

Journey into Quantum: How do I  
get started on the journey to  
realise business benefits from  
quantum computing?

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**29 June  
2023**

# Digital Catapult - the UK authority on advanced digital technology

**Our mission is to accelerate industry adoption of advanced digital technologies, driving growth in the UK economy.**

**We create new opportunities through collaboration and innovation.**

Digital Catapult was started in 2014, as an innovation intervention by Innovate UK, and is a neutral and independent organisation with multiple sources of funding.

## WHAT WE DO:



Deliver specialised **acceleration** and **innovation programmes** aligned to industry challenges and themes



Build **testbed facilities**, run **pilots** and **proof of concepts** and test new **business models**



Facilitate **R&D projects**, inform **policy recommendations** and **lead research** on emerging tech trends

## WHO WE WORK WITH:



Government & public sector



Startups & scaleups



Corporates and industry



Investors



Academia



Catapult network

# Overview of quantum computing



We are bombarded with news about quantum computing : is it relevant?

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By Frank Gardner  
BBC security correspondent

27 January

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BY ALEX CHALLANS • MAY 4, 2022 • EXCLUSIVES

JANUARY 19, 2022

## Quantum computing in silicon hits 99% accuracy

by University of New South Wales

HARDWARE > QUANTUM | March 15, 2023

# National Quantum Strategy launched in UK government's 2023 Budget

Funding, skills and regulation are all included in the strategy, which could help drive quantum adoption by businesses.

By Ryan Morrison

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## Suppressing quantum errors by scaling a surface code logical qubit

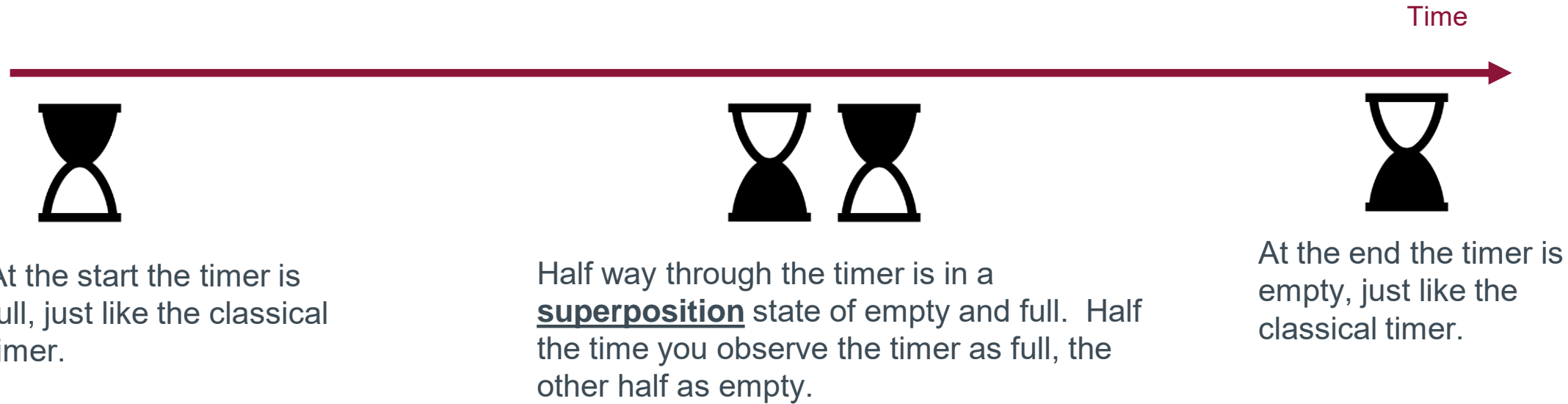
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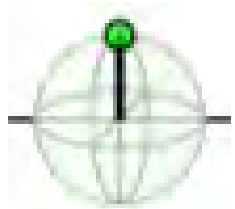
## Germany Announces 3 Billion Euro Action Plan For a Universal Quantum Computer

BY MATT SWAYNE • MAY 3, 2023 • NATIONAL

# A thought experiment: "the quantum egg timer"



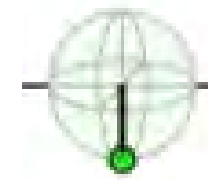
A qubit is like the quantum egg timer and has similar states



