

Fujitsu World Tour

Fujitsu Innovation Gathering



shaping tomorrow with you

Human Centric Innovation

Driving a Trusted Future

Quantum Computing in Action

Dr. David Snelling, Program Director AI (EMEIA)

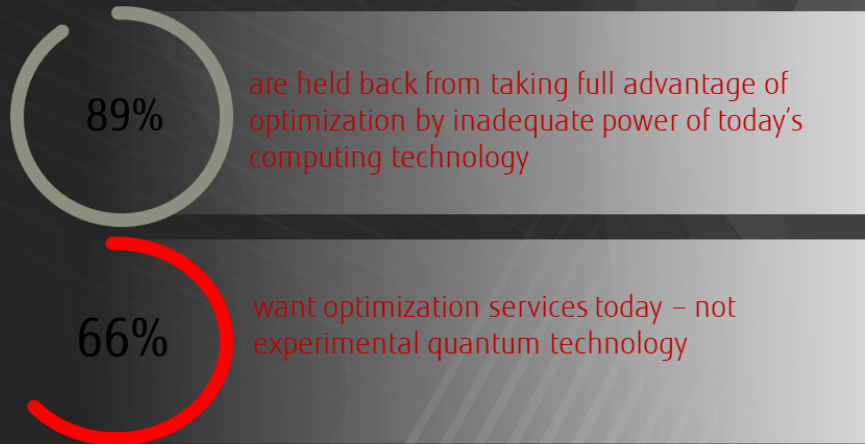
Fujitsu EMEIA

Is Business Ready to Take the Quantum Plunge?

What companies are saying today (Survey results 2019)



81% of the respondents have appetite for innovation



350

Participants: 300 senior business leaders at large and mid-sized businesses

8

Countries: Canada, Finland, Germany, Ireland, Spain, Sweden, UK and USA

Survey Details

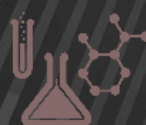
Manufacturing



Financial Services



Life Science



Transport



Retail



Utilities



Quantum Computing comes with Challenges



Stability

Requirement for isolation from magnetic field resulting in error correction application and longer calculation time



Complex Infrastructure & Cost

Isolating the system from any external interference requires running at milli-Kelvin degrees



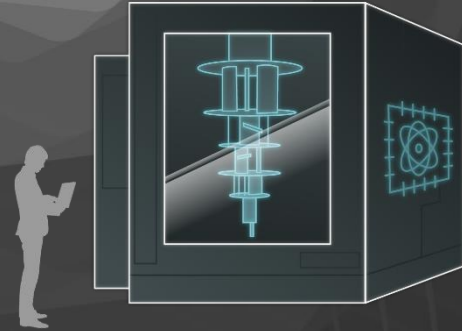
Accuracy

Higher possibility of errors in calculation, as qubits tend to quickly lose the state of superposition

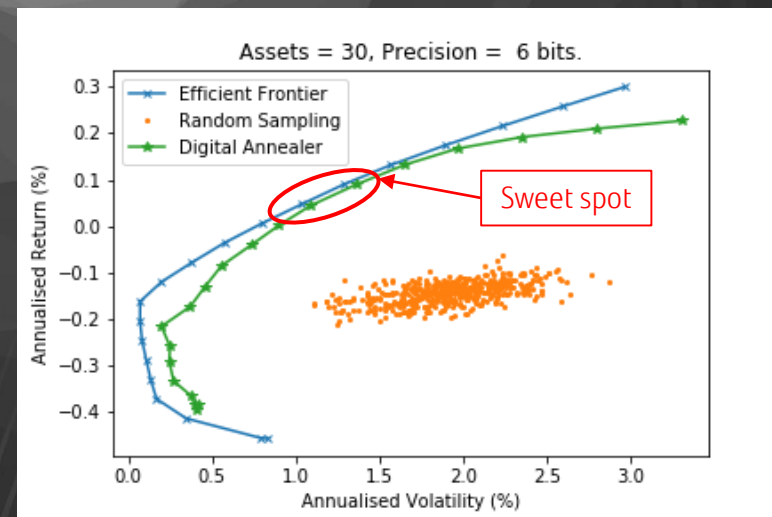


Readiness

In many cases, the solution is not ready to solve real world problems yet, only useful for research



- **Requirement:** Maintain a sizable (£120bn) portfolio of High Quality Liquid Assets (HQLAs).
 - Required by governments following the 2008 financial crisis.
- **Objective:** Minimize the risk associated with a portfolio of HQLAs.
 - Risk is defined in terms of the relative volatility of HQLAs with respect to each other.
- **Constraints:**
 - Assets can only be purchased in sizable lots.
 - There is a limited budget available for purchasing the portfolio.
 - A minimum target return is required.
- The “Efficient Frontier” represents the theoretically best return for a given level of risk.
- In PoC with NatWest*, the DA was 300 times faster than current approaches.
- DA version 2 will handle portfolios of around a 1000 assets.



