ENTRÉE CAPITAL

Quantum Computing Real World Use-Cases

Q1-2025

Rapyd Glovo STASH monday stripe
gusto PillPack prospa coupang cazoo
HiBob CLASSIQ TALON empathy.

Entrée Capital Quantum Portfolio and General Stats

CLASSIQ

LightSolver

Quantum Art

Quantum Transistors

NVISION

PIQ|C>

1st DECADE MILESTONES

7 IPOs

43 Exits

$1.25Bn

ASSETS UNDER MANAGEMENT

Forbes Midas List

EUROPE & MIDDLE EAST

#1

(2023)

GLOBAL

#30

(2024)

For more details contact quantum@entreecapital.vc

Preface - Quantum Computing - Closer Than You Think

For decades, quantum computing has been seen as a technology of the distant future—fascinating, but always just out of reach. Many assumed that practical applications were something for the next generation to worry about.

However, recent advancements in error correction and emerging quantum modalities have accelerated progress, with multiple vendors expected to deliver quantum advantage within the next two years. We now stand at the threshold of a new computational era.

This document offers a snapshot of how leading corporations are positioning themselves to become *Quantum Ready*. The transition won't happen overnight, but those preparing today will be the ones ready to capitalize when the breakthrough moment arrives.

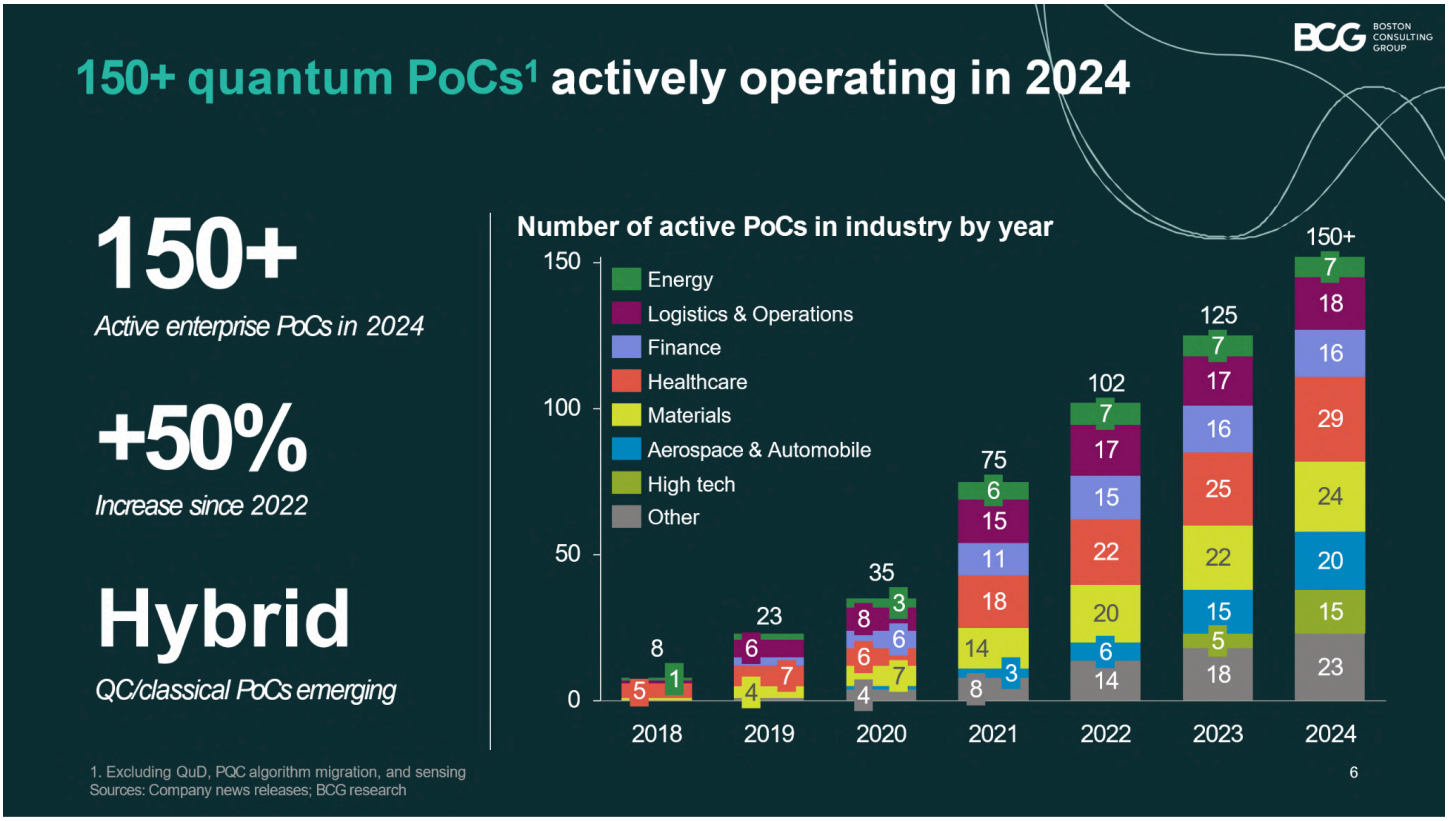
The industries leading this shift are already mapping out potential use cases, identifying where quantum computing could provide an edge. From financial services optimizing complex risk models to automakers enhancing material science for electric vehicles, and pharmaceutical companies accelerating drug discovery—organizations are laying the groundwork for quantum-driven breakthroughs. Companies across banking, healthcare, automotive, defense, telecom, and energy are hiring quantum talent, investing in research, and actively exploring ways to integrate quantum capabilities into their long-term strategies.

Quantum computing is no longer a distant dream. It's coming sooner than most expect, and the time to get ready is now.

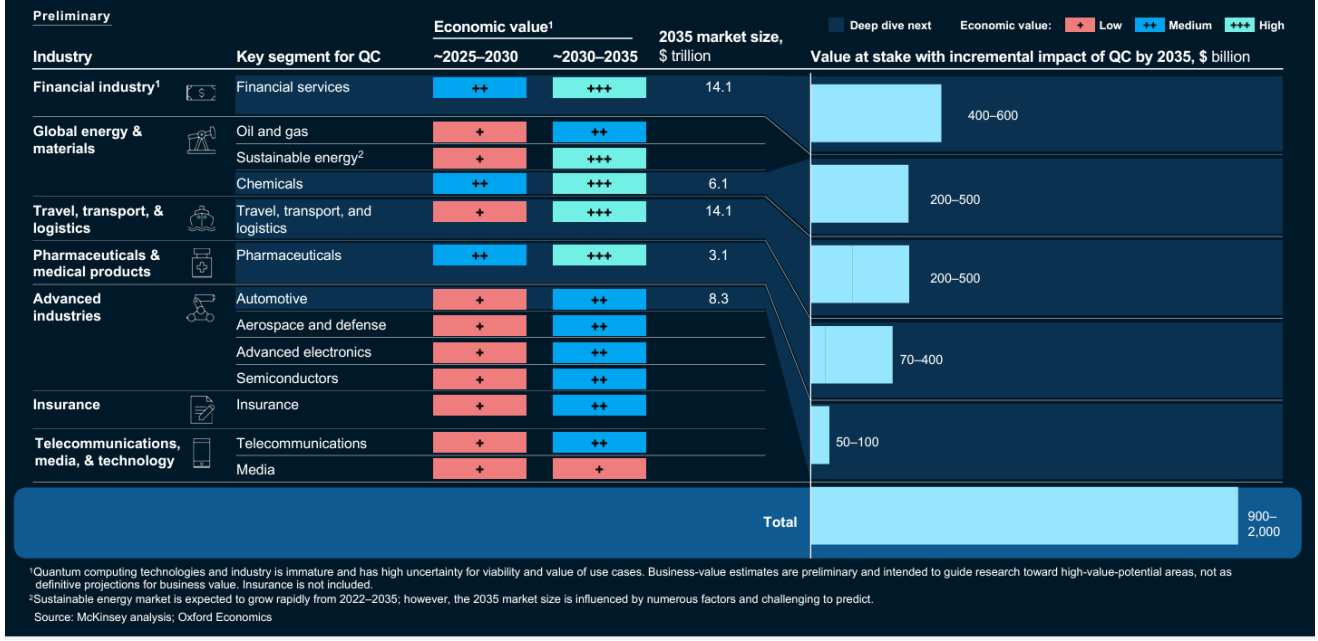
Table of Contents

Use-Cases


ENTERPRISES ARE ALREADY BECOMING "QUANTUM READY".
SAMPLE OF CORPORATES HIRING TALENT AND EXPLORING USE-CASES...
BMO
Morgan Stanley
HSBC
citi
Santander
J.P.Morgan
DBS
INTESA SANPAOLO
Goldman Sachs
WELLS FARGO
PayPal
MERCK
moderna
AstraZeneca
BAYER
janssen
novo nordisk
AMGEN
Pfizer
NOVARTIS
GSK
Roche
United Healthcare
"Quantum Computing Enables Hundreds of Use Cases with a Value-Creation Potential of $10B to $100B Each"
BCG BOSTON CONSULTING GROUP
2025: The year to become Quantum Ready
Quantum Ready can help future proof your organization today for a quantum-powered tomorrow
Explore the program >
Microsoft
BMW
Mercedes-Benz
BOSCH
DAIMLER
Ford
TOYOTA
VW
gm
GE
Lufthansa
Rolls-Royce
BOEING
AIRBUS
LOCKHEED MARTIN
DELTA
AT&T
vodafone
NTT
Deutsche Telekom
BT
TELSTRA
bp
Air Liquide
أرامكو السعودية saudi aramco
e·on
TotalEnergies
ExxonMobil
Shell
CLASSIQ


BCG BOSTON CONSULTING GROUP
150+ quantum PoCs[1] actively operating in 2024
150+
Active enterprise PoCs in 2024
+50%
Increase since 2022
Hybrid
QC/classical PoCs emerging
Number of active PoCs in industry by year
Energy
Logistics & Operations
Finance
Healthcare
Materials
Aerospace & Automobile
High tech
Other
150
100
50
0
2018
2019
2020
2021
2022
2023
2024
8
23
35
75
102
125
150+
1. Excluding QuD, PQC algorithm migration, and sensing
Sources: Company news releases; BCG research
6

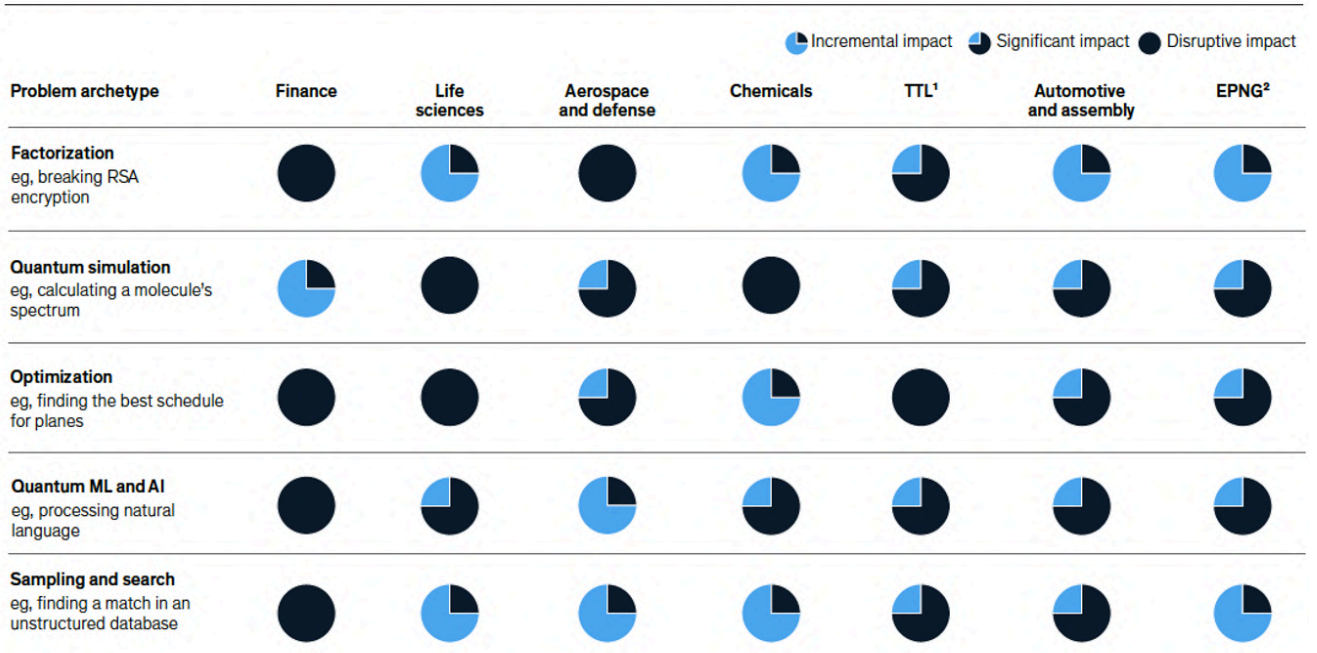
QC presents a $1T to $2T opportunity, with rapid acceleration expected in the coming five to ten years.



[1]Quantum computing technologies and industry is immature and has high uncertainty for viability and value of use cases. Business-value estimates are preliminary and intended to guide research toward high-value-potential areas, not as definitive projections for business value. Insurance is not included.
[2]Sustainable energy market is expected to grow rapidly from 2022–2035; however, the 2035 market size is influenced by numerous factors and challenging to predict.

Source: McKinsey analysis; Oxford Economics

The use cases most likely to have the highest value over the long term are in the finance and life sciences sectors.



[1] Travel, transport, and logistics.
[2] Electric power and natural gas.

Source: Expert interviews

McKinsey&Company

1 Quantum-advantaged mathematical function	**Sparse matrix math**				
4 Computational problem types	**Simulation** ($175 billion–$330 billion)	**Optimization** ($100 billion–$220 billion)	**Machine learning** ($95 billion–$250 billion)	**Cryptography** ($40 billion–$80 billion)	
100+ High-value industry use cases (Sizing at tech maturity)	Pharma: Drug discovery $40 billion–$80 billion	Finance: Portfolio optimization $20 billion–$50 billion	Automotive: AV AI algorithms Up to $10 billion	Government: Encryption and decryption $20 billion–$40 billion	
	Aerospace: CFD $10 billion–$20 billion	Insurance: Risk management $10 billion–$20 billion	Finance: AML and anti-fraud $20 billion–$30 billion		
	Chemistry: Catalyst design $20 billion–$50 billion	Logistics: Network optimization $50 billion–$100 billion	Tech: Search/advertising optimization $50 billion–$100 billion	Corporate: Encryption and decryption $20 billion–$40 billion	
	Energy: Solar conversion $10 billion–$30 billion	Aerospace: Route optimization $20 billion–$50 billion	Other use cases $25 billion–$110 billion		
	Finance: Market simulation (e.g., derivates pricing) $20 billion–$35 billion				
	Other use cases $75 billion–$115 billion				

Sources: Industry interviews; BCG analysis.

Note: AML = anti-money laundering; AV AI = audiovisual artificial intelligence; CFD = computational fluid dynamics.

	Applications	Value creation potential[1] ($B) Low	High
Cryptography ($40-$80B)	Encryption/decryption	$40	$80
Optimization ($100-$220B)	Aerospace: Flight route optimization	$20	$50
	Finance: Portfolio optimization	$20	$50
	Finance: Risk management	$10	$20
	Logistics: Vehicle routing/network optimization	$50	$100
Machine learning ($150-$220B)	Automotive: Automated vehicle, AI algorithms	$0	$10
	Finance: Fraud and money-laundering prevention	$20	$30
	High tech: Search and ads optimization	$50	$100
	Other: Varied AI applications	$80+	$80+
Simulation ($160-$330B)	Aerospace: Computational fluid dynamics	$10	$20
	Aerospace: Materials development	$10	$20
	Automotive: Computational fluid dynamics	$0	$10
	Automotive: Materials and structural design	$10	$15
	Chemistry: Catalyst and enzyme design	$20	$50
	Energy: Solar conversion	$10	$30
	Finance: Market simulation (e.g. derivatives pricing)	$20	$35
	High tech: Battery design	$20	$40
	Manufacturing: Materials design	$20	$30
	Pharma: Drug discovery and development	$40	$80

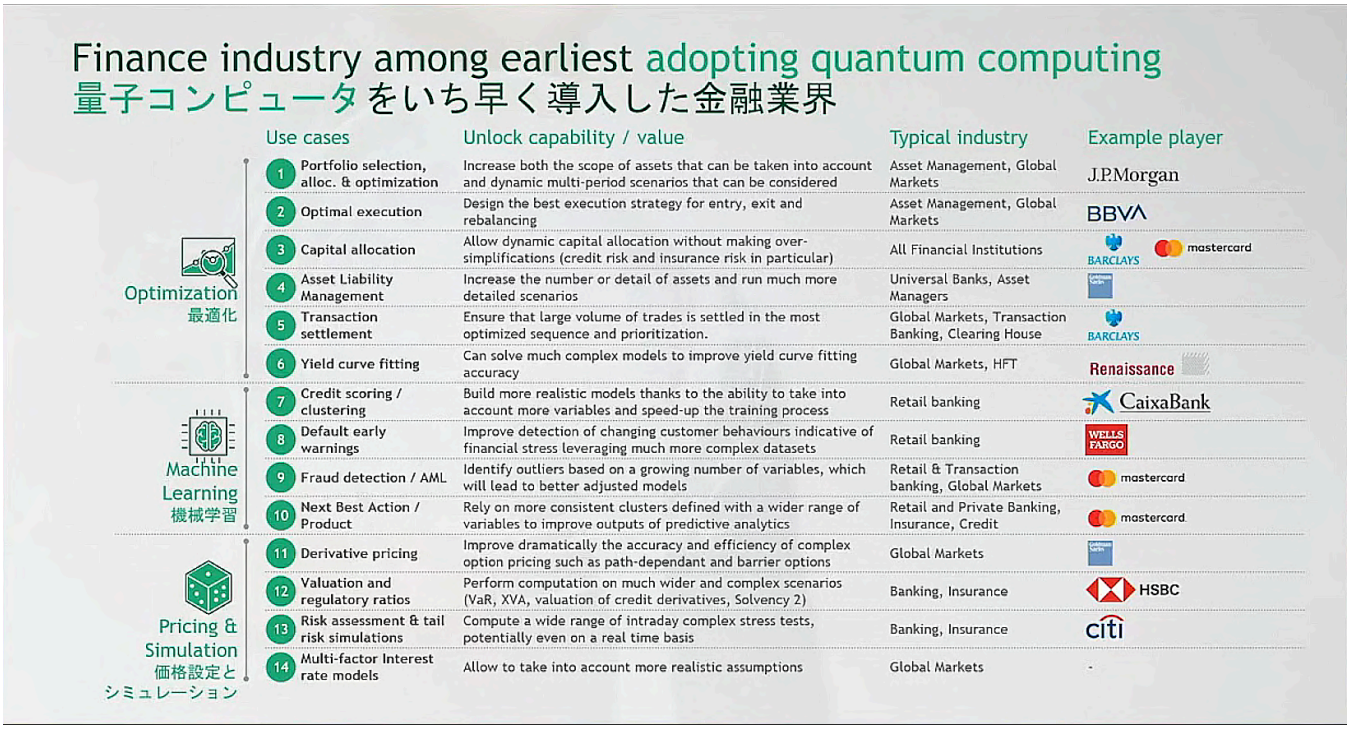
Sources: Academic research, industry interviews, BCG analysis.

[1]Represents value creation opportunity of mature technology.

BCG BOSTON CONSULTING GROUP

Financial Services

The financial services sector has historically been an early adopter of advanced computing technologies to gain a competitive edge. From mainframes in the 20th century to high performance computing for algorithmic trading, the industry has consistently embraced cutting-edge solutions. Quantum computing is the next frontier, offering transformative potential for optimization, risk analysis, and real-time data processing. Early investments in quantum research by banks and investment firms signal their commitment to leveraging this technology. By exploring its capabilities early, financial institutions aim to solve previously intractable problems, enhance efficiency, and stay ahead in an increasingly complex and competitive market.



The **Bank of Canada** uses quantum computing for complex financial challenges, including simulating cryptocurrency adoption among non-financial companies in a ten-person network, partnering with Multiverse Computing to model various outcomes. The researchers' model can complete in half an hour what would take a regular PC longer than a human lifetime.
Bank of Canada Using Quantum Computing to Simulate Crypto Adoption Scenarios
Improving the Efficiency of Payments Systems Using Quantum Computing - Bank of Canada

The **Bank of Montreal (BMO)** is exploring QC's potential to enhance trading product accuracy. Teaming up with Xanadu, BMO aims to leverage Xanadu's quantum Monte Carlo algorithm for computational speedups and improved trading product accuracy.|
BMO Financial Group Partner with Xanadu on Quantum Speedups for Trading Products

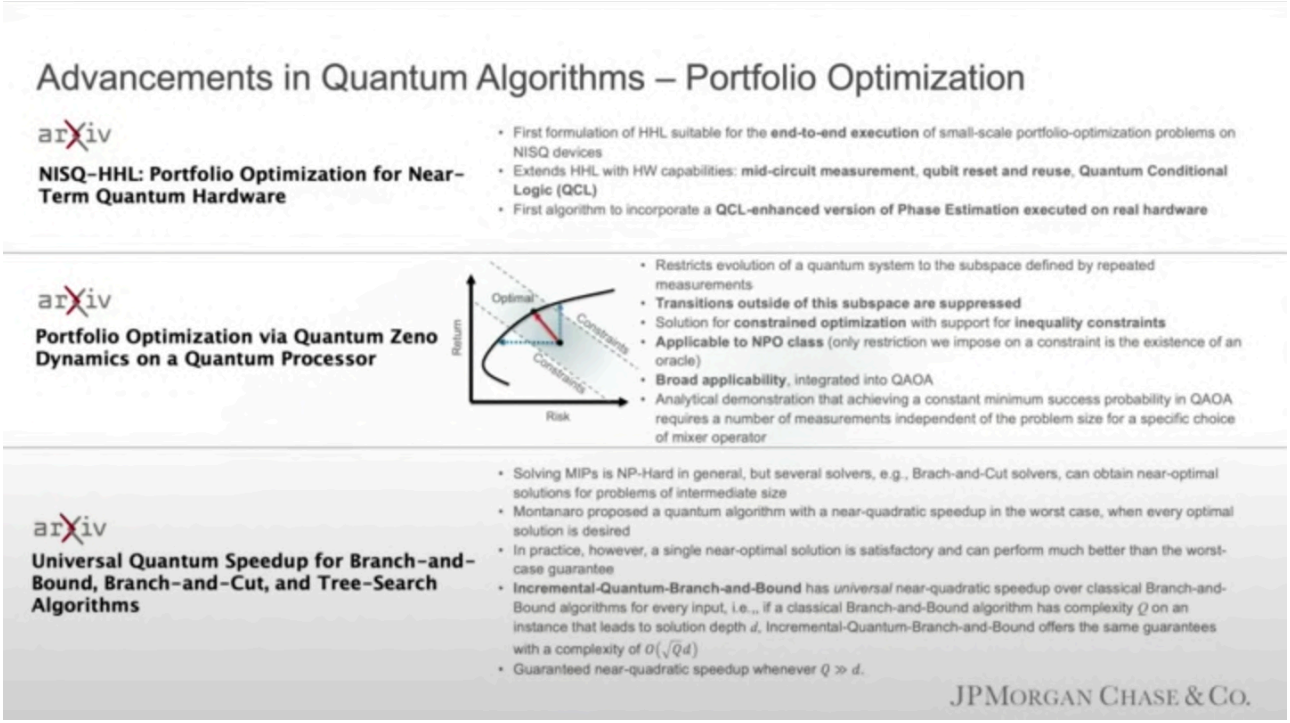
Ally Financial leverages Microsoft's Azure tools to develop quantum skills, collaborating in the Enterprise Acceleration Program to explore use cases and build expertise while forming partnerships in the quantum ecosystem.
Ally Financial joins Azure Quantum to transform customer experiences

Bank of America is gradually engaging in quantum tech through webinars and events with a small dedicated team, adopting a "fast follower" approach. Their investment banking division actively explores early-stage opportunities in this realm.

Citigroup identified quantum computing's potential in finance in 2019, emphasizing its benefits. Their increased research investment in quantum computing in 2020 was noted but undisclosed in detail.
Citi and Classiq advance quantum solutions for portfolio optimization using Amazon Braket

The Federal Reserve prioritizes fostering an innovative environment and protecting the nation's financial infrastructure, including the development and implementation of quantum computing technologies.
Federal Reserve - Assessing The Quantum Threat By The Numbers-Finally

JPMorgan delves into quantum algorithms for AI and optimization, publishing experiments and exploring use cases like portfolio optimization and fraud detection. They collaborate with Q-NEXT to advance quantum technology.

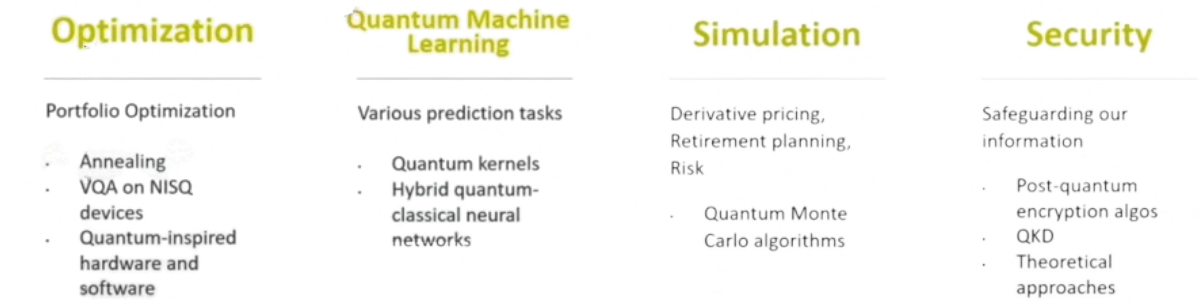


Q2B 2022 SV | Quantum Technology at JP Morgan Chase | Marco Pistoia | JP Morgan Chase & Co.

Goldman Sachs' substantial research team aims to demonstrate quantum advantage in finance problems by leveraging superior quantum algorithms for Monte Carlo simulations, tailored for near-term quantum hardware.
Engineering Quantum Algorithms | Goldman Sachs

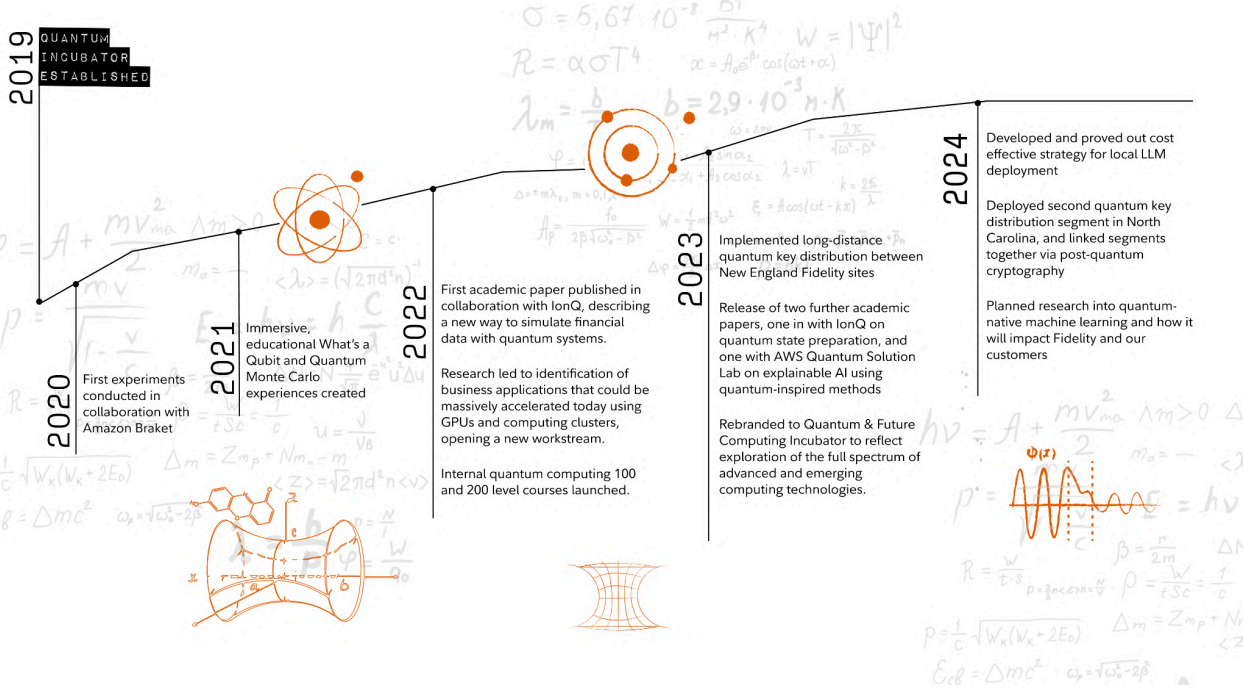
Morgan Stanley has an innovation and tech team. One of their responsibilities is to cover quantum computing. The business has also put out several generalist articles covering the potential of the technology.

Fidelity has been working on developing quantum algorithms and running them through [Amazon's Braket](), a cloud service that utilizes quantum computers from D-Wave, [IonQ](), and Rigetti.



[Q2B 2022 SV | Quantum Computing - Fidelity Center for Applied Technology]()

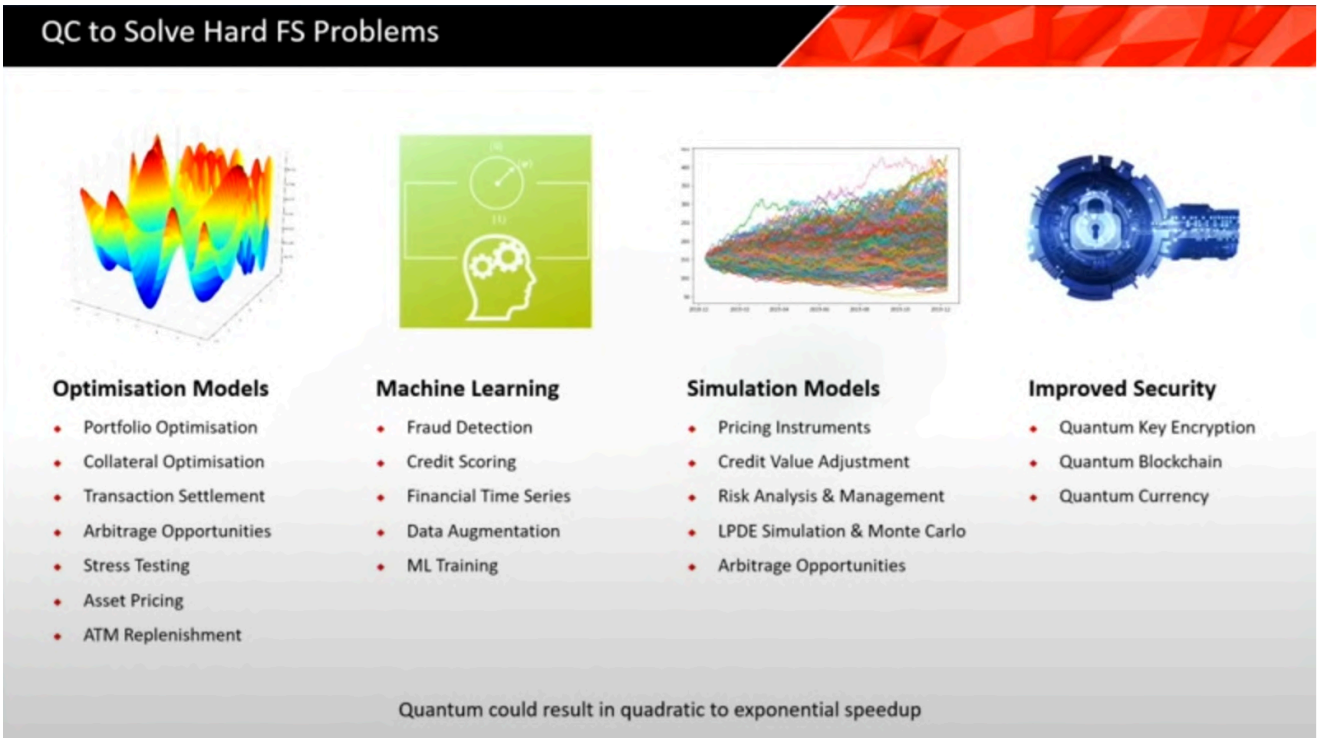
[Fidelity Center for Applied Technology - Quantum Incubator and Future Computing]()

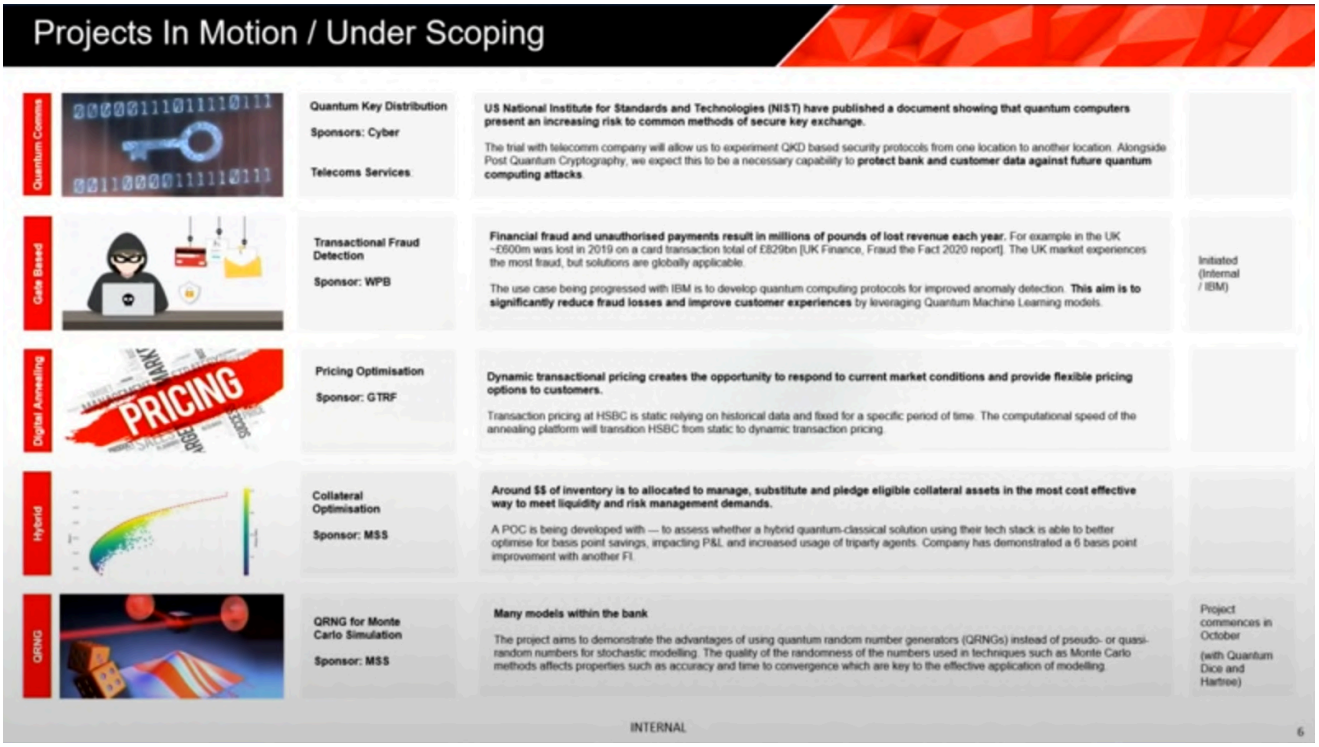


Mastercard advances quantum-resistant technology for contactless payments, explores quantum computing's potential in banking services like rewards programs, and participates in QCoir to unify Ireland's quantum research groups.
[How Mastercard is preparing for a quantum future]()

PayPal and IBM partnered to explore quantum computing for improving fraud detection, credit risk, and security. PayPal's emerging tech division includes quantum computing and cryptography among its focuses.
[Inside PayPal's partnership with IBM to use quantum computing to improve how it detects fraud]()

HSBC collaborates with IBM and other partners to explore quantum computing's potential for pricing, portfolio optimization, achieving net-zero goals, and addressing fraud. The bank has tested quantum key distribution for secure trades, joined a quantum secure metro network, and is enhancing cybersecurity by connecting its global headquarters using quantum key distribution.





[Q2B 2022 SV | Quantum Technology Innovation in Commercial Finance | Mekena Metcalf | HSBC]

Satispay and D-Wave Quantum are partnering to develop a quantum-hybrid application that enhances customer rewards programs by 50% with the same budget. The application will be utilized weekly by Satispay's internal teams as it transitions into production, supporting the fintech's increasing adoption in Italy and France.
D-Wave and Satispay Aim to Accelerate Growth of Leading European Payment Network through Quantum-Fueled Customer Rewards Program

Wells Fargo
Wells Fargo has been building partnerships and even creating quantum algorithms for years.

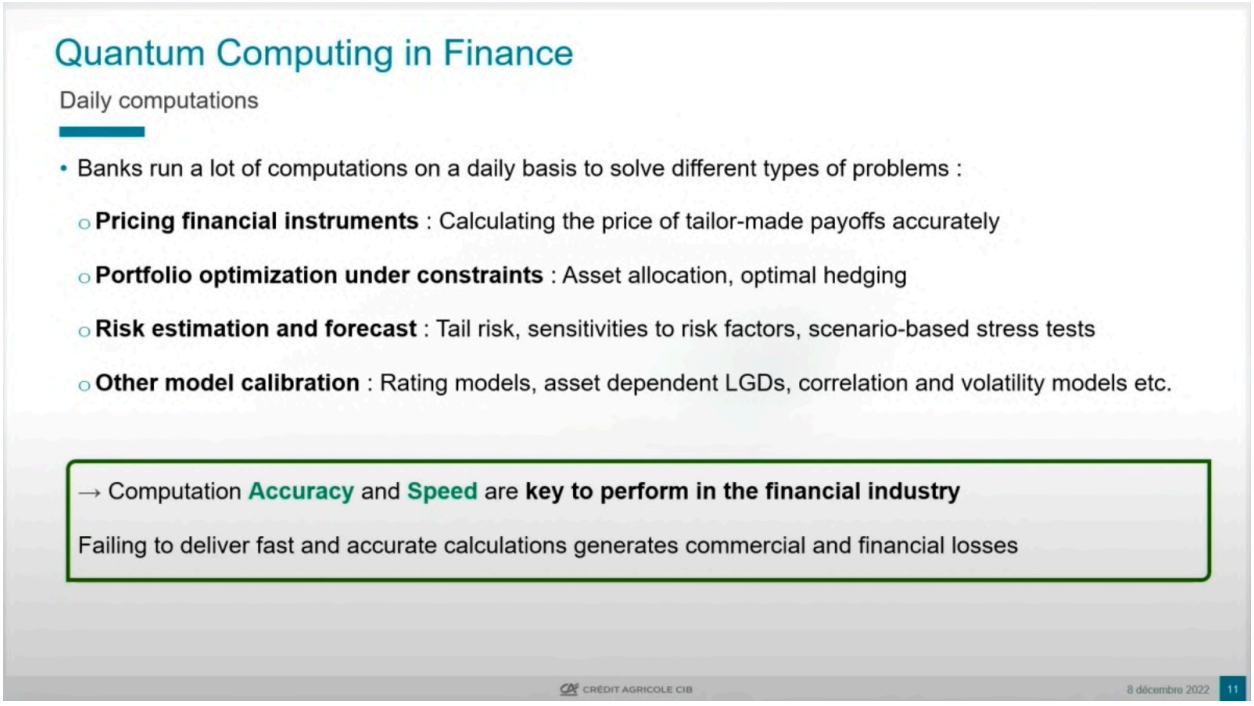
For example, the company joined the IBM Quantum Network in 2019 and has dedicated a team of quantum researchers and programmers through the partnership with IBM. Wells Fargo published six papers on quantum algorithms in 2022 — and more are coming.

"We're building quantum-friendly algorithms and we test them on IBM's infrastructure," Mehta said. "[What we're saying is], as the value and usefulness of quantum computers starts to emerge, these are the kind of algorithms we want to execute."

Recently, Wells Fargo researchers have started exploring the larger systems IBM is developing, including the 433-qubit IBM Osprey processor, the most recent and largest to-date quantum processor IBM has deployed.

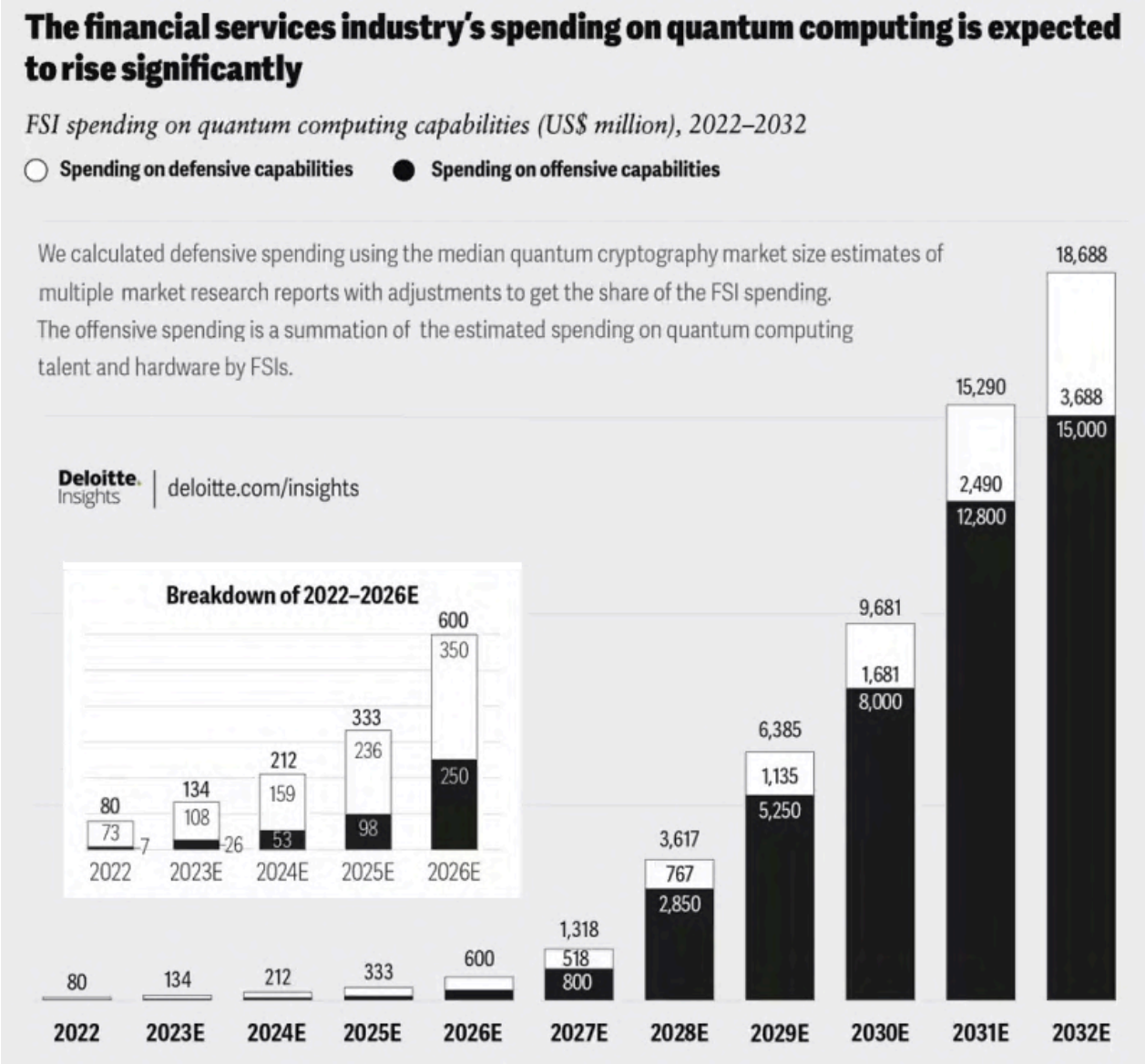
Q2B 2022 SV | Quantum Computing at Wells Fargo | Constantin Gonciulea | Wells Fargo

Credit Agricole



Q2B 2022 SV | Credit Agricole CIB at the Forefront of Quantum Computing | Achraf Seddik | CIB

The age of quantum computing is fast approaching, and the financial services industry is already preparing now. Increased capital investments and patent filings for hardware technology indicates spending on quantum-related capabilities will likely grow quickly over the next few years. Globally, the financial services industry's spending on quantum computing capabilities is expected to grow 233x from just US$80 million in 2022 to US$19 billion in 2032, growing at a 10-year CAGR of 72%. Firms that are working on developing quantum-related capabilities now could enjoy a competitive advantage as these capabilities mature. (Quantum computing in financial services | Deloitte Insights)



Classiq > Applications > Finance > Credit card fraud detection
Classiq > Applications > Finance > Estimating European Option Price Using Amplitude Estimation
Classiq > Applications > Finance > Portfolio Optimization with QAOA
Quantum Finance | Classiq

Automotive & Transportation

The automotive sector will see significant QC impacts by 2025-2030, continuing through 2030-2035. QC can enhance materials science for lighter, stronger materials, optimize manufacturing processes, and improve autonomous vehicle algorithms.

Quantum Computing In The Automotive Industry What's Next

Automotive Industry Challenges Addressed
Current State Of Quantum Adoption
Optimizing Vehicle Design Processes
Material Science Breakthroughs Expected
Autonomous Vehicles Enhanced Safety
Supply Chain Optimization Strategies
Predictive Maintenance Revolutionized
Electric Vehicle Battery Innovations
Cybersecurity Threats Mitigated Effectively

Automotive Quantum Computing Market Projected to Grow to $5B

Ford and Microsoft partnered to explore applying quantum-inspired technology to solve complex problems unsolvable by current computers. They simulated numerous vehicles' impact on congestion, showcasing the potential of this innovation.
How Ford Is Exploring the Quantum World with Microsoft to Help Reduce Congestion

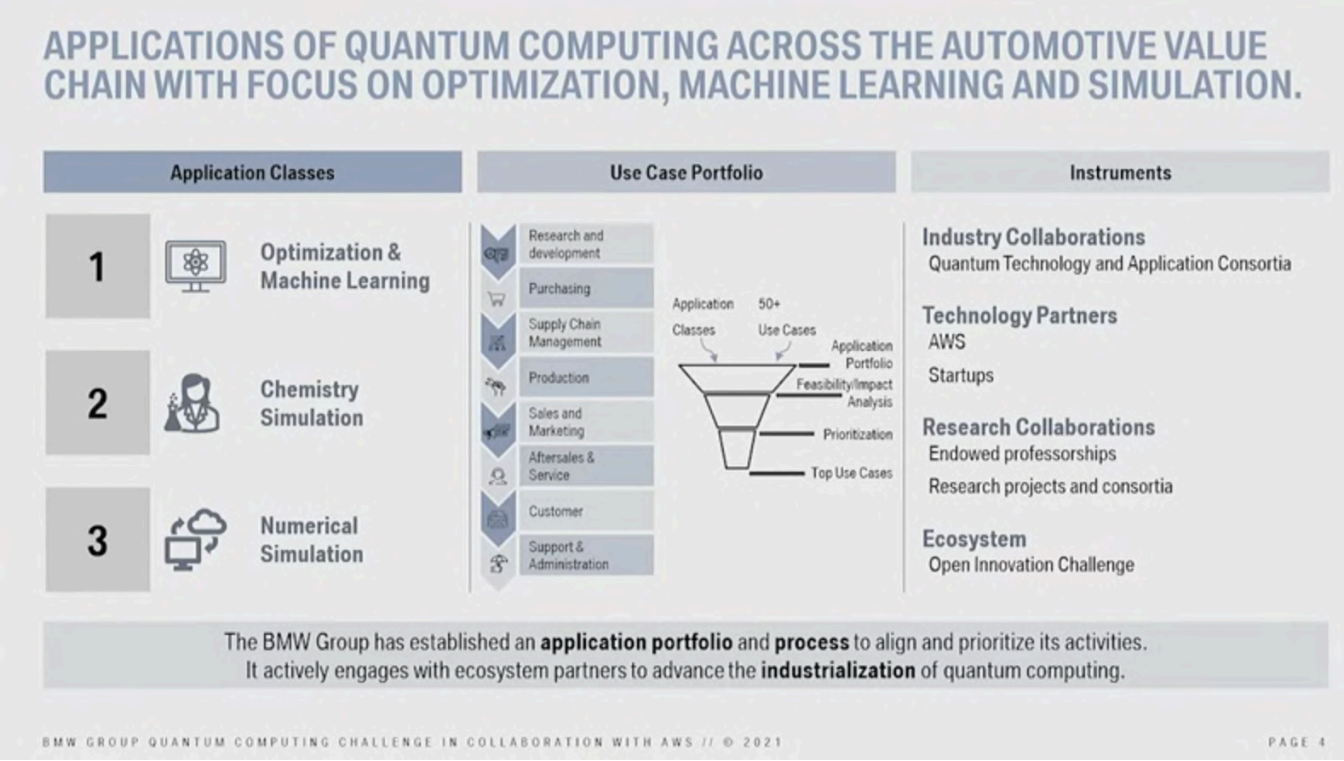
General Motors intends to use its quantum computing project to run real-world industrial algorithms on an actual quantum computer.
Paint shop sequencing - Quantum computing considering color changeover and painting quality

Andretti Autosport has teamed up with Zapata to explore using quantum computing in their race-time analytics setup. This collaboration aims to use advanced algorithms to boost performance, refine strategies, and gain a competitive advantage in racing.
Zapata & Andretti build Race-Time Analytics Infrastructure for Quantum-Readiness

Bosch, collaborating with QuSoft since 2019, is actively involved in quantum computing applications and has invested in quantum companies like Zapata and IonQ. Additionally, Bosch, in partnership with IBM, aims to advance quantum research and establish Germany as a leader in the quantum market, with recent efforts including a 2022 startup focused on developing quantum sensors for biomedical applications.
Bosch Partnering with IBM on Strategic Quantum Computing Materials Science Engagement

Mercedes-Benz is partnering with quantum-computing leaders like IBM to utilize quantum computing for accurate simulations of internal processes in electric car batteries. The objective is to improve battery performance and drive increased adoption of electric vehicles.
Mercedes-Benz bets on quantum to craft the future of electric vehicles

BMW has utilized Honeywell's quantum computer to optimize component procurement and is keen on exploring quantum computing's transformative potential in the automotive industry. The company is focusing on chemistry applications and optimization, managed by different divisions, with an internal team dedicated to research.
[How BMW Can Maximize Its Supply Chain Efficiency with Quantum]



[Q2B 2021 | BMW and AWS Explore Industrial Use Cases for Quantum Computing | Panel]

[Q2B 2022 SV | Quantum Computing at the BMW Group: Towards a Practical Quantum Advantage | BMW Group]

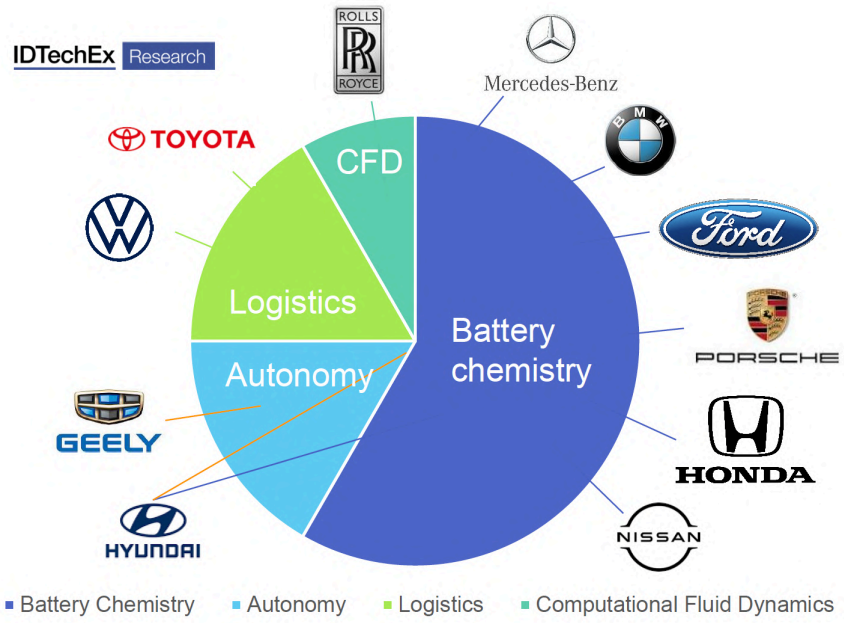
[Classiq Collaborates with BMW Group and NVIDIA to Drive Quantum Computing Applicability in Electrical Systems Engineering]

Daimler launched the Quantum Computing Initiative in 2015 to explore the potential of quantum technology. Led by Ben Boeser, the initiative focuses on understanding emerging trends, particularly quantum computing, with a long- term research perspective of 10 to 15 years. The goal is to grasp the basics and actively participate in the evolving quantum computing landscape.
[IBM and Daimler use quantum computer to develop next-gen batteries]

The Porsche Digital Lab is actively researching quantum computing to reduce the company's carbon footprint. The focus includes quantum sensing, imaging, and computation, with a particular emphasis on optimization within the realm of quantum computing.
[Taking a quantum leap - Porsche Newsroom]

Volkswagen and D-Wave demonstrated the first real-time traffic- routing system to rely on quantum computing to predict traffic volumes and route trips to minimize wait times for passengers and travel times for using buses in Lisbon, Portugal. Quantum computers may be better suited for these types of problems than classical computers, according to Florian Neukart, Director, Volkswagen Group Data:Lab in Munich.

[Volkswagen takes the quantum computing revolution from the lab to the factory]



The U.S. Department of Transportation (USDOT) is exploring quantum technologies to enhance transportation systems' safety, efficiency, and sustainability. In its July 2024 workshop, USDOT examined how quantum computing can address optimization challenges, such as EV charging station placement and supply chain logistics, while quantum sensors can improve navigation, infrastructure monitoring, and leak detection. These technologies promise transformative benefits, including higher sensitivity, stability, and efficiency, across various transportation modes.

USDOT's next steps include participating in national quantum initiatives, developing a technology assessment framework, and fostering research partnerships with agencies like DARPA and DOE. Near-term projects focus on integrating quantum optimizers with digital twins for network optimization

and employing quantum sensing for infrastructure health and environmental monitoring. By engaging early with quantum advancements, USDOT aims to position U.S. transportation at the forefront of innovation, ensuring readiness for future breakthroughs while addressing current challenges in safety and sustainability. The table below summarizes the quantum computing opportunities identified during the workshop and maps each to the transportation modes for which benefits may accrue:

How Might Quantum Computing Change the Way USDOT Works In the Future?

● = identified opportunity; ○ = not applicable or unknown.

Quantum Opportunity	Transportation Mode: Vulnerable Road Users	Passenger Vehicles	Rail	Trucking	Public Transit	Aviation	Infrastructure	Maritime & Seaway	Pipeline/ Hazardous Materials
Predictive Safety and Maintenance	○	●	●	●	●	●	●	●	●
Routing/Scheduling/ Congestion Management	○	●	●	●	●	●	●	●	●
Supply Chain Optimization	○	○	●	●	○	○	○	●	○
Revenue Forecasting	○	○	○	○	●	○	●	●	○
Emergency Management/ Network Disruption Mitigation	●	●	●	●	●	●	●	●	○
Weather Forecasting	●	○	○	○	○	●	●	●	●
Materials Discovery	○	○	○	○	○	○	●	○	●
Battery Design	○	●	○	●	○	○	○	○	○
Corrosion Chemistry	○	○	●	○	○	○	●	●	●
Computational Fluid Dynamics	○	○	○	○	○	●	●	●	○
Fuel Efficiency	○	●	●	●	●	●	○	●	○
Smart Mobility Corridors	○	●	○	○	●	●	○	○	○
Close Call/Near Miss Mitigation	●	●	●	●	●	●	●	●	●
Cybersecurity	○	●	●	●	●	●	●	●	●
Human/Automated Vehicle Interaction Simulation	●	●	●	●	●	●	●	○	○
Last Mile/Curb Management Optimization	○	●	○	●	●	●	●	○	○
Crash Simulation	○	●	○	●	●	●	●	○	○
Connection Protection	●	●	●	●	●	●	●	●	●

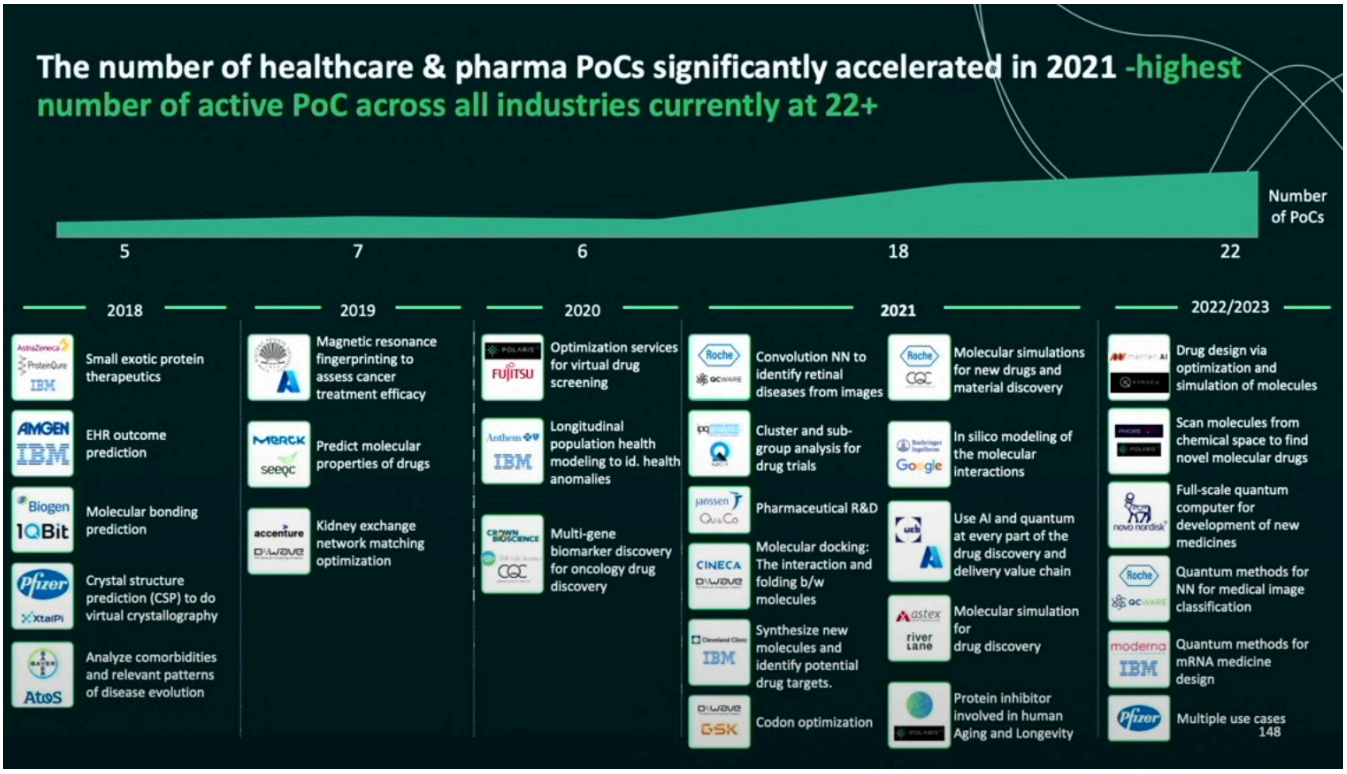
Quantum Technologies in Transportation Workshop Report | November 2024

[Quantum Technologies in Transportation]

[Classiq > Applications > Logistics > Facility Location Problem]
[Classiq > Applications > Logistics > Travelling Salesman Problem]
[Classiq > Applications > Optimization > Integer Linear Programming] (e.g. [Pickup & Delivery Routing Problem])
[Quantum Computing In Automotive Industry | Classiq]

Healthcare and Pharma

Quantum computing leverages the peculiar characteristics of quantum particles, and is increasingly being adopted by pharmaceutical and healthcare companies. This 'quantum advantage' is what pharmaceutical companies aim to harness for rapid in silico evaluation of drug molecule targets and protein folding characterization. Quantum computing's potential to integrate genomics, transcriptomics, and all human 'omics to make more reliable predictions than traditional computers is a significant draw for these companies.



Amgen has used Quantinuum's computer hardware as a first step toward computer-aided drug design. The algorithm classified peptides according to their binding affinity to a particular molecule to identify a therapeutic capable of regulating the immune response. Amgen also participated and invested in the Quantinuum $300M round.
The Path to Quantum Breakthroughs: Insights from Amgen

Cleveland Clinic and IBM have started the deployment of the country's first private sector onsite, IBM-managed quantum computer.
Cleveland Clinic and IBM Unveil First Quantum Computer Dedicated to Healthcare Research

Astex Pharmaceuticals and Riverlane are partnering to showcase quantum computers' capabilities in modeling chemical compounds binding to proteins in the human body.
Riverlane partner with bio-tech company Astex

Merck collaborated with HQS Quantum Simulations for a three-year partnership to apply quantum chemical software for quantum computers. Merck notes that quantum computing (QC) is applicable to a limited subset of their challenges.
Using quantum technology in industry
Quantum computing is the start of possibilities without end - Merck

Moderna recognizes the importance of quantum computing (QC) for its industry and is collaborating with IBM to utilize generative artificial intelligence and quantum computing for advancing mRNA technology, crucial for the development of the company's Covid vaccine
Moderna, IBM Quantum Researchers Use Quantum Computers For Critical Step in RNA-based Therapeutic Design.

Pfizer is starting to attend quantum technology webinars and events. Researchers from Pfizer are looking at using a modeling technique called crystal structure prediction (CSP) to map the 3D structure of molecules calculations that typically take months to complete.
How Quantum Physics and AI is Disrupting Drug Discovery & Development

UnitedHealth Group is exploring quantum computing through Optum Technology, UHG's technology arm, in the areas of patents and defensive publishing.
How UnitedHealth Group Is Using Quantum Computing

Janssen collaborated with Qu&Co (now merged with PASQAL) for three years to explore the application of quantum computing in computational chemistry and machine learning for pharmaceutical R&D, aiming to identify potential benefits and the expected timeframe for implementation.
Qu&Co and Janssen Develop and Test Quantum Computational Methods Pharma R&D

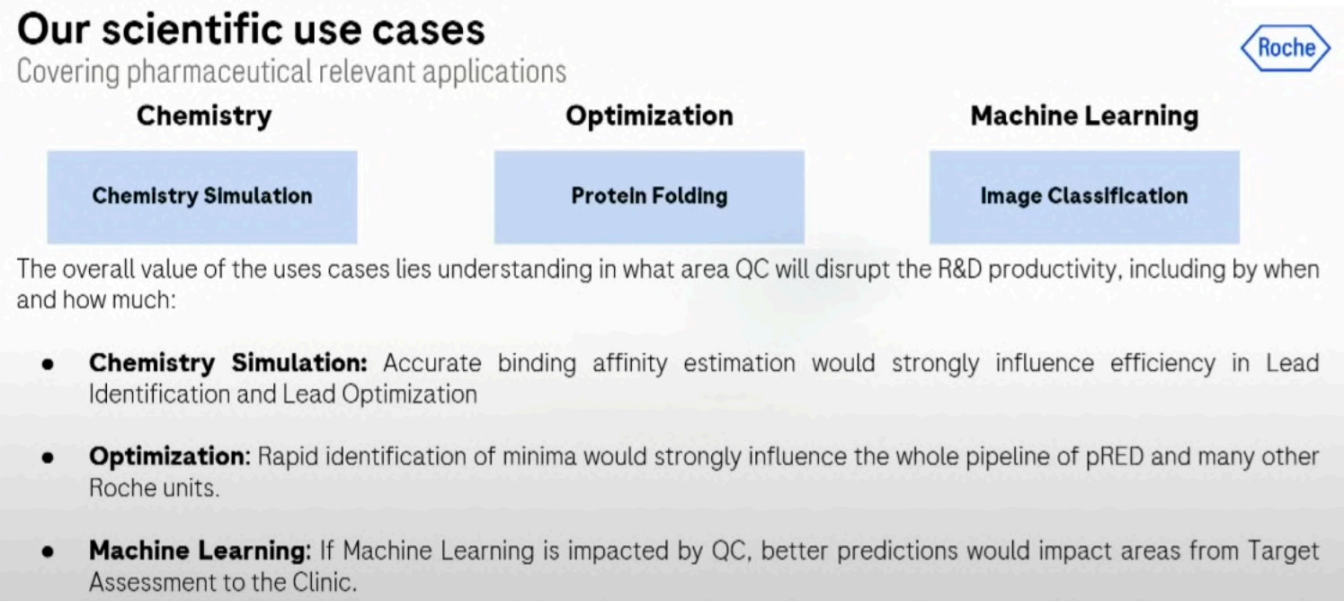
The Novo Nordisk Foundation Quantum Computing Programme, in collaboration with the Niels Bohr Institute, is set to establish a fully functional quantum computer within the next 10–12 years, focusing on quantum simulators for medicinal development and climate change insights. The program received a grant of US$200 million (DKK 1.5 billion) for this initiative.
Novo Nordisk Foundation Quantum Computing Programme

Bayer is partnering with Google to accelerate its in-silico research and development by utilizing Google Cloud's high-speed processors, particularly Tensorflow Processing Units for large quantum chemistry calculations. This collaboration also involves leveraging AI technology, including Google Cloud's Vertex AI and Med-PaLM 2, to enhance clinical trials and advance AI integration in radiology.
Bayer to Accelerate Drug Discovery with Google Cloud's High-Performance Compute Power

Siemens Healthineers and UCL are collaborating to explore the application of quantum machine learning techniques for enhancing cognitive computing in healthcare.
Quantum Algorithms for Cognitive Healthcare

AstraZeneca collaborates with ProteinQure to design novel peptide therapeutics, leveraging ProteinQure's expertise in biologics to support AstraZeneca in completing experimental validation.
ProteinQure Collaborates with AstraZeneca to Design Novel Peptide Therapeutics

Roche recognizes the potential of quantum computing and has established a quantum computing task force guiding its initiatives in the field. The company has collaborated with Cambridge Quantum Computing to explore drug discovery use cases, particularly in Alzheimer's research. In addition to:



Q2B 2022 SV | The Potential of Quantum Computing for Drug Development - Roche | Yvonna Li

Boehringer Ingelheim is using quantum algorithms to investigate the behavior of small molecules in the vicinity of proteins to predict protein–ligand binding energies. Pfizer and IBM have also collaborated to integrate generative AI and quantum computing to improve clinical trial performance and speed results.
Q2B 2023 Paris | Perspective on Challenges & Opportunities in Life Science | Clemens Utschig-Utschig

GSK is actively partnering with various quantum companies, exploring the potential of quantum computing for specific workloads that face scalability and complexity challenges with traditional architectures, particularly in the realm of genetic algorithms.
GlaxoSmithKline Marks Quantum Progress with D-Wave

The **NIH** is exploring quantum computing's potential to tackle complex healthcare challenges, focusing on applications that accelerate biomedical advancements. Key use-cases include medical imaging, where quantum algorithms like quantum Fourier transform and quantum machine learning improve diagnostics through enhanced image analysis and pattern recognition. In genomics, quantum methods speed up tasks such as sequence alignment and mutation detection, crucial for precision medicine. Drug discovery also benefits from quantum simulations and hybrid workflows, enabling faster and more accurate modeling of molecular interactions. NIH funds interdisciplinary efforts and challenges to align quantum advancements with healthcare needs, ensuring innovations address challenges while maintaining data security and ethical standards.

Classiq > Applications > Chemistry > Protein Folding Algorithm
Classiq > Applications > Optimization > Max Independent Set (e.g. Gene Co-Expression Network)
Classiq > Algorithms > QML > QSVM (e.g. Clinical Symptom Classification)
Quantum Computing In Healthcare | Classiq

Telecom

Telecom benefits from quantum computing through enhanced data security via quantum encryption, which protects against hacking. Quantum algorithms optimize network traffic, reducing latency and improving bandwidth management. They enable faster error correction in communication systems, ensuring reliability. Additionally, quantum computing enhances signal processing for better call quality and data transmission. It accelerates research and development of 5G/6G technologies. Lastly, quantum-enabled simulations improve infrastructure planning and deployment efficiency.

Additionally, telecom operators function as extensive IT, financial, customer-facing, and service organizations, making them well-positioned to benefit from quantum computing advancements across these domains.

AT&T (reference call) is diving into quantum technology, aiming to be "quantum ready" by 2025 for better security. AT&T Labs explores quantum computing's network impact, focusing on edge intelligence and future processing. AT&T CDO is working on cyber security related Quantum POC. Collaborations with institutions like CalTech accelerate quantum tech for more secure communication channels.
AT&T Aims to be 'Quantum Ready' by 2025

NTT & NTT Data
NTT is investing heavily in quantum technologies, particularly quantum cryptography and quantum computing applications for telecom. NTT's R&D is focused on integrating quantum technologies into network optimization, secure communications, and distributed systems.
NTT Research Center for Theoretical Quantum Information
Quantum Computing at the NTT DATA EMEAL Innovation Center
Innovating Optical Quantum Computing | NTT STORY

British Telecom (BT)
BT is actively exploring quantum key distribution (QKD) for ultra-secure communication. The company is also exploring quantum computing applications in circuit switching, packet routing, signal processing, and antenna beam steering.
Shaping the UK's quantum enabled economy

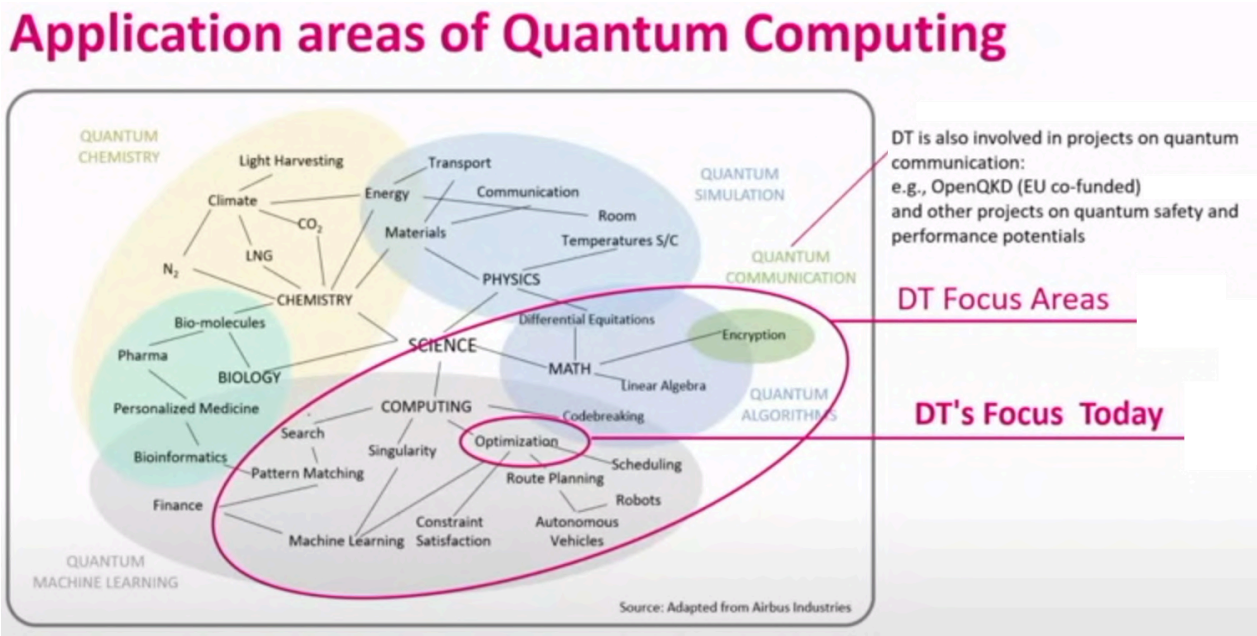
Telstra
Telstra is collaborating with Australian quantum computing startups to explore applications in network optimization, encryption, and next-generation telecommunications technologies.
Telstra takes a step closer to quantum secure networking

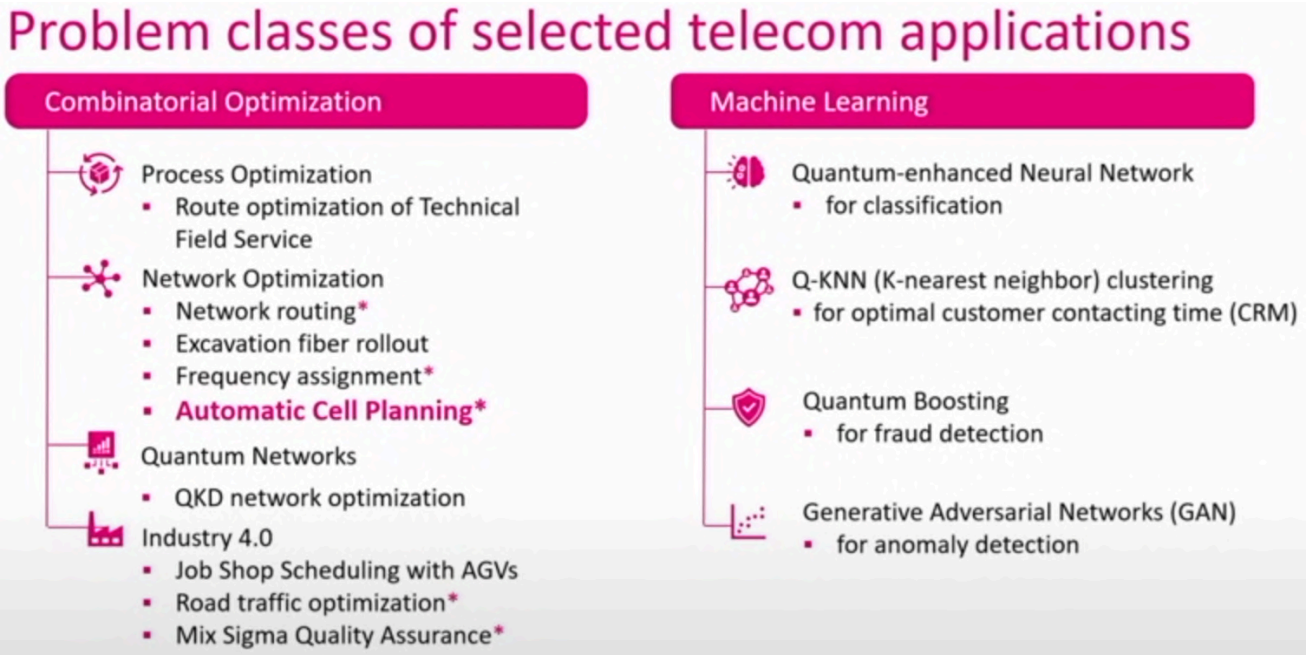
Vodafone
Vodafone is collaborating with IBM and other quantum companies to explore quantum computing for telecom applications. This includes optimizing network performance, enhancing machine learning for anomaly detection, and testing quantum-safe VPNs. In the UK, Vodafone leads the GSMA Post-Quantum Telco Network Taskforce, driving the development of quantum-secure policies to safeguard future telecommunications infrastructure.
Vodafone explores quantum computing for network optimisation

Deutsche Telekom (DT)

Deutsche Telekom is part of several European quantum initiatives on quantum-safe communication. DT is also exploring quantum computing for optimizing network performance and reducing operational costs. In addition to being a large system integrator and offering quantum computing services with T-Systems.

Deutsche Telekom opens quantum research lab; Practical Quantum Computing: Telecom Use-case





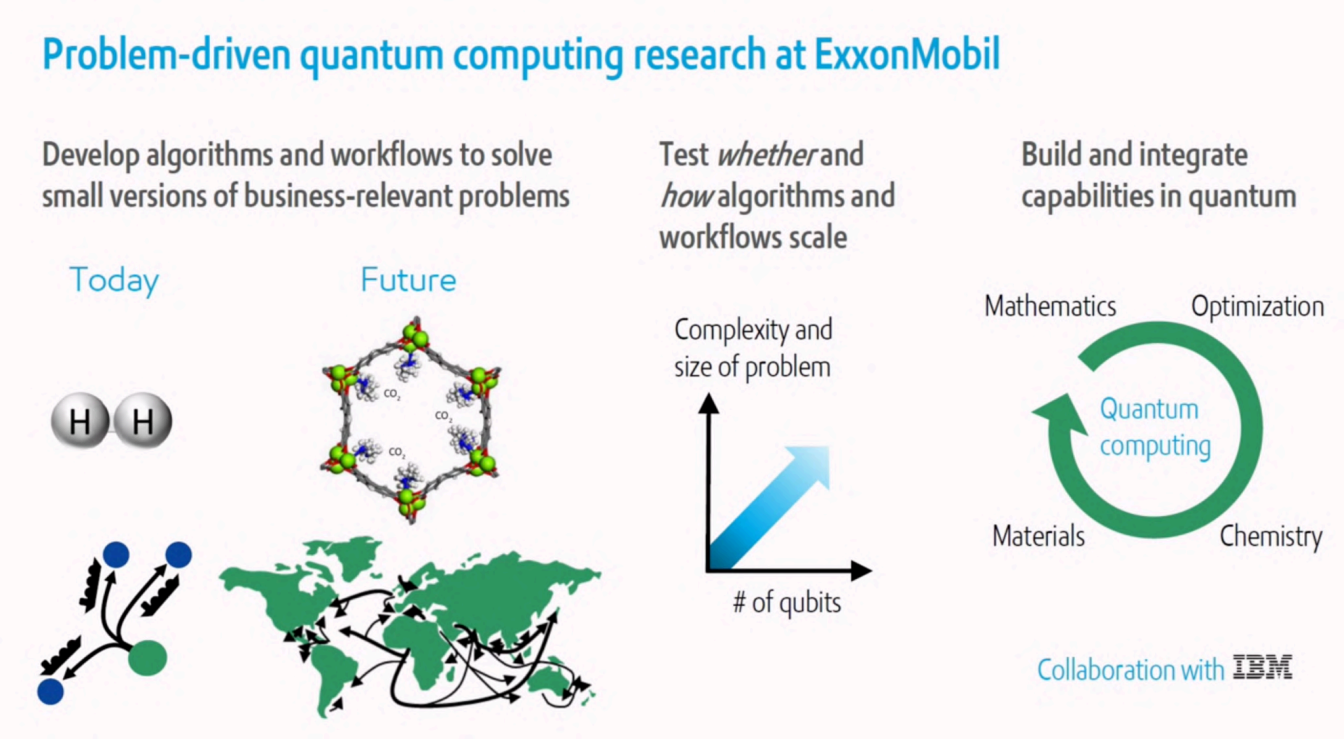
Classiq > Applications > Logistics > Workflow Scheduling Problem
Classiq > Applications > Optimization > Max Independent Set (e.g. Wireless Network Optimization)
Classiq > Algorithms > QML > Quantum GANs (e.g. Broadband Channel Estimation)

Oil & Gas and Energy

Quantum computing holds immense potential for transforming the oil and gas industry by addressing some of its most complex challenges. One of its key applications lies in subsurface analysis, where quantum computers can process intricate geological data with greater efficiency and precision. This leads to more accurate subsurface models, improving the identification of hydrocarbon reserves. Additionally, advanced molecular modeling, explored by companies like TotalEnergies and Shell, can help design more effective materials for carbon capture and storage, contributing to emission reduction efforts and supporting sustainability initiatives.

Beyond exploration and environmental applications, quantum computing also has the potential to optimize operational efficiency. Quantum algorithms can significantly enhance supply chain logistics by improving the alignment of production with demand, thereby reducing costs and operational inefficiencies. Moreover, quantum computing's ability to process vast amounts of seismic data can revolutionize data interpretation, aiding in better exploration and resource management decisions. While still in its early stages, the adoption of quantum computing in the oil and gas sector promises to drive innovation, operational improvement, and environmental responsibility.

ExxonMobil partnered with IBM to explore quantum computing's potential in advancing energy and manufacturing technologies. This collaboration aims to boost ExxonMobil's research and development capabilities.



ExxonMobil and IBM to advance energy sector application of quantum computing
Q2B 2020 | Quantum computing research at ExxonMobil | Amy Herhold | ExxonMobil

VINCI Energies is actively collaborating with QuantumBasel and D-Wave's quantum technology in a pilot project to enhance efficiency in sustainable building design, particularly in HVAC systems. The project, utilizing D-Wave's quantum computers and quantum hybrid solvers, represents a crucial step in

applying quantum computing to address complex challenges and advance environmental and digital transition initiatives in building design.
Collaboration between VINCI Energies, QuantumBasel and D-Wave Improves Efficiency in HVAC System Design with Quantum Computing

TotalEnergies is intensifying its research in Carbon Capture, Utilization, and Storage (CCUS) technologies by entering a multi-year partnership with UK start-up Quantinuum (formerly Cambridge Quantum Computing). This collaboration aims to leverage quantum algorithms to accelerate the development of CCUS technologies, crucial for achieving carbon neutrality by 2050.
Total is exploring quantum algorithms to improve CO2 capture

Shell cooperates with theoretical physicists and chemists of Leiden University to research how quantum computer algorithms can help simulate complex molecules.
Shell works with Leiden and VU researchers on quantum computer algorithms for chemistry

BP has partnered with the IBM Quantum Network to explore quantum computing applications for business and engineering challenges, leveraging IBM's expertise and a premium 65-qubit quantum system. The collaboration aims to drive efficiencies and reduce carbon emissions, aligning with bp's clean energy goals.
bp joins the IBM Quantum Network to advance use of quantum computing in energy

EPRI (Electric Power research institute) explores AI-enhanced cybersecurity in utilities, focusing on quantum science and technology. The Quantum Challenge initiative aims to speed up adopting new quantum tech in the electric industry.
EPRI is leading quantum challenges focusing on how quantum technologies can address energy industry challenges

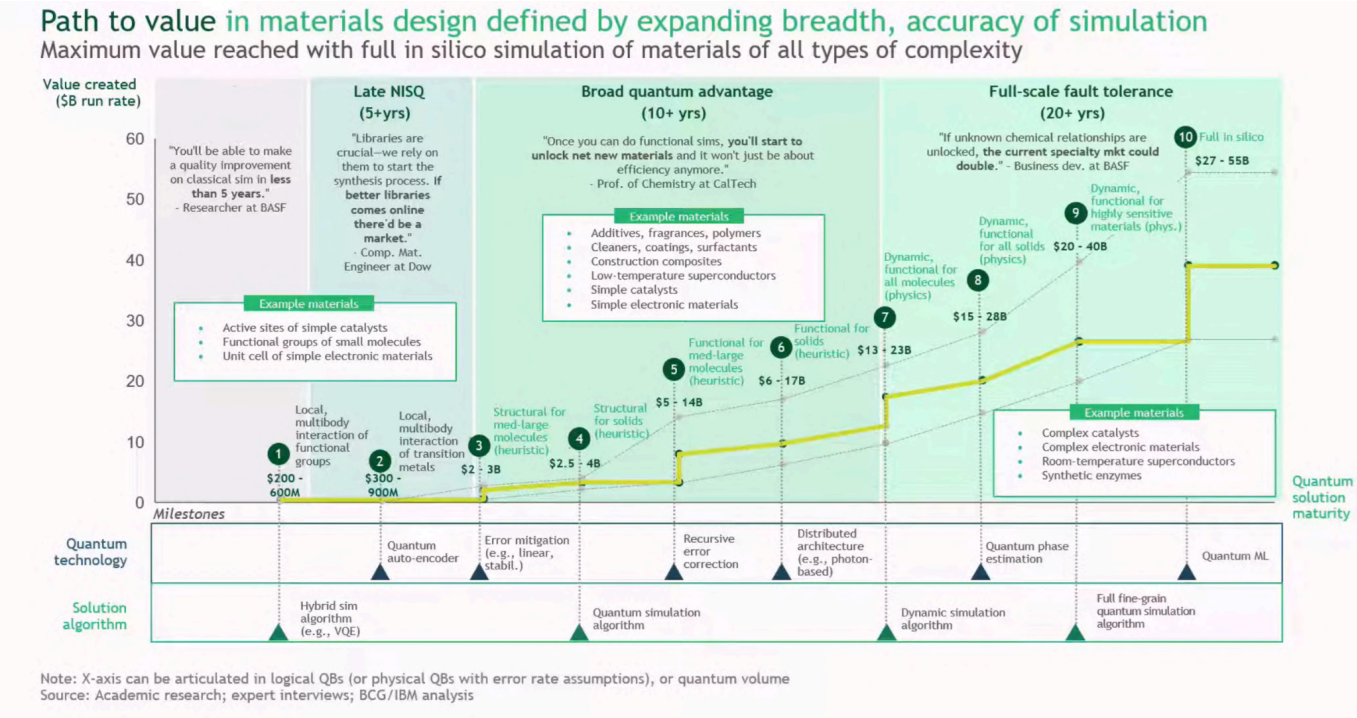
The **US DOE** plays a pivotal role in advancing quantum computing for energy-related applications by fostering innovation through its National Quantum Information Science Research Centers and Quantum testbeds. These initiatives address critical computational challenges, enabling breakthroughs in energy systems that are beyond the reach of classical computers. For instance, quantum computing can accelerate the development of advanced energy storage systems by simulating complex quantum interactions in materials, optimizing catalytic processes for cleaner energy production, and improving grid efficiency through sophisticated modeling. Realizing these use-cases requires addressing key hurdles in quantum hardware, such as mitigating noise, refining material purity, and enhancing device stability, alongside innovations in system architecture and algorithms. By allocating $2.5 billion over five years DOE is supporting foundational advances in materials science, device fabrication, and algorithm development, the DOE is paving the way for transformative energy solutions, enabling deeper insights and more sustainable technologies for a clean energy future.

US DOE 2024 - Quantum Information Science Applications Roadmap

Classiq > Applications > Optimization > Electric Grid Optimization using QAOA
Classiq > Algorithms > HHL Algorithm (e.g. Energy Grid Power Flow)
Classiq > QMOD > Library Functions > Quantum Fourier Transform (e.g. Seismic Data Processing)
Quantum for Energy & Networks | Classiq

Chemical & Materials

Quantum computing mimics nature's fundamental processes by accurately simulating quantum systems, making it ideal for revolutionizing materials science. Its application enables breakthroughs in areas like the design of low and room-temperature superconductors, advanced construction composites, and simple catalysts. Quantum technology also supports the development of highly functional electronic materials, synthetic enzymes, and dynamic materials for sensitive applications. By unlocking new materials and processes, quantum computing drives innovation across industries, from clean energy solutions to advanced manufacturing.



Mitsubishi Chemical is actively exploring quantum computing to enhance material development and chemical research. In collaboration with Classiq Technologies and Deloitte Tohmatsu, they achieved up to 97% compression of quantum circuits, improving calculation accuracy for new material development. Additionally, partnering with PsiQuantum, they aim to design energy-efficient photonic materials using fault-tolerant quantum computers. These initiatives demonstrate Mitsubishi Chemical's commitment to leveraging quantum technology for innovative solutions in material science.
Classiq, Deloitte Tohmatsu, and Mitsubishi Chemical Compress Quantum Circuits by Up to 97%

BASF is applying quantum computing to tackle key challenges in chemistry and material science. The company focuses on optimizing molecular structures, reaction pathways, and catalyst designs to enhance chemical processes. Quantum simulations are used to improve battery technologies, enabling advancements in energy storage and efficiency. BASF leverages quantum algorithms to reduce the need for extensive physical experiments, accelerating the R&D process. The technology also supports the development of sustainable solutions, such as environmentally friendly materials and energy-efficient production methods. Collaborating with academic and industrial partners, BASF

ensures access to cutting-edge quantum research and applications. This integration of quantum computing enhances precision and innovation in BASF's core areas of expertise.

Q2B 2022 SV | Qemistry: Quantum Computing at BASF | Joshua Speros | BASF Venture Capital
Quantum Computing- BASF Website

Classiq > Applications > Chemistry > Molecule Eigensolver (VQE method)
Classiq > Applications > Chemistry > Creating a Molecule's Potential Energy Curve
Classiq > Applications > Chemistry > Quantum Phase Estimation (QPE) for Solving Molecular Energies
Quantum Computing Applications - Chemistry| Classiq

Cyber Security

Quantum computing is poised to revolutionize cybersecurity by enhancing the efficiency and effectiveness of various classical algorithms used in cyber defense. Techniques such as anomaly detection, malware classification, and intrusion detection, which currently rely on algorithms like Support Vector Machines (SVMs), Decision Trees, and K-Means clustering, could see significant performance improvements through quantum algorithms. For instance, quantum clustering methods have demonstrated superior performance compared to classical clustering techniques in analyzing cybersecurity vulnerabilities. Additionally, quantum deep learning-based anomaly detection techniques offer robust solutions for identifying network attacks, potentially leading to more efficient and accurate threat detection systems.

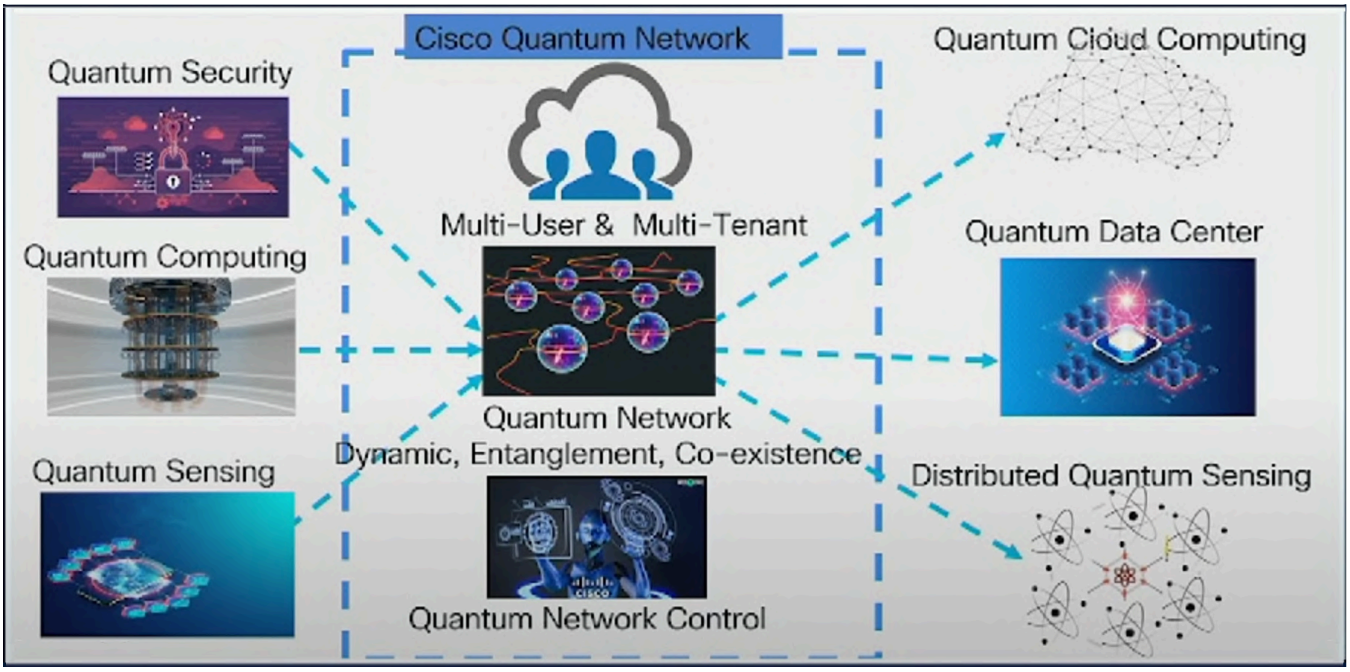
While much of this research remains in the academic realm, the potential applications of quantum computing in cybersecurity are vast. The ability of quantum computers to encode complex relationships using quantum states, represent quantum uncertainty, allowing for richer, more complex representations of probabilistic systems, Capture correlations using quantum entanglement, enabling non-classical dependency structures, Utilize quantum inference methods like quantum measurement and amplitude amplification and process complex computations at unprecedented speeds could enable real-time analysis of large datasets, rapid identification of sophisticated cyber threats.

Quantum Technology at the Forefront of Cyber Defense - Defence Cyber Marvel 3
Defence Cyber Marvel 3 (DCM3), Europe's premier cyber defense exercise organized by the Army Cyber Association, brings together defense, government, industry, and international allies to tackle evolving cyber threats in a simulated environment. The event showcases cutting-edge technologies critical to network security. A highlight of DCM3 is the integration of quantum computing, led by Infleqtion utilizing Oxford Quantum Circuits' 32-qubit OQC Toshiko superconducting quantum computer to demonstrate the potential of quantum systems in cybersecurity. The company focuses on identifying maximally distinguishable quantum circuits to simulate files in distributed databases, illustrating quantum computing's capacity for secure and efficient data management. By bridging quantum technology and cyber defense, DCM3 underscores the transformative potential of quantum systems in addressing critical security challenges.

IBM's patent, "Quantum Computing Machine Learning for Security Threats" introduces a transformative approach to cybersecurity by combining quantum computing and machine learning to counter non-linear cyberattacks. Utilizing the Bloch sphere for attack path visualization and the Quantum State Probabilities Matrix (QSPM) for predicting attacker transitions, this innovation enables real-time threat analysis and proactive defense strategies. By anticipating unpredictable attack patterns, identifying adversary profiles, and strengthening cloud security, this quantum-enhanced model addresses the limitations of traditional linear frameworks.
IBM Quantum Computing Machine Learning Cyber Warfare - Threat Detection and Response

EPRI Energy explores AI-enhanced cybersecurity in utilities, focusing on quantum science and technology. The Quantum Challenge initiative aims to speed up adopting new quantum tech in the electric industry.
Quantum Technologies for AI-Enhanced Utility Cybersecurity

Cisco is at the forefront of quantum technology, with significant contributions spanning quantum networking, security, and collaboration within the quantum research community. As a corporate partner of the Chicago Quantum Exchange, Cisco is driving innovation in quantum communications and research, fostering partnerships to develop groundbreaking technologies. Cisco's Quantum Research Lab is central to its efforts, exploring quantum algorithms, systems integration, and applications to address critical challenges in networking and security. The company is also committed to developing quantum-safe standards, focusing on quantum key distribution (QKD) and other cryptographic techniques to mitigate future quantum cyber threats.



Cisco Quantum Summit 2024; What Cisco is Researching, Developing, and Incubating in Quantum Networking (presentation)

Sample academic papers:

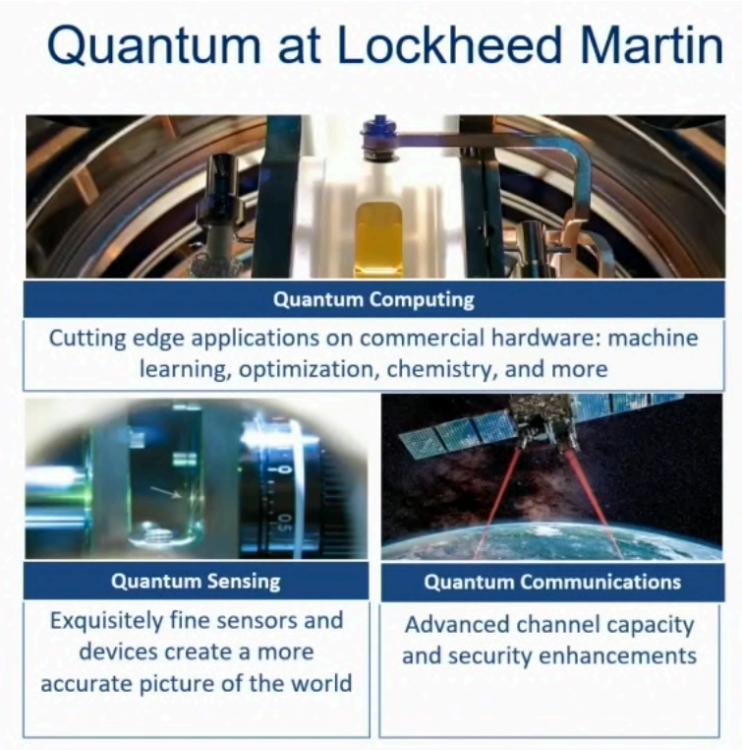
Quantum deep learning-based anomaly detection for enhanced network security
Network attack detection scheme based on variational quantum neural network
Quantum Machine Learning Algorithms for Big Data Analytics in Cyber Security
Analysis of a Huge Amount of Network Traffic Based on Quantum Machine Learning
A Quantum LSTM-based approach to cyber threat detection in virtual environment
Adaptive Quantum Learning Frameworks for Real-Time IIoT Attack Identification
QML-IDS: Quantum Machine Learning Intrusion Detection System

Enhancing Cyber Security Using Quantum Computing and Artificial Intelligence: A Review

Classiq > Applications > Cyber Security > Link Monitoring for Internet-of-Things
Classiq > Applications > Cyber Security > Tackling Kill-Chains with Quantum Computing
Classiq > Algorithms > QML > Hybrid Classical Quantum Neural Networks (e.g. Cyberattack Detection)
Quantum Cyber Security | Classiq

Defense & Aerospace

Quantum technologies hold transformative potential in defense and aviation through advancements in computing, sensing, and networking. Quantum computing enables rapid simulations for aerodynamics, structural modeling, and mission planning, offering strategic advantages. Quantum sensing enhances navigation, detection, and surveillance systems with unprecedented precision, such as detecting submarines or stealth aircraft. Networking advancements through quantum communication provide ultra-secure data transmission, ensuring confidentiality in military operations. These technologies also support optimization of logistics, fuel efficiency, and fleet management. Additionally, quantum computers can potentially break classical encryption, which defense sectors aim to exploit for offensive as well as must be ready on the defensive side with cybersecurity strategies. These applications collectively strengthen operational efficiency and security across the defense and aviation domains.



Lufthansa Industry Solutions is set to concentrate on air traffic applications, utilizing quantum computing to optimize maintenance processes, flight plans, flight routes, gate assignments, and air cargo distribution. The focus will be on solving scheduling and routing problems within the aviation industry.
Quantum algorithms for optimal processing at airports

Delta Airline has entered a multi-year contract with the IBM Quantum Network to accelerate quantum research and application development.
Delta Partners with IBM to Explore Quantum Computing

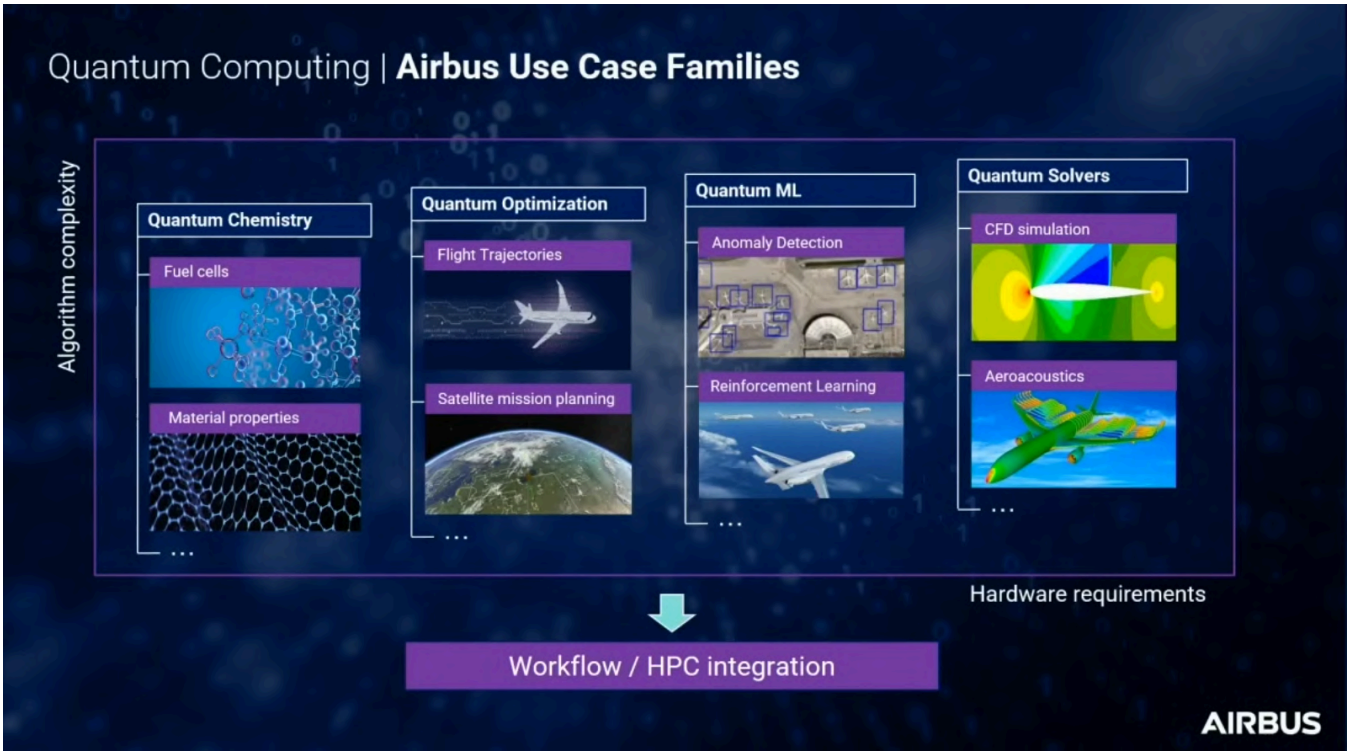
Lockheed Martin is a member of QED-C. The USC-Lockheed Martin Quantum Computing Center is a joint scientific research effort between Lockheed Martin Corporation and the University of Southern California.
USC-Lockheed Martin Quantum Computing Center

Rolls-Royce will work with Classiq on a hybrid approach to quantum computing that will speed up testing.
NVIDIA, Rolls-Royce and Classiq Announce Quantum Computing Breakthrough for Computational Fluid Dynamics in Jet Engines

GE showcased quantum computing's potential, focusing on optimization and demonstrating its application in Aviation service shops. Additionally, IonQ and GE Research collaborated on risk management using hybrid quantum computing to predict future performance from historical data indexes.
[IonQ and GE Research Demonstrate High Potential of Quantum Computing for Risk Aggregation]

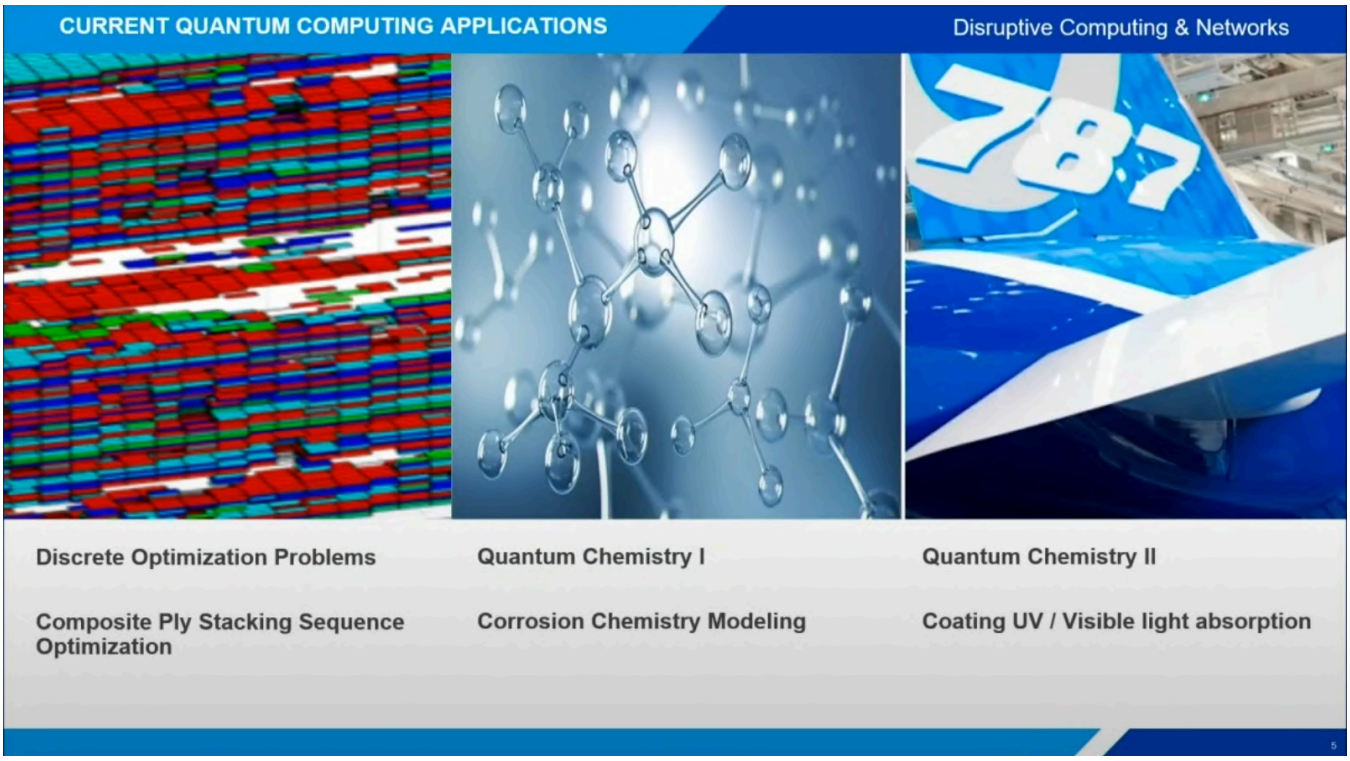
Airbus is leveraging quantum computing to tackle critical aerospace challenges and advance its products and services. The company focuses on quantum computing, sensing, and communication. By collaborating with organizations like IonQ, Q-CTRL, and QC Ware, Airbus and initiatives such as the Airbus Quantum Computing Challenge and partnerships with global and European stakeholders, Airbus is actively shaping the future of quantum technologies to improve operational efficiency, sustainability, and product innovation. In addition, its leadership in the European Quantum Communication Infrastructure (QCI) initiative underscores Airbus's commitment to advancing quantum communication and sensing technologies.

Quantum computing supports Airbus's ambition to address the high computational demands of the aerospace industry, particularly in areas such as computational fluid dynamics (CFD), optimization, and machine learning. Recent projects include fuel cell modeling for hydrogen-powered aircraft and flight path optimization, which aims to enhance fuel efficiency by integrating quantum algorithms. Airbus also focuses on quantum-inspired techniques for solving combinatorial problems like aircraft loading and trajectory planning. With ongoing collaborations, Airbus is developing algorithms and hardware-efficient solutions tailored to aerospace and energy challenges, driving the industry's transition toward sustainable innovation.



[Q2B 2022 SV | Bringing Aerospace into the Quantum Era | Jasper Krauser | Airbus]

Boeing partners with IBM Quantum for aerospace innovation, exploring corrosion solutions and supporting young researchers through the Boeing Quantum Creators Prize. Their Disruptive Computing & Networks unit focuses on practical quantum aerospace applications.



Q2B 2022 SV | Aerospace and Materials Design Use Cases for Quantum Computers | Jay Lowell

Classiq > Applications > Optimization > Max Clique Problem (e.g. Air conflict resolution)
Classiq > Algorithms > HHL Algorithm (e.g. Computational Fluid Dynamics)
Classiq > Algorithms > Algebraic > Shor (e.g. Decryption Attacks)
Quantum for Aerospace & Defense | Classiq