Tentative Translation

Strategy of Quantum Future Industry Development

Summary

April 2023

Secretariat of Science, Technology and Innovation Policy, Cabinet Office

Strategy of Quantum Future Industry Development

- ○ The **Vision of Quantum Future Society** establishes the visions and goals to be achieved by quantum technology (QT)
- ○ This strategy summarizes the **priority actions to realize the goals by making QT practically-applied and industrialized**
- ○ This report is positioned as a "**strategy that sets out a policy and action plan for the practical application and industrialization of quantum technology**"

Research

Quantum Technology and Innovation Strategy

Established in January 2020
Revision of technology roadmap on April 2022
R&D Strategy for Quantum Technology

Vision

Vision of Quantum Future Society

Established in April 2022
Strategy for social transformation
Future vision, targets, etc.

Industry

Strategy of Quantum Future Industry Development

Established in April 2023
Practical application and industrialization strategy of quantum technology

Goals by 2030

10 million quantum technology users in Japan

Through quantum technology, production to 50 trillion Yen

Fostering quantum unicorn companies to create future markets

The direction of the industry and three perspectives

○ Setting the **direction of the industry to be aimed**, also taking into account the 2030 targets of the Vision for Quantum Future Society
○ Establish **three perspectives** for future practical and industrialization efforts of QT

Direction of the quantum industry (X to Quantum)

Participation, collaboration and co-creation of diverse industries

Practical application and industrialization of QT

Development and growth of start-up, venture and new businesses

Industrialization through industry-academia-government collaboration

Global collaboration and deployment

Many industries can access and utilize quantum technology

Goals by 2030

- **10 million quantum technology users** in Japan
- **Through quantum technology, production to 50 trillion Yen**
- **Fostering quantum unicorn companies** to create future markets

Three perspectives for making QT practical and industrialization

Collaboration
Participation, collaboration and co-creation of diverse industries, global cooperation, industry-academia-government collaboration

Accessibility
Realization of an environment for the use of QT open to industry

Incubation
Aggressive support of start-up/venture and new business creation

Challenges for practical application and industrialization, and basic policy

○ The **main challenges** for the practical application and industrialization of QT
○ Establish a **basic response policy** to the main issues

Main challenges for practical application and industrialization

- Few effective use cases for quantum utilization
- High hurdles to quantum technology
- High business risk due to uncertain technologies and markets
- Insufficient environment for start-up and new business creation
- Shortage of industrial human resources (HR)

■ Collaboration ■Accessibility ■Incubation

+ Acceleration

Basic Response Policy

Support for building use cases	Improvement of the user environment	Business risk response	Start-up creation	Industrial HR develop
・Support for the creation of attractive use cases from management perspectives ・Establishment of effectiveness and performance indicators through the use of QT	・Developing user environment of quantum computers, etc. ・Support to industry (education program, technical assistance) ・Providing info. for new entrants	・Development of equipment shared by several companies ・Co-creation of multiple companies, e.g. common components ・Basic research support	・Creation and support of start-ups and new businesses ・Entrepreneurial HRs development ・Pitch contest ・Ecosystem formation	・Education programmes for industry and other HRs ・Exchange and flow of personnel between industry, academia and government ・Education programmes for young people

Promote initiatives based on the Basic Response Policy.

Efforts toward practical application and industrialization (1)

