Современное состояние квантовых компьютеров

События

2018 [edit]

- MIT scientists report the discovery of a new triple-photon form of light.[208][209]
- Oxford researchers successfully used a trapped-ion technique where they place two charged atoms in a state of quantum entanglement, to speed up logic gates by a factor of 20 to 60 times as compared with the previous best gates, translated to 1.6 microseconds long, with 99.8% precision.[210]
- QuTech successfully tests silicon-based 2-spin-qubit processor.[211]
- Google announces the creation of a 72-qubit quantum chip, called "Bristlecone",[212] achieving a new record.
- Intel begins testing silicon-based spin-qubit processor, manufactured in the company's D1D Fab in Oregon.[213]
- Intel confirms development of a 49-qubit superconducting test chip, called "Tangle Lake".[214]
- Japanese researchers demonstrate universal holonomic quantum gates.[215]
- Integrated photonic platform for quantum information with continuous variables.[216]
- On December 17, 2018, the company IonQ introduced the first commercial trapped ion quantum computer, with a program length of over 60 two-qubit gates, 11 Fully-connected qubits, 55 Addressable pairs, One-qubit gate error <0.03% and Two-qubit gate error <1.0% [217] [218]
- On December 21, 2018, the National Quantum Initiative Act was signed into law by President Donald Trump, establishing the goals and priorities for a 10-year plan to accelerate the development of quantum information science and technology applications in the United States.[219][220][221]

2019 [edit]

- IBM unveils its first commercial quantum computer, the IBM Q System One,[222] designed by UK-based Map Project Office and Universal Design Studio and manufactured by Goppion.[223]
- Nike Dattani and co-workers de-code D-Wave's Pegasus architecture and make its description open to the public.[224][225]
- Austrian physicists demonstrate self-verifying, hybrid, variational quantum simulation of lattice models in condensed matter and high-energy physics using a feedback loop between a classical computer and a quantum co-processor. [226]
- A paper by Google's quantum computer research team was briefly available in late September 2019, claiming the project has reached quantum supremacy.[227][228][229]
- IBM reveals its biggest yet quantum computer, consisting of 53 qubits. The system goes online in October 2019.[230]

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a $1.2 billon law to boost US quantum tech

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Новые компании

Company	Date initiated	Area	Technology	Affiliate University or Research Institute	Headquarters
IQM[35]	2019	Computing	Superconducting	Aalto University and VTT Technical Research Centre of Finland	Espoo, Finland
Pasqal	2019	Computing	Neutral Atom Quantum Computing	Institut d'Optique Graduate School	Palaiseau, France
QNTM	2019	Information Technology and Services			Belgium, Leuven, Kontich
Quanterro Technologies	2019	Communication	Quantum communication and encryption		Abu Dhabi, UAE
QuiX	2019	Computing	Photonic Quantum Computing	University of Twente	Enschede, The Netherlands
QuSecure	2019	Computing	Post-Quantum Cryptography, Cybersecurity		Menlo Park, California, US
Elyah[18]	June 6, 2018	Computing	Algorithms		Dubai, UAE
Atom Computing[9]	2018	Computing	Neutral Atom Quantum Computing		Berkeley, CA, USA
Alpine Quantum Technologies	2018	Computing	Trapped Ion	University of Innsbruck	Innsbruck, Austria
Baidu[12]	2018	Computing	Algorithms	University of Technology Sydney[12]	Beijing, China
Max Kelsen[39]	2018	Computing and Research	Superconducting, Algorithms	University of Queensland	Brisbane, Australia
Quantonation	2018	Computing/Communication			Paris, France
Quantum Thought	2018	Computing	Algorithms, Simulation, Cryptography		Menlo Park, California, US
Quantum Xchange	2018	Information Technology and Services	Information security and quantum encryption		Bethesda, Maryland, US
Rahko	2018	Computing		Quantum Machine Learning	London, UK
R QUANTECH	2018	Computing	Algorithms	Polytechnic University of Madrid	Geneva, Switzerland

Список квантовых процессоров

Manufacturer	Name/Codename/Designation	Architecture	Layout	Socket	Fidelity	Qubits	Release date
Google	Bristlecone	Superconducting	6×12 lattice	N/A	99% (readout) 99.9% (1 qubit) 99.4% (2 qubits)	72 qb[3][4]	5 March 2018
Google	Sycamore	Nonlinear superconducting resonator	N/A	N/A	N/A	54 transmon qb 53 qb effective	2019
IBM	IBM Q 53	Superconducting	N/A	N/A	N/A	53 qb	October 2019
IBM	IBM Q 50 prototype	Superconducting	N/A	N/A	N/A	50 qb[7]	
Intel	Tangle Lake	Superconducting	N/A	108-pin cross gap	N/A	49 qb [10]	9 January 2018
Google	N/A	Superconducting	7×7 lattice	N/A	99.7%[1]	49 qb[2]	Q4 2017 (planned)
IBM	IBM Q 20 Austin	Superconducting	5x4 lattice	N/A	N/A	20 qb	(Retired: 4 July 2018)[6]
IBM	IBM Q 20 Tokyo	Superconducting	5x4 lattice	N/A	99.812% (average gate) 93.21% (readout)	20 qb[7]	10 November 2017
Google	N/A	Superconducting	N/A	N/A	99.5%[1]	20 qb	2017
Rigetti	19Q Acorn	Superconducting	N/A	N/A	N/A	19 qb[12]	17 December 2017
Intel	17-Qubit Superconducting Test Chip	Superconducting	N/A	40-pin cross gap	N/A	17 qb[8][9]	10 October 2017
IBM	IBM Q 17	Superconducting	N/A	N/A	N/A	17 qb[5]	17 May 2017
IBM	IBM Q 16 Rüschlikon	Superconducting	2×8 lattice	N/A	99.779% (average gate) 94.24% (readout)	16 qb[5]	17 May 2017 (Retired: 26 September 2018)[6]
Rigetti	16Q Aspen-1	Superconducting	N/A	N/A	N/A	16 qb	30 November 2018[11]

