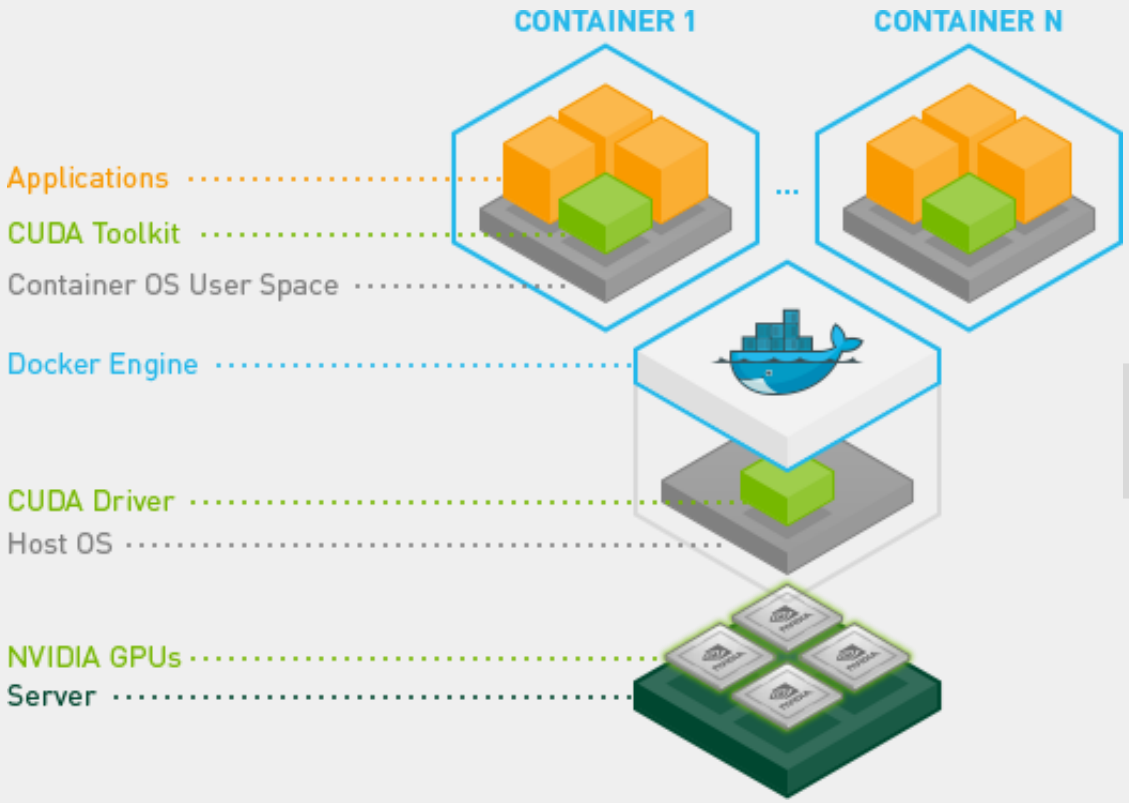


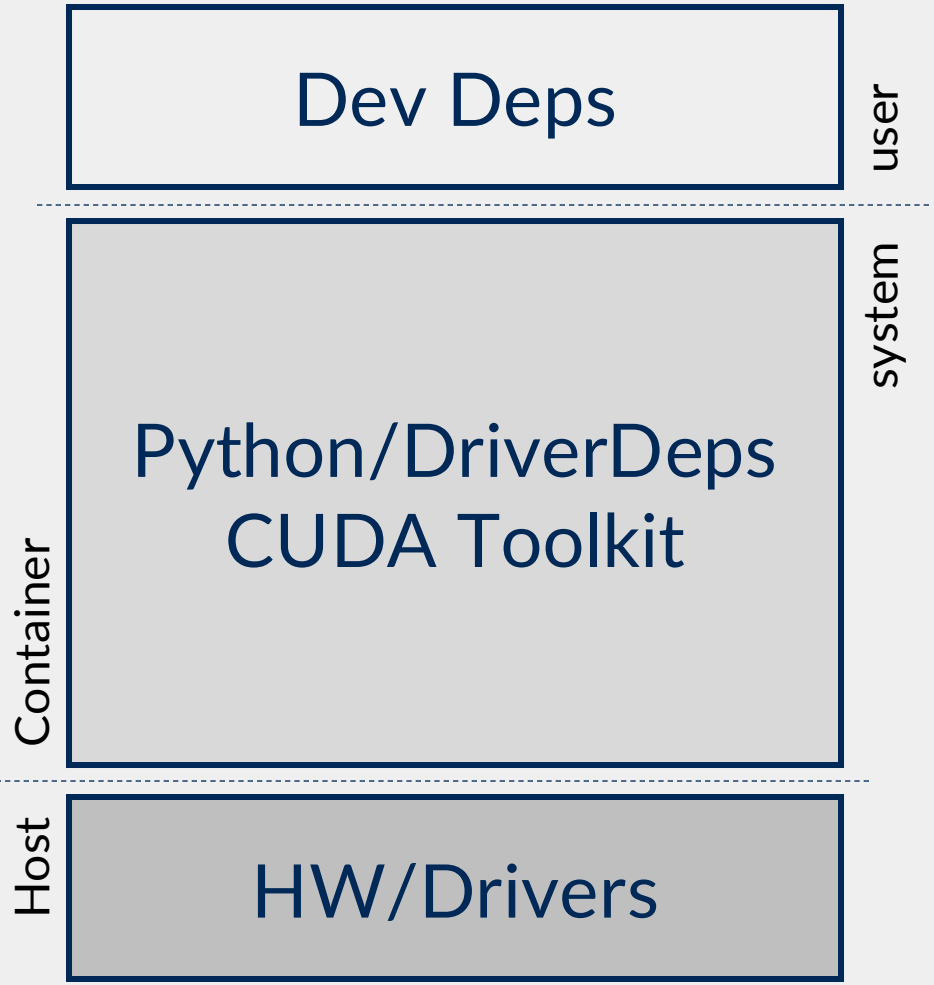
Stirbu, et al. Qubernetes: Towards a unified cloud-native execution platform for hybrid classic-quantum computing. Information and Software Technology (2024)

```
pip install q8s
```

