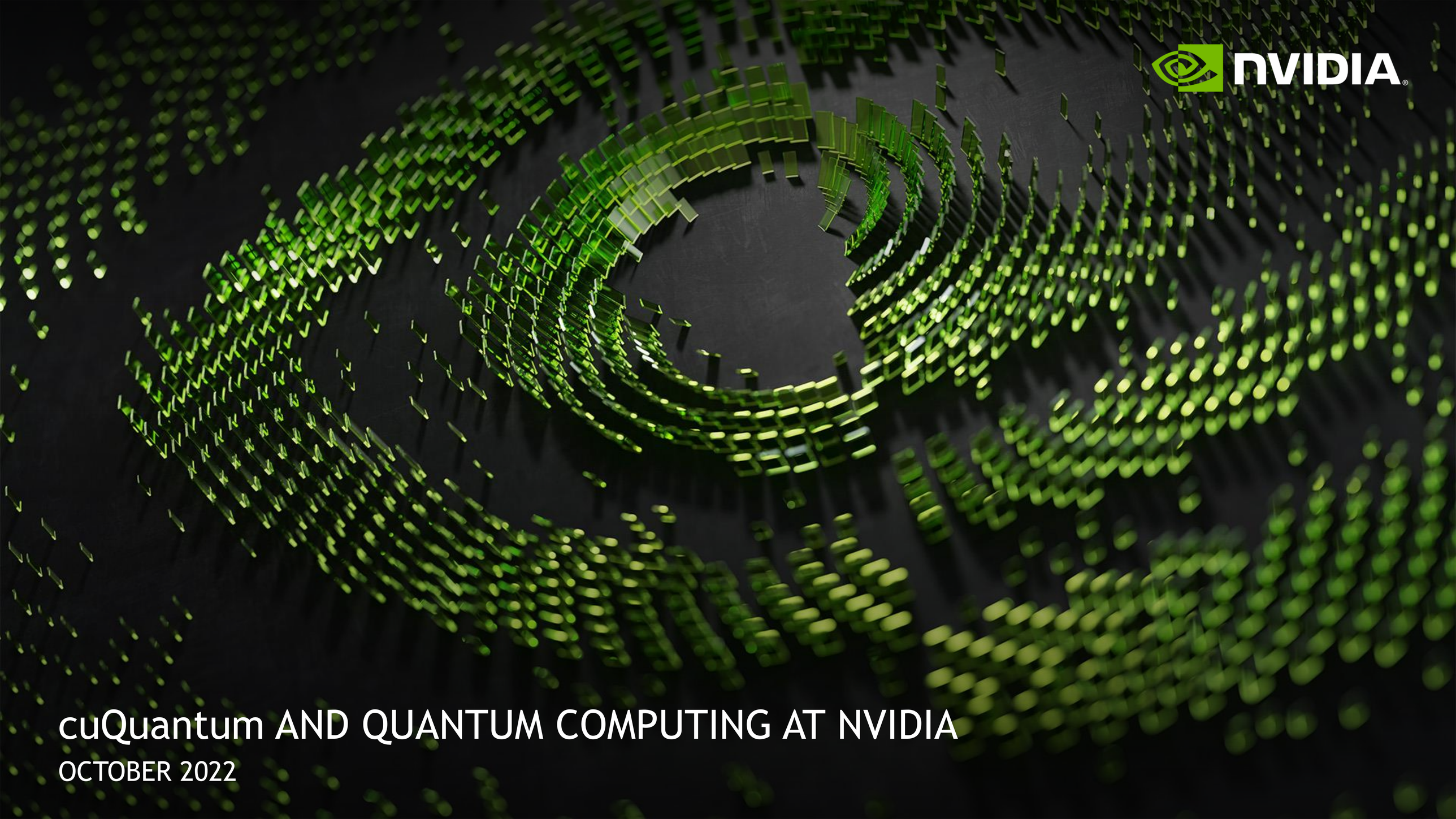
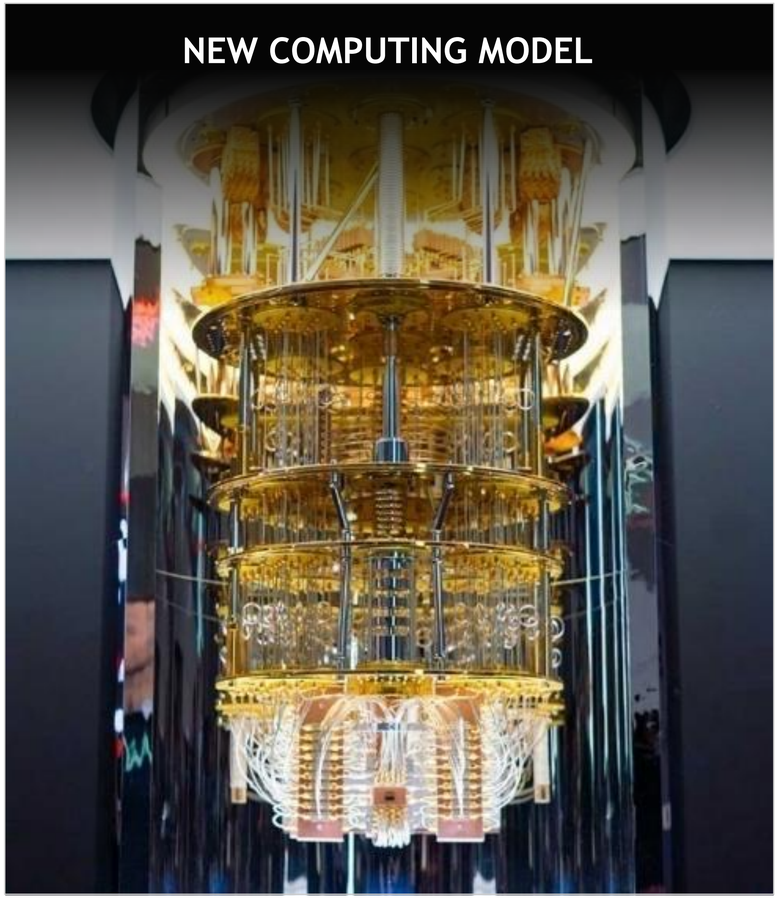