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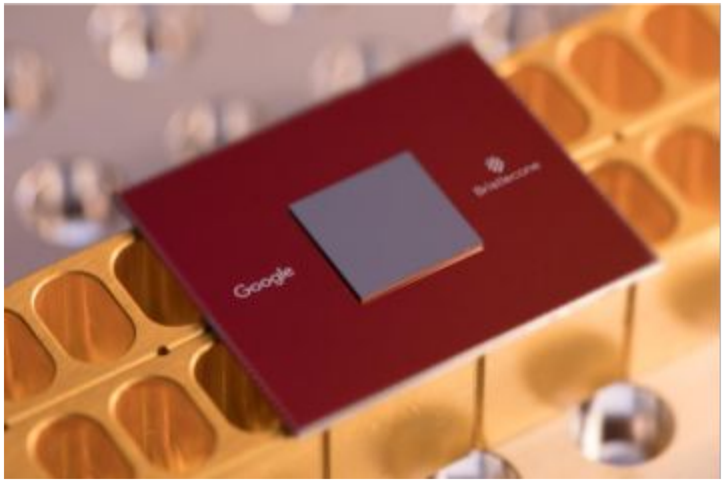
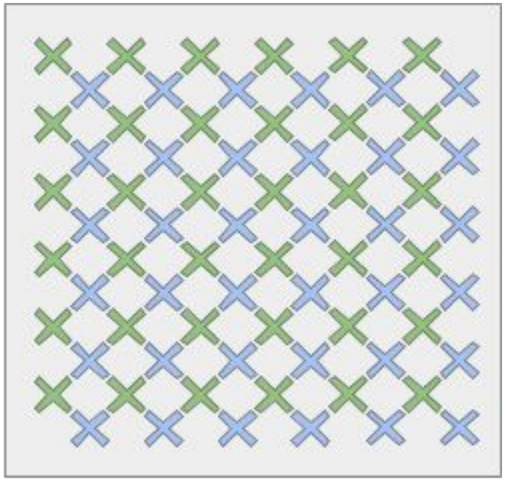
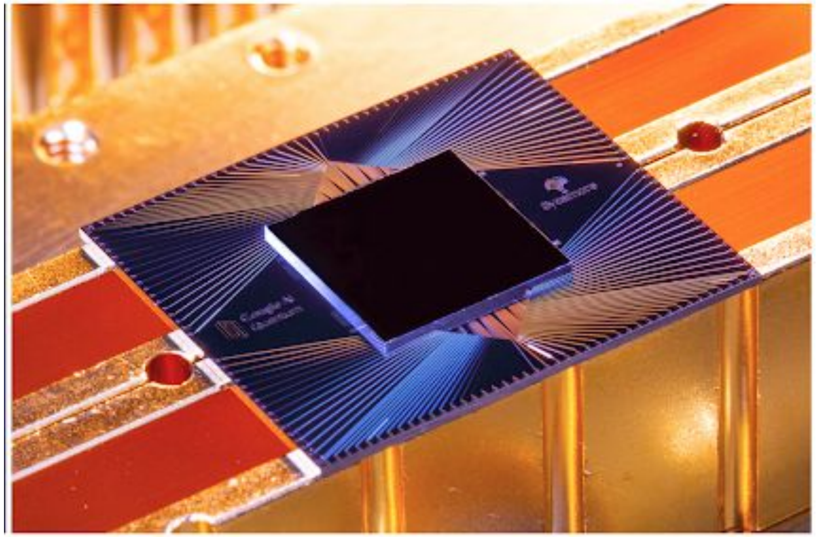
15 милликельвинов

Процессоры Google



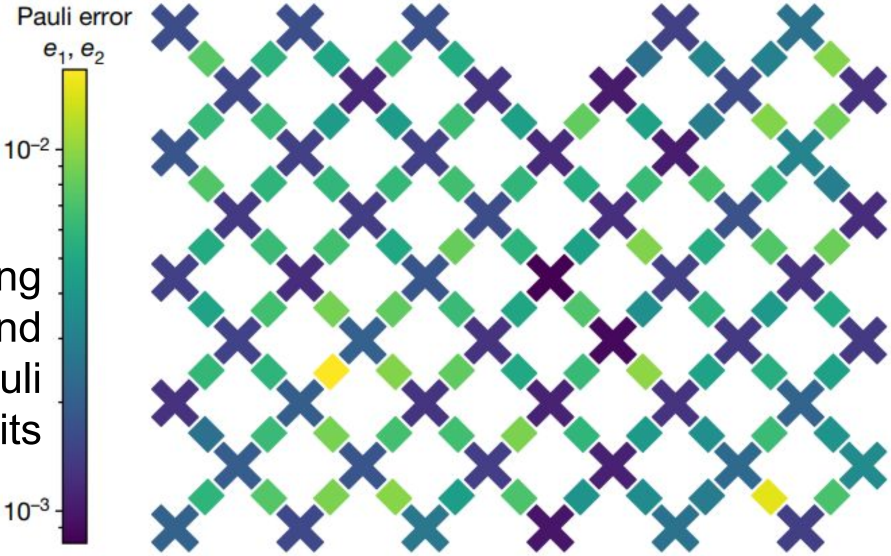


Bristlecone (72 qubits) Google's quantum processor (left). On the right is a cartoon of the device: each "X" represents a qubit, with nearest neighbor connectivity.

