Quantum-HPC integration: state-of-the-art, challenges and opportunities

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Over the past decade, the field of quantum computing has progressed from theory and experiments in university laboratories to operational computing machines developed by several companies and startups. Even at these early stages of development, quantum computers are becoming increasingly popular among scientific and industrial users who want to test their real-world performance and adapt their solutions to this new programming paradigm.

Operating and controlling quantum devices requires classical computing: instructions for quantum operations and the readout of the quantum processing unit (QPU) are orchestrated by a "classical" computer. Moreover, there are no purely quantum algorithms, since several algorithmic pre- and post-processing subroutines rely on classical computation.

All these factors point toward the integration of quantum and classical computers, extending the capabilities of supercomputers by enabling a new chip technology. In this talk, I will address the roadmap for quantum–HPC integration, including its motivation, methods, challenges, and opportunities. I will also summarize the experience that the Barcelona Supercomputing Center is gaining through the installation, operation, and integration of two quantum computers at its facilities.