

Introduction to Digital Annealer

Fujitsu Quantum-Inspired Computing

Digital Annealer [Overview]

Fujitsu Limited

Increasing Data

Global Data Volume *IDC

2020
59 ZB



2025
175 ZB

Increasing Complex Risk Factors

Complexity of all risk factors including environmental, economic, political, geographic, etc.

Shorter Decision making Time

Decision-making time is decreasing in response to rapid changes

“Decision making” is becoming more difficult



Logistics

Transportation planning takes a long time and relies on the expert's intuition

An increase of plan changes and alternative delivery destinations due to shutdown of sites/factories

Constantly reviewed as circumstances change



Manufacturing

Primarily, production planning takes time and schedule changes are cumbersome.

Due to delays in material procurement and personnel changes, it is necessary to respond to sudden production fluctuations

Reach conclusion in a short time



Finance

Portfolio generation is computationally expensive and can be estimated or constrained

Rapid changes require highly precise and frequent recombination

Multiple decision criteria

Solving "combinatorial optimization problems" is important for business

What are “Combinatorial Optimization Problems”?

■ The problem of selecting the “best combination” from the given “combinations” that satisfy the specified conditions.

e.g. **Traveling salesman problem**

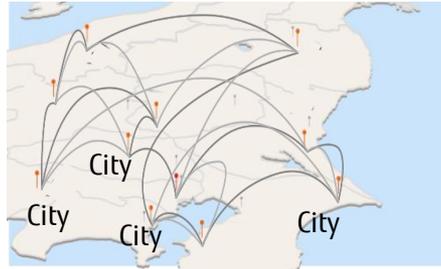
The problem of finding the **route that minimizes the travel distance** with the restriction that it **must pass through** each city **only once**

N Cities



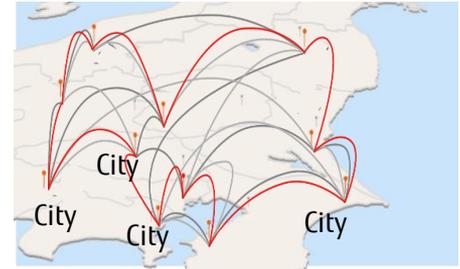
Option: Number of Cities

Route Combinations



Evaluation: Distance travelled between cities
Limit: Once per city

Shortest Route



Best solution (best value):
Shortest route

120 possible routes for 5 cities → 26,300 quadrillion × 10 quadrillion possible routes for 32 cities

The number of combinations increases exponentially

Fujitsu Quantum Inspired Technology: Digital Annealer

Digital Annealer is a quantum inspired computing technology that enables fast solution of combinatorial optimization problems which are difficult to solve with current general-purpose computers.

By courtesy of RIKEN

Enterprise System



Application of Advanced Scientific Technologies



FX-10



Digital Annealer



Quantum Computer



High-Performance Computing

Frequency Increase

2000

Multi-Core

2010

Processor Technology



FX-1000

Many-Core

2020



A64FX

Processor (A64FX, Next-Generation Processor)

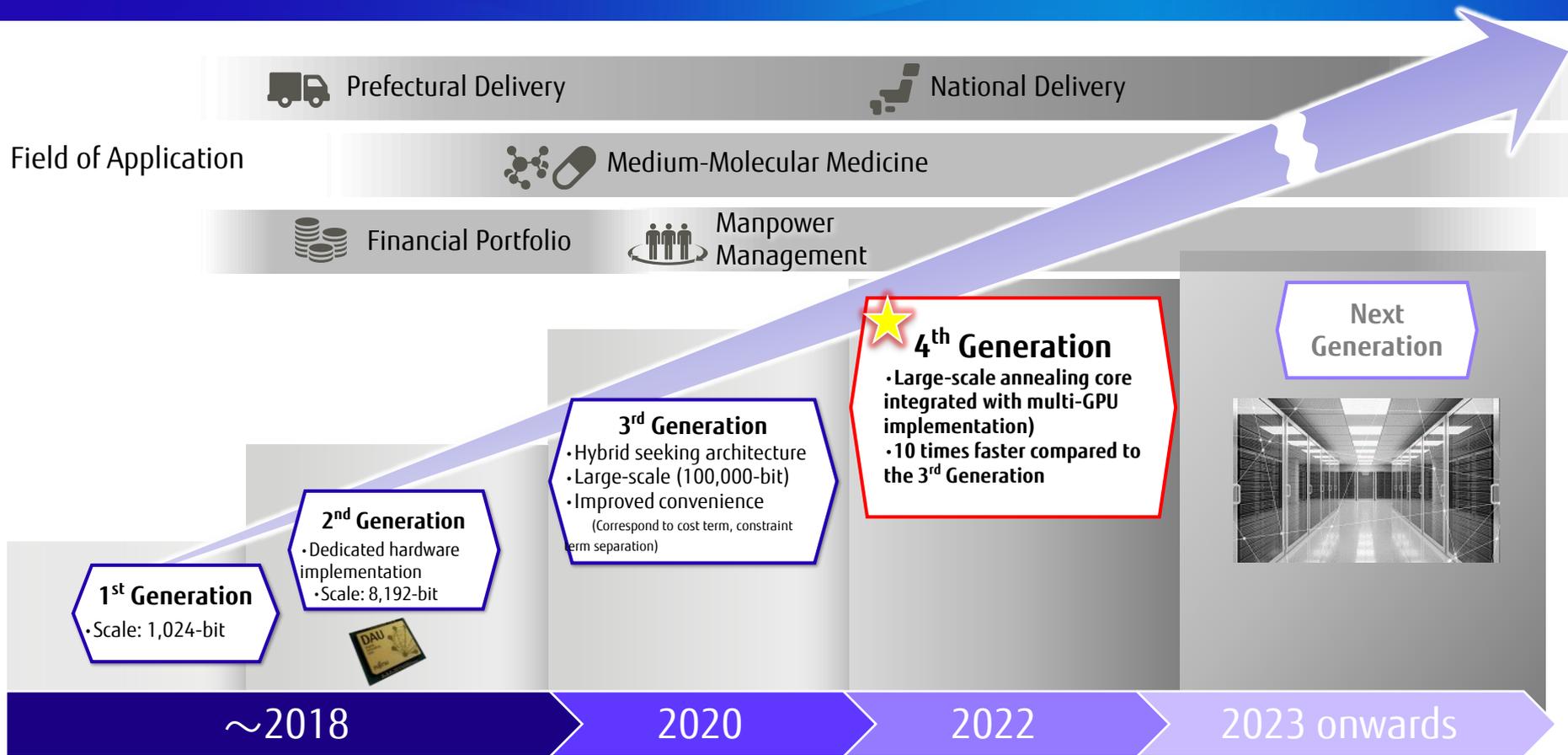
Memory-Centric

2030

2040

Technology Roadmap

* The contents of the roadmap are subject to change without prior notice



Large-scale annealing core *1 provides high-speed optimal solutions while maintaining the convenience of the 3rd generation

●Fast solving of large-scale problems

Up to 10 times faster than the 3rd generation by incorporating a large annealing core (multi-GPU implementation)

●Convenience

Inheriting the convenience of the 3rd generation, a new API has been added to eliminate the need for QUBO formulation of 1hot constraints*2, reducing input data and eliminating complexity at the time of input

*1:Fujitsu's original technology inspired by quantum and physical phenomena

*2:A common constraint that frequently appear in real problems such as scheduling problems

*3:QUBO (Quadratic Unconstrained Binary Optimization)

BQP (Binary Quadratic Programming)

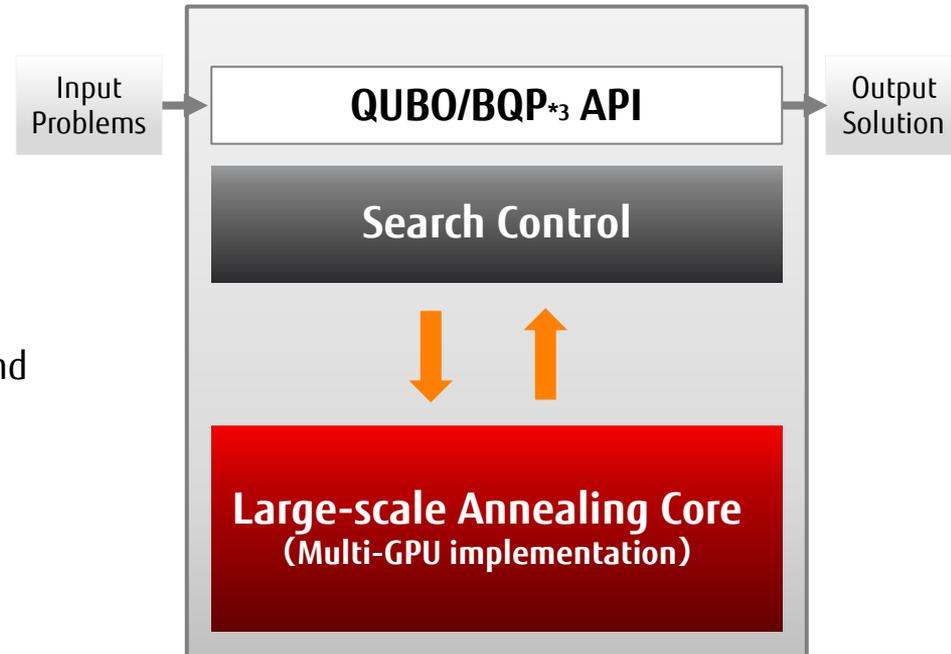
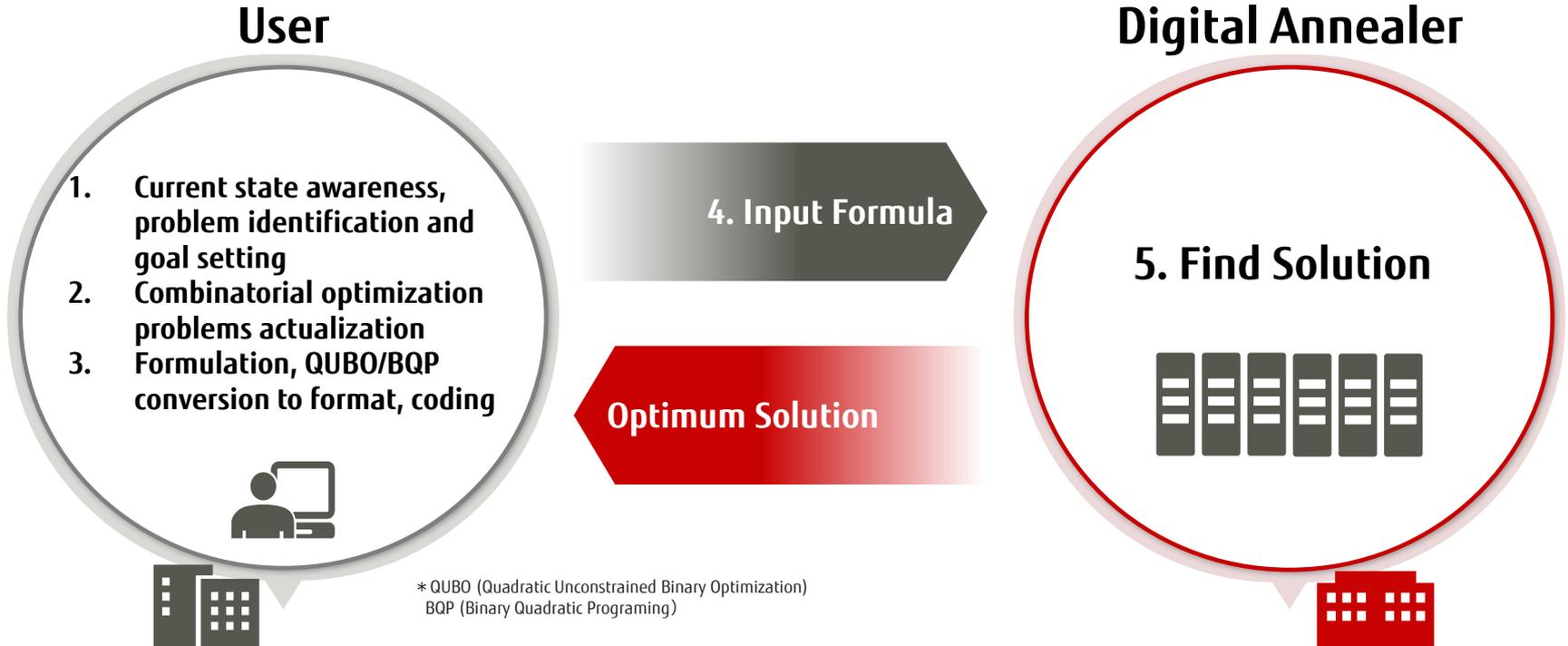


Image of Optimal Solution Calculation using the Digital Annealer

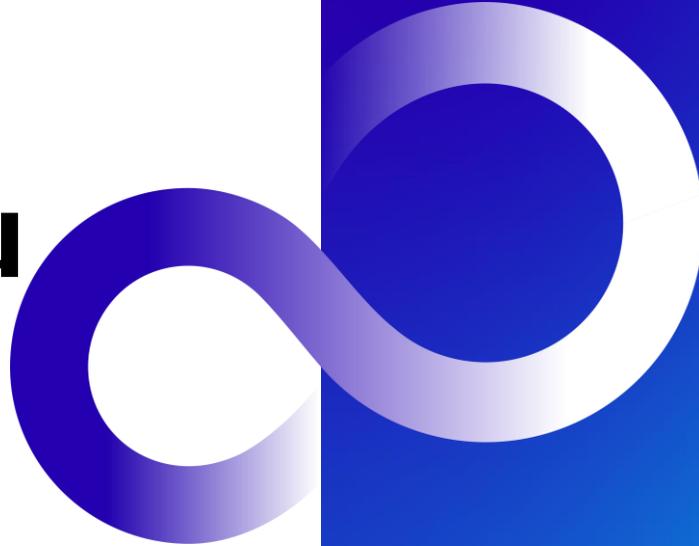


Scope of Digital Annealer

Aiming to solve social issues



Thank you



Digital Annealer Public Website

<https://www.fujitsu.com/global/services/business-services/digital-annealer/>