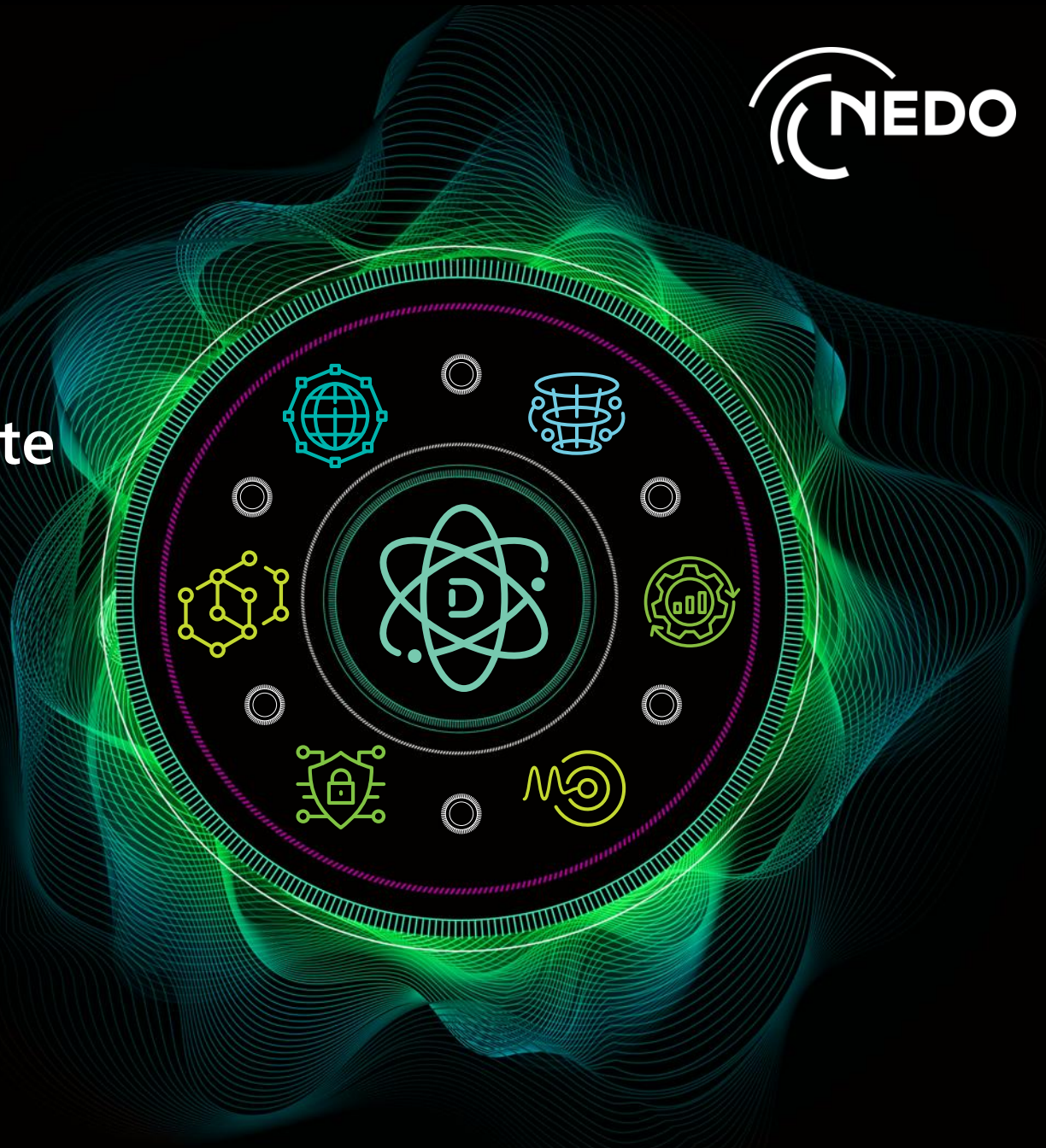
Quantum Computing Use Cases

Improving the Design of Composite Materials for Aircraft

Boeing/IBM



New Energy and Industrial Technology Development Organization (NEDO)

Boeing/IBM:
Improving the Design of Composite Materials for Aircraft [2023/01]

Validation

Industry	Process Manufacturing
Process	research and development
Method	Simulation
Category	Gate*

Background

- Boeing's plants **produce much of the world's critical aerospace infrastructure,** including satellites, defense systems, spacecraft, and commercial jets
- Many of the projects **utilize ply composites to assemble wings, fuselages, and other aerospace components** that are light as a feather, durable, and layered.
- The design of ply composites is a very complex problem that is **beyond the capabilities of conventional supercomputers, so Boeing engineers solve very complex problems by breaking them into smaller problems, but at a cost.**

Issues and motivation to be solved

- Boeing's ply design problem **has to deal with up to 100,000 variables, which is way beyond the power of a traditional supercomputer.**
- Boeing and IBM have teamed up to **harness quantum technology to solve complex problems in ply composites**

Problem setting as a quantum computer

- Solved a **simplified ply design problem** that essentially narrows down Boeing's ply design problem to find how to best stack layers of materials
  - ✓ The simplified ply design problem involves **40 variables**
- Instead of encoding one variable in each qubit, they **encoded three variables in each qubit** to solve the quantum optimization

Expected business benefits

- Using this quantum optimization method, we were able to **achieve a dramatic improvement in Processing efficiency (about twice as much)** in comparison with conventional quantum optimization algorithms.
- With this achievement, we were able to **analyze a very large optimization problem at the core of product design and show that quantum computers can solve part of that optimization problem**.

IBM"Boeing seeks new ways to engineer strong, lightweight materials" (https://www.ibm.com/case-studies/boeing)
*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)

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”.