Digital Transformation NETWORK

A Business Software Alliance Initiative

Quantum Leap

A New Computing Reality

Quantum computing (QC) is not just a faster form of classical computing—it's a fundamentally different paradigm. Traditional computers rely on bits that represent either a 0 or a 1. Quantum computers, on the other hand, use qubits, which can exist in multiple states simultaneously, thanks to principles like superposition and entanglement. This allows quantum systems to explore vast solution spaces all at once, offering radically new ways to solve complex problems—from simulating advanced chemical reactions to optimizing global supply chains.

Although still an emerging technology, quantum computing is already demonstrating meaningful progress and early practical applications. That's where this report begins. This report explores how quantum technologies are being applied across industries today—often in combination with artificial intelligence (AI)—and where they're headed next. From materials science and energy to finance, healthcare, and national defense, quantum computing is beginning to reshape entire sectors. As we continue in the International Year of Quantum Science and Technology[1] in 2025, BSA also outlines key policy considerations to help ensure global stakeholders are prepared for what comes next.

Quantum is a fundamentally different way of computing. Still in its infancy, this technology could transform everything from particle physics to financial services, bringing great benefits to society and the economy alike. BSA members are at the cutting edge of quantum developments. This report sets out the work they are doing, and the next steps for quantum technology. Divided into three sections, it explores:

SECTION 1
Quantum for industry

SECTION 2
Quantum for services

SECTION 3
Quantum for science

SECTION 1

Material Changes: Quantum for Industry

QC at scale, especially when combined with AI, could turbocharge fields such as drug discovery, smart electrical grid integration, and materials engineering, according to a new report[2] by the Quantum Economic Development Consortium (QED-C). And according to Microsoft,[3] QC could help solve the mysteries of material science, such as why certain materials suffer corrosion or cracks. Scientists could create self-healing materials that repair bridges, airplane parts, and shattered phone screens.

Some of the biggest developments are in areas where governments actively encourage and support businesses engaged in delivering and using quantum solutions, such as material science, healthcare, logistics, and energy. BSA members have been working on every aspect of quantum technology, including chips, networking, sensors, programming languages, algorithms, error mitigation, and integration solutions.

DX AT WORK

AUTODESK

DX at Work: Building Bridges, Better

British firm Arup has always embraced new technologies: in 1968, they used room-sized computing systems to design the Sydney Opera House. Today, they're using AI-based tools to solve for complex problems like wind analysis. Arup's teams are researching how to use quantum computing simulators to model complex physical phenomena like bridge deflection under passing loads, says Rob Greig, Arup's Global Chief Information Officer, explained in his **Autodesk** University talk.[4]

"The interesting thing about quantum computers is that they can handle more variables than a normal computer," Greig says. "They approach the problem in a different way, and we can be much more sophisticated about how we answer the questions and challenges that we face in the future."

DX AT WORK

ORACLE

DX at Work: Quantum's Bright Future for Solar

Oracle is working with Swiss startup QMware on a range of hybrid quantum solutions.[5] They recently showcased a quantum machine learning (QML) application that could be used to improve solar forecasting. The quantum model had an error rate of about 8%, which CEO Markus Pflitsch told Silverlinings is "about 41% better than other, non-quantum approaches." AI at scale has already made it easier for utility companies to integrate renewable energy sources[6] with historically volatile outputs, such as solar, into the grid. Quantum can take that to the next level by knowing when output peaks will come.

SECTION 2

Quantum Is Served: IT, Healthcare, Banking, and Beyond

Quantum has the potential to revolutionize the service industries, from personalized medicine to optimizing delivery routes. The IBM Institute for Business Value writes that QC could significantly transform the financial services landscape.[7] Financial institutions that adopt quantum early could seize major competitive advantages, and experimental quantum systems are already being used to test and develop applications such as targeting and prediction, asset trading optimization, and risk profiling.

DX AT WORK

IBM

DX at Work: Beating a Virus With Computers

Cleveland Clinic researchers are working with **IBM**'s Discovery Accelerator partnership[8] on predicting protein structures in healthcare. Current ML methods are very effective at predicting the structure of small proteins, but not large ones. The team developed a new QAI framework that could predict the folding of a small fragment of Zika virus protein[9] faster and more accurately than state-of-the-art classical computing methods.

"To advance our knowledge of quantum computing, we are starting with problems we know are inadequately solved using classical computing methods," says Daniel Blankenberg, PhD, of the Center for Computational Life Sciences. "If we can overcome these limitations with quantum computing techniques, it will transform our ability to treat rare diseases and develop personalized medicine."

DX AT WORK

DX at Work: A Quantum Shift for Banking and Beyond

Financial services has a history of successfully applying physics to help solve its thorniest problems. The Black-Scholes-Merton model, for example, uses the concept of Brownian motion to price financial instruments—like European call options—over time.

IBM Institute for Business Value foresees great value[10] in applying emerging quantum technology to financial problems, particularly those dealing with uncertainty and constrained optimization. Greater compliance, using behavioral data to enhance customer engagement, and faster reaction to market volatility are some of the specific benefits they expect quantum computing to deliver.

DX AT WORK

salesforce

DX at Work: Quantum to Make the Trains Run on Time

Salesforce's corporate venture arm Salesforce Ventures' first quantum technology investment[11] was in Australian quantum sensing vendor Q-CTRL. The startup's hybrid technology uses AI to bolster quantum computing enterprise adoption.

With their pioneering quantum sensors, Q-CTRL aims to deliver value through quantum technology. They developed a quantum-enhanced rail scheduling solver with the UK's Network Rail[12] utilizing QC to solve problems of unprecedented scale, bringing a practical quantum advantage within reach.

DX AT WORK

Microsoft

DX at Work: Quantum Consultancy

Emulating quantum effects on today's computers has led to the development of Microsoft's Quantum-Inspired Optimization (QIO) algorithms. KPMG is working with **Microsoft**[13] to explore the near-term applications of these, using Azure Quantum—the world's first full-stack, public cloud ecosystem for quantum solutions.

The financial services, telecommunications, logistics, and pharmaceutical sectors could benefit from QIO algorithms, which are great for providing incremental improvements to highly complex processes.

DX AT WORK

DX at Work: When, Not If: After Encryption

Quantum computers will advance human knowledge in many fields. At the same time, they spell the end of current mainstream cryptography methods: put very simply, a big quantum computer can just try every password, all together, all at once. "We must keep moving quickly because we don't know exactly when today's classic cryptography will be broken," **Microsoft** explains.[14]

Together with other with academic and industry partners, they have been developing cryptographical systems that rely on various difficult mathematical problems. The goal is robust, trusted, tested, and standardized post-quantum cryptography.

DX AT WORK

paloalto NETWORKS

DX at Work: Maintaining Cyber Resilience for the Quantum Era

Quantum computing will bring untold benefits but also new risks, namely by breaking the cryptographic foundations of modern cybersecurity. To stay secure in the post-quantum era, global governments from the United States[15] to the European Union[16] are developing strategies to help organizations migrate from vulnerable cryptography to new Post-Quantum Cryptographic (PQC) standards.

Palo Alto Networks is empowering organizations everywhere to take the first step on their quantum migration journeys, through a cryptographic inventory tool[17] to help organizations understand their foundational risk posture and ensuring all new Next Generation Firewalls are "quantum ready" by integrating global PQC standards.

DX AT WORK

CISCO

DX at Work: Scaling Up Quantum

Today's biggest quantum processors have hundreds of qubits, but a lot of meaningful applications will require millions. **Cisco** drew on their experience from when classical computing faced similar challenges, where the solution was to connect smaller nodes together through networking infrastructure.

Scaled-out quantum data centers, where processors work together through specialized networking, will be one practical path forward. Cisco's quantum network entanglement chip,[18] developed as a prototype in collaboration with University of California at Santa Barbara, will help enable this. The chip operates at standard telecom wavelengths, functions at room temperature, and is energy efficient, as well.

DX AT WORK

DX at Work: ERP Suite Smell of Success

Through the **SAP** Innovation Center Network, the company is piloting quantum-inspired algorithms to forecast Enterprise Resource Planning (ERP) supply and demand fluctuations in global manufacturing networks. The goal: optimize inventory levels and supplier coordination, even amid geopolitical and climate-driven disruptions.

"If quantum technologies realize their potential, we may in the future be able to solve complex tasks that even the most powerful supercomputers fail at today," says Martin Heinig, head of New Ventures and Technologies at SAP.[19]

In logistics, for example, the optimal route, mode of transportation, and product quantity for deliveries could be identified at each point in the supply chain and updated in real time as conditions change. For other industries too, enterprise software solutions from SAP could simulate business processes more easily and infinitely faster.

DX AT WORK

DX at Work: A Network for Success

The **IBM** Quantum Network[20] is a worldwide collective shaping the future of quantum computing and fostering quantum research collaborations. IBM offers access to powerful quantum computers via the cloud and powered by Qiskit, the quantum software stack built for performance.

Joining them on this journey are 250+ Fortune 500 companies, academic institutions, national labs, and startups, which comprise the IBM Quantum Network. Quantum technologies could also massively accelerate ML in SAP solutions by making AI super-intelligent and allowing training data to be fed into the software more quickly.

SECTION 3

Entanglement for Untangling Nature: Mysteries, Quantum, and Science

The quantum era promises to take scientific research to the next level, processing the vast amounts of data produced in experiments in a fraction of the time.

QC can be especially useful in fields where fundamental components are influenced by quantum behavior, not just a simple on/off binary, such as chemical simulations and materials science, and the data from particle accelerators.

DX AT WORK

DX at Work: A Quantum Leap for Particle Physics

CERN, the European particle-physics laboratory outside Geneva, Switzerland, produces data faster than the most powerful supercomputers on Earth can store and process it. Quantum computing can help, so CERN became an **IBM** Quantum Hub.[21]

Together, they used a so-called quantum support vector machine (QSVM) to classify data. It can distinguish which collisions produce the Higgs boson, the elementary particle that gives all other fundamental particles mass.

DX AT WORK

DX at Work: A Modeling Contract for Iron Sulfides

Cleveland Clinic, one of America's leading academic medical centers, and Japan's RIKEN national scientific research institute are using **IBM**'s Quantum System One to explore algorithms for electronic structure problems that are fundamental to chemistry.[22]

Building on prior techniques, IBM and RIKEN researchers have made use of quantum hardware to accurately model the electronic structure of iron sulfides, a compound present widely in nature and organic systems.

Conclusion: The Dawn of the Quantum Era

The real-world deployment of quantum computing is just beginning. BSA members are working with partners globally to find game-changing applications for this new technology. To take advantage of this revolution in computing, policymakers need to create an auspicious environment where innovation can thrive. Our accompanying policy document outlines steps global leaders can take to achieve this.

Endnotes

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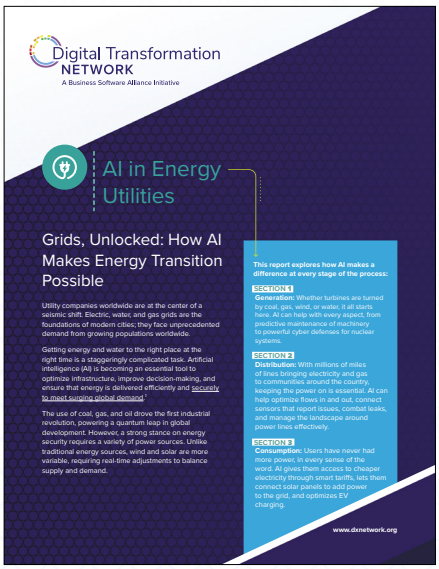
Cross-Sector Series Overview

Digital transformation is having profound impacts across all industries. This series of reports is intended to demonstrate how software-enabled technologies and innovative companies are enabling the creation and improvement of business processes, culture, and customer experiences across sectors.



Grids, Unlocked: How AI Makes Energy Transition Possible

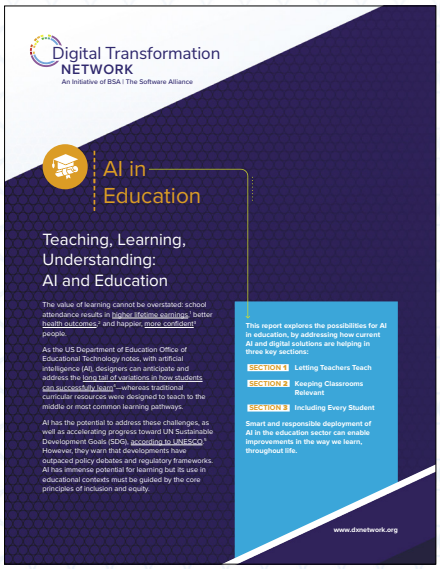
Getting energy and water to the right place at the right time is a staggeringly complicated task. AI is becoming an essential tool to optimize infrastructure, improve decision-making, and ensure that energy is delivered efficiently and securely.

Beyond the Game: AI, Sports, and Digital Transformation

The integration of AI into sports has influenced everything from decision-making among coaches and athletes to where and how people watch events. These real-life examples show how AI is changing the game, for good.

Small Companies, Big Difference: AI Adoption Transforms SMEs

This report explores how AI makes a difference for SMEs in three key areas: saving time and money, improving customer journeys, and enhancing cybersecurity.

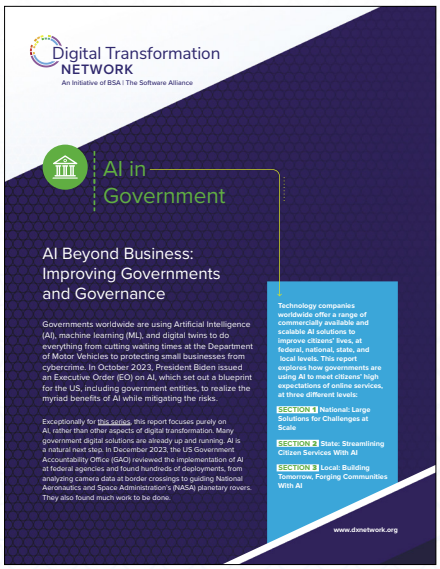


Teaching, Learning, Understanding: AI and Education

This report explores the possibilities for AI in education, by addressing how current AI and digital solutions are helping in three key sections: letting teachers teach, keeping classrooms relevant, and including every student.

From Farm to Fork: Agriculture's AI Transformation

This report explores how AI is already helping farmers grow safe, nutritious, sustainable food for the world's growing population—and what comes next.



AI Beyond Business: Improving Governments and Governance

Governments worldwide are using Artificial Intelligence (AI), machine learning, and digital twins to do everything from cutting waiting times at the Department of Motor Vehicles to protecting small businesses from cybercrime.

Digital Tools Transform Supply Chain Management

In the last decade supply chains have gone from a quiet, background corporate function to a global buzzword. The COVID pandemic, war in Ukraine, Brexit, and volatile energy prices have brought disruption to everything from basic vegetables on the dinner table to luxury vehicle deliveries.

AI and Digital Tools for Better Health

As artificial intelligence (AI), machine learning (ML), and cloud computing become mainstream, health professionals worldwide are finding these new tools equally invaluable.

Learn more at www.dxnetwork.org/sectors/.

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