QC Benchmarks seen from science policy & science communication perspective

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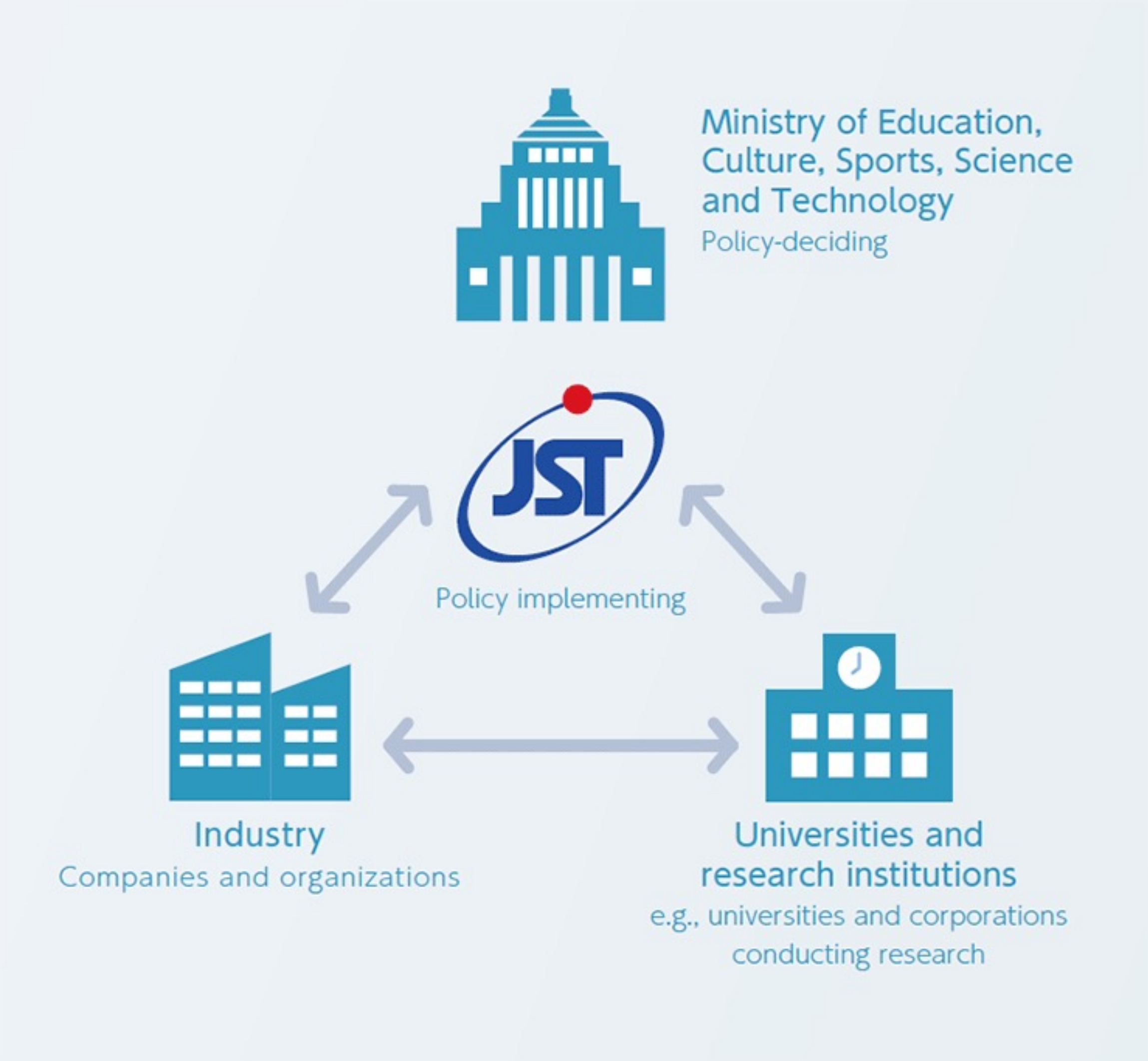

R&D Strategy Planning

Throughout dialogue with stakeholders and data analysis, JST formulates R&D strategies toward the future.

