CENTRE FOR
QUANTUM COMPUTATION &
COMMUNICATION TECHNOLOGY

AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE

PRACTICAL APPLICATIONS OF QUANTUM COMPUTING

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UTS

ZAPATA

Barclays Bank takes a crack at IBM's quantum computer

Quantum computer simulates largest molecule yet, sparking hope of future drug discoveries

Rahko raises £1.3M for quantum chemistry simulation

PROTEINQURE RAISES $5.2 MILLION CAD FOR PROTEIN-FOCUSED DRUG DESIGN PLATFORM

IBM teams up with Samsung, JPMorgan to develop quantum computing

Volkswagen and Google to bring quantum computing benefits to cars

PUBLISHED THU, DEC 14 2017·2:55 AM

You Won't See Quantum Internet Coming

Quantum computing "ideal for portfolio optimisation"

By Michael McCaw | 28 August 2018

IBM quantum computers will unleash weird science on business

VW wants to use quantum computing for traffic management

Its algorithms could make life a lot easier for commuters.

What Will Quantum Computer Games Be Like?

Five ways quantum computing will change cybersecurity forever

Pentagon sees quantum computing as key weapon for war in space

Experts Topics

Finally, Proof That Quantum Computing Can Boost Machine Learning

Quantum computers pose a security threat that we're still totally unprepared for

Quantum computing should supercharge this machine-learning technique

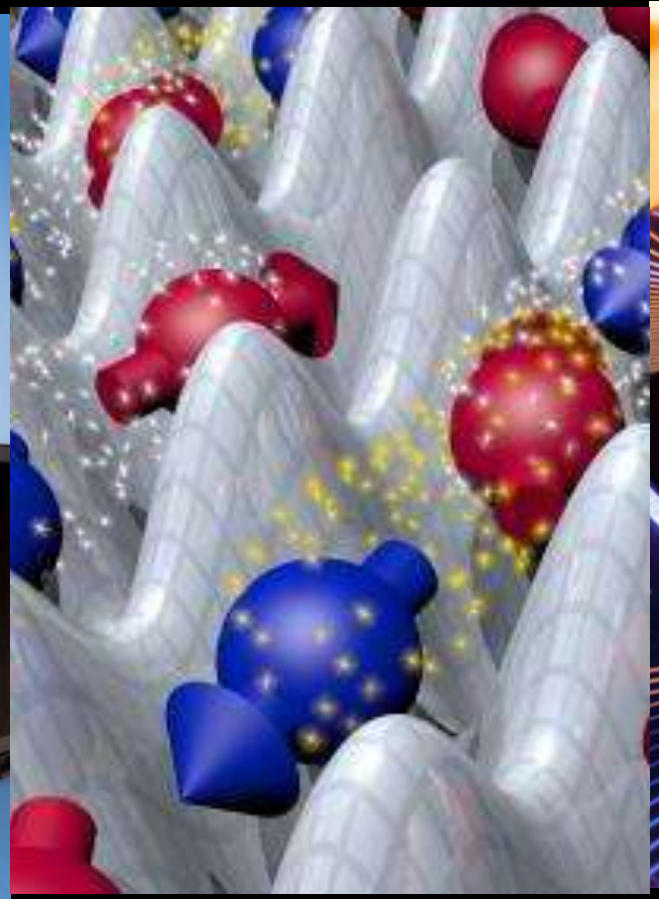
Quantum computing, not AI, will define our future

