AQARIOS

Efficient. Dynamic. Scalable.

Quantum Optimization: The future of problem-solving.

Aqarios - a Spin-off from LMU Munich

Founded in 2016, among top 12 QC universities worldwide and collaborating with more than 20 DAX companies.

Michael Lachner

CEO

Strategy & Business Operations

Prof. Dr. **Claudia Linnhoff-Popien**

QAR-Lab, Prof. LMU

Business Relations & Scientific Advisory

Prof. Dr. **Sebastian Feld**

Asst. Prof. TU Delft

Quantum Optimization & Quantum Machine Learning

Dr. **Thomas Gabor**

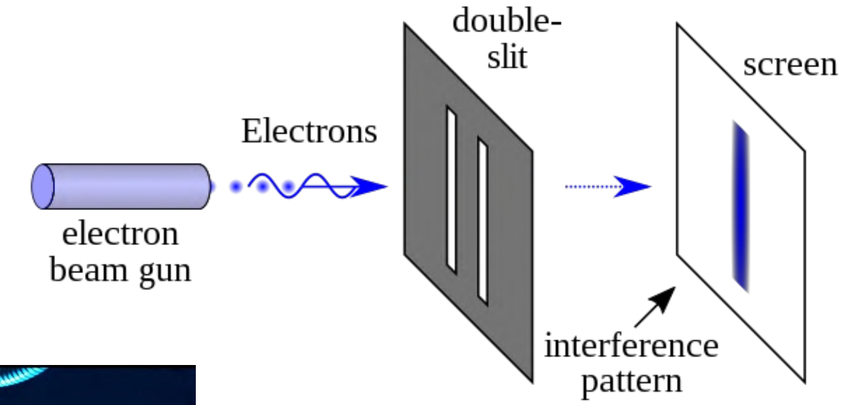
QAR-Lab, PostDoc LMU

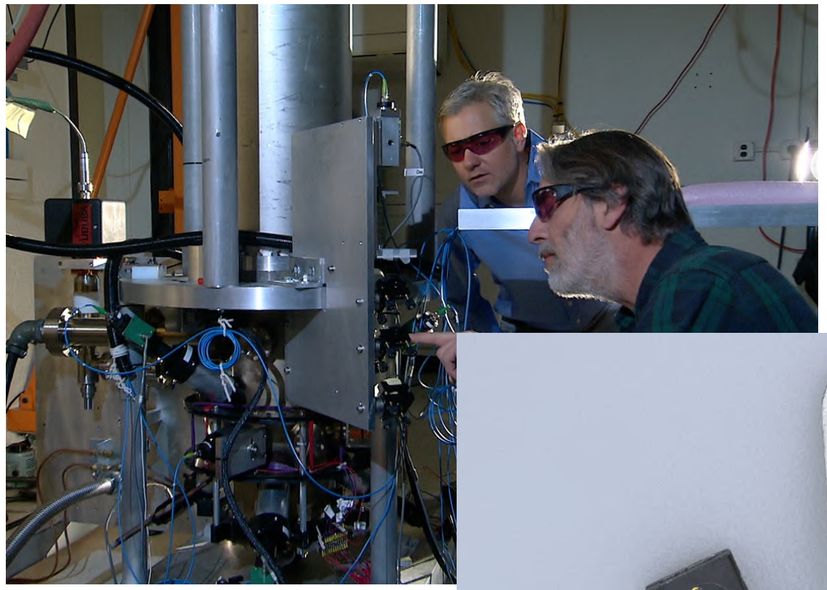
Quantum Optimization, AI & Evolutionary Algorithms

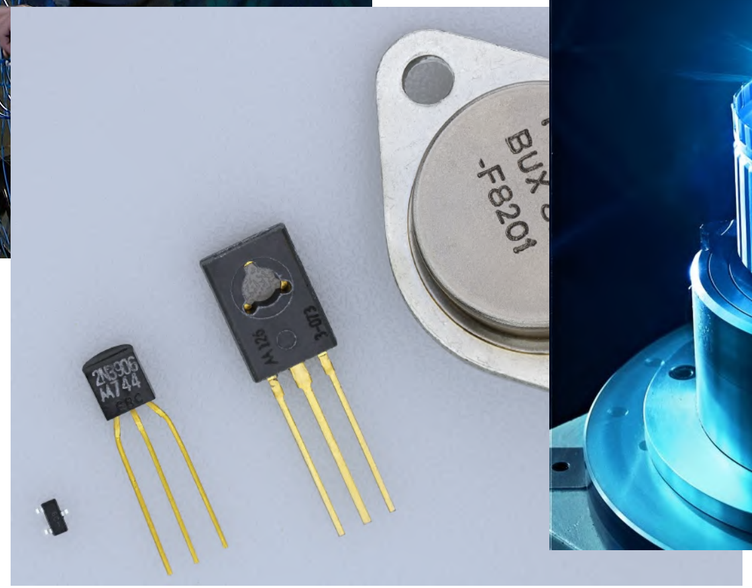
... and a growing team of 30+ Quantum Computing experts and Software Developers

The first Quantum Revolution

Discovering quantum mechanics.







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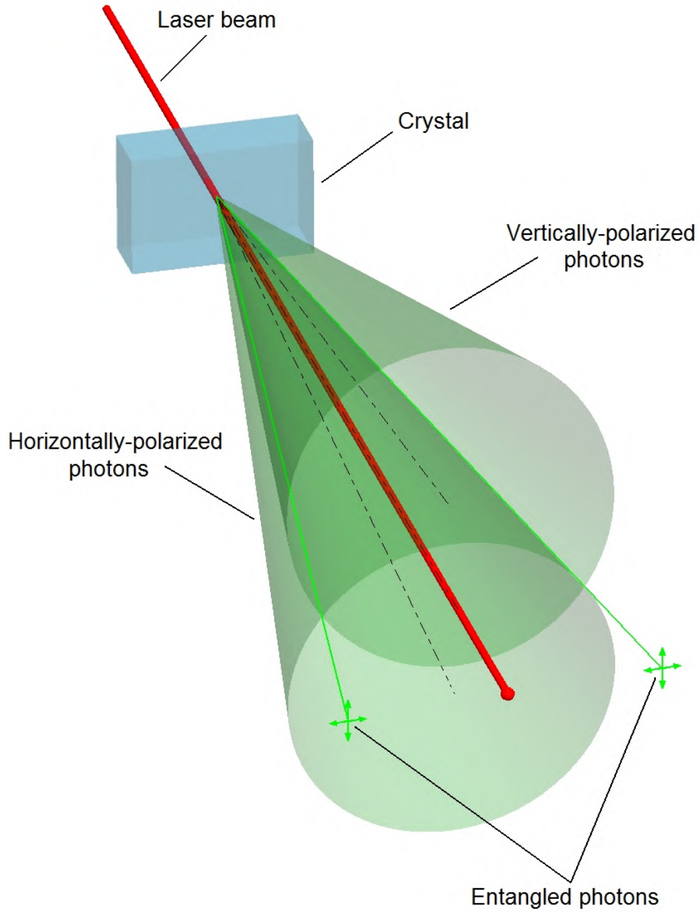
The second Quantum Revolution

Manipulating quantum systems at will.



https://en.wikipedia.org/wiki/Quantum_entanglement#/media/File:SPDC_figure.png

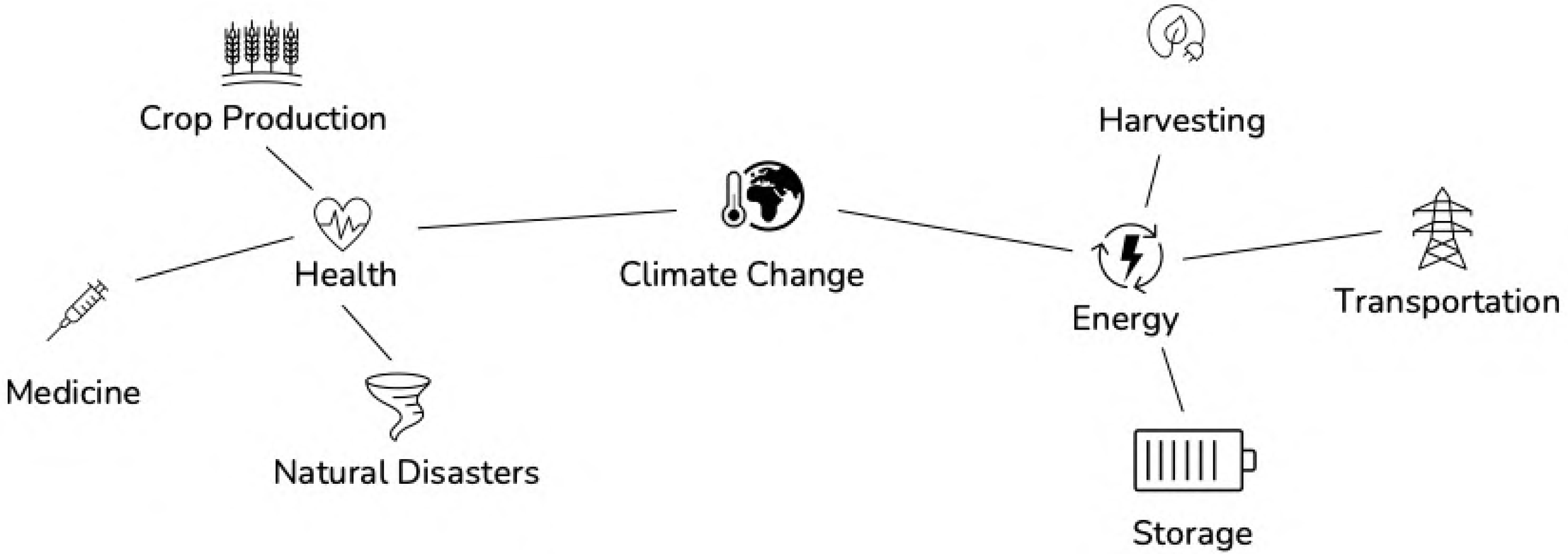
The impending third Quantum Revolution

Controlling large quantum systems, revolutionizing our world.

