

## Bloomberg Intelligence

# Amazon Quantum Computer Acceleration



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### Amazon Cloud May Disrupt Quantum Computer Pricing, Technology

(彭博行业研究) -- Amazon Web Service's (AWS) new cloud for quantum computing may boost users and accelerate the development speed of related computer technology. The superconductor technology developed by IBM and Google could fiercely compete with the trapped-ion method of Honeywell and IonQ. (09/03/20)

#### 1. AWS Ignites Quantum Computer Development Race

The development of quantum computer technology may accelerate due to Amazon's cloud service on quantum computing, Amazon Braket. An individual contract with a quantum computer provider may cost \$20,000-\$300,000 a year, but users could use Amazon Braket at \$0.50-\$5 on a pay-as-you-go basis. AWS offers D-Wave's annealing machines, IonQ's trapped-ion gate devices and Rigetti's superconducting gate machines. Microsoft has also launched a cloud service, using quantum computer hardware made by Honeywell, IonQ and qci.

It may take 10-20 years to put a quantum computer into practical use, but the increase in users may accelerate technological innovation. (09/03/20)

Amazon Braket Price List

Hardware Provider	QPU family	Per-task price	Per-shot price
D-Wave	2000Q	\$0.30000	\$0.00019
IonQ	IonQ device	\$0.30000	\$0.01000
Rigetti	Aspen-8	\$0.30000	\$0.00035

Source: AWS

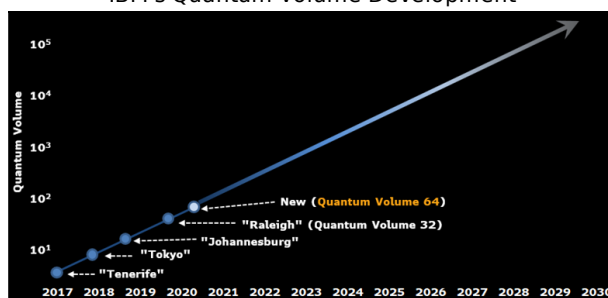
#### 2. Superconducting Machines Taking Initial Lead

Superconducting quantum computers, made by IBM and Google, could continue to lead the development in the next few years. A quantum state is created by a superconducting circuit, and both 0 and 1 can be represented at the same time. IBM announced in August 2020 that it had doubled the "quantum volume," which represents the performance of such computers, to 64 from 32. Google hasn't made big disclosures since it announced quantum supremacy in October 2019. Superconducting quantum computers haven't made the desired performance improvements in terms of reliability and stability.

The trapped-ion method, developed by Honeywell and venture company IonQ, is closely following the superconducting method. (09/03/20)

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IBM's Quantum Volume Development



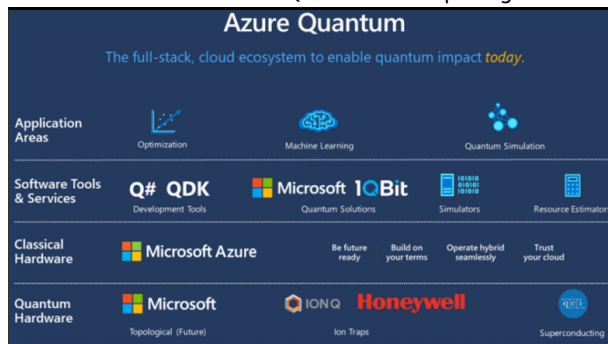
Source: IBM, Bloomberg Intelligence

### 3. Trapped-Ion Machines Are More Reliable

The trapped-ion method allows computers to maintain the quantum state for a longer period, improving calculation reliability. Ionized atoms are trapped and used as qubits. Ions have the property of having two energy states at the same time, which can be used in the quantum computation. The trapped-ion method needs to be operated at an ultra-low temperature of minus 273 degrees Celsius, and a cooling device, made by Bluefors, may be necessary like the superconducting method. If calcium ions or ytterbium ions are used, the quantum state could last from several tens to several hundreds of seconds, which should be a big difference from the superconducting method.

Microsoft Azure provides two trapped-ion machines and one superconducting machine, implying that the trapped-ion method could be the mainstay. (09/03/20)

Microsoft Azure Quantum Computing



Source: Microsoft

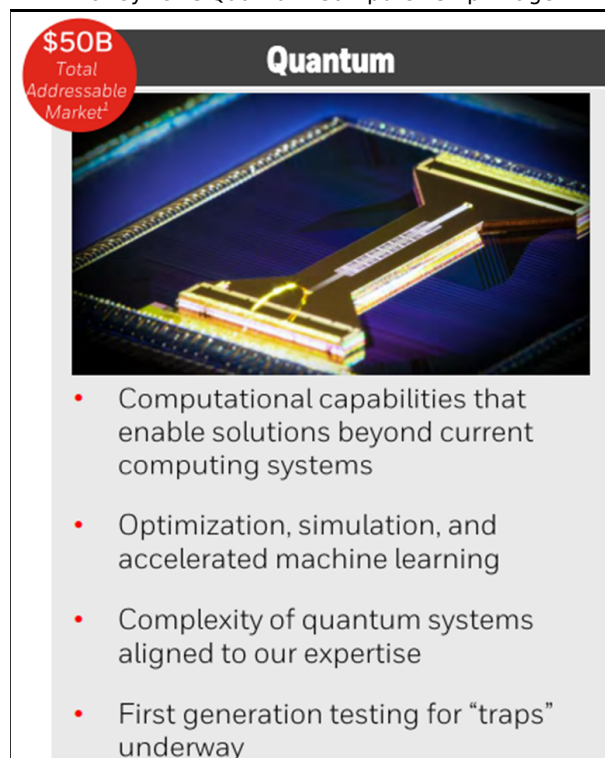
### 4. Honeywell May Suggest Future of Quantum Computing

Trapped-ion hardware may become the mainstream of quantum computers. Honeywell announced in June that it had developed a machine with quantum volume of 64. It expects the market size to be \$50 billion with a view to providing solutions to various industries such as pharmaceuticals, chemicals, finance and defense. The company has invested in two quantum computer ventures, Zapata and Cambridge Quantum Computing (CQC). Japanese companies may be able to co-develop quantum computing technologies with Zapata, whose CEO Christopher Savoie is a Japanese citizen.

CQC entered the Japanese market in December 2019, co-developing new technology with JSR and Nippon Steel. (09/03/20)

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### Honeywell's Quantum Computer Chip Image



Source: Honeywell

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