Funding Program

As a network-based research institute, JST promotes R&D leading to innovation and address economic & social issues throughout the implementation of research results and international joint researches.

Public Engagement

Promoting dialogue with various stakeholders toward co-creation of a future society. JST also fosters next generations talents in the fields of S&T as well as human resources who can contribute to S&T innovation.

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Importance of Quantum Computing Benchmarks

1. Science Policy

Clear and fair QC benchmarks promote healthy competition in the QC market and drive quantum innovation.

- QC benchmarks are crucial for the industry.
- Vender companies use QC benchmarks to evaluate their products and services, and to compare them with rivals.
- Users (in B2B and/or B2C) refer to QC benchmarks to make product selections.

2. Project Management

Accurate and multi-layer QC benchmarks lead to efficient progress to achieving project goals.

- QC benchmarks quantitatively assess project progress and identify potential obstacles early on.
- QC benchmarks allow for comparison of different approaches and technologies, enabling the redistribution of resources.
- QC benchmarks maybe useful to optimize QC architecture.

3. Science Communication

Easy-to-understand benchmarks are a good tool for outreach scientific achievements to the general public and stakeholders.

- Benchmark results can visually demonstrate the capabilities of QC, aiding in their accurate comprehension.
- In outreach to the media and the general public, benchmarks may help explain the potential impact of quantum computing.

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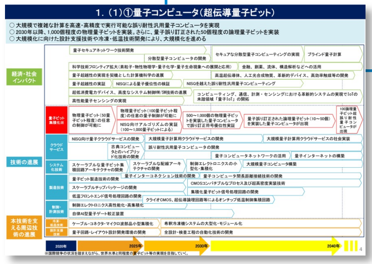
Japan’s National Quantum Strategy

R&D Roadmap

QT Innovation Strategy
(Jan. 2020)

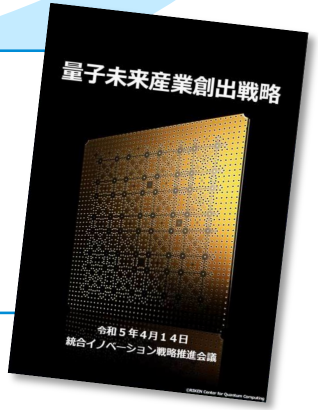


Vision & Goals

Vision of Quantum Future Society (Apl. 2022)

Action Plan

Quantum Future Industry Creation Strategy
(Apl. 2023)



2030 Target

10 million
domestic QT users

50 trillion JPY*
produced by QT

*370B USD

Unicorn* QT startup
to open up future markets

*Valuation > 1B USD

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QC Hardware in the Cambrian Age

	North America	Europe	Asia Pacific
Superconducting	IBM🇺🇸, Google🇺🇸, Rigetti Computing🇺🇸, qci🇺🇸, Bleximo🇺🇸, D-wave🇨🇦, Nord Quantique🇨🇦	QuTech🇳🇱, QuantWare🇳🇱	Alibaba🇨🇳, Origin Quantum🇨🇳, Fujitsu（w/Riken）🇯🇵
Trapped-ion	IonQ🇺🇸, Quantinuum🇺🇸	Oxford Ionics🇬🇧, Universal Quantum🇬🇧, AQT🇦🇹	启科量子（Qudoor）🇨🇳
Cold atom	Infeqtion🇺🇸, Atom Computing🇺🇸, QuEra Computing🇺🇸	Pasqal🇫🇷, Planqc🇩🇪	
Silicon q-dot	EeroQ🇺🇸, Photonic Inc🇨🇦	Intel（w/QuTech）🇳🇱, Quantum Motion🇬🇧	Silicon Quantum Computing🇦🇺, Hitachi🇯🇵
Photonic	PsiQuantum🇺🇸, Xanadu🇨🇦,	ORCA🇬🇧, QuiX Quantum🇳🇱	TuringQ🇨🇳
Diamond NV			Quantum Brilliance🇦🇺
NMR			SpinQ🇨🇳
Topological	Microsoft🇺🇸, Nokia/BellLabs🇺🇸		