https://cdn.mos.cms.futurecdn.net/rFMm9mi8RB3hWbffaTpXSE.jpg

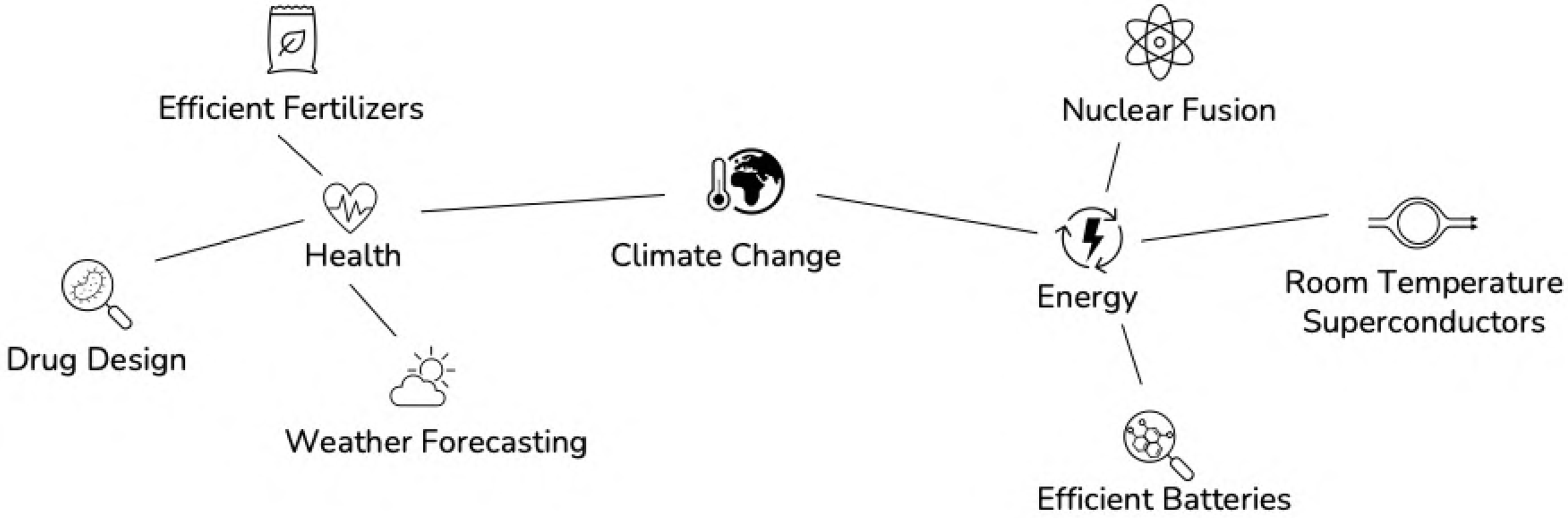
Existential Challenges of Humanity

The biggest problems we are facing today.



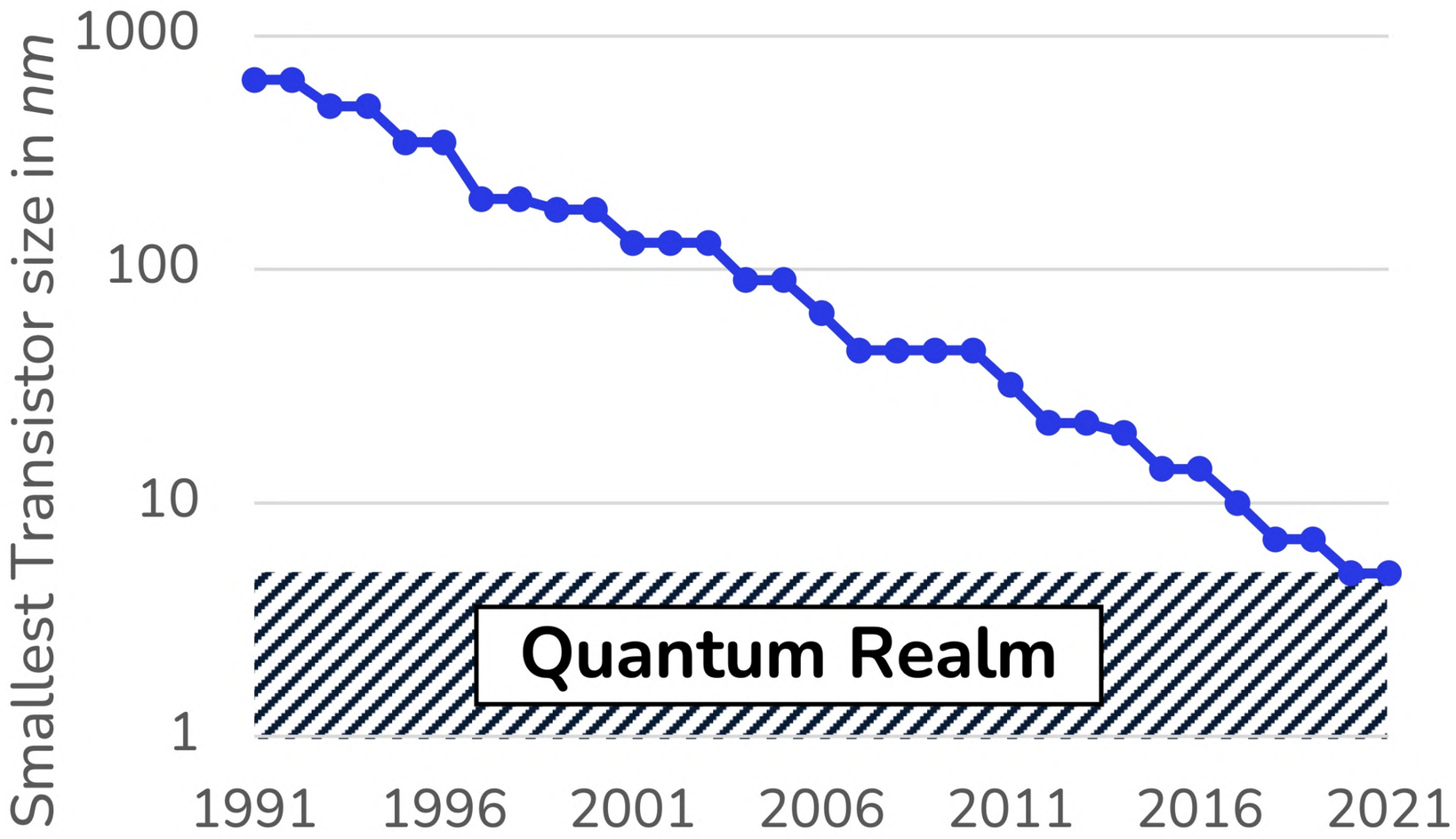
Existential Challenges of Humanity - Solutions

Ideas for solutions to these challenges already exist.



Moore's Law

Our current hardware is hitting a roadblock.

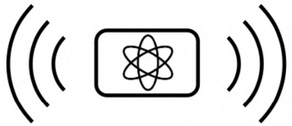


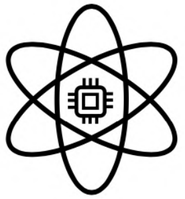
The next Technological Revolution

Promising applications of quantum technologies.

Quantum Sensing
Study of sensors (e.g., measuring time, gravity, etc.) utilizing quantum effects.

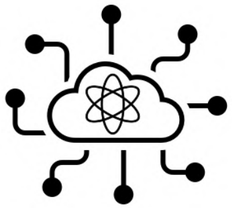
→ higher precision





Quantum Computing
Paradigm of computation exploiting quantum effects like entanglement and superposition.

→ computational speedup



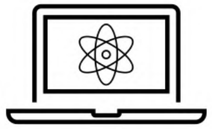
Quantum Communication
Secure data transfer via quantum internet, built e.g., from photons carrying quantum information.

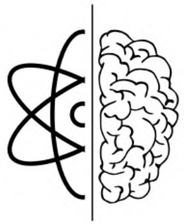
→ provably secure

Archetypical Use Cases of Quantum Computing

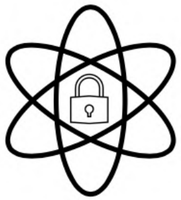
Where the computational speedup of quantum can be used.

Quantum Simulation
Simulation of (quantum)-physical systems and processes (i.e., solving partial differential equations).

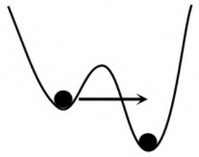




Quantum Artificial Intelligence
Solving linear algebra problems as native formulations of quantum mechanics.



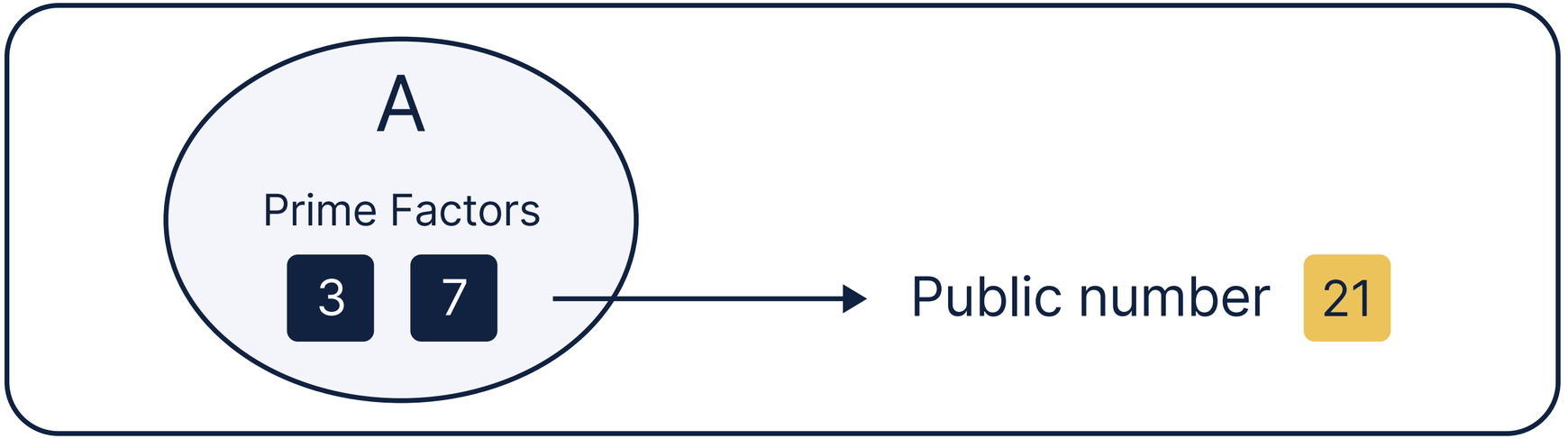
Quantum Cryptography
Decryption like in Shor's factorization algorithm and secure quantum communication.

