Quick Take

Cloud-based Quantum Computing: A Growing Assortment of Opportunities for QC Application Developers

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This Quick Take looks at the growing availability of commercial cloud-based quantum computing (QC), supported through either direct access to true QC systems or QC simulators based on traditional digital hardware. In addition to QC hardware, most cloud-based QC providers are also rolling out their own software development environments to help existing and new QC software developers more effectively explore QC programming. The choice of options for potential QC users is growing, and each of the QC providers offers a distinct take on QC architecture and programming.

- Hyperion Research believes that this trend can only help drive progress in QC application development across a wide range of scientific and engineering disciplines in the government, commercial, and academic sector and that these current cloud-based QC access services could prove to be a harbinger of widespread QC access and usage for at least the next 3-5 years.

SITUATION OVERVIEW

Recently, several different commercial efforts centered primarily in the United States and China have stood up cloud-based quantum computing access to researchers interested in conducting QC-based algorithm and related software development. In most cases, vendors are offering a combination of true QC-based systems with a relatively low qubit count and classic digitally-based simulators with a higher qubit capability. Currently, the overall cost to use these services is relatively low (if not free), and they are more geared to helping build a base of future QC users than to generating near-term financial returns.

Key US Cloud-based QC Vendors

D-Wave, the first commercial quantum computing supplier (founded in 1999), recently launched its cloud platform for quantum computing, called Leap, that features real-time access to its D-Wave 2000Q quantum systems. Unlike most other QC hardware aspirants, D-Wave uses a unique and specialized approach to quantum computing based on a process called quantum annealing, which offers up many qubits (D-Wave's biggest system currently has 2000) but that operates exclusively on applications scoped as optimization problems. Despite this apparent limitation, D-Wave's base of applications is perhaps the largest in the QC field today, and the architecture is proving useful in a wide and growing range of applications.

IBM, with the longest committed effort in quantum computing development dating back to the 1970's, began offering its cloud-based Q Experience in mid-2017 through its Quantum Information Software Developer Kit (QISKit), designed to allow users to develop and deploy quantum algorithms via a Python interface. Current QC devices available on the Q Experience include 5-, 14-, and 16-qubit systems, as well as a 32-qubit simulator. A key element of IBM's effort is that its Q network outreach program is targeted to explore practical applications of quantum computing with business and science leaders including JPMorgan Chase, Daimler AG, Samsung, Oak Ridge National Lab, Oxford University, and the University of Melbourne. Since standing up its Q Experience, IBM has seen 80,000 users run more than 3 million remote executions.

Rigetti, a relative newcomer to computing founded in 2013, recently announced that it was offering a Quantum Cloud Services (QCS) that is a combination of a cloud-based classical computer, it's Forest software development platform, and access to its quantum back-end processors. Rigetti stresses that a closely integrated hybrid classical/quantum computer configuration offers a strong opportunity for developers to demonstrate quantum-based applications with performance beyond anything possible on a classical computer. For the QCS, Rigetti will likely offer its 16- and 32-qubit systems to its users, along with along with their QVM, a quantum virtual machine. The firm has announced plans to build and deploy a 128-bit quantum processor sometime in 2019.

Key Chinese QC Vendors

Alibaba, a major Chinese multi-national technology company, recently launched a cloud-based 11-qubit quantum computing based service through its cloud services company (Aliyun), in conjunction with the Chinese Academy of Sciences. Aliyun is also offering a new 32-qubit quantum computer simulation service. Although there is little detail on the service, Alibaba, ranked as one of the top three global cloud service providers, is strongly positioned to expand its presence in cloud-based QC offerings not only in China, but around the world. In addition, continued cooperation between Aliyun and the Chinese Academy of Sciences in their joint QC development lab could be a rich source of new QC-related technology.

Huawei, another Chinese high-tech equipment supplier, announced in October 2018, a new cloud service platform for simulating a quantum computer, called HiQ. Unlike some of the other systems discussed here, HiQ uses only traditional digital technology for its simulation capabilities. The service also includes a quantum programming framework to develop software for the simulator. Huawei offers a range of simulation options: the HiQ platform can simulate quantum circuits with at least 42-qubits for full-amplitude simulations and at least 81-qubits for single amplitudes. In addition, for low-depth circuits, the qubit number can reach 169 for single-amplitude simulations. The HiQ platform will be open to the public to enable quantum research and education in the field.

FUTURE OUTLOOK

By offering cloud-based QC capabilities, vendors can provide wide and immediate access to their systems with a relatively low cost to users. In addition, a multi-user remote access model allows these suppliers to make better use of their existing stock of QC systems as many current QC applications do not require significant user time for any single job. These vendors can also benefit from having a wide base of users contributing to their library of QC algorithms.

From the user's perspective, aside from access to QC hardware, some of the major benefits of these cloud-based QC offerings include support within a full software stack – typically using classical programming languages like Python - to help facilitate QC software development, support for community discussion and idea-sharing mechanisms within the QC developer community, and the option to tap into a growing base of established QC-based algorithms that can be readily incorporated into new code developments. This support can only help to develop and expand the QC programming workforce.

Although there is no clear superior cloud-based QC service choice at this time, increased, widespread, and relatively cheap access to QCs will almost certainly enable more robust QC algorithmic and application development within a growing base of international QC programmers that will over time require less and less rigorous understanding in the underlying quantum physics.

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Hyperion Research provides data-driven research, analysis and recommendations for technologies, applications, and markets in high performance computing and emerging technology areas to help organizations worldwide make effective decisions and seize growth opportunities. Research includes market sizing and forecasting, share tracking, segmentation, technology and related trend analysis, and both user & vendor analysis for multi-user technical server technology used for HPC and HPDA (high performance data analysis). We provide thought leadership and practical guidance for users, vendors and other members of the HPC community by focusing on key market and technology trends across government, industry, commerce, and academia.

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