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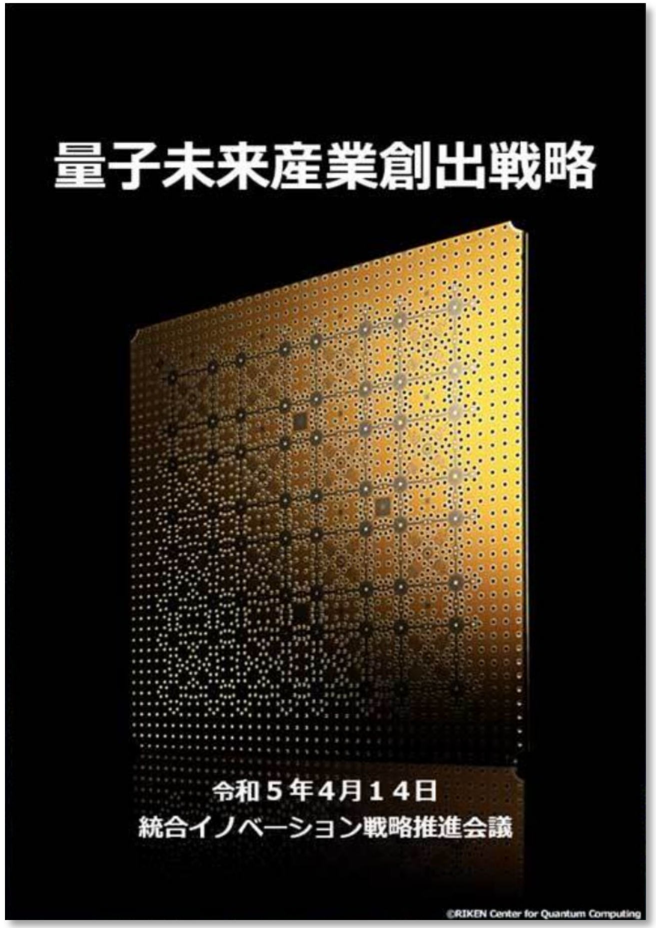
Quantum Future Industry Creation Strategy



Accurate benchmarks will be set for the superiority and effectiveness of quantum technology over existing technologies in terms of performance, cost, convenience, etc., and information will be provided to help users make decisions on the use of QT from a management perspective. Since quantum computers and other technologies are still in the process of development, the current status and future prospects necessary for users to make commercialization decisions will be provided in the form of TRL (Technology Readiness Level) and BRL (Business Readiness Level).

For users, it does not matter whether the computer is quantum or not, as long as it solve their problem. It is important to search for use cases of quantum/classical hybrid systems that incorporate and integrate quantum technology into conventional (classical) technology systems, and to conduct benchmark comparisons with existing technologies to clarify the benefits of utilizing quantum technology.

(Translated by me w/ GPT-4)

