CLABBY ANALYTICS

Research Report

Analysis of IBM's Quantum Computing Strategy and Go-to-Market Approach

Overall Positioning

The building of a quantum computer involves scientific quantum research, advanced systems design, integrated software design, and system/software tuning – in other words, not just hardware improvements but instead a unified systemic approach to system design and deployment. And, over the past several decades, IBM has developed formulaic, systemic approach to the design of advanced systems. This company knows how to build the world's most advanced computers – and it is applying that knowledge to the building of quantum computers.

From a strategic perspective, IBM's strategy is to, over time, build industry-leading high-performance, fault-tolerant quantum computers – and to drive the market for those computers. These systems will draw-in customers who have certain types of complex computing needs that can benefit from the ability of quantum computers to process large data sets exponentially faster than traditional, classic computers.

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As for its go-to-market approach, IBM has heavily leveraged the open-source community and the software ecosystem to help build software solutions; it has partnered with numerous customers and business partners to build and share quantum expertise and has made its quantum computers available to experimentalists and early adopters through its quantum cloud (the IBM Q Experience). IBM has also worked closely with the educational community to build teaching tools and programs to attract a new generation of computer programmers. In other words, IBM has taken a very "open" approach to building its quantum computers and associated ecosystem.

The System Challenges Ahead

There are two major problems faced by makers of quantum computers: scale and stability. These are industry-wide challenges – not specific to IBM.

This scaling challenge has to do with lining-up and managing more and more qubits. The amount of work a quantum computer can process measured in qubits and is called "quantum volume." To scale, quantum computers need to be able to process more and more qubits to tackle large scale problems. As quantum volume increases, quantum computers will thus be able to tackle tougher and tougher challenges.

The good news for IBM customers today is that IBM has reached an industry-leading quantum volume position with its 50 qubit quantum computer. And, even better news, IBM has been able to double quantum volume every year for the past three years. If IBM can follow its current trajectory – one hundred and two-hundred qubit systems are not that far off in the future.

The good news for IBM customers today is that IBM has reached an industry-leading quantum volume position with its 50 qubit quantum computer. And, even better news, IBM has been able to double quantum volume every year for the past three years. If IBM can follow its current trajectory – one hundred and two-hundred qubit systems are not that far off in the future. Meanwhile, other vendors are also aggressively tackling the quantum volume scaling issue.

Clabby Analytics expects that IBM's double-the-performance track will continue for several years well into the future (on a linear path in much the same way Moore's Law progressed for decades in the classical computing world).

The stability challenge has to do with ensuring that qubits remain in the state that they are put in before losing their information (this is called a "coherence" challenge). The stability challenge, however, will take a bit more time for the industry to solve. To address the stability levels required to achieve commercial success, IBM has identified eleven inhibitors to qubit stability – and is working, along with the rest of the industry, to mitigate or negate those inhibitors over time. (These inhibitors include calibration errors, coherence, measurement fidelity, gate fidelity and parallelism, crosstalk, initialization fidelity, and speculator errors).

2019: Great progress in Quantum Dev Tools

For years, until May of 2019, Clabby Analytics viewed quantum computing as an interesting scientific experiment. Prototypes had produced interesting results – but common wisdom amongst the analyst community reasoned that it would take at least a decade for quantum computing to become commercially viable.

Back in June 2019, however, Clabby Analytics published a blog entitled "A New Inflection Point in Quantum Computing? IBM's Evolving Quantum Development Environment." In that blog, we stated: "Clabby Analytics is now a believer in the commercial viability of quantum computing. IBM's quantum computing program has progressed a lot further and more rapidly than we expected."

What triggered our new-found enthusiasm was the vast improvement we saw in the software stack and development tools used to build quantum applications.

In May, IBM had demonstrated a development environment, complete with application programming interfaces and visual management tools that provided developers an integrated toolset for visualizing and building quantum applications. As part of its development tools demonstration, IBM showed us how developers could architect "circuits" that could be deployed on quantum computers. IBM emphasized that these circuits are the main building block of quantum computing. A circuit can be created by stringing quantum gates together to perform a computing function – and IBM's integrated development environment demonstrated how easily quantum circuits could be built. With IBM quantum hardware improving at a predictable pace, and with a solid software stack and the availability of easy-to-use development tools, IBM convinced us that commercially available quantum computers have the potential to arrive sooner than most people expect.

What we saw was the creation of unique problem-solving circuits that can't be emulated using traditional computers. And those circuits represent the key to the ultimate success of quantum computers: Quantum Advantage.

Go-to-Market Activities

For seventy-five years, IBM has been bringing advanced systems technologies to market. And, over the past decade, we've noticed that IBM has become almost formulaic in the way it brings its systems to market. In the case of Q System development, we observed the following go-to-market approach (and note, many of these actions occurred in tandem, not serially).

- Lab investment for proof of concept.
- Outreach to the scientific community (because not all quantum mechanics experts reside at IBM).
- Outreach to the vendor community (to create business partner relationships and to foster ecosystem growth).
- Outreach to the Open Source community for open-source software support, as well as software contributions to the open-source community (such as Qiskit, IBM's open-source, modular, full-stack quantum software framework).
- Quantum experimentation available to the public via IBM's Q network (cloud) and IBM's Q Experience program. This network and community stimulates the learning process. Premium access (on a fee basis) is also available to business partners who require dedicated resources and access to the latest technology and support resources.
- Customer/business outreach (for testing and feedback on new devices – as well as to stimulate commercial application growth). And,
- Education. IBM already has relationships with thousands of academic institutions, researchers, and educators through other academic initiatives that the company has fostered over the years. These initiatives offer a self-service program that provides students and faculty at accredited academic institutions with

access to select IBM resources at no-charge for teaching, learning, and non-commercial research. Interested parties are also encouraged to join the IBM Q Experience community, wherein community educational support is shared amongst members.

Summary Observations

IBM is highly committed to quantum computing, as evidenced by its continued investment in hardware, software, the quantum ecosystem, and the massive educational effort required to educate developers on the use of quantum computers.

For us, the turning point in becoming quantum enthusiasts was not a demonstration of IBM's quantum computers, but rather the software stack and developmental tools that have evolved to encourage circuit development on IBM Q System quantum computers. We also note that:

- Members of the research community have, over the past few years, released 203 research papers that discuss IBM developmental tools and Q Systems;
- IBM's Q community, the Q Experience, numbers 160,000+;
- Users of the IBM Q Network (the IBM quantum cloud) have run over 15 million experiments on IBM Q Systems (not simulators);
- Qiskit downloads now exceed 245,000. (Note: this adoption rate is slowing as users are shifting to a browser-based approach in the cloud that does not require a download).

The beauty of IBM THINK is that it is the one place to go every year to get caught up on the company's overarching strategy and new product offerings

The two obstacles to widespread quantum computing adoption are overall system performance and stability challenges – and IBM is demonstrating that it can eventually overcome both obstacles over time. As these challenges are overcome, quantum computers offer an opportunity to accelerate the processing of exponential workloads greatly – and this will open a whole new universe of applications to IBM and other quantum computer makers.

When all is said and done, IBM has demonstrated leadership in quantum computer design and is executing a roadmap that doubles the performance of its Q Systems every year. The company has designed a software stack, made it open source, and populated it with development tools to drive the creation of commercial quantum applications. The company has been highly active in helping build a quantum ecosystem – and has also been a leader in helping drive quantum computing education. All of these activities, working in concert, will help to bring quantum computing to the forefront sooner, rather than later.

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