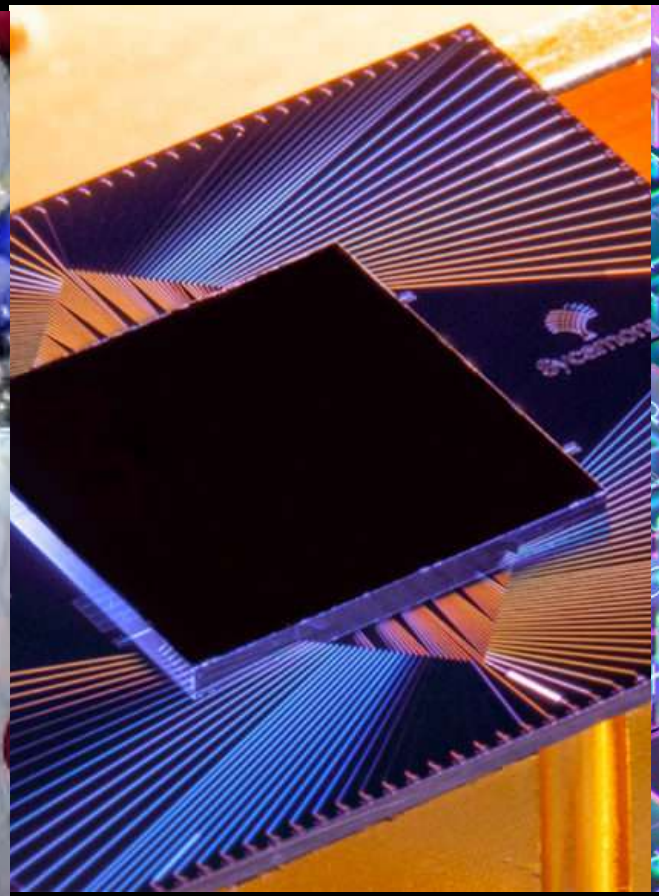
How a quantum computer could break 2048-bit RSA encryption in 8 hours

How quantum computing could wreak havoc on cryptocurrency

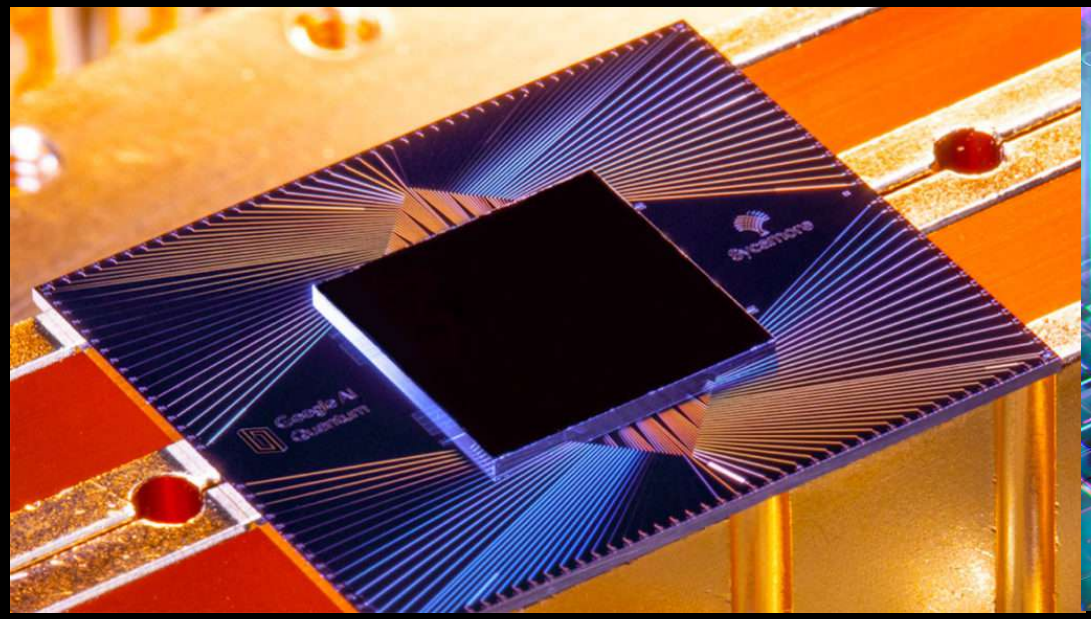
Why Quantum Computing's Threat To Bitcoin And Blockchain Is A Long Way Off

