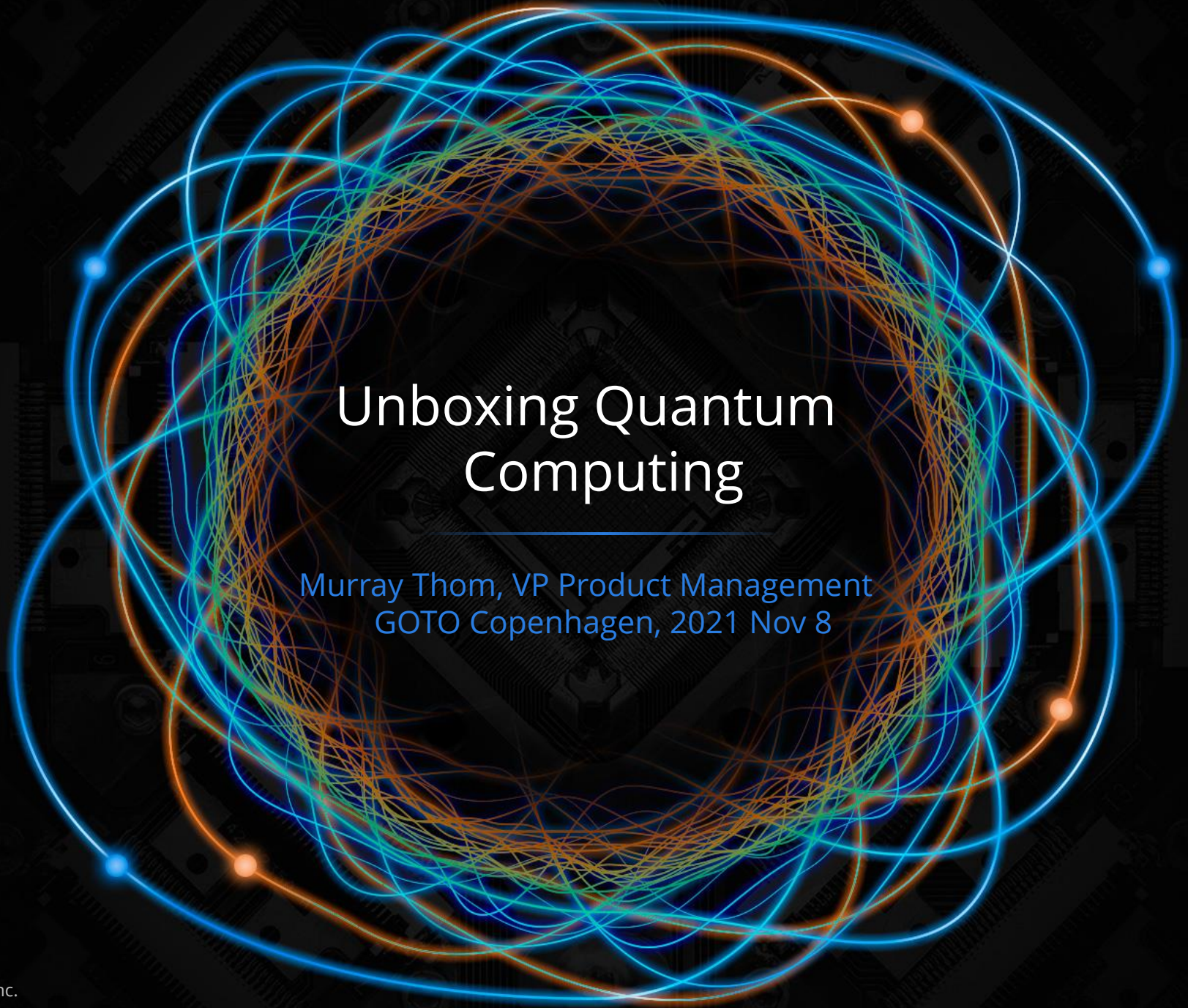
goto;

GOTO
Copenhagen 2021

#GOTOcph



Unboxing Quantum Computing

Murray Thom, VP Product Management
GOTO Copenhagen, 2021 Nov 8

Over 250 Early Applications Across Multiple Industries

Financial Services | **Scheduling & Logistics** | **Manufacturing & Mobility** | **Life Sciences / Materials Discovery**

Streamline the Automotive Supply Chain for Efficiency Gains

Paint Color Switches

Auto manufacturer incurred high costs and waste due to numerous paint color switches in assembly line

80%
Reduction in Waste

5x More Efficient

Using the D-Wave Hybrid Solver Service, the manufacturer can now paint 5x more cars per color switch

"This application has immediate, real-world implications for production and logistics."

—Volkswagen quantum researcher Sheir Yarkoni.

Business-Critical Tasks in Minutes Instead of Hours

Productivity Loss

Grocery chain was spending 25 hours a week on operational optimization tasks

500x Speedup

With D-Wave Hybrid Solver Service, the company replaced classical approaches and saw a 500X speedup

"D-Wave gives us the ability to seamlessly integrate quantum into our business problems."

