Full Stack Quantum Computing

ZKI-Herbsttagung 2025

Computing Technology at Fujitsu

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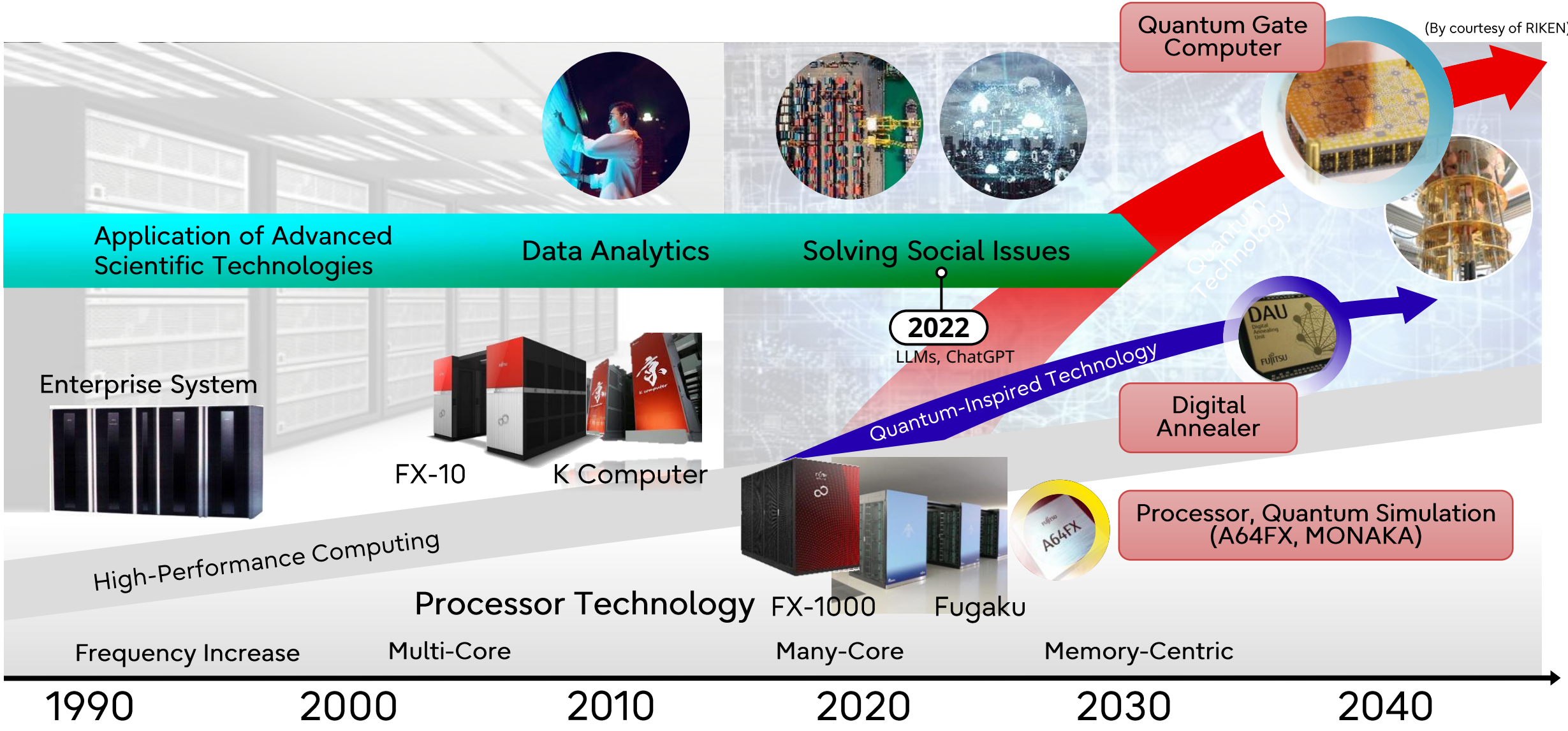

Our Strategy for Quantum Computing

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- Cover all the technology layers with the world's leading research institutions
- Put emphasis on software technologies, while working on several types of hardware
- Develop applications with end users by using Hybrid Quantum Computing Platform

Full Quantum Stack

Quantum Application	Research with end-user: **Materials** **Drug discovery** **Finance**		**FUJIFILM, Tokyo Electron, TU Delft** etc.
Quantum Software	**QunaSys** Algorithm	**Keysight Technologies** Error Suppression	**Osaka Univ.** Error Correction[3]
Quantum Platform	Middleware	Complier	Cloud Technology
Quantum State Control, Device & Integration	**RIKEN** Superconducting Qubits	**TU Delft** Diamond Spin Qubits[2]	Exploring other possibilities, Neutral Atom etc.

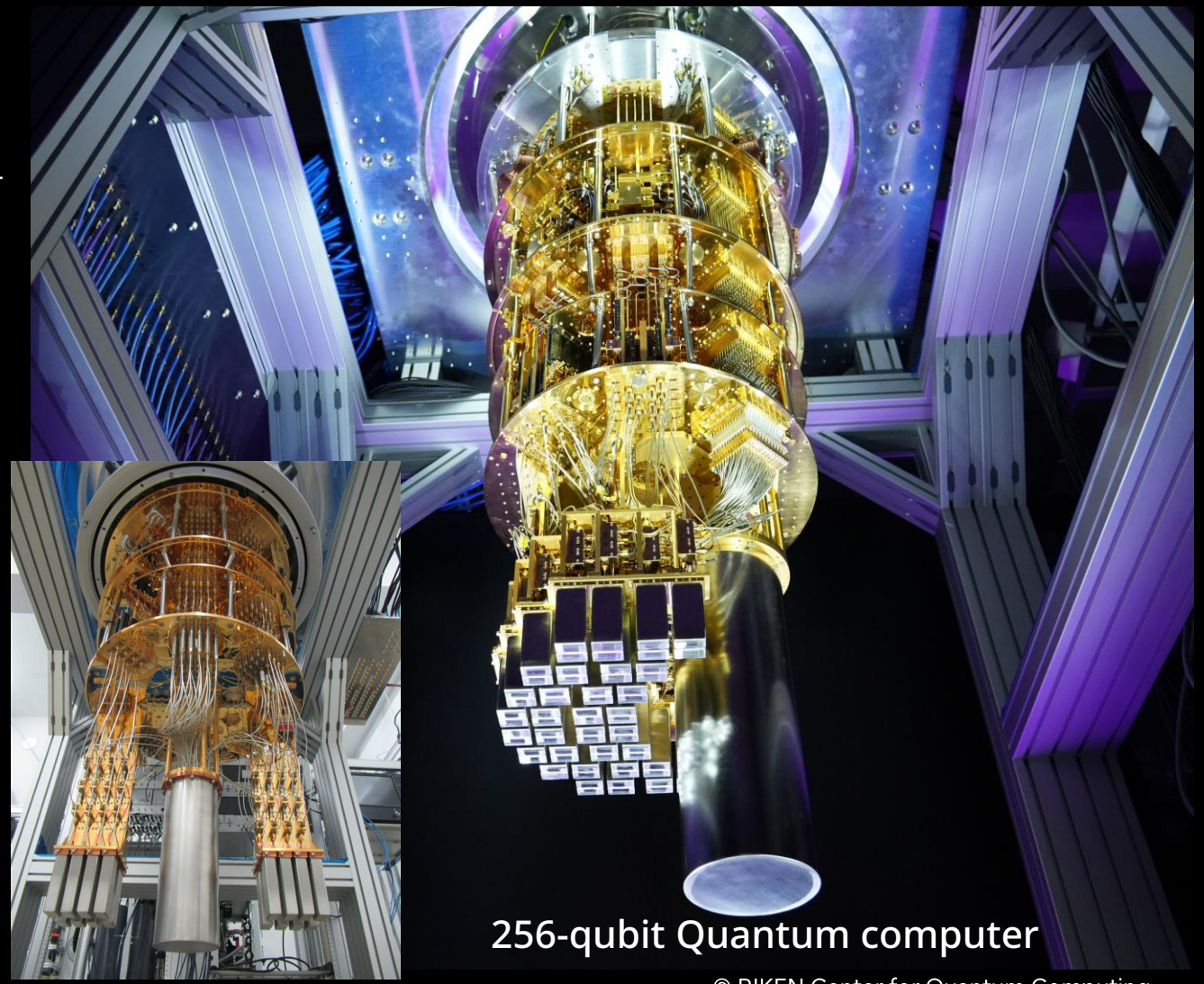
Osaka Univ. Platform Software as OSS[1] Open Quantum Toolchain for Operators and Users

(1) Fujitsu and research partners launch open-source quantum computer operations software
(2) https://www.fujitsu.com/global/about/resources/news/press-releases/2025/0324-02.html
(3) https://www.fujitsu.com/global/about/resources/news/press-releases/2024/0828-01.html

Developed 256-Qubit Quantum Computer

Press release:
https://pr.fujitsu.com/jp/news/2025/04/22.html

- Achieved the development of one of the world's largest-class quantum computers[1] through thermal design and high-density integration technology
- 2026: 1024-qubit Quantum computer
- 2023: 10 000+ qubit Quantum computer[2]



256-qubit Quantum computer

64-qubit Quantum computer

(1) Quantum computer available for external users
(2) https://global.fujitsu/en-global/newsroom/gl/2025/08/01-01

40-qubit Quantum Computer Simulator

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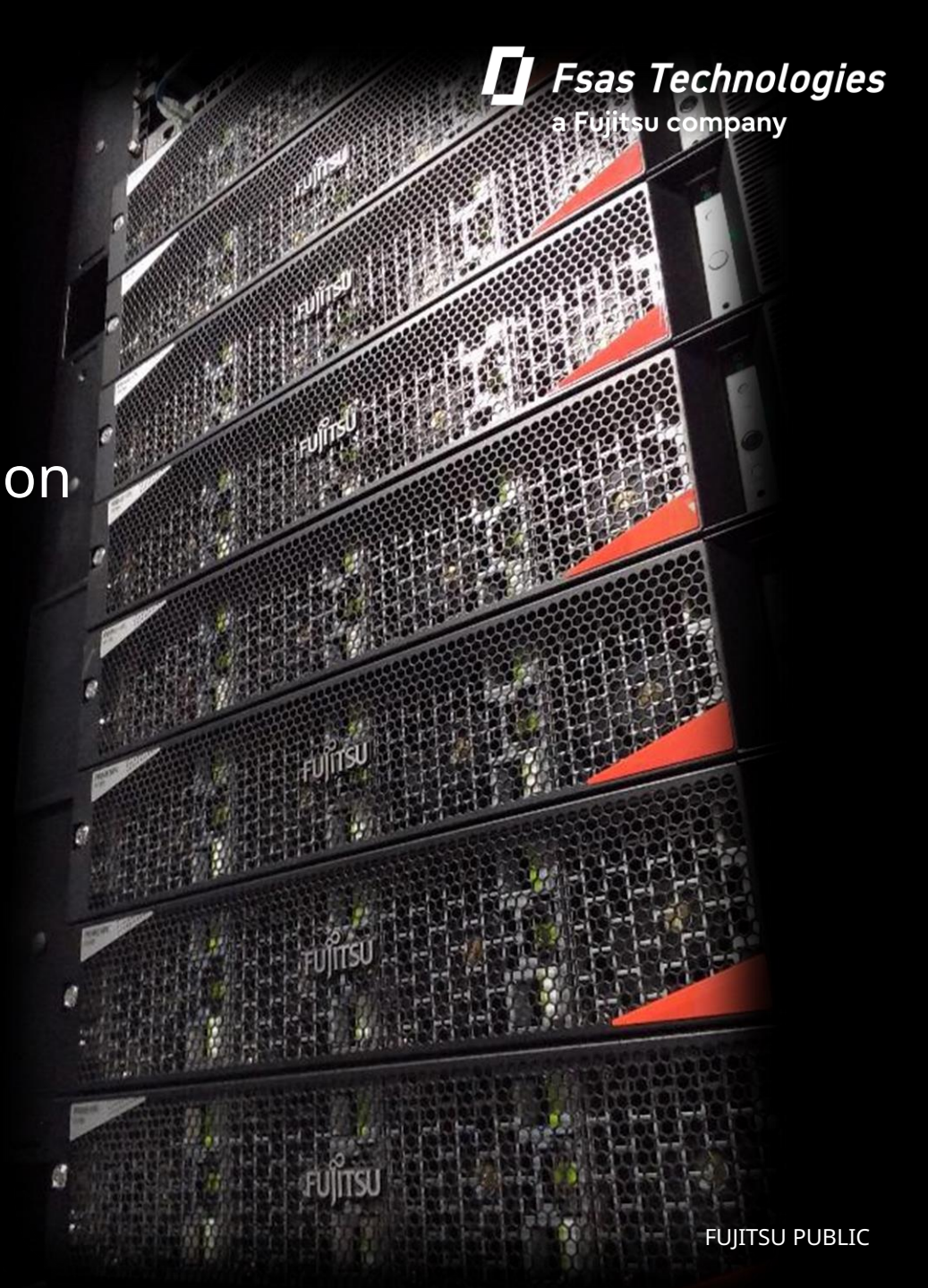
Press release:
https://pr.fujitsu.com/jp/news/2024/02/19.html

- The world largest-class state vector simulator on PRIMEHPC FX700 cluster as a permanent dedicated system
- Worldwide Quantum Simulator Challenge
  (2025: 2nd Place Technische Universität Ilmenau)[1]
- Research on new-type simulators for larger scale
  - ✓ Tensor Network simulator with *Barcelona Supercomputing Center*[2]
  - ✓ Decision Diagram simulator with the Univ. of Tokyo



(1) https://pr.fujitsu.com/jp/news/2025/03/28.html

(2) https://www.fujitsu.com/global/about/resources/news/press-releases/2023/0419-02.html

Digital Annealer Introduction

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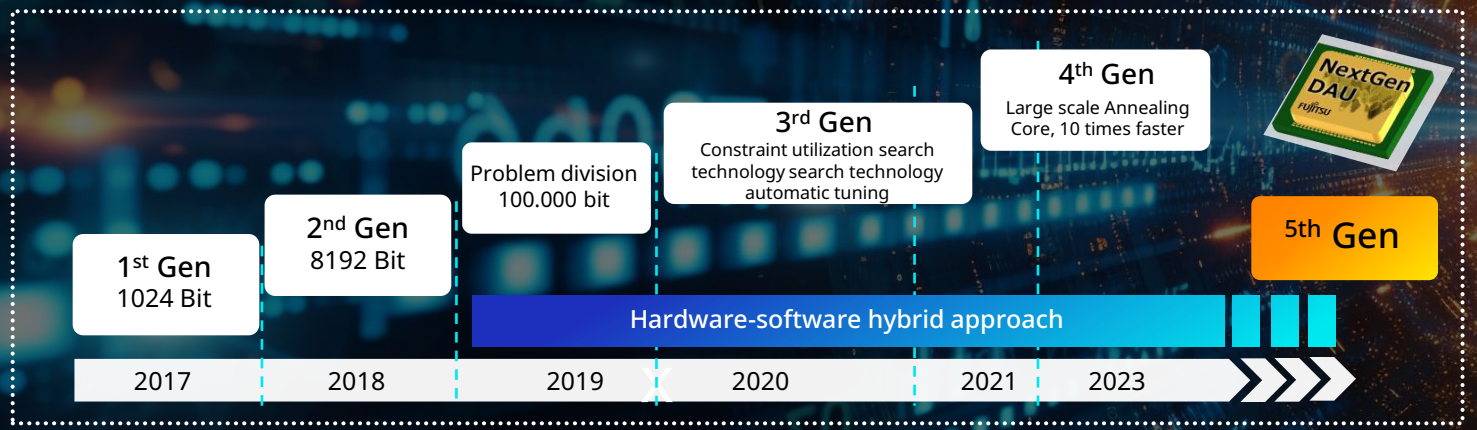


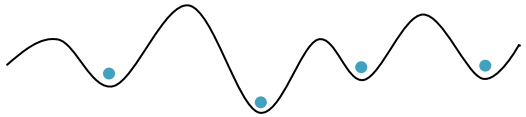
Digital Annealers Sweet Spots

- **Real time requirements:** Equal quality solution in shorter time
- **Quality requirements:** Better quality solution in same time
- **Disruptive solution:** Possibility to find solution

Quantum Annealing

Combinatorial Optimization Problems

$$E(X) = -\sum_{\{i,j\}} W_{ij} x_i x_j - \sum_i b_i x_i$$



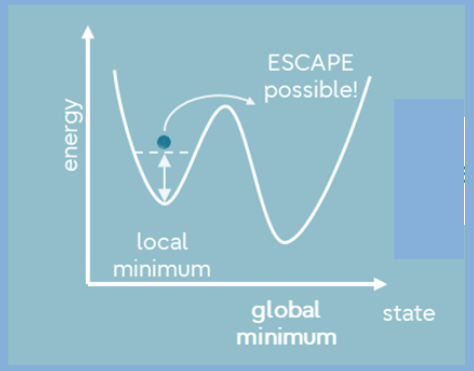
Emulation

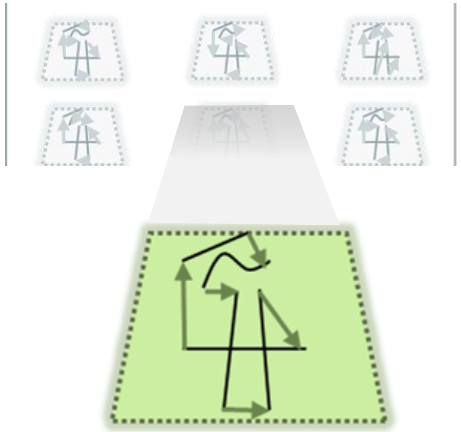
For a set of possible solutions...

... define a search space and a cost function ...

$$E(X) = \sum_{t=0}^{N-1} \left(1 - \sum_{s=0}^{N-1} \sum_{e=0}^{1} x_{t,s,e}\right)^2 + \ldots$$

Digital Annealer





... where the minimum corresponds to an optimal solution

Fujitsu Digital Annealer: Get Started : Fujitsu Deutschland

Selected Customer Projects

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Network Optimization

Deutsche Telekom

Up to 40% solution quality improvements

Portfolio & Risk Optimization

VR Smart Finanz

Improved feature selection determines model parameter as good as productive system in seconds

NatWest

300-times faster portfolio optimization

Job Shop Scheduling

Leibniz University Hannover

Scaling for continuous production

Traffic Flow Optimization

Hamburg Port Authority

Up to 20% reduced travel times

Transport Optimization

Deutsche Bahn

10% more train connections

MediaMarktSaturn

Up to 5 % savings in transport costs

Drug Discovery

Polaris QB

80% shorter preclinical time periods

Toray

Identify stable molecule candidates in minutes

Global collaboration with universities and research institutions

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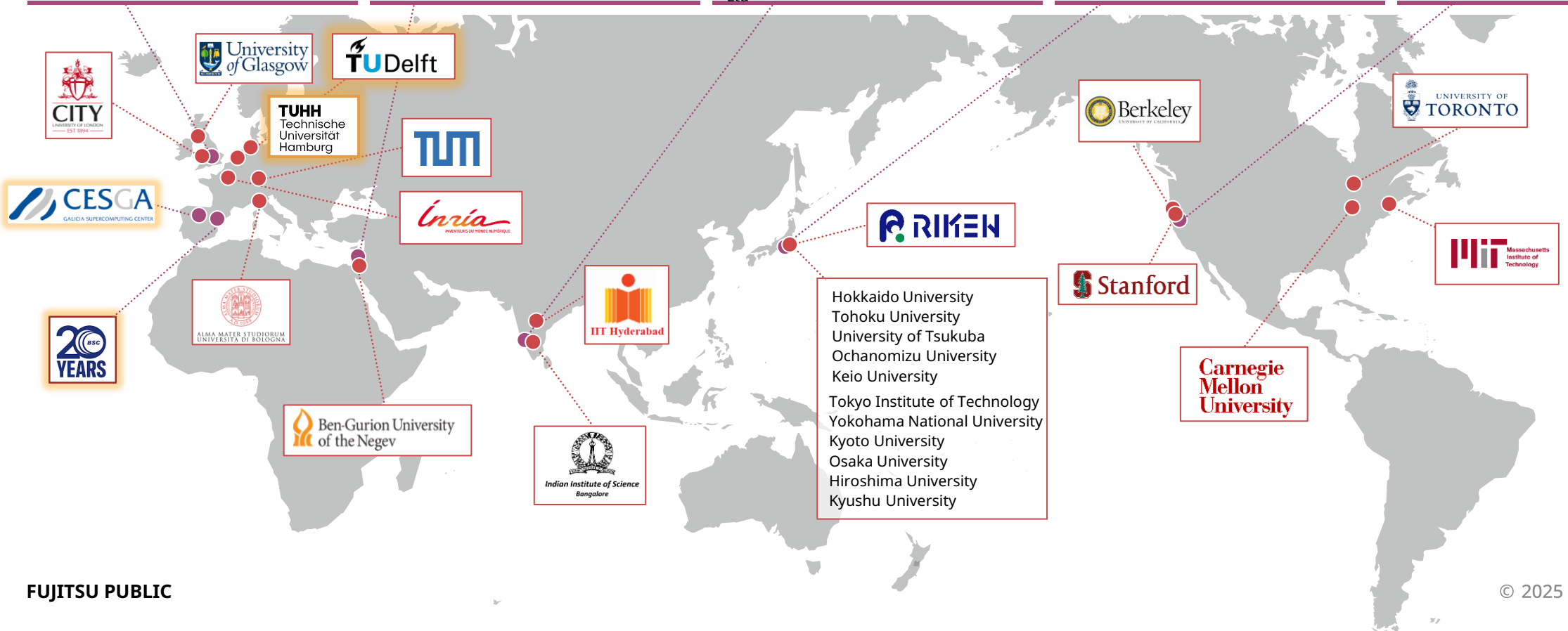
Fujitsu Research Group

FRE	FRE Israel	FRIPL	Fujitsu Limited	FRA
AI, Quantum Converging Technologies FRE: Fujitsu Research of Europe Ltd	Data & Security, AI	AI, Computing Quantum Software FRIPL: Fujitsu Research of India Private Ltd	AI, Computing, Quantum Network, Data & Security Converging Technologies	AI, Computing, Quantum Converging Technologies FRA: Fujitsu Research of America, Inc



Further Information

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Website

You can find more information on our website.

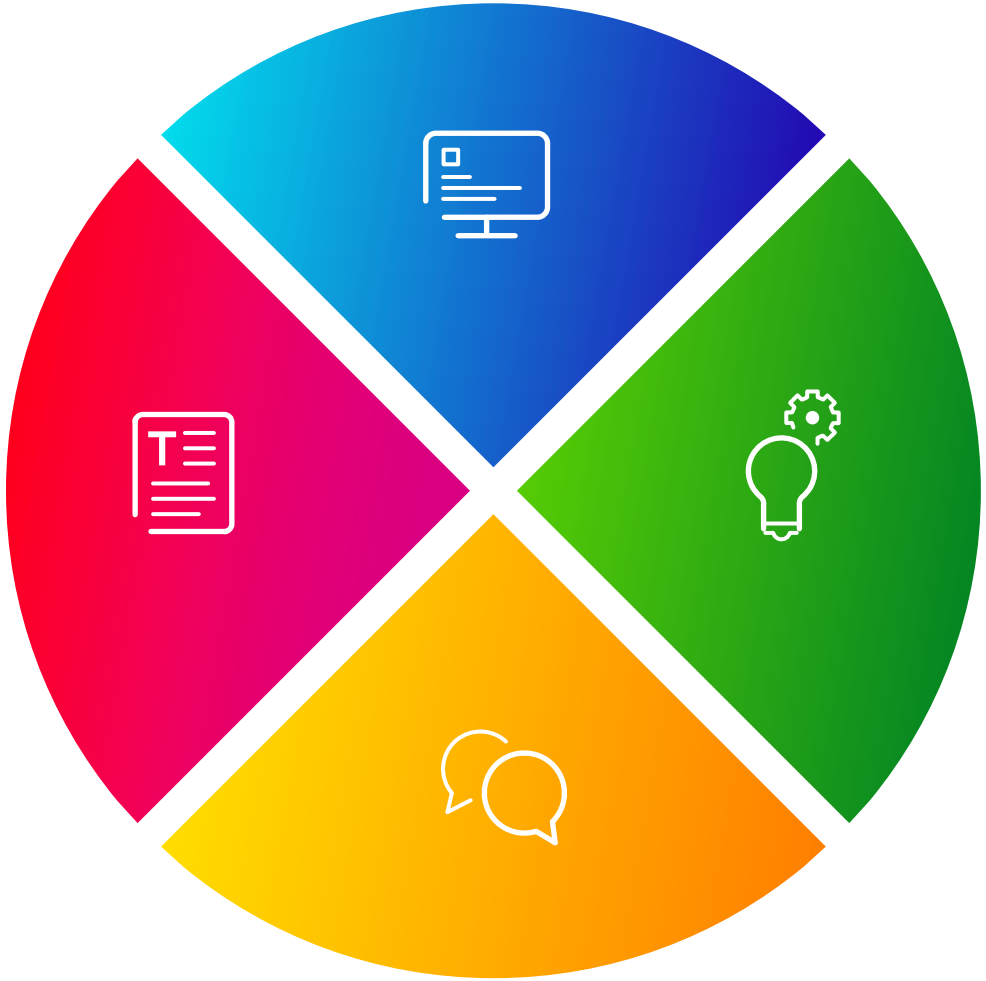
Tutorial

Tutorials: How to make a QUBOs and work with the Digital Annealer including an emulator can be find here.

Selected Papers Germany

We regulary work with universities and other science societies on actual problems. Please find some scientific publications here:

- Job Shop Scheduling Paper with Leibniz University
- Traffic Signal Light Optimization
- A comprehensive benchmark of an Ising machine on the Max-Cut problem



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