White Paper

# Demystifying the Capabilities of Quantum Technologies Available Today and in the Future

## Chapter 2: Quantum Sensing

ATARC Global Quantum Working Group

*July 2024*

Copyright © ATARC 2024

ATARC
Advanced Technology Academic Research Center

# Table of Contents

Introduction ..... 1

Chapter 2- Quantum Sensing ..... 2

Quantum Sensing and Metrology ..... 2

Global Interest in Quantum Sensing ..... 2

Understanding Quantum Sensing ..... 6

- The Advantages of Quantum Sensing ..... 7
- Types of Quantum Sensing Technology ..... 8

Quantum Sensing Providing Commercial and National Security Value ..... 10

- Commercial Value ..... 11
- National Security Value ..... 12
- Research Value ..... 12

Implementation and Challenges ..... 13

- Technology Readiness of Quantum Sensing ..... 14
- Leading Players ..... 16

Quantum Sensing Policy and Recommendations ..... 17

Chapter 2 - Conclusion: A Call to Action for a Future Powered by Quantum Sensing ..... 17

***Disclaimer***: *This white paper was prepared by the ATARC Quantum Working Group members in their personal capacity. The opinions expressed do not reflect any specific individual nor any organization or agency they are affiliated with. This white paper is intended to be a helpful guidance relating to current quantum technological capabilities.*

# Chapter 2: Quantum Sensing

The quantum revolution consists of a surge in quantum technology development capable of disrupting numerous industries. Quantum sensing is one such technology. Quantum sensing is an advanced sensor technology that aims to vastly improve the "accuracy of how we measure, navigate, study, explore, see, and interact with the world around us by sensing changes in motion, and electric and magnetic fields. The analyzed data is collected at the atomic level." By collecting data at the atomic level, quantum sensing technology more accurately detects variations in motion, as well as electric and magnetic fields. This enhances our ability to measure, study, and understand our surroundings.

While realizing the full potential of many quantum technologies may still be years away, tech development is rapidly progressing, promising to unlock new capabilities across various applications and industries. For quantum sensing, the technology is viewed to be more mature than other quantum technologies, and this chapter aims to provide a non-technical review of quantum sensing technologies and discuss their capabilities and maturity levels.

## Quantum Sensing and Metrology

- Quantum properties can be used to significantly enhance sensing and measurement techniques, enabling precision measurements beyond what is possible with classical physics alone. According to Jonathan Dowling, a former U.S. professor in theoretical physics who specialized in quantum sensing and quantum imaging, and Gerard Milburn, an Australian theoretical quantum physicist who specialized in quantum feedback control and quantum measurements, the impact of quantum sensing on fields such as navigation, radiofrequency communications, geological surveying, and medical diagnostics will be significant. Their research shows quantum sensing will provide more accurate and sensitive detection of environmental changes, gravitational fields, electromagnetic radiation, and even molecular structures. Since quantum sensors rely on quantum particles to make measurements, they are inherently more sensitive than traditional sensors, which introduces a significant range of new applications, data insights, and decision-making capabilities.

## Global Interest in Quantum Sensing

As with all quantum technologies, there is interest across governments to advance the science, build the industry, and expedite adoption of powerful quantum sensing technologies.

---

[1] https://www.baesystems.com/en-us/definition/what-is-quantum-sensing#:~:text=Quantum%20Sensing%20is%20an%20advanced,collected%20at%20the%20atomic%20level

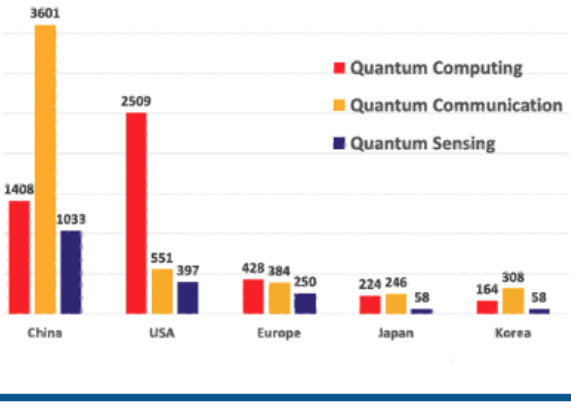
[2] https://royalsocietypublishing.org/doi/10.1098/rsta.2003.1227

NQI funds research projects, workforce development, and public-private partnerships and the quantum sensing programs are focused on accelerating the development of new approaches and prioritize appropriate partnerships with end users to elevate the technology readiness of new quantum sensors. The U.S. government is interested in quantum sensing applications for national security, including threat detection and secure communication, as well as healthcare for early disease detection. However, use of quantum sensing technology is much broader and can impact a variety of different industries including telecommunications, manufacturing, oil & gas, and more. According to the U.S. National Science & Technology Council , the realization of new quantum sensors is tangible, and therefore, a near-term objective should be to enhance adoption of quantum sensors as it will provide a foundation for providing disruptive advantages in a variety of different applications.

The European Union's (E.U.) Quantum Flagship Initiative aims to solidify Europe's position in the global race for quantum technologies including dedicated research projects on quantum sensing, focusing on areas like magnetometry and gyroscopes. The E.U. is particularly interested in quantum sensing applications for navigation, including enhanced GPS capabilities, environmental monitoring, and fundamental science research.

In China, the National Key R&D Program identifies quantum technologies as a strategic priority, listing quantum sensing as a key focus area. Significant investments in that region are being made in research institutions and government-backed companies developing quantum sensing technologies. China is interested in applying quantum sensing technology to advance national security and resource exploration (oil & gas).

Figure 1: Quantum Patents by Country

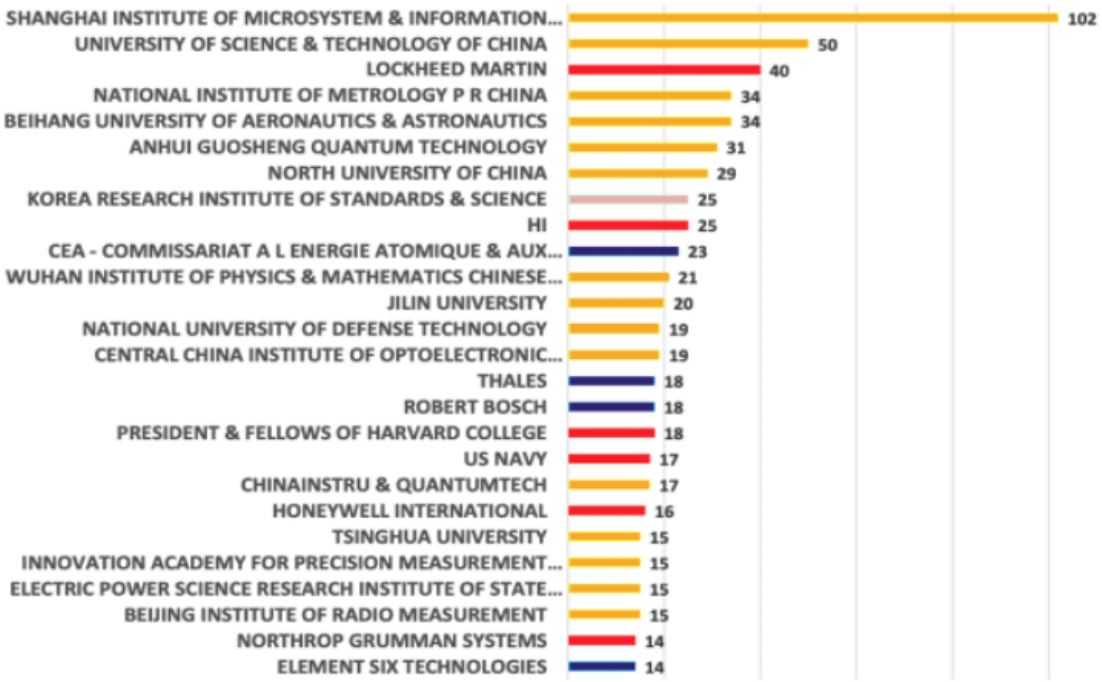



The vast number of quantum patents issued across the globe represents the widespread interest in quantum sensing technologies (see Figure 1). In their 2024 review of quantum patents by country, the European Quantum Consortium (QuIC) showed China leading the way with quantum communications and quantum sensing patents, while the U.S. has the largest number of quantum computing patents.

[3] https://www.quantum.gov/wp-content/uploads/2022/03/BringingQuantumSensorstoFruition.pdf
[4] https://qt.eu/projects/index
[5] https://www.euroquic.org/wp-content/uploads/2024/03/QuIC-White-Paper-IPT-January-2024.pdf

According to QuIC, the patents for quantum sensing (see Figure 2) show the companies, academia and areas of the globe which are heavily focused on quantum sensing technologies. Most of the Chinese patents are with academia while other global regions patents are held by industry and government.

Figure 2: Quantum Sensing Patents by Patent Family




Interest is not solely within governments. According to a recent report from Citi Global Insights, in 2023, venture capital invested $80 million in quantum sensing companies. Citi Global Insights believed that a market of $3.25-5bn could develop for just one type of quantum sensor, in the aviation industry alone.

## Understanding Quantum Sensing

Traditional sensor technologies face several limitations that hinder a sensors ability to measure certain phenomena with the utmost detail. Those limitations include:

- **Sensitivity:** Traditional sensors can only detect signals above a certain threshold. Weak signals, which are crucial for early disease detection or faint environmental changes, often fall below this threshold and remain undetected by traditional sensors.

[6] https://www.citigroup.com/global/insights/global-insights/quantum-sensing-tech-s-new-eyes-and-ears

- **Precision:** All sensors experience noise, which introduce elements of uncertainty into measurements. Noise can limit the precision of a sensor, making it difficult to distinguish between close values.
- **Resolution:** The design and materials used in traditional sensors limit its ability to resolve fine details. For example, a thermometer with a thick mercury bulb may not be able to detect minute changes in temperature with the same level of accuracy as a more sensitive sensor. Measurement of time is also classed as a sensing application. As an example, a common quartz wristwatch is accurate to within 15 seconds in a month. In comparison, atomic clocks are a type of quantum sensing technology that offer the highest resolution measurement of time possible down to less than $1x10^{-10}$ of a fraction of a second, or less than a tenth of a billionth of a second, yielding an accuracy of 1 second variation in 300 million years.

Often, there's a trade-off between these limitations. Increasing sensitivity can sometimes lead to decreased precision due to amplified noise. Similarly, enhancing resolution might require a bulky sensor design, which can impact portability.

## The Advantages of Quantum Sensing

Quantum sensors overcome the limitations of traditional sensors by leveraging unique properties of the quantum world. The superior sensing capabilities offered by quantum technology in some cases is due to several fundamental principles of quantum mechanics: superposition, entanglement, wave/particle duality and atomic energy level structures. These quantum properties make possible the development of sensors capable of unprecedented sensitivity, accuracy, and resolution, thereby opening doors to previously inaccessible measurements. Some sensors, such as atomic clocks, manipulate energy levels of atoms to achieve their measurements. These

**Superposition:** The quantum principle that allows particles, such as atoms, ions, electrons, or photons, to exist in multiple states simultaneously. In classical physics, a system can only be in one state at any given time. For example, a switch is either on or off, not both. However, in the quantum realm, particles can be in a superposition of states, such as being in two places at once or spinning in opposite directions.

**Entanglement:** The quantum phenomenon where pairs or groups of particles become interconnected so that regardless of distance, the state of one instantly influences the state of the other. As such, the measurements performed on one entangled particle immediately affect measurements of the other.

**Atomic energy level structures:** Atoms are composed of a nucleus, containing protons and neutrons, surrounded by a halo or cloud or orbiting electrons. The outermost electrons of an atom of are called “valence” electrons, which is where most quantum sensing occurs. Valence electrons can only exist in discrete energy states. By knowing the energy structure of an atom and manipulating and/or measuring the reaction of a valence electron with light and/or magnetic fields, high precision measurements can be taken, such as the sensing of time and the reception of radio frequency-based signals.

differing capabilities enable quantum sensors to achieve accuracy-levels impossible with classical physics.

Superposition, entanglement, and the nature of the energy level structures of atoms enable quantum sensors to measure with unparalleled sensitivity and precision, detecting faint forces, such as slight variations in gravitational or magnetic fields. The enhanced sensitivity and accuracy over classical sensors, opens up new possibilities in a number of fields and industries, as discussed below.

## Types of Quantum Sensing Technology

Similar to the quantum computing market, quantum sensors are not a monolithic technology. According to Citi Global Insights (see Figure 3) the quantum sensing industry includes a variety of technologies. Complete descriptions of these technologies can be found in the Quantum Economic Development Consortium (QED-C) report on Quantum Sensing Use Cases. Like quantum computing, different technologies are also advancing at different speeds.

Quantum sensing can measure various physical properties and incorporates different materials, each of which provides different benefits to the sensors.

**Atomic Clocks** measure time with incredible accuracy by using the vibrations of atoms, typically cesium or rubidium, as a "pendulum." Repetitive atomic vibrations enable an ultra-precise timekeeping mechanism. This category of sensors leverages the energy level structure of atoms to function.

- **Applications**: Atomic clocks are crucial to maintain accuracy of GPS satellites, since the smallest error in time measurement can lead to significant errors in determining positions on Earth. In fact, all GPS satellites carry an atomic clock, which provides a timing signal that is accessed anytime GPS is used. GPS also plays a vital role in science, technology, and financial systems that require precise time synchronization. Having an on-site atomic clock, instead of relying exclusively on the timing signal from the GPS satellites, enables GPS resilience in the event of lost, jammed, or spoofed GPS signals, and permits greater efficiencies in data processing for data centers.

Quantum Radiofrequency Receivers use specific high-energy atomic states to sense and receive radiofrequencies with a sensitivity many times greater than current antenna technology with a significantly smaller hardware footprint.

[7] https://www.citigroup.com/global/insights/global-insights/quantum-sensing-tech-s-new-eyes-and-ears
[8] https://journals.aps.org/rmp/abstract/10.1103/RevModPhys.89.035002
[9] https://quantumconsortium.org/sensing22/

- **Applications**: Quantum radiofrequency receivers allow for the creation of dark communications networks by detecting low strength radio signals below the noise floor of traditional antenna technology. There is also the possibility of replacing current radio tower infrastructure with much smaller, more energy efficient quantum radiofrequency receiver infrastructure.

**Quantum Magnetometers** measure magnetic fields with extreme sensitivity by measuring the strength and direction of materials, like superconducting qubits or atoms in gas, in the presence of magnetic fields.

- **Applications**: Quantum magnetometers are used in applications ranging from detecting submarines, finding buried artifacts, and mining mineral resources.[1] Within medicine, brain imaging techniques, such as magnetoencephalography, also use quantum magnetometer technology.

**Quantum Gravimeters** measure gravitational forces with high sensitivity. The devices detect minute changes in gravity by observing the behavior of atoms in free fall using techniques related to atomic clocks.

- **Applications**: Quantum gravimeters are used to detect underground structures like tunnels or oil reserves, study volcanic activity changes, and monitor groundwater levels. The devices offer exceptional accuracy in geophysical surveys and underground mapping.

**Quantum Gyroscopes** measure orientation and rotational motion while **Quantum Accelerometers** measure linear movements. Both are inertial quantum sensors.[11] Quantum gyroscopes and accelerometers use the principles of quantum mechanics to measure motion with high accuracy and precision, often through the behavior of supercooled atoms or photons in a state of superposition.

- **Applications**: Quantum gyroscopes and accelerometers have uses in navigation systems for vehicles, ships, and aircraft, especially in environments where GPS is unavailable, unreliable, or intentionally jammed. The devices are critical for drones, ships, aircraft, satellites, and consumer electronics, and will enable truly autonomous self-driving vehicles.

**Quantum Interferometers** measure displacement, optical path length, and physical constants by observing the interference patterns of quantum particles like electrons, neutrons, or photons.

---

[10] https://www.degruyter.com/document/doi/10.1515/teme-2023-0116/html?lang=en
[11] https://www.nktphotonics.com/applications/aerospace-defense/quantum-inertial-sensing/

The devices leverage the wave-like nature of particles to detect changes in the path length with incredible precision.

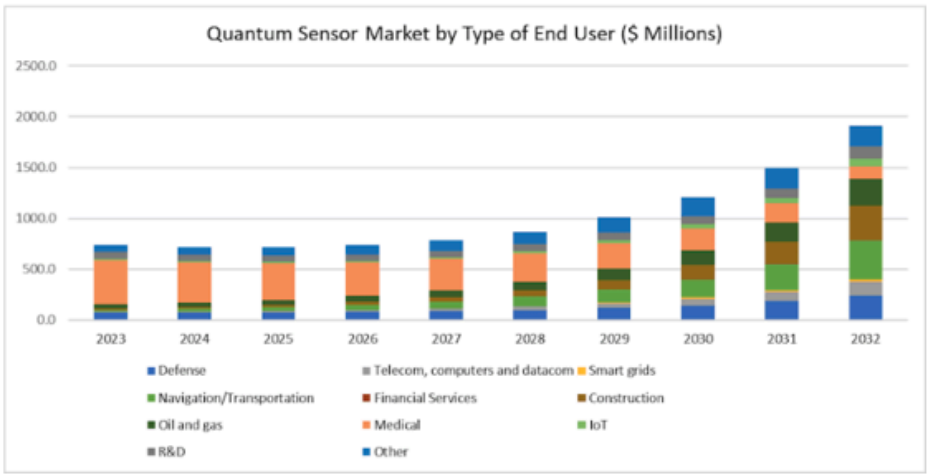
- **Applications**: Quantum interferometers are used in scientific research to test fundamental theories of physics and have applications in detecting gravitational waves, measuring the Earth's rotation, and improving the accuracy of optical measurements. Commercial applications can include tunnel detection for defense and border security, underground surveying, oil and gas exploration, and glacier monitoring.

Quantum sensing technologies offers significant benefits in terms of sensitivity, precision, and the ability to operate in environments where traditional sensors fail. The implications of quantum sensing in commercial industries and national security are profound, making it a focal point of investment and research.

## Quantum Sensing Providing Commercial and National Security Value

Quantum sensing capabilities translate to high commercial and national security value across various sectors. As highlighted by Inside Quantum Technologies News (see Figure 5), There are growing number of industries poised to benefit from quantum sensing technology, including navigation, telecommunications, and sustainable energy to name a few.

Figure 5: Industries who can benefit from Quantum Sensing




[12] https://royalsocietypublishing.org/doi/10.1098/rsta.2003.1227
[13] https://www.insidequantumtechnology.com/news-archive/iqt-researchs-new-report-estimates-revenues-from-quantum-sensors-to-reach-1-9-billion-in-2032/

## Commercial Value

The commercial value of quantum sensors resides within its ability to provide unprecedented accuracy and increased sensitivity. Use cases across industries can vary. In this section we will provide a highlight of potential use cases. This is not deemed to be a full list, but instead a small sampling of the types of use cases and applications per industry.

**Navigation and Positioning**: In addition to improving the accuracy of GPS-free navigation in mining, submarine navigation, and archaeology mentioned above, quantum sensors can lead to safer, more reliable self-driving cars, autonomous drones, and more efficient air travel providing more precise data and enhanced collision avoidance.

**Telecommunications and wireless infrastructure**: All data centers and network communications rely on a timing signal from GPS for time stamping and synchronization; however, GPS signals are easily interrupted and can cause communications and network outages. Enabled with quantum sensors, telecom networks are more resilient against GPS interruptions by offering a local timing signal for continuous operations. High sensitivity quantum radiofrequency receivers can reduce the physical infrastructure footprint of wireless data infrastructure while increasing energy efficiency.

**Medical Diagnostics and Drug Discovery**: In healthcare, quantum sensing technologies can lead to the development of highly sensitive imaging tools, enabling doctors to detect conