Quick Take

QC-HPC Partnerships Signal Rising Interest in Hybrid Quantum-Classical Applications

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HYPERION RESEARCH OPINION

Hybrid quantum-classical algorithms show significant promise in effectively harnessing the computational capabilities of near-term quantum systems when combined with classical HPC systems on key applications. Two recent developments reveal a growing interest in advancing such algorithms: the first, a trio of European-based organizations partnering to build a complete quantum computing R&D ecosystem: the second, a commercial partnership between quantum annealing vendor D-Wave and the Japanese supercomputer vendor, NEC. Successful growth of hybrid capabilities will require a merging of quantum and related HPC skills and can only contribute to the overall development pace of the quantum computing sector writ large. Additional partnerships with similar intentions will likely emerge soon.

CURRENT SITUATION

Most quantum computing researchers indicate that hybrid quantum-classical algorithms show considerable potential in delivering near-term performance gains in a wide range of important QC-related applications and use cases. Optimization is considered one such promising area of research in solving problems that are exponentially hard on classical computers alone, but that can extract useful results from the currently available and near-term range of quantum systems, which have limited qubit counts and vexing issues with noise.

- One of the most promising examples is in quantum chemistry, where variational quantum eigensolver algorithms perform a heuristic search by iterating between a quantum machine and a classical computer to find the lowest energy state of a particular molecule.

On-going research in these areas indicate that hybrid algorithms can benefit from access to powerful classical systems, particularly HPCs, to maximize potential performance. Two announcements within the past few weeks highlight increasing interest and emphasis in hybrid algorithms that combine quantum computers and HPCs.

Three European-based quantum computing organizations, Atos of France, and IQM and CSC of Finland, recently announced the formation of a partnership to create a European-only quantum computing ecosystem that includes an advanced quantum simulator, a universal quantum programming environment, and superconducting quantum hardware.

- Atos, a global corporation with products in cloud, cybersecurity, and high performance computing, will bring its considerable capabilities in quantum digital simulators developed

through its series of Quantum Learning Machines (QLM), along with expertise in QC hardware-specific topics including quantum gate tomography and numerical noise modeling.

- IQM will use the Atos QLM to help further its development of superconducting quantum computers that use application-specific processors developed though a hardware-software co-design scheme.
- CSC will contribute access to its recently acquired 30-qubit Atos QLM, called Kvasi, targeted to help Finnish users from academia and industry acquire skills and develop further expertise in the field of quantum computing.

The deal further cements a cooperative agreement between Atos and CSC that began in 2018 when CSC signed a 37 million euro 3-year contract with Atos for the delivery of its then newest HPC, the BullSequana XH2000, with a theoretical peak performance of 6.4 Pflops.

- CSC has already been designated as one of three EU sites to receive pre-exascale systems in 2021 under the EU-funded EuroHPC Joint Undertaking. The system, named Lumi, is targeted for a theoretical peak performance 200 Pflops, ten times faster than Europe's current fastest HPC, the Marcini-100 at CINECA.

Meanwhile, US D-Wave, a leading supplier of quantum annealers, recently entered into a partnership with Japan's NEC to support the integration of NEC supercomputers into D-Wave's quantum annealing cloud computing service. The partnership, bolstered by NEC's $10 million investment in D-Wave, will focus on the development of hybrid technologies and applications that will draw on the collective capabilities of D-Wave's quantum annealer and NEC's HPCs.

- The effort is targeted initially towards potential users in Japan, but the newly developed service will be available to customers of both companies around the world through Leap, D-Wave’s quantum cloud-based offering.
- Finally, the two companies will explore the possibility of enabling access to NEC's supercomputers though D-Wave's Leap as well.

FUTURE OUTLOOK

The daunting complexities of building reliable, error-corrected quantum computers with adequate qubit capabilities and related architectures are leading QC researchers to seek near-term solutions that can tolerate the current class of noisy systems yet still produce compelling and useful results. Hybrid algorithms offer significant potential within these limitations, and applications that can combine quantum and HPC performance advantages stand a strong chance of demonstrating new performance heretofore unavailable.

- Development of such hybrid quantum-classical capabilities will require a merging of quantum and related HPC skills to drive progress such as those described here and can only contribute to the overall development pace of the quantum computing sector writ large. Additional partnerships with similar intentions will likely emerge soon.