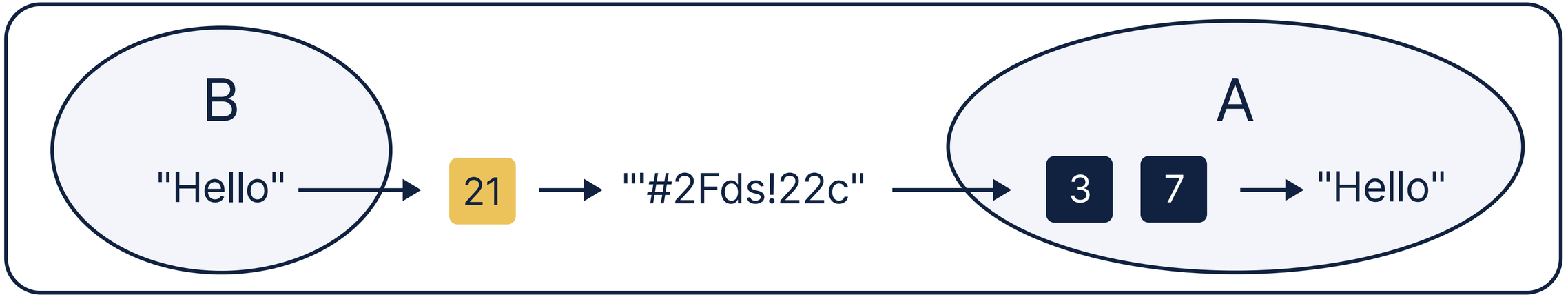


Quantum Optimization
Exploiting powerful quantum algorithms and heuristics using exponential quantum parallelism.

The RSA Algorithm

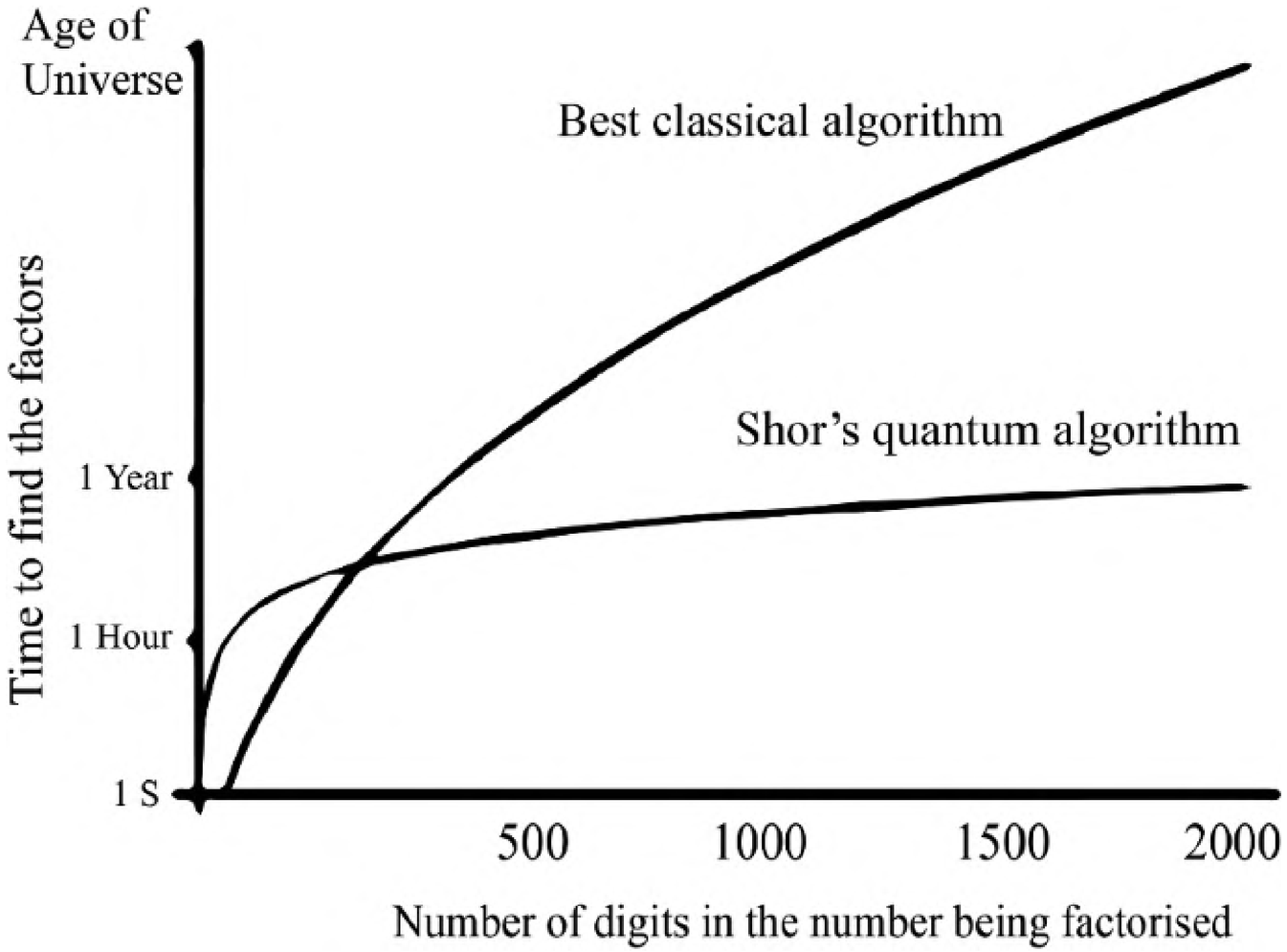
A popular encryption method based on prime factorization.





Shor's: Unleashing the Power of Quantum

How we can harness the fundamentals of quantum mechanics.

