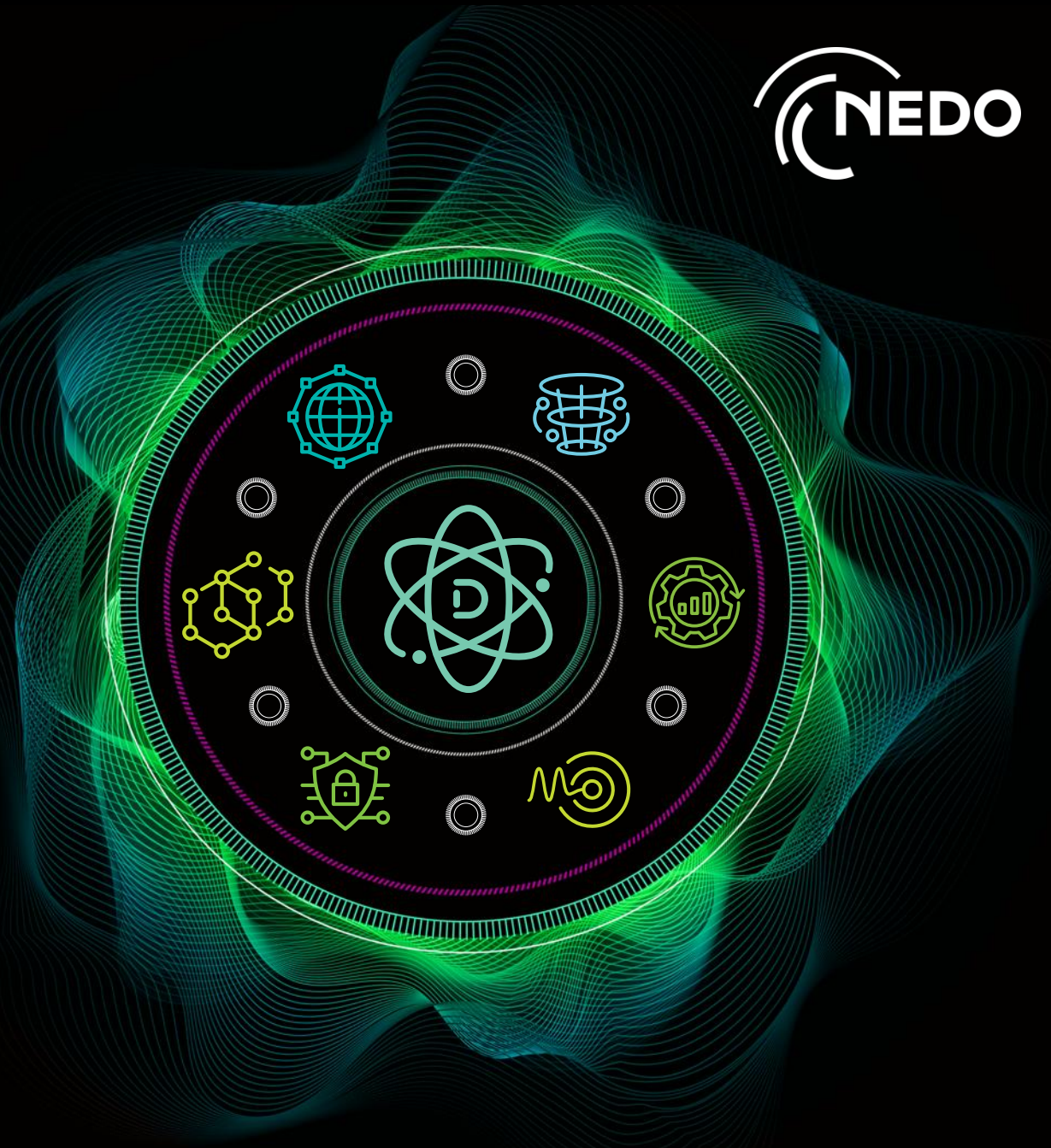
Quantum Computing Use Cases

Multimodal Transport System Route Optimization

DENSO



New Energy and Industrial Technology Development Organization (NEDO)

DENSO: Multimodal Transport System Route Optimization [2023] 1/2

Validation

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

Background

- Taxis and ride-hailing services have become **essential transportation to get around many cities around the world.**
  - ✓ Tourists are heavy users of taxis, and many use them as sightseeing opportunities on their way to their destinations.
- But when it comes to ride-hailing, **it's hard to get enough vehicles at the right place and time to minimize the time wasted by both drivers and waiting passengers.**

