Quantum computing in financial services

How to understand the opportunity and mitigate risk

> Quantum computing has the potential to rival artificial intelligence in its impact. To be ready, businesses need to prepare now with many financial services firms already investing resources to understand the risks and opportunities of the technology."

Quantum leaps

Quantum computing is expected to initiate a paradigm shift in computational power. By leveraging quantum phenomena such as superposition and entanglement, it offers exponential increases in processing capability, which can transform our ability to solve complex problems.

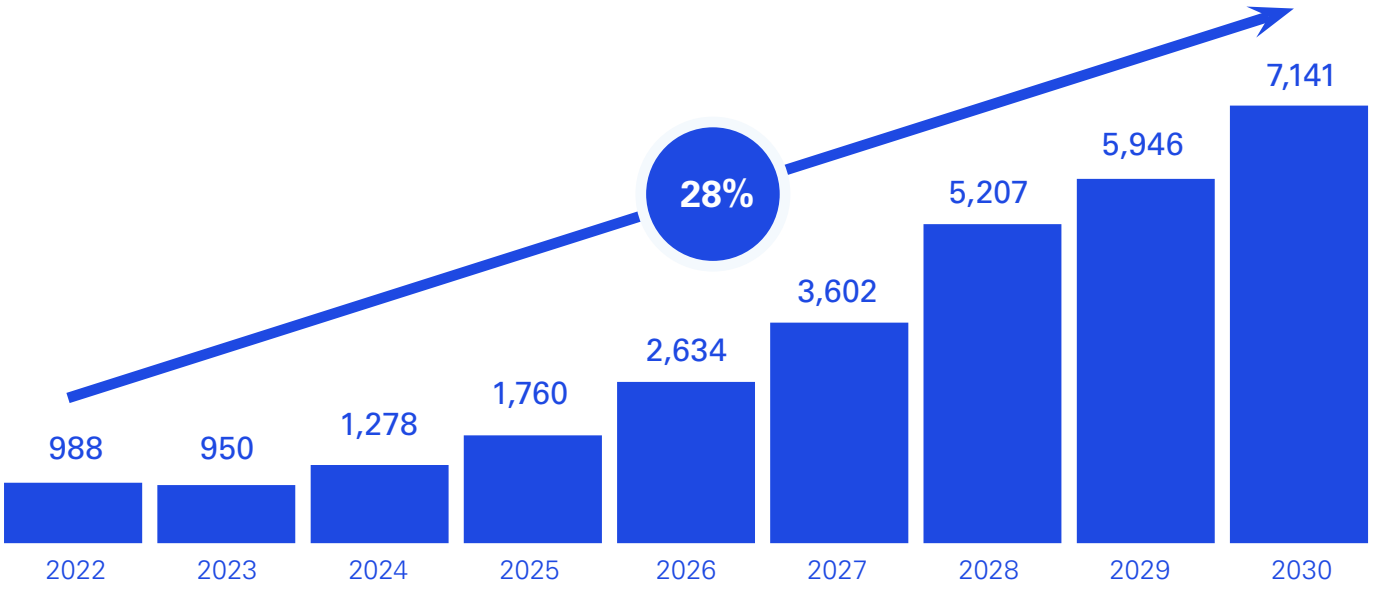
Of course, people have been saying much the same thing about AI for decades, and yet it is only recently – since the explosion of ChatGPT and other generative AI tools into the mainstream – that many businesses have understood the possibilities of the technology. The trajectory of AI's journey to the mainstream is therefore a timely reminder of how quickly technologies can move from the theoretical to the business critical.

Nobody can say when quantum computing will have its own ChatGPT moment, but most agree that it is coming. Recent years have seen significant advances, such as the development of quantum error correction techniques and the deployment of quantum algorithms for complex problem-solving. At KPMG, we forecast that such advances will fuel growing demand for quantum computing services in the coming decade, leading to average annual market growth of close to 30%.

