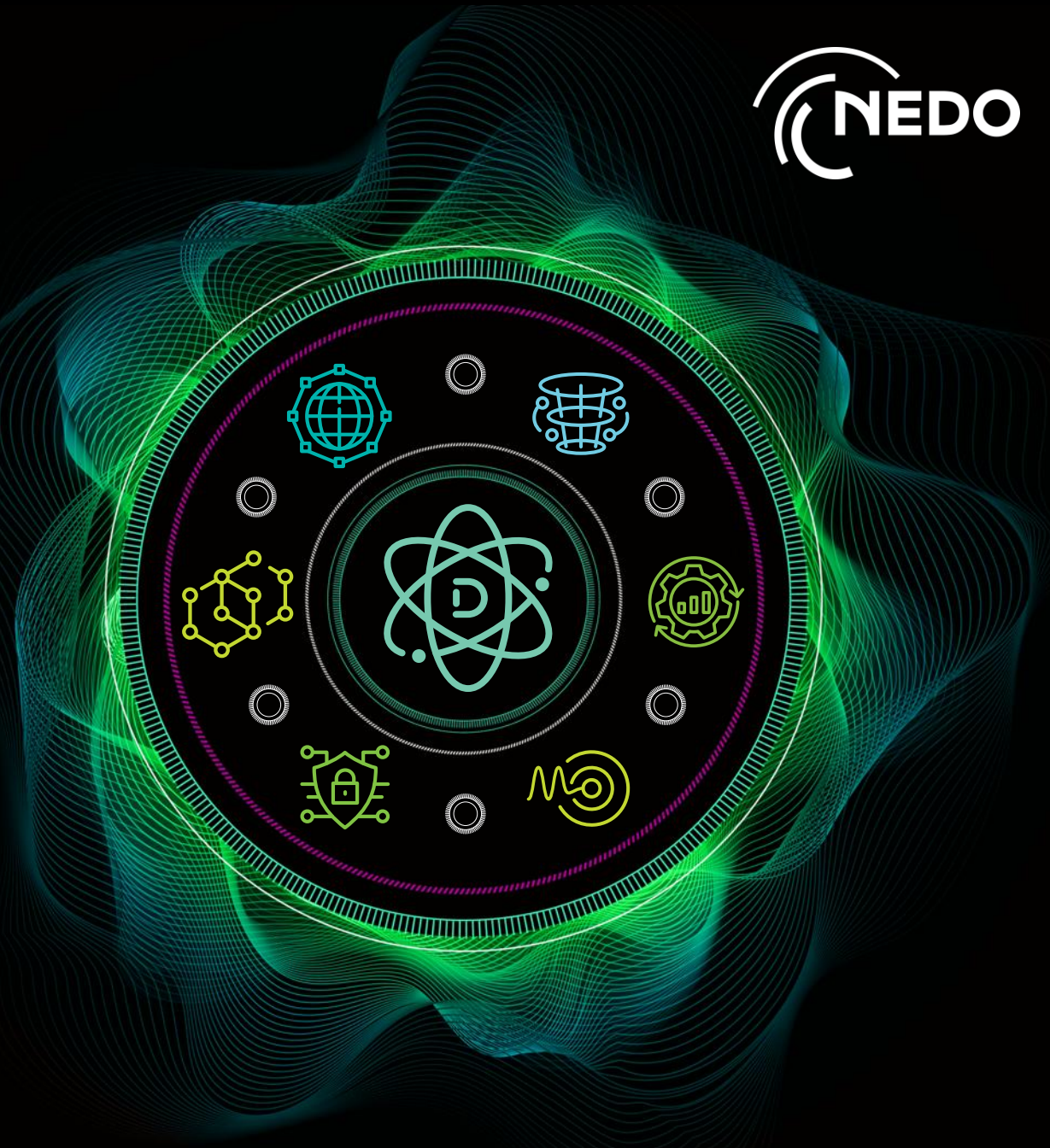
Quantum Computing Use Cases

Increase efficiency of large-scale logistics

TOYOTA SYSTEMS



New Energy and Industrial Technology Development Organization (NEDO)

TOYOTA SYSTEMS: Increase efficiency of large-scale logistics [2020/09] 1/2

Validation

Industry	Discrete Manufacturing Transportation
Process/Means	Shipping and sales/land transportation
Method	combinatorial optimization
Category	Ising*

Background

- In recent years, the importance of logistics has increased as an infrastructure that supports society, but there are a variety of issues
  - ✓ Driver shortage, traffic congestion, increased CO2 emissions, etc.
- On the other hand, **distribution management of necessary parts to factories** is the basis of the supply chain, and further **efficiency improvement and cost reduction** are required.
- TOYOTA SYSTEMS was established in January 2019 as an IT solutions company to support Toyota Motor Corporation and its group companies with technological capabilities and productivity. Since 2018, TOYOTA SYSTEMS has been conducting research with Fujitsu on the application of quantum computing.