$|1\rangle$


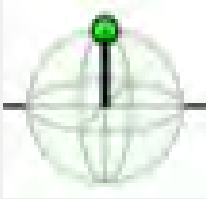
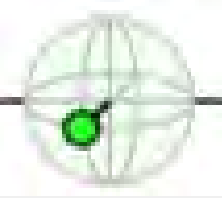

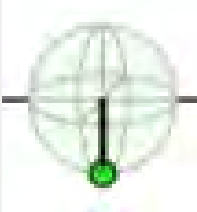


$\frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$



$|0\rangle$

# A qubit differs fundamentally from a classical bit because of superposition

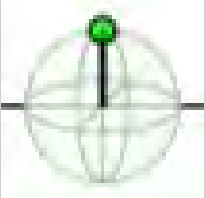
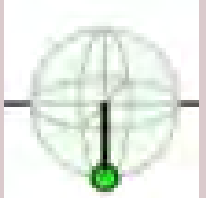
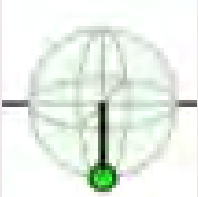
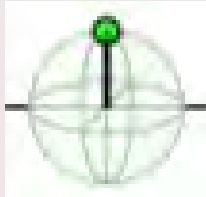
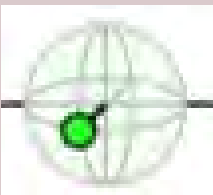
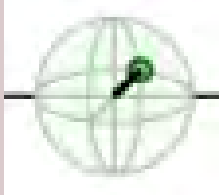
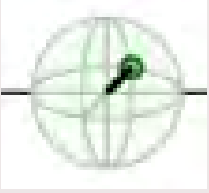

Classical bit	Qubit
Only ever in states "1" or "0"	
 1	 $ 1\rangle$
	 $\frac{1}{\sqrt{2}}( 0\rangle +  1\rangle)$
 0	 $ 0\rangle$

When a qubit is in a superposition state and is measured the result of the measurement is probabilistic.

**Parallel processing over many qubits in superposition can give quantum computers huge benefits over classical computers.**

**Quantum entanglement and quantum phases are also important**

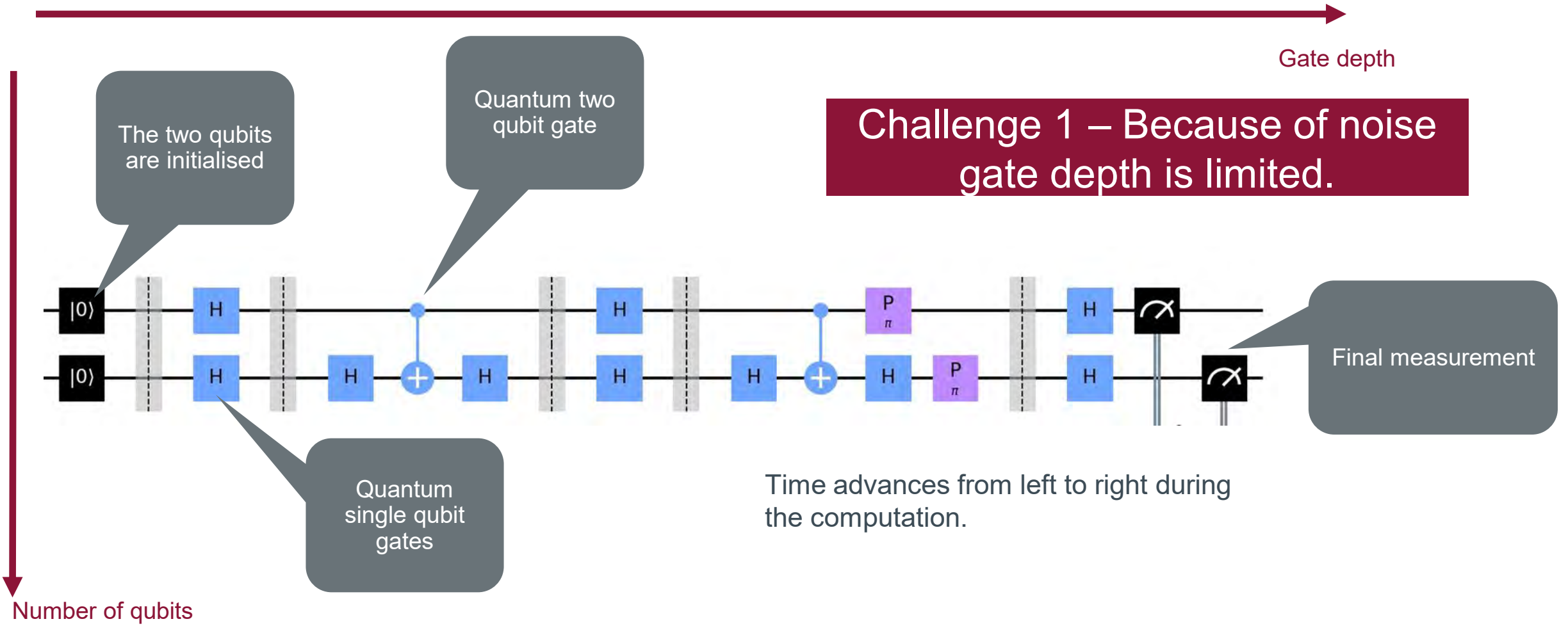
If two quantum objects are entangled measuring one gives information about the other, even if it is separated.

Qubit 1	Qubit 2
	
	
	
	

Entanglement forms the basis of quantum key distribution, because measuring one qubit forces the other into a known quantum state.



The quantum circuit model is illustrated with two qubits

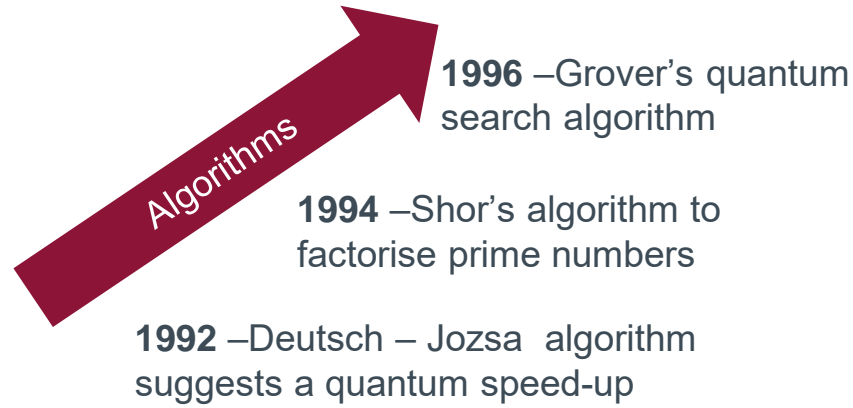


Challenge 2 – At present the number of qubits is limited.

Challenge 3 – Qubits connectivity may be limited.



# The journey to date, and likely next steps



We are currently in the Near Scale Intermediate Quantum ('NISQ') era, with relatively few, noisy qubits and specialised hybrid algorithms.

In the future large, universal fault tolerant quantum computers will be transformational. Physical qubits will be grouped into logical qubits, enabling errors to be detected and corrected.

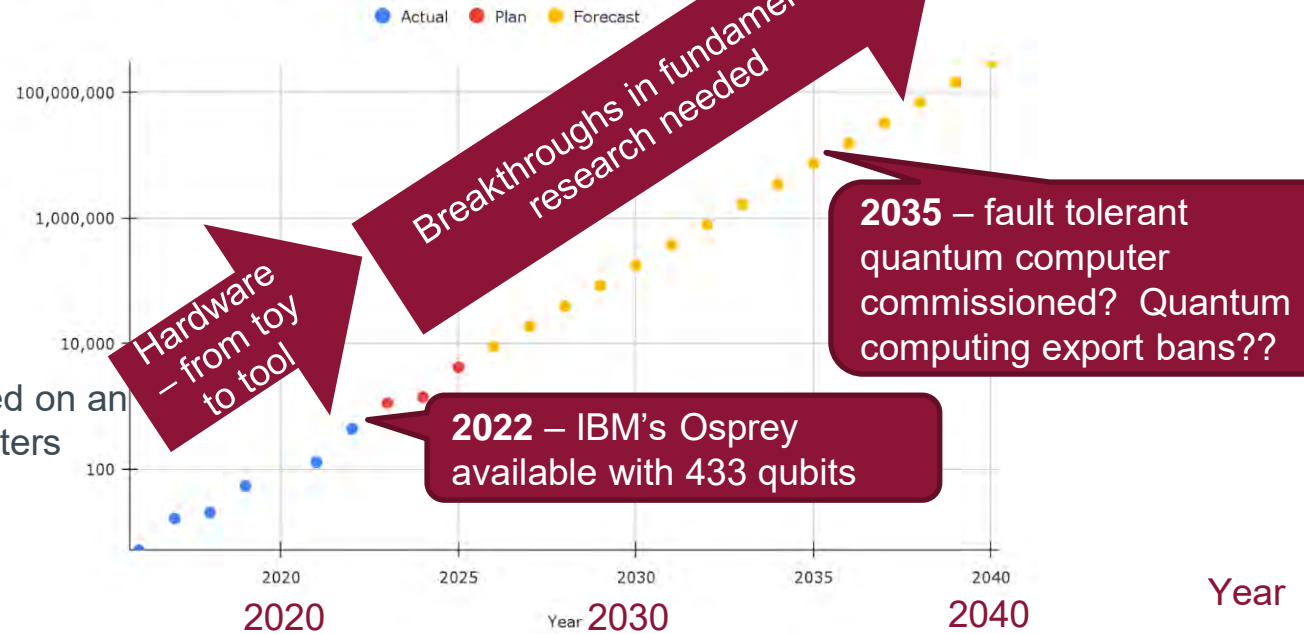
**Foundational concepts developed**

1985 –Deutsch describes a universal quantum computer

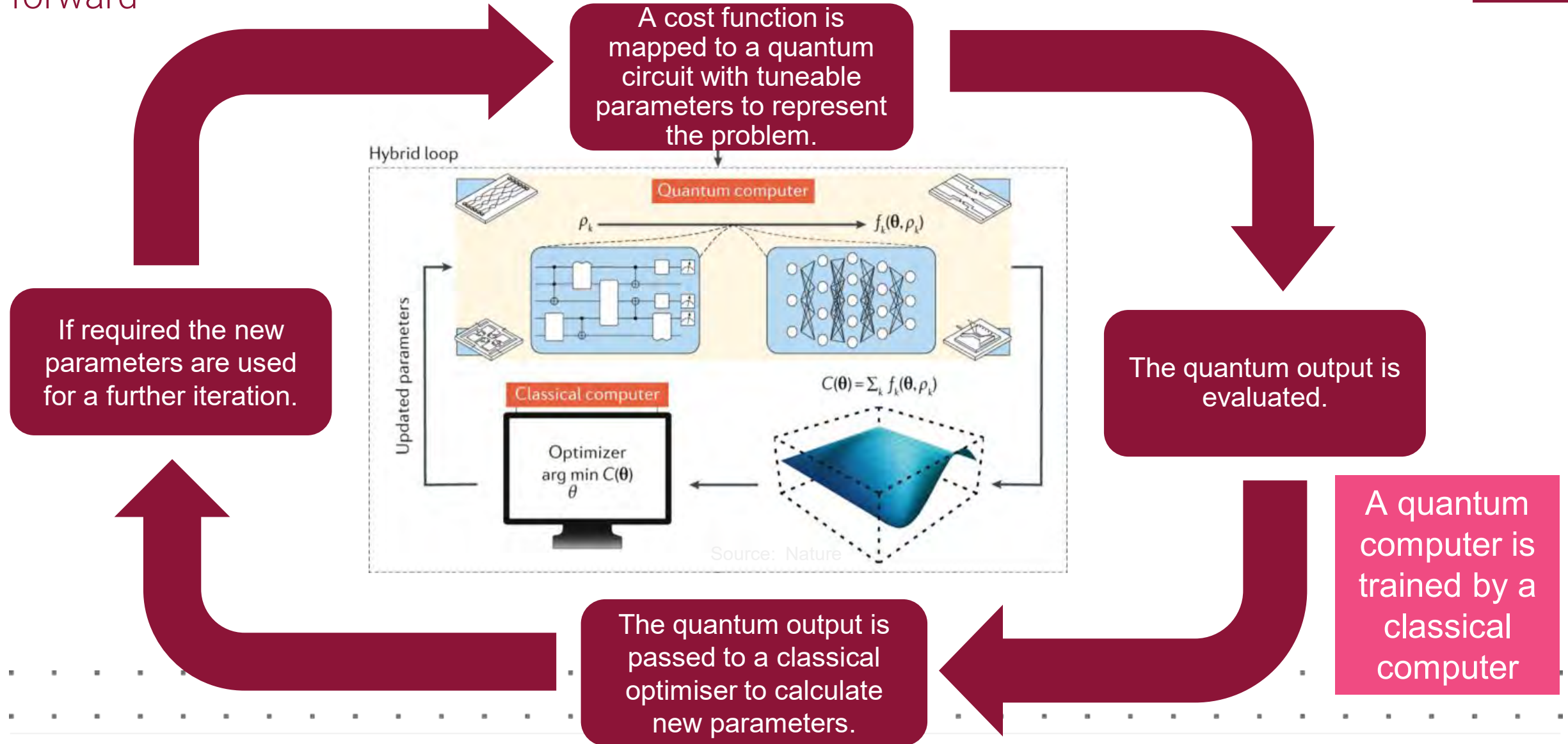
1985 –Feynman proposes Quantum computing