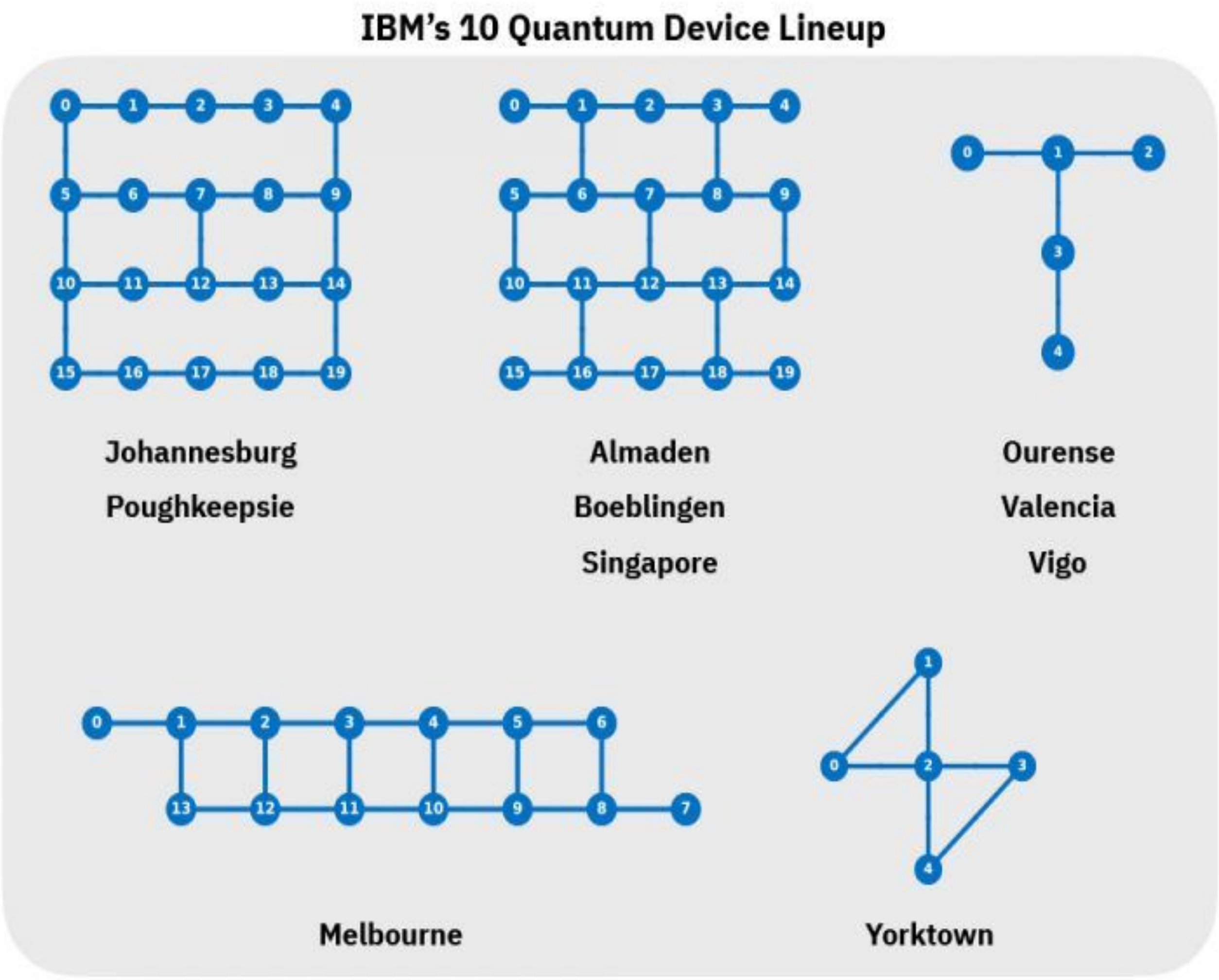


Photograph of the Sycamore processor.

Heat map showing single- and two-qubit Pauli errors for all qubits operating simultaneously.



Процессоры IBM



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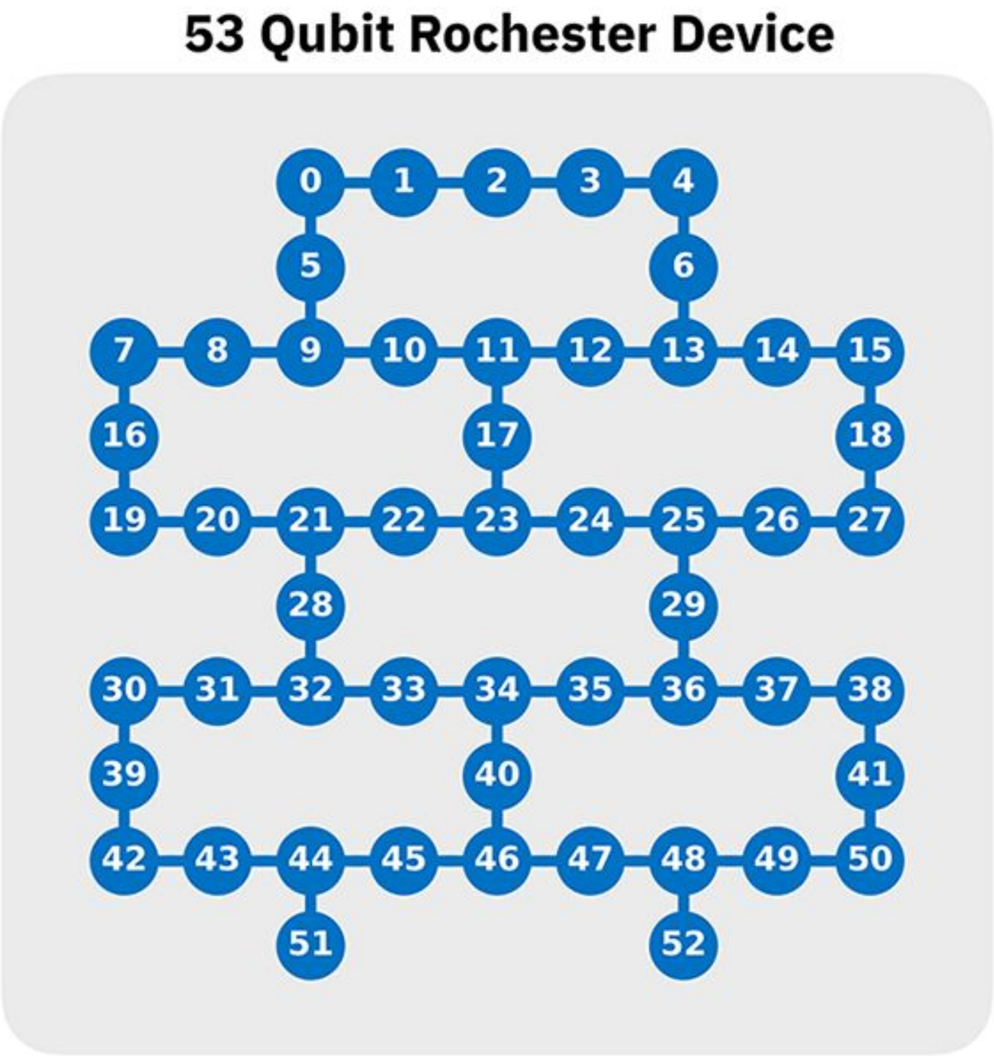


В Центре квантовых вычислений IBM начнет работу 53-кубитный облачный квантовый компьютер, став самой крупной квантовой системой в коммерческом доступе. Всего в центре будет работать 14 облачных квантовых систем, включая пять 20-кубитных, один 14-кубитный и четыре 5-кубитных.

Процессоры IBM

IBM Q Systerm One

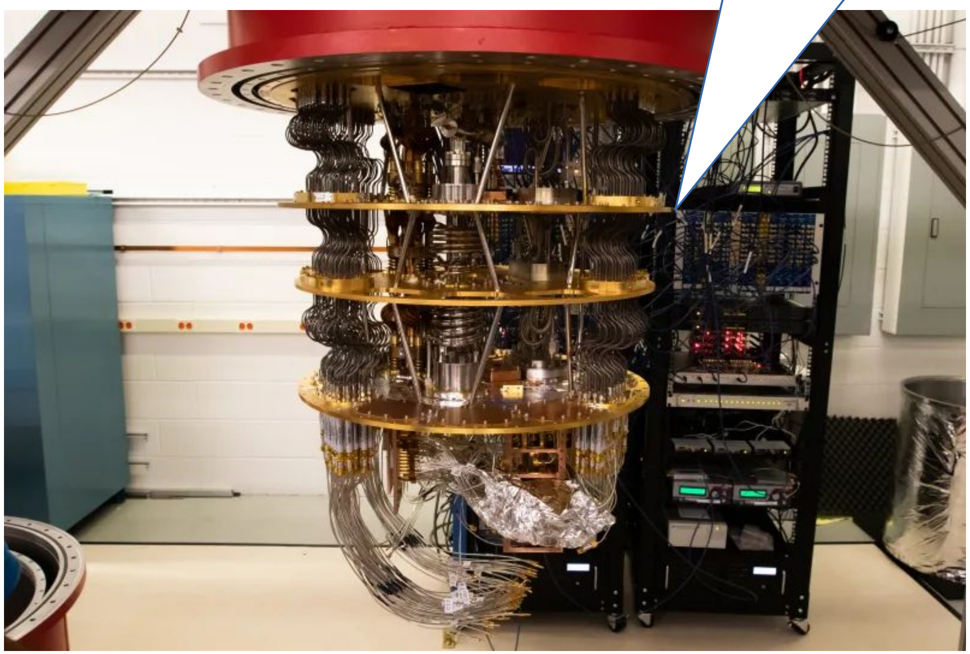
Корпорация IBM представила Q System One – компактный модульный квантовый компьютер, который сами представители компании окрестили «первой в мире интегрированной универсальной квантовой вычислительной системой, разработанной для научного и коммерческого применения».

