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ONE HUNDRED FIFTEENTH CONGRESS
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House of Representatives
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MEMORANDUM

May 16, 2018

To: Subcommittee on Digital Commerce and Consumer Protection Democratic Members and Staff

Fr: Committee on Energy and Commerce Democratic Staff

Re: Hearing on "Disrupter Series: Quantum Computing"

On **Friday, May 18, at 9:15 a.m. in room 2322 of the Rayburn House Office Building**, the Subcommittee on Digital Commerce and Consumer Protection will hold a hearing titled "Disrupter Series: Quantum Computing."

I. BACKGROUND

All information inside a conventional computer, from text characters to picture images, is stored and processed as numbers, with the smallest unit of data called a bit or a binary digit. The computing power of a traditional computer depends on the number of electrical on-off switches the computer contains with one bit represented by one switch.[1] Unlike conventional computers, quantum computers harness the unique physical properties of atomic and subatomic particles to create quantum bits or "qubits."[2] A single qubit can perform two tasks at once, and as more qubits are added, the computational power increases exponentially.[3]

The potential to perform many tasks simultaneously has several real-world applications. Quantum computing could be used to model the behavior and interaction of molecules, allowing

[1] *Has the Age of Quantum Computing Arrived?*, The Guardian (May 22, 2016).

[2] *15 Things Everyone Should Know About Quantum Computing*, Forbes (Oct. 10, 2017).

[3] *Id.*

rapid development of safer and more effective drugs.[4] Or, it could perform highly complex calculations of optimal routes to reduce traffic congestion and make supply chains more efficient, and it is being considered for applications in agriculture, climate study, financial analysis, and artificial intelligence.[5] Experts estimate that most real-world applications may still be several years away.[6]

Quantum computing also has significant implications for cryptography systems. While quantum computing could someday render all current encryption methods obsolete, it may be decades before quantum computing is able to break current encryption methods.[7] The National Academies of Science is due to release a study later this year assessing the timing and probability of these various applications, with particular emphasis on the future of encryption.[8]

Private companies, academic institutions, and government entities in the U.S. and abroad are working to build quantum computers.[9] Yet, the technology is still in its infancy.[10] The few prototypes have yet to achieve "quantum supremacy," a milestone representing the point at which a quantum computer can perform calculations beyond the capacity of the fastest supercomputers.[11] Quantum computers are still relatively small; Google just announced a 72-qubit computer, and IBM debuted its 50-qubit processor last year.[12] Current versions are also error-prone and fragile.[13] In addition, challenges remain in creating the algorithms and software necessary to bridge the gap between these computers and real world applications.[14]

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[4] *6 Practical Examples of How Quantum Computing Will Change our World*, Forbes (Jul. 10, 2017).

[5] *Id.*

[6] *Serious Quantum Computers are Finally Here. What Are We Going to Do with Them?*, Technology Review (Feb. 21, 2018)

[7] *Quantum Computing Would Make Today's Encryption Obsolete*, Bloomberg (Jul. 20, 2017); *Quantum Computing Will Not Break Your Encryption Yet*, Forbes (Oct. 23, 2017).

[8] National Academies of Sciences, Engineering, and Medicine, *Technical Assessment of the Feasibility and Implications of Quantum Computing* (Project No. DEPS-AFSB-16-01).

[9] *Quantum Computers May be More of an Imminent Threat than AI*, Washington Post (Feb. 5, 2018).

[10] *The Race to Sell True Quantum Computers Begins Before They Really Exist*, Wired (Mar. 6, 2017).

[11] *Google Thinks it's Close to "Quantum Supremacy." Here's What That Really Means*, Technology Review (Mar. 9, 2018).

[12] *Id.*

[13] *Serious Quantum Computers are Finally Here. What Are We Going to Do with Them?*, Technology Review (Feb. 21, 2018).

[14] *First Quantum Computers Need Smart Software*, Nature (Sept. 13, 2017).

II. ADVANCING QUANTUM COMPUTING

In 2016, the Interagency Working Group on Quantum Information Science produced a report for the President's National Science and Technology Council on the challenges and opportunities for advancing quantum information science (QIS Report).[15] The QIS report identified instability in U.S. research funding as one impediment to progress.[16] The report noted that funding has fluctuated greatly over the years, leading to discontinued research programs and researchers looking for opportunities outside the U.S.[17] At the same time, China is building a $10 billion national lab, scheduled to open in 2020, and the European Union has launched an "EU Flagship Quantum Program," investing two billion euros over the next ten years.[18]

The QIS report also identified gaps in education and workforce training as another factor impeding progress in the quantum computing field. In-depth teaching of quantum mechanics is rare outside of physics departments, and the field is in need of more computer scientists, mathematicians, and engineers with an understanding of quantum principles.[19] The report also noted needs for greater collaboration in research among universities and across departments, more transfer of technology and information from academic and government labs to the private sector, and improvements in materials and fabrication tools needed to build quantum devices.[20]

III. WITNESSES

Christopher Monroe Chief Scientist
IonQ, Inc.

Matthew Putman
Chief Executive Officer
Nanotronics, Inc.

Michael Brett
Chief Executive Officer
QxBranch

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[15] National, Science, and Technology Council, Office of the President, *Joint Report: Advancing Quantum Information Science: National Challenges and Opportunities* (July 2016).

[16] *Id.*

[17] *Id.*

[18] *Forget the Trade War. China Wants to Win Computing Arms Race*, Bloomberg (Apr. 8, 2018); National Institute of Standards and Technology, *Testimony before the United States House of Representatives, Committee on Science, Space and Technology on "American Leadership in Quantum Technology"* (Oct. 24, 2017).

[19] *See* note 14.

[20] *Id.*

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