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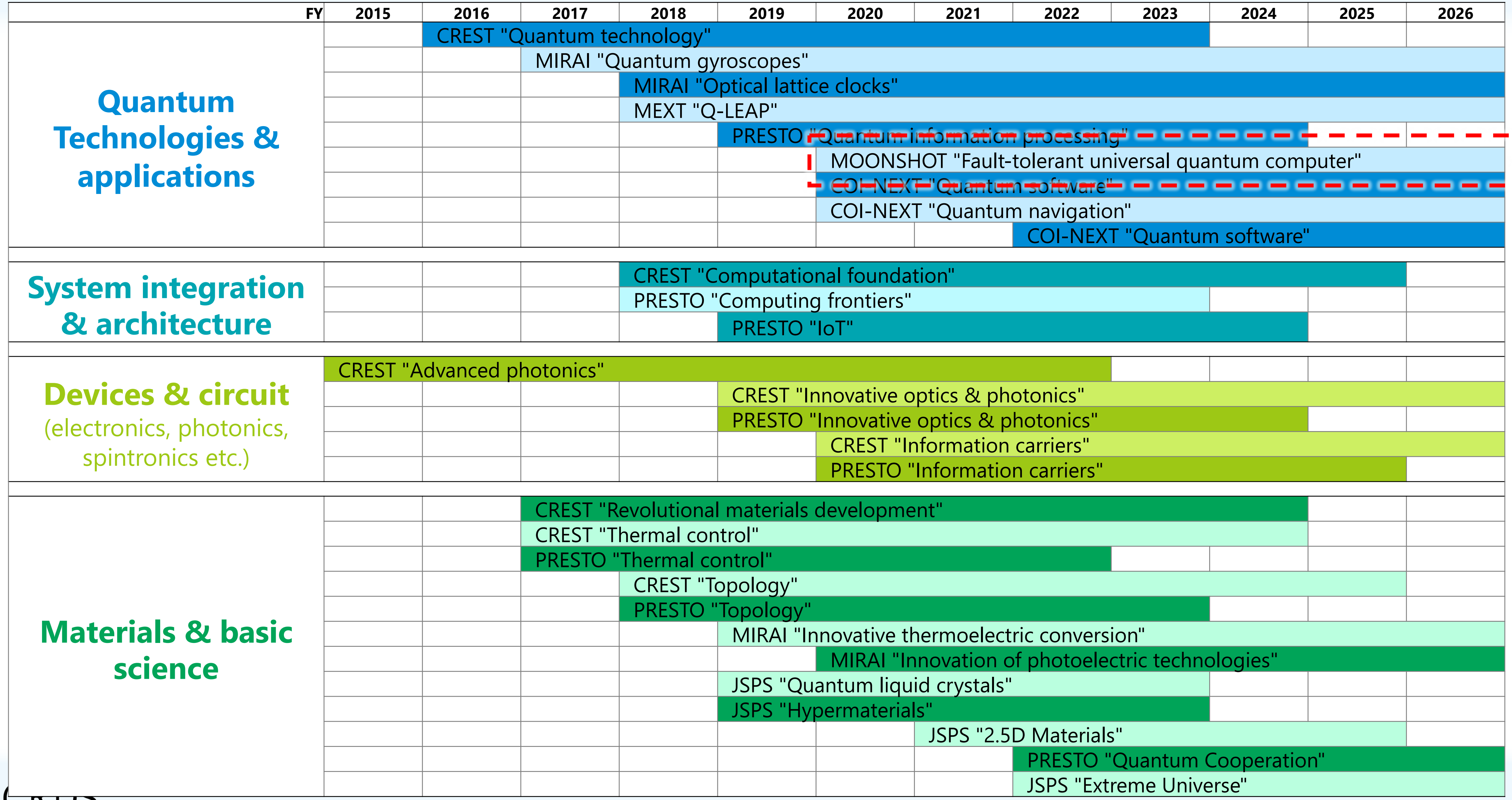
Japanese on-going Quantum Projects



