

CMOS Annealing

Quantum-inspired optimization automates complex crew and vehicle operating plans
Cuts planning from months to about one week, enabling timely timetable updates

Applicable Field (Industry, Business)

Railway / Crew Operation and Rolling Stock Operation Plans

Customer's Issue

- Must satisfy timetable and work-rule constraints simultaneously
- Expert-dependent planning creates bottlenecks during revisions

Solution, Customer Benefits

- Model rail constraints as combinatorial optimization
- CMOS Annealing quickly finds accurate feasible plans
- Crew scheduling plan: **several months → about 1 week**
- Rolling Stock Scheduling plan: **about 20 days → about a few days**
- KPI views help experts compare and select plans
- Rapid recalculation supports changes and disruptions
- Cloud launch targeted by FY2027 for future/BCP timetables

Operational Image



Figure: Automatic generation and evaluation of railway operation plans using CMOS annealing
Source: Hitachi Ltd. News Release (July 14, 2026)



Optimization Expands Beyond Ising Machine

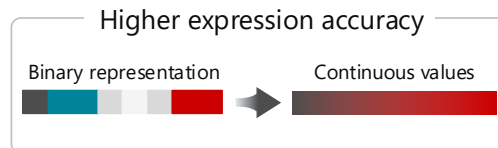
Extending optimization to continuous variables and hard constraints
Cloud applications support rapid deployment

Breakthrough Technology

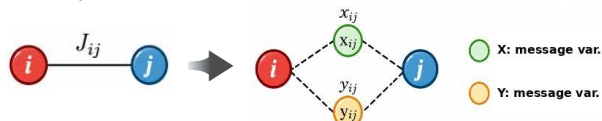
- One of the world's largest 2.25-bit annealing systems, composed of multiple dedicated semiconductors*
- Momentum annealing (MA) for complex problems using GPUs
- Automatic tuning technology capable of handling various real-world problems

1 Expand to Mixed-Binary QP

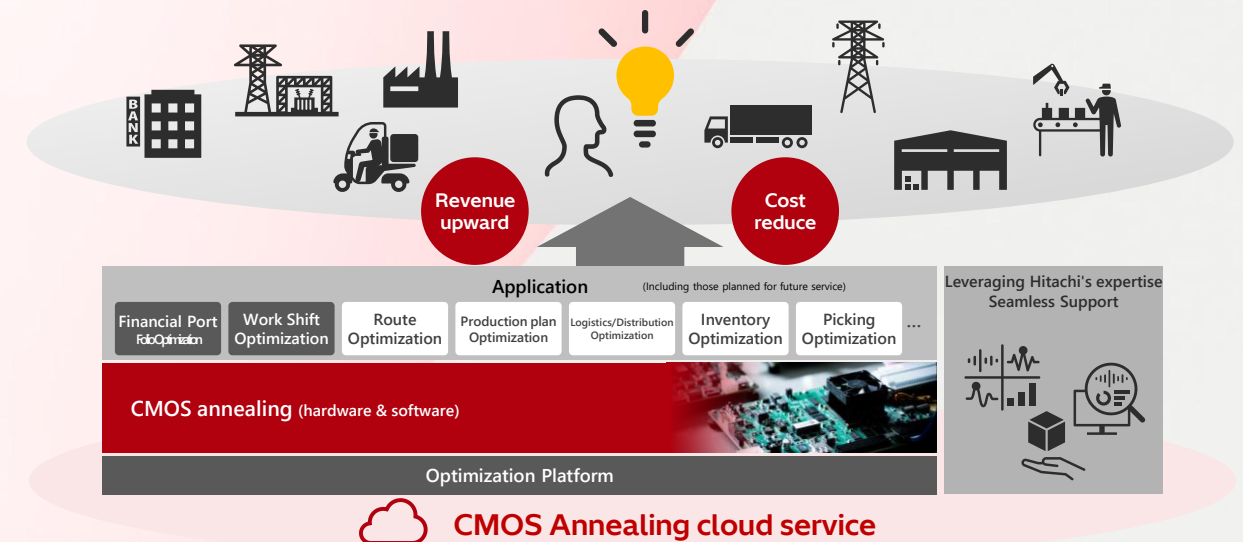
- Extend CMOS annealing (MA) to mixed-binary QP
 - ✓ Variables take $\{-1, +1\}$ or any value in $[-1, +1]$
 - ✓ Supports quadratic optimization with binary and real variables
- **Broadens solvable problems with few added variables**



- Parallel updates preserved



Operational Image



* Part of this work is based on results obtained from a project, JPNP16007, commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

Optimization Expands Beyond Ising Machine

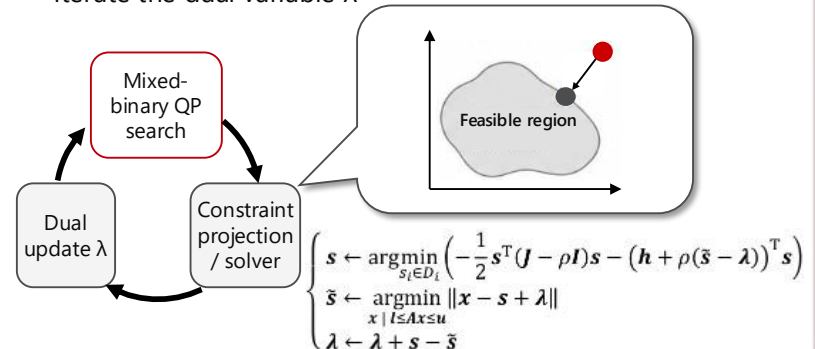
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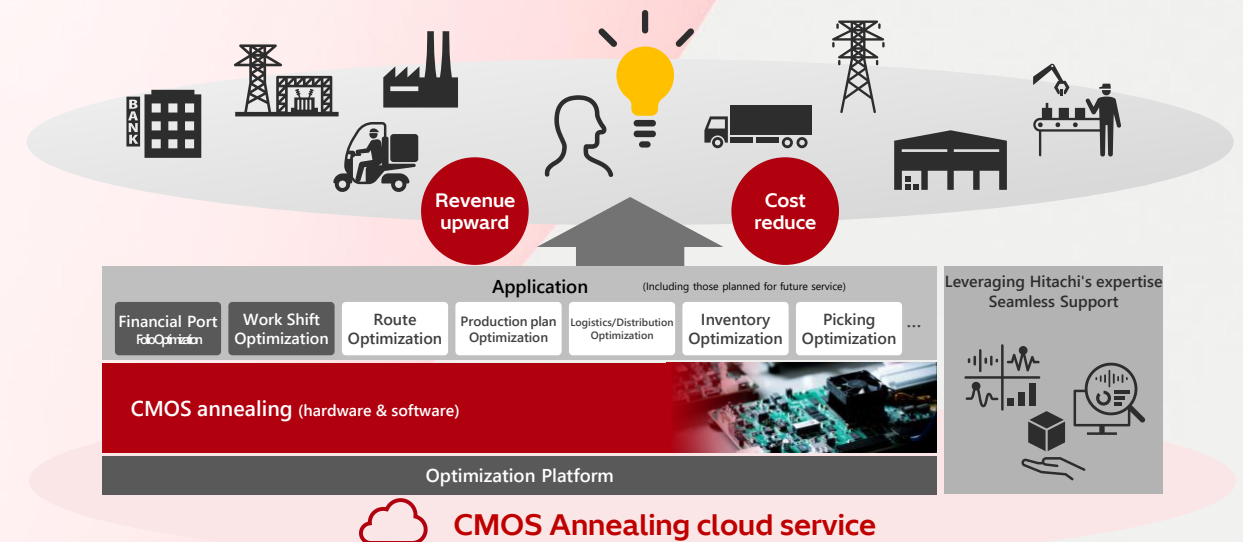
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2 ADMM for Hardware Constraints

- Assign each subproblem to the best-suited solver
 - ✓ Mixed-binary QP: CMOS annealing
 - ✓ Constraints: projection or optimization solvers
- Iterate the dual variable λ



Operational Image



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Applications

Optimize operations across rail, finance, logistics, industry, chemicals, and energy.
Turn sector constraints into decision-support applications.

Relief Supply Delivery

Optimize routes from multiple bases for distance and equitable coverage



81 shelters+10 vehicles | distance –21%

Materials Discovery

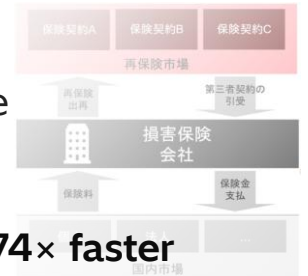
Improve predictions by exploring QUBO-based feature sets



Explore vast candidate spaces efficiently

Reinsurance

Balance return and risk with continuous-variable MBQP



2.6 years → 5.5 days | 174× faster

Traffic & Transport

Stagger departures to smooth traffic on nearby roads



~1,700 vehicles | planned in ≤6 min

Shift Scheduling

Build weekly shifts from staffing, facility, and on-site constraints



~300 people | built in ~1 hour

AI Integration

Transfer small-problem insights to NNs and scale to large graphs



150K nodes | loss improved ~34%