Issues and motivation to be solved

- In the logistics industry, **the conventional (classical) method (conventional optimization engine) requires enormous calculation time as the problem size increases, and manual adjustment is required.**
- Concerning automobile manufacturing, we planned to **apply Fujitsu's digital annealer to calculate the effect on a large-scale logistics network with more than 3 million possible routes.**

Expected business benefits

- As a result of simulation (trial calculation), we were able to **calculate in less than 30 minutes a new route that can reduce the total logistics cost** from more than 3 million possible routes (we discovered an effective logistics route that had not been found before).
- In addition, we expect **a cost reduction effect of approximately 2~5% compared to the conventional method (classic).**

Reference: Fujitsu Limited "TOYOTA SYSTEMS and Fujitsu Prove Efficiency of Large-Scale Logistics Using Digital Annealer" (https://pr.fujitsu.com/jp/news/2020/09/10-1.html)
*Ising: A computing approach, mainly associated with quantum annealers and simulators specialized for the Ising model, in which a problem is first formulated as an Ising model and then solved computationally. It is particularly well suited to problems that involve finding the optimal combination from a vast number of possibilities.

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Problem setting as a quantum computer

- Of more than 3 million distribution routes, **the route with the lowest distribution cost** was calculated.
  - ✓ It is assumed that parts will be purchased from more than hundreds of suppliers and delivered to dozens of factories through several intermediate warehouses.
  - ✓ Logistics costs were calculated based on the number of trucks, the total distance traveled, and the amount of cargo sorting work.
- In order to apply the system to actual logistics operations, we developed a system incorporating the following two technologies and applied them to the demonstration.
  - ✓ global search technique: a technique to search a wide area while efficiently escaping from a local solution group
  - ✓ Dynamic multipoint search technology: A technology that dynamically determines the starting point according to the status of the search
- The machine uses **Fujitsu's quantum-inspired digital annealer**

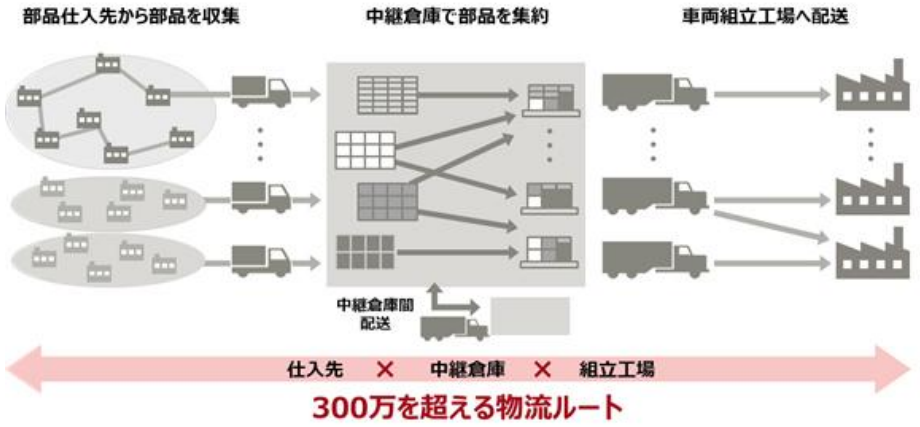
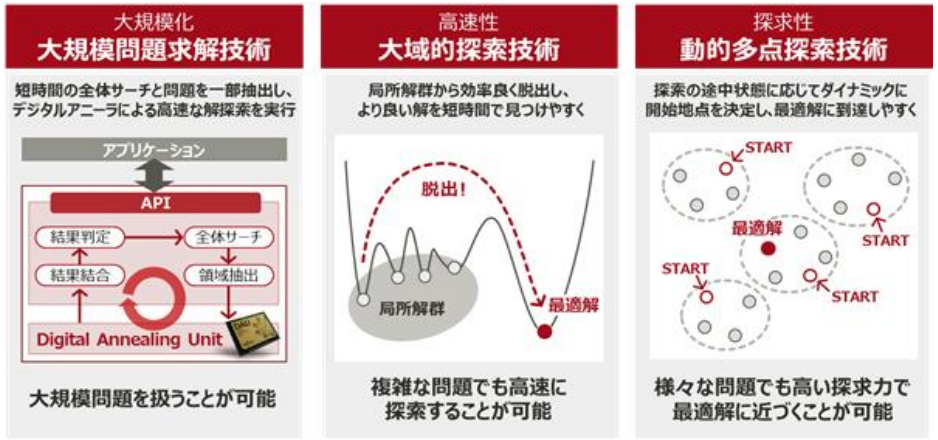


Image of Large-Scale Logistics Network



solution technology of digital annealer

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More use cases are available on our website. We invite you to explore them.
https://www.quantum-computing-use-cases.nedo.go.jp/english/

More Use Cases

New Energy and Industrial Technology Development Organization (NEDO)
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This collection of use cases was obtained as a result of the work commissioned by the New Energy and Industrial Technology Development Organization (NEDO) "Cyber-Physical Development Business of Quantum/Classical Hybrid Technology/Study of Use Case of Quantum Technology" and the "Post-5G Information and Communications System Infrastructure Reinforcement R & D Project (Quantum Industrialization)/Comprehensive Study for Promoting the Industrialization of Quantum Computers".