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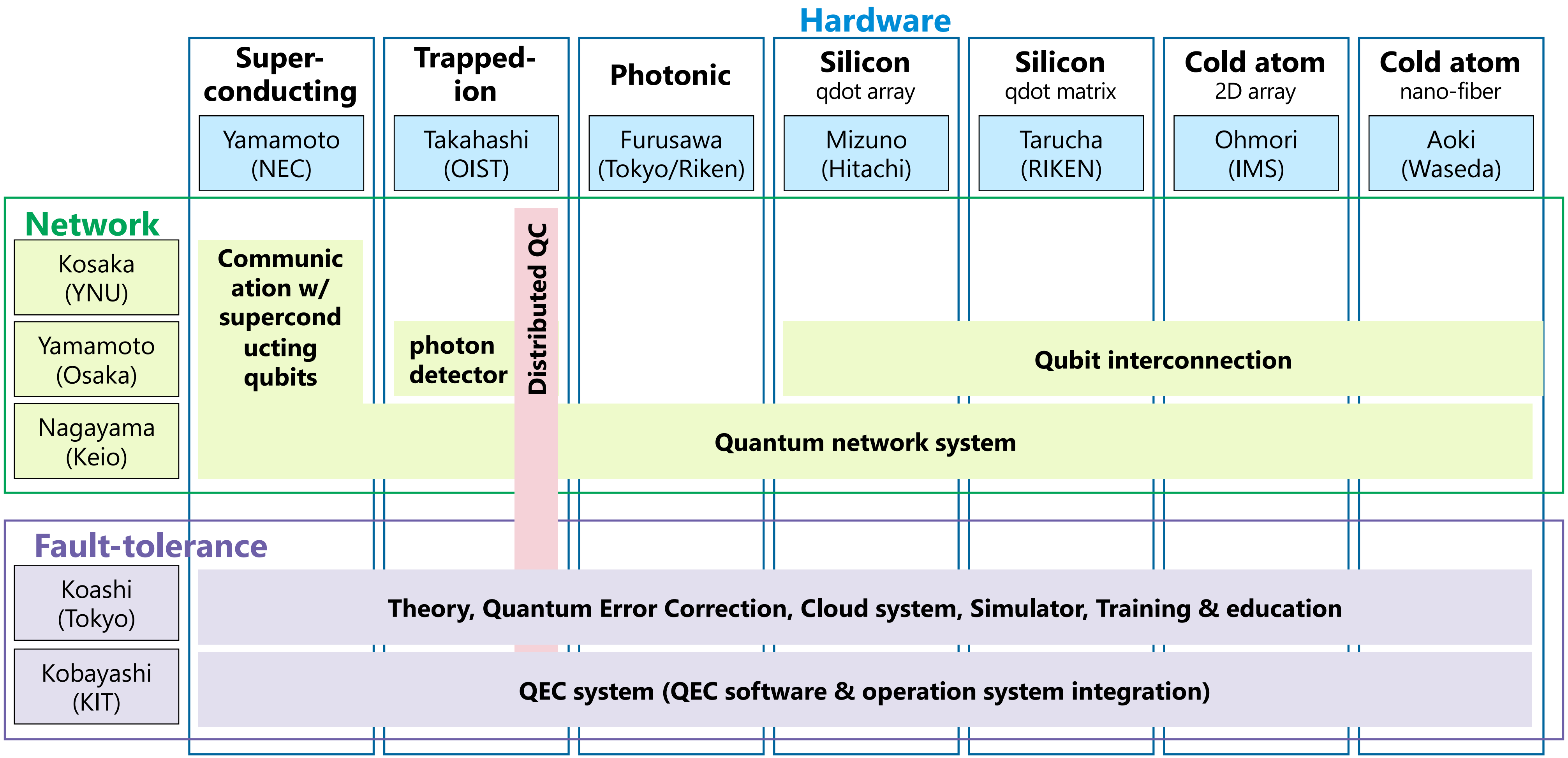
https://www.jst.go.jp/inter/washington/quantumdcl2021.html

Moonshot Project

Goal: Realization of a fault-tolerant universal quantum computer by 2050.



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https://www.jst.go.jp/moonshot/en/program/goal6/

QC Benchmarks Diversity

Quantum circuit ↕ System & Device

Benchmark	Proposed by	Measure
SupermarQ	Super.tech	Probability of success when executing common quantum algorithms and subroutines
App-oriented benchmark	QED-C	Probability of success when executing common quantum algorithms and subroutines
Q-Score	Atos	Maximum problem size that can be handled by that qc hardware in an optimization problem
Mirror Circuits	Sandia National Lab.	Probability of success when executing mirror circuits (improved RB)
Circuit Layer Ops / sec (CLOPS)	IBM	Circuit Layer Operations Per Second
Quantum Volume	IBM	The size of the largest executable square random quantum circuit
#qubit, T1,T2, Gate fidelity, speed, etc…		Physical properties of qubit/qgate implementation

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Quantum Hype ?