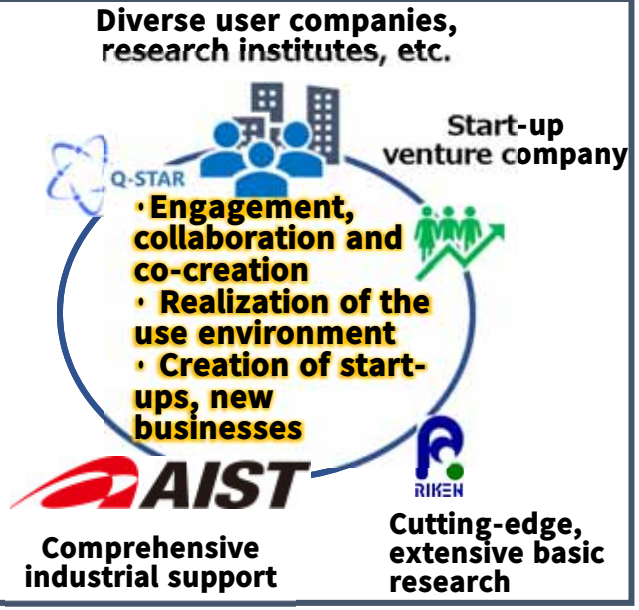
Quantum computer

[Software, development of user environment]

- ✓ Support for **creation of appealing use case**
- ✓ Investigation of **performance indicators of QT** from a management perspectives
- ✓ **Wide use of domestically developed quantum computers**
- ✓ Building a **real-use environment** to lead industrialization
- ✓ **Quantum/classical hybrid computing** environment

[Hardware, infrastructure technology]

- ✓ Accelerate the development of **domestic quantum computers**
- ✓ Accumulation of **operational experience and know-how**
- ✓ **Building a stable and robust supply chain** (clarification of necessary devices, participation of many companies, study of strategies to secure parts, materials, and technologies)



Quantum security networks

- ✓ **Creating appealing use cases**
- ✓ **Promoting the use of public authorities** as anchor tenants/early adopters
- ✓ Support for development **through test-bed operation, accumulation of operational and usage results and overseas expansion**
- ✓ Building infrastructure for the **authentication of quantum cryptography communications equipment**
- ✓ Building a comprehensive **quantum and classical architecture**.
- ✓ **Enhancement of wide-area test beds**
- ✓ Research and development of **quantum internet** and roadmap study

Quantum measurement and sensing/quantum materials

- ✓ Support for development and commercialization of **quantum sensing technology to diverse industries**
- ✓ Development of industry-academia-government **consortia**
- ✓ **Creating an environment** in which companies can easily use and develop quantum sensing
- ✓ **Support for the creation of use cases**
- ✓ Promotion of integrated hardware and software technology development and commercialization
- ✓ Establishment of a **stable supply system for quantum materials**

Efforts towards practical application and industrialization (2)

Innovation infrastructure

[Global collaboration and development of the quantum industry]

- ✓ **Support on global collaboration** and development in the public and private sectors
- ✓ **Demonstration of services abroad** (Europe, US, Asia, etc.)
- ✓ Support for **overseas development of start-ups**
- ✓ **International cooperation, dialogue, exchange** at various levels of industry, academia and government

[Development of infrastructure for the creation of start-ups, new businesses]

- ✓ **Matching support** with financial institutions, incubation providers, partner companies
- ✓ **Young entrepreneurial human resource (HR) development** of start-up leaders, HR matching
- ✓ **Mechanisms for identifying and generating business ideas**

[Developing industrial HR]

- ✓ **Develop and secure HRs in user fields** and business HRs in **management, IP, law** etc.
- ✓ Provision of **education programs based on clarification of the skills** required for each level, certification systems, education for young people
- ✓ **HR matching and development ecosystem** between domestic and international industry, academia and government

[New partnership between industry, academia and government]

- ✓ **Organizational partnership between the Quantum Technology Innovation Hub and Q-STAR** (Q-Partnership (tentative name))

[Standardization, IPR, benchmark]

- ✓ **Strategic standardization promotion** by industry, academia and government working together
- ✓ **Set and provide benchmark indicators** for effectiveness and performance from management and technical perspectives
- ✓ Strategic IPR in quantum technology innovation hubs

[Establish strategic supply chains]

- ✓ **Supply chain map** based on consideration of critical devices, components and materials
- ✓ **Consideration of development of common devices, etc. and use of general-purpose products, etc**
- ✓ **Building a broad industrial ecosystem**, including identifying enterprises, including SMEs

[Platform strategy and co-creation environment building]

- ✓ Strategies to **ensure common underlying technologies (platform technologies)** are required irrespective of future technology methods
- ✓ Creation of **systems and mechanisms for open innovation in which multiple companies collaborate**