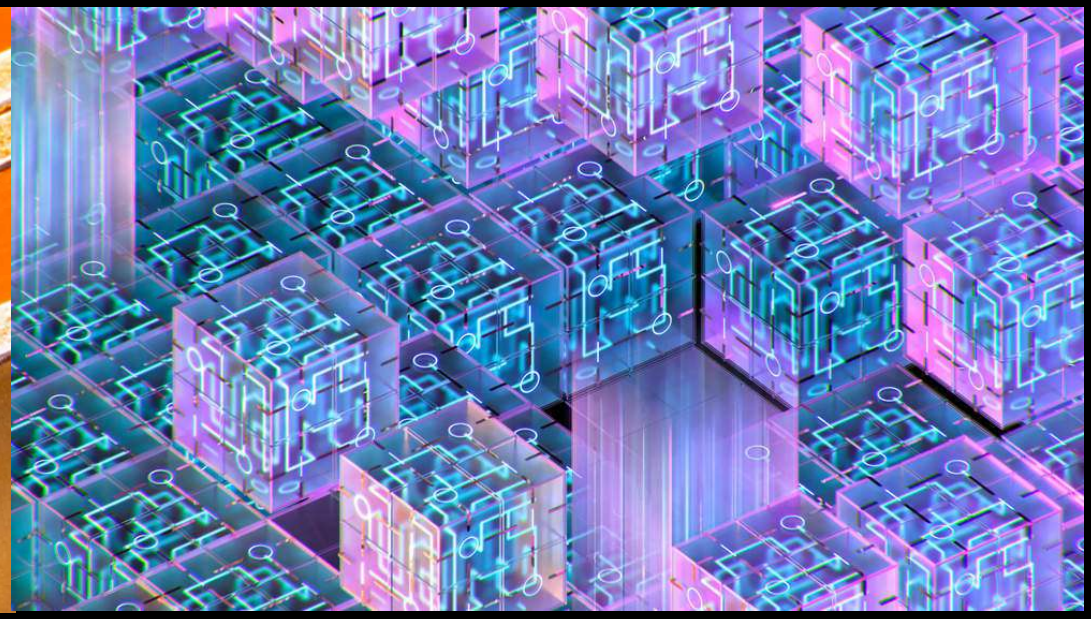
What we talk about when we talk about quantum computing





[D-wave, Automatski, Google, Chemistry World]





Noisy Intermediate-Scale Quantum era is starting

Limited, short computations
Hybrid algorithms

Fault-tolerant computers are 5-20 years away

Arbitrary length computation
Search, factoring & more

J. Preskill, Quantum Computing in the NISQ era and beyond, Quantum 2018

Three Questions About Quantum Algorithms

What are the projected applications?

When can we expect to implement it?

How confident are we about the potential speedup?

Shor’s algorithm for factoring

[Medium]

Shor's Algorithm for Factoring

What are the projected applications?