—Save-on-Foods

Optimize Automated Guided Vehicles on Factory Floors

Production Inefficiencies

Vehicle control, collision avoidance, and production lines can all be streamlined

Streamlined Vehicle Flow

D-Wave's system reduced AGV waiting time by over 15%

Why Quantum Computing

Enormous *potential* speed-up

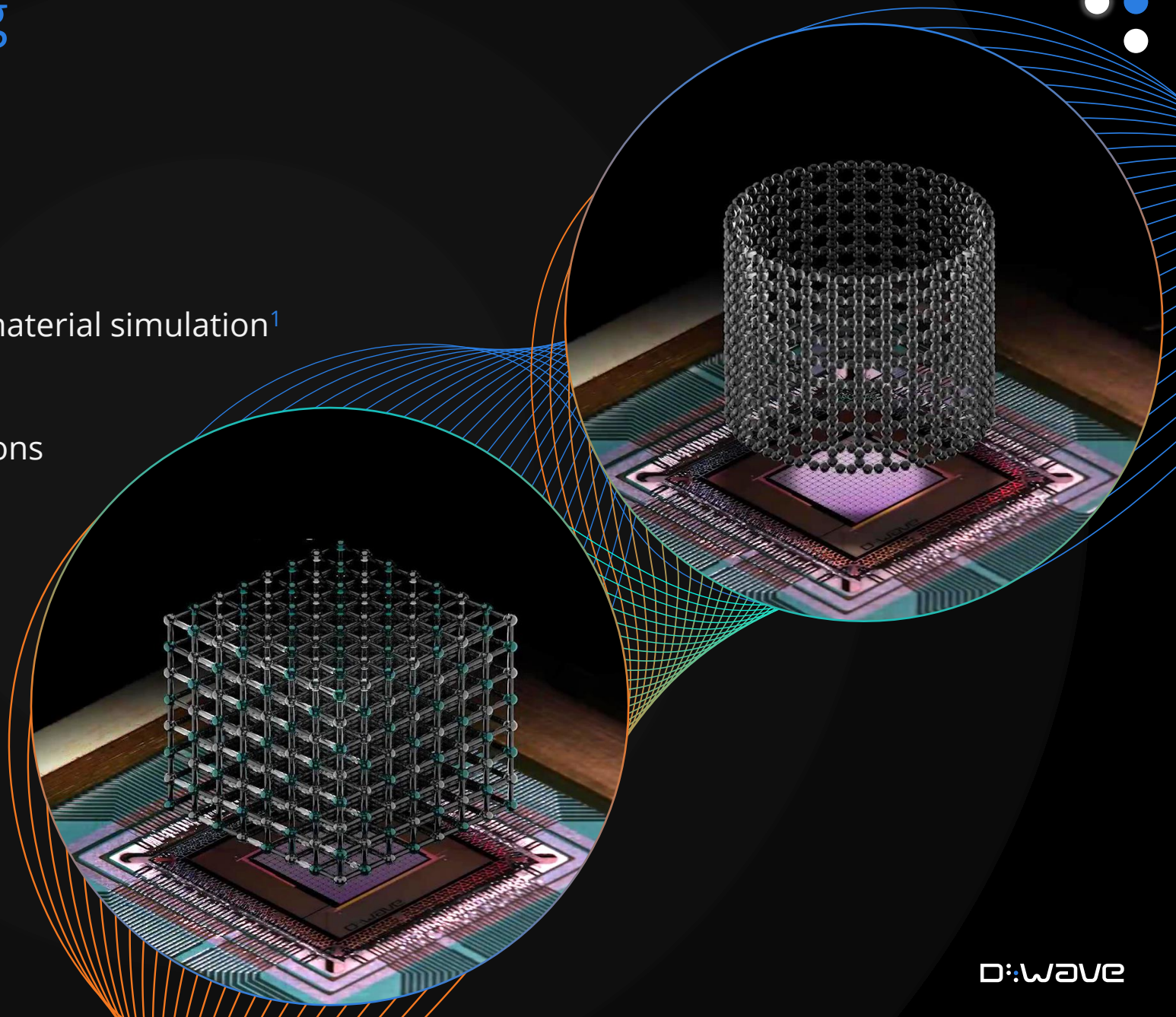
- Referred to as super-exponential

Observed speed-ups so far

- 3,000,000X in applications of quantum material simulation[1]

Real world applications

- 100X-500X in early commercial applications



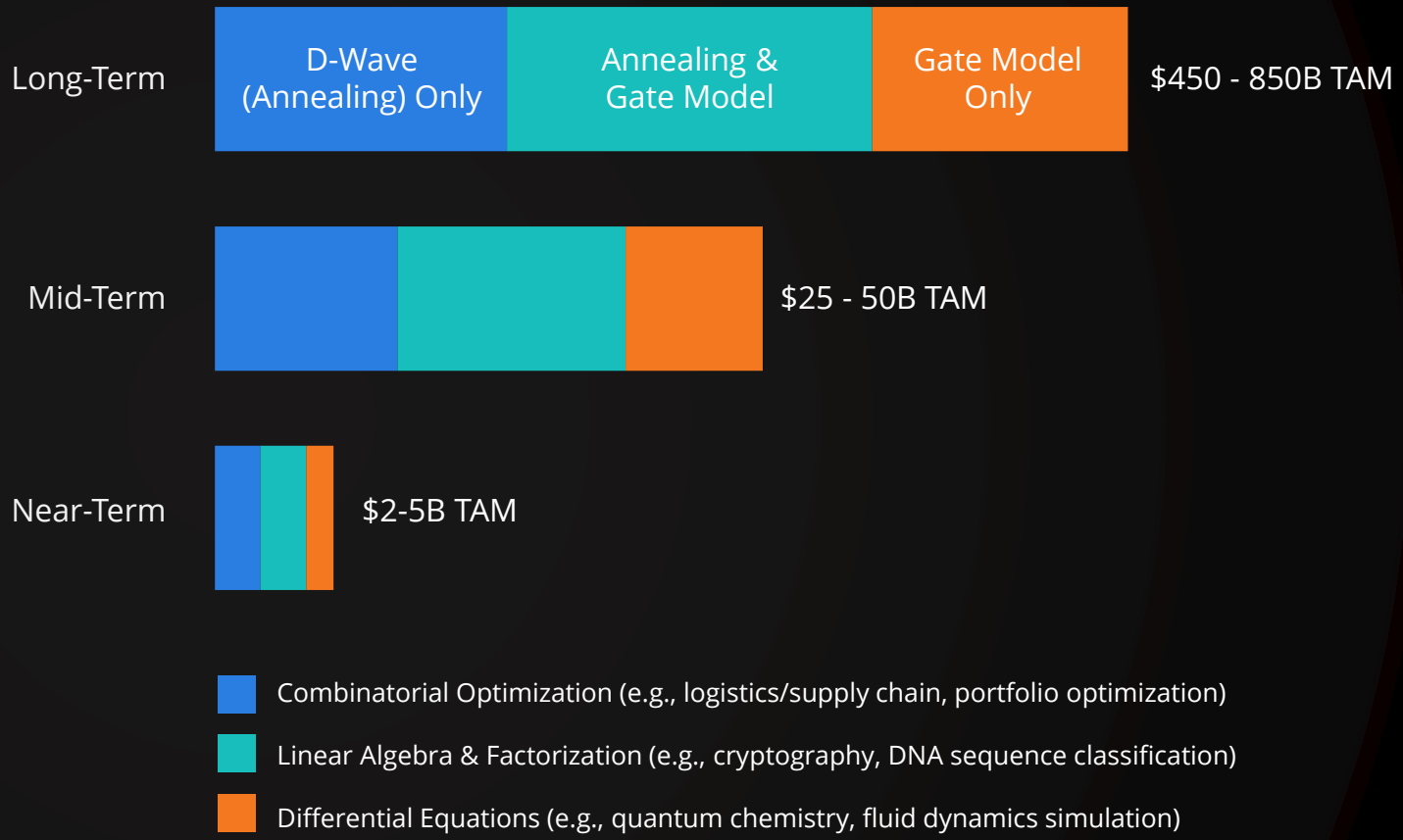
[1]King, A.D., Raymond, J., Lanting, T. *et al.* Scaling advantage over path-integral Monte Carlo in quantum simulation of geometrically frustrated magnets. *Nat Commun* **12,** 1113 (2021). https://doi.org/10.1038/s41467-021-20901-5

