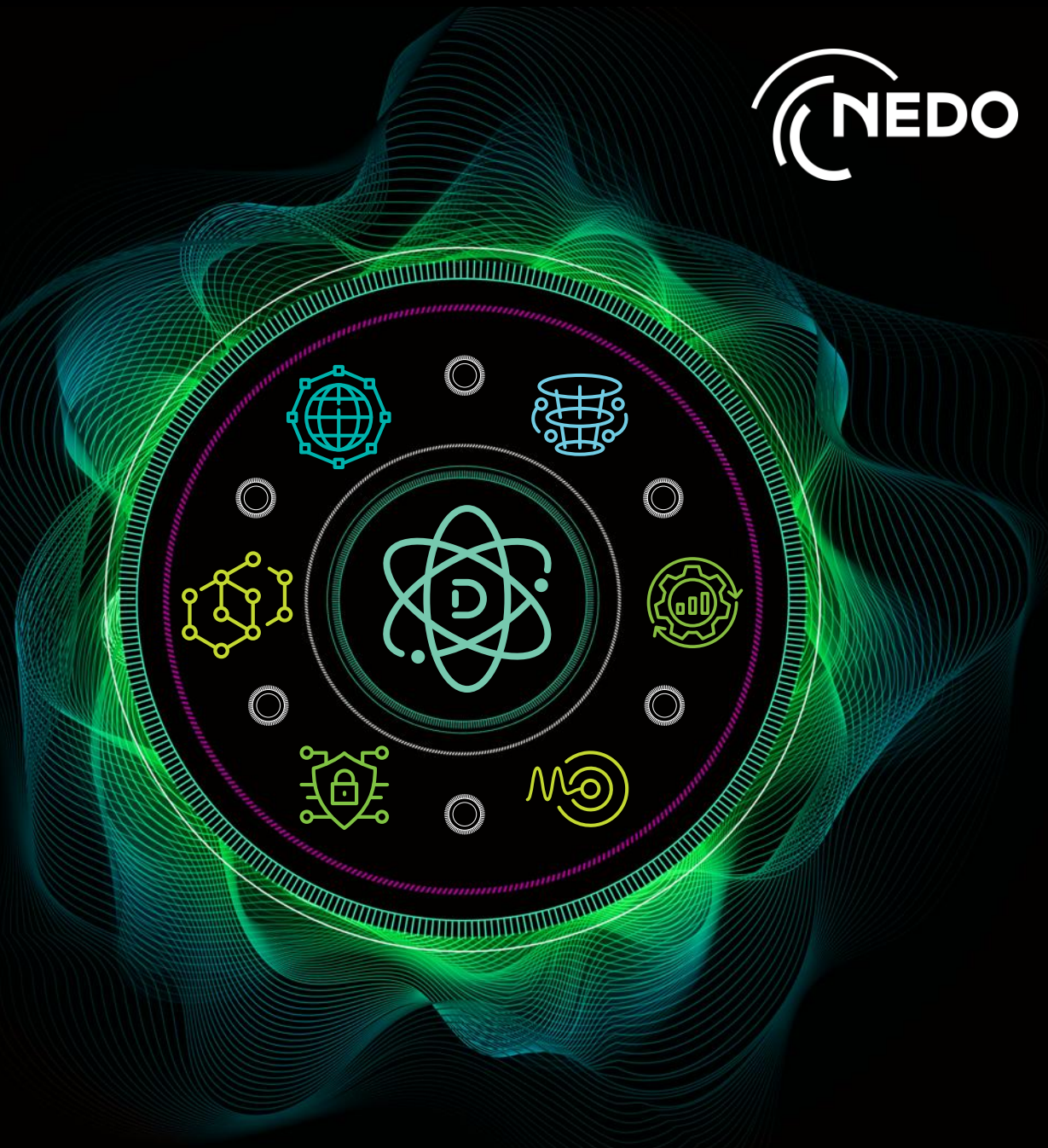
Quantum Computing Use Cases

Base Station Tracking Area Optimization in Mobile Network Operations

D-Wave Quantum Inc. × NTT DOCOMO



New Energy and Industrial Technology Development Organization (NEDO)

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Validation

Industry	Others
Process	Others
Method	combinatorial optimization
Category	Ising*

Background

- As mobile networks become more complex and traffic continues to increase, **optimizing network operations has become increasingly important** in the telecommunications business. In order to maintain network quality amid growing numbers of users and rising data traffic, it has **become necessary to manage base station operating configurations efficiently**
- To maintain high-quality service while restraining additional infrastructure investment even as network traffic increases, it's **important to optimize the way existing facilities themselves are used**
- Against this backdrop, NTT DOCOMO and D-Wave undertook a pilot project to improve mobile network performance using quantum optimization technology

Issues and motivation to be solved

- One of the **key challenges in mobile networks is optimizing the configuration of base station tracking areas**
- In particular, when a device moves between tracking areas, it is necessary to determine the optimal combination of base stations for re-establishing the connection while predicting future movement patterns. Because this process involves handling extensive historical data on device movement, **the computational load can become substantial**
- Since an increase in paging signals leads to greater pressure on base station resources, it **was important to suppress congestion associated with increased call traffic during peak periods while maintaining and improving the required connection quality**
- For this reason, this initiative aimed to use quantum optimization technology to search for high-quality solutions in a shorter time and **make it possible to execute configuration optimization related to actual network operations within a practical timeframe**