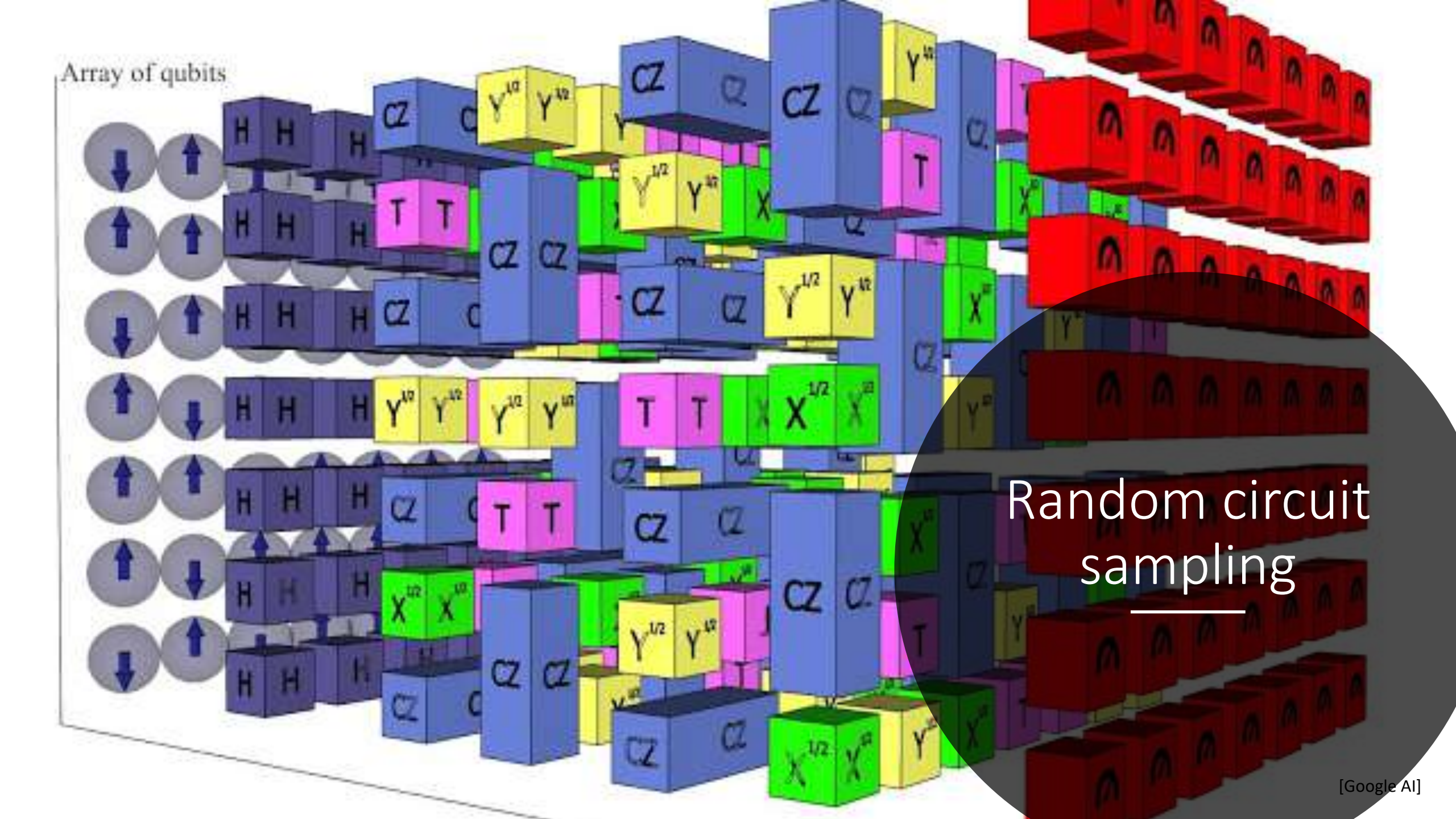
→Breaking cryptography

When can we expect to implement it?

→20 million qubits

How confident are we about the potential speedup?

→ Very – exponential speedup compared to the best known l algorithm


Array of qubits
Random circuit sampling
[Google AI]

Random Circuit Sampling

What are the projected applications?