[Strengthening of quantum technology innovation hubs]

- Global Research and Development Hub for Business by Quantum-AI Technology (AIST) (enhanced)
- Quantum Computation Pioneering Hub (RIKEN) (enhanced)
- Foundational Quantum Technology Centre (tentative name) and Quantum Life R&D Centre (Institute of Quantum Science and Technology) (enhanced)
- Quantum Frontier Industry Development Hub (Tokai National University Organization) (additional candidate)

*The name of the hub is provisional

Strengthening Quantum Technology Innovation Hubs

Strengthen the Quantum Technology Innovation Hubs to strongly support the creation of new value in industry, such as the creation of new industries, productivity improvements and solutions to social issues, by fusing and collaborating with various industrial sectors and quantum technology, taking advantage of Japan's industrial strengths.

Global Research and Development Hub for Business by Quantum-AI Technology (National Institute of Advanced Industrial Science and Technology) — Enhance

Creation of a global development center on the industrialization of quantum technology. Establishment of **a real-use computing environment for quantum-AI hybrids and provision of an environment and services to support use case creation, development, evaluation and prototyping** of components, materials, devices and integrated circuits.

Quantum Computation Pioneering Hub (RIKEN) — Enhance

Development of the Advanced Computing Centre, which will provide a state-of-the-art quantum/classical hybrid computing environment, etc., linking quantum computers and Fugaku, etc., and the exploitation of new industrial and scientific frontiers using this environment.

Foundational Quantum Technology Centre (tentative name) and Quantum Life R&D Centre (National Institute for Quantum Science and Technology) — Enhance

R&D and industrial support for quantum technology infrastructure, including the development of an **environment in which industry can use, test and evaluate** quantum materials, quantum sensing, etc., as well as **support for use and technology**, and the development of technologies and devices that also utilize optical science and technology.

Quantum Frontier Industry Development Hub (Tokai National Higher Education and Research System) — Add (candidate)

Developing technological and industrial frontiers through the fusion of chemistry, materials and other fields, in which Japanese industry has strengths, **and quantum technology,** creating new quantum industries, and **fostering human resources who will be responsible for collaboration and fusion between the fields** of quantum x chemistry and materials.

Quantum solutions (Tohoku University)

Quantum materials (NIMS)

Quantum sensing (Tokyo Institute of Technology)

Quantum Software Research (Osaka University)

Quantum computer applications (University of Tokyo Business Alliance)

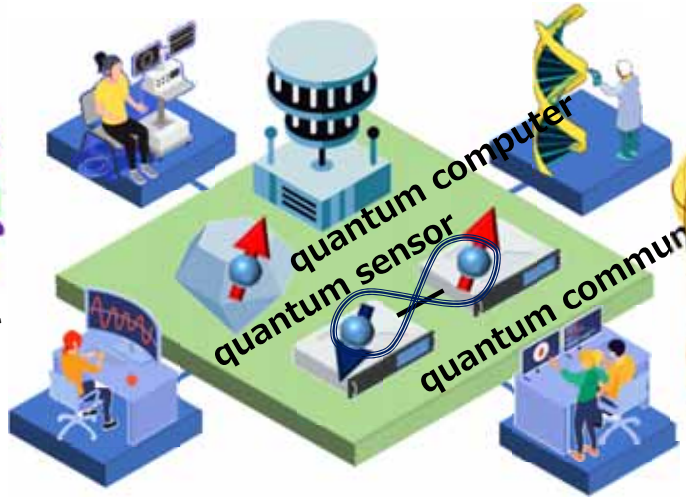
Quantum security (NICT)

Quantum technology international collaboration (OIST)

*Names of strengthened and new sites are provisional.