As with AI, excitement around quantum computing is balanced with a growing awareness of the risks it poses. For example, quantum computers will be able to break most common encryption methods currently in use. As the technology evolves, the time is now for those businesses likely to be most affected to build quantum readiness and develop proactive strategies to harness its potential while mitigating its risks.

Global Quantum computing market size forecast

$, millions



Source: Aggregated third-party estimates, KPMG Analysis

Quantum computing explainer

Quantum computing is not merely an evolution of today's computers but a fundamentally different technology, that leverages quantum mechanical phenomena.

Exponential power

Where classical computers use bits (0 or 1) as their fundamental unit of information, quantum computers use quantum bits (qubits), which are capable of existing in a superposition of states (both 0 and 1 simultaneously). Qubits can also be entangled with each other, creating a connection where the state of one qubit can depend on the state of another regardless of the distance separating them, a property allowing for radically advanced computational power. Indeed, a system of 300 qubits can reflect more states than there are atoms in the universe, theoretically delivering computational power far beyond anything classical computers can achieve.

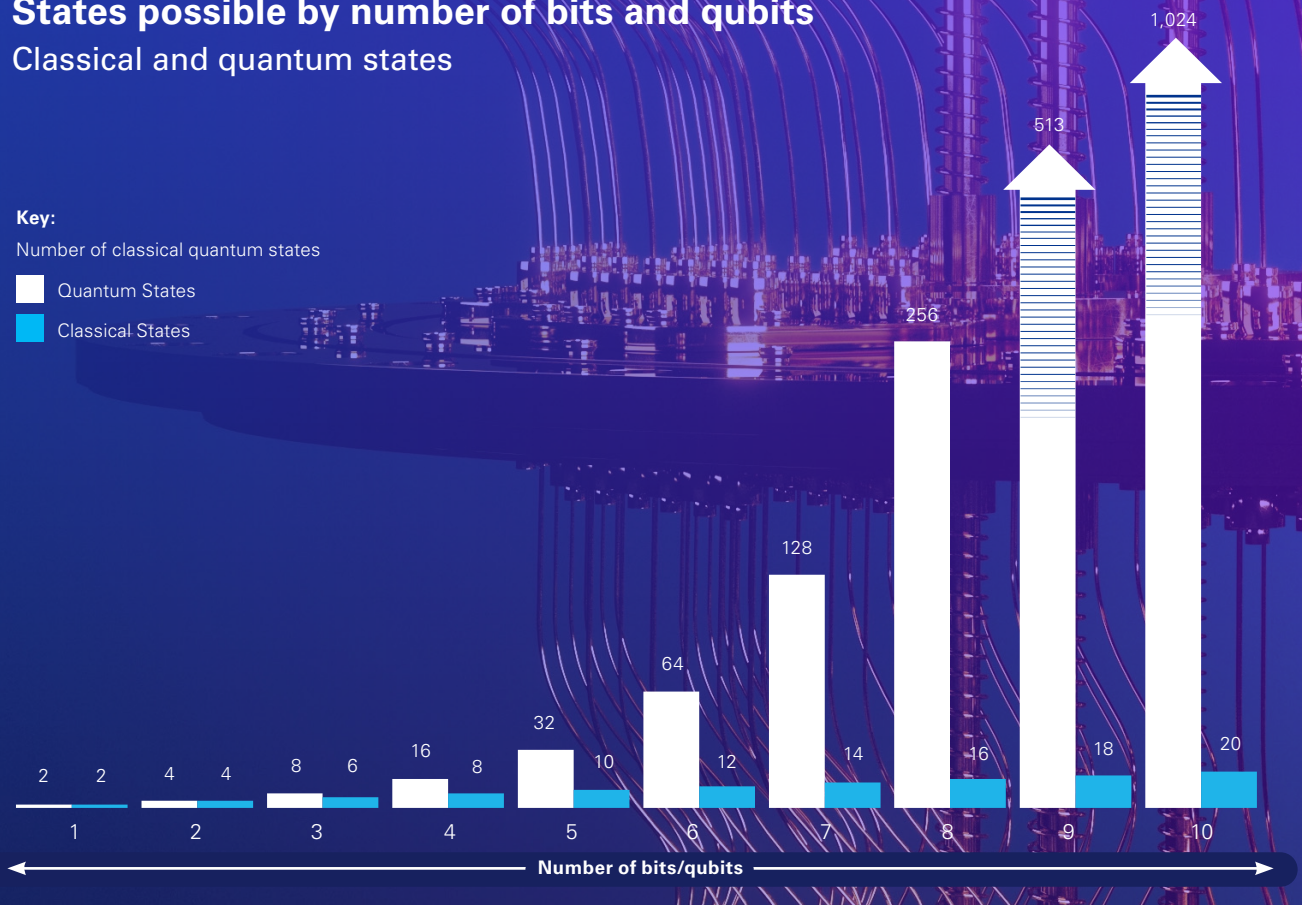
As a consequence, quantum computers excel in solving optimisation problems, mimicking atomic processes, and factoring large numbers—tasks pivotal in finance, chemistry, and cryptography. They handle large unstructured datasets and complex simulations with unprecedented speed. Quantum computing could also revolutionise AI, improving training efficiency and model optimisation for large language models (LLMs).