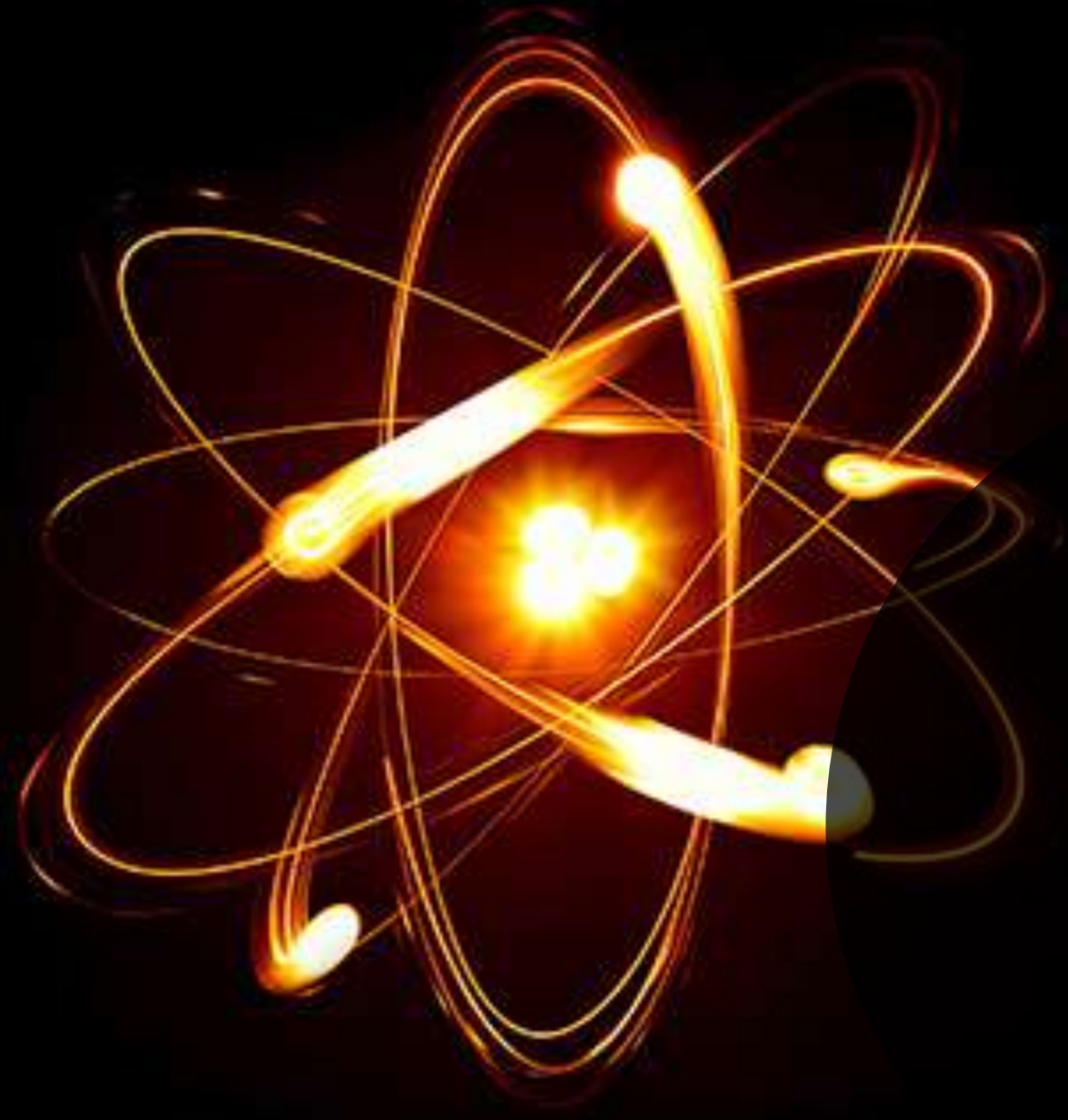
→None

When can we expect to implement it?

→Now

How confident are we about the potential speedup?

→Provable subject to CS conjectures



Quantum dynamics simulations

[Arstechnica]

Quantum Dynamics Simulations

What are the projected applications?

→Quantum Chemistry, New materials, Drug discovery

When can we expect to implement it?

→Quantum advantage in a decade

How confident are we about the potential speedup?

→Provable subject to CS conjectures

→Application dependent

Quantum Approximate Optimization Algorithm

[Los Alamos]

Quantum Approximate Optimization Algorithm (QAOA)

What are the projected applications?