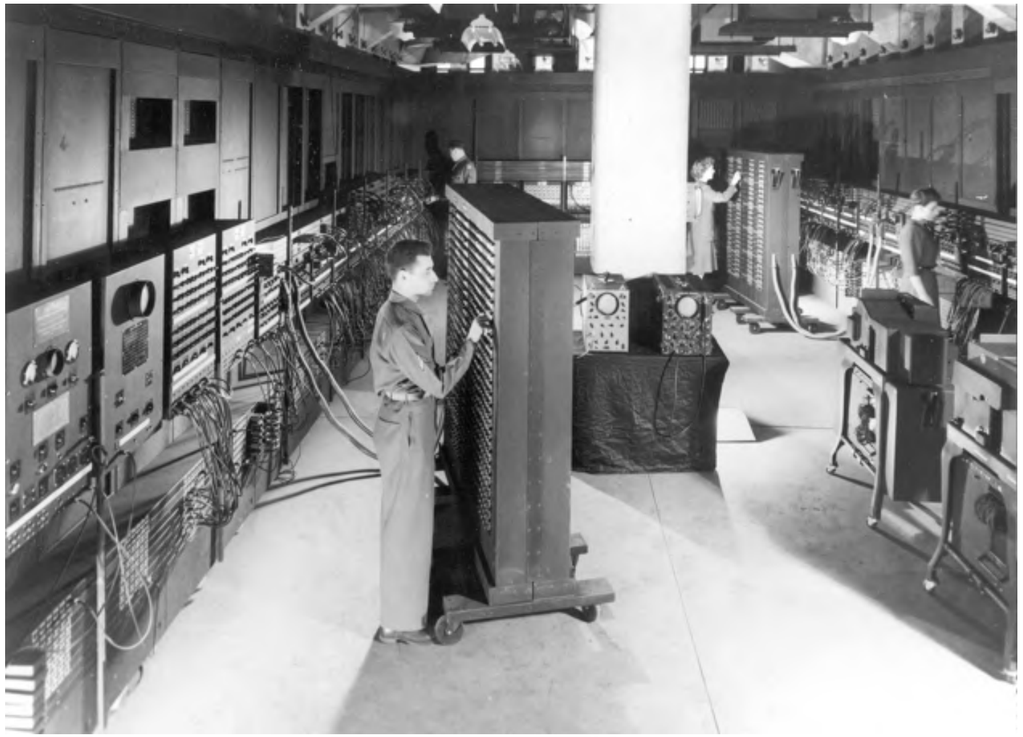


Superposition

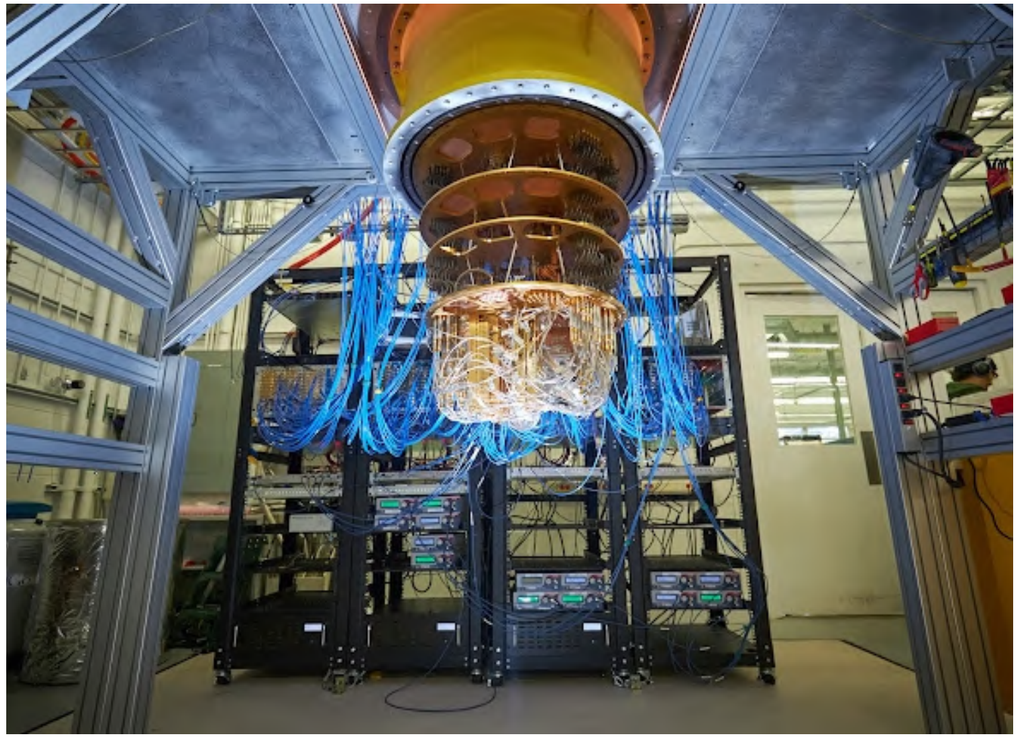
Entanglement

The Quantum Hardware Challenge

What's stopping us from using these algorithms?



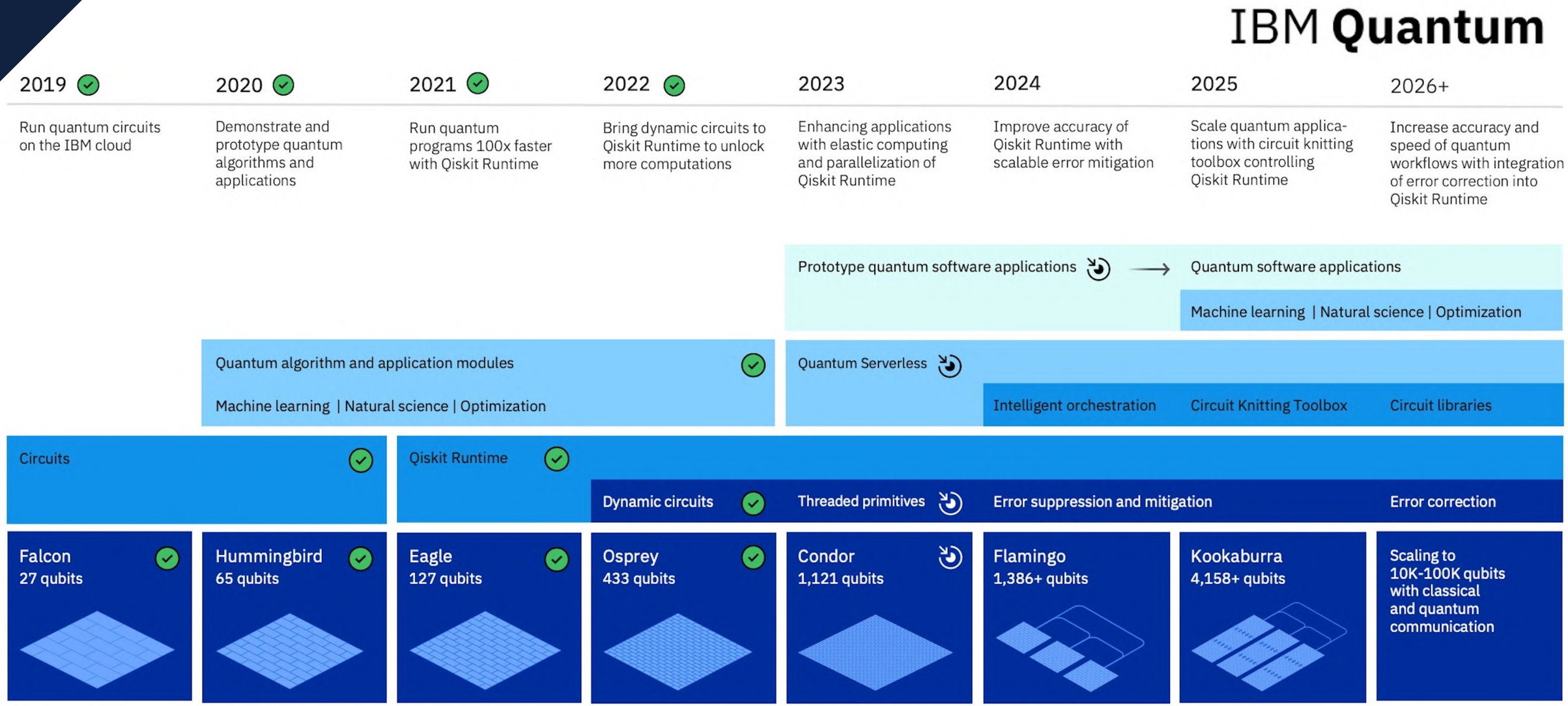
U. S. Army Photo



Google’s Sycamore processor. Photo Credit: Rocco Ceselin

Shor's: Breaking the 2048-bit RSA Algorithm

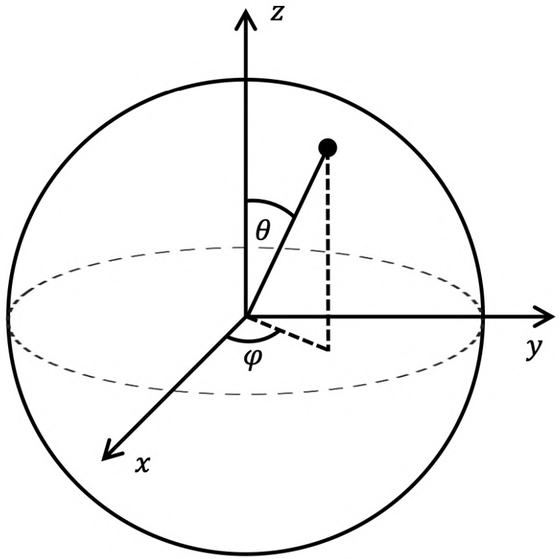
Fujitsu: We need 10.000 qubits and 104 days.



The Problem of our Qubits

A qubit is not always a qubit.

- **Noise and Imperfections**: Prone to errors and noise.
- **Limited Coherence Time**: Short-lived quantum states.
- **Scaling**: Adding more qubits is not trivial.



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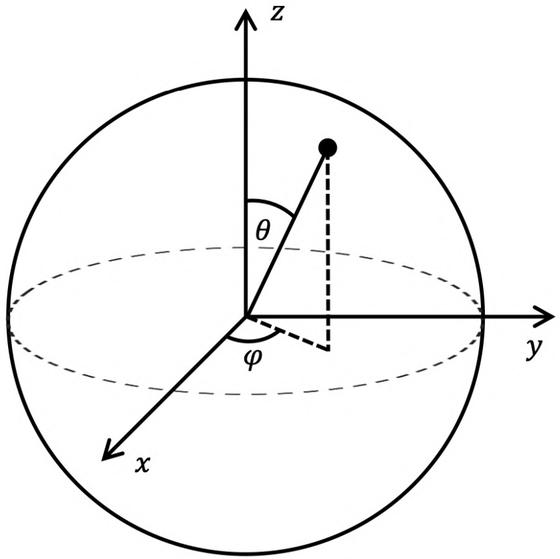

- **Noise and Imperfections**: Prone to errors and noise.
- **Limited Coherence Time**: Short-lived quantum states.
- **Scaling**: Adding more qubits is not trivial.

⟶ Combine multiple physical qubits into a logical qubit!