Анонсированная на международной выставке потребительской электроники CES 2019 система представляет собой 20-кубитное вычислительное устройство четвертого поколения, заключенное в герметичный корпус в форме куба с гранью длинной 2,75 м, который выполнен из боросиликатного стекла толщиной 1,27 см. Помимо квантового процессора в корпусе Q System One располагаются различные управляющие модули, а также система охлаждения.

Google vs IBM

Квантовое превосходство!

Google Sycamore

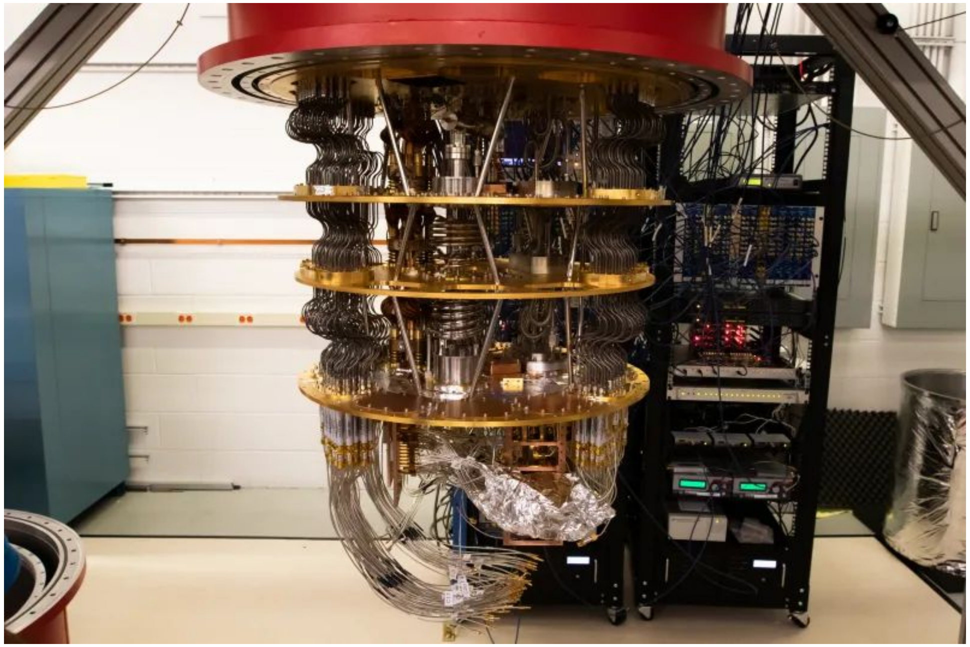


IBM Summit

Google vs IBM

Нет!

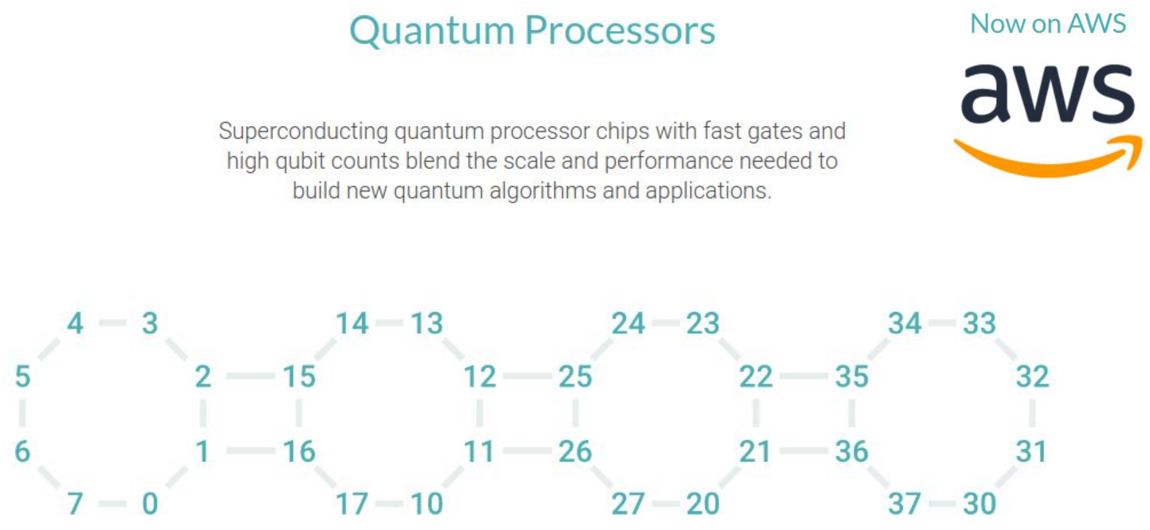
Google Sycamore



IBM Summit

Rigetti Computing

- Rigetti Computing is a Berkeley, California-based developer of quantum integrated circuits used for quantum computers. The company also develops a cloud platform called Forest that enables programmers to write quantum algorithms.



[Portfolio rebalancing experiments using the Quantum Alternating Operator Ansatz]

D-Wave

Manufacturer	Name/Codename/Designation	Architecture	Layout	Socket	Fidelity	Qubits	Release date
D-Wave	D-Wave Advantage	Superconducting	N/A	N/A	N/A	5000 qb	2020
D-Wave	D-Wave 2000Q	Superconducting	N/A	N/A	N/A	2048 qb	2017
D-Wave	D-Wave 2X	Superconducting	N/A	N/A	N/A	1152 qb	2015
D-Wave	D-Wave Two	Superconducting	N/A	N/A	N/A	512 qb	2013
D-Wave	D-Wave One (Ranier)	Superconducting	N/A	N/A	N/A	128 qb	11 May 2011

Облачная платформа Leap

D-Wave объявила о запуске гибридной платформы с открытым исходным кодом под названием D-Wave Hybrid. Она предназначена для разработки и запуска квантово-классических гибридных приложений. Платформа является частью пакета для разработки ПО Ocean в облачном сервисе Leap Quantum D-Wave и уже доступна для загрузки.

Pegasus

Pegasus is a significant advancement over D-Wave's Chimera topology, which is available in the 2000Q product and its predecessors. Pegasus features qubits of degree 15 and native K4 and K6,6 subgraphs.