Quantum Computing Hype is Bad for Science

Published on July 17, 2021

Victor Galitski
Professor, Joint Quantum Institute, Univ. of Maryland (all views are my own)

1 article + Follow

Unless you've been living under a rock, you've probably noticed the recent proliferation of striking headlines about revolutionary developments in quantum science and technology, amazing recent successes of world-changing quantum startups, and huge government and private investment in quantum computing to capitalize on the imminent second quantum revolution. Being a bit familiar with quantum physics and having recently spent some time trying to understand how the new “quantum industry” operates, I am getting more and more concerned that this recent quantum computing (QC) commotion is a self-perpetuating “intellectual” Ponzi scheme, a bubble, which may sooner or later crash and take legitimate research and innovation efforts down with it. To be sure there are gems in this "quantum technology space," but they are far and few between. Most ventures are questionable at best and are kept afloat by a huge & growing influx of funding, which is not based on any rational thinking or reasonable

https://www.linkedin.com/pulse/quantum-computing-hype-bad-science-victor-galitski-1c/

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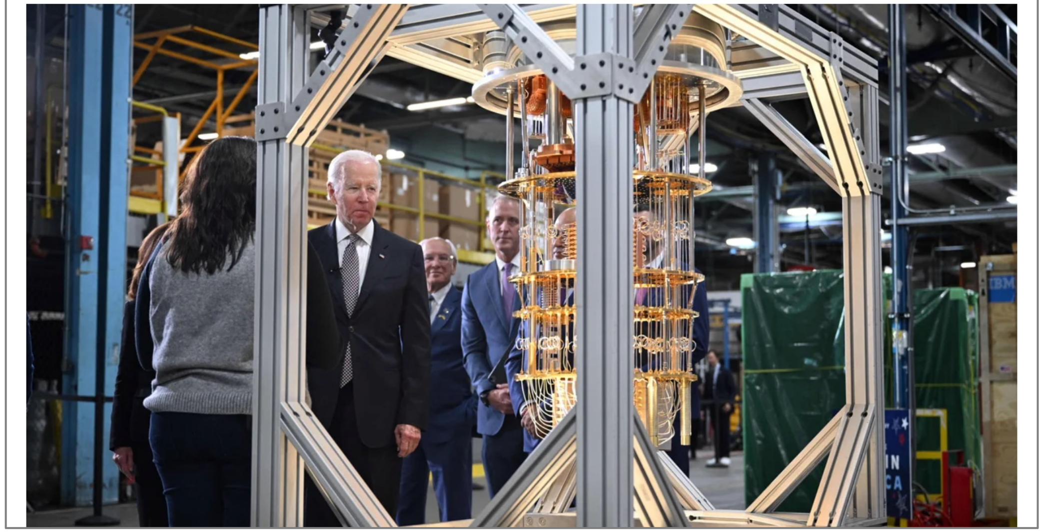
QUANTUM COMPUTING

Biden’s push for new quantum controls has one big problem: Nobody knows where to draw the line

The Commerce Department is talking with quantum computing companies in an effort to develop additional trade restrictions on the technology. The discussions fit into the Biden administration’s plan to protect emerging and foundational tech.