（Ref. 1） Perspectives on the practical-use and industrialization of QT

Collaboration	Accessibility	Incubation

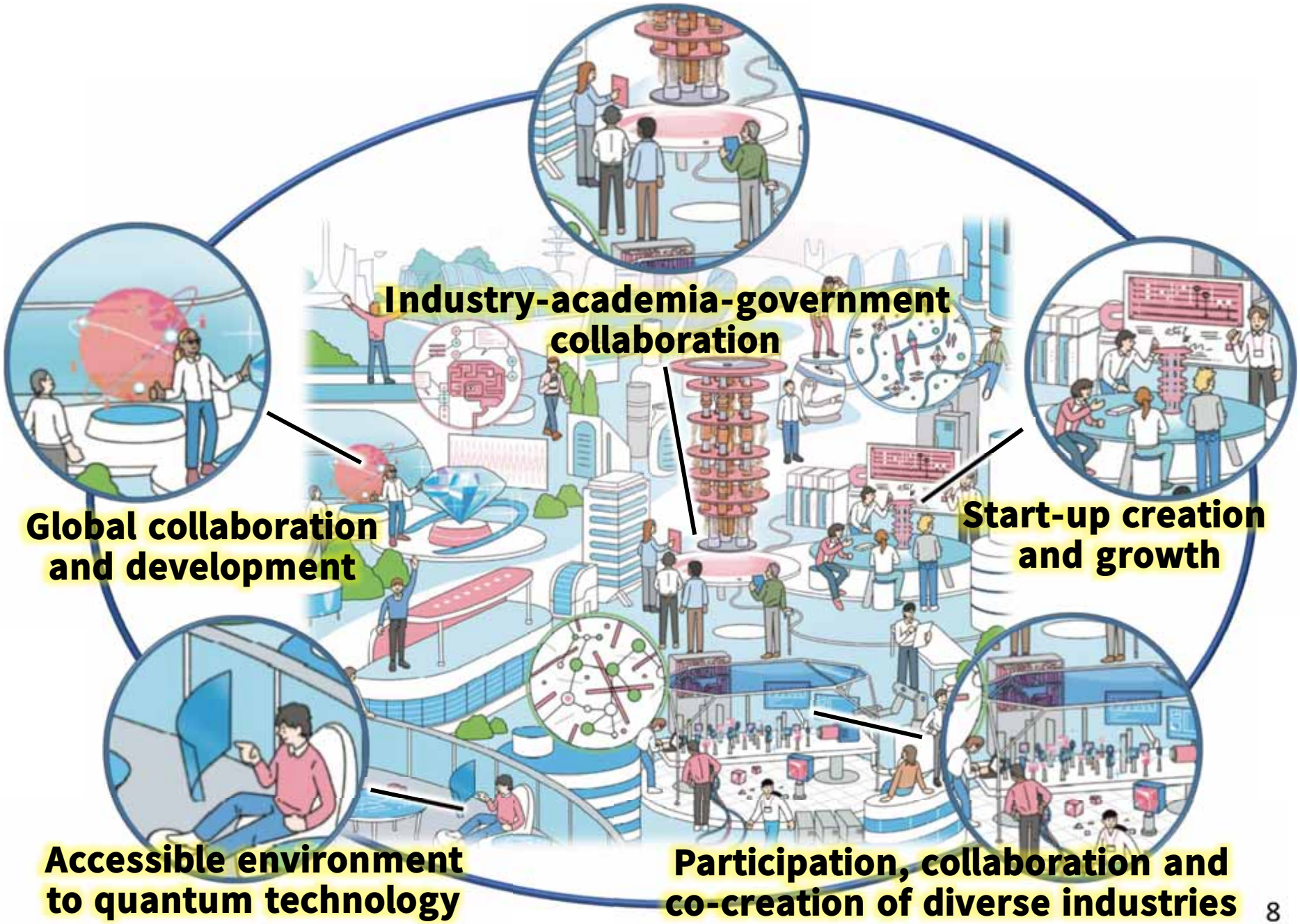


- **Creation of new value under participation, collaboration and co-creation of diverse industries**
- **Support for the creation of appealing use** cases for user companies
- **Strengthening global cooperation and market development, and industry-academia-government collaboration**, with a focus on the global market.

- **Creating an environment in which user companies** in diverse fields **can use QT.**
- **Support to facilitate the use of QT** (e.g. utilization support, technical support, educational support, etc.)
- **Dissemination of information on advantages and effectiveness (performance, cost, convenience, etc.)** over existing technologies.

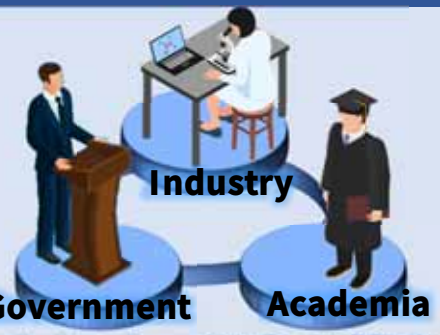
- **Creation and support of start-ups, new businesses, etc., and formation of venture ecosystems** by stimulating long-term and stable investment.
- **Formation of a comprehensive innovation infrastructure to** create and support start-ups, etc. **(e.g. financial institution matching, entrepreneurial human resource development, etc.)**

(Ref. 2)　Image of the quantum future industry (Overview)



(Ref. 3) Image of the quantum future industry (detail)

Industry-academia-government collaboration

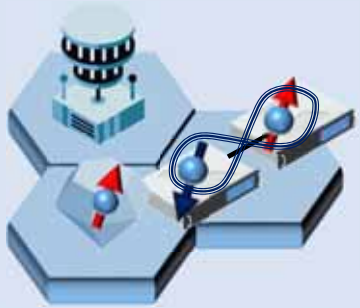


- Proximity of academia and industry
- Organizational collaboration between research hubs and industry associations.
- Support for initiatives from research to industrial applications

Participation, collaboration and co-creation of diverse industries

- Service creation and development through diverse user participation
- Hardware and system manufacturing through participation and co-creation of a wide range of industries

Access to QT



- Services for providing an environment for the use of QT
- Provision of educational services
- Construction and utilization of quantum/classical hybrids

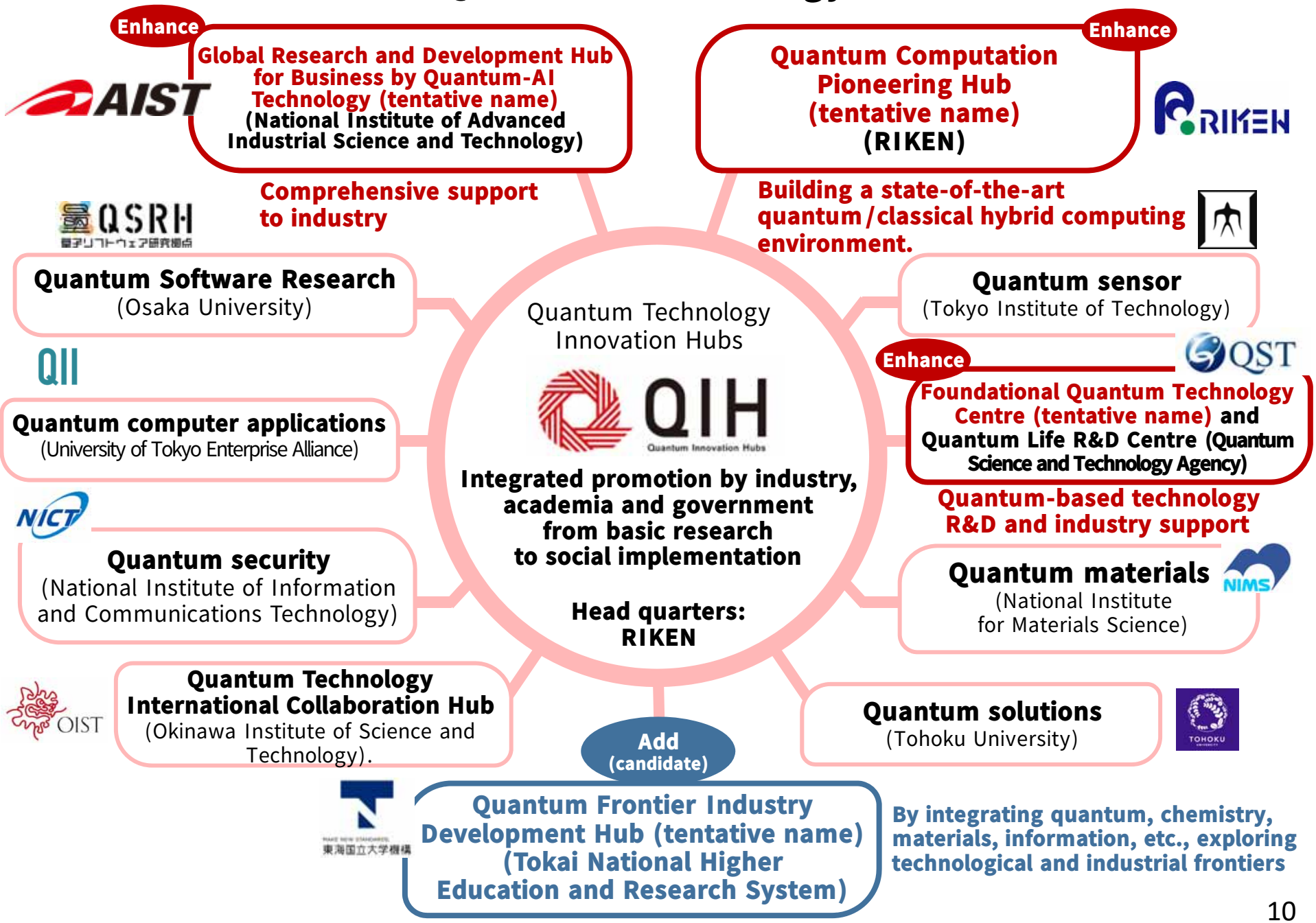
Global collaboration and development

- Aggressive global expansion
- Cooperation with companies from volunteer countries
- Ensuring an open-close strategy in IP

Creation and growth of start-ups, etc.

- Formation of venture ecosystems
- Developing and securing entrepreneurs, managers and investors
- Creation of new businesses and carve-out ventures in large companies

(Ref. 4) Overall Quantum Technology Innovation Hubs



(Annex 1)

Vision for Quantum Future Society

(22 April 2022.)

Government of Japan

https://www8.cao.go.jp/cstp/english/outline_vision.pdf

Vision of Quantum Future Society

Introduction

- ✓**Quantum technology (QT) has been rapidly advancing and its influence on society has been increasing.**
- ✓QT is becoming extremely **important for economic security**.
- ✓In order to realize the transformation of society as a whole to **create growth opportunities** for Japanese industry, and to **solve social issues** such as carbon neutrality, **vision of future society through QT and strategies to realize this vision** were discussed.

Quantum Technology and Innovation Strategy (January 2020) (R&D of QT) → Vision of Quantum Future Society (April 2022) (Social application of QT) → Socioeconomic Transformation

Changes in the environment surrounding quantum technology, etc.

- Intensifying international competition in Quantum industry
- Rapid progress in DX caused by the Corona disaster
- Contribution to a carbon neutral society
- Development of basic technologies supporting quantum computers
- Importance of quantum technology for economic security.


Google

Increased international competition!

<Benchmark comparison>.
Google (US) (published May 2021)
1,000 logical qubits in 2029
IonQ (US) (published Dec 2020)
1,024 logical qubits in 2028
Japan (Moonshot) (published 1 Jan 2020)
Tens to 100s of logical qubits by 2030

Three basic concepts of this vision

- ✓Create opportunities for **industry to grow and solve social challenges** by **incorporating QT into the overall socioeconomic system** and integrating it with conventional (classical) technology systems (**hybrids**)
- ✓**Promotion of the use of QT** by development of testbeds, etc.
- ✓**Creation and revitalization of industries and startups** using QT

Goals by 2030 for Vision of Future Society

10 million quantum technology users in Japan

Through quantum technology, production to 50 trillion Yen

Fostering quantum unicorn companies to create future markets