

Quantum computing: opportunities and challenges

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So I want to talk today about an idea. It's a big idea. Actually, I think it'll eventually be seen as probably the single biggest idea that's emerged in the past century. It's the idea of computation.

— Stephen Wolfram, TED talk, 2000s

I think there is a world market for maybe five computers.

— Thomas Watson, chairman of IBM, 1943

What is
quantum computation?

Quantum theory

- Atoms
- Molecules
- Elementary particles
- Solid state theory

Classical bit vs Quantum bit

- Classical: 0 or 1
- Quantum bit = Qubit: 0, 1, “0 + 1”

Nature isn't classical, dammit, and if you want to make a simulation of nature, you'd better make it quantum mechanical, and by golly it's a wonderful problem, because it doesn't look so easy.

— Feynman 1981

Simulating quantum

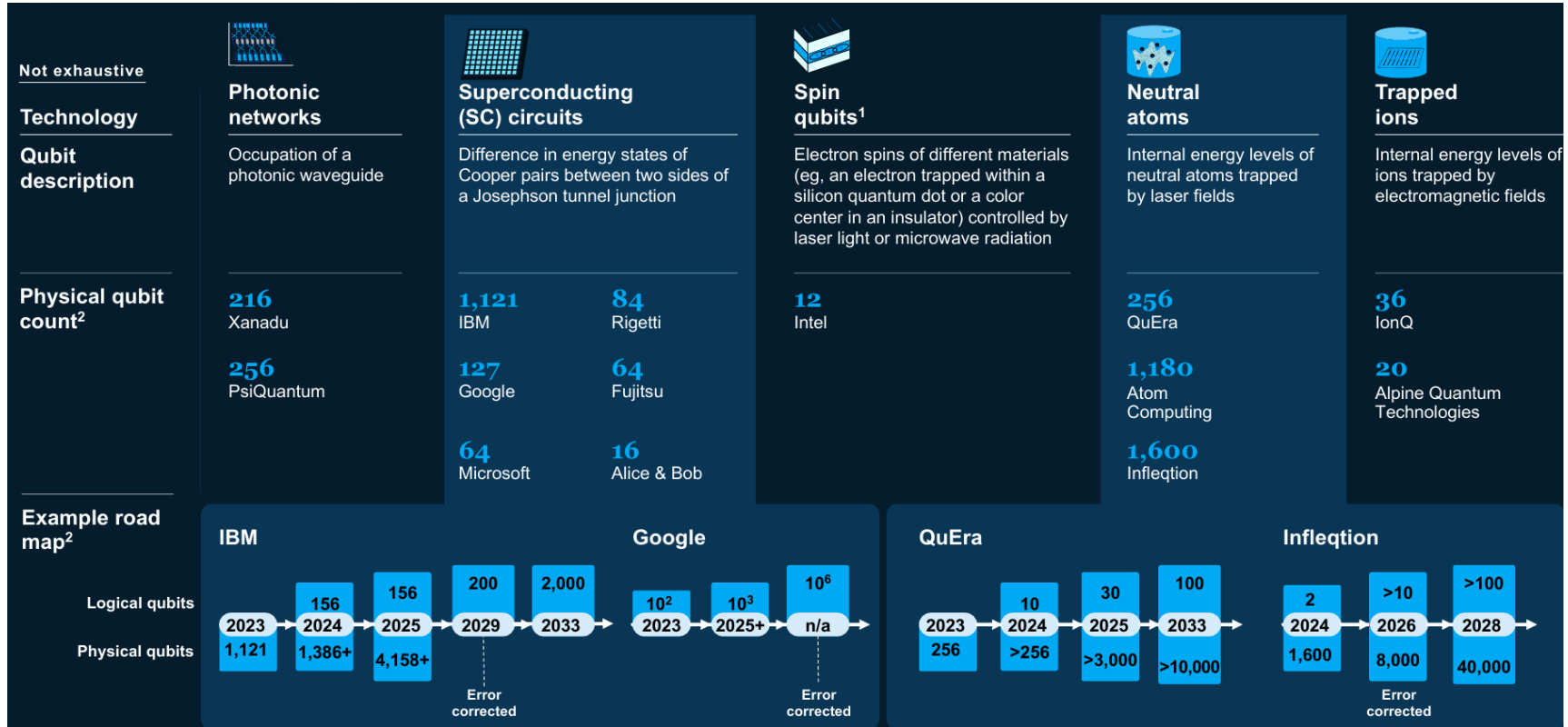
- Classical simulation: 10^{80} numbers
- Quantum simulation: 300 qubits

Shor 1994

Break RSA

Quantum word processor?

Quantum hardware



Summary

- The bright and the dark side of QC
- First applications in modelling quantum physics — huge opportunities
- Can we avoid Y2Q?
- Estonia: software rather than hardware
- Quantum roadmaps: watch progress on FTQC
- Quantum algorithms are difficult for our classical brains: new area of research