cuQuantum AND QUANTUM COMPUTING AT NVIDIA

OCTOBER 2022

A NEW COMPUTING MODEL — QUANTUM



POTENTIAL USE CASES

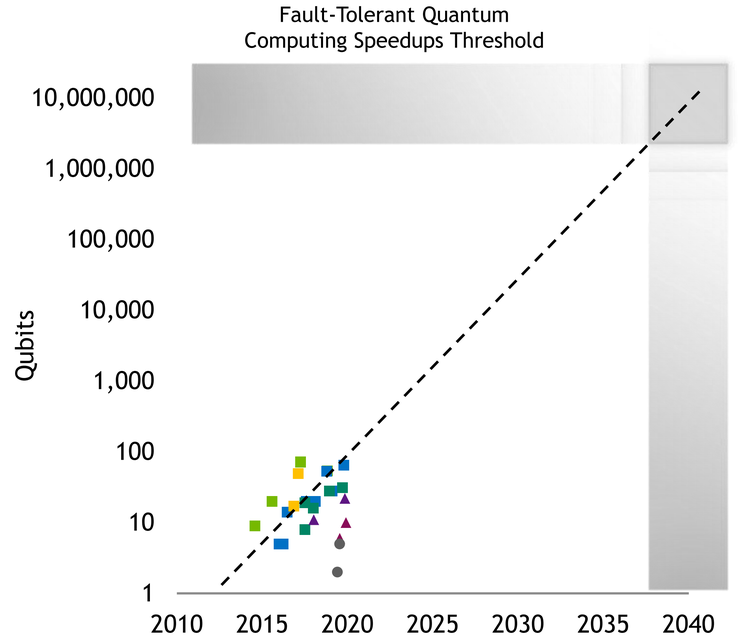
Computational Finance

Quantum Chemistry

Cryptography

Optimization

REQUIRES QUBITS SCALE TO DOUBLE EVERY YEAR



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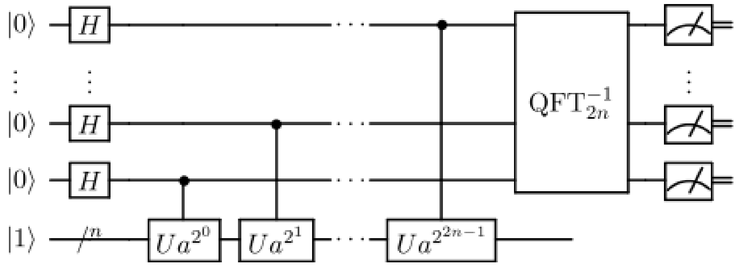
FAR TERM APPLICATIONS

