Goal 6 Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050.

Quantum Cyberspace with Networked Quantum Computer

Project manager

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R&D institutions

Osaka University, Hamamatsu Photonics K.K. (HPK), National Institute of Information and Communications Technology (NICT), Waseda University, and Okinawa Institute of Science and Technology (OIST)

Summary of the project

This R&D project will develop quantum network technologies to connect and scale up quantum computers on a small/medium scale, which are not large enough to realize a fault-tolerant universal quantum computer on their own. At the same time, we are conducting research to enable the implementation of any quantum algorithm, including distributed quantum computing by networking, and simultaneously solving the cybersecurity attacks manifested by "fault-tolerant universal quantum computers." Based on current technology, the hardware candidates for quantum computers include superconducting, optical, atom/ion, and semiconductor physical systems. We plan to realize a large-scale networked quantum computer and implement the quantum protocols by connecting these quantum computers in a network.

Milestone by year 2030

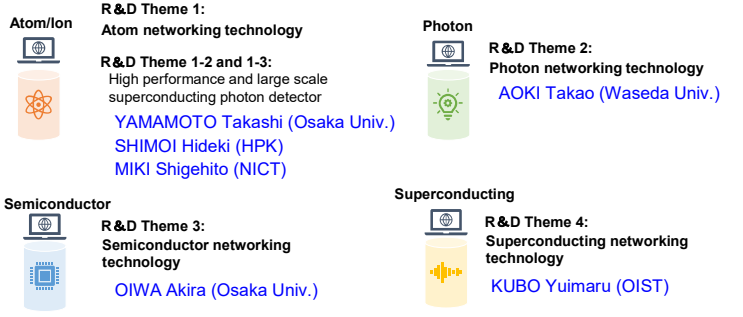
We will realize networked quantum computers on a large-scale enabling quantum error correction by connecting modular quantum computers on a small/medium scale. We will demonstrate quantum protocols with distributed quantum computers connected to the quantum internet.

Milestone by year 2025

To show that the number of qubits can be expanded to the scale required for error correction, we will demonstrate network connections between distant qubits or quantum memories. Fundamental remote quantum protocols will be demonstrated.

R&D theme structure of the project

In this project, the R&D themes corresponding to each physical system are running, such as "atom networking technology," "photon networking technology," "semiconductor networking technology," and "superconducting networking technology." In addition, the development of superconducting photon detectors commonly used in networking will be conducted by the "atom networking technology" team. The results will be applied to each R&D theme, as well as to other projects. Each principal investigator is shown in the figure below. In "atom networking technology," the team is working on quantum entanglements among atoms and photons on a large scale for networking. In "photon networking technology," the team is working to realize the interaction between photonic qubits by using cavity QED technology and to create quantum entanglement among photonic qubits on a large-scale network. In "semiconductor networking technology," the team is working on quantum interfaces between photons and silicon qubits and silicon qubit interconnection technologies to network semiconductor quantum computers. In "superconducting networking technology," the team is working on a quantum interface (transducer) to network superconducting qubits operating at microwave frequencies at cryogenic temperatures. In the end, the results of this R&D project will be actively applied to other projects and contribute to achieving Moonshot Goal 6.



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