Zensar

Quantum Computing

in Financial Services

An RPG Company

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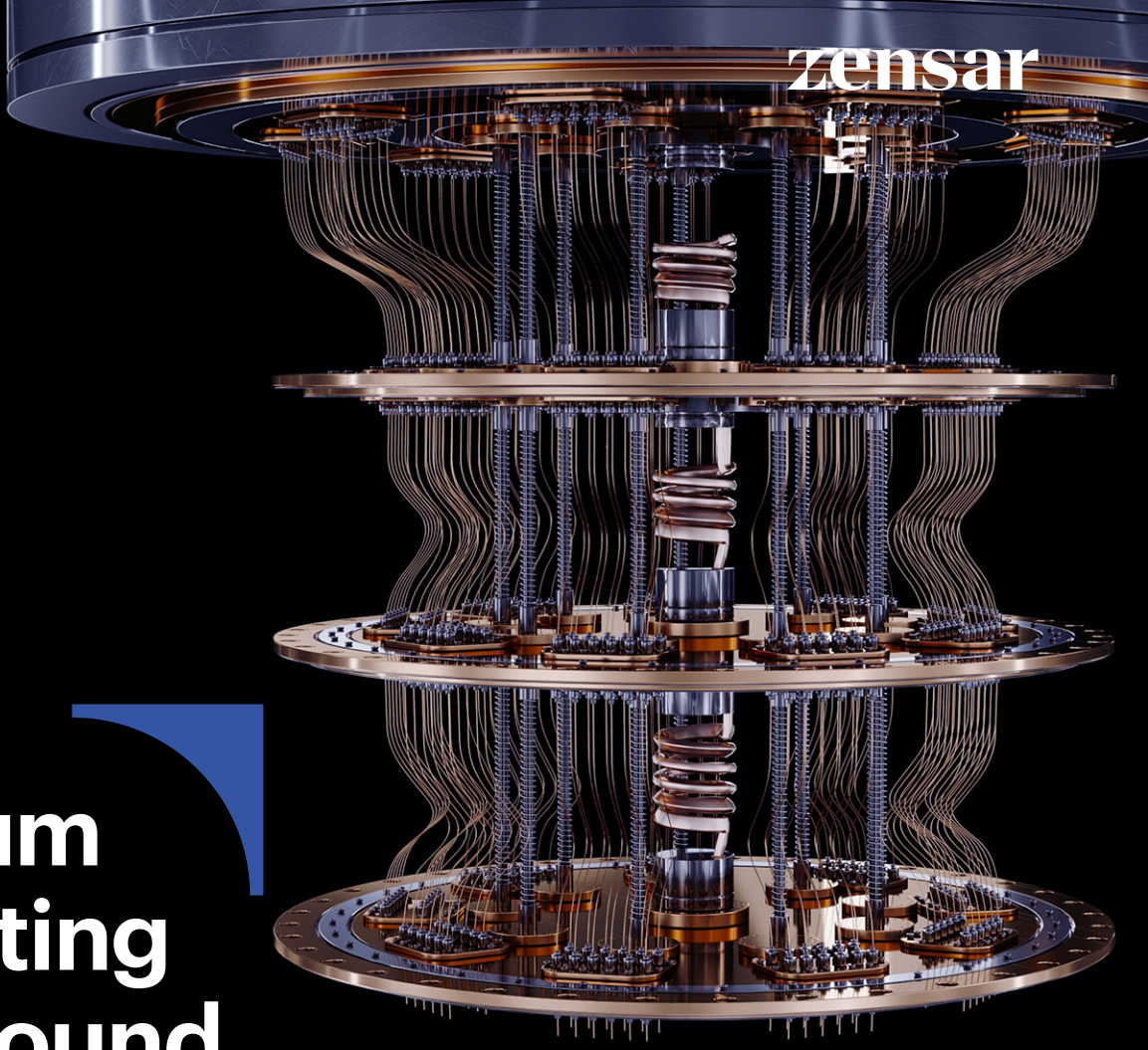
Executive Summary

The enigma of quantum computing (QC) has captured global attention for a while. But will quantum computing become mainstream anytime soon? Can businesses start using them in the industry? Should we wait more years for the technology to evolve and mature before investing and exploring? Are quantum computers only useful for heavy computations such as drug discovery or meteorological predictions and not for my industry?

For years, industry leaders have had these and many other questions regarding quantum computers. In this article, we attempt to decipher these aspects and present Zensar's perspective on not only the industry outlook of quantum computing but also on its applications, centered on the financial services industry.



Quantum computing background

While still in a nascent stage and an emerging technology, quantum computing promises a new generation of transformation and disruption in many walks of life. It has the power to revolutionize industries and fields that require significant computing capability.

In 2019, Google published a study in Nature Journal, a division of the international scientific publishing company Springer Nature, demonstrating quantum supremacy over classical computers. They demonstrated that quantum computers were far superior to the best-known classical supercomputer on some tasks. They did so by carrying a computation in three minutes and 20 seconds, which would have typically taken about 10,000 years on a classical supercomputer.

Many complicated problems arise across asset management, investment banking, and retail and corporate banking in the financial services industry. Such issues are computationally complex and come with the added expectation of being resolved in the shortest possible time. This makes them a perfect fit to be attempted on quantum computers. This paper presents a view on the state of maturity of this technology, its impediments, and key opportunities in the financial services market, where it is expected to deliver the most significant impact. The paper concludes with a note on the current investments in the industry.

Understanding quantum computing?

Classical computers perform computations with the help of bits (a bit can store either a 0 or 1). However, quantum computers have qubits (quantum bit) that can store 0, 1, or both 0 and 1 with different probabilities. These qubits model the probability distribution via the waveform pattern of quantum particles, which is why such computers are known as quantum computers. Therefore, we usually say that quantum computers perform calculations based on the laws of quantum mechanics.

The qubits model the probability distribution of the data and operate at the data distribution level itself. This results in fewer unnecessary computations than classical computers, giving quantum computers an exponential advantage.

Transformative forces

The real potential of quantum computing is to uncover previously considered hard-to-solve solutions. This is the main driving force for different industries to develop quantum computing capabilities. As predicted by one of the research firms, by 2023, 25% of the Fortune Global 500 will gain a competitive advantage from quantum computing. What are the fundamental transformative forces that require broader focus from the industry for quantum computing to evolve and mature so that we become ready for the next industrial revolution?

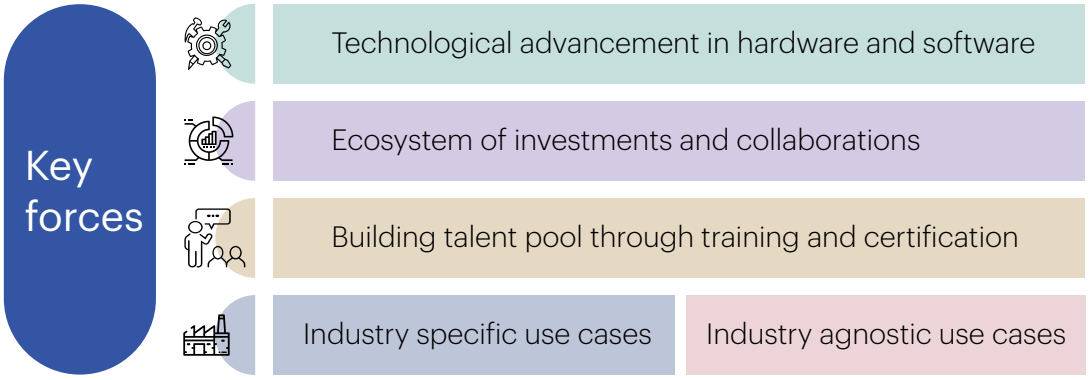


Figure 1: Transformative forces for quantum computing

Technological advancement in hardware and software:

Technological development is one of the critical drivers for quantum computing. Several leading firms have developed quantum computers based on technological advances in hardware and software. Some key players focused on developing quantum capabilities include IBM, Google, and D-Waves Systems. They have developed superconducting qubits and provide commercial quantum computing as a service (QcaaS) on the cloud. It is expected that several companies will be able to offer fault-tolerant quantum computing hardware between 2026 and 2030.

Creating an ecosystem of investments and collaborations:

The involvement of Governments and private firms has increased substantially, with the US and China at the forefront with private and public investments in quantum technologies. The Government of India, too, has launched its National Mission on Quantum Technologies and Applications at an investment of Rs. 8,000 Crore. Zensar is actively collaborating with several industry start-ups and academia to develop use cases, build thought leadership, and nurture talent in this space.

Building a talent pool through training and certifications:

Leading companies such as Zensar are building talent teams to create capabilities in quantum computing. As the technology matures, the need and demand for quantum skills will increase.

Industry-specific use-cases:

The four industries expected to realize the earliest use cases are expected to be pharmaceuticals, automobiles, chemicals, and finance. The value at stake could be around $700 billion, with use cases in finance expected to generate $100 billion potentially.

Industries like financial services provide potential in various use cases, such as forecasting and predicting fraud, trade optimization, and risk profiling. Additional details are provided in the subsequent section focused on financial services.

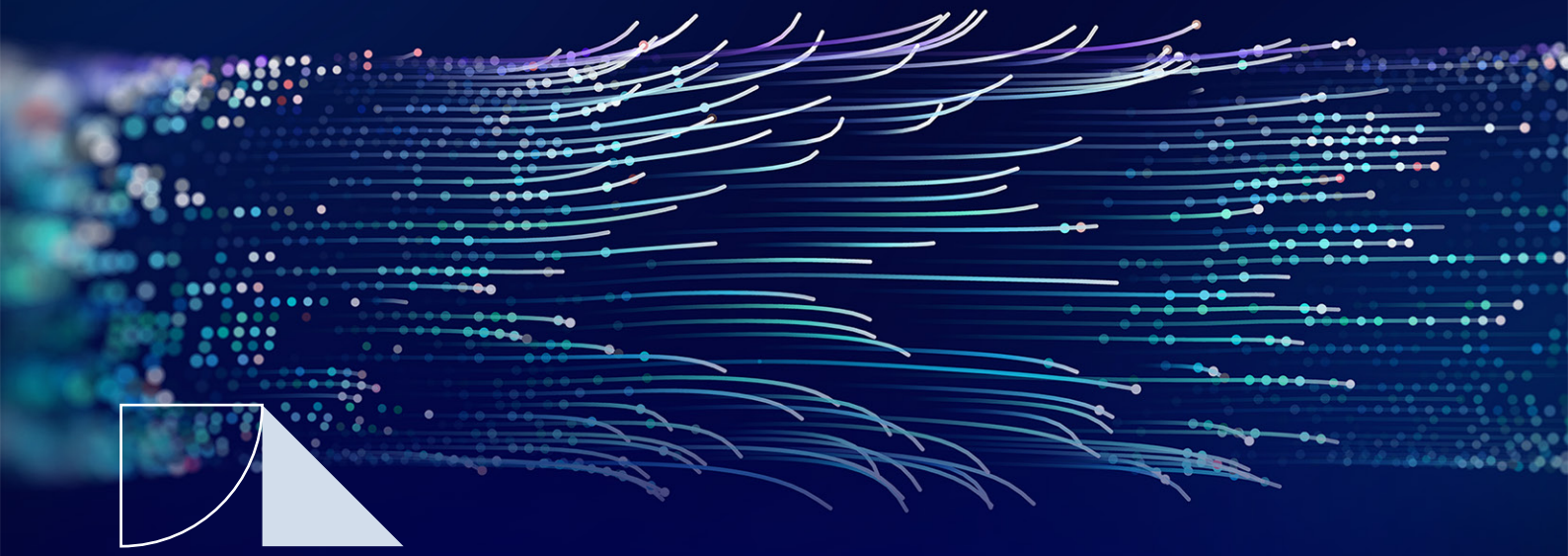
Industry agnostic use cases

Blockchain and cryptographic agility:

Quantum computing will impact current public key encryptions like RSA and Blockchain, driving many institutions to develop post-quantum computing algorithms to make encryption quantum safe. Several quantum computing use cases in blockchain are being developed. For example, the data generated by blockchain mining, which is massive and requires high computational power to analyze, is beyond classical computers' reach.

AI/ML:

Quantum computing is also used for the rapid training of machine learning models and to create an optimized and stable AI which can complete years of analysis in a short time. Quantum AI is being used for the computation of ML algorithms as well as to create quantum algorithms that perform better than classical algorithms. That is why Google has invested in quantum computing research for the improvement of Google AI.



Benefits of quantum computing and its impact on Financial Services

Till date, quantum computing appeared to be rocket-science. However, it has gained more attention with the evolution of quantum ecosystems. The real-life applications of quantum computing are taking shape in many industries, even in rocket science (pun intended). Though classical computing has advanced over the years, solving time-consuming, complex multilevel problems with multiple objectives is still a substantial challenge for the industry.

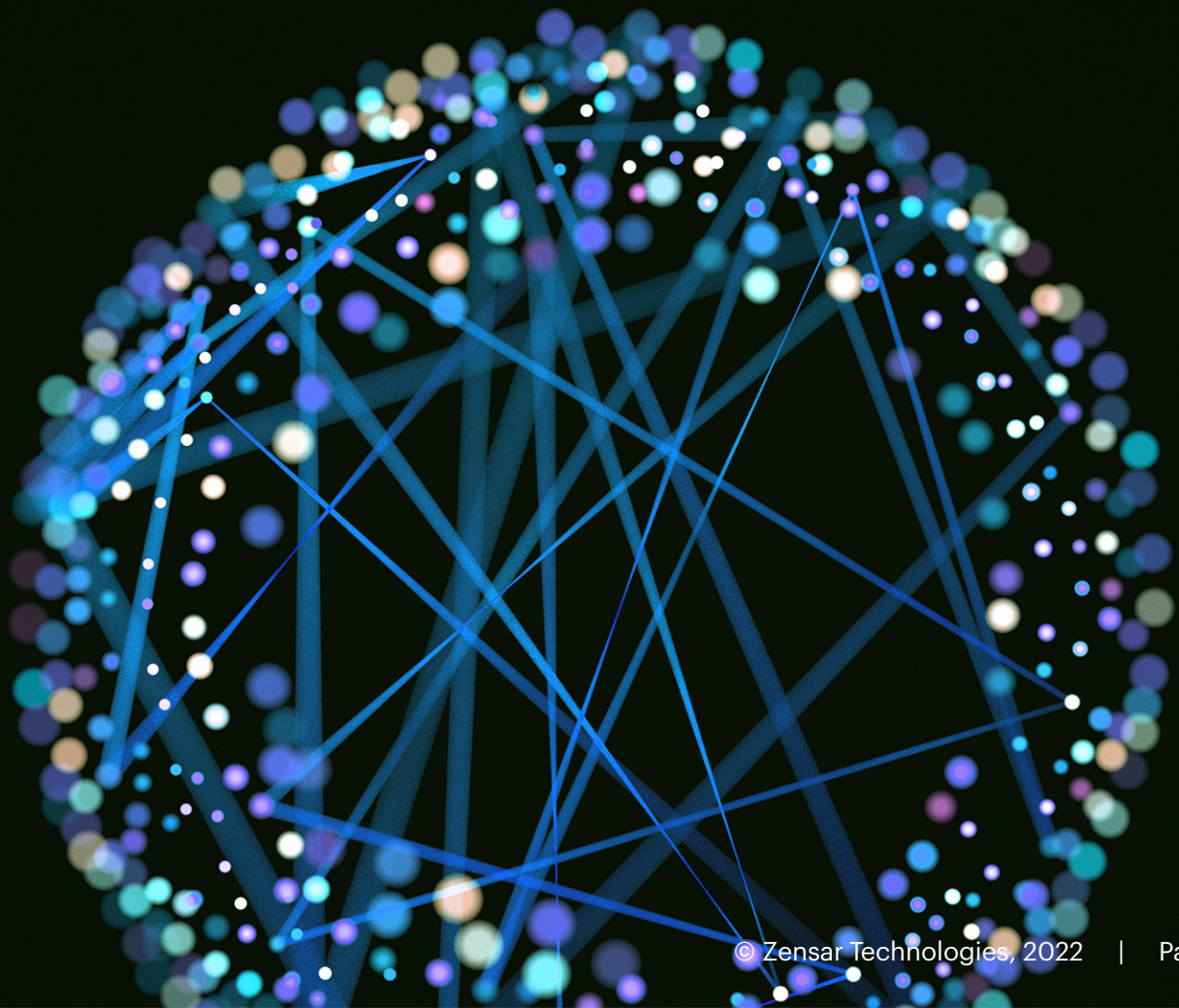
But now, industries such as pharma/biotech, oil and gas, automotive, aerospace, logistics, transportation, banking and finance, IT, and cyber security are set to reap the benefits from quantum computing soon. Apart from dominant market players such as IBM, Google, and Amazon, some unlikely players have already marked their footprint in applying quantum computing. For instance, Save-On-Foods is a chain of supermarkets that reduced their computing time for some tasks from 25 hours/week down to mere seconds, in collaboration with a commercial quantum computer provider, D-Wave.

A 2019 report published by McKinsey projected that some specific industries would gain significant value by 2025 if they undertake quantum computing initiatives, and amongst them, the topmost industry to benefit is finance.

Impact of quantum computing on financial services

The primary objective of the financial industry is to increase returns and reduce financial risk not only for individual investors, but also for the industry as a whole. The financial services industry has always been an early adopter of advances in technology to meet this objective, and the early adoption of quantum computing is not an exception. The availability of information at the right time is critical for making any financial decision. However, classical computing had limitations to process even the available information at the right time. Below are some of the problems that classical computing has been struggling to solve.

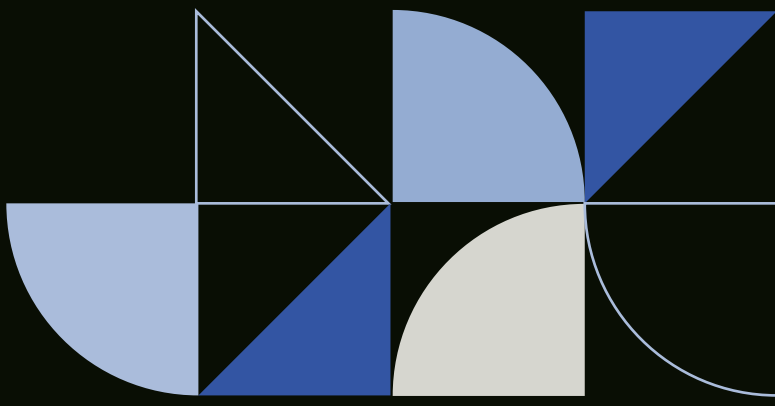
- Financial modeling and portfolio optimization
- Fraud detection and management
- Catastrophe modeling and insurance pricing optimization
- Conducting real-time stress tests for too-big-to-fail banks
- Real-time portfolio risk exposure



The financial services industry was trying to manage these complex and time-consuming problems by making approximations and assumptions. Classical computing was not capable of performing near real-time calculations for some financial modeling problems. Such problems had to be solved in advance using past data for future use. For example, portfolio risk exposures were calculated the previous night, and these values were used throughout the next day despite any portfolio changes happening during the day.

Quantum computing can now process data to solve financial problems within seconds that otherwise would take exponential time. For instance, real-time fraud detection could potentially save billions of dollars as quantum computing will be able to integrate and analyze co-relations among events (money laundering, insurance claims, etc.) and detect patterns to flag potential fraud and help businesses prevent it in real-time.

The insurance industry is heavily dependent upon the modeling of many real-life events. For example, modeling risk by analyzing weather from various geographies with respect to seasons, civilization, and human behavior, etc., can be used to simulate the impact of catastrophic events and be well-prepared to handle the risks better. Events like economic downturn, pandemics, or natural disasters are out of human control and carry multilevel and multi-dimensional aspects, which classical computing could not address, but quantum computing now can.



Similarly, problems such as portfolio optimization, algorithmic trading, optimized lending, risk management, real-time and efficient Monte Carlo simulation, etc., can be solved with quantum computing. It is apparent that the financial industry will be the top beneficiary of the quantum computing revolution. Figure 2 depicts some use cases that will benefit from quantum computing.

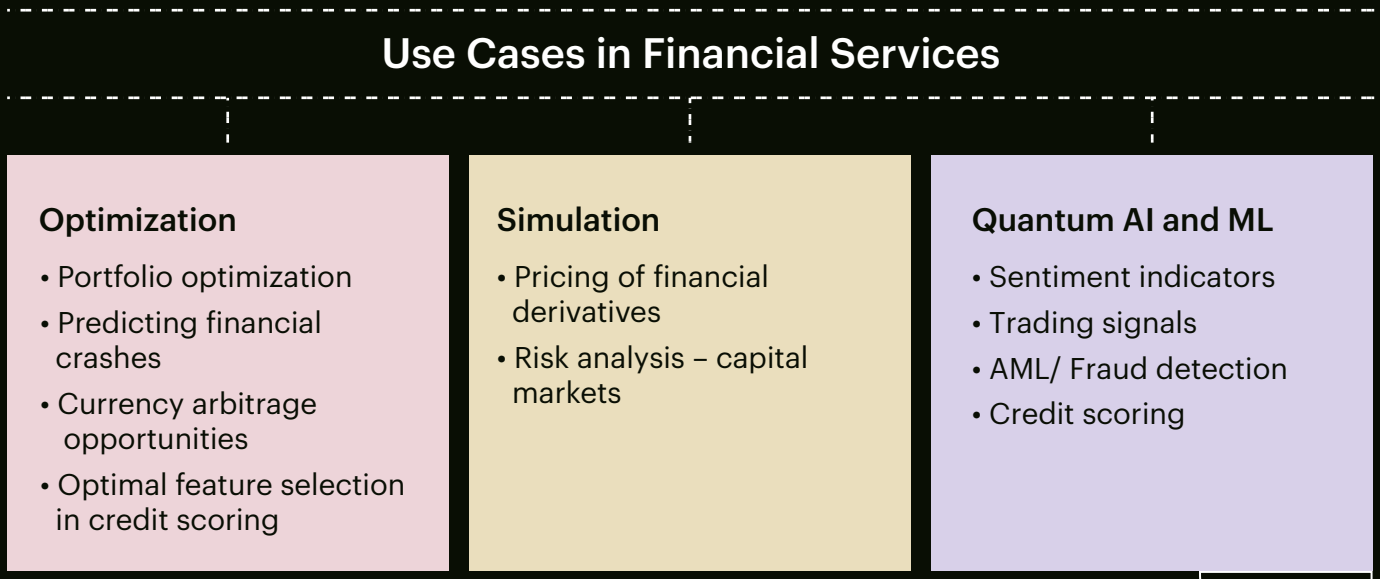


Figure 2: Potential quantum computing use cases in Financial Services

Figure 3 depicts potential revenue from quantum computing applications in the financial services industry.

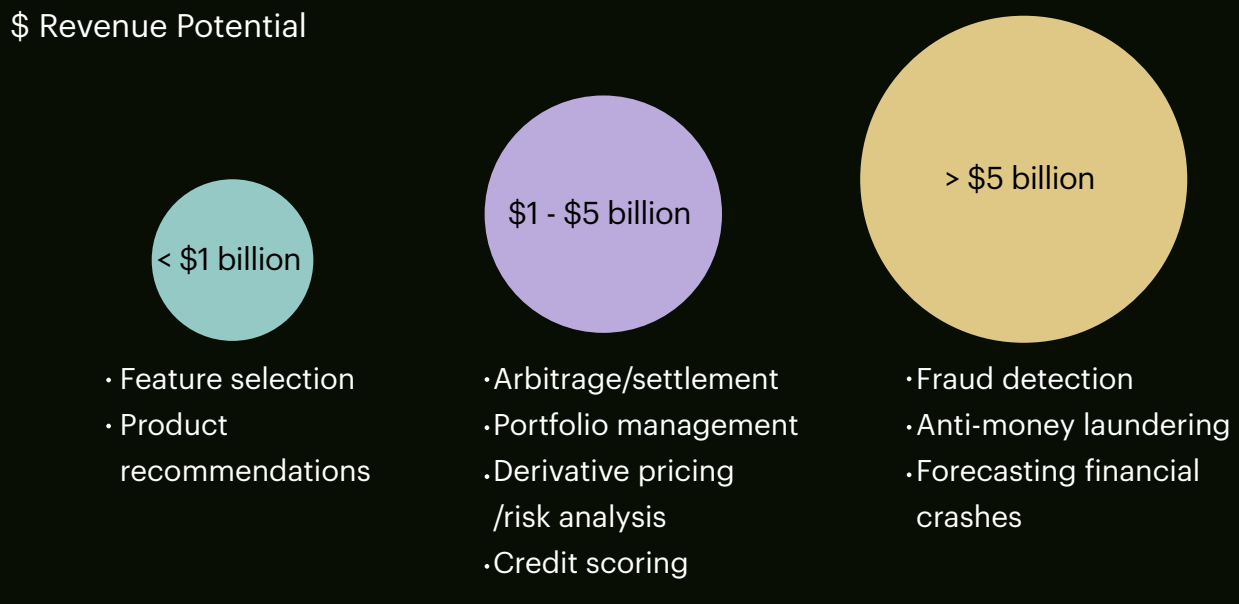


Figure 3: Financial services activities that benefit from quantum computing

Challenges in the adoption of quantum computing

Recent advances in technologies have made business leaders more receptive to experimenting with newer technologies. In addition, the excitement about and the expectation from quantum computing are at their peak. This is mainly because of the possibilities for the future unraveled by recent advances. However, quantum computing adoption will also be hampered by common challenges often faced by any new technology for mainstream adoption. This section presents a perspective on some impediments that will require attention sooner than later.

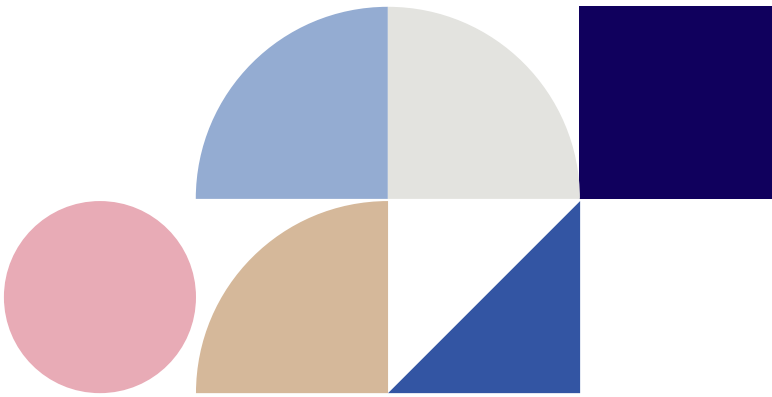
Software libraries of quantum computing

The most popular software libraries in use for quantum computing are Qiskit by IBM, Cirq by Google, and QDK by Microsoft. These libraries so far work on their respective quantum hardware. These are still low-level programming libraries that are used to create quantum circuits.

However, in other streams of technologies, higher-level programming languages are available, making it possible for software developers to write programs without knowing all the necessary mathematics involved underneath. Quantum computing is still waiting for such libraries to evolve.

Use case qualification

Quantum computing is not a silver bullet to solve all computing problems; therefore, it will not replace classical computing for the foreseeable future. Also, it is not straightforward to identify and qualify the tasks for which quantum computing is better suited than classical computing. Therefore, a framework and a set of clear guidelines are required for business leaders and solution architects to identify and qualify the problems that can be solved via quantum computers.



Return on investment

It is important to note that an alternative to quantum computing is available, i.e., industrial applications can be developed using heuristic methods on classical computers and sometimes deep-learning-based techniques on GPU/TPU. Quantum computing is still far from being commoditized; therefore, its price is much higher than GPU- or TPU-based hardware. There are very few business units in the world that can demonstrate suitable ROI and better results by using quantum computers so far.

Evolution of quantum computers:

Quantum computers still need to evolve significantly with respect to their processing power, efficiency, and stability. Some fundamental expectations of business from developers of quantum computers are listed below.

- Today's quantum computers have a small number of qubits; therefore, they cannot solve problems with all the complexities involved. It needs a more significant number of qubits to meet business expectations and outperform deep-learning-based approaches.
- Quantum computers need to become much more fault-tolerant, and the approaches for quantum error correction still need to evolve.
- The portability and maintenance of quantum computers must improve considerably for better stability and availability.

How are firms responding?

The current transformative developments in quantum computing will create opportunities for any industry to solve ever-pending problems. By 2023, 90 percent of the industry will collaborate with consulting and technology service providers to accelerate their quantum computing innovation, and 95 percent will utilize it as a service (QCaaS).

Following are some of the recent adoptions of quantum computing by industry:

Pharmaceuticals

Rigetti Computing is working with Astex Pharmaceuticals for drug discovery using a hybrid platform that mixes classical and quantum processing.

Electric Utility

IBM is working with European electric utility company E.ON to develop future decentralized electrical grid solutions using the open-source Qiskit quantum computing SDK and IBM Cloud.

Insurance

In 2020, Anthem became the second founding member of the IBM Q Hub at NC State University. It uses quantum computing for better prediction of health outcomes and personalized treatments.

Logistics

BMW collaborated with Honeywell and Singapore-based, Entropica Labs, to develop a proof-of-concept on supply chain optimization using quantum computing.

Similarly, **financial services** firms are experimenting with the following proof-of-concepts using quantum computing:

NatWest

Demonstrated that calculations of high-quality liquid assets portfolio can be completed 300 times faster than a classical computer while maintaining a superior level of accuracy with efficient allocation.

Willis Towers Watson

Working with Microsoft to develop new quantum-powered risk management protocols.

JP Morgan

Partnered with IBM and Honeywell to develop quantum algorithms that take advantage of two different quantum technologies.

Goldman Sachs

Using quantum computing for Monte Carlo simulations.

HSBC

Involved in cross-industry 'Next Applications of Quantum Computing' (NEASQC).

Formation of Quantum Technology ecosystem

A remarkable increase in quantum computing service providers has been observed in the past few years. These firms can be loosely classified into the following four categories based on the services provided under quantum computing.

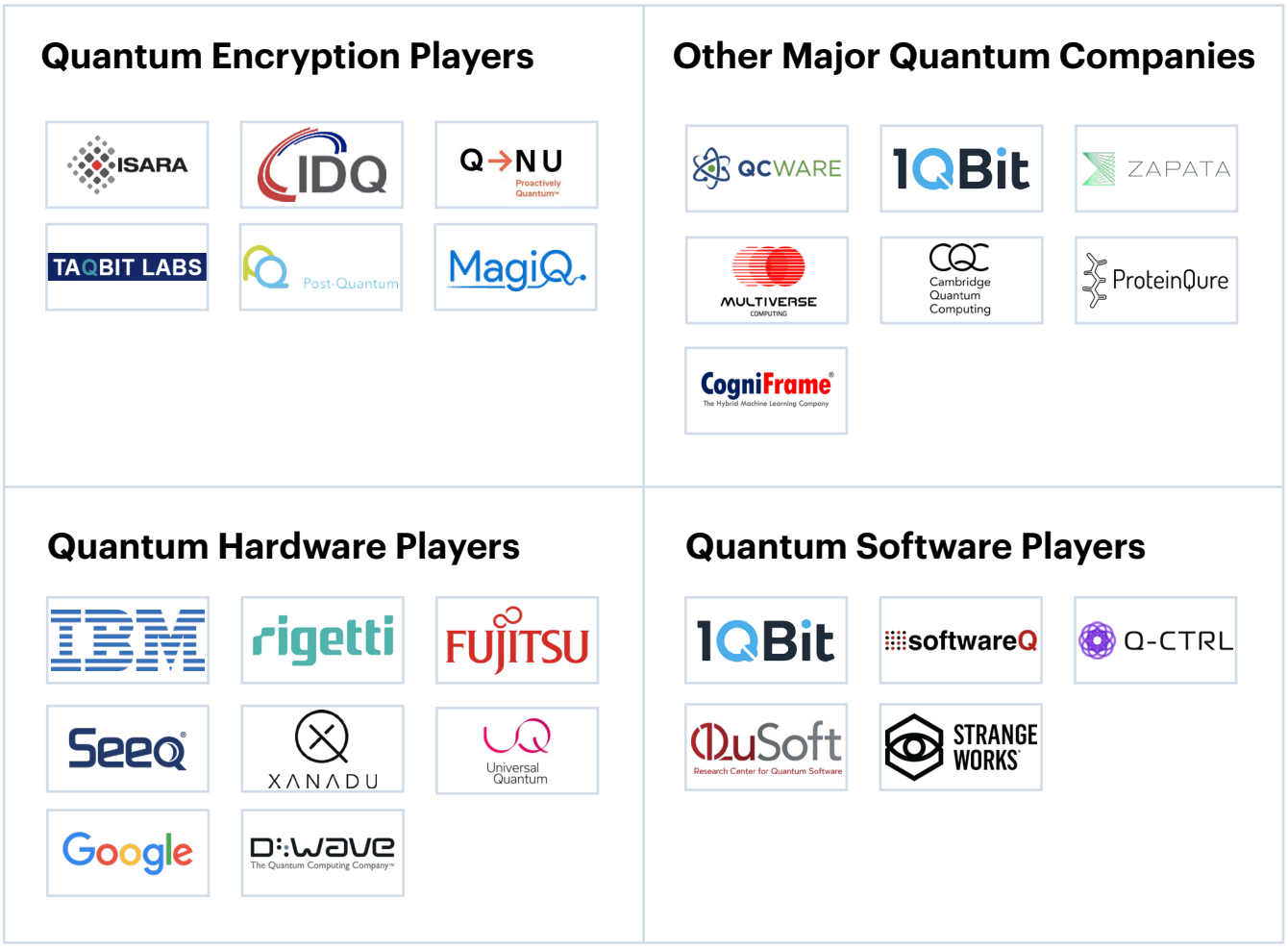


Figure 4: Technology ecosystem

An ecosystem that is technologically equipped and favorable for quantum computing will certainly help any industry function super efficiently and effectively like never before.

The Road Ahead

Financial firms have to follow a consortium-based approach to accelerate adoption and make an impact. This consortium can have the following segments of members:

Host business domains

Firms need to identify problems impacting business and set up a strategic program to leverage quantum computers to solve such problems.

Academia

Academicians keep themselves up to date with recent advances and research publications in their field of work. With quantum computing evolving at such a fast pace, their involvement is highly crucial.

Start-ups

Today, start-ups are known as growth engines of innovation and for promoting the adoption of tech advances into mainstream applications. Therefore, their involvement is instrumental for such consortiums.

Strong SI partners such as Zensar

End-to-end solution of a real-world problem requires multiple technologies and integration of different products. This not only involves solution architects but also people with various knowledge streams. The SI partners provide expertise through a blend of consulting and technology skills suited for successful implementation.

Quantum computing could fuel explosive value generation for diverse industries as the technology is evolving quickly. Early movers will shape how quantum computing matures and this will empower them with a competitive advantage.

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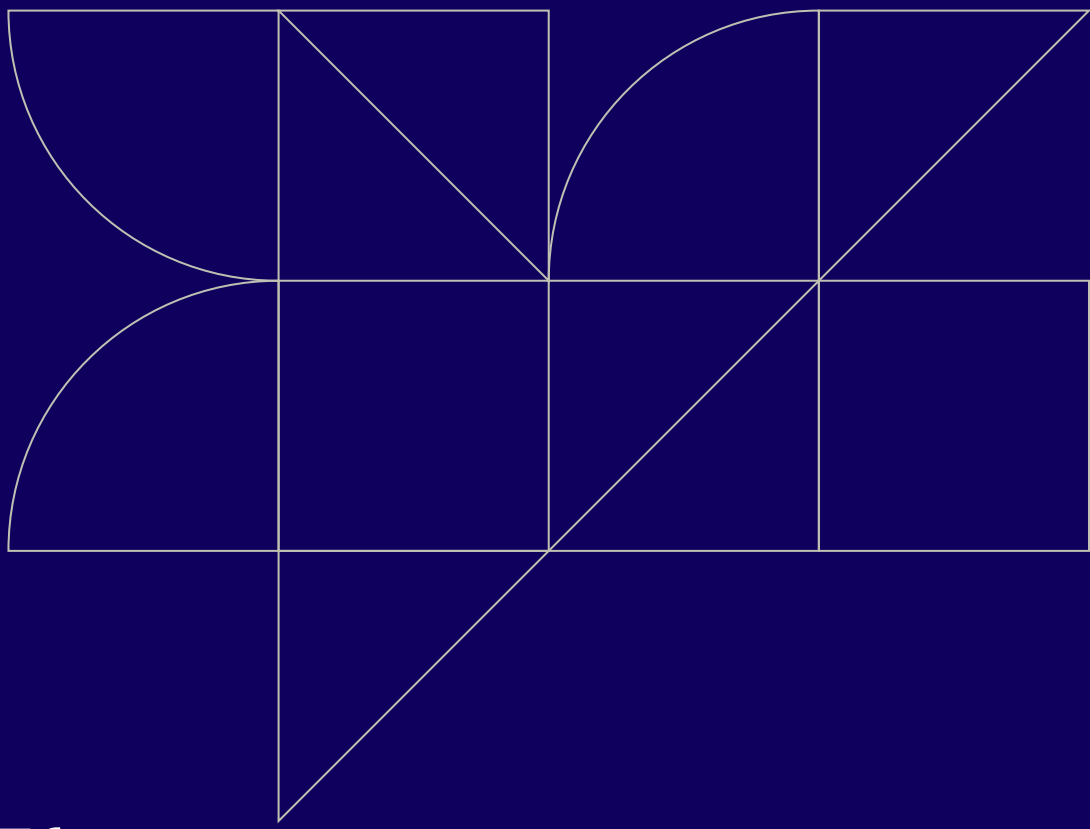

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With headquarters in Pune, India, our 11,500+ associates work across 30+ locations, including Milpitas, Seattle, Princeton, Cape Town, London, Singapore, and Mexico City.

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