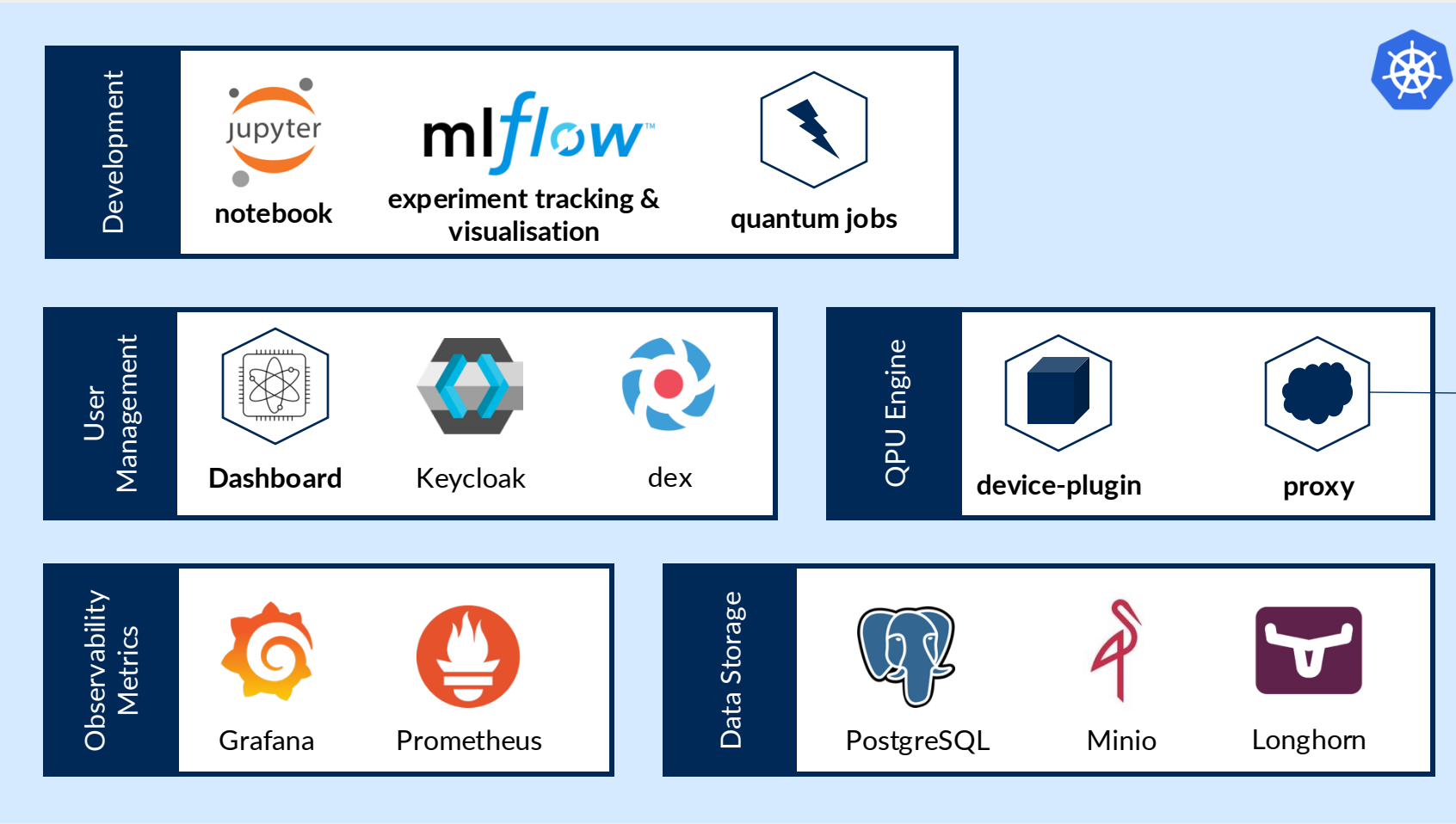
- q8sctl jupyter
- q8sctl execute --target **gpu** app.py

Simplify simulations on CUDA with Qubernetes





The Qubernetes stack



Conclusions

- Expertise to enter the space is very high
- Runing code wins
- Abstractions are important

Thanks

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https://www.qubernetes.dev

https://github.com/qubernetes-dev/q8s-kernel

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