Advantages of this new topology include:

• more efficient embeddings of cliques, bicliques, 3D lattices and penalty models, and improved heuristic embedding run times;

• novel class of couplers that help error correction schemes, boosting energy scales and providing parity/auxiliary qubits; these are also useful in encoding various logical constraints.

Pegasus

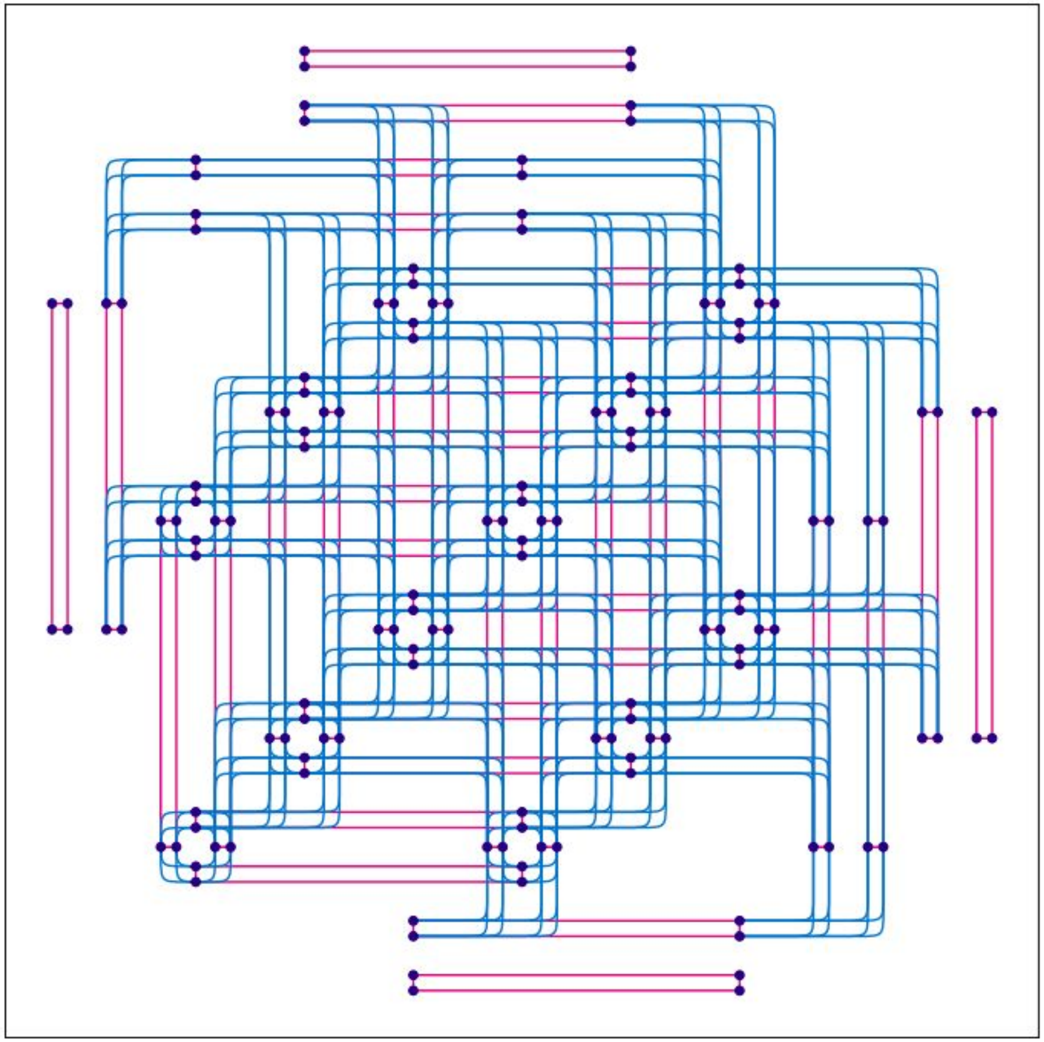


Figure 1: Roadway-style drawing of qubits (dots) and couplers (lines) in a P_3-sized Pegasus(0) processor, where curved blue lines are "internal" couplers, long red lines are "external" couplers, and short red lines are "odd" couplers.