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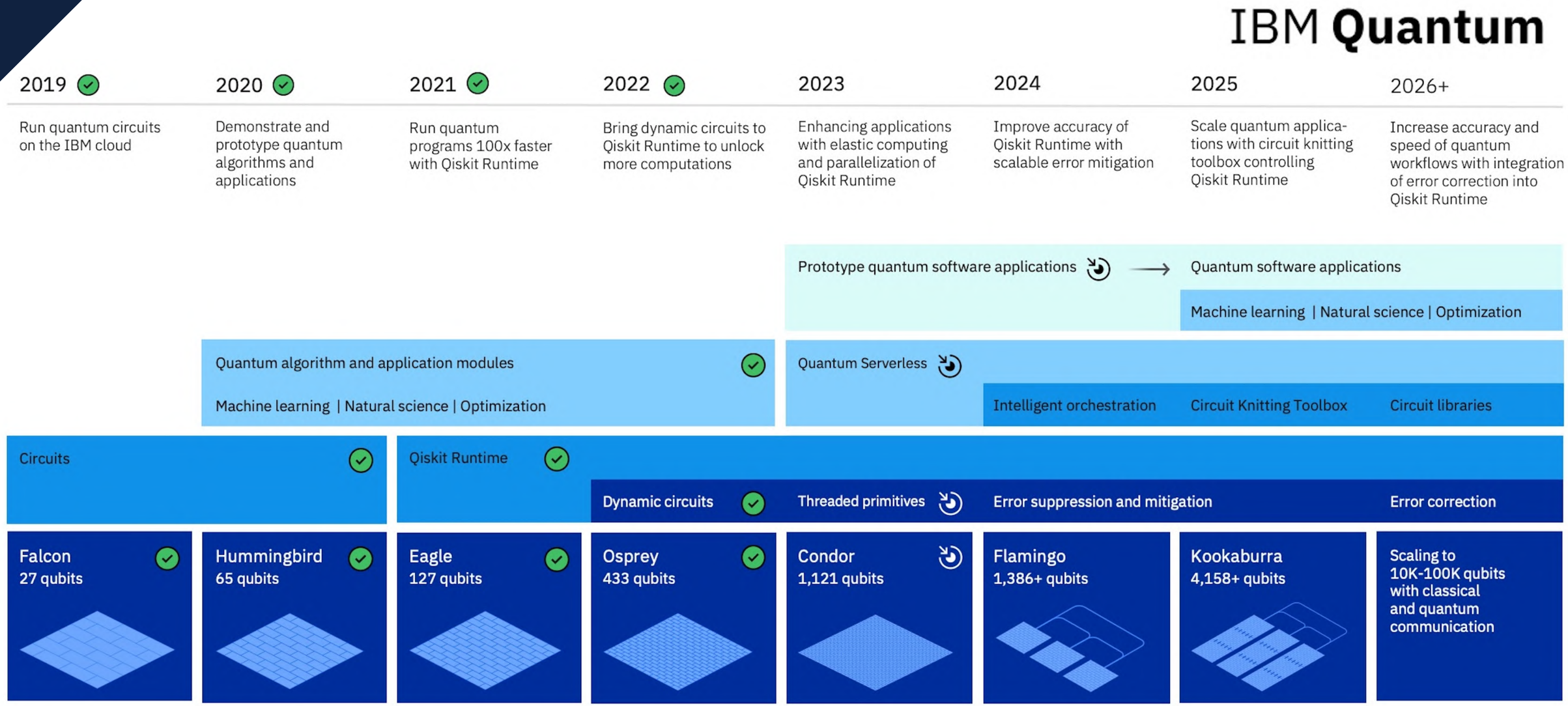
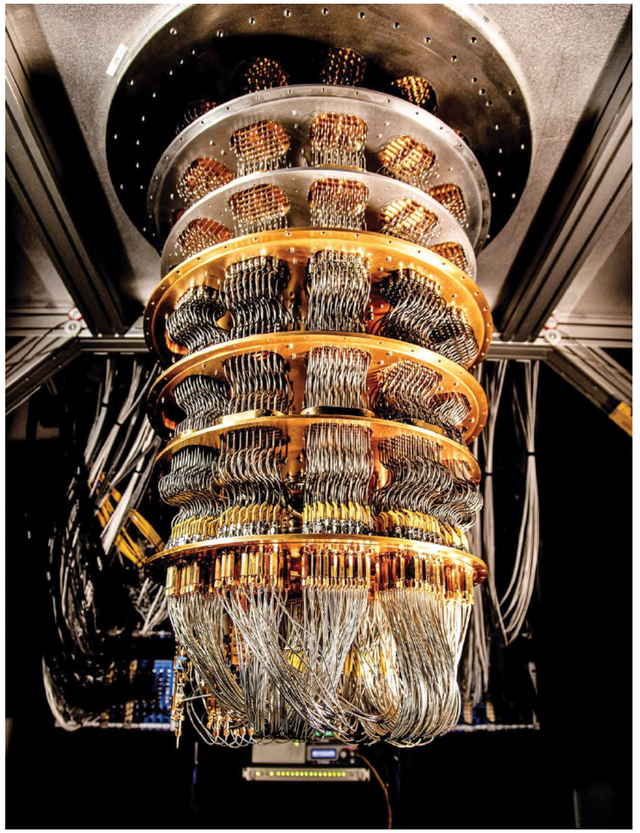
Shor's: Breaking the 2048-bit RSA Algorithm

Google: We need 20.000.000 **physical** qubits and 8 hours.



Why Quantum Computing Today?

The importance of preparing for the age of Quantum Computing.



https://de.m.wikipedia.org/wiki/Datei:IBM_system_360-50_console_-_MfK_Bern.jpg
ERIK LUCERO/GOOGLE QUANTUM AI

Quantum Computing in the Near Future

We don't have to wait for Shor's algorithm.

Shor's algorithm is known not to be usable any time soon.

But Quantum Computing is not just about Shor's algorithm.

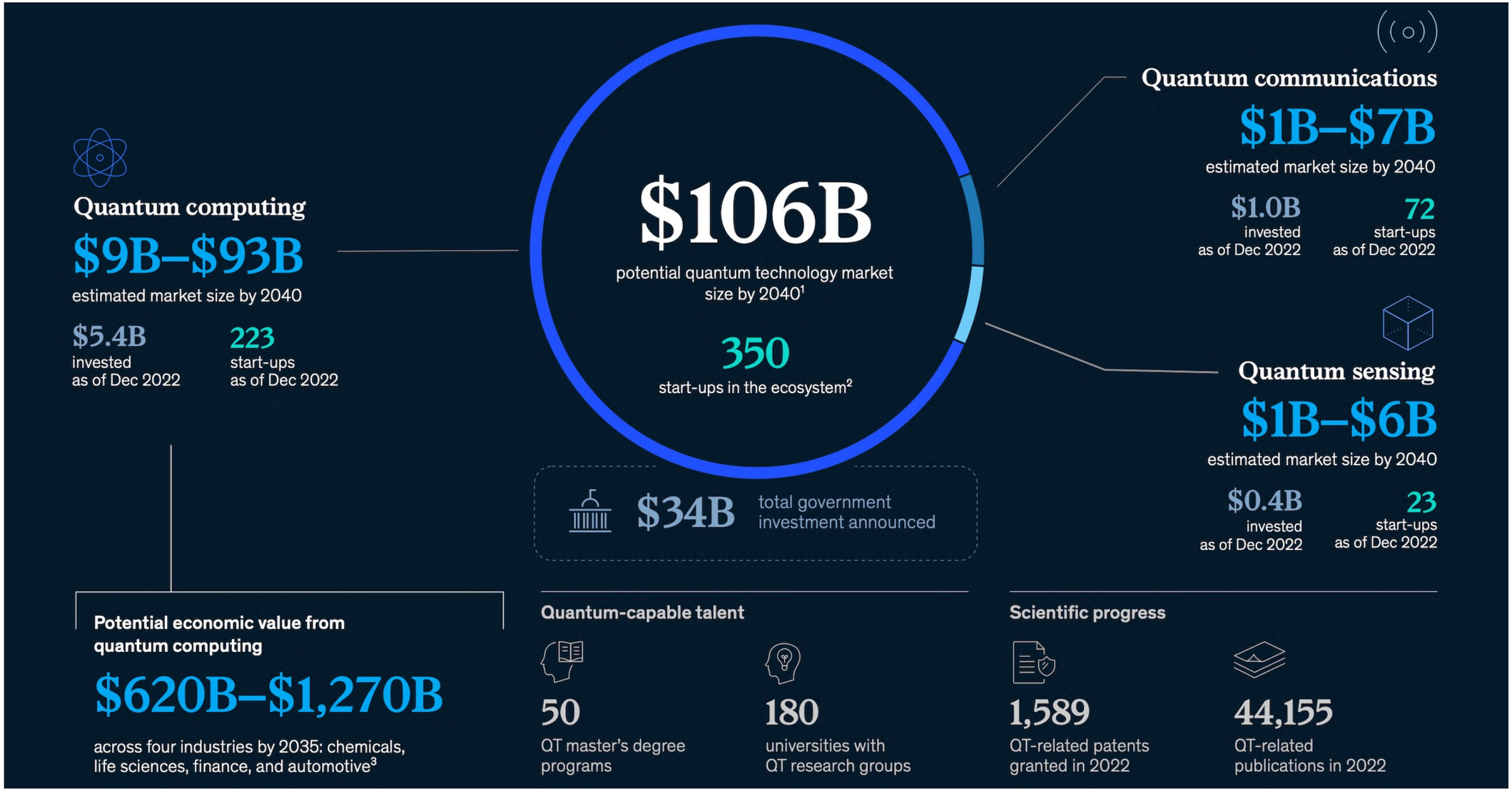
Quantum Simulation, AI & Optimization

Quantum Annealing

Hybrid Algorithms

The Quantum Technology Ecosystem

A McKinsey study on quantum technology monitor findings.