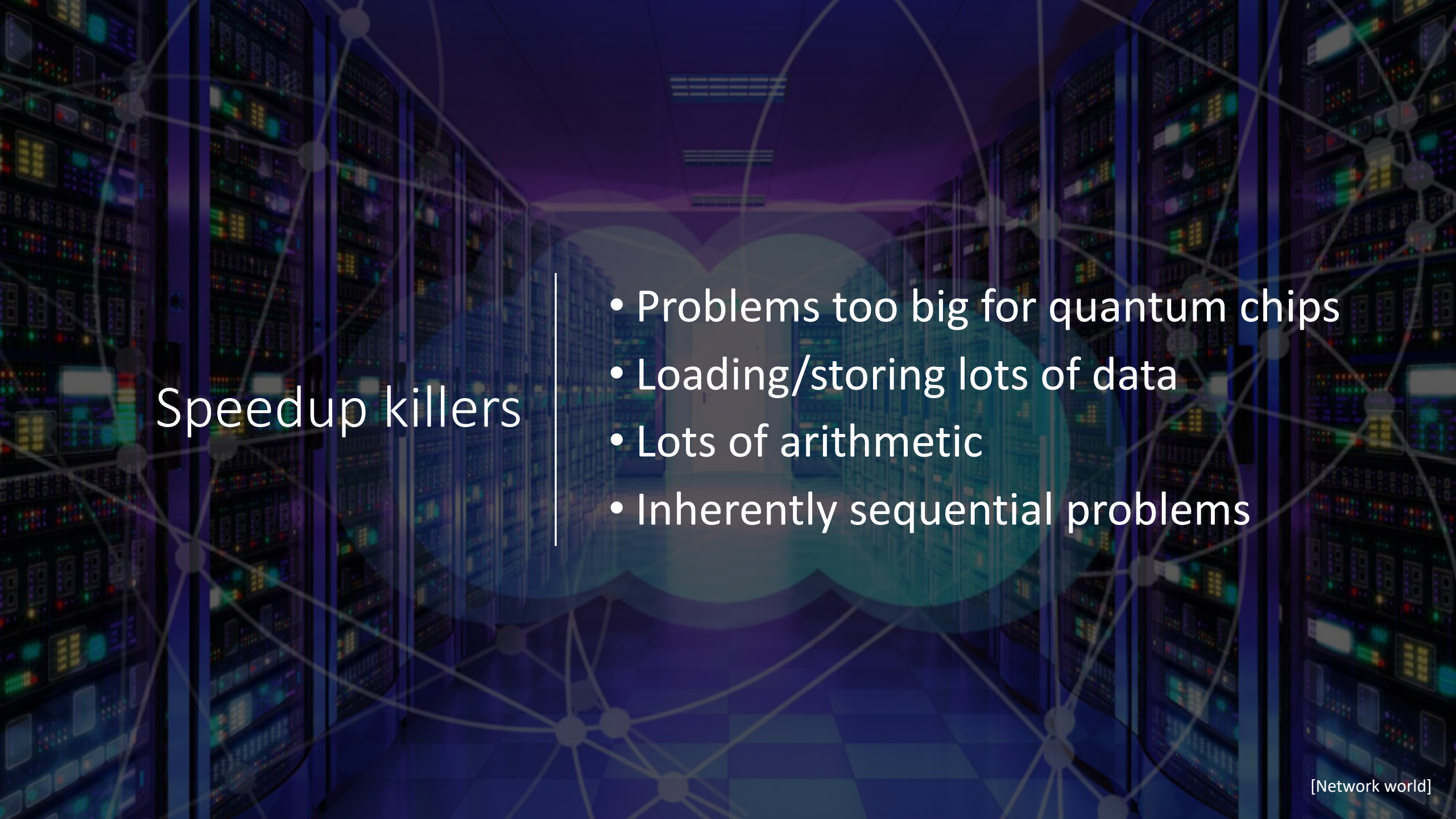
→Optimization – Finance, Planning, Aerospace

When can we expect to implement it?

→5 years

How confident are we about the potential speedup?

→Unclear



Speedup killers

- Problems too big for quantum chips
- Loading/storing lots of data
- Lots of arithmetic
- Inherently sequential problems

[Network world]

Simplified models
General problems
Rigorous answers
Asymptotic scaling

Complex problems
Unique structure
Numerical benchmarks
Cost for a given problem

[Christopher Berry, clipart]

Quantum computing is coming

Speedups are not straightforward

Get ready and ask questions

Thank you

[Graham Carlow]