Issues and motivation to be solved

- DENSO is one of the world's leading manufacturers of automotive components, and **the technology that enables connected driving is important.**
- DENSO **planned two demonstrations using quantum technologies to improve the efficiency and sustainability of urban transport.**
  - ✓ Optimization of the number of taxis
  - ✓ Route Optimization of Multimodal Transportation Systems

Problem setting as a quantum computer

- Targeting sightseeing taxis in Kyoto, **optimization of the number of taxis dispatched** was studied.
  - ✓ The number of taxis required for 400 taxi trips is compared between the conventional method and quantum technology.
- **Route optimization was studied by formulating a multi-modal transportation system scenario under various conditions, such as different numbers of vehicles, different numbers of passengers, and different boarding and alighting places per vehicle,** which combines cars, shuttle buses, and taxis shown below.
  - ✓ Multiple cars will meet multiple guests at different locations and relay passengers to the turnoff where the shuttle bus will be waiting.
  - ✓ The shuttle bus takes the assembled passengers to another junction
  - ✓ picked up by a taxi from the junction and taken to various destinations
- Machine utilizes **D-wave Hybrid Solver Service**

Reference: D-WAVE"DENSO: Optimizing Transportation with Quantum Computing" (https://www.dwavesys.com/media/f1hpibxr/denso-case-study2_v3.pdf)
*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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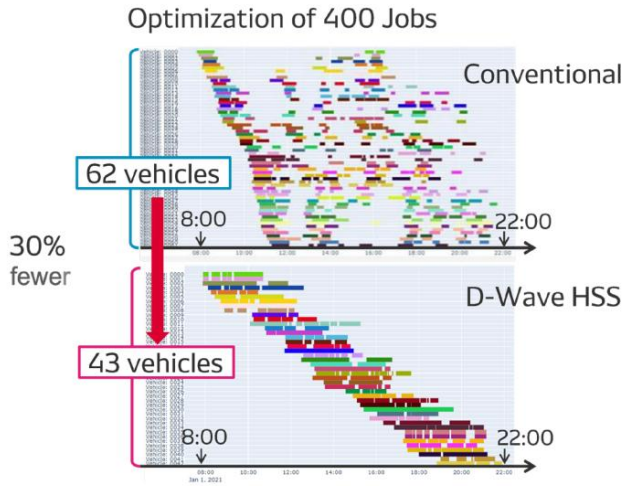
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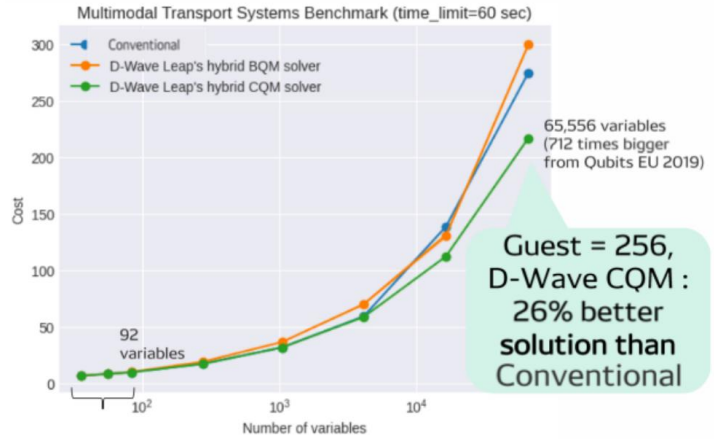
Expected business benefits

- **Comparing conventional methods with quantum technologies, we were able to reduce the number of taxis required to accommodate 400 trips by approximately 30%**
  - ✓ The previous requirement of 62 units was reduced to 43 units through the use of quantum technology
  - ✓ Optimization of the number of taxis **has the potential to significantly reduce CO2 emissions**

- For route optimization of a multimodal transportation system, a scenario with 256 passengers was **26% more efficient routing than conventional technology compared with quantum technology (D-wave CQM)**
  - ✓ The complexity of the scenario increased the computation time, but was able to **make the D-wave CQM solver more than 100 times faster on complex routing computations at the expense of 10% efficiency of the best solution**



optimization of the number of taxis



Route Optimization of Multimodal Transportation Systems

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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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