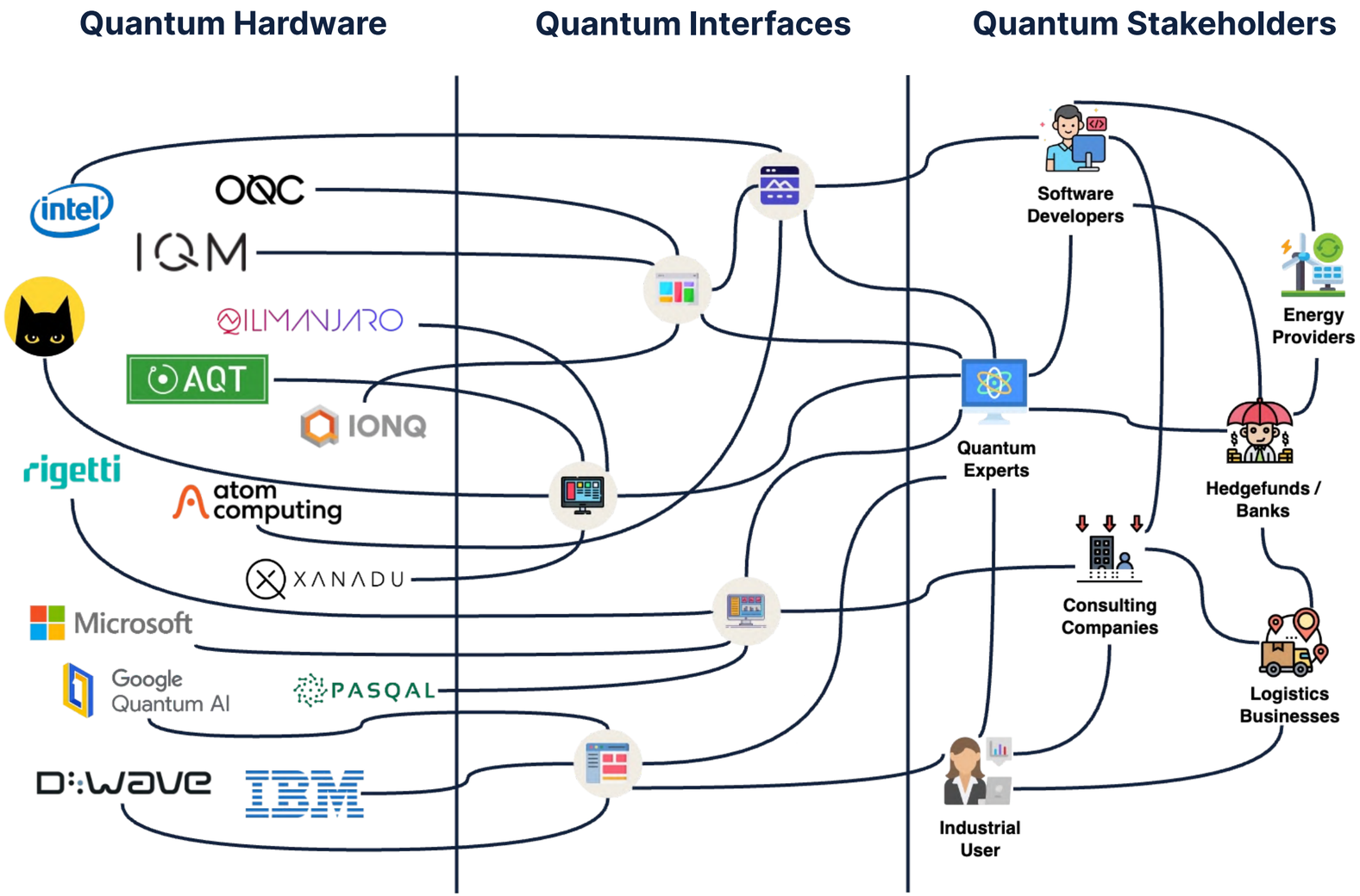
The Status Quo of the Quantum World

An opaque landscape of processes and infrastructures.

? When and how to use quantum computing?

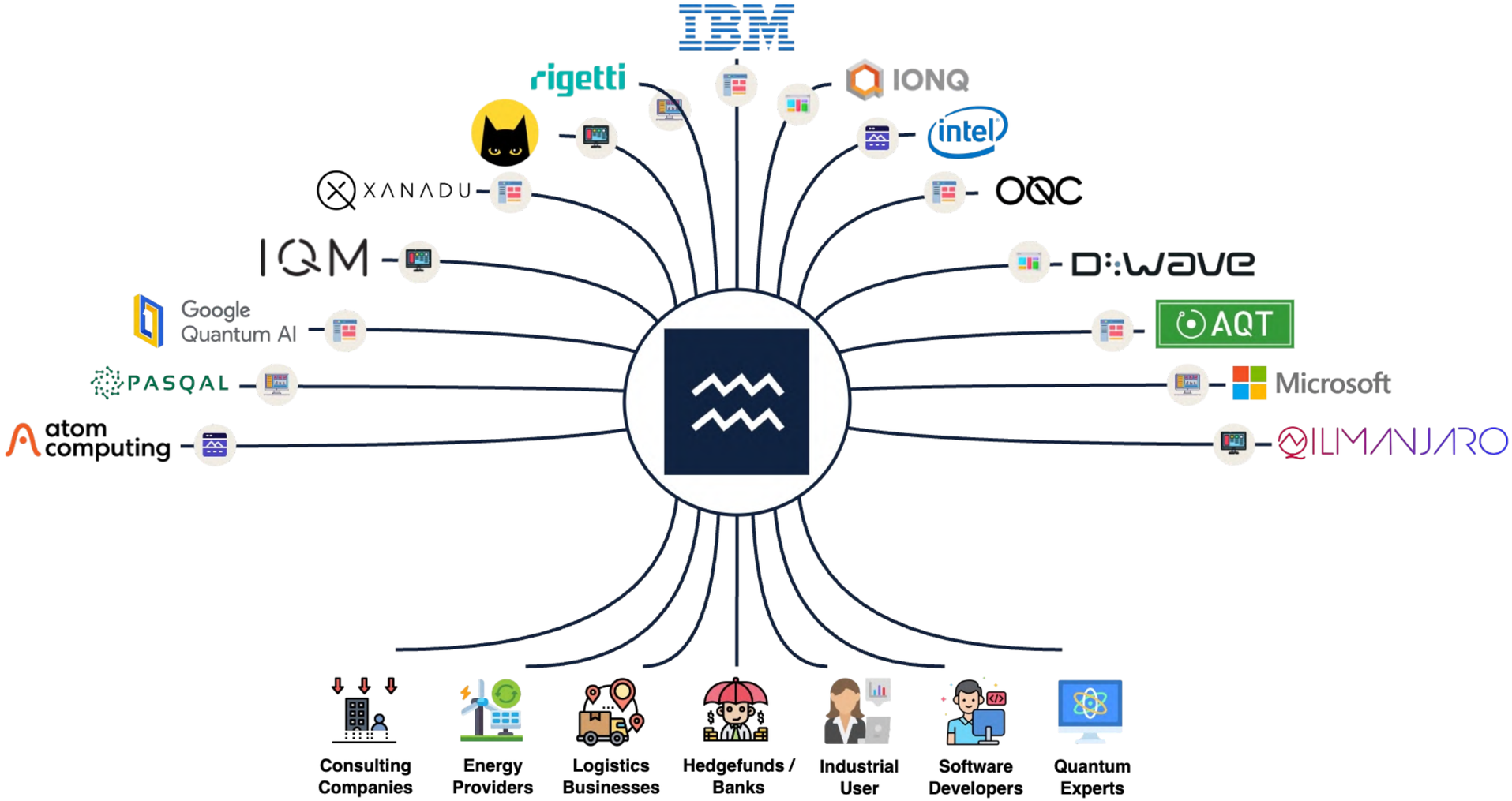
? Which quantum hardware and algorithm?

? Where to find affordable quantum experts?



Aqarios as the Central Nervous System

The new world: A **single platform** for many stakeholders.



Aqarios Luna

The cloud platform to solve real-world and large-scale optimization problems using quantum technologies.

We show you when quantum computing should be used.

We recommend the best hardware and algorithm.

We take the role of your affordable quantum experts.

We solve the most challenging optimization problems by intelligently applying the most suitable solution from all available quantum, hybrid and classical approaches.

Services of Aqarios Luna

How users can benefit from Quantum Computing through Luna.

Aqarios Luna

LunaSolve

Solve your optimization problem with the best combination of software and hardware for your use case.

Solving recurring optimization problems efficiently.

LunaBench

Evaluate your algorithm or use case against state-of-the-art quantum, hybrid and classical approaches.

Benchmarking or discovering a quantum advantage.

LunaQ

Access quantum hardware, develop your own approach, and run quantum algorithms in varying fields.

Accessing quantum hardware and applying algorithms easily.

LunaLib

Library of use cases, application examples, and knowledge about quantum and optimization.

Onboarding of new users and discovering new knowledge.

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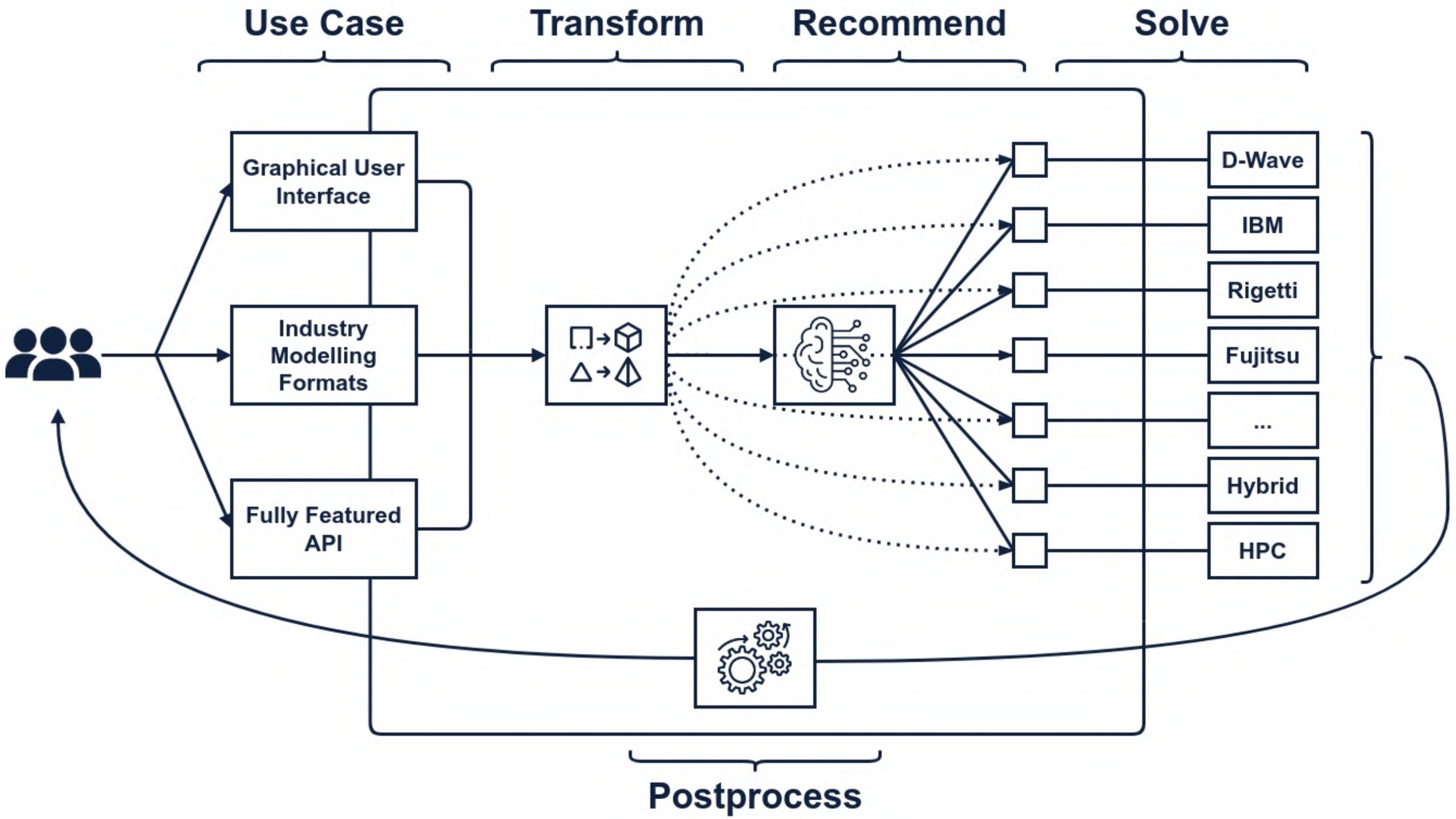

