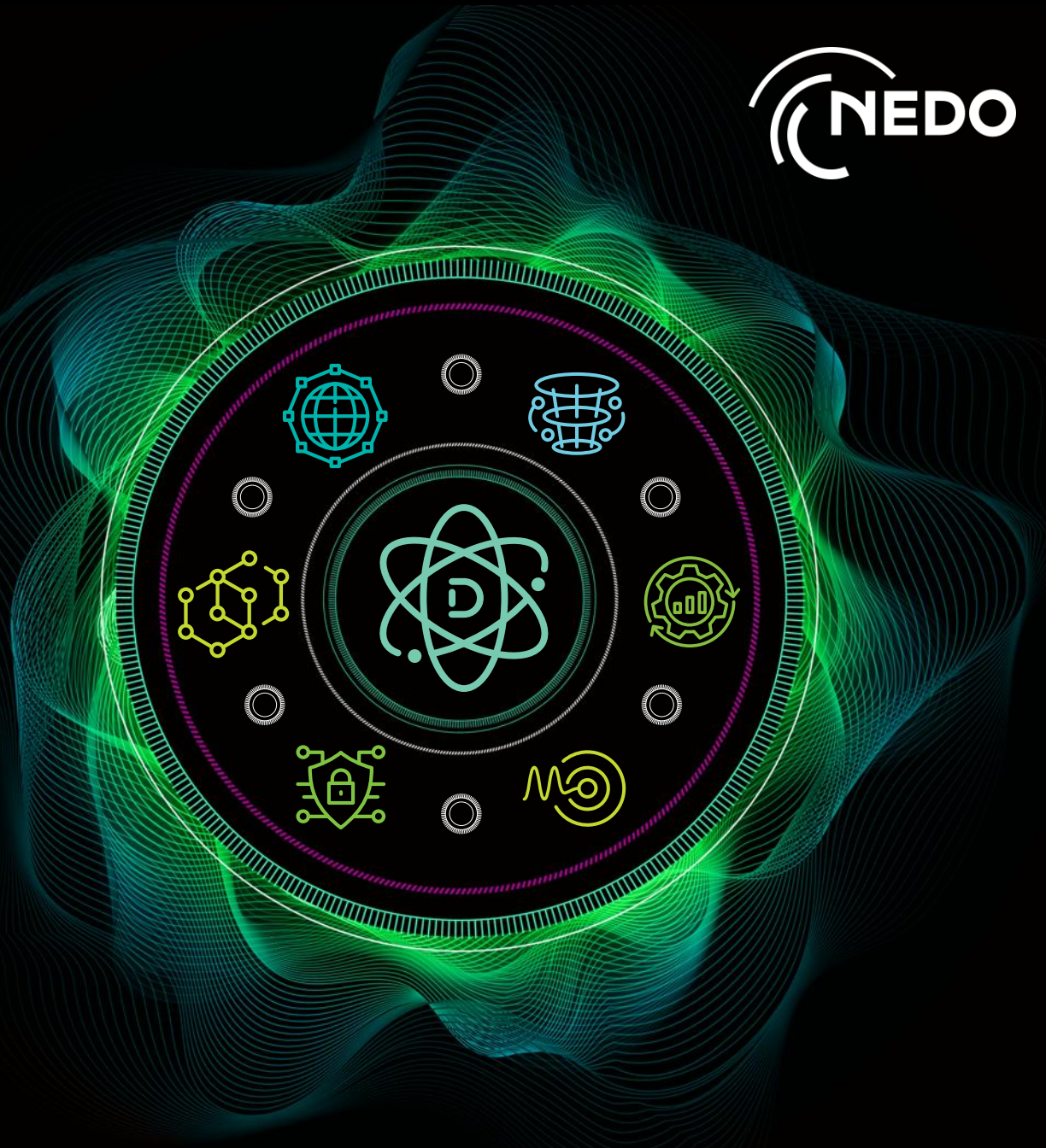
Quantum Computing Use Cases

Railway scheduling optimization

Q-CTRL, Network Rail



New Energy and Industrial Technology Development Organization (NEDO)

Q-CTRL, Network Rail: Railway scheduling optimization [2025/5]

Validation

Industry	Transportation
Means	Human Movement _ Land Transport
Method	combinatorial optimization
Category	Gate*

Background

- Through its extensive and complex operations, the rail industry faces a variety of challenges at every planning stage, from network design and train scheduling to crew management
- Significant obstacles must be overcome before quantum computing can realize its potential to outperform other approaches in complex optimization problems. Current quantum devices are vulnerable to environmental interference, leading to errors that limit the usefulness of today's quantum computing
- Introducing Fire Opal, error suppression performance management software allows users to get the most performance out of their current Quantum hardware

Issues and motivation to be solved

- To quickly calculate course setting and time adjustment of many trains in a short time in a form of zero contention and minimum delay under safety constraint.

Problem setting as a quantum computer

- By combining Q-CTRL's error suppression technology with problem-specific workflow development, coupled with ongoing exchanges with Network Rail to align problem formulations with real-world requirements, we have made significant progress in turning the promise of quantum computing into tangible benefits.
- Using the Fire Opal performance optimization platform, Q-CTRL runs a real scheduling problem on IBM quantum hardware, setting a new record as the largest constrained quantum optimization problem to date.
  - ➢ Calculated the exact route of 26 trains over a 18 minute period at London Bridge Station

Expected business benefits

- Optimizing scheduling by increasing the number of trains that can pass in the same time frame and reducing congestion in the station yard

See Also: Quantum Computing Report: "Q-CTRL and Network Rail Demonstrate Large-Scale Quantum Optimization for Rail Scheduling" (https://quantumcomputingreport.com/q-ctrl-and-network-rail-demonstrate-large-scale-quantum-optimization-for-rail-scheduling/); Q-CTRL: "Accelerating the schedule for quantum-enhanced rail" (https://q-ctrl.com/case-study/accelerating-the-schedule-for-quantum-enhanced-rail)
*Gate（gate-based）: A computing approach in which operations are applied sequentially to qubits to perform calculations. Similar in concept to logic circuits in classical computers, it can address a wide range of problems.

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)
AI and Robotics Department (e-mail: quantum_ai@ml.nedo.go.jp)

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