

White paper

Quantum computing in financial services

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There is no shortage of theoretical applications of quantum computing, at a grand scale, that approaches science fiction. How will it really affect the financial services industry? And how can you prepare? This paper looks into several practical applications of quantum computing in financial services and discusses the steps you can take today to prepare for the coming revolution.

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Quantum's potential for the financial services industry

Imagine being in two places at once, say, resolving a client's toughest financial problem while surfing in Hawaii or skiing in the Alps. That's more or less what quantum computing is about and why so many people are excited about it. In classical computing, a bit can exist in one of two states: 1 or 0. In quantum computing, a quantum bit (qubit) can exist in both states, simultaneously, which allows it to perform many calculations at once.

Though quantum computing is in its formative stages, scientists are eagerly anticipating its ability to perform miracles such as eradicating diseases and unlocking the mysteries of the universe. However, quantum computing needs to outperform classical computing first. That ability is generally expected to require 50 qubits. The quantum community refers to this goal as quantum supremacy.

The long, steady march toward quantum supremacy

IBM unveiled a 50-qubit quantum computer in November 2017 with the ability to preserve a quantum state for an industry record time: 90 nanoseconds. After that it decoheres or dissipates like smoke. Qubits also require an operating temperature of 10 MilliKelvin, near absolute zero.

Even with these limitations, the industry is abuzz with excitement for the progress. At this rate, the business world will be able to harness quantum computing in 5-10 years. What does that mean for financial services? And how can we separate hype from practical application?

What quantum means for financial services

Encryption and Cybersecurity

Cryptocurrency, or bitcoin, is a current innovation that will be a target for quantum computing with its ability to break the underlying security technology behind it. For instance, Frederik Kerling, Business Consultant and Senior Quantum Expert at Atos, says that crypto "breakings" can occur in the financial market through blockchain breaking. Current encryption standards, therefore, will be particularly vulnerable to quantum attacks, which makes cybersecurity a critical aspect of quantum computing.

Nearly all financial services companies have two known vulnerabilities in common:

- Reliance on legacy hardware
- Inability to change encryption standards quickly

Cybersecurity is one reason. Kerling says the biggest impact on financial services will not be the deployment of quantum computers. It will be preparing for the cyber criminals to have quantum computers. However, it's not time to panic. None of this is real yet. Experts agree that quantum vulnerabilities will be countered by quantum solutions.

In addition to encryption and security, quantum computing will have an incredible impact, throughout the financial services industry, from high-frequency trading to retail banking to insurance.

The driver for innovations in financial services

"No one knows exactly at what scale and how," says Jerome Sandrini, Atos VP and Head of Big Data, North America. "But we do know that quantum computing will be a strong driver for innovations in financial services. It will most definitely revolutionize trading, risk management and cybersecurity. We need to start preparing for this revolution right now; this is why our Quantum Learning Machine (QLM) makes total sense for organizations who want to understand how to leverage Quantum Computing and start developing and testing software for it.

High-frequency trading

To picture the effects of quantum computing in financial services, look at high-frequency trading (HFT). It's hard not to. Computers and algorithms can execute thousands of trades per second. According to TABB Group, HFT accounts for more than half of all trades. Many analysts and traders blame it for recent unprecedented stock market volatility. Quantum computing will accelerate trading further yet, and enhance it with artificial intelligence (AI) and predictive capabilities.

Analytics-driven CRM

In retail banking and insurance alike, customer relationship management will be improved by the automation of more tightly targeted services. Quantum can provide greater accuracy in simulating customer purchasing preferences based on demographic data, whether that's a new insurance policy or mortgage. Customer personal information, meanwhile, can be protected more effectively through simultaneous automation and analytics of pending threats, anticipating and prescriptively responding to security attacks.

Preparing for a better future

Many organizations are patiently awaiting the actual arrival of quantum and the options that surround it. Others have learned from the evolution of classical computing: The time it takes to develop useful applications is wasted when the hardware is ready but you can't actually use it. With the revolution of quantum computing, we have the advantage of being able to develop applications now, before the hardware is ready. And we know many areas that absolutely need attention.

It's already known that applications such as portfolio optimization (e.g., Monte Carlo simulations) will be improved. Large banks around the world are actively investing in quantum computing research and development specifically to drive improvements to known applications such as Monte Carlo.

"If you invest in quantum computing and you have quantum computers of the right size then you know you can use it to improve that kind of application," says Kerling. "But everyone else already knows that, too. If everyone is investing in it then it will be less like a secret weapon and more like required IT."

There are ways to prepare for the future in quantum computing and understand more as we progress.

Create a quantum team

According to Kerling, finding the right people for a quantum team is the key to success. You'll need a couple of specialized mathematicians who fully understand quantum algorithms. They are rare, simply because it's an emerging science. It's even harder to find them in the financial industry, so you'll have to pull them out of academia where they learned their skills. They'll be able to educate others on your team.

You also need python programmers or other computer engineers who are enthusiastic to learn and experiment. To complete the team, recruit people with expertise in your area of financial services. They'll understand the market well enough to know what's worth researching and what isn't.

Let them learn

One of today's best advantages, for those preparing for quantum computing, is the state of high-performance computing (HPC) and analytics. Atos is at the forefront of both these fields, with our leading HPC and supercomputers as well as Atos Codex, our advanced analytics platform.

Last year, we tapped into those strengths to deliver the Atos Quantum Learning Machine (QLM), a quantum simulator that allows researchers, engineers and students to develop and experiment with quantum software. Rather than wait 5-10 years, organizations can start now to develop new applications and test them for a Quantum world.

When you have the mathematical, business and engineering mindsets together you can start to develop quantum applications. Much can be accomplished with only two to four people and a QLM. But the investment doesn't need to be huge when you have the right team of people building experience and developing applications for quantum.

With the revolution of quantum computing, we have the advantage of being able to develop applications now, before the hardware is ready.

Quantum development tools

Considering the multimillion-dollar price tag of the few, limited quantum computers available today, the most practical way to start developing and testing quantum applications is to use a simulator. Google, Microsoft and IBM offer simulators in the cloud. If you're reluctant to share your data and algorithms on a public cloud then you'd be better served by a QLM in your own data center.

QLM is a classical piece of hardware that simulates quantum computers up to 40 qubits, which until now was only possible with supercomputers. It's the size of an enterprise server that can be isolated on-premises. QLM can run several kinds of simulators, allowing you to develop applications that can run on different kinds of technologies.

"If you just go to IBM, you're going to get a superconductor. If you go to Microsoft, you're just going to get something for the cloud.. With QLM, you get all the technologies. So instead of worrying about which technology to invest in, you only have to focus on the application. We make sure that it runs on all technologies," Kerling says.

For less than \$1 million, a QLM gives you a sandbox of general-purpose quantum computing programming that's accessible 24x7 and dedicated to you.

This is a relatively simple and cheap way to create an entire catalog of applications, tests and simulations. Build it up over 3-4 years and then you'll be ready when the hardware catches up. The return on investment will be in the range of tenfold, as quantum becomes business ready and more pervasive

Application Readiness for Quantum

The way you approach the future should be determined by the speed at which you need ROI. Quantum is still far away. However, Atos Codex running on Bull HPC platforms is the key to automation (AI) and business outcomes from data analytics and predictive models across the enterprise.

Atos Codex helps financial services companies collect, integrate, manage and transform data to create business insights and outcomes in areas such as corporate finance, commercial and investment banking, financial planning, insurance, and public accounting. By using Atos Codex, in these areas, you can start preparing for a Quantum application future:



What we can do today to prepare for a Quantum World

Quantum risk assessments

We can help you leverage your quantum based future by conducting a quantum risk assessment now.

Quantum computing is incredibly complicated, yet the fundamental security threats have not changed. The challenge is a lack of insight into quantum-attack vulnerabilities within an organization, because encryption is often embedded into hardware and software. A quantum risk assessment discovers where these vulnerabilities are, their likelihood and impact, and the timeline in which this will unfold.

These risk assessments are an extension of our Quantum Program, which is guided by a Scientific Council of world-renowned quantum physicists and mathematicians.

Their work in quantum computing and quantum-safe cryptography allows us to identify emerging threat actors and spot them in your organization.

At the conclusion of a risk assessment, you'll have:

- Impact and likelihood analysis
- Vulnerability prioritization and next steps
- Timeline and critical period indication

The Quantum Program Scientific Council joined forces in late 2016 to accelerate quantum computing solutions and algorithmic standards. Progress after its first year includes:

- Launching the QLM and delivering it 6 months later to Oak Ridge National Laboratory, the U.S. Department of Energy's largest multi-program science and energy laboratory
- Simulating physical qubits more efficiently by integrating a "quantum noise" model that improves research on qubit architectures
- Developing quantum-safe algorithm standards to anticipate future critical needs in cybersecurity

A financially secure quantum future with Atos

The next 10 years will be completely transformed through quantum computing and that's especially true for the financial services industry so why not start now? Atos has the team of quantum experts you need to ensure cybersecurity and prepare you for the exciting innovations that quantum computing is sure to deliver.

Atos is a recognized leader in data and analytics, helping financial services companies around the world create customer-centric business models supported by data and emerging technologies. We are committed to developing innovative HPC systems and solutions to solve the major challenges of the 21st century. Beyond Bull system design and delivery, we offer complete professional services to design, install, operate, manage and continuously improve HPC infrastructures. A leader in quantum computing research, our Quantum Learning Machine (QLM) is the highest performing quantum simulator available today.



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About the Authors



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Jerome is the expert for Big Data and HPC platforms, Advanced Analytics, Data Science and Machine Learning. He successfully led the deployment of the Atos Quantum Learning Machine in the North American Market. He collaborates with Quantum teams from national research laboratories and with companies anticipating the upcoming Quantum revolution. Jerome has an engineering background in Distributed Computing systems and software development, as well as a strong entrepreneurial profile. In 2004, he founded FastConnect, a consulting company in France with over 150 employees specializing in Big Data architectures and application cloud enablement. FastConnect was ultimately acquired by Atos in 2013. Jerome relocated to New York in 2016 to create and grow the Big Data practice and bring Atos innovations in Big Data and Analytics to Atos' North American customers.



Frederik Kerling

Senior Quantum Expert, and member of the Scientific Community

Frederik Kerling is a Senior Quantum Expert heading the quantum consulting team based in the Netherlands. He is also a member and an editorial board member of the Atos Scientific Community. As a theoretical physicist specializing in Quantum engineering he made the transition to consulting after his time in Copenhagen. He is internationally active within the quantum community, and collaborates in several consortia and initiatives to promote quantum technology. In addition he develops patents in quantum technology, and is always open for a good discussion about quantum fundamentals. Frederik is often employed in innovation tracks in the role of innovation manager or even determining innovation strategies on a corporate level. And in his spare time can be found exercising, gaming, teaching and doing improv.

About Atos

Atos is a global leader in digital transformation with approximately 100,000 employees in 73 countries and annual revenue of around € 13 billion. European number one in Big Data, Cybersecurity, High Performance Computing and Digital Workplace, the Group provides Cloud services, Infrastructure & Data Management, Business & Platform solutions, as well as transactional services through Worldline, the European leader in the payment industry. With its cutting-edge technologies, digital expertise and industry knowledge, Atos supports the digital transformation of its clients across various business sectors: Defense, Financial Services, Health, Manufacturing, Media, Energy & Utilities, Public sector, Retail, Telecommunications and Transportation. The Group is the Worldwide Information Technology Partner for the Olympic & Paralympic Games and operates under the brands Atos, Atos Consulting, Atos Worldgrid, Bull, Canopy, Unify and Worldline. Atos SE (Societas Europaea) is listed on the CAC40 Paris stock index.

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Let's start a discussion together



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