https://www.protocol.com/enterprise/quantum-computing-export-controls

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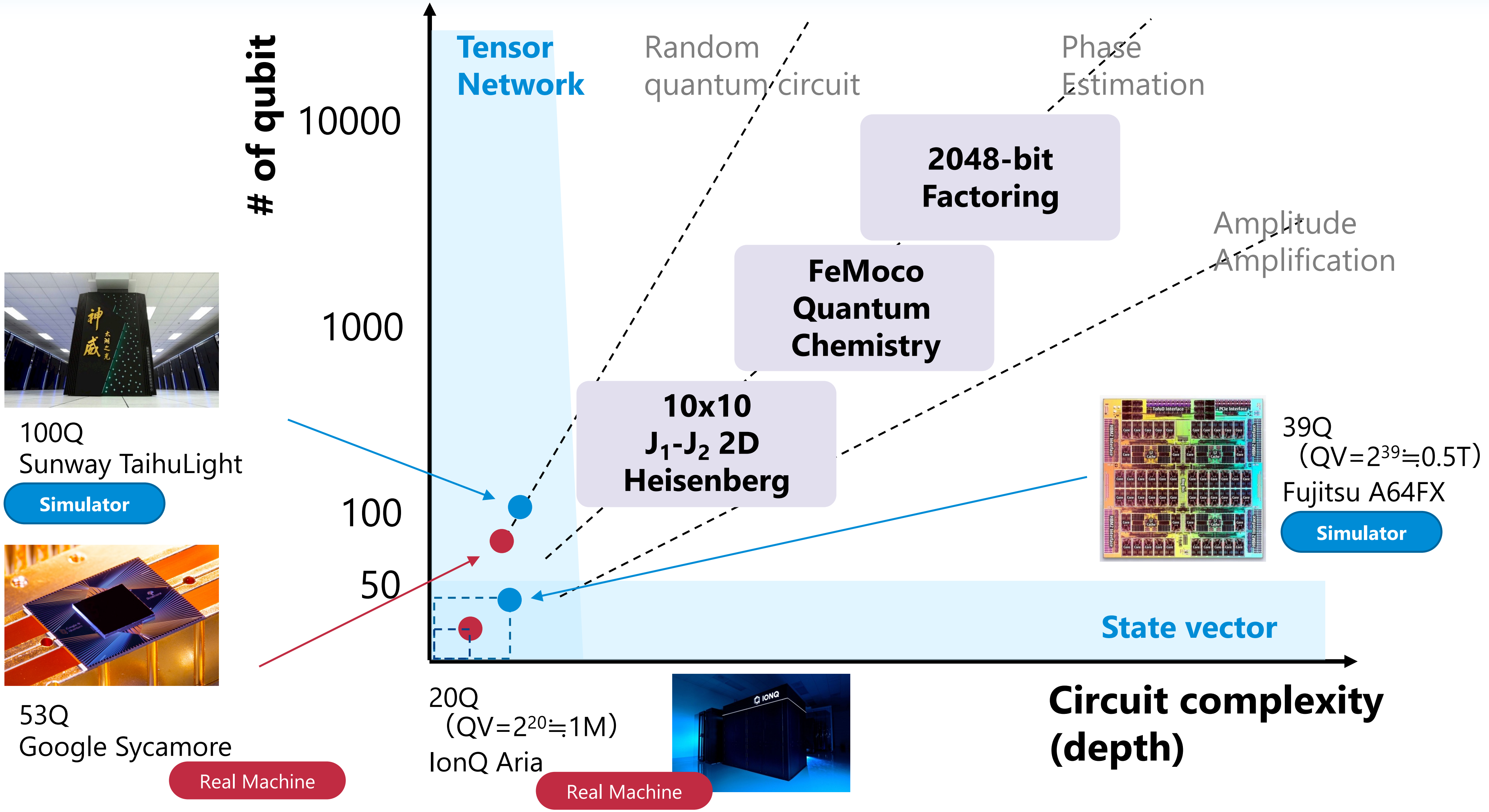
QC-HPC co-evolution



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Challenge of QC benchmarks

1. Science Policy

Clear and fair QC benchmarks promote healthy competition in the QC market and drive quantum innovation.

- Quantum advantage
- Energy (OPs/W)
- Cost ($/OPs)
- Non-functional requirement (availability, reliability, maintainability, security, etc...)

2. Project Management

Accurate and multi-layer QC benchmarks lead to efficient progress to achieving project goals.

- Benchmarks diversity
- Rich information beyond QV
- Device simulator, CAE
- Consistency
- Reproducibility
- International standards

3. Science Communication

Easy-to-understand benchmarks are a good tool for outreach scientific achievements to the general public and stakeholders.

- Balance between clarity (easy-to-understand) and accuracy
- Communication between expert and non-expert

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