2002 –fifteen factorised on an NMR quantum computers

Actual, Plan and Forecast IBM Qubit numbers by year



Variational Quantum Algorithms offer a way forward



# Quantum computing use cases

Which quantum computing use cases are appropriate in the near term?

### Quantum optimisation

Using Quantum annealing or variational algorithms in the quantum circuit model. May be used to optimise networks.



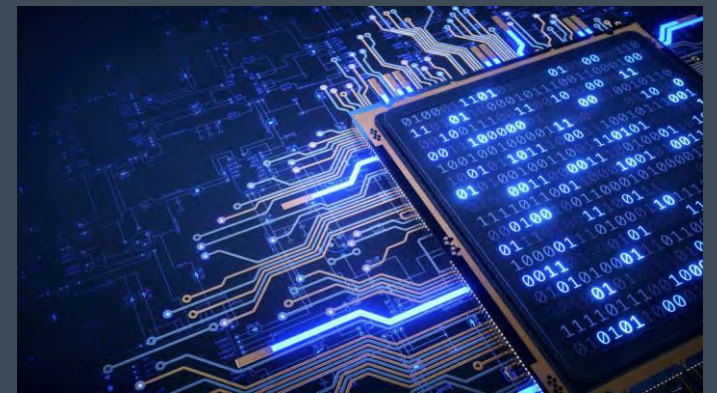
### Quantum simulation of physical systems

Includes quantum chemistry and fluid dynamics. A quantum computer is a good way to simulate a quantum system.



### Quantum machine learning

Using quantum computers for certain machine learning applications. Network fault detection is being evaluated.



**How should I future  
proof my business to  
be ready for quantum  
computing?**



## Our message to business - avoid future shock

### 1. Ensure your encryption is quantum-safe!

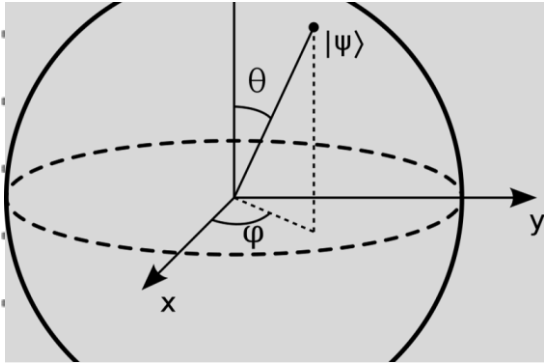
- Shor's quantum factorization algorithm could undermine the widely used RSA encryption widely used in less than a decade.
- Beware of "store now, break later" attacks. At least understand what encryption you use,
- How long will it take to identify and replace all non quantum-safe encryption?

### 2. Can you afford to be unprepared for quantum computing?

- What happens if quantum computing becomes relevant to improve a vital business process?
- If that happens how long will it take you to catch up?
- Is it better to make a small investment to start to quantum proof your company today?



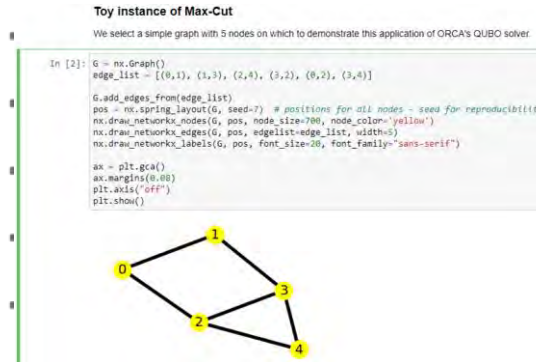
# Get started on your quantum journey with qTAP



Receive training and education on quantum technology



Discuss algorithms with industry experts



Experiment by running quantum computing simulations



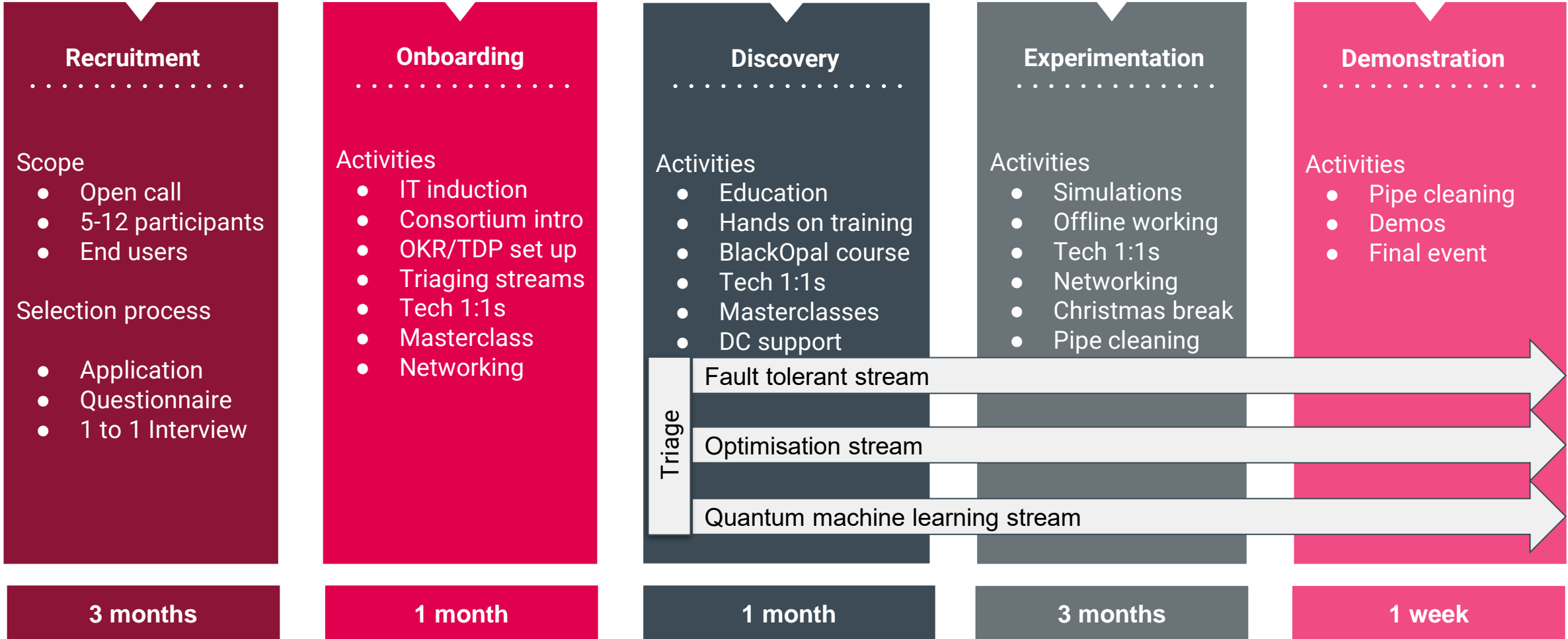
Run algorithms on an ORCA photonic quantum computer

Digital Catapult's open call for a quantum Technology Access Programme (qTAP) with ORCA, Riverlane, KETS, BT, PQ Shield and academic partners goes live **3rd July 23**.

**APPLY via DIGITAL CATAPULT WEBSITE!**

qTAP is a unique combination of free education, consultancy and hands on experience

5 months structured programme with tailored support



# Programme Benefits

**Free structured  
Programme & tailored  
support**

**Access to experts in the  
field**

**Development of Use  
Cases relevant to  
organisation**

**Access to Quantum  
Hardware & Software**

**Access to a network of  
Partners**

**Upskill employees within  
organisation**

**De-risk future  
investments in Quantum  
Computing**

**Get on the front footing:  
Understanding of the  
benefits of Quantum  
Computing & the  
timescales for the  
technology**



# Thank you

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