However, for now such benefits remain largely theoretical with true "quantum advantage" whereby quantum computers outperform their classical counterparts still not achieved.

The Exponential Power of Qubits

States possible by number of bits and qubits

Classical and quantum states



Quantum computing in Ireland: well positioned, more to do

As a global tech hub, Ireland is in a strong position to capitalise on the emergence of this new technology, hosting as it does most of the world's top technology companies. Despite this robust presence, however, there are relatively few quantum-focused private companies in Ireland. The government has sought to address these gaps, recently launching its Quantum 2030 Investment Strategy, which compliments cross-EU initiatives such as Quantum Flagship and QuantERA, aimed at building talent and capability in the sector. The Irish strategy seeks to drive investment in research infrastructure, fill the talent pipeline, foster collaboration between relevant stakeholders and innovators, encourage entrepreneurship, and promote quantum technologies to relevant stakeholders. This approach aims to leverage Ireland's existing quantum research base and the strong foundation created by the presence of global big tech, in order establish Ireland as a leader in the space.

Furthermore, Ireland's data centre scale could enable synergies with quantum technology advancements. Although this integration of quantum computers with data centres and the associated adaptions or new approaches required have significant technical challenges, promising advancements are already being made in this regard:

- Data centre provider Equinix announced plans for quantum computing company Oxford Quantum Circuits to Install a quantum computer within the Equinix IBX® Data Centre with the intention of providing access to the power of quantum computing to customers globally
- Irish headquartered Quantum computer start-up, Equal1 is developing a hybrid quantum/classical chip based on silicon technology that can be integrated into existing data centre infrastructure negating the need for expensive adaptions or new specially developed facilities.

Indeed quantum computers may also help to allay concerns around the energy consumption required to run data centres via their inherently energy efficient approach to problem solving.

