

# Quantum

Briefing paper

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Quantum technology takes advantage of phenomena at sub-atomic scales. Over the next 20 years, this technology will provide significant advances in cryptography, computation, precision navigation and timing (PNT), sensing and imaging, communications, and materials. Quantum is amongst the most nascent of emerging and disruptive technologies (EDTs), with wide investments in applications and research being allocated in this technology.



## Implications

**Economic Implications** – Unprecedented advances in quantum technologies are predicted to significantly impact all key economic sectors in the next decade. Specifically, significant focus will be placed on accelerating computer processing capabilities. For this reason, there is currently a global economic race, with various countries vying to be the first to design, create and deploy this technology.

**Military Implications** – Emerging quantum sensors can provide extremely accurate PNT capabilities, especially in areas where Global Navigation Satellite System (GNSS) is denied. There's potential for gravimetric (or magnetic) sensors to reliably detect submarines and subsequently make the ocean more 'transparent', while new radars could make allied stealth capabilities ineffective. Quantum communications and cryptography can create ultra-secure networks (for example, with intrusion detection and low

probability of intercept), but quantum computing also poses challenges for protecting our own sensitive communication from adversaries. Assisted by AI, quantum modelling and simulation will have the capacity to aid complex decision-making, improve target identification, and fine-tune the accuracy of weapons systems.

**Societal Implications** – Quantum sensing can enable accurate, real-time monitoring of biological processes, accelerated drug discovery, medical imaging, and disease detection. Advances in quantum communications are considered to be essential for developing effective 6G technologies. Quantum computing could also support the development of new sustainable, environmentally friendly materials, thus helping to reduce and offset emissions by improving energy storage and driving more carbon-neutral methods of energy production.



## Key Technology Areas

**Computing** – Quantum computers harness the power of superpositions and entanglement at the sub-atomic level, and could therefore exploit untapped potential for exponential growth in computing power. As such, quantum processors are likely to become a key part of the next generation of supercomputer systems.

**Communications** – Quantum technologies that exploit entanglement (a key principle of quantum mechanics), such as quantum key distribution (QKD) and quantum random number generators (QRNG), are developing at an unprecedentedly rapid rate. It is also notable that, while next-generation post-

quantum encryption techniques already exist and are likely to enhance rather than replace existing secure communications networks, they still require verification and standardisation.

**Sensors** – Quantum sensors are the most developed of the three key quantum technologies, and may greatly exceed the capabilities of their classical counterparts in measuring magnetic, electric, and gravitational fields with substantially increased precision. These types of sensors include technologies such as atomic clocks, gravimeters, accelerometers, magnetometers, optical sensors and GHz-THz radiation detectors.



## Technology Convergence

**AI, Electronics, Energy, Materials, Space and Hypersonics** – Quantum technologies converge with a large number of other EDTs. In particular, quantum computing will have a strong impact on training for robotics and autonomous systems, significantly optimizing these processes. It can additionally enhance AI-enabled software, and facilitate better modelling and simulation for additive and advanced

manufacturing. This in turn would support the development and testing of AI, hypersonics, energy systems, materials, electronic systems and biotechnologies. Quantum communication and sensing will also have a significant impact on space technologies, with improved accuracy, security and sensitivity and an increased use of passive sensors.