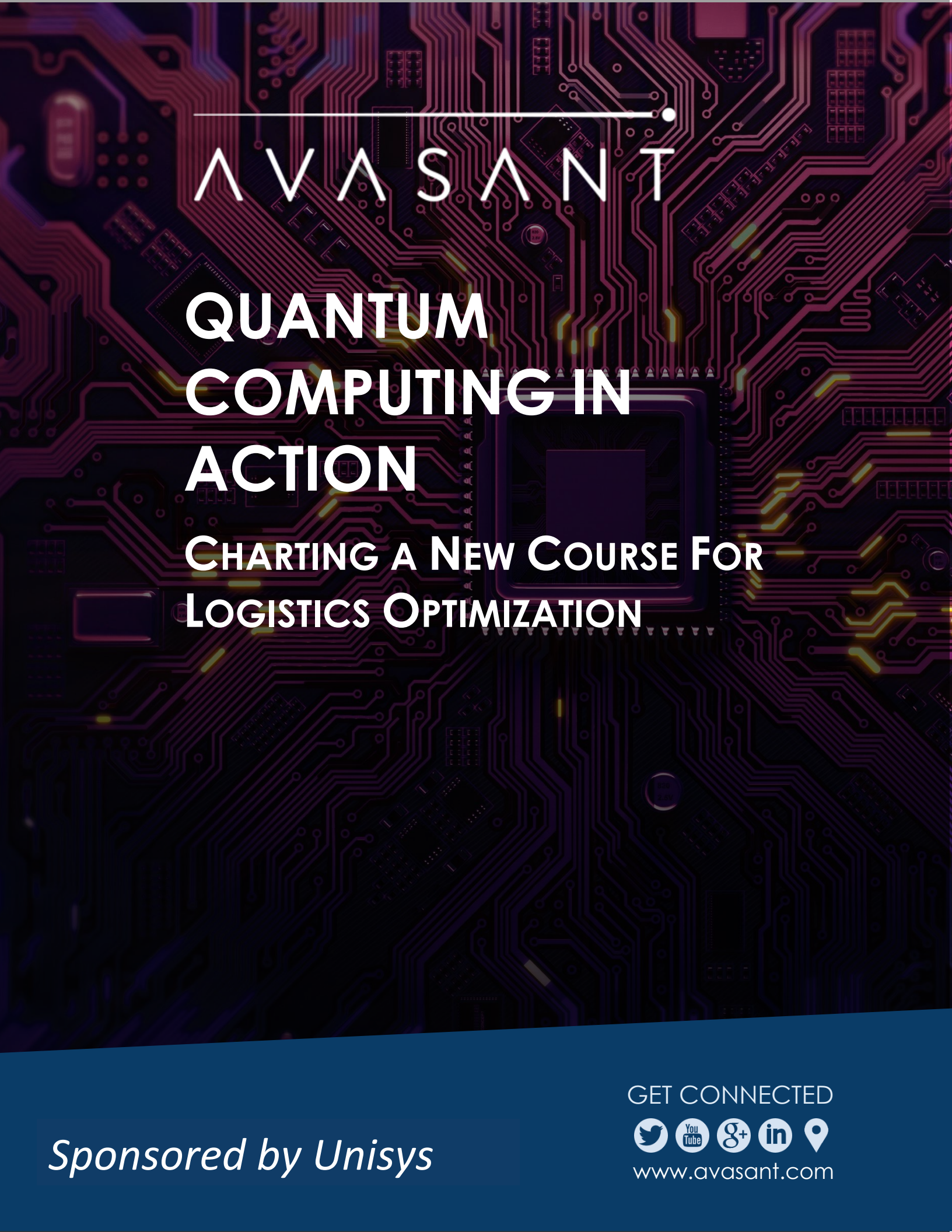

QUANTUM COMPUTING IN ACTION

CHARTING A NEW COURSE FOR LOGISTICS OPTIMIZATION

Sponsored by Unisys

INTRODUCTION

In today's interconnected world, optimization decisions, whether large or small, profoundly impact business operations. From optimizing travel routes to reducing risk in financial operations, optimization permeates the most foundational aspects of business workflows. Nevertheless, not all of these decisions are straightforward. Business problems with an exponential set of potential solutions, such as the traveling salesperson problem that aims to find the shortest possible route to deliver mail and packages, are notoriously tough due to the necessity of exploring all options to reach the best solution. This highlights the paramount importance of data and understanding its intricate relationships in deriving the most optimal solutions.

DATA IS THE KEY

Data has always been a cornerstone of digital transformation. But enterprises that lack robust data management and insights strategy often struggle to fully realize the benefits of digital initiatives. Figure 1 identifies common data-related challenges.

Figure 1: The most prominent data-related challenges organizations encounter.

Data visibility: With a substantial portion of enterprise data being unstructured (for example, handwritten notes, email communications, images of cargo, and voice recordings), it often turns into "dark data," which remains unused as training data and, therefore, unsearchable in conventional databases. This unused data ends up being overlooked for business intelligence purposes. The problem becomes more pronounced in hybrid, heterogeneous landscapes, where data is dispersed across various systems, leading to limited or no visibility. To counter this, organizations should leverage advanced data discovery tools, data cataloging, and artificial intelligence/machine learning (AI/ML) technologies to analyze and process unstructured and "dark data."

Data observability: Traditional data quality tools with predefined metrics based on data management policies are still widely used. These tools are typically designed for technical teams and fail to incorporate data quality considerations from operational teams. Instead, organizations must adopt data observability tools that use ML and statistical analysis for real-time monitoring, anomaly alerts, and issue resolution. This approach encourages business and technical teams to contribute to data quality initiatives.

Quality training data: Acquiring, labeling, and preparing training data for ML models is often intricate and time-consuming. Most companies overinvest in creating unique training datasets when pre-trained ML models could offer a quicker deployment.

Real-time data processing: Many organizations lack the tools to process newly generated data. As IoT and edge devices produce fresh data, enterprises must classify and structure this data immediately. Doing so ensures the ML models remain up-to-date, enabling them to detect data patterns and insights that mirror the latest market trends.

Addressing these challenges requires strategic investment in innovative tools, robust data management practices, and using pre-trained ML models effectively. However, the ever-accelerating pace of data generation and the need to run numerous scenarios for optimal decision-making continues to be daunting. The limitations of traditional computing capabilities often pose significant challenges in managing vast amounts of data in real-time. This situation underscores the need to pivot to the next generation of computing power—high-performance computing, edge, and quantum computing modalities.

HARNESSING REAL-TIME INSIGHTS WITH QUANTUM

Quantum computing, a popular topic of conversation today, is rapidly integrating into the mainstream. Classical computers, operating on bits that can hold a value of either 0 or 1, execute computations sequentially, which makes them optimal for addressing problems without an exponential quantity of variables. In contrast, quantum computers bring forth an innovative model of computation built on the principles of quantum mechanics. Unlike their classical counterparts, these computers utilize quantum bits, or qubits, which can exist in a superposition of states, simultaneously representing a spectrum of values between 0 and 1. This enables them to perform synchronous calculations and solve intricate scientific and engineering issues that involve factoring, optimization, materials science, and chemistry.

Beyond pure science and academia, quantum computing offers compelling practical implications. Quantum systems can execute business tasks traditionally reliant on time-intensive computations in a fraction of the time required by their classical counterparts. This newfound speed paves the way for real-time analytics, improved decision-making, more accurate forecasting, rapid prototyping, and the development of novel products. While gate-based quantum computing still faces challenges, such as high noise and decoherence, specific complex problems, notably in optimization, can be solved now using quantum annealers, which are relatively immune to these errors. Quantum annealers are digital architectures that perform parallel, real-time optimization calculations with speed, precision, and scale, leap ahead of classical computing.

While gate-based quantum computing holds immense potential to transform the computing, networking, sensing, and security paradigm, its widespread use is limited due to obstacles such as high noise levels and decoherence. However, these challenges only partially limit the broader scope of quantum technology. Quantum annealers, in particular, demonstrate resilience to these errors, presenting an immediate solution for tackling complex business problems, primarily optimization tasks. Major technology

companies such as IBM, Google, and Microsoft are steadfastly pursuing advances in gate-based quantum computing. Simultaneously, other firms, namely D-Wave Systems, Quantinuum, and 1Qbit are channeling their expertise into quantum annealing. While the former holds promise for various applications, including simulations, cybersecurity, and developing new materials, the latter finds its forte in optimization problems.

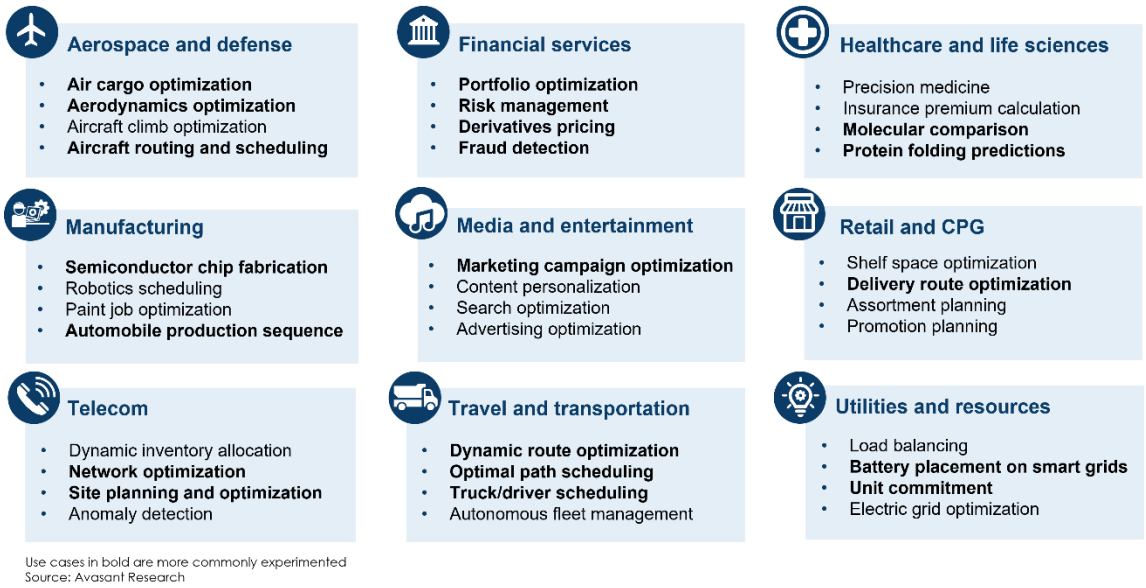

Figure 2: Indicative list of industry-specific use cases gaining traction in quantum optimization.

As we anticipate the full realization of gate-based quantum computers, quantum annealing has emerged as a stepping stone toward this futuristic technology. Despite their limited problem-solving scope compared to what we expect from full-fledged quantum computers, quantum annealers come with a unique set of benefits. They are relatively simpler to construct, reducing the technical and resource barriers to entry. More significantly, they offer computational superiority over classical computers in handling certain optimization tasks, where their real value lies. Today, we see many enterprises leveraging quantum annealers to solve intricate optimization problems previously difficult or impossible to resolve using classical computers.

CASE IN POINT: LOGISTICS OPTIMIZATION

The COVID-19 pandemic has pushed enterprises into uncharted territory, leading to unprecedented challenges in developing and maintaining efficient logistics processes. Adding to the complexity are geopolitical issues, such as the Russia-Ukraine conflict, which have sparked volatility in fuel prices and transportation costs, further straining logistics operations. Lack of transparency in supply chains—another considerable challenge—can negatively impact delivery times and efficiency. Considering the numerous links in the logistics supply chain, from manufacturing to transport and production to distribution, bottlenecks are inevitable. Identifying and rectifying potential errors is critical but equally challenging because communication can falter at multiple points.

For instance, in the aviation industry, with daily operations spanning hundreds of flights, airlines face the constant challenge of utilizing a diverse fleet with different capacities and high operating costs to transport cargo across the globe. It is, therefore, extremely tough to make decisions with multiple complex variables such as fleet availability, revenue maximization, packaging restrictions, and shipment and sustainability priorities.

Source: Avasant Research

Figure 3: Complex optimization problems faced by airlines during air cargo movement.

To help airlines anticipate and evaluate multiple intricate factors in their decision-making processes across the movement of goods through the value chain, Unisys has introduced an advanced data analytics solution suite, Unisys Quantum IQ™. The first industry product launched under this portfolio is the Unisys Logistics Optimization solution, backed by the company's extensive experience in logistics management systems. Leveraging its domain expertise, Unisys has built complex business workflows and rules engines and collected over 40 million data records across air cargo management operations. Unisys Logistics Optimization solution is a unique data analytics solution that combines this rich domain knowledge with the power of hybrid quantum computing. This architecture leverages the strengths of both classical and quantum computing.

The unique proposition of Quantum IQ is its utilization of quantum annealers enabling the execution of numerous optimization scenarios that previously would have taken days on traditional computing platforms. Moreover, as new data is generated and collected from IoT and edge devices, Quantum IQ uses AI to classify and structure this new data as it becomes available. The solution also comprises an in-built reinforcement learning layer to train the data models continuously, ensuring they remain relevant and adaptable to changing logistics dynamics.

End-to-end supply chain visibility – from sourcing to delivery of the final product – is crucial for mitigating risks and minimizing business disruptions. It empowers businesses to respond swiftly to market changes, ensuring operational agility and business continuity amidst uncertainties. Unisys plans to address this enterprise need as part of its product road map for the coming year. It intends to expand its offerings across the logistics value chain, integrating aspects of freight, oceans, and railway, creating an end-to-

end supply chain optimization solution. This solution is also positioned to encompass financial services, such as procurement management and accounts payable and receivable cycles.

A pilot program was launched earlier this year to empower airline customers with predictive optimization strategies. It includes optimal container build suggestions for loading, recommendations for ideal packaging for inventory management, and dynamic rerouting options in response to weather and traffic disruptions. Unisys' plans for expansion into other sectors, such as banking, are already in motion. The extended solutions will cover use cases such as fraud detection, portfolio optimization, and hyper-personalization solutions aimed at reducing customer churn rates. By 2025–2026, Unisys intends to broaden its reach further, catering to the healthcare and telecom sectors, thus positioning itself as a specialized player offering optimization solutions across industries.

CIO TAKEAWAYS

1. **Leverage expert solutions for faster time to market:** Building an in-house data analytics team can be costly and time-consuming, and it can divert focus from primary business objectives. Similarly, partnering directly with platform and computing platform providers can be tedious as they do not fully understand the enterprise architecture from a customization standpoint. Therefore, partnering with service providers with a deep understanding of industry-specific challenges, market trends, and regulatory requirements becomes crucial. It will help organizations develop customized data analytics solutions that align with their operational processes and business goals.
2. **Empower your workforce with an intuitive user interface (UI):** Equip employees with easy-to-use software applications that are quick to deploy through application programming interfaces for faster decision-making. These UIs should be designed with low-code or no-code capabilities, ensuring employees do not need extensive technical expertise to navigate and interpret data. Enterprises must also leverage dashboards as-a-service to avoid duplication of reports and adapt to changing business circumstances more quickly. Additionally, advanced visualizations such as 3D models can be employed for complex tasks, including managing unit load devices in cargo handling operations.
3. **Adopt cutting-edge technologies for competitive edge:** Use quantum computing to process data in real-time and make critical decisions faster, primarily in areas like industrial automation, autonomous vehicles, smart cities, and healthcare, where timely responses are vital to safety and efficiency. While real-time processing facilitates immediate insights, more complex analyses require extensive computational resources and time. Emerging technologies such as 6G and quantum computing offer significant improvements in data processing and communication speed, reducing latency and enhancing the company's agility and responsiveness.