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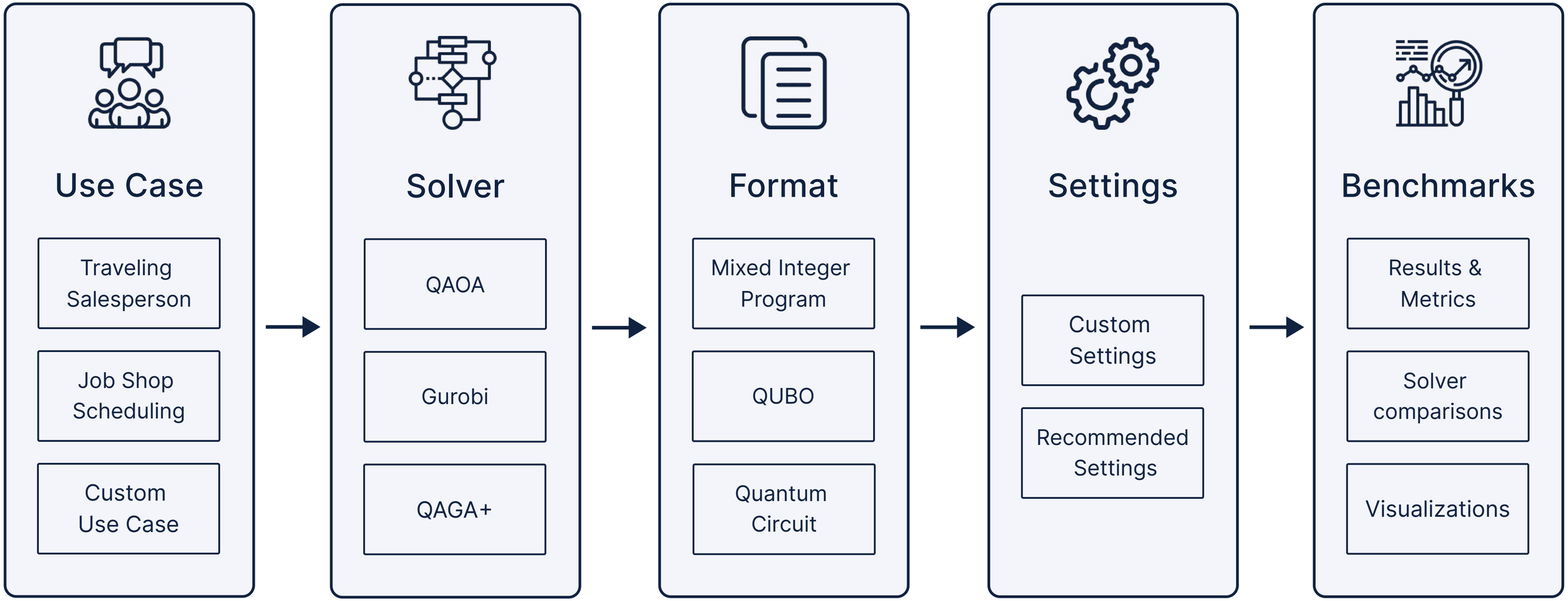

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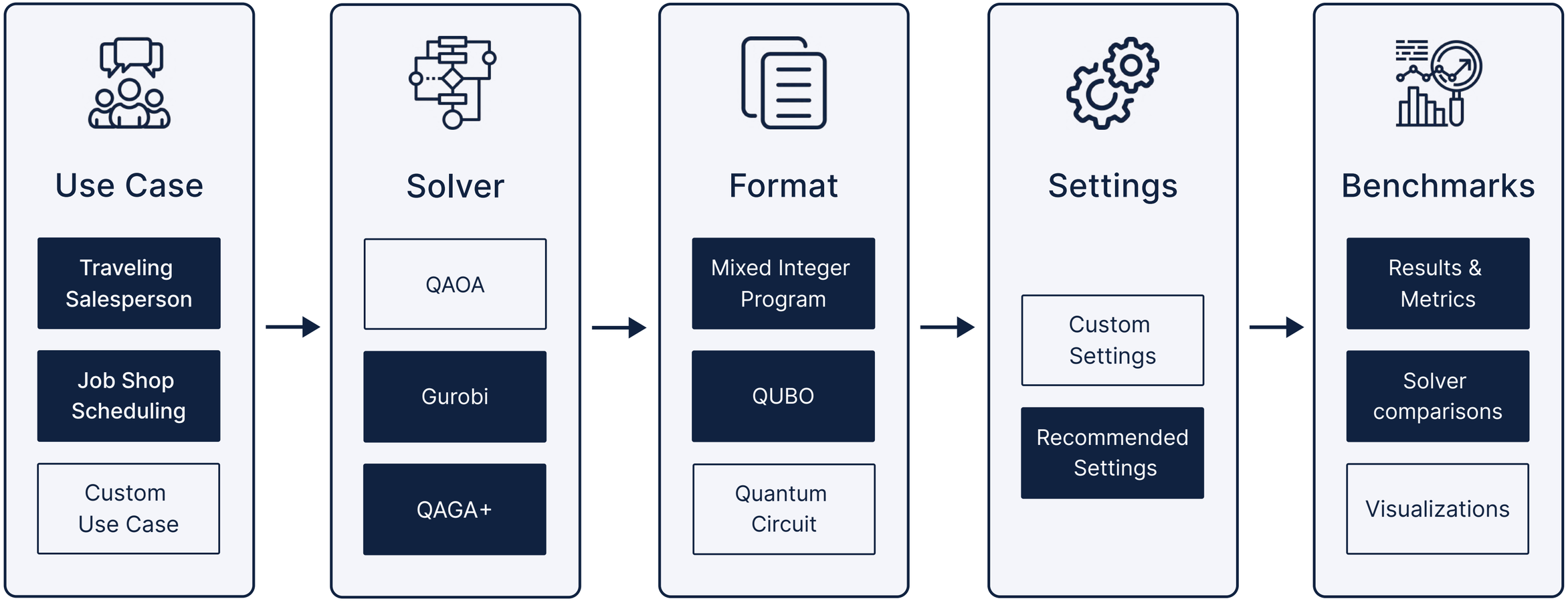

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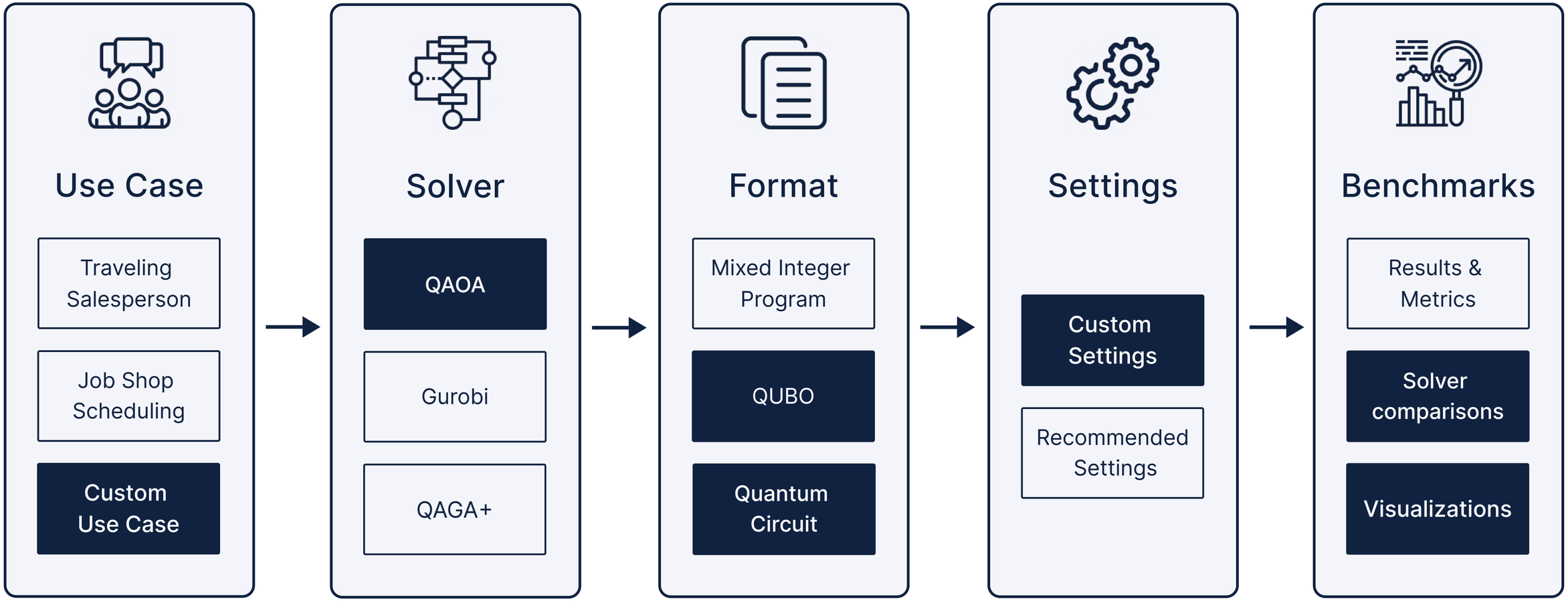