Quantum Computing Total Addressable Market

D-Wave is the Solution of Choice for Optimization Problems

Short, medium, and long term, annealing will dominate the optimization space in quantum computing.

Value of **$5 billion to $10 billion** should start accruing to **users** in the near to mid term (BCG).



Source: Boston Consulting Group: "Where Will Quantum Computers Create Value – and When?" May 2019 (80% of TAM accruing to end-users; 20% to quantum hardware, software and services providers)

Better Together: A Comprehensive Platform

advantage

THE QUANTUM COMPUTER BUILT FOR BUSINESS

New processor

Larger + more complex problems

5,000+ qubits

15 way connectivity

Leap

THE QUANTUM CLOUD SERVICE BUILT FOR BUSINESS

Immediate access

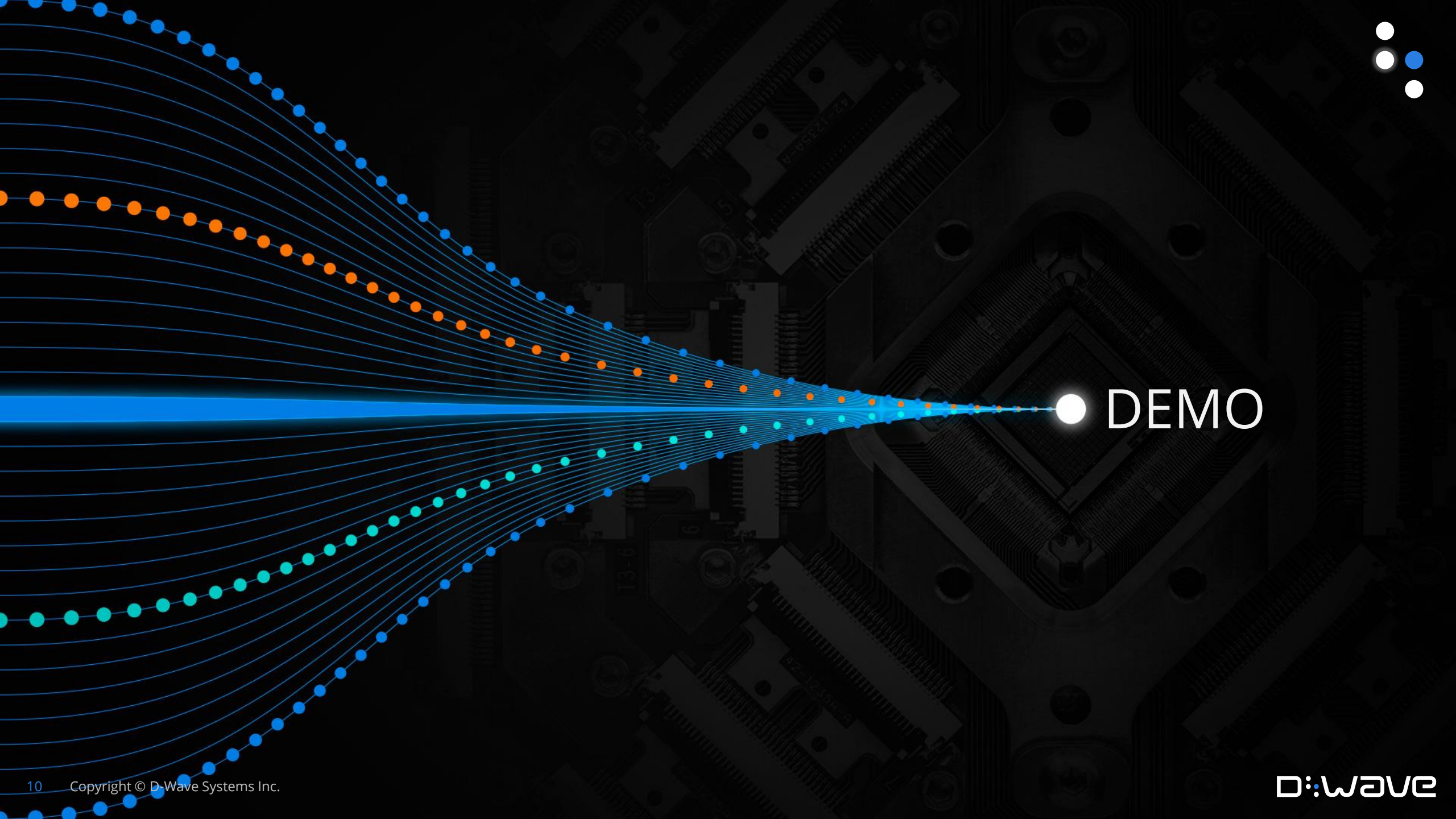
Integrated IDE

1 million variable hybrid solver

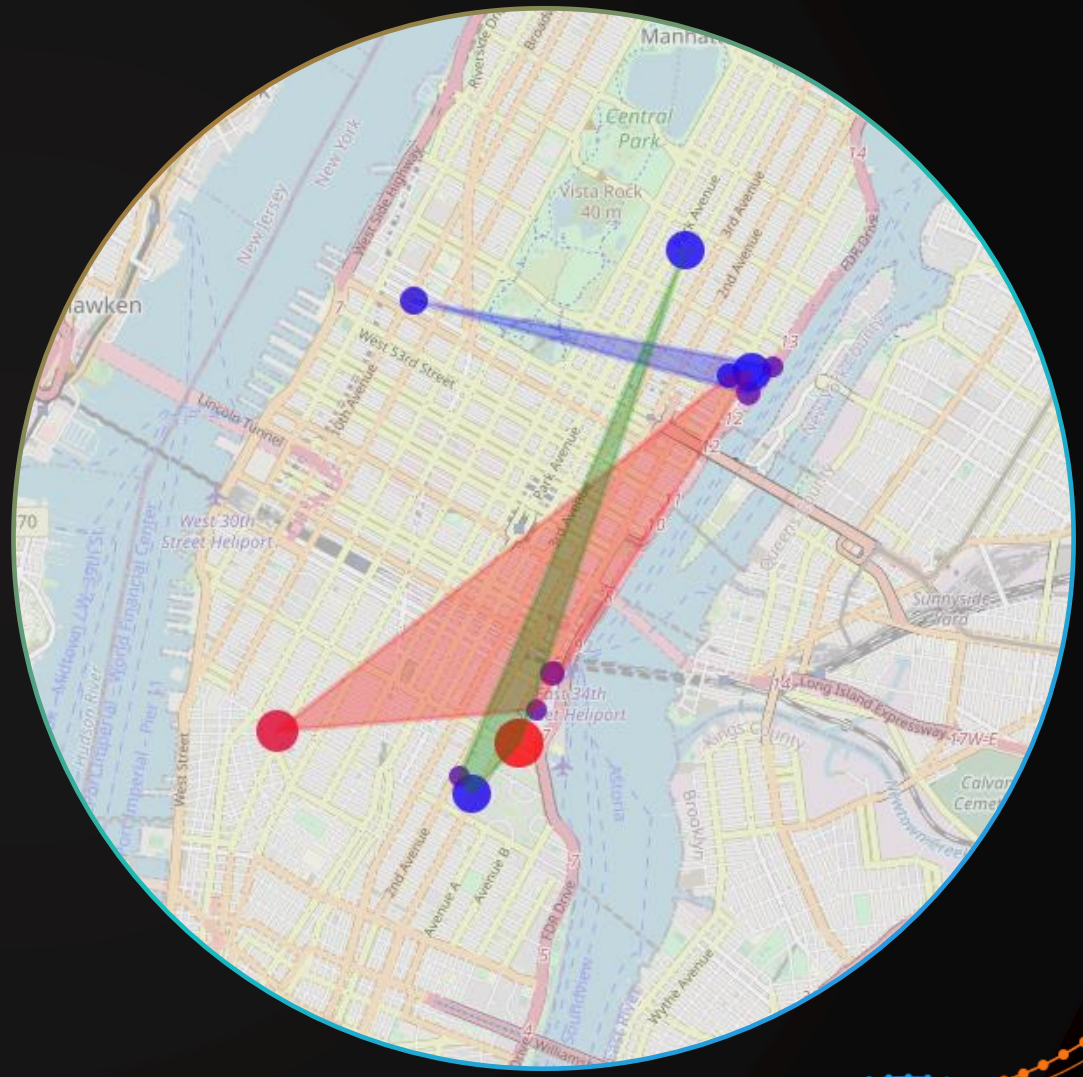
Collaboration

Performance updates available in Leap Today!

All new Constrained Quadratic Model solver!



Hospital Allocation with Constrained Quadratic Models



Given

- Hospital locations
- A surplus or shortage of beds, per hospital
- A transfer cost between hospitals

The problem

- Assign each hospital to a group
- Each group must have a net surplus of beds
- Minimize the total cost of transfers

Hospital Allocation with Constrained Quadratic Models

1. Create binary variables matching each hospital to a group.
2. Enforce that no hospital can be in more than one group.

```
for hospital in hospitals:
  cqm.add_discrete([(hospital, group) for group in range(num_groups)])
```

3. Enforce that each group must have a net surplus of beds.

```
for group in range(num_groups):
  cqm.add_constraint(sum(variables[hospital, group]*beds for hospital, beds in hospitals.items()) >= 0)
```

4. Minimize the total cost of transfers

```
objective = 0
for hospital1, beds1 in hospitals.items():
  for hospital2, beds2 in hospitals.items():
    if beds1 > 0 and beds2 < 0:
      for group in range(num_groups):
        objective += variables[hospital1, group]*variables[hospital2, group]*distances[hospital1, hospital2]
cqm.set_objective(objective)
```

5. Solve on the Hybrid Solver Service (HSS)

```
sampleset = LeapHybridCQMSampler().sample_cqm(cqm)
```

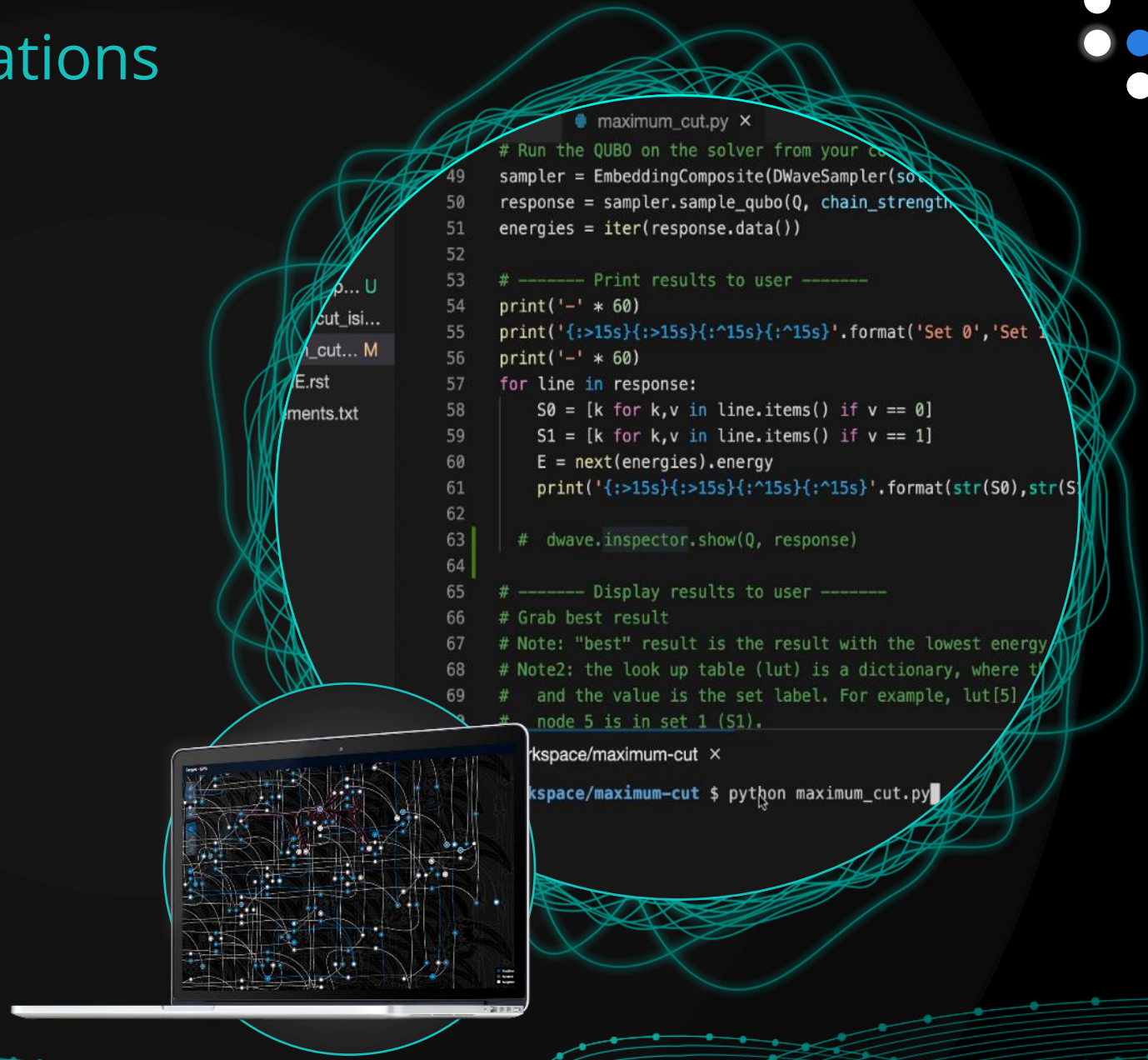
Built for In-Production Applications

Advantage Access Today:

- Developers, businesses and new users have access to the most connected and powerful quantum computer built for business

Real-Time Cloud Access:

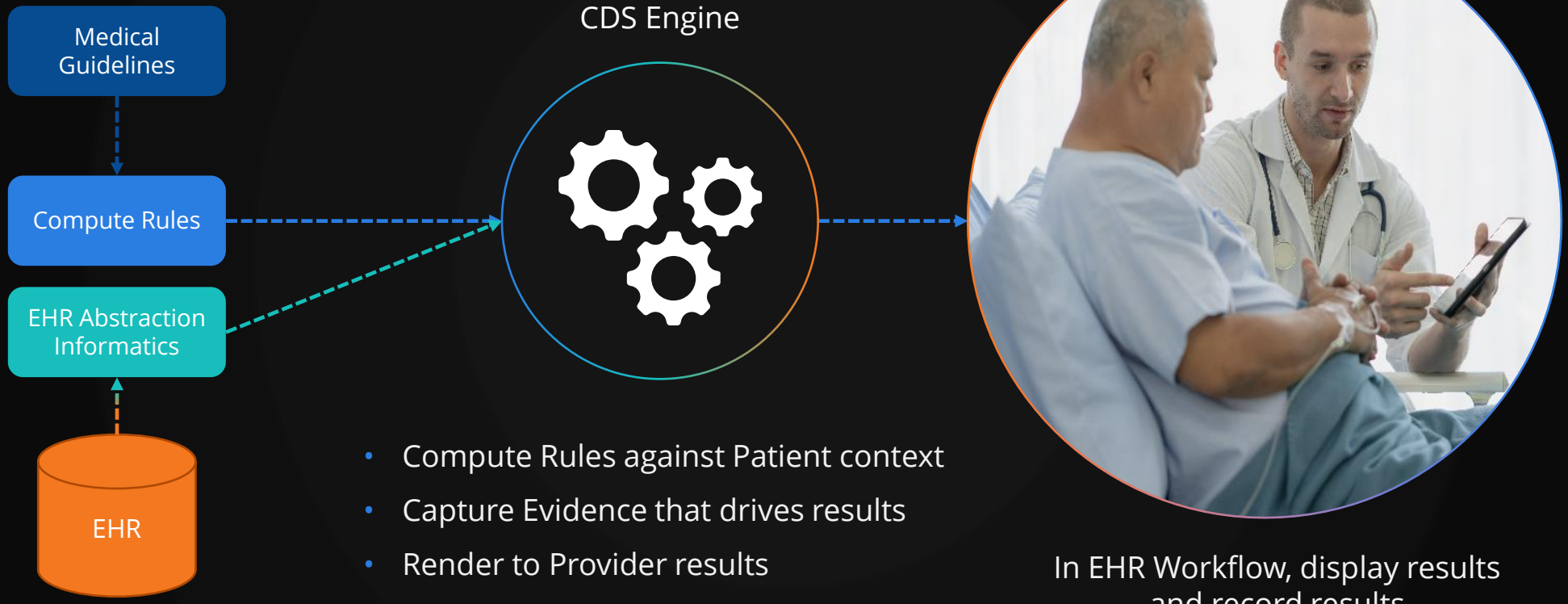
- Open-source Ocean tools and examples
- Online IDE and interactive visualization
- Hybrid solvers adapted to the latest QPU technology and improving with ongoing algorithm development
- Online training and resources



Application Workflows

Consider a Clinical Decision Support System

BASICS OF KNOWLEDGE BASED CDS SYSTEM



- Compute Rules against Patient context
- Capture Evidence that drives results
- Render to Provider results

In EHR Workflow, display results and record results

Workforce Scheduling

Operations scheduling

- Centralized scheduling
- Distributed expertise in machine operation
- Solution structure follows business process

Class scheduling

- Centralized scheduling
- Distributed preferences informing constraints
- Wide variations, frequent changes

Find Optimization Methods With Open Code Examples

Variable encodings, selecting options

- Sudoku
- N-Queens

Assignment to a group

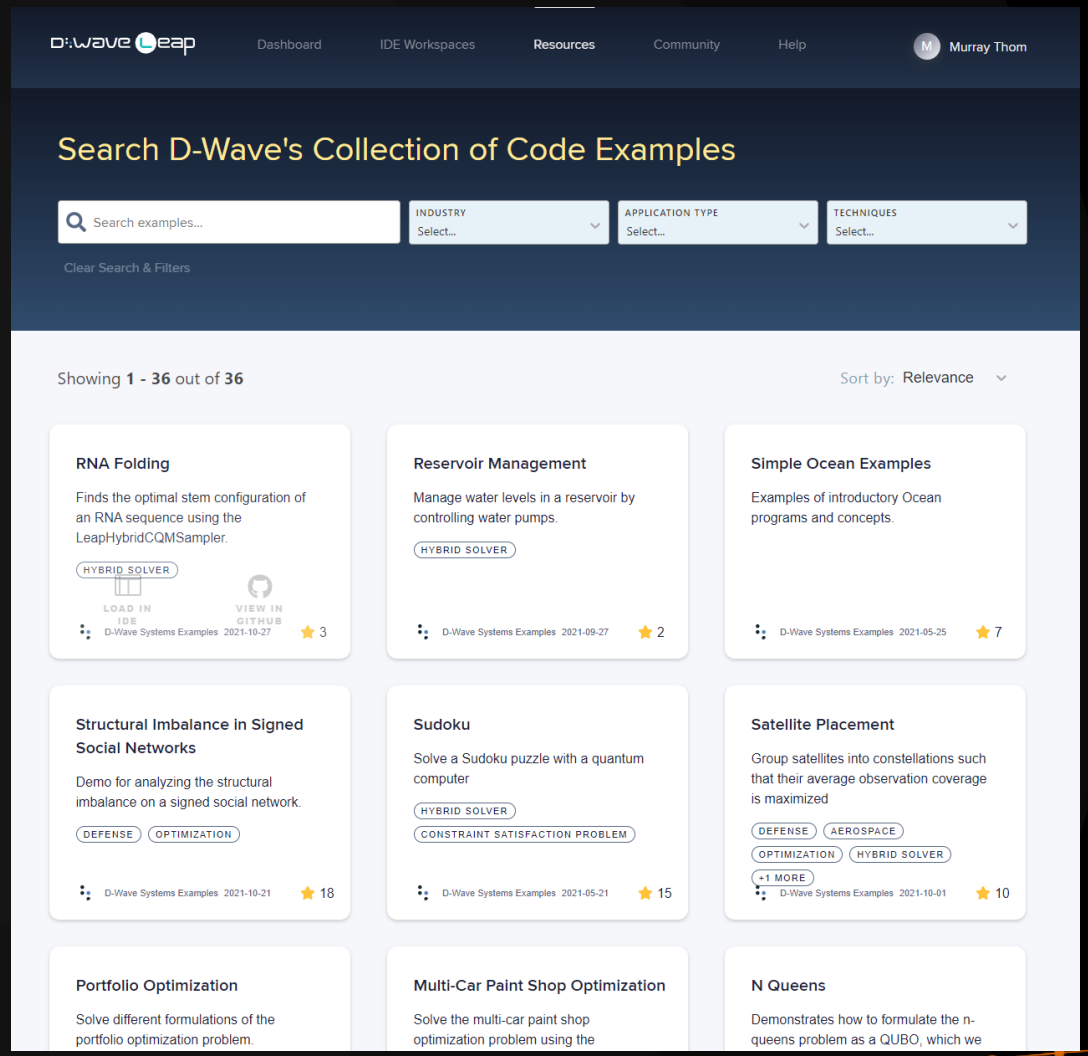
- Graph colouring
- Cell tower frequencies

Network coverage

- Min Vertex Cover
- Satellite Placement

Interacting elements

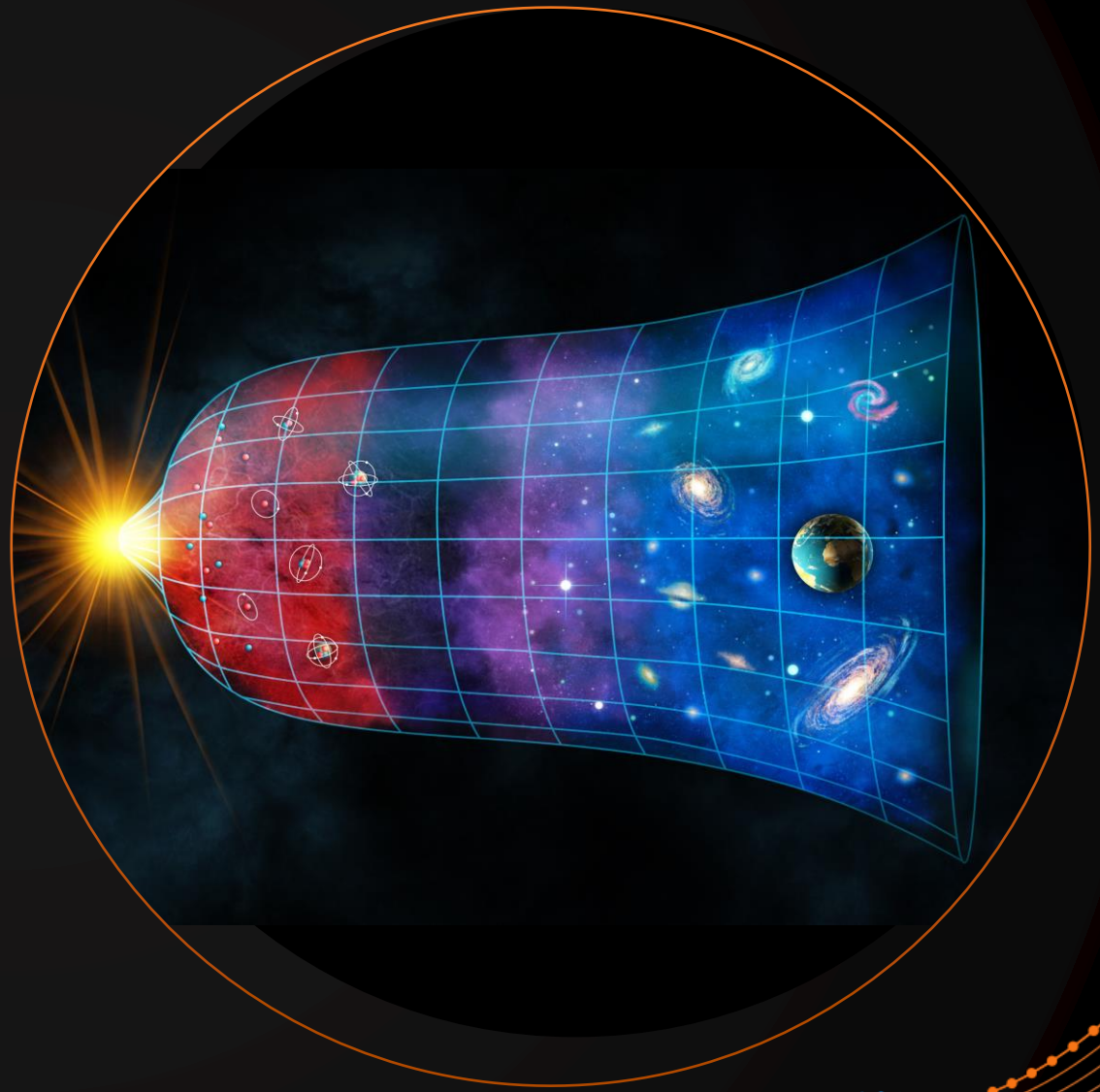
- Maximum Independent Set
- Portfolio Optimization



Business Value Meets
The Frontier of Advancing Science

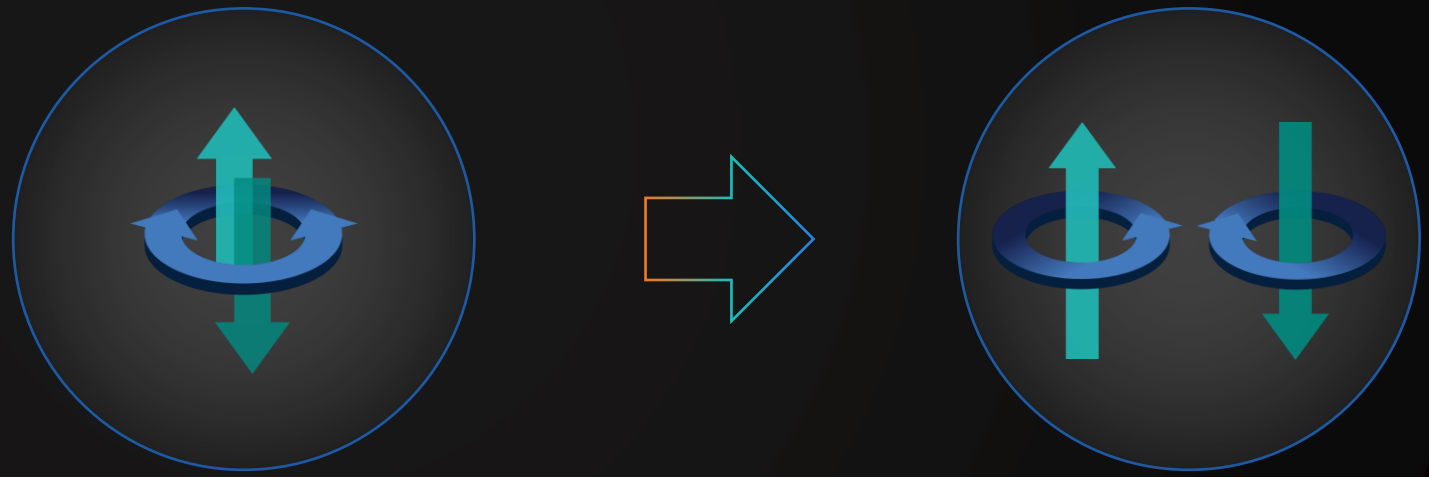
How Quickly Can Information Be Processed?

Tom Kibble determined the rates of domain structure formation in the early Universe



Emergence of Structure in Quantum Computing

Wojciech Zurek related those rates to domain formation in quantum matter like superfluids

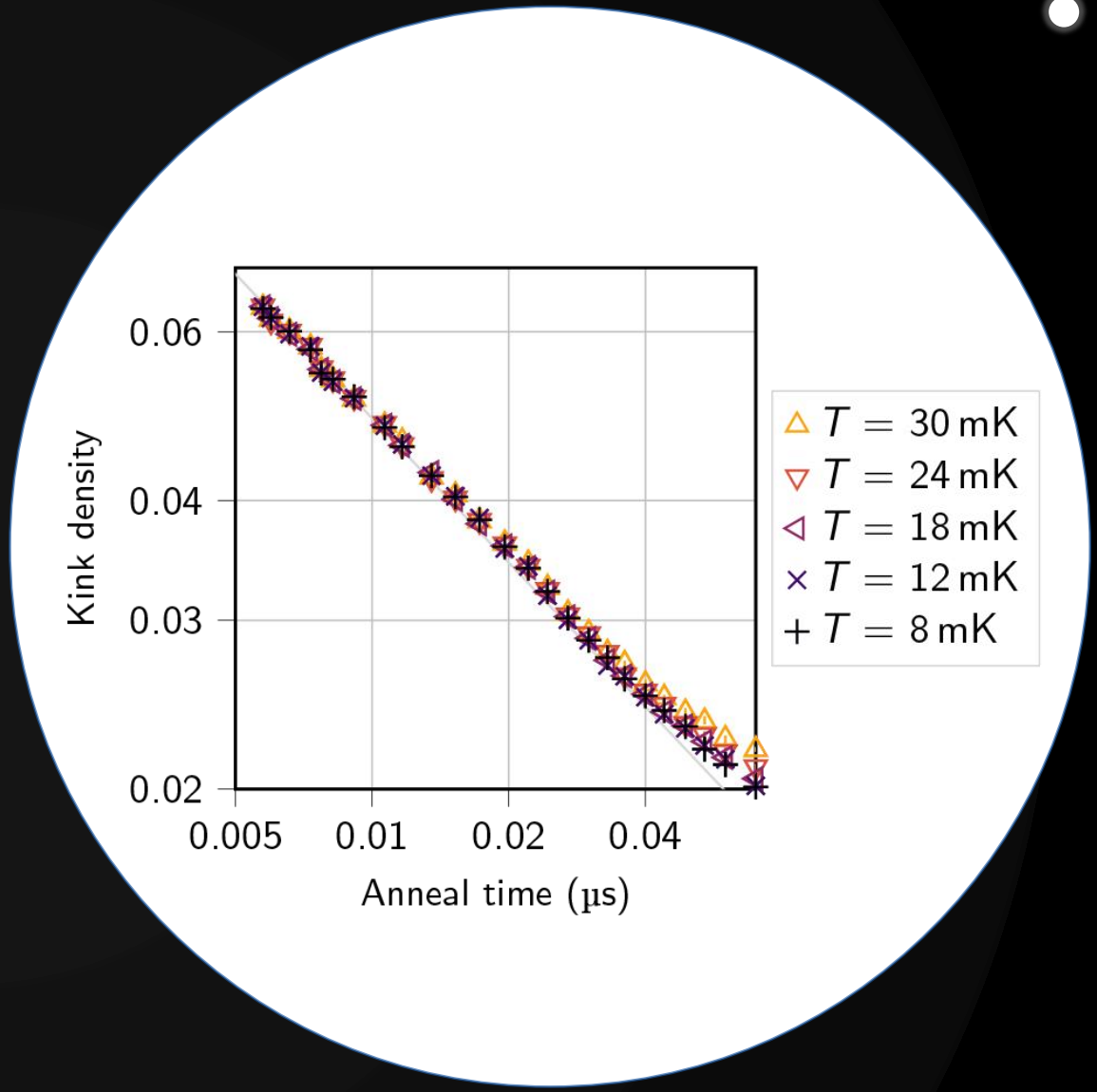


Quantum And The Universe

The early Universe and quantum computing share common foundations

Coherent quantum annealing now observed in commercial quantum processors

Further disruptive accelerations are ahead



Join The Masterclass On Friday

Friday Nov 12 09:00 – 16:00

Quantum Computing for Everyone

REGISTER

Victoria Goliber

Senior quantum computing technical analyst

Join Victoria to demystify the art of quantum computing in this hands-on programming workshop. By approaching quantum annealing through the lens of practical applications, you will leave this masterclass with an understanding of the basic building blocks required to solve real-world optimization problems on D-Wave's Leap™ quantum cloud service.

Together we will go through everything needed to create and run a python program using D-Wave's Ocean™ SDK, and will run these programs live on D-Wave's quantum computers and hybrid solvers.

Next Steps to Learn More or Get Started Today

D-Wave Applications: Check out customer use cases and real-world applications.

- https://www.dwavesys.com/applications

D-Wave Launch Program: Learn about our multi-phased approach to quantum computing adoption.

- https://www.dwavesys.com/d-wave-launch

D-Wave Leap Free Sign-Up: Sign up for D-Wave Leap today to explore and get started.

- https://cloud.dwavesys.com/leap/signup

Sign up for Access to Exclusive Content: Sign up to get access to the content from the Qubits conference (Oct 5-7).

- https://tinyurl.com/DWQubits

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