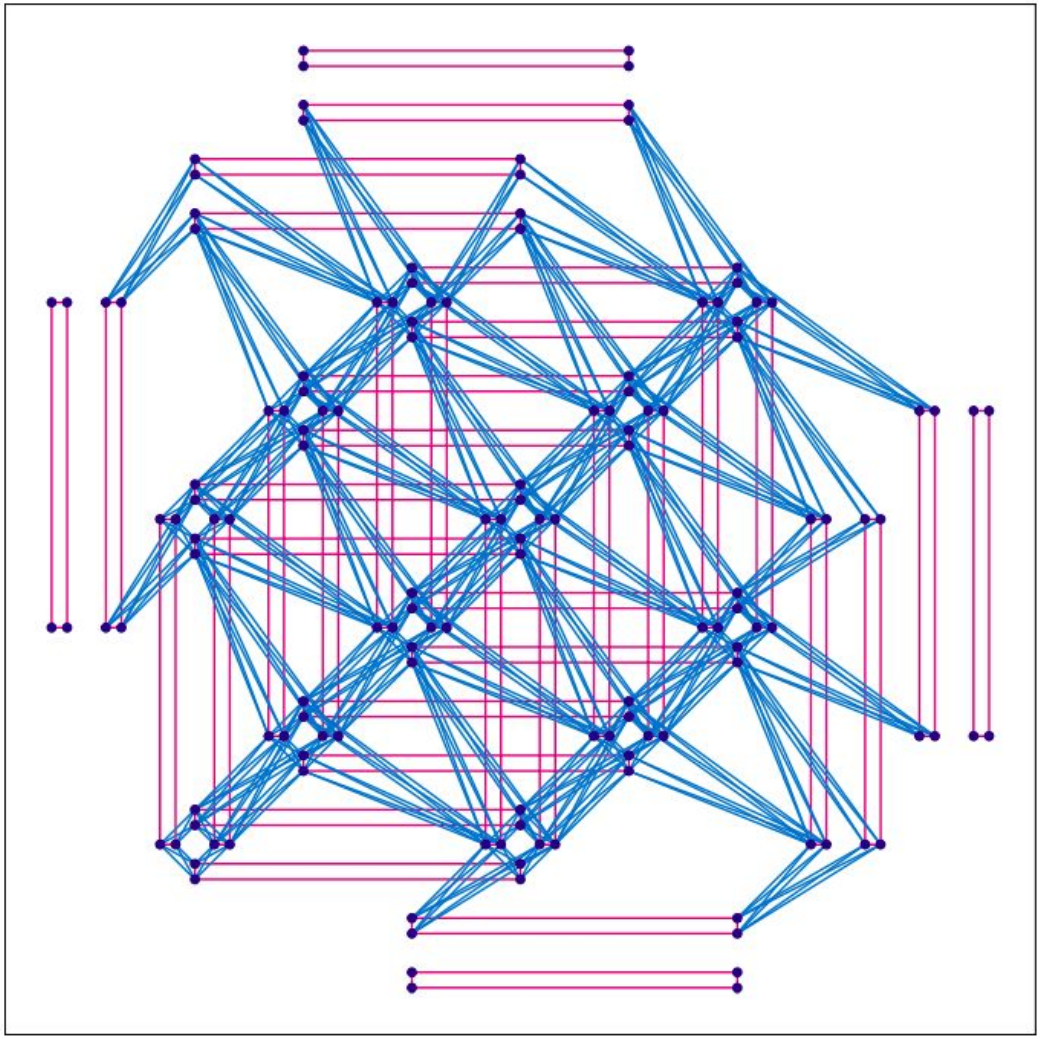
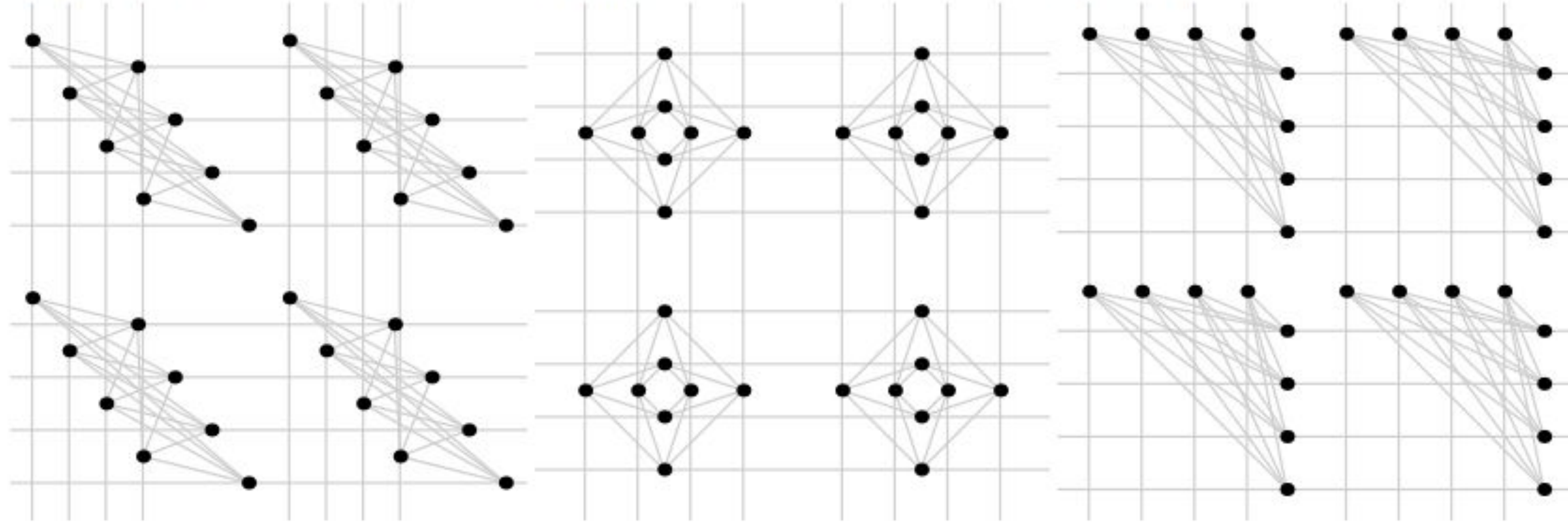


Figure 2: Straight-line drawing of qubits (dots) and couplers (lines) in a P_3-sized Pegasus(0) processor, where blue lines are "internal" couplers, long red lines are "external" couplers, and short red lines are "odd" couplers.

Pegasus

Figure 1: Three different depictions of the Chimera graph, with open edges to show that the pattern repeats.

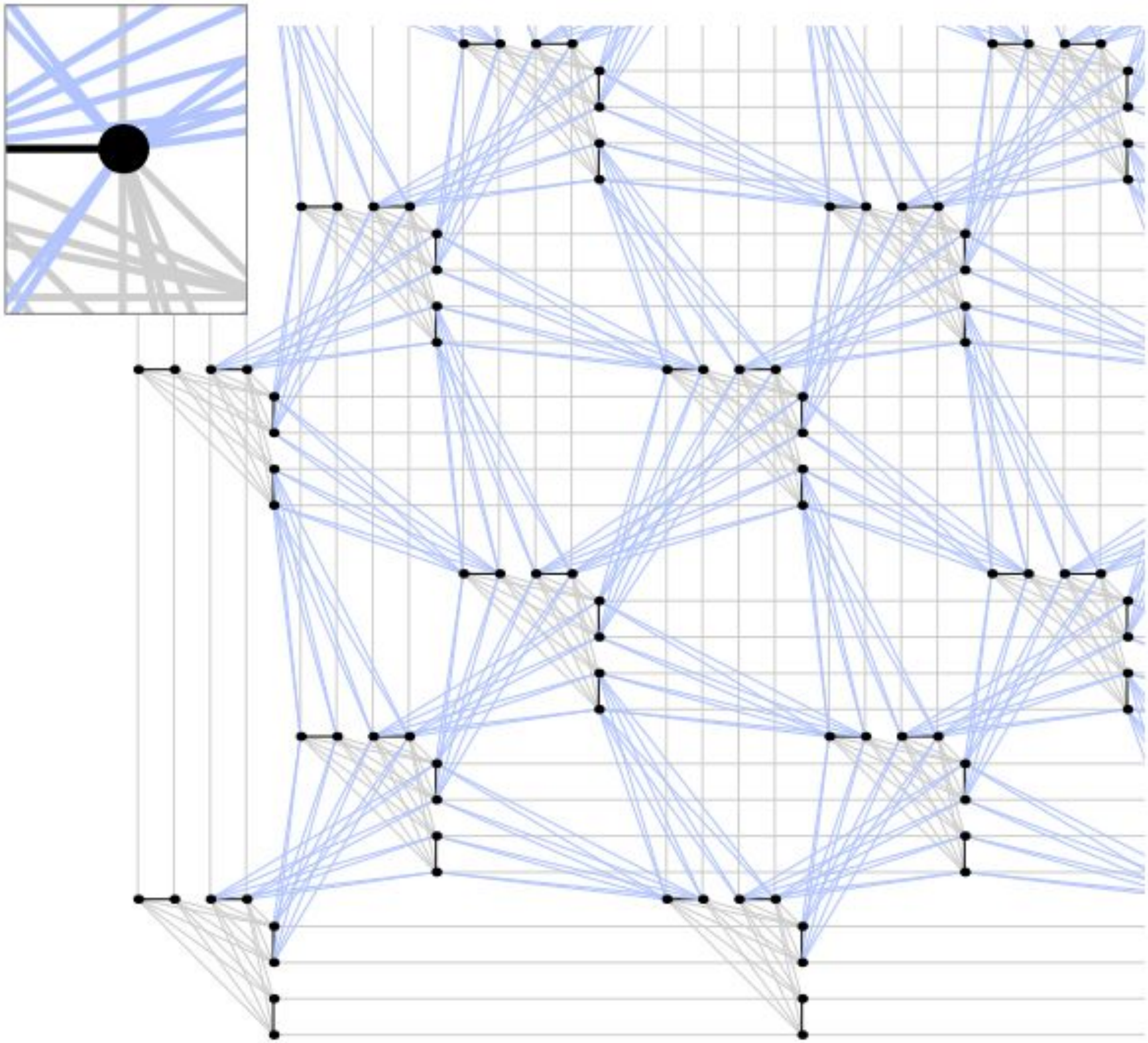
(a) Tilted classic (b) Diamond (c) Triangle