* <https://www.rbs.com/rbs/news/2018/09/natwest-begins-testing-with-quantum-computing-power-to-help-solv.html>

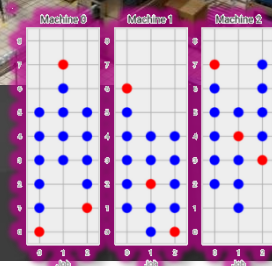
Job Shop Scheduling

Minimize overall production time and enable fast re-planning in a dynamic production line

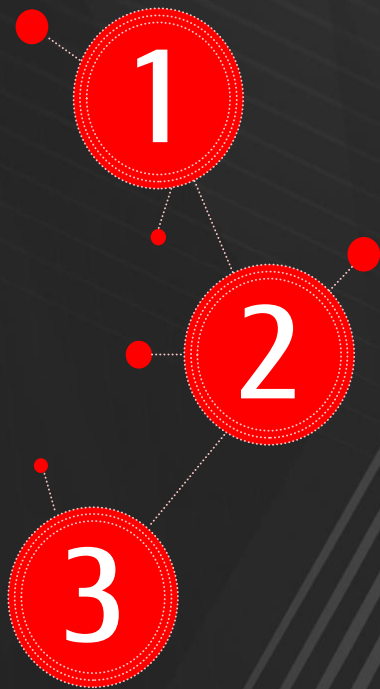
- Production jobs are sequential operations on machines
- Some jobs require multiple operations on a single machine and each job may require different sequencing of operations
- Requires some sense of scale and difficulty here – number of combinations?
- Digital Annealer computes runtime in less than a second



	Operation 0	Operation 1	Operation 2
Job_0	m: 0, p: 1	m: 1, p: 1	m: 2, p: 1
Job_1	m: 1, p: 1	m: 2, p: 2	m: 0, p: 1
Job_2	m: 1, p: 1	m: 0, p: 2	m: 2, p: 1



Engagement Model | Co-create



Identify the problem

What is the problem that you are trying to solve?

- Assess the optimization problem
- Creating new disruptive markets



E.g.: vehicle navigation or cash in-transit

Map the problem

Transform the identified problem to mathematical model – Ising or QUBO

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

Run it on Digital Annealer

Identify optimal solution in seconds
Solve intractable business problems



Full Connectivity

64-bit precision

Parallelism

Roadmap



CY 2018

CY 2019

May 2018:
DA Cloud Service introduced in Japan

April 2019:
DA Cloud Service introduced in RoW

1st Generation



- 1,024 bits
- Full interconnection
- 16-bit precision
- 65,536 gradations

2nd Generation



DAU: Digital
Annealing Unit

On-Premises

- Up to 8,192 bits
- Full interconnection
- Up to 64-bit precision
- 18.45 quintillion gradations

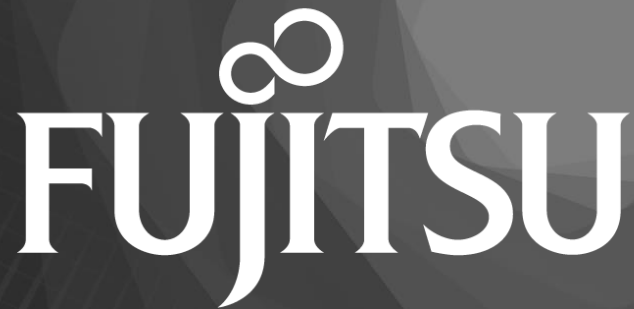
Next Generation

- Large-scale parallel-processing
- 1 million bit scale

Up next...

A visit to the Demo Center

16.30 Drinks reception, prizes and surprise entertainment



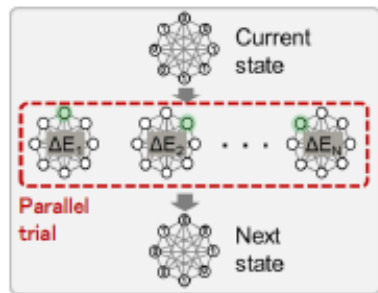
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How was Fujitsu able to achieve this?

Built on digital circuit based architecture, inspired by quantum computing

Unique architecture

Inspired by superposition

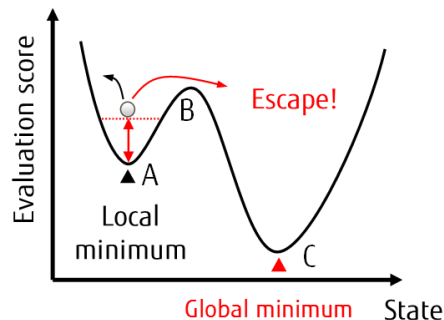


Parallel Speed up

- **Scale of 8192bits**
- **Parallel processing** making it much faster than standard computing
- Stochastic parallelism providing significant **speed up**

Differentiators

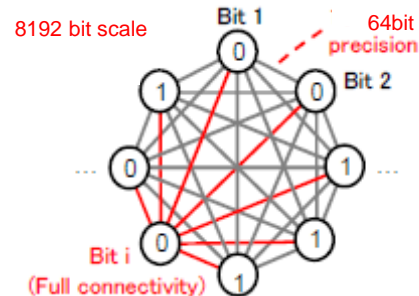
Inspired by quantum tunneling



Annealing Process

- **Cost effective and energy efficient** process in comparison to Quantum Annealing used today
- DA **increases escape probability** from the local minimum energy state with parallel state evaluation
- **Faster** than traditional simulated annealing

Inspired by entanglement



Easy Problem Mapping

- Full connectivity through the 8192 bit scale with **64-bit precision**
- Provides the ability to **represent a large scale problem effectively**
- Faster than standard computing and more **cost effective** than QA systems in the market today.
- The system **works at room temp**