Reference: NTT DOCOMO and D-Wave Improve Mobile Network Performance by 15% with Quantum Optimization Technology
（https://www.dwavequantum.com/company/newsroom/press-release/ntt-docomo-and-d-wave-improve-mobile-network-performance-by-15-with-quantum-optimization-technology/）
*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

- **Base station tracking area optimization was formulated as a combinatorial optimization problem in mobile network operations**
  - ✓ A tracking area refers to a group of base stations that collectively send paging signals
- Using call completion and incoming call logs, as well as statistical data on movement between base stations, the problem was formulated as one of searching for the combination of base stations that would reduce paging signals, based on a model that predicts the number of paging signals for each grouping condition
  - ✓ The demonstration used base station data from the Tokai, Chugoku, and Kyushu regions of Japan
- **Tracking area optimization was then carried out using D-Wave's annealing quantum computing solution / hybrid solver, and an optimization solution for practical deployment was validated while handling extensive historical data**



Figure: Overview of the quantum computing platform

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Expected business benefits

- In the demonstration, **paging signals were reduced by 15%, showing the potential to alleviate base station congestion and confirming improved network efficiency during peak-time calls**
- It was also shown that, by improving the use of base station resources, **approximately 1.2 times more terminals could be connected,** suggesting that high-quality network traffic can be maintained even during periods of concentrated usage
- In terms of computation time as well, **a calculation that required 27 hours with a general-purpose solver was completed in 40 seconds using D-Wave's hybrid solver, indicating that network configuration optimization could be carried out more easily within a practical timeframe**
- As a result, **the approach is expected to be applied to operations that maintain high-quality service while restraining additional infrastructure investment** even as network traffic increases. Going forward, in addition to nationwide deployment, the application of quantum optimization to other fields such as finance, retail, transportation and logistics, and construction is also under consideration

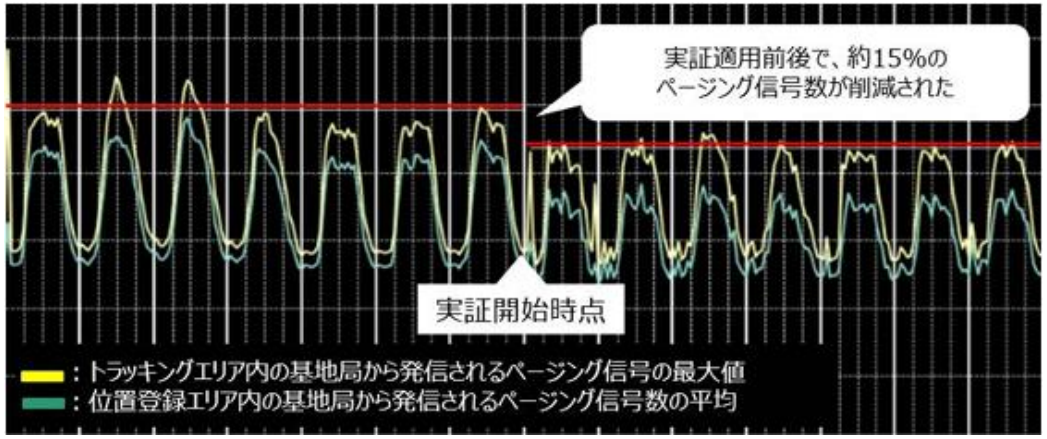


Figure: Reduction in the number of paging signals demonstrated through the proof-of-concept experiment

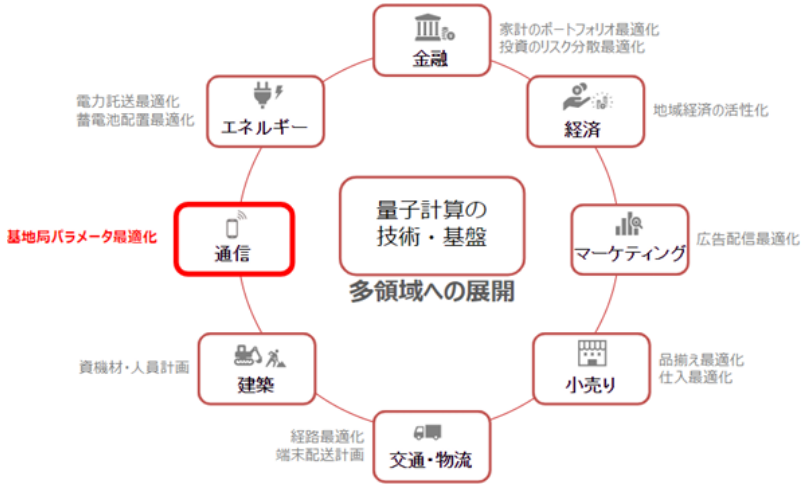


Figure: Illustration of how the quantum computing platform can be utilized

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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

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