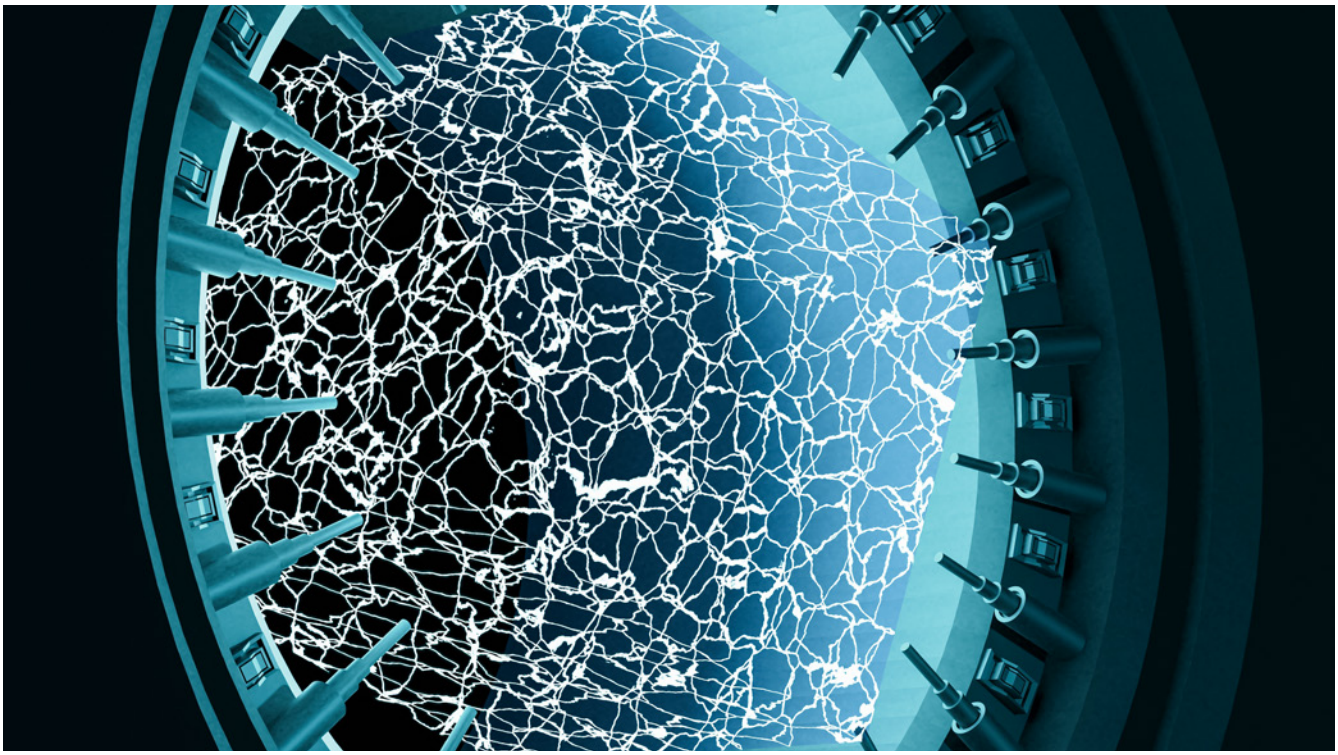
Financial services: early adopters

In the past three decades, quantum computing has advanced from a largely theoretical state to working computers with hundreds of qubits. While significant costs and development challenges mean that commercial viability remains in its infancy for most use cases, it may become more realistic for others. Financial services is particularly suitable for early adoption, considering the wide range of relevant use cases.

Core FS use cases

Subsector	Use case
Investment Banking	Complex derivative pricing and risk management.
Asset Management	Portfolio optimisation and market analysis.
Retail Banking	Credit scoring and fraud detection.
Trading	Arbitrage detection and high-frequency trading optimisation.
Insurance	Risk modelling and pricing.
Regulatory Compliance	More efficient calculation of regulatory capital requirements and stress testing.
All subsectors	Use of quantum cryptography for encrypting and transmitting secure data. Modern encryption methods such as RSA and AES are secure against classical computers but may be broken by quantum computers in the future, hence, quantum encryption will be necessary to protect sensitive data.

> "We see financial services as one of the early adopter sectors for quantum computing. Indeed, we are already engaging with local and international players within the sector on potential use cases and solutions"
>
> **Jason Lynch**
> **CEO Equal1**



Building a footprint in quantum computing is challenging.
FS institutions have three choices:

1 Build a quantum computing team in house:

HSBC and JP Morgan are prominent examples of banks going this route, both having formed dedicated quantum research teams to develop applications for quantum computing in the financial sector. HSBC has pioneered the use of quantum protection for AI-powered foreign exchange trading[1] while JP Morgan Chase has collaborated with quantum computing startup QC Ware to build a quantum-powered deep hedging algorithm[2].

2 Invest in pre-existing quantum computing firms:

BNP Paribas[3] and Axa Venture Partners[4] have both invested in quantum startups (carbon nanotube pioneer C12 and post-quantum cyber security provider CryptoNext, respectively) which help them gain entry into the field and position themselves for rapid responses to future quantum computing developments.

3 Develop partnerships to focus on specific projects:

Citi Innovation Labs[5] has partnered with quantum computing startup, Classiq, to explore quantum solutions for portfolio optimisation, while Mizuho Bank[6] is actively involved in researching quantum applications in banking and finance through its research arm, Mizuho Information & Research Institute.

[1] https://www.hsbc.com/news-and-views/news/media-releases/2023/hsbc-pioneers-quantum-protection-for-ai-powered-fx-trading
[2] https://www.forbes.com/sites/moorinsights/2023/05/22/jpmorgan-chase-and-qc-ware-collaborate-on-quantum-finance-breakthrough-in-deep-hedging/
[3] https://www.datacenterdynamics.com/en/news/french-startup-c12-quantum-electronics-raises-194m-in-pre-series-a-funding-round/
[4] https://www.axavp.com/cryptonext-security-raises-11me/
[5] https://fintechmagazine.com/articles/citi-explores-quantum-computing-for-portfolio-optimisation
[6] https://www.fintechfutures.com/2020/08/ibm-mizuho-and-mufg-join-japanese-quantum-innovation-consortium/

> Quantum computing may be in its experimental phase, but that doesn't mean that organisations should ignore the opportunities and threats it promises. For us at Fidelity, quantum computing is an increasingly important part of our innovation pipeline "

Michael Dascal
Director of Quantum Product Management
Fidelity Investments

Conclusion

Quantum computing remains in an early prototype phase, but its inflection point may be nearing. Businesses that want to get ahead of the curve need to develop a strategy now to ensure they understand the technology's implications and have planned for its adoption. To conclude, we list some key takeaways by organisation type:

FS operators

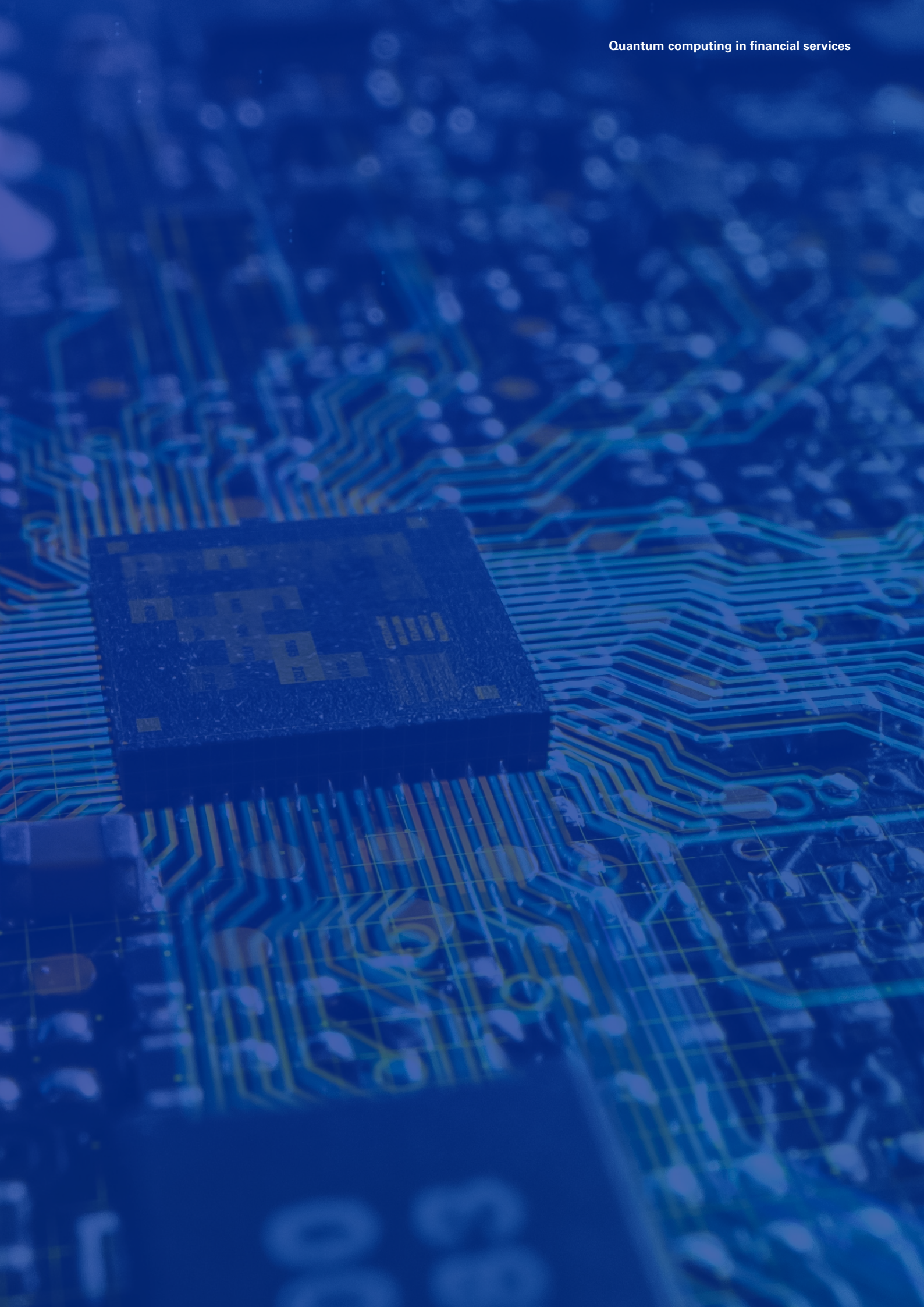
- Do the work now to understand where quantum computing is relevant to your business. Financial services is particularly rich with use cases, with many organisations already beginning to grapple with the implications for their business in areas such as cyrptography, risk in areas such as cyrptography, risk modelling and portfolio optimisation amongst others.
- Three main pathways to implementation include: building a proprietary quantum computing team; acquiring quantum computing startups; partnering with quantum computing providers.
- Despite a large forecast range for the advent of true quantum supremacy, use cases right now are being realised by major banks including Goldman Sachs and JP Morgan Chase, amongst others.

Investors

- Global private sector investment in quantum technologies has decreased since 2022 with the wider investment cycle. However, there remain opportunities to capitalise on the opportunities presented by startups and more mature players in the sector. Investors can capitalise on startups and companies that are early adopters of quantum technology.
- For existing portfolio investments, understand how quantum computing could disrupt those companies and sectors. Take a risk lens first, and then shift thinking towards value creation.
- Quantum computing is still nascent, with practical, large-scale applications possibly a decade away. Take a sceptical view to the hype cycle but understand that there are opportunities in the short, medium and longer term.

Policy makers and regulators

- Government can use its platform to convene cross-industry working groups including FS institutions, tech providers, academic institutions and government agencies.
- Regulators will need to gain a clear understanding of the risks posed by quantum computing before the technology becomes widely adopted to ensure they are not playing catch up to the technology. The European Commission's recommendation for a harmonised approach to post-quantum cryptography is welcome in this regard.
- Government has an opportunity to foster the quantum computing industry in Ireland and position the country for rapid adoption, including by: reducing the talent gap; introducing support for emerging quantum computing firms; supporting quantum research and development.



Get in touch to find out how we can help you

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Produced by: KPMG's Creative Services. Publication Date: October 2024 (10719)