

Room-temperature quantum accelerators for database science

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Room Temperature Diamond Quantum Computing



Stuttgart



Freiburg



Sydney



Canberra



Melbourne



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A full-stack Quantum Computing effort

**Quantum
Applications**

 **OAK RIDGE**
National Laboratory

Compilers & Libraries

**Hardware Mgmt.
& Drivers**

 **OAK RIDGE**
National Laboratory

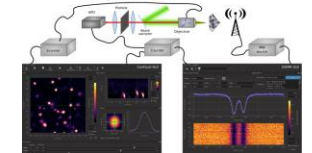
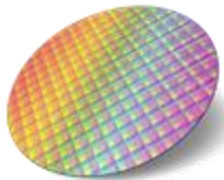
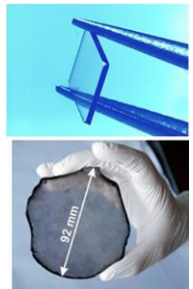
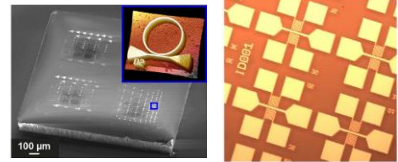
Integration Framework

Embedded Firmware

Quantum Motherboard

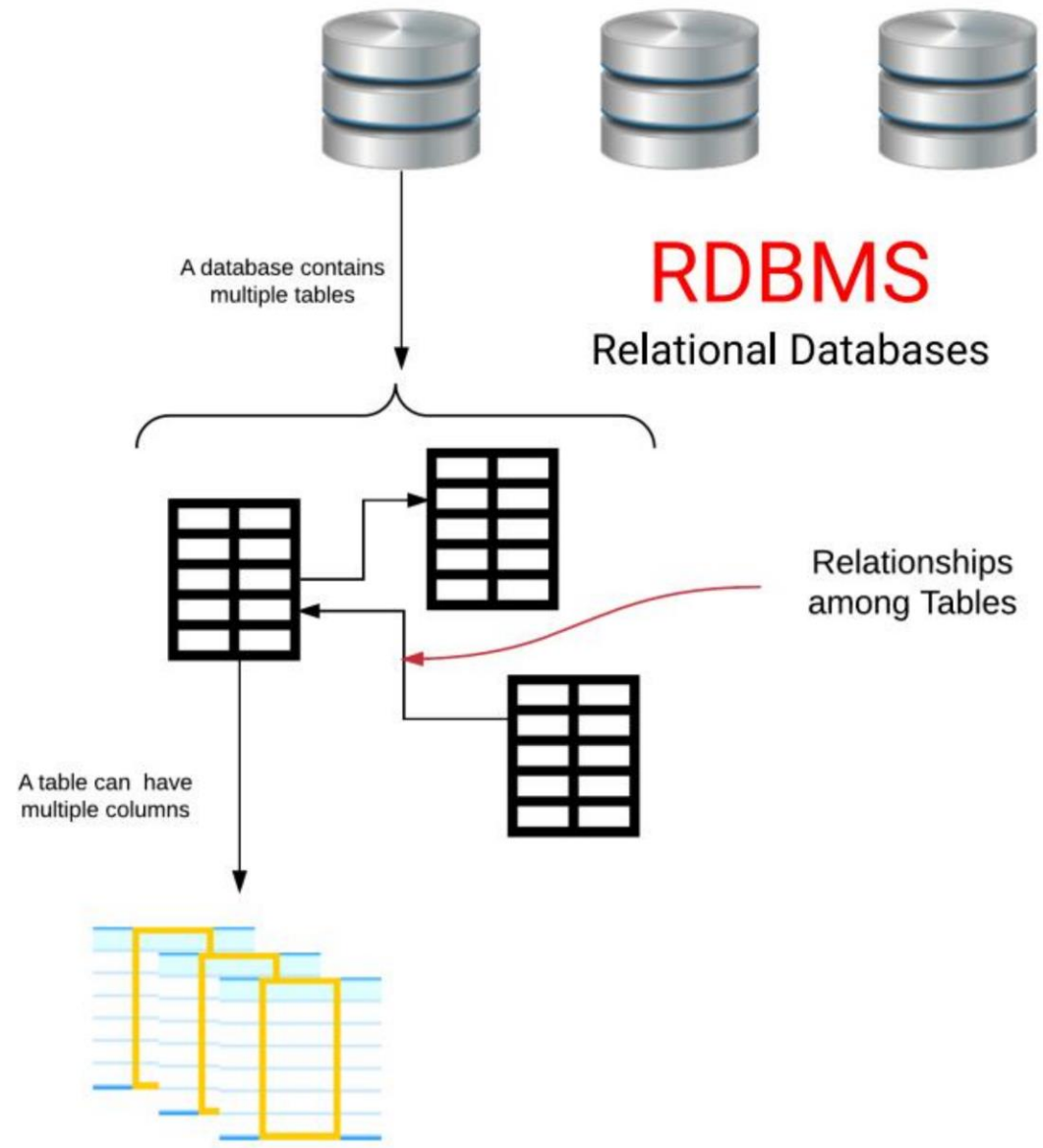
Diamond Materials

**Diamond Interfacing:
Nano Electronic & Optical**



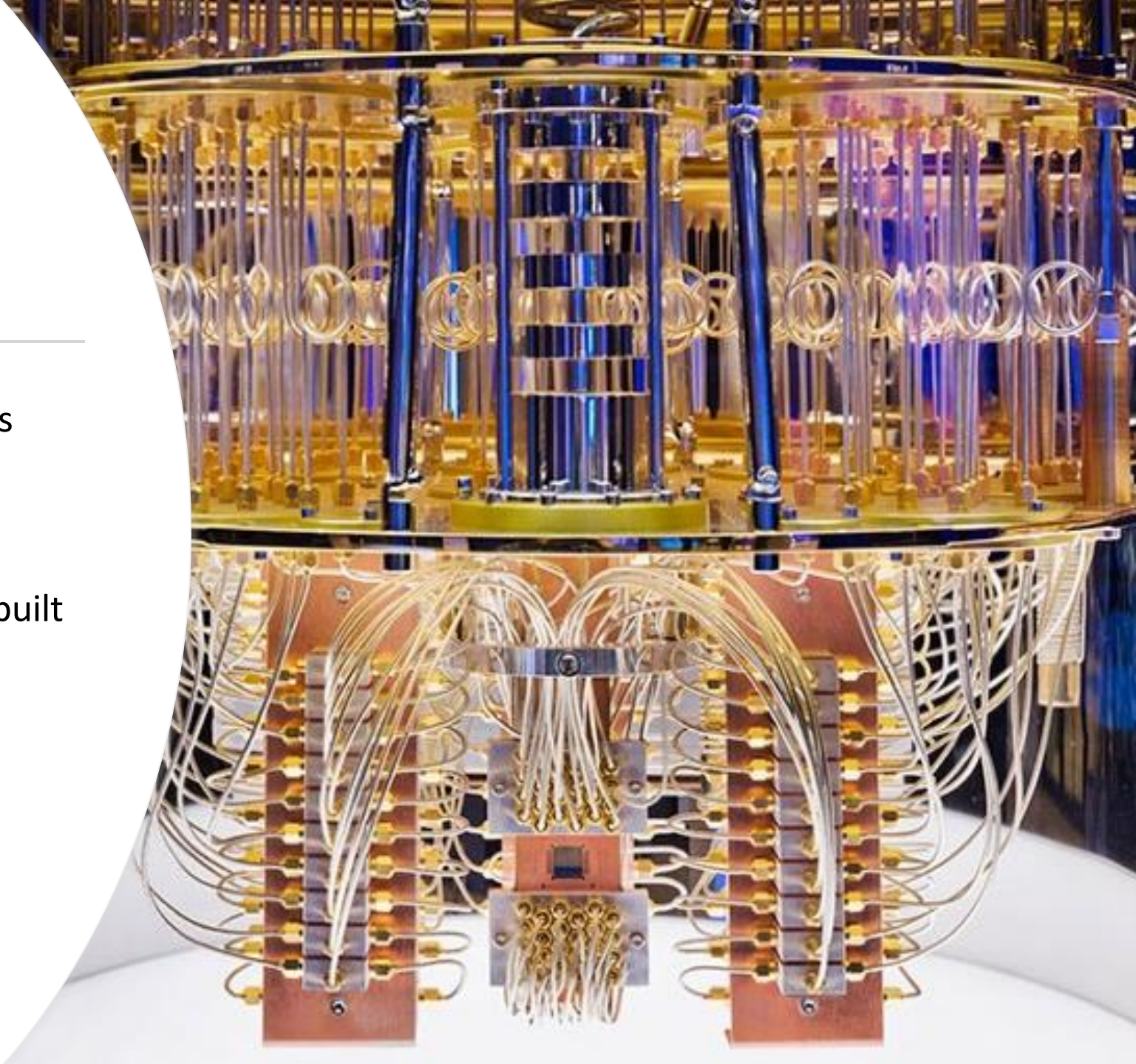
Physicist:

- Fast & reliable DB access has been solved.
- Cloud access is simple.
- Only need Grover's algorithm to reap quantum benefits.