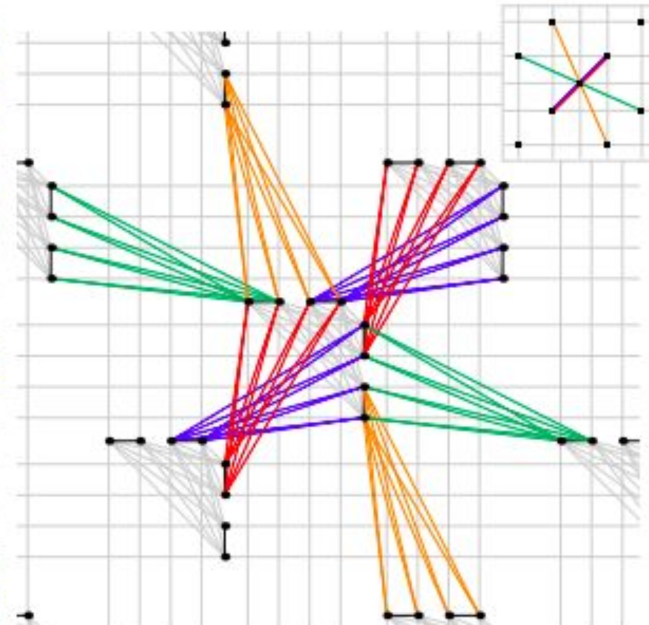
Pegasus

Figure 2: The Pegasus graph.

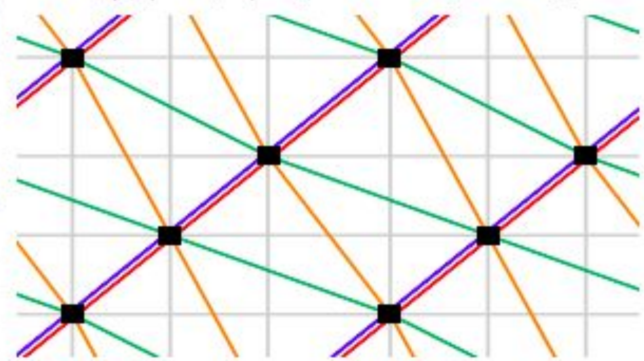
(a) A patch of size $(X, Y, Z) = (2, 2, 3)$ cropped out of a Pegasus graph. Grey edges are part of the three layers of Chimera graphs, while black and blue edges form the remainder of the Pegasus graph (the latter connecting different layers).



(b) Groups of $K_{2,4}$ edges connecting cells belonging to different Chimera layers, colored according to Eqs. (12)-(19).

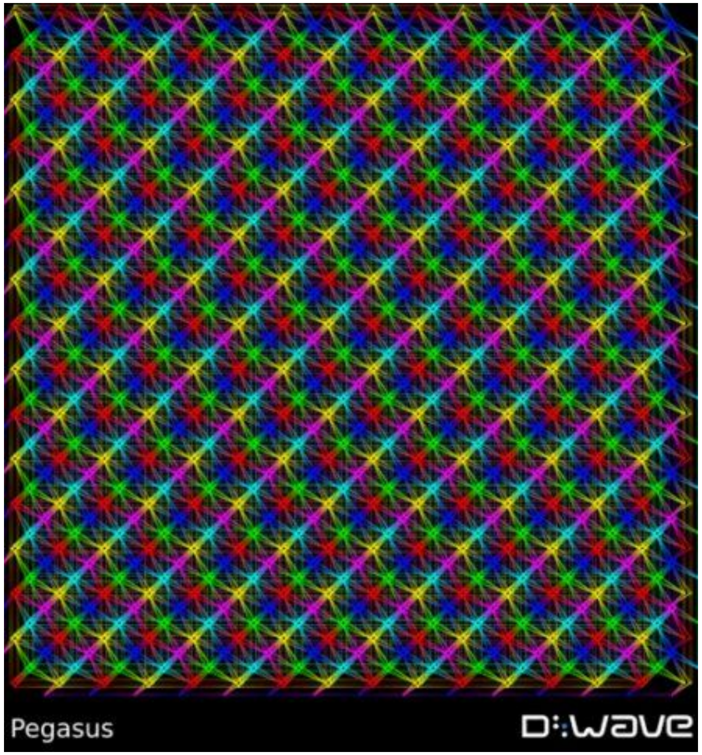


(c) 'Compressed' version of the Pegasus graph, with each cell represented by one vertex and each $K_{2,4}$ (8 edges) represented by one edge.



D-Wave Advantage

NEWPORT, R.I., Sept. 24, 2019 -- D-Wave Systems Inc., the leader in quantum computing systems, software, and services, today announced that its next-generation quantum system will be named Advantage™. Advantage will be available in the Leap™ quantum cloud service in mid-2020. Designed to speed the development of commercial quantum applications, the Advantage quantum system will power a new hardware and software platform that will accelerate and ease the delivery of quantum computing applications.



“Quantum computing is only as valuable as the applications customers can run,” said Alan Baratz, chief product officer, D-Wave. “With the Advantage quantum system, we are building the first ever quantum computer designed to deliver business benefit. Our investments across our quantum platform, which includes the Leap quantum cloud service, the Advantage quantum system, and the Ocean developer tools, will together allow customers to solve even more complex problems at greater scale and bring emerging quantum and hybrid applications to life.

