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
Quantum computing is highly theoretical, impractical and only available to a small group within the scientific community.

**The past 20 years**

- **PHASE 1**: Speed-Up On Benchmark Problem
  - 100x speedup over best classical heuristics

- **PHASE 2**: Speedup on Physics Problems
  - 3Mx speedup over best classical heuristics

- **PHASE 3**: Theoretical Foundation Strengthened
  - 250+ Early Applications
    - Menet: 100x speedup
    - Save-on-Foods: 500X speedup
    - VW: 80% waste reduction
  - Professional services go-to-market yielding business applications running in production with demonstrated ROI

- **PHASE 4**: Quantum Advantage
  - Quantum computers demonstrate absolute advantage on real world problems

**Gate Model**

- Advantage Performance, 2, 3...
- Hybrid Solver Services, Real Time Access, IDE, Community

**D-Wave 2000Q**

**D-Wave 2000QLN**

**You Are Here**
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)$^2$
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).

<table>
<thead>
<tr>
<th>Term</th>
<th>D-Wave (Annealing) Only</th>
<th>Annealing &amp; Gate Model</th>
<th>Gate Model Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-Term</td>
<td>$450 - 850B TAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-Term</td>
<td>$25 - 50B TAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near-Term</td>
<td>$2-5B TAM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Combinatorial Optimization (e.g., logistics/supply chain, portfolio optimization)
- Linear Algebra & Factorization (e.g., cryptography, DNA sequence classification)
- Differential Equations (e.g., quantum chemistry, fluid dynamics simulation)

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

Jülich SC Boolean Satisfiability
D-Wave: Outperforms Gate QAOA and noiseless simulators

LANL Evaluations
D-Wave: 15 seconds to solve
Gate QAOA: ~30 hours to solve (50% to 100% more iterations)
Better Together

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

Copyright © D-Wave Systems Inc.
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
All New Solver: Constrained Quadratic Model (CQM)

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

---

<table>
<thead>
<tr>
<th>Solution Cost</th>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Without quantum acceleration</td>
<td>1.0</td>
</tr>
<tr>
<td>With quantum acceleration</td>
<td>0.8</td>
</tr>
</tbody>
</table>

---

Copyright © D-Wave Systems Inc.
Q&A
Contact D-Wave: Request additional information or schedule a meeting with our staff.
➢ Email: 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