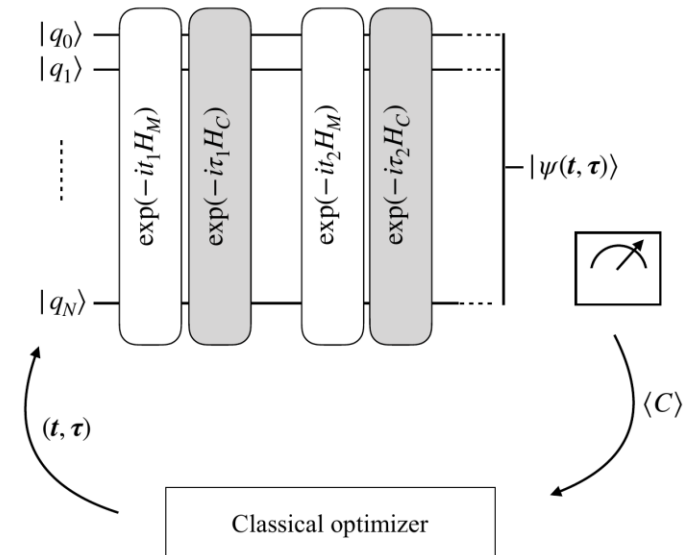
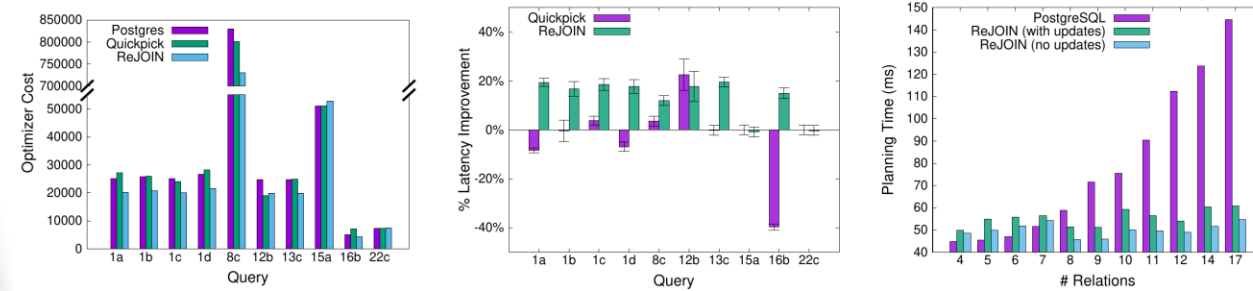
Physicist:

- QC can do everything classical computers can, so QC will replace CC.
- QC hardware is isolated in special infrastructure that can only be purpose-built at supercomputing centers
- QC will only solve quantum mechanical problems



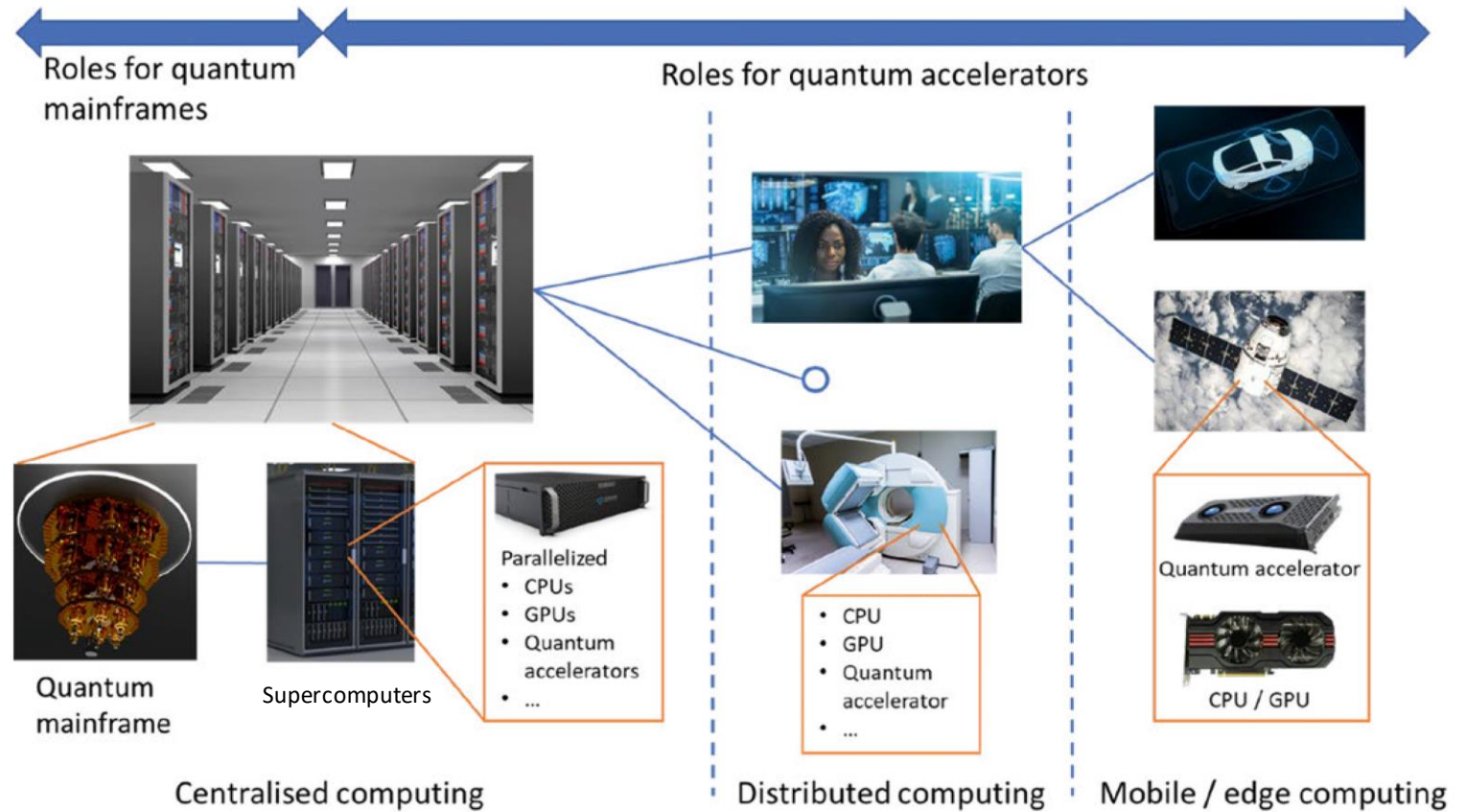
Realities

- SQL is everywhere.
Fast(er) & (more) reliable access remains a challenge
- Quantum Computing will always be hybrid quantum-classical computing.



Realities

- QC hardware can be part of simple general-purpose datacenters.
- We need to be creative to make QC useful.



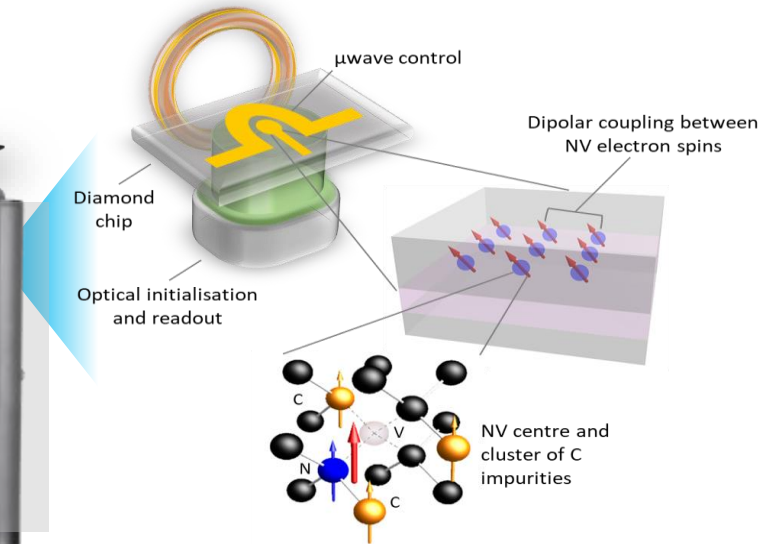
Integrated quantum accelerator hardware

- Put the QC where the data is, not the data where the QC is!
- Ambient-conditions QC possible with NV centers in diamond: "Molecule frozen in & protected by carbon grid."
- Expect 50-100 qubits in the next ~5 years, and 10-100s of QPUs in parallel

Rethink algorithms to exploit non-mainframe QC!



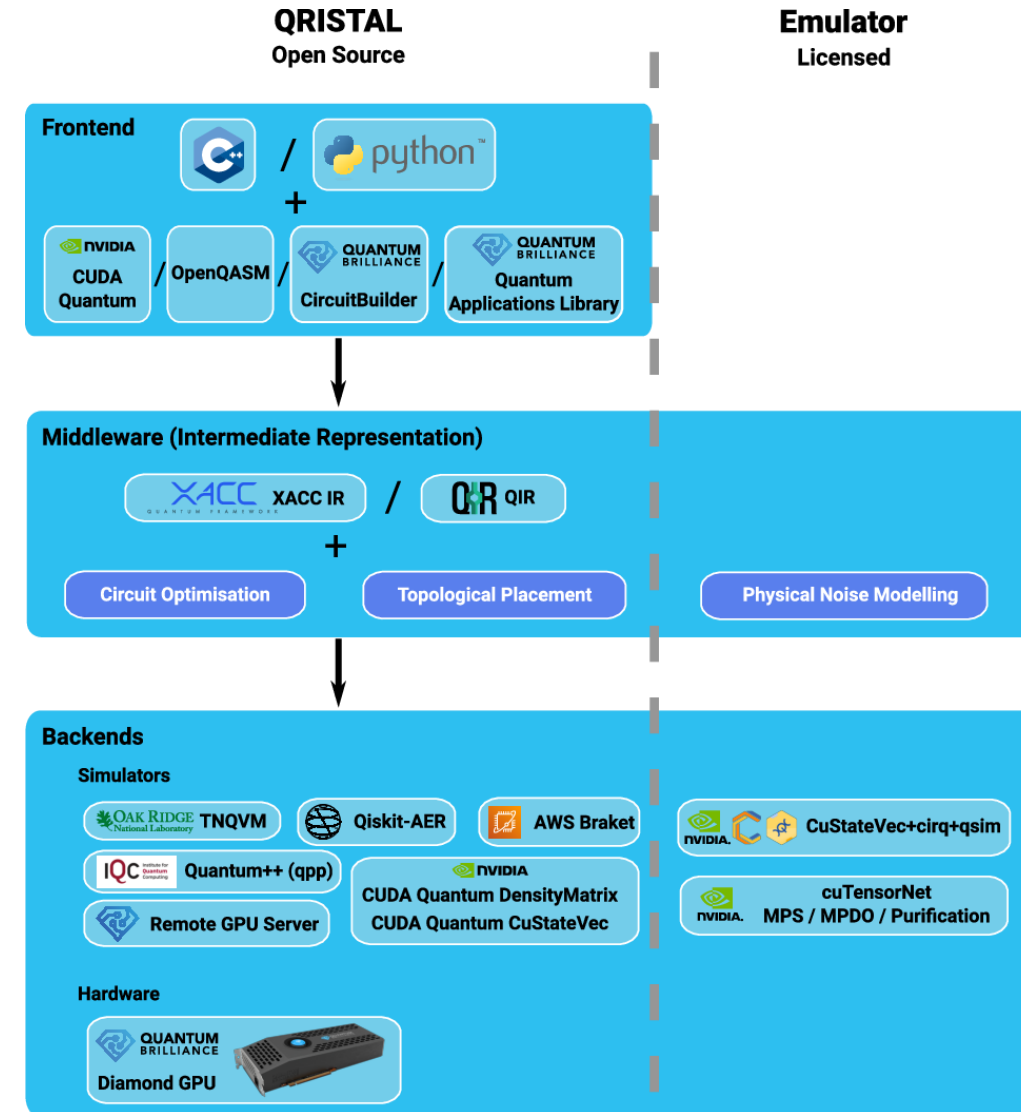
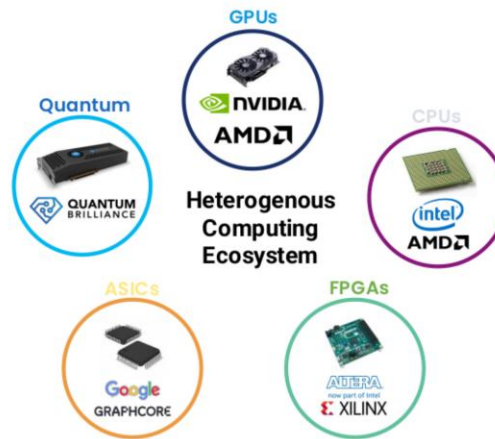
[Pawsey Installs First Room-Temperature On-Premises Quantum Computer in a Supercomputing Centre](#)



Integrated quantum accelerator software

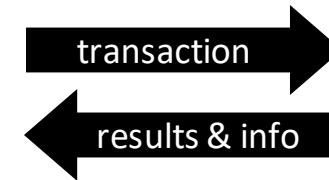
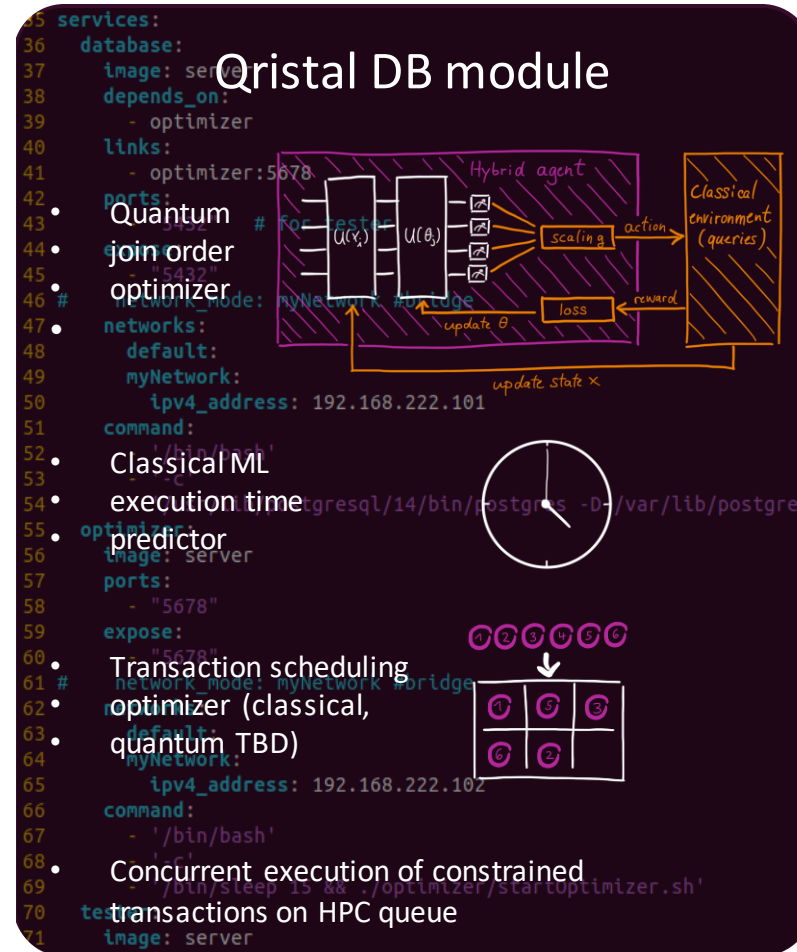
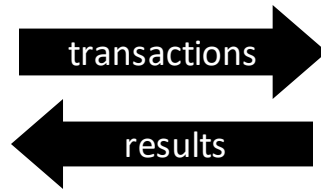
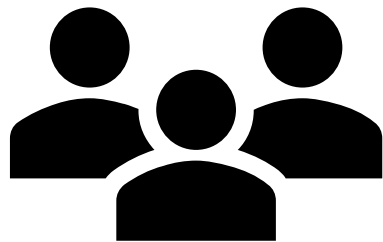
- Integrate seamlessly into existing HPC frameworks and languages
- Offload onto multi-CPU/GPU/QPU system w/o added complexity to user
- Interoperability with other quantum prototyping SDKs

Quantum algorithms are only useful if the full software stack is efficient.



Quantum Algorithms for DBMS: The QC4DB project

In collaboration with
Universität zu Lübeck



Final thoughts

Noise - learn to love it.

Hardware and software need to go hand in hand.

(or prepare yourself for a long wait)



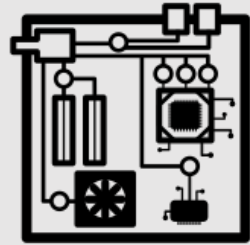
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Looking forward to an interesting workshop!

Dr. Stefan Prestel

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What is inside our Quantum Computer?



Control Systems



Quantum Chip

Quantum Motherboard

Control compute

Processor

FPGA

DAC

Digital I/O

Connection to off-board

Lasers

Photon detectors

MW chain

RF chain

Power supply unit

Peripherals

Quantum Chip

- Diamond material
- Diamond nano electronic and optical interfaces
- Photonics chip
- Electronics chip
- Packaging