GSMA™

Executive Summary:

Quantum Technologies – Telecom Use Cases

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The GSMA is a global organisation unifying the mobile ecosystem to unlock the full power of connectivity so that people, industry and society thrive.

Led by our members, we represent the interests of over 1,100 operators and businesses in the broader ecosystem. The GSMA also unities the industry at world-leading events, such as MWC (in Barcelona, Kigali, Las Vegas and Shanghai) and the M360 Series.

Unlock the benefits of GSMA membership

As a member of the GSMA, you join a vibrant community of industry leaders and visionaries – helping to shape the future of mobile technology and its transformative impact on societies worldwide.

Our unique position at the heart of the mobile industry means you get exclusive access to our technical experts, data and analysis – as well as unrivalled opportunities for networking, innovation support and skills acceleration.

For more information, please visit: http://www.gsma.com/membership/

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Executive Summary: Quantum Technologies – Telecom Use Cases

1. Overview

Quantum technologies have the potential to transform the telecommunications sector, offering new paradigms for security, computation, sensing, and networking. This whitepaper provides a comprehensive assessment of the state of quantum technologies most relevant to telecoms, including quantum computing, quantum communications, quantum entropy, quantum sensing, and quantum positioning, navigation, and timing (PNT). It is intended for decision makers and senior experts in the broader telecom and tech industry, as well as academics seeking a detailed understanding of use cases, relevance, and maturity of quantum technologies in the telecom context.
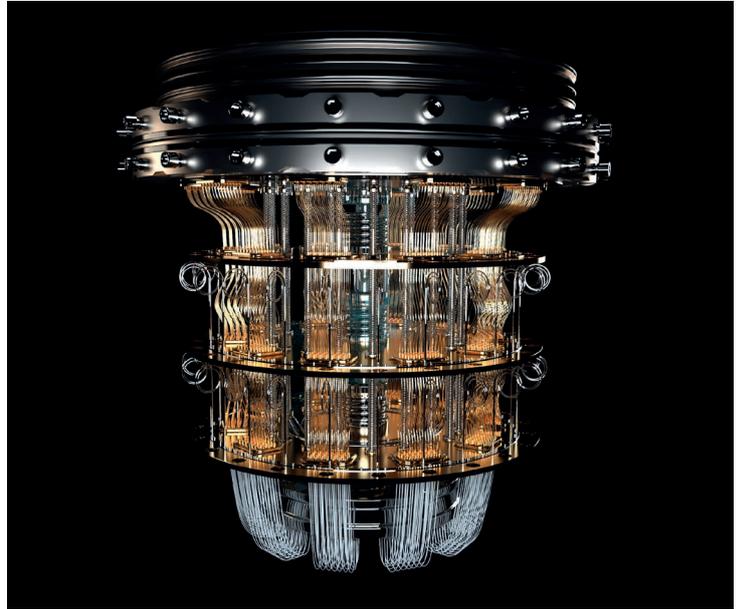
2. Quantum Computing

2.1. Quantum-Computing-as-a-Service (QCaaS)

QCaaS facilitates access to quantum computers by delivering quantum capabilities via cloud platforms. This model allows telecom operators and enterprises to experiment with quantum algorithms for optimisation, cryptography, and AI/ML applications without large upfront investments in specialised hardware. QCaaS can be structured in three layers: frontend (user interface and Software Development Kits (SDKs), middleware (orchestration and job scheduling), and backend (quantum processors). Industry efforts are converging on standardisation (e.g., Quantum Intermediate Representation, QIR) to ensure interoperability across platforms.

2.2. Quantum Computing for Telecom Optimisation

Quantum computing promises to solve complex optimisation problems in telecom, such as network routing, antenna placement, spectrum allocation, and energy-efficient network design. Early pilots show potential for exponential speed-up and improved efficiency. However, current quantum hardware is in the Noisy Intermediate-Scale Quantum (NISQ) era, limiting practical deployment to small-scale problems and hybrid quantum-classical workflows.

2.3. Quantum AI/ML

Quantum Machine Learning (QML) leverages quantum algorithms to enhance traditional ML tasks, with promising applications in predictive maintenance, anomaly detection, customer analytics, and network optimisation. Quantum-inspired techniques, such as Large Language Model (LLM) compression for example, can already deliver tangible benefits in energy savings and data imputation. However, fully quantum-native solutions remain in the research phase, with scalability and benchmarking as key challenges.

# 3. Quantum Communication

3.1. Quantum Key Distribution (QKD)

QKD is the most mature quantum communication technology, enabling ultra-secure key exchange based on quantum mechanics. QKD is being piloted in metropolitan networks and for safeguarding data in sensitive industries such as healthcare and finance. To overcome current distance limitations, trusted nodes as well as new QKD technologies can be used, while satellite based technology is being developed. Standardisation and certification efforts are advancing, but broad adoption is constrained by cost, integration complexity, and skills gaps.

3.2. Quantum Physical Unclonable Function (qPUF)

PUFs provide hardware-based authentication, leveraging physical randomness for device identity. Quantum readout PUFs (QRPUFs) enhance security by using quantum probes, making modelling attacks infeasible. While classical PUFs are deployable today, quantum PUFs remain a long-term vision, dependent on advances in quantum memory and error correction.

3.3. Quantum Networking

Quantum networking enables entanglement-based links between nodes, laying the foundation for the quantum internet. Use cases include distributed quantum computing, ultra-secure cloud services, and advanced sensing. Key challenges include hardware immaturity, synchronisation, cost, and scalability. Industry collaborations are working toward large-scale, fault-tolerant quantum networks by 2030.
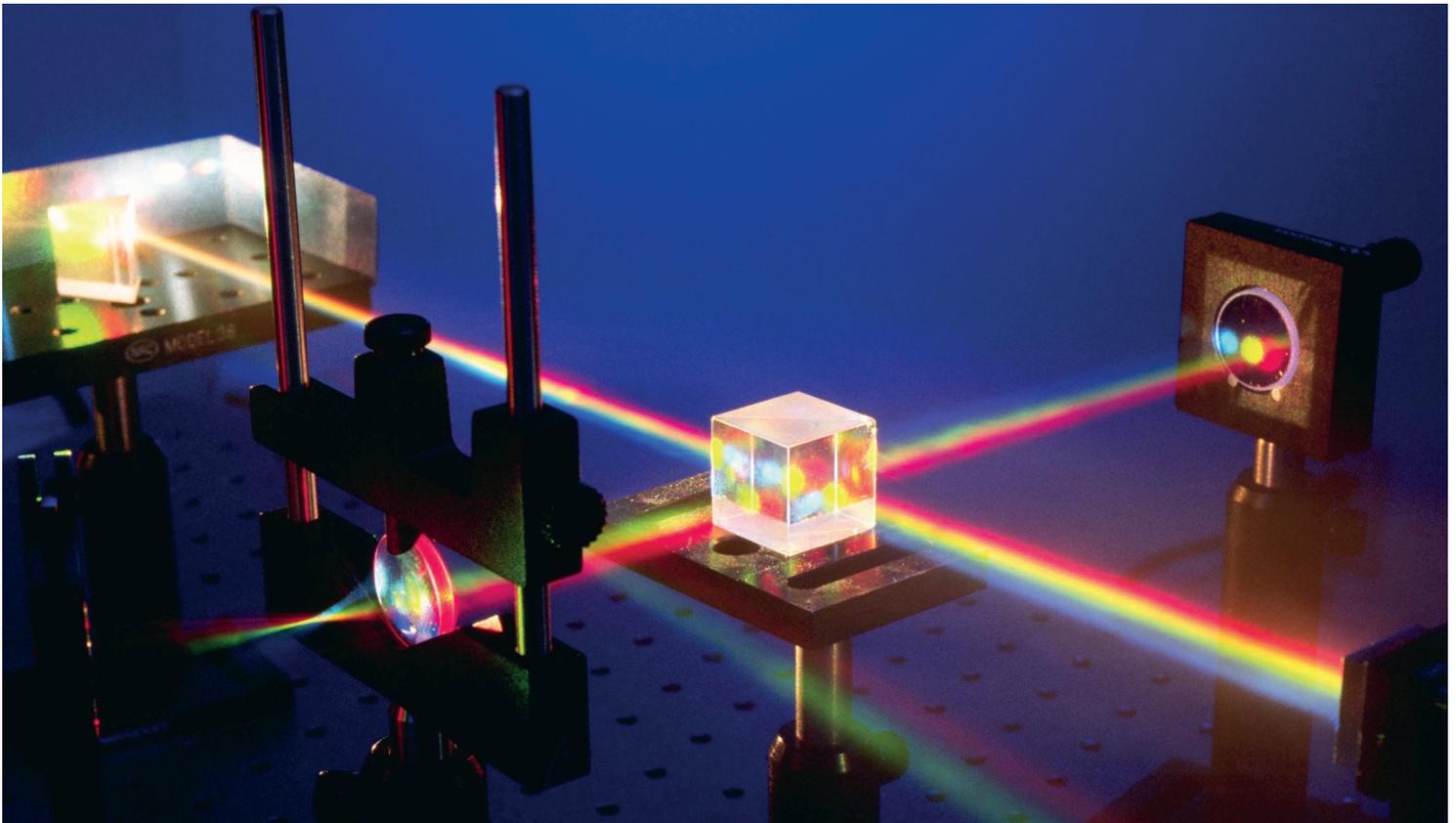
4. Quantum Entropy

Quantum Random Number Generators (QRNGs) provide true randomness, essential for cryptographic protocols. QRNGs are being integrated into hardware security modules (HSMs), virtual private networks (VPNs), and select mobile devices. Quantum-Entropy-as-a-Service (QEaaS) extends secure entropy to IoT and cloud environments. Certification and device-independence remain active areas of development.

5. Quantum Sensing & PNT

Quantum sensing technologies, such as Rydberg atom RF receivers and Superconducting Nanowire Single-Photon Detectors (SNSPDs), offer enhanced sensitivity and precision for telecom applications. SNSPDs are critical for advanced QKD protocols and fibre network monitoring. Quantum PNT (Positioning, Navigation, and Timing) promises drift-free navigation and ultra-precise timing, with potential to enhance or augment classical PNT like GNSS.

6. Challenges, Opportunities, and GSMA's Role

As with many new technologies, there are still several significant challenges across quantum technologies, including hardware fragility and scalability, improved error correction, algorithm and software readiness, integration into existing systems, cost and accessibility, regulatory and security concerns, and skills and workforce gaps.

At the same time, quantum technologies also offer new opportunities, such as unprecedented optimisation power, enhanced classical computing capabilities, new cryptographic paradigms, new services and revenue streams, as well as scientific and R&D leadership.

The GSMA can actively guide the telecom sector's approach to quantum technologies by defining telecom use cases and driving trials, building ecosystems and partnerships, facilitating standardisation and certification, promoting knowledge transfer and skills development and advocating for interoperability and regulatory
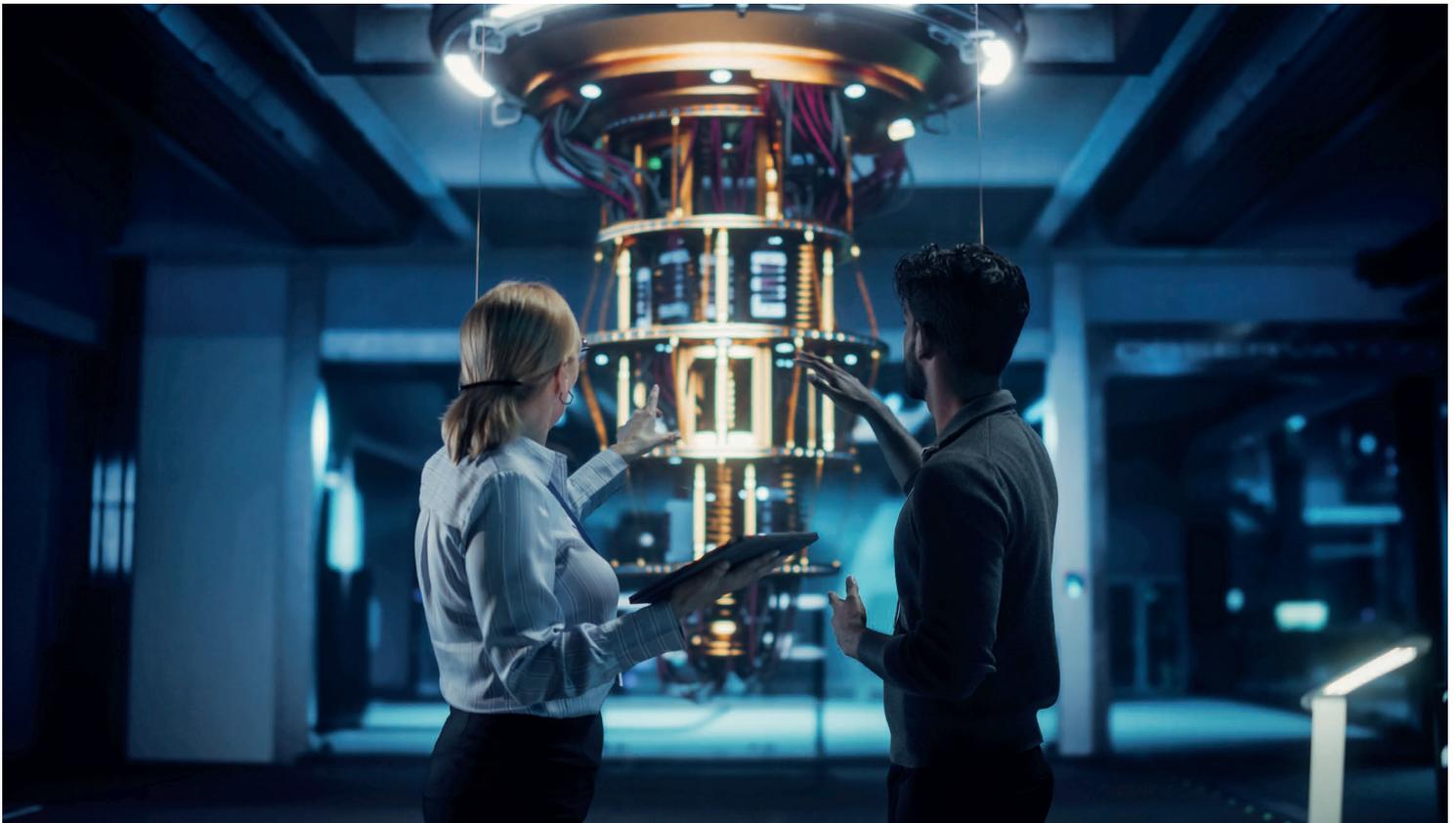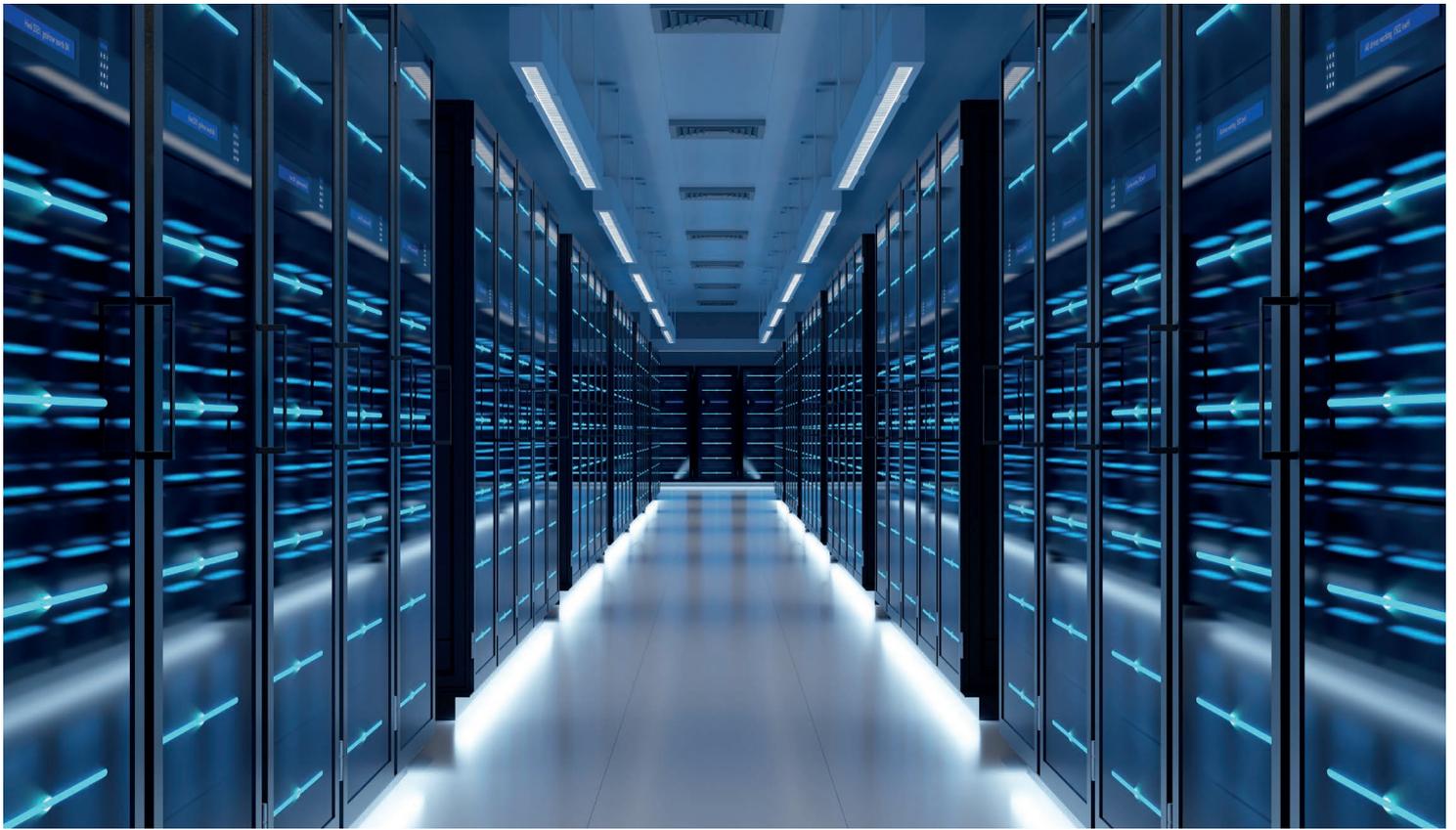
7. Outlook

Quantum technologies are poised to redefine the telecom landscape, enabling secure, efficient, and innovative services. Early adoption and strategic investment can position telecom operators at the forefront of next-generation connectivity. The quantum internet, integrating quantum computing, communication, and sensing, represents the ultimate vision for distributed, entanglement-based networks.