Yoshihisa Yamamoto - Program Manager (PM)

1973 Received B.S. from Tokyo Institute of Technology
1978 Received Ph.D (Doctorate of Engineering) from the Graduate School of Engineering, The University of Tokyo
1978 – 1992 NTT (presently R & D Fellow)
1992 – 2014 Professor, Stanford University (currently Professor Emeritus)
2003 – 2014 Professor, National Institute of Informatics
2013 – 2014 Group Director, RIKEN

Profile
Established quantum information technology group at the NTT Basic Research Laboratories in 1983. Subsequently was on the front lines of global research into quantum information, communications and computation for more than 30 years. Has led many major national projects both in Japan and in the United States. From 2009 to 2014, was a core researcher in the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST) of the Cabinet Office.

The Challenges for the PM and the Impact of Success

Overview

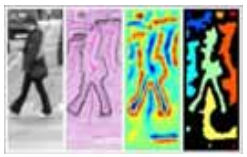
The neural network that governs information processing in the brain (made up of neurons and synapses) is composed of a single quantum wave function that extends coherently throughout the entire system. It is able to solve much faster than existing modern computers the kind of large-scale combinatorial optimization problems.

Impact on industry and society

Drug discovery / Life sciences

Wireless communications / Navigation

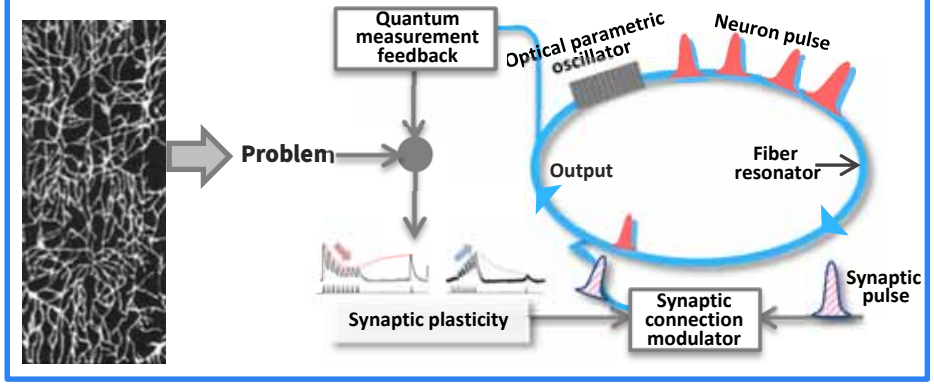
Machin learning



Social networks

Disruptive Innovation

Each of the 10,000 - 1,000,000 light pulses generated simultaneously in a fiber parametric oscillator is considered as a neuron, and these are mutually coupled by a quantum measurement-feedback circuit to create a synaptic network. Combinatorial optimization problems are mapped using the synaptic plasticity of a quantum measurement-feedback circuit.



Scenario for Success and Achievement Targets

Principle:
Use of the phase transition of a parametric oscillator network operating at the quantum limit as a computational process.

Method:
Search for new methods through the integration of quantum information science, computer science and brain science.

Core technologies:
Multiplexing optical pulse parametric oscillator, quantum measurement-feedback circuit.

Achievement targets:
Development of a quantum artificial brain with a clock frequency of 1 GHz and a pulse number of 5,000 - 10,000, and demonstration of superiority to existing modern algorithms.

Advanced Information Society Infrastructure Linking Quantum Artificial Brains in Quantum Network

Overall R&D Program Structure Created by the PM

(1) Quantum artificial brain (Ising model)

P1. Quantum theory for optical parametric oscillator network and computational experiment
P2. Small-scale machine development and benchmarks
P3. Development of large-scale parametric oscillator network
P4. Development of large-scale quantum measurement-feedback circuit

⇨ Development of quantum artificial brain with 5,000 - 10,000 neurons and ～100 million synaptic connections, and demonstration of applicability to combinatorial optimization problems

(2) Quantum simulation (transverse field Ising model -> Fermionic Hubbard model)

P5. Quantum models for strongly-correlated system and nonequilibrium open system
P6. Development of superconducting circuit quantum simulator
P7. Development of optical semiconductor quantum simulator
P8. Development of cold atom quantum simulator

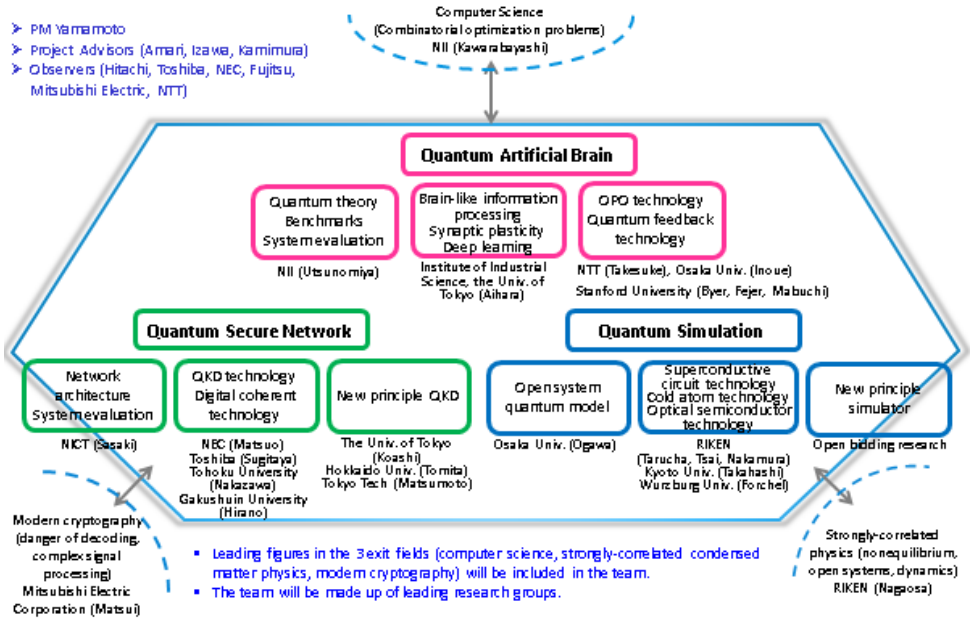
⇨ Development of three quantum simulators and demonstration of validity for large-scale many-body systems

(3) Quantum secure network (quantum key distribution)

P9. Network architecture and globalization technology
P10. Development of Decoy BB84 quantum key distribution system and application interface
P11. Development of technology for secure communication with multilevel modulation (digital coherent optical communications)
P12. Basic study of quantum key distribution and secure networks based on new principles

⇨ Construction of a quantum secure network in a metropolitan area to achieve services for potential users

Implementation structure as Assembled by the PM



- Leading figures in the 3 exit fields (computer science, strongly-correlated condensed matter physics, modern cryptography) will be included in the team.
- The team will be made up of leading research groups.

Total R&D Program Cost

JPY3.0 billion

* May increase/decrease depending on development progress
* Expenses required for PM activities and support will be provided as a separate allowance.