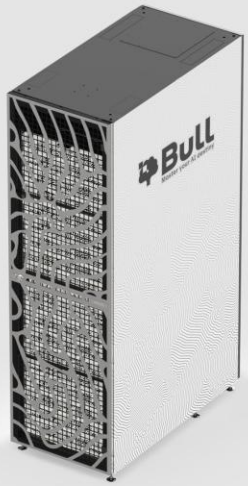
Qaptiva™ HPC

Enabling quantum emulation in high-performance computing through dedicated software



With years of expertise, Bull is dedicated to designing and delivering custom HPC solutions tailored to the specific needs of computing centres. Reinforcing its commitment to innovation and market foresight, Bull offers Qaptiva HPC, a forward-looking platform that enables the seamless integration of large-scale quantum emulation into existing HPC infrastructures.

Qaptiva HPC is groundbreaking licensed software that offers a full programming and emulation environment specifically designed for high-performance computing (HPC) environments. This innovative solution significantly boosts simulation capabilities, resulting in remarkable improvements in computing speed, efficiency, and capacity and opening up exciting new avenues for research and development. It allows for the emulation of over 40 qubits, with capacity limited only by the cluster memory, significantly reducing emulation and simulation processing time from days to hours. The computation is performed in double precision (64-bit).

Capabilities and key benefits

Seamless Integration with Existing HPC Infrastructure

Built on distributed-memory HPC hardware architectures (e.g. Message Passing Interface), Qaptiva HPC enables seamless integration with existing HPC infrastructures, enhancing traditional HPC clusters through quantum emulation, without the need to purchase new hardware. This allows computing centres to adopt cutting-edge technology while optimising existing resources.

On-Premises Deployment and Data Sovereignty

Deployed on-premises, Qaptiva HPC preserves confidentiality and privacy for research programmes and innovation projects. It reinforces data sovereignty by ensuring full control over sensitive workloads within the organisation's own HPC environment.

Scalable Quantum Emulation on HPC Clusters

Qaptiva HPC provides advanced emulators for large-scale quantum simulations by leveraging a distributed architecture that aggregates CPUs and memory across multiple nodes. By executing quantum simulations collectively on the cluster's CPUs, it accelerates processing, optimises resource utilisation, and delivers higher performance for faster and more accurate results.

GPU Acceleration

By harnessing multiple GPUs and multi-node execution, Qaptiva HPC significantly reduces emulation time. GPU acceleration combined with distributed resources can deliver up to a 10× performance boost, enabling faster large-scale quantum simulations.

Comprehensive Quantum Software Stack and Programming Flexibility

Qaptiva HPC includes the QAT library and extends Qaptiva's capabilities with HPC-powered features for scalable quantum simulation. It supports the efficient development of linear-algebra-based quantum algorithms (e.g. Shor's and Grover's), multiple programming paradigms (gate-based, annealing, and analog), and remains agnostic to qubit technologies. Fully interoperable with major Python-based frameworks (OpenQASM, Cirq, Qiskit, etc.), it also provides an abstraction layer (AQASM, via Atos Quantum Assembly Python) for universal quantum assembly and hybrid simulation.

HPC-Native Architecture and Developer Environment

The Qaptiva HPC emulator is developed in C++ with a Python API, enabling seamless integration into HPC workflows. Fully compatible with multi-node Slurm environments, it leverages compilation plug-ins and gate-based processing to optimise execution and deliver high performance on HPC infrastructures. Qaptiva HPC also provides optimisation tools, mathematical libraries, and a Jupyter Notebook environment with ready-to-use examples and algorithms accessible via a web browser.

End-to-End Compatibility and Extensibility

Programs developed with myQLM or Qaptiva are fully compatible with Qaptiva HPC and can run directly on HPC environments via Slurm batch jobs. Through Qaptiva Access, users can also connect to myQLM, Qaptiva appliances, or external QPUs from the same environment. Qaptiva further supports custom plug-in development, execution-stack customisation via a dedicated SDK, and the integration of third-party open-source connectors, ensuring flexibility and adaptation to target quantum hardware topologies.

Qaptiva HPC emulators

- Gate: CLinAlg, PyLinAlg and D-LinAlg (Distributed + GPUs multi-nodes), D-Noisy (Deterministic) (Distributed + GPUs multi-nodes), Matrix Product State and Matrix Product Operator.
- Analog qubit simulation: D-MPSTraj (Deterministic, Stochastic, Distributed + GPUs multi-nodes), and QutipQPU (Deterministic and Stochastic).
- Analog simulation: QutipQPU (Bosonic) and QutipQPU (Fermionic).

Experience exceptional performance

With Qaptiva HPC, benefit from advanced quantum computing emulation capabilities thanks to its large number of qubits. Qaptiva HPC has been tested with GPUs from both NVIDIA and AMD, ensuring reliable performance across leading accelerator platforms.

Distributed CPU mode:

Total cluster memory (RAM)	Max # qubits (L)
1 TB	35
2 TB	36
4 TB	37
16 TB	39
128 TB	42
256 TB	43

Each added qubit doubles node or memory requirements. Max qubits = L + $\log_2$(N), with L per node and N nodes.

Quantum accelerators for writing and optimising quantum algorithms.

Comprehensive quantum solution that caters to diverse needs in terms of capabilities and access.

Successful strategic partnerships with the leading quantum computer providers.

Why Bull

Pioneering since **2016**	Proven **expertise and experience**
Leader in HPC/QC **hybridisation**	**20+** international research projects
96+ Quantum computing patents	**Global trusted partner** for your quantum journey

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