D-Wave Overview

Quantum computing for the real world today

Vern Brownell, CEO
September 2018
What An Exciting Time to Be Part of the Quantum Computing Ecosystem
Introduction

• Thanks to all of you for coming – customers, partners and others interested in D-Wave

• We need your help to:
  – Help prioritize our developments efforts and roadmap
  – Develop and share research, use-cases, and applications
  – Give us feedback on our support for you
  – Share with one another your experiences
  – Develop as a community of users
To...today!

System Customers

Cloud access to systems

Cyber-Security 1
What We’ve Accomplished Together

2016

Help prioritize our developments efforts and roadmap
Develop and share research, use-cases and applications
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2018

Growing global customer and user base – Japan, Germany, Italy, UK, UAE, US, etc
Nearly 100% of customers are using the D-Wave 2000Q system
80+ early quantum applications built with you and by you
Growing global community - 4th Qubits users conference, 50+ seminars, 50 classes training for 1000+ new quantum programmers
D-Wave Leap™ Quantum Application Environment available Oct 4th
Executive Team – Many are Here at Qubits

Vern Brownell, CEO
Dan Cohrs, CFO
Bo Ewald, Pres. D-Wave Intl
Alan Baratz, EVP R&D, Chief Product Officer

Jen Houston
SVP, Marketing

Tanya Rothe
General Counsel

Victoria Brydon
VP, Human Resources
Era of the Quantum Application
A Growing Ecosystem of 80+ Early Applications!

**Optimization**
- Multi-period portfolios
- Radiotherapy
- Internet ad placement
- Satellite Placement
- Traffic flow

**Machine Learning**
- Image recognition
- Tree cover classifier
- Find Higgs Boson
- DNA Binding
- Individual cancer drugs
80+ Early Applications – Continued!

**Materials properties**
- Solid state materials quantum simulation
- Quantum chemistry simulation of molecules
- Quantum molecular dynamics
- Atomic magnetometer

**Cyber security & Fault detection**
- Formation of terrorist networks
- Facial recognition
- Fault detection in circuits
D-Wave Leap Quantum Application Environment

- Enabling a Developer Ecosystem
- Easy, Real-Time Access to the D-Wave Quantum Computer
- Comprehensive and Open Software Development Tools
- Online Training with Demos and Reference Examples
- Community and D-Wave Customer Support
Software Stack Evolution

- Social Network Analysis
- Circuit Fault Diagnosis
- Document Classification
- Graph Mapping
- Constraint Compilation
- Generative Machine Learning

Simple software commands

Applications

Methods

Uniform Sampler API

Samplers

Compute Resources

E(s) = \sum_{i}^{n} h_i s_i + \sum_{i,j}^{n} j_{ij} s_i s_j
D-Wave 2000Q System
Real Systems Are Available for Comparison

QTRL
Quantum Technology Readiness Levels describing the maturity of Quantum Computing Technology

- QTRL9: QCs (QAs) exceed power of classical computers
- QTRL8: Scalable version of QC (QA) completed and qualified in test
- QTRL7: Prototype QC (QA) built solving small but user-relevant problems
- QTRL6: Components integrated in small quantum processor w/ error correction
- QTRL5: Components integrated in small quantum processor w/o error correction
- QTRL4: Multi-qubit system fabricated; classical devices for qubit manipulation developed
- QTRL3: Imperfect physical qubits fabricated
- QTRL2: Applications / technologically relevant algorithms formulated
- QTRL1: Theoretical framework for quantum computation (annealing) formulated

Experimental qubit devices

D-Wave quantum annealer
IBM, Google, Rigetti Computing

SIMULATION ON / OF VARIOUS TYPES OF QUANTUM COMPUTERS
ORAP FORUM MARCH 29, 2018 | KRISTEL MICHELSSEN

Performance vs. Classical Computers

Computational Performance Today

Classical

Benchmark problems

Customer problems

Quantum

Time
Approaching Advantage for Customer Problems

- Computational Performance
  - Time
  - Quantum
  - Classical

Gate Model
Achieving Advantage over Classical for Customer Problems

**Computational Performance**

- **More powerful systems**
  - More qubits
  - Denser connectivity
  - Annealing features & controls
  - Lower noise
  - Reduced latency
  - Universal annealer
  - Software & algorithms

- **Easier to use**
  - Software development tools
  - Cloud services for broad access
  - Developer ecosystem
  - Algorithms and apps
Glimpses of Advantage on Customer Problems

**Machine Learning**
Univ. of Southern California: “... a QUBO approach such as [quantum annealing] realized via [D-Wave] may be the algorithm of choice.”

https://www.nature.com/articles/s41534-018-0060-8

**Optimization**
Los Alamos National Lab: “...quantum and hybrid classical-quantum approaches are shown to equal or out-perform current “state of the art” methods.”

https://arxiv.org/abs/1705.03082

LANL: “In many instances of the 2D problem we solved, the D-Wave outperformed a state-of-the-art classical tool... There is still a ways to go before practical applications to hydrology can be made.”

Glimpses of Advantage on Customer Problems

Quantum Chemistry
OTI Lumionics

Display Advertising
Recruit Communications: “Quantum annealing finds a better solution than the greedy method.”

Machine Learning
USC / Cal Tech: “The annealer-trained classifiers...demonstrate some advantage over traditional machine learning methods for small training datasets.”
https://www.nature.com/articles/nature24047
How D-Wave Builds the Quantum Ecosystem

• Deliver practical forms of quantum computing to our customers and partners
• Ignite thousands of smart thinkers to experience and learn programming on a live quantum computer
• Help our customers solve real-world problems
• Continue to grow and invest in our team
• Continue aggressive innovation in products and research
• Help fuel the growth of quantum computing research and investment
Recent Events

- Released and shipped D-Wave 2000Q system with annealing controls
- Expanding customer base with over 80 early applications
- Founding sponsor of Creative Destruction Lab (U of Toronto) program in quantum machine learning
- Next-gen processor prototype completed early
- $50 million convertible notes from PSP Investments
- Launched Quadrant™ business unit to deliver deep learning services
- Awarded C$10M grant from Sustainable Development Technology Canada due to low energy consumption of systems
- Publication in *Science* and *Nature* of “…the first truly useful application of a quantum computer...a premiere goal of scientific computing…”
Our Very Strong Investor Group
Raised an Additional $50m in Capital from PSP
Thank You!

• D-Wave’s mission is to bring practical quantum computing to the world

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  – Share with one another your experiences
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• We are thankful for each of you and your amazing work!