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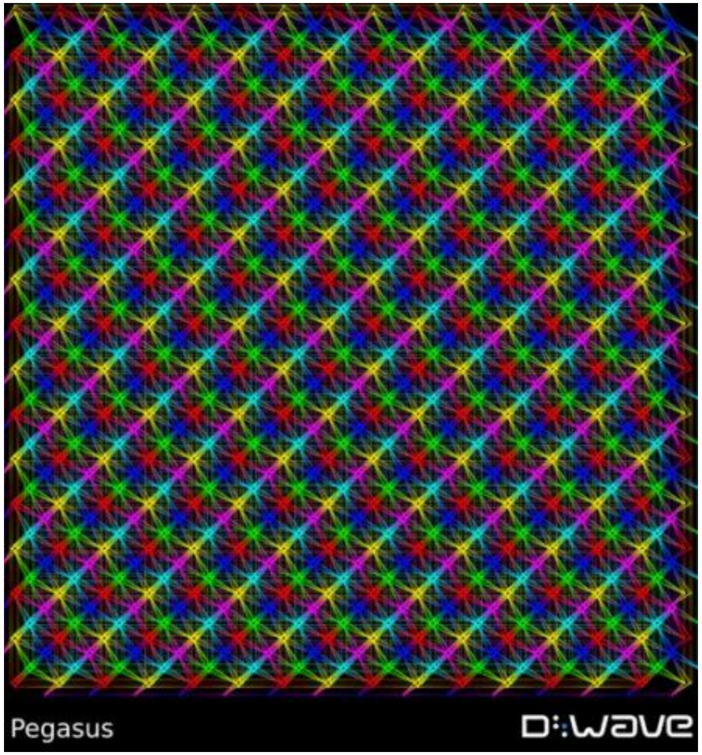

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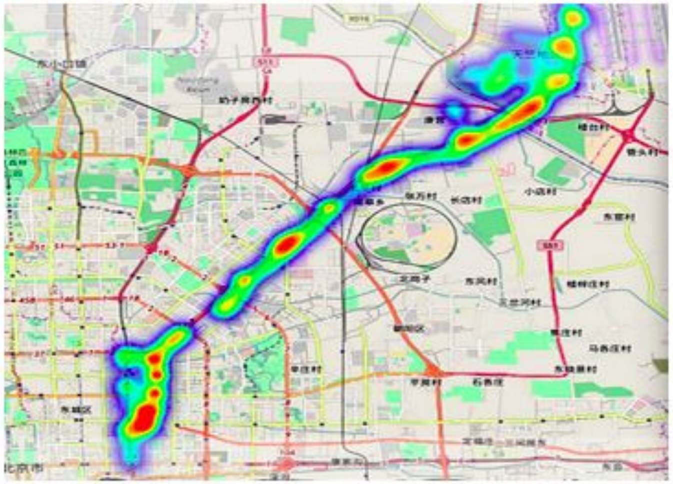
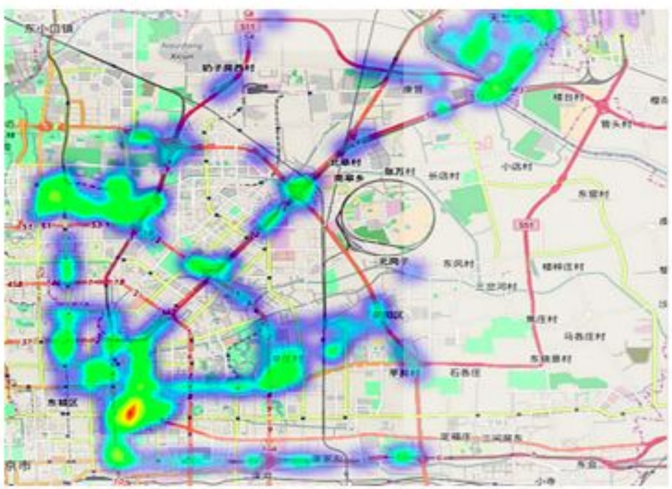
Сотрудничество с Volkswagen

Before: Congestion to the airport



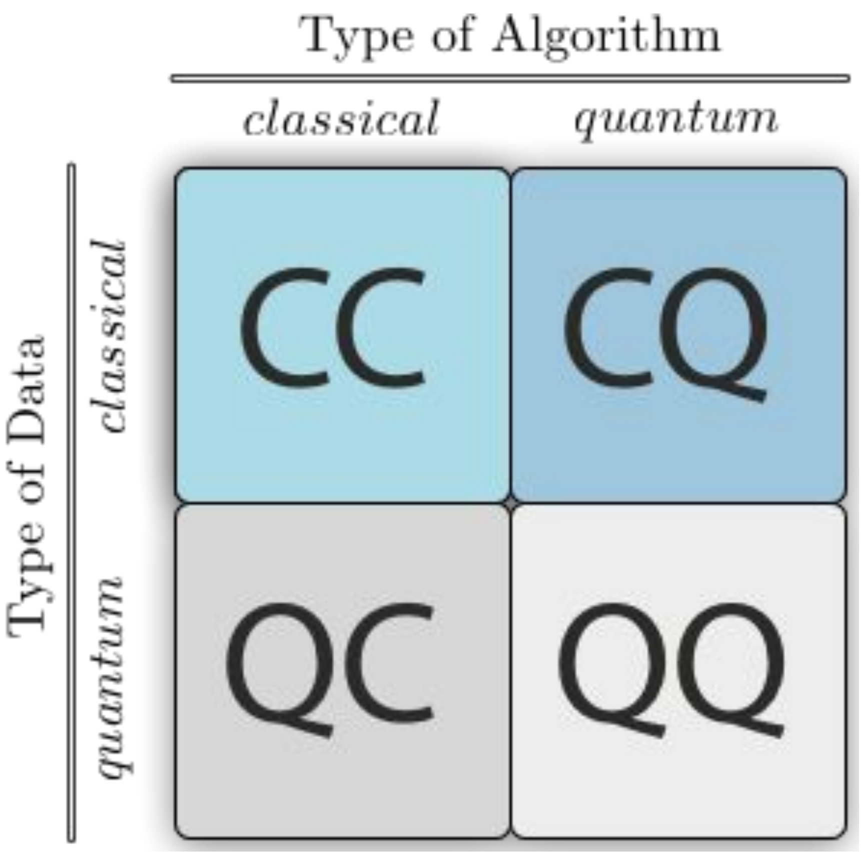
After: Optimized traffic flow



The First Production Quantum Application

Based on the proof-of-concept, Volkswagen developed a mobile app which predicts the best route to any given destination, and unveiled it to attendees of the 2019 WebSummit in Lisbon. Nine buses running on three lines commuted the half hour between the city center and the conference. To calculate the optimal routes, VW used traffic data from Here Maps, providing updates to bus drivers every two minutes. They are in talks to offer their new state-of-the-art traffic management system to cities around the globe, enabling public transportation organizations, taxi companies, and transport service providers to deploy their fleets more efficiently while minimizing waiting times for passengers and reducing air pollution and accidents.

Quantum machine learning



- Linear algebra simulation with quantum amplitudes
- Quantum machine learning algorithms based on Grover search
- Quantum-enhanced reinforcement learning
- Quantum annealing
- Quantum sampling techniques
- Quantum neural networks
- Hidden Quantum Markov Models
- Fully quantum machine learning
- Quantum learning theory

Ропозиторий с кучей информации по этому поводу

Спасибо за внимание