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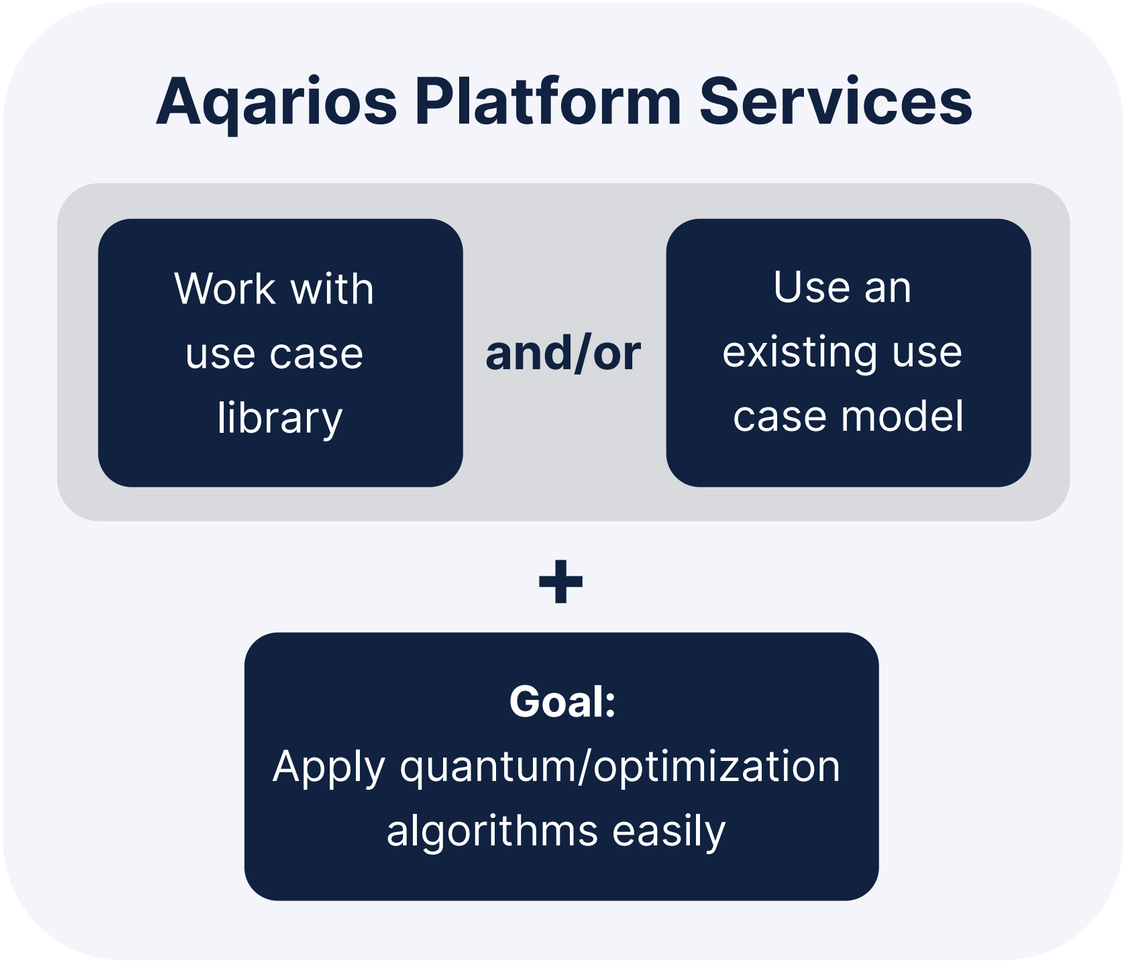
How to start your quantum journey with Aqarios.



Services of Aqarios

How to start your quantum journey with Aqarios.

Aqarios Customer Projects

Model a new custom use case

and/or

Learn about Quantum Computing

+

Goal:
Project on (quantum) optimization or (quantum) AI

Aqarios Platform Services

Work with use case library

and/or

Use an existing use case model

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Apply quantum/optimization algorithms easily

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But why Aqarios?

What makes us unique in the quantum landscape.

Pragmatic.

Quantum is coming, but we know it's not the solution to all our problems today.

Solution-driven.

We focus on providing the best solutions, not overselling due to unreasonable hype.

Hardware-agnostic.

Be it quantum, hybrid, quantum-inspired or classical - we provide the best of all worlds.

Transparent.

No hidden processes to sugarcoat results - you get actual assessments of real performances.

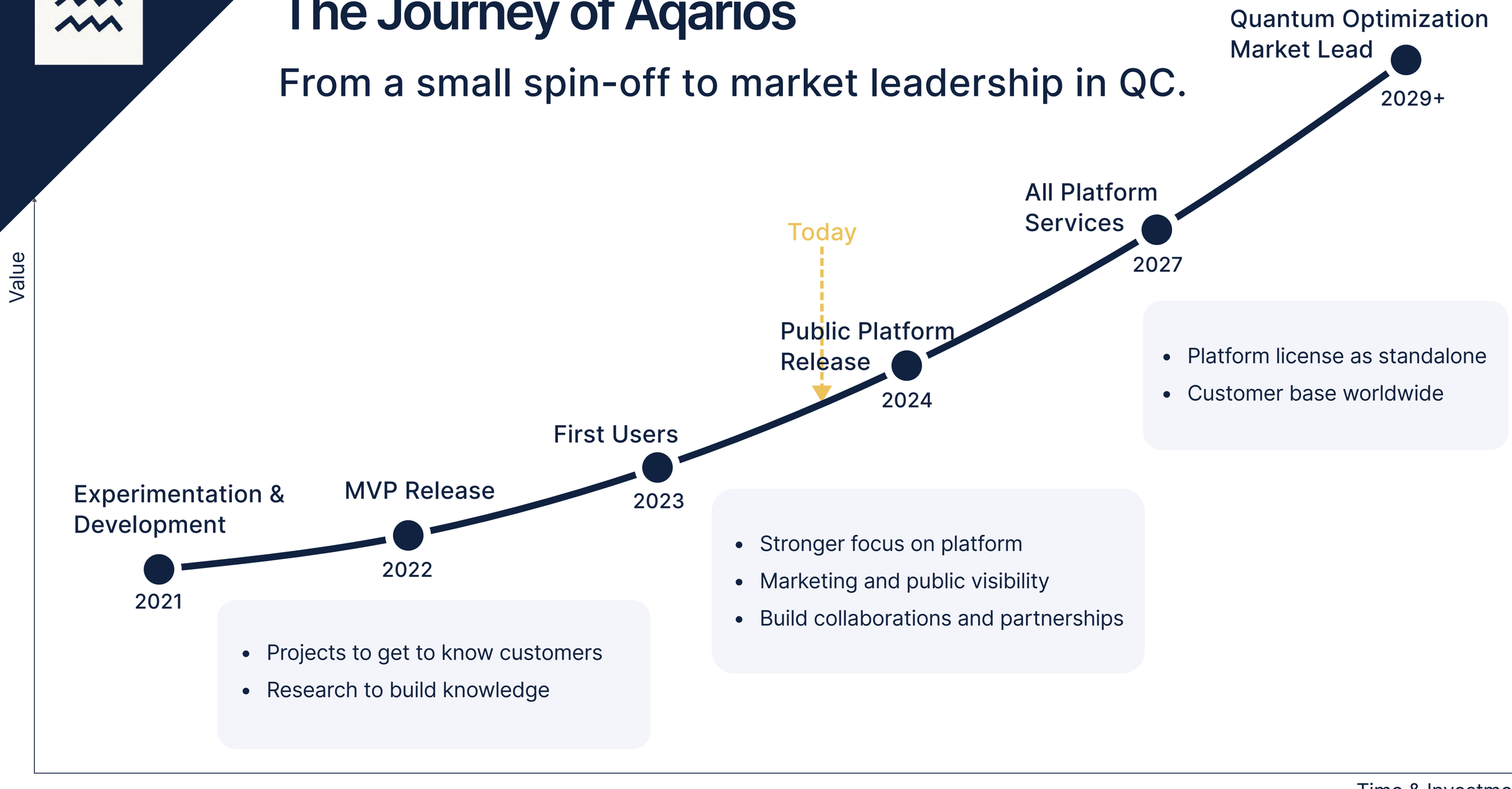
Partnerships, Projects and Core Verticals

Choosing big players in the relevant industries.

QuCUN	SAP, BASF We create chemistry, LMU Ludwig-Maximilians-Universität München	→ Platform
QCHALLenge	BMW Group, Siemens, SAP	→ Logistics
Q-Grid	e.on, LMU Ludwig-Maximilians-Universität München	→ Energy
QC Finance	LMU Ludwig-Maximilians-Universität München, Z	→ Finance
QC Ecosystem	Gurobi Optimization, TUM, Deloitte.	→ Networking

The Journey of Aqarios

From a small spin-off to market leadership in QC.



- Projects to get to know customers
- Research to build knowledge

- Stronger focus on platform
- Marketing and public visibility
- Build collaborations and partnerships

- Platform license as standalone
- Customer base worldwide

The Takeaways of Today's Talk

So, should you invest in Quantum Computing?

Quantum Computing will not bring any production value today.

Hardware is not mature enough to solve real-world problems on a large scale.

But:

Quantum Computing will revolutionize many industries. Most likely yours as well.

The potential impact is enormous, creating billions to trillions in economic value.

Acquiring quantum knowledge is neither easy nor fast.

Evaluating use cases and training your team takes time and effort.

AQARIOS

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