Rigorous proofs of advantage, many “perfect” qubits required

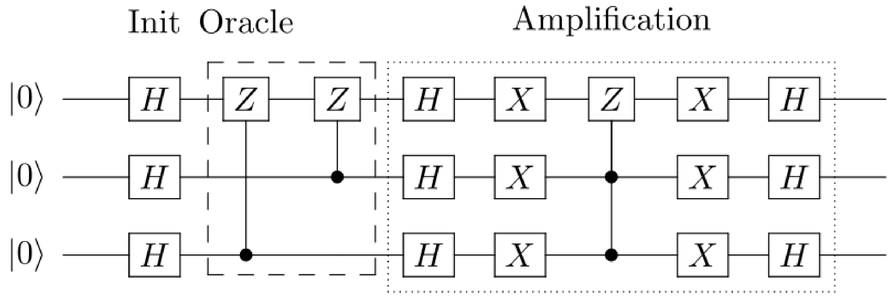
SHOR’S ALGORITHM

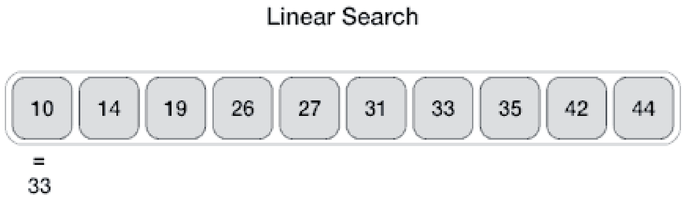
- Prime factorization of numbers - encryption
- Exponential speed-up



GROVER’S ALGORITHM

- Unstructured search
- Quadratic speed-up



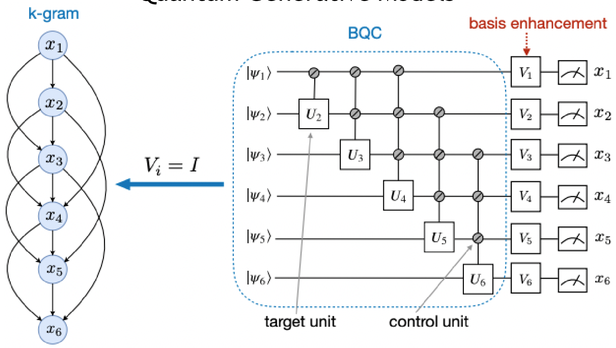


POTENTIAL NEAR-TERM QUANTUM USE-CASES

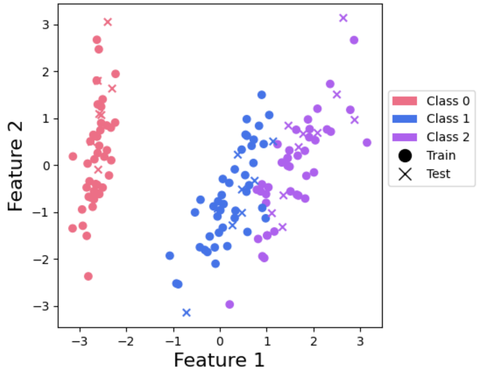
Applications with near-term potential, but quantum advantage is an open question

