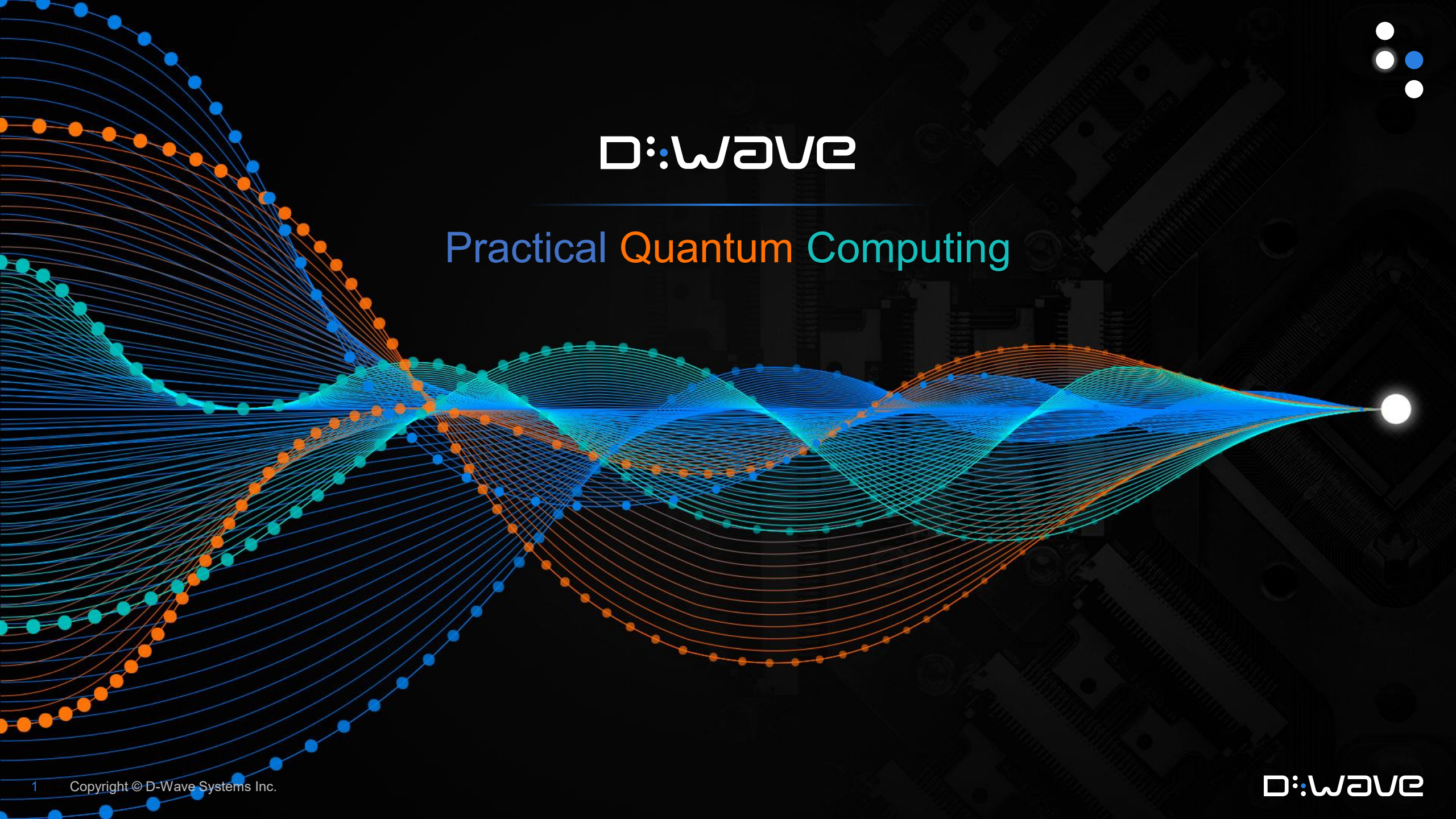
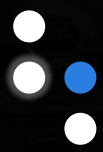




# Practical Quantum Computing





# The Forefront of a Maturing Quantum Industry

Already supporting commercial applications

20,000+ developers in Leap

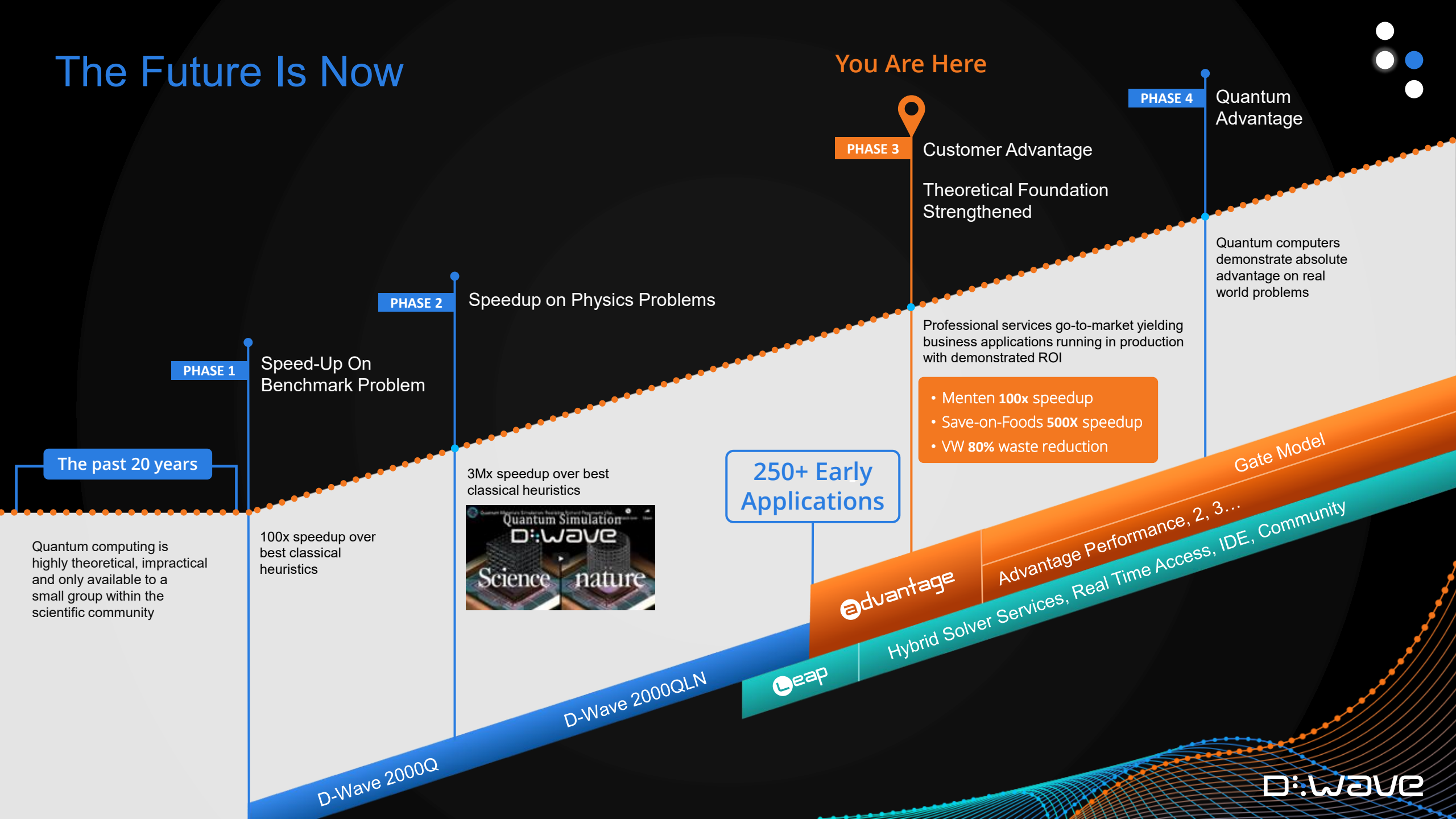
Entrepreneurs are building businesses based on quantum

Service providers tooling up

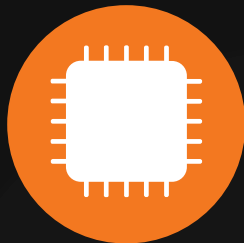
Incubators and universities are producing quantum start-ups



# The Future Is Now



# Engineered for Business



## Annealing Quantum Processor Design

5000+ Qubits; 35,000+ Couplers

## New Topology

Higher connectivity (degree 15)

More compact embeddings = Better QA performance

Embed up to 15x15x12 lattice - Up from 8x8x8 lattice



## Superconducting Circuit Fabrication

1M+ Josephson Junctions

Active area (8.4mm)<sup>2</sup>

110m of wiring





# Advantage Performance Update

## Larger and More Complex Problems

More qubits and couplers enabled for more problem types

## More Precision

Better solutions with lower energy

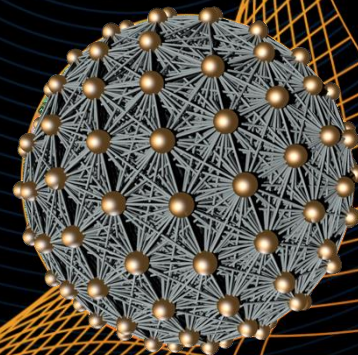
## Higher Quality Answers Faster

Win: 57%, draw: 40%, lose: 3% on NAE3SAT inputs vs. Advantage

Optimal solutions 2x faster than for 3D lattice problems vs. Advantage

## Available in Leap

Available today via the cloud



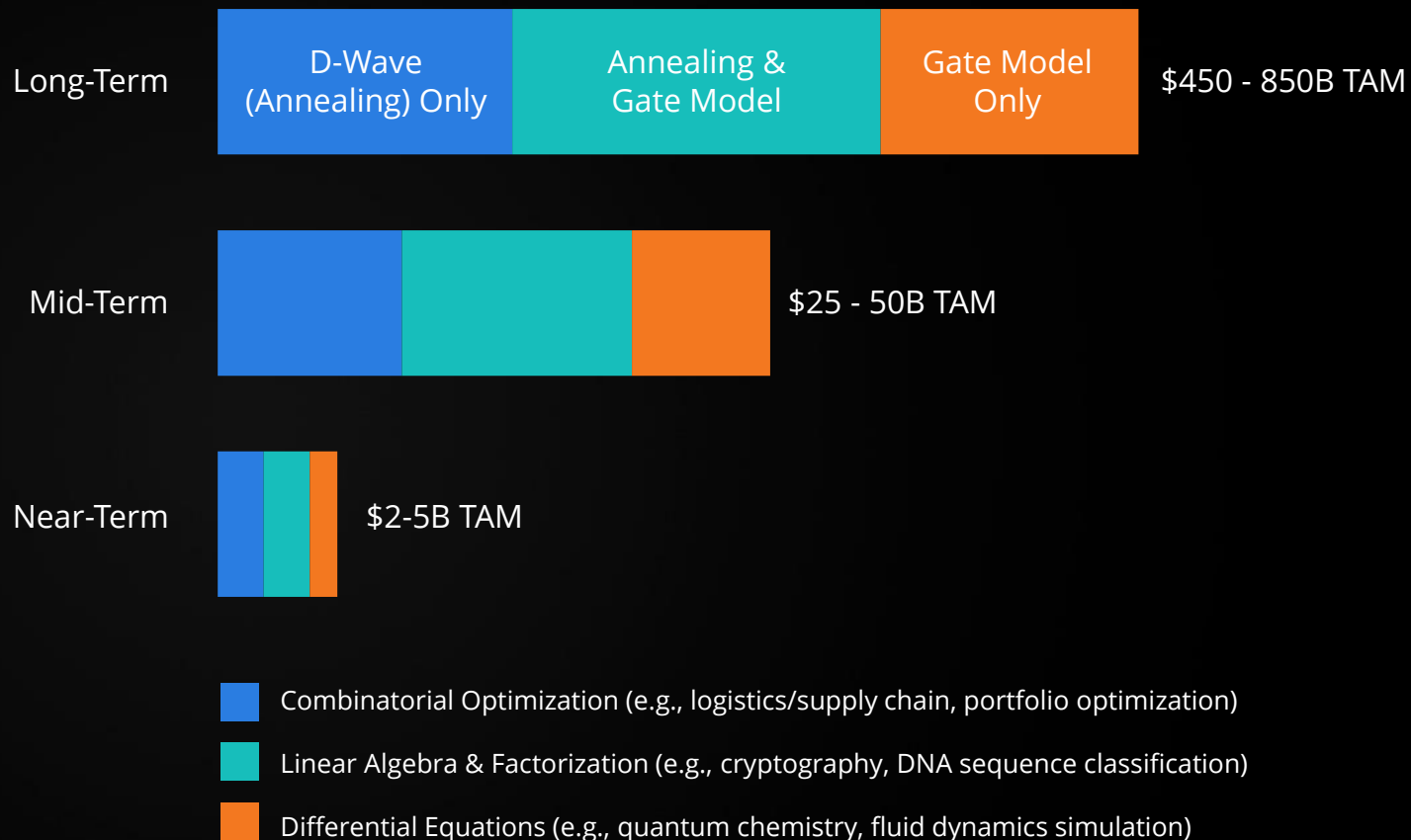
# Quantum Annealing is Here to Stay



## 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).



1 Boston Consulting Group; "Where Will Quantum Computers Create Value – and When?" May 2019



# Annealing Outperforms Gate Model on Optimization Problems

## QA does not involve heavy preprocessing overhead

QA can deliver good solutions without the costly, NP-Hard step of tuning parameters on classical computers that is required by GM approaches like QAOA.

## QA cuts through the noise

QA is much more tolerant of errors than GM and can extract good solutions from the noise.

## QA scales to large, complex problem sizes

High error-tolerance, connectivity, and qubit count enable QA-based systems to solve large, complex real-world optimization problems.

### *Real Annealing Proof Points:*

#### **VW Paint Shop Scheduling**

D-Wave: 80% waste reduction at 750 cars  
Gate QAOA: Like random guessing at 11 cars<sup>2</sup>

#### **Jülich SC Boolean Satisfiability**

D-Wave: Outperforms Gate QAOA  
and noiseless simulators<sup>3</sup>

#### **LANL Evaluations**

D-Wave: 15 seconds to solve  
Gate QAOA: ~30 hours to solve<sup>4</sup>  
(50% to 100% more iterations)



## The quantum computer built for business

- New processor
- More complex problems
- 5,000+ qubits
- 2.5x qubit connectivity



## The quantum cloud service built for business

- Immediate access
- Integrated IDE
- 1 million variable hybrid solver
- Collaboration



In-production applications at business scale



# Hybrid Solvers

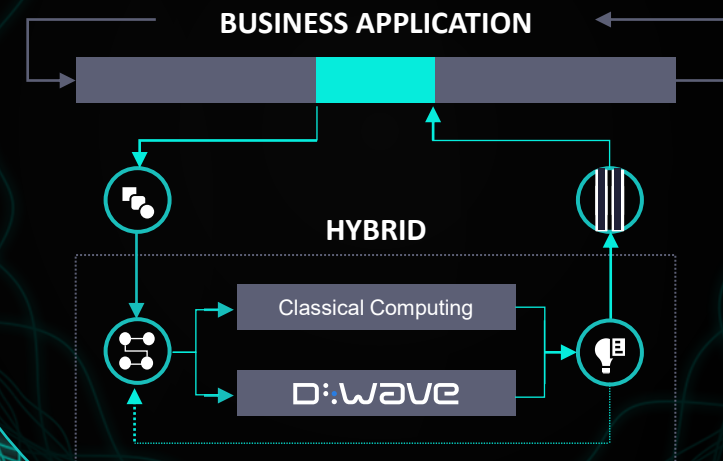
## Binary quadratic model solvers

- Up to 1,000,000 variables
- Enables enterprise-scale problem solving
- Accepts problems with binary variables

## Discrete quadratic model solvers

- Expands into new problem types
- Enables optimization with option selection: e.g., Choose one of 11, 19, 29
- Accepts discrete multi-level variables

SOLVERS THAT  
RUN PROBLEMS ON A  
COMBINATION OF QUANTUM  
AND CLASSICAL RESOURCES



# All New Solver: Constrained Quadratic Model (CQM)

New!

## An Expanded Hybrid Solver Portfolio

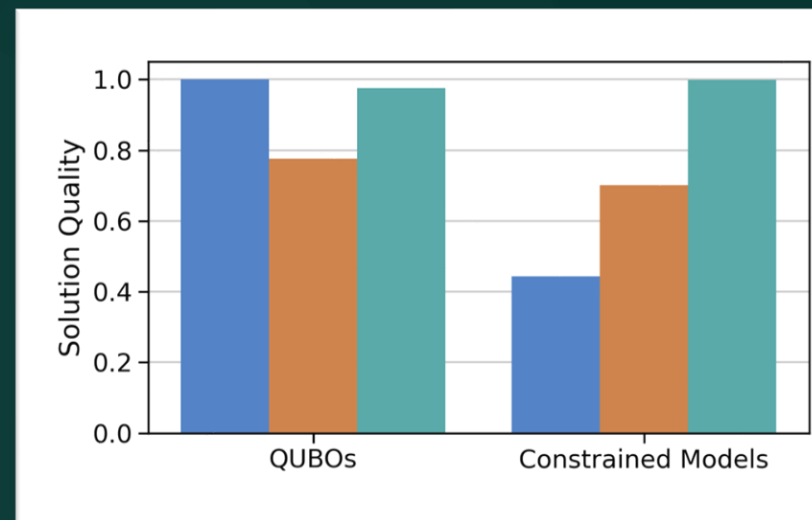
- The best hybrid choice for constrained problems with non-binary variables

## More Native Representation of Problem

- Formulate constraints directly instead of using penalties or transformations

## Unlocks Larger Application Problems

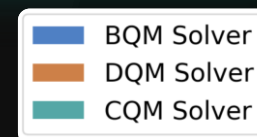
- Binary and integer variables
- Linear and quadratic terms
- Up to 100,000 constraints
- Inequality & equality constraints



Performance of BQM vs DQM vs CQM on problems native to each:

CQM solver is the best hybrid choice for constrained problems on non-binary variables

BQM solver is the best hybrid choice for unconstrained binary problems





# Leap Hybrid Solver Performance

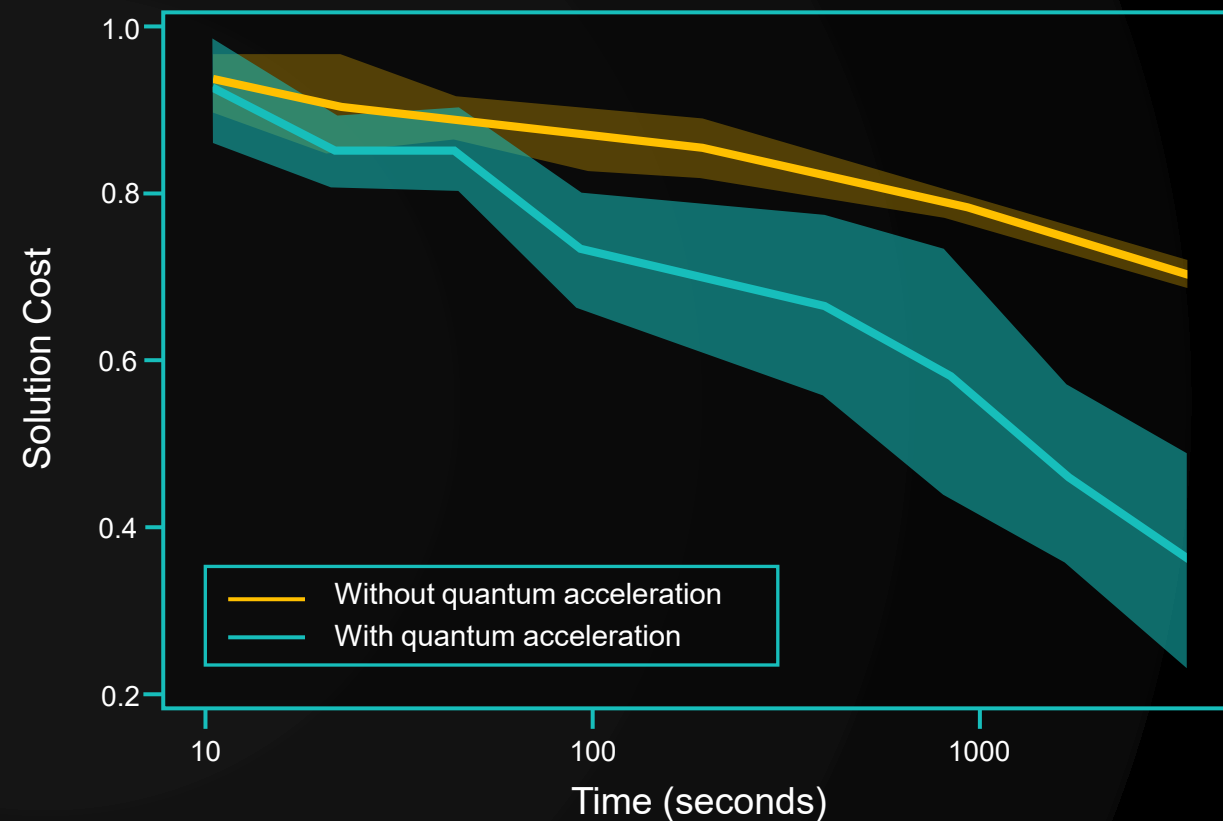
## HSS Performance

Built for production applications

Quantum accelerated classical heuristics exploit the best features of both paradigms

As good or better than all of 27 classical heuristics on 87% of 45 application-relevant inputs

- Problems selected for size, difficulty, and application relevance
- Test instances and competing algorithms available online





# Q&A



# Next steps to Learn More about Quantum Computing



**Contact D-Wave:** Request additional information or schedule a meeting with our staff.

➤ Email: [sales@dwavesys.com](mailto:sales@dwavesys.com)

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

➤ <https://www.dwavesys.com/d-wave-launch>

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

➤ <https://www.dwavesys.com/applications>

**D-Wave Online Resources:** Explore resources for executives and developers. Videos, whitepapers and more.

➤ <https://dwavesys.com/resources>

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

➤ <https://cloud.dwavesys.com/leap/signup>