

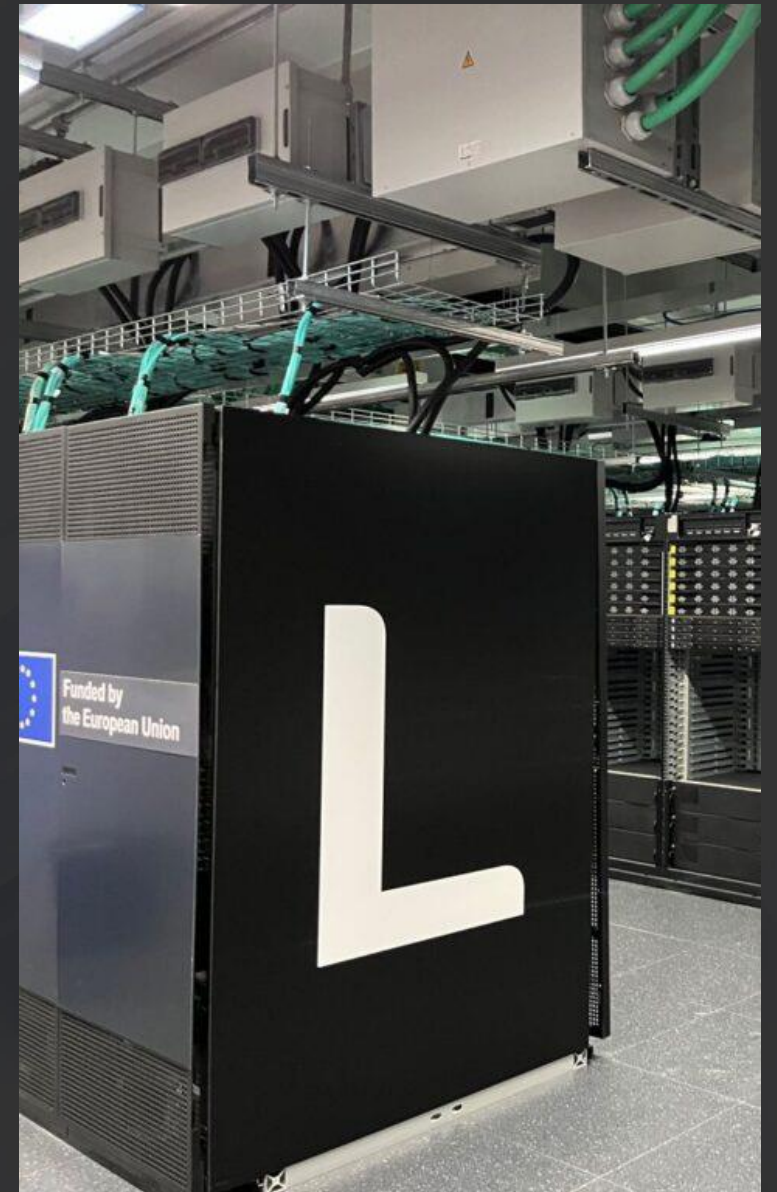
Integrating a QC in a HPC environment

Quantum Computing and HPC in Italy and Europe

Daniele Ottaviani

CINECA HPC

- CINECA is a Consortium composed by 98 universities and public institutions
- Since its origins in 1969, Cineca offers **support to scientific research, public and industrial**, through supercomputing and the use of the most innovative computing systems based on state-of-the-art architectures and technologies.
- **HPC Italian National Center**, owner of the **4th most powerful supercomputer in the world** (Leonardo, 240 Petaflops peak performance)



Cineca Quantum Computing Lab

Teaching, Outreaching
and Dissemination



European and National
projects



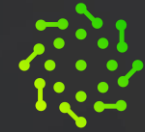
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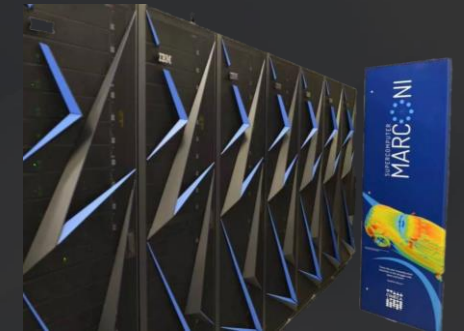
Quantum Computing
Resources

Cloud QC



PASQAL

HPC QC
Emulation



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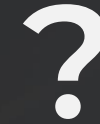
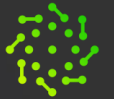


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Quantum Computing
Resources

Cloud QC

D:WAVE
The Quantum Computing Company™



PASQAL

Hybrid HPC-QC System









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EuroHPC
Joint Undertaking

The EuroHPC JU has selected six sites across the European Union to host and operate the first EuroHPC quantum computers in:







-  Czechia
-  France
-  Germany
-  Italy
-  Poland
-  Spain





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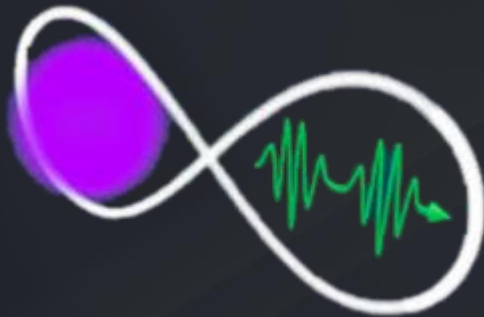
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EuroQCS

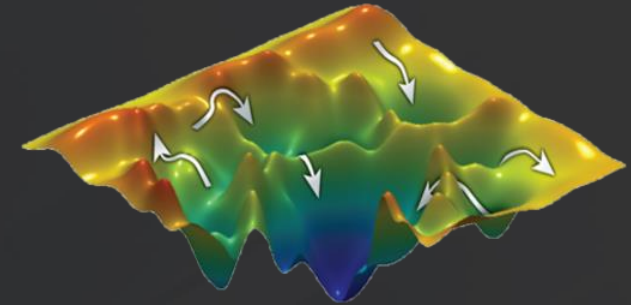


EuroQCS
Italy

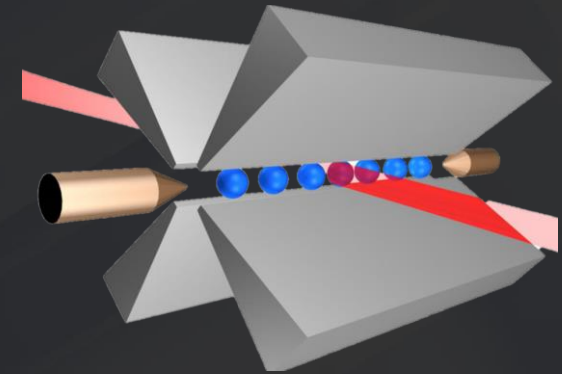


EuroQCS
France

EuroQCS



EuroQCS
Spain

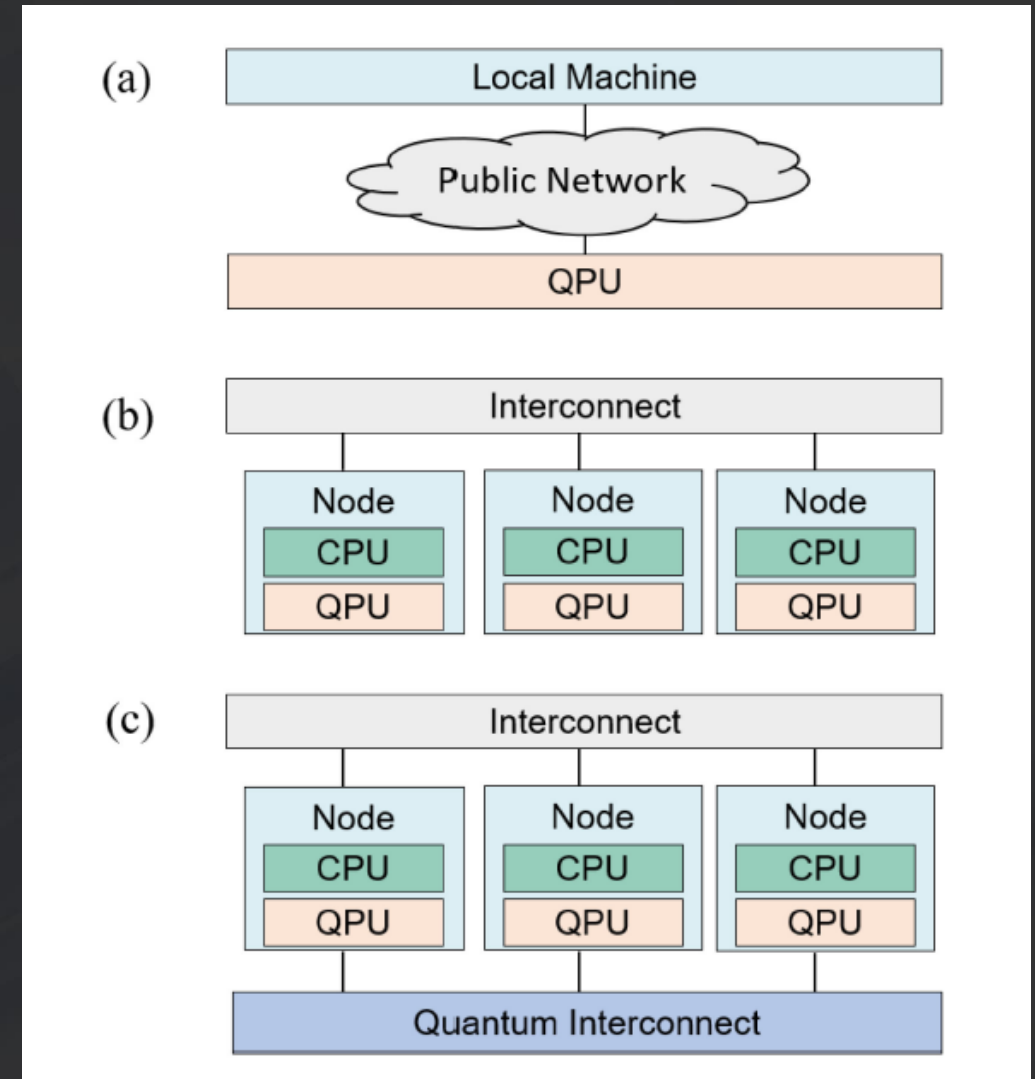
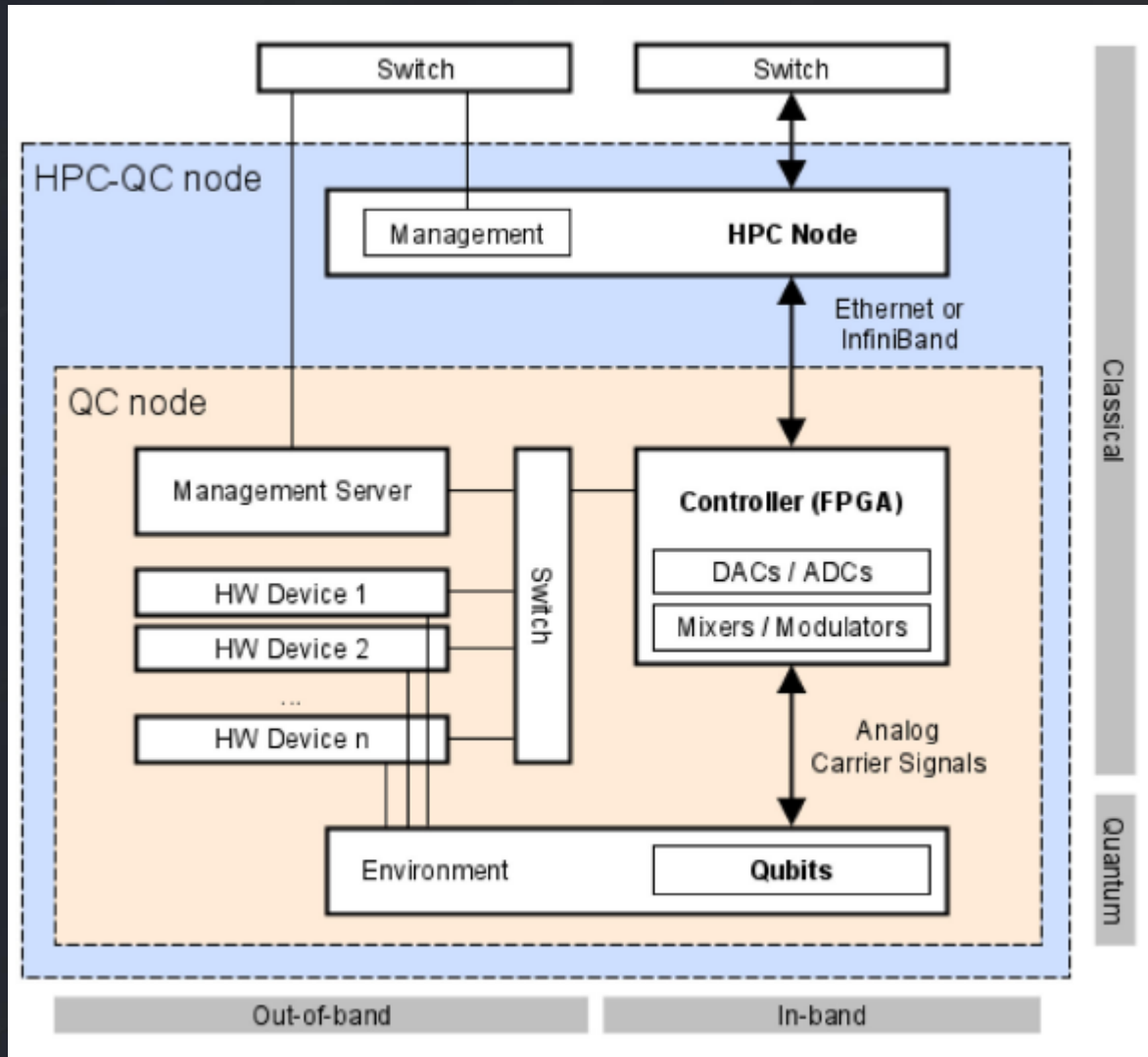


EuroQCS
Poland

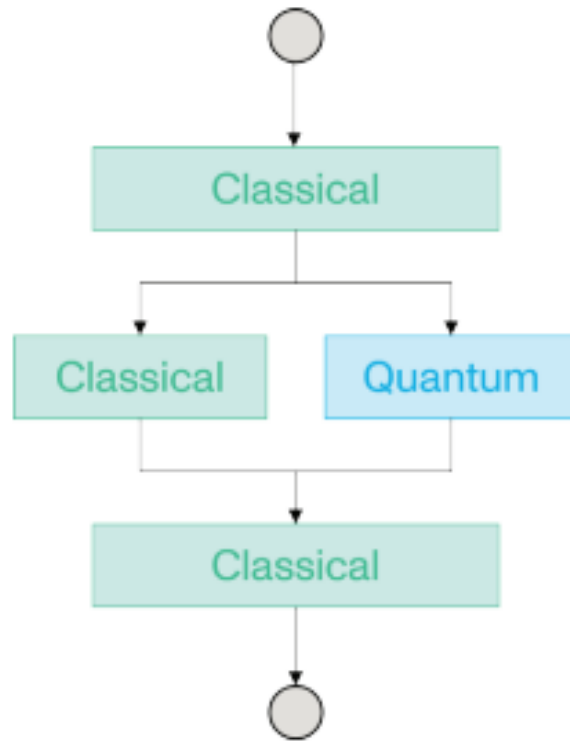
Integration of a QC into a HPC environment



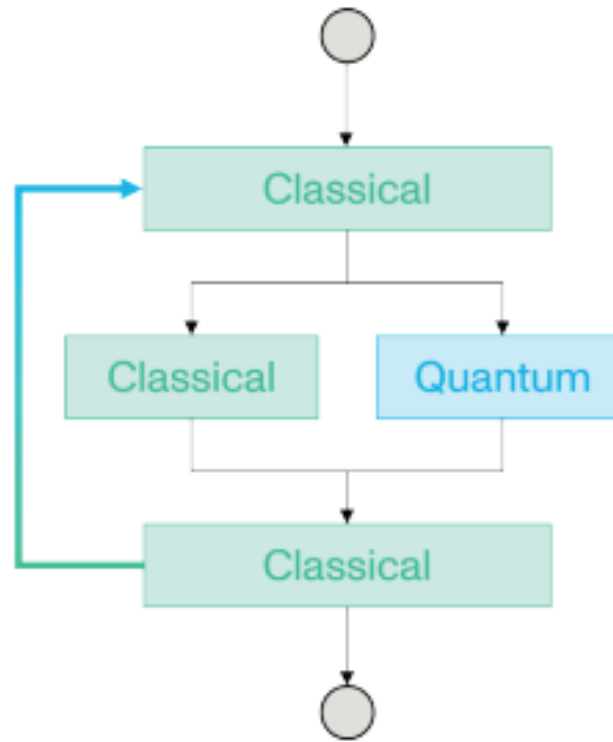
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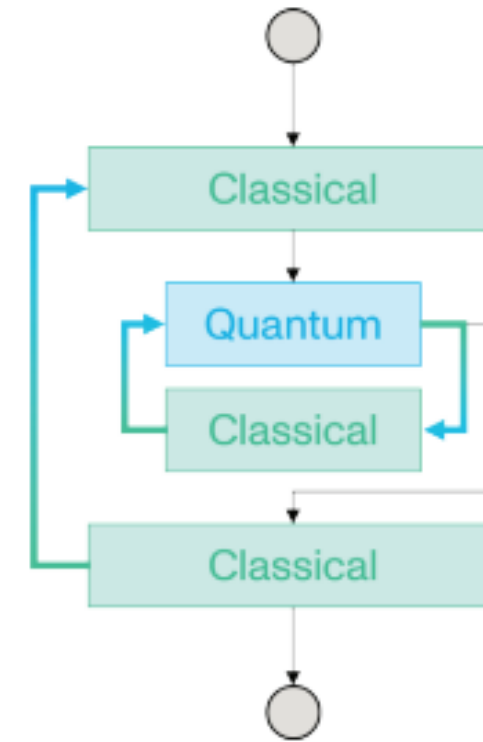
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(a) usage of quantum in workflow

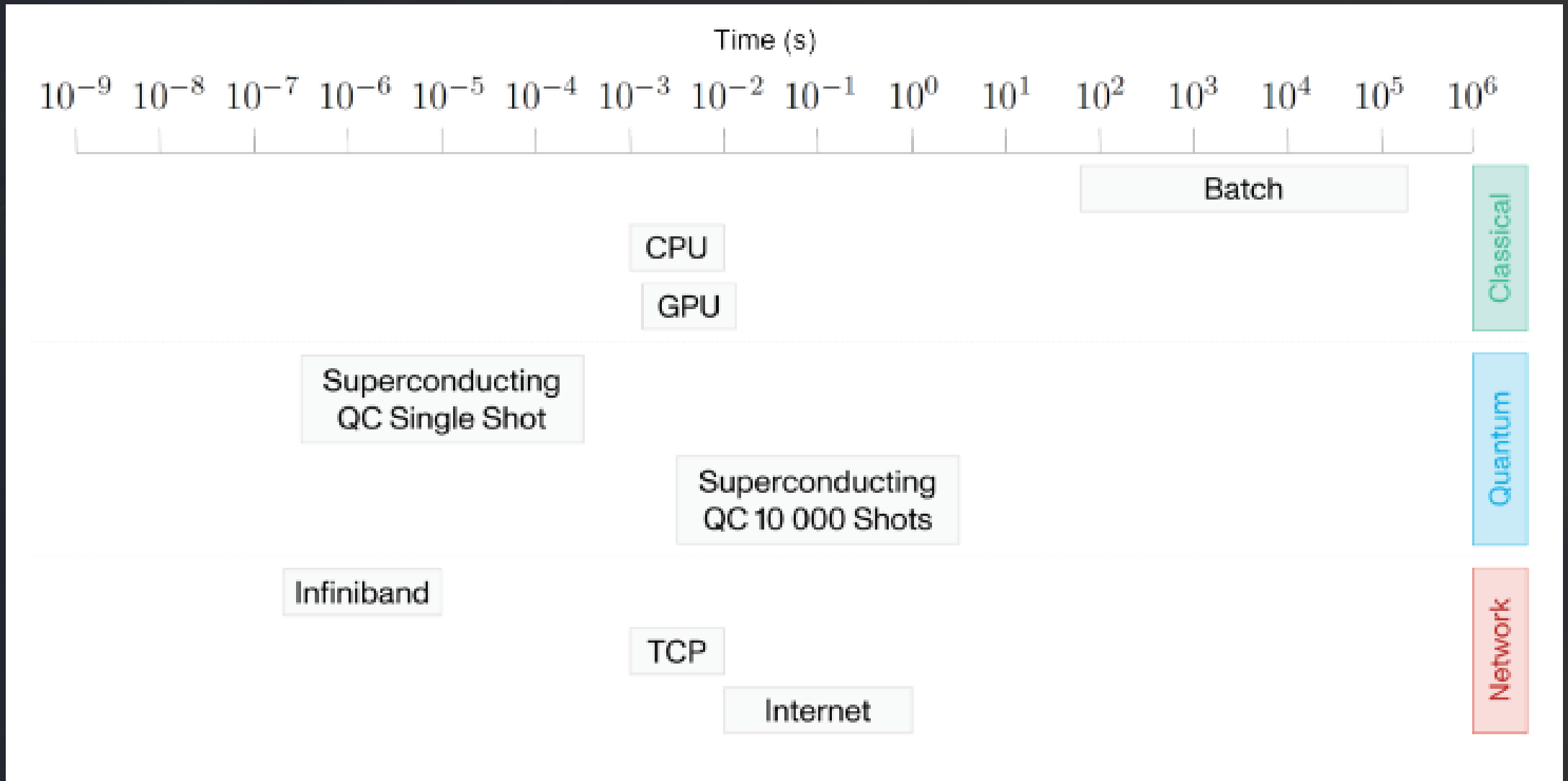


(b) iterative workflow

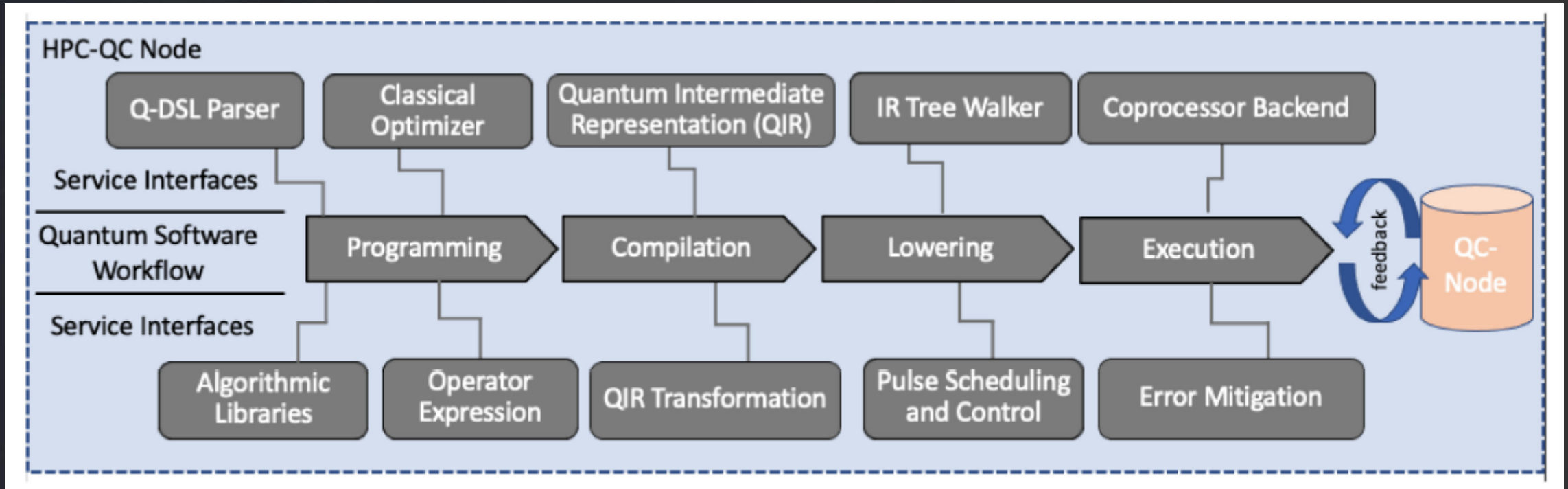


(c) onloading workflow

Integration of a QC into a HPC environment



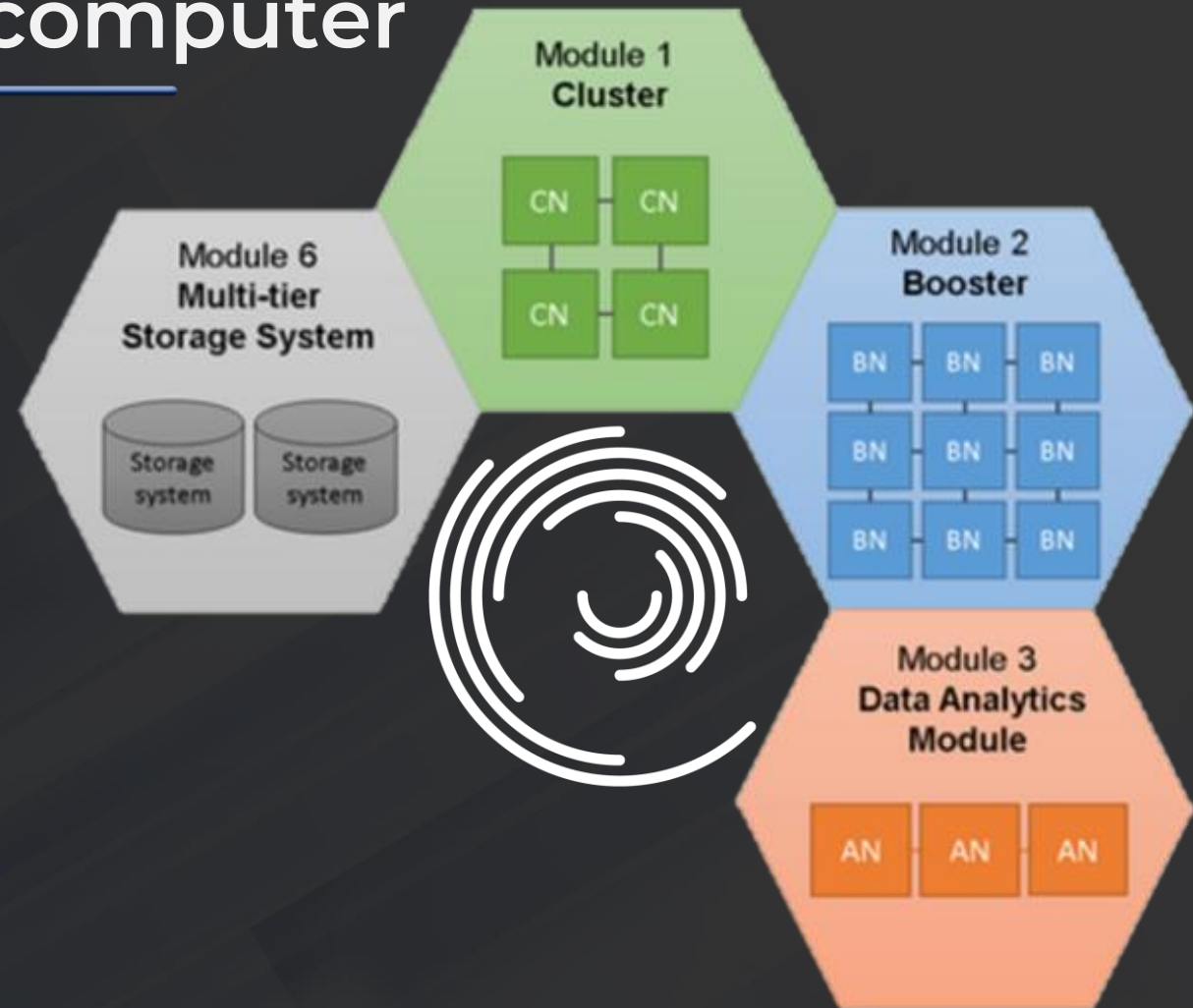
Integration of a QC into a HPC environment



Decomposition of the software architecture required for quantum-HPC integration into a series of workflow steps, each exposing a unique set of service interfaces. This architecture maximizes the flexibility, modularity, and extensibility of the suggested integration strategy. Here we show the workflow decomposed into programming, compilation, IR lowering, and execution components. Each component exposes a series of service interfaces intended for the implementation of concrete use cases.

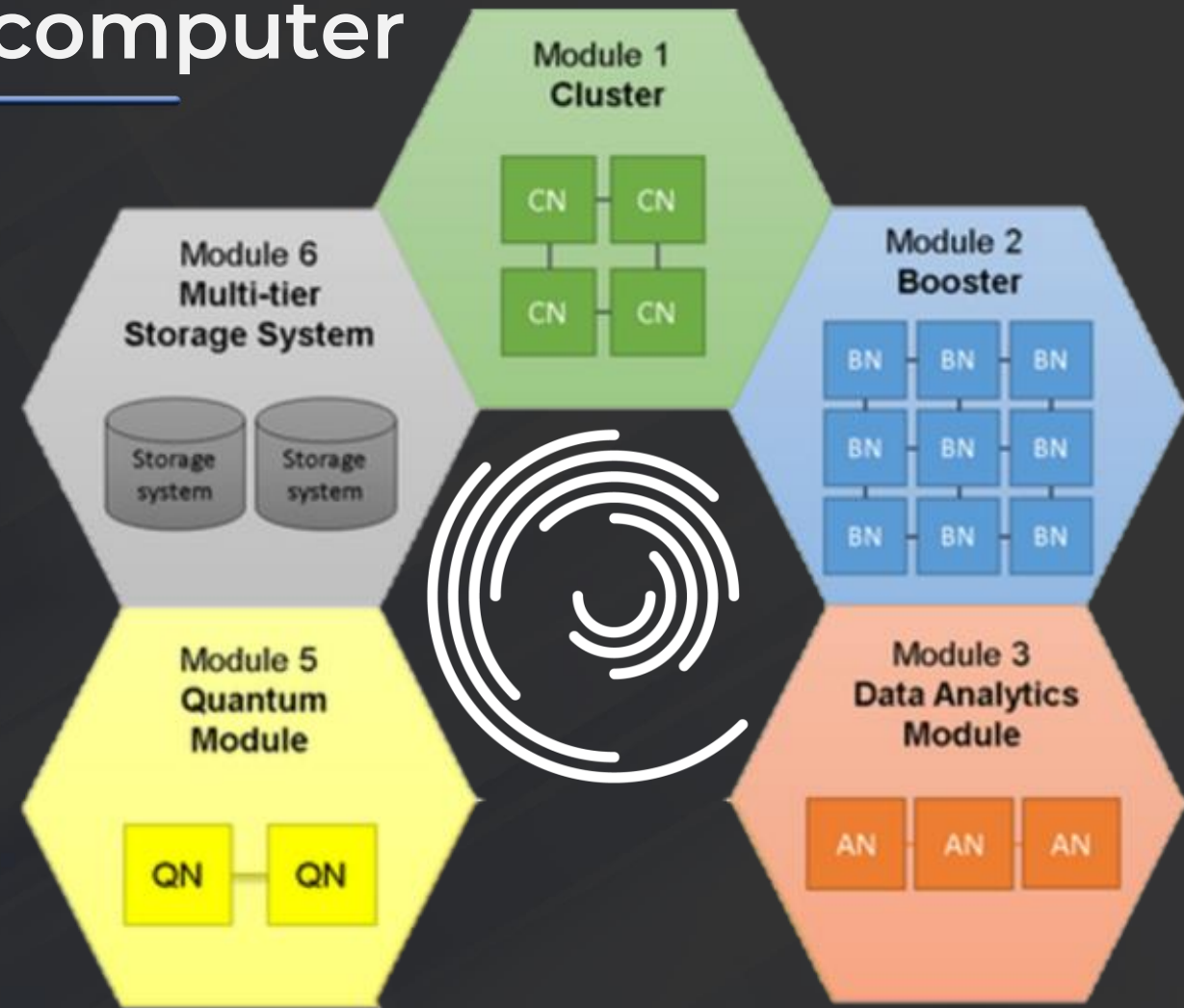
Leonardo: A Modular Supercomputer

- First half 2023: Leonardo
 - Fourth most powerful supercomputer in the World
 - 255+ petaflops (peak performance)
 - Modular Supercomputing Architecture (MSA)



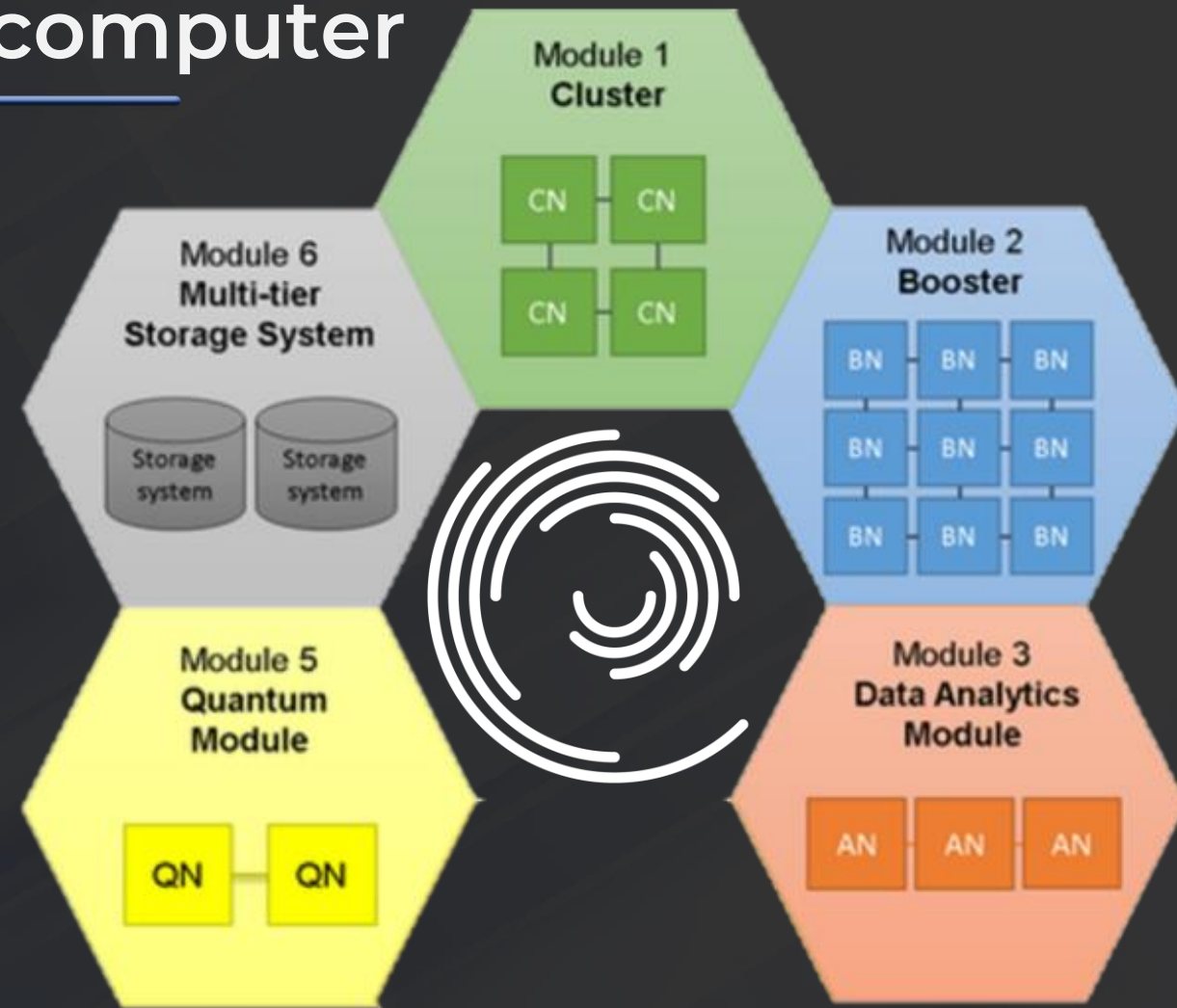
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 - 200 qubits Neutral Atoms Quantum Simulator (analog QC)



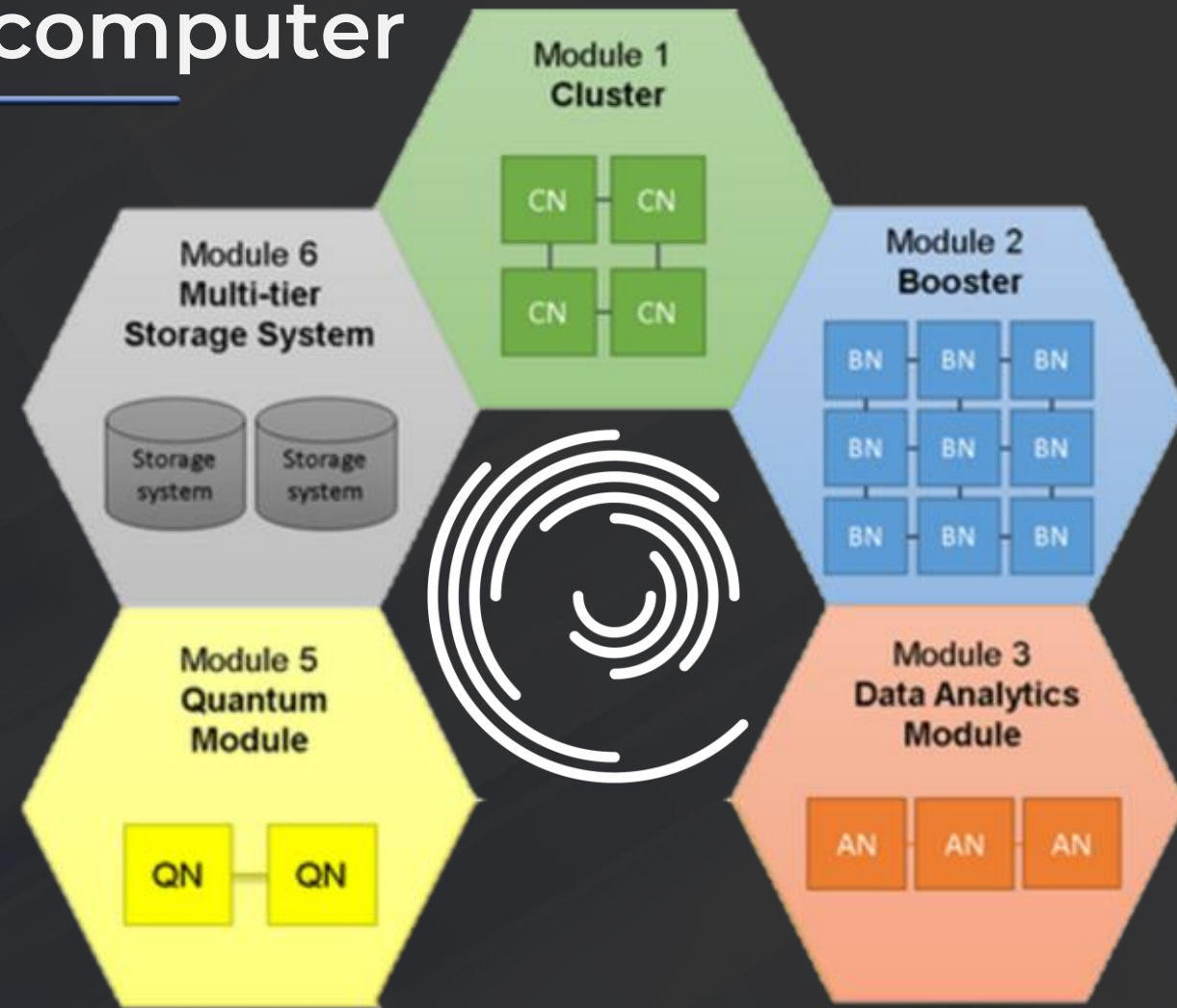
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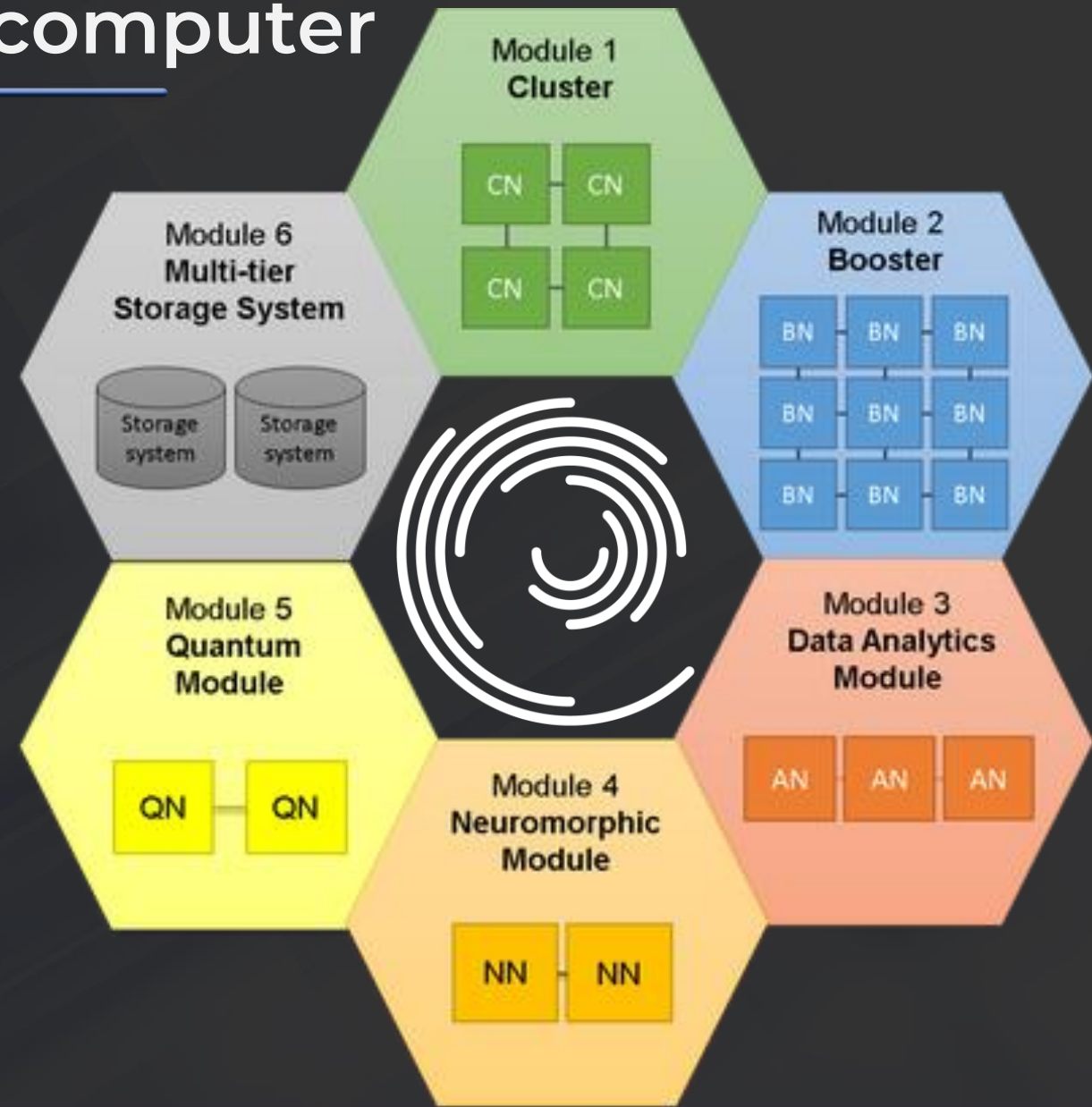
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 - 500 qubits digital/analog QC

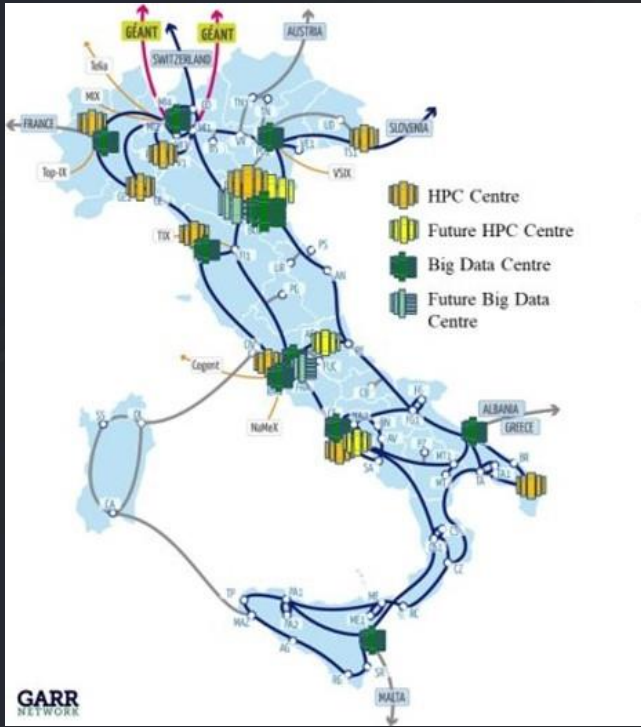


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- Future Improvements...

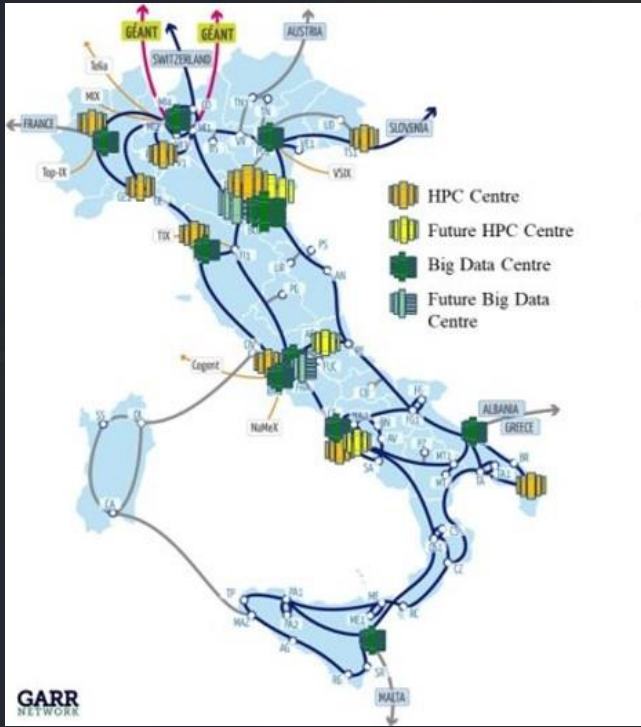


Italian and European QC Environment



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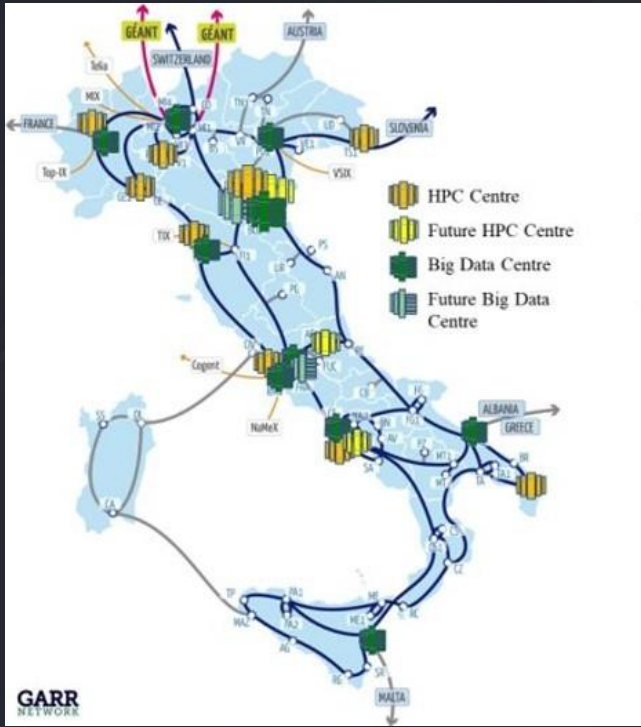
EuroHPC
Joint Undertaking



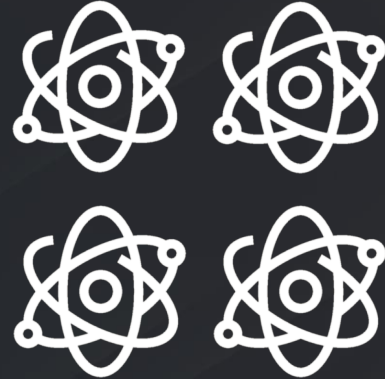
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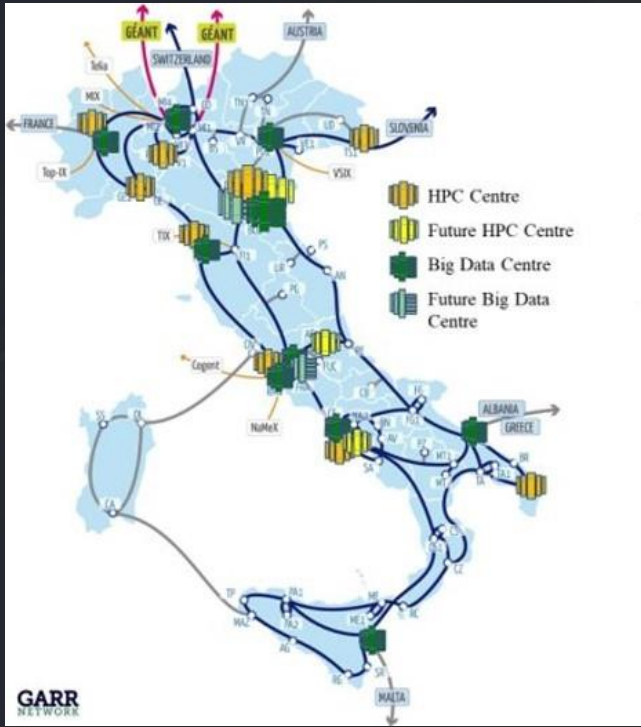
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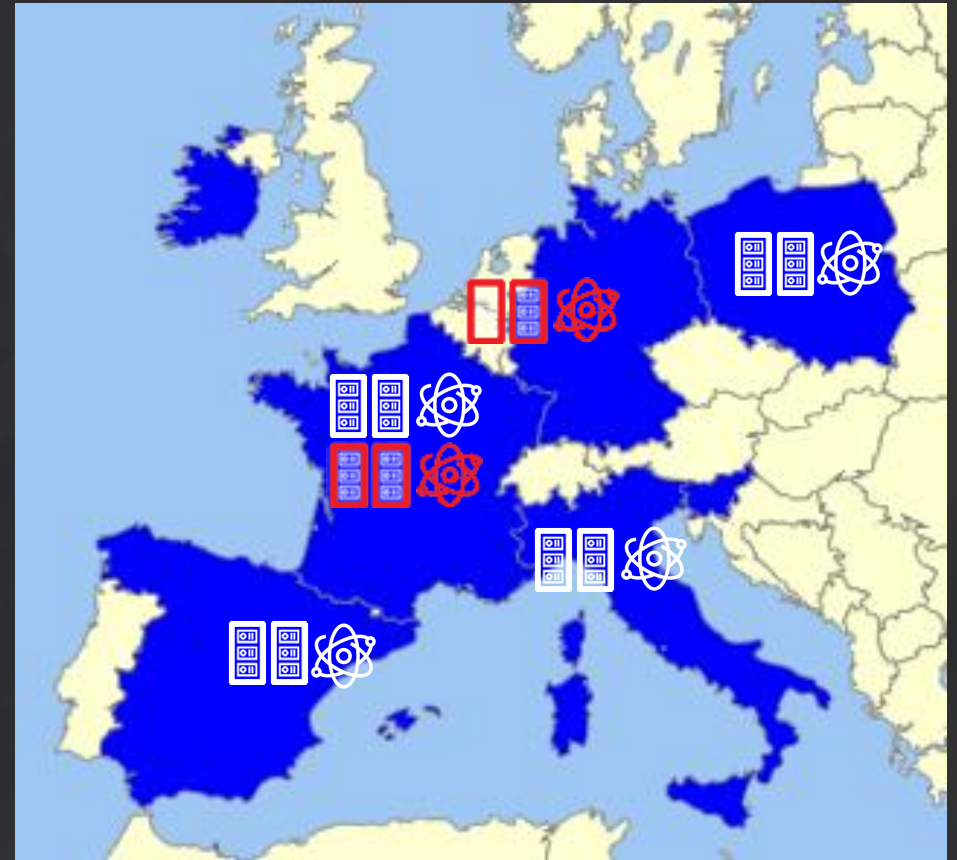
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Thank
you!