Quantum Machine Learning

Quantum Generative Models



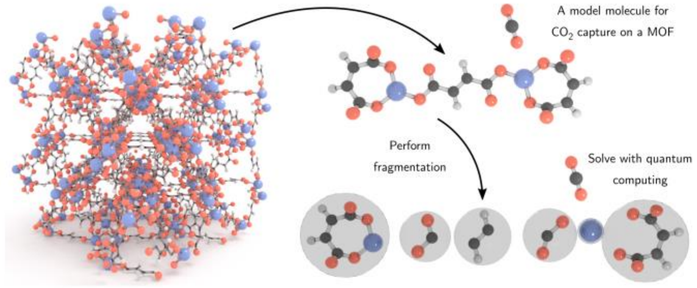
Quantum Support Vector Machine



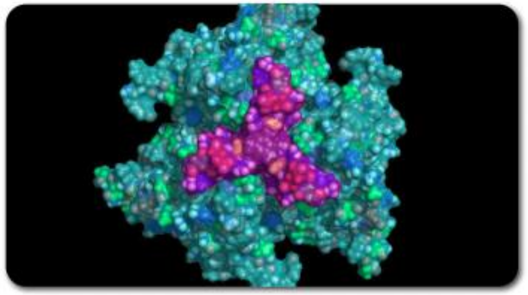
Gao, et al, Phys. Rev. X **12**, 021037
Pennylane.ai

Quantum Chemistry

Variational Quantum Eigensolver for carbon capture



Protein folding



Greene-Diniz, et al, arXiv:2203.15546,
Menten.ai

Combinatorial Optimization

QAOA for resource allocation

Logistics optimization

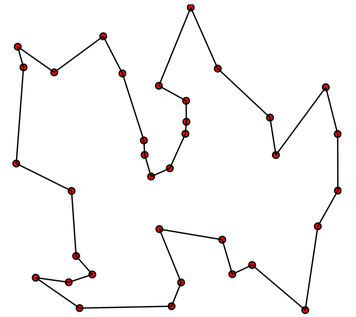


Image from ibm.com
Wikipedia.com

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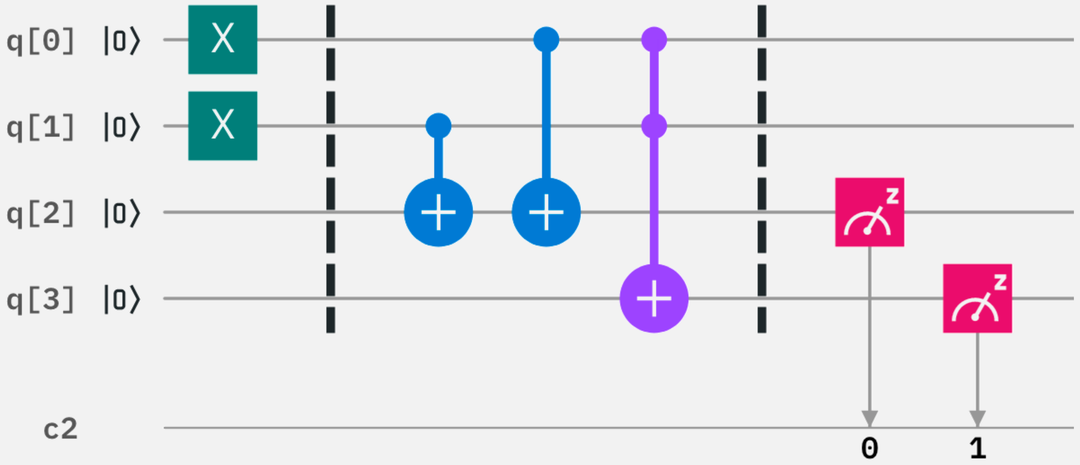
GPU-BASED SUPERCOMPUTING IN THE QUANTUM COMPUTING ECOSYSTEM

Researching the Quantum Computers of Tomorrow with the Supercomputers of Today

QUANTUM CIRCUIT SIMULATION

Critical tool for answering today's most pressing questions in Quantum Information Science (QIS):



- What quantum algorithms are most promising for near-term or long-term quantum advantage?
- What are the requirements (number of qubits and error rates) to realize quantum advantage?
- What quantum processor architectures are best suited to realize valuable quantum applications?

HYBRID CLASSICAL/QUANTUM APPLICATIONS

Impactful QC applications (e.g. simulating quantum materials and systems) will require classical supercomputers with quantum co-processors

+

- How can we integrate and take advantage of classical HPC to accelerate hybrid classical/quantum workloads?
- How can we allow domain scientists to easily test coprogramming of QPUs with classical HPC systems?
- Can we take advantage of GPU acceleration for circuit synthesis, classical optimization, and error correction decoding?

NVIDIA cuQuantum Ecosystem

NVIDIA

cuQuantum PERFORMANCE

cuQuantum enables speedups for a range of use cases and users

Faster Quantum Algorithm for Physics-ML

100X
Faster Time-to-solution

24X
More Circuit Depth

New PennyLane Integration via AWS Braket

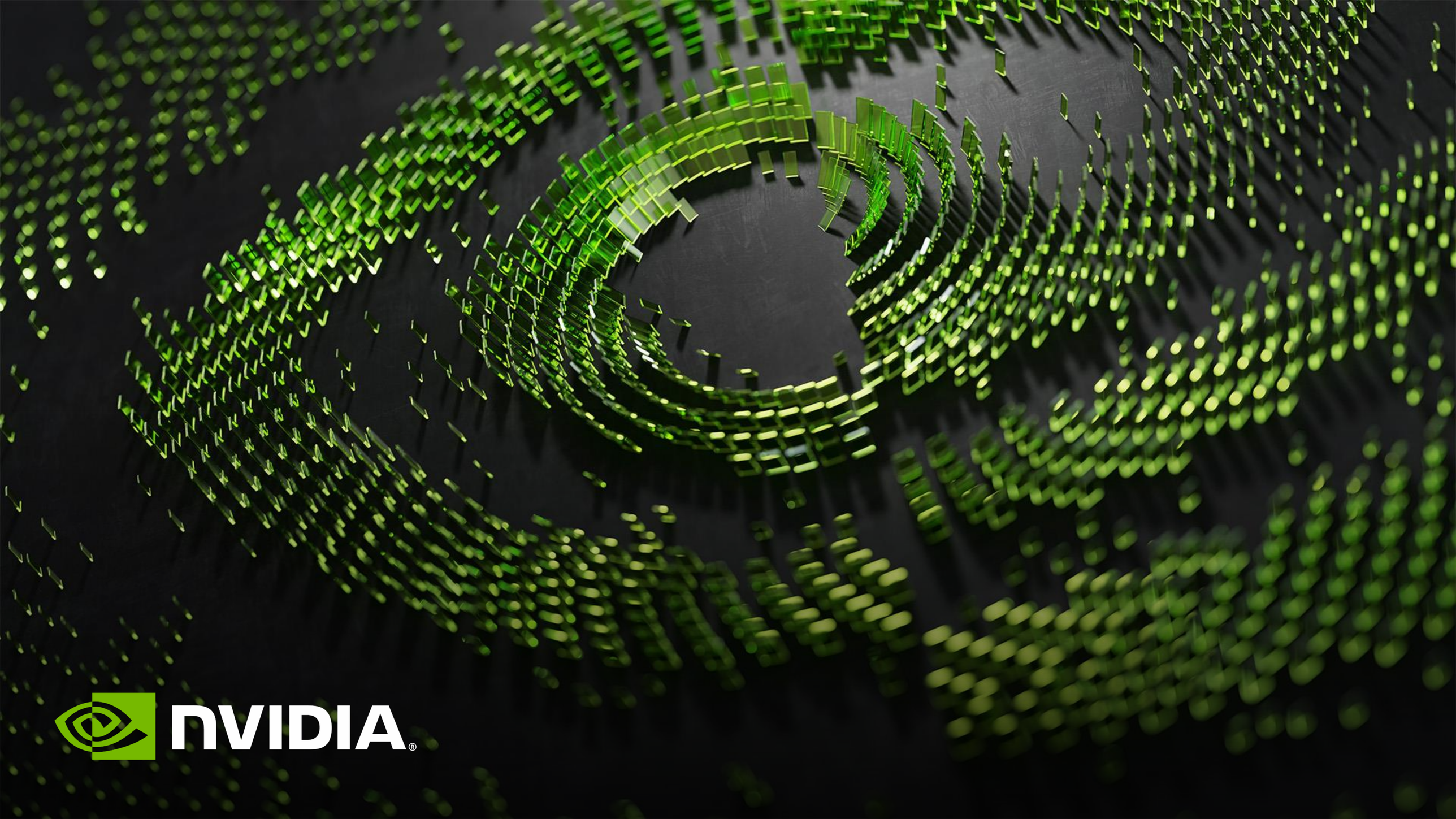
900X
Faster Time-to-solution

3.5X
Lower Costs

Orquestra Platform Integration

100X
Faster Time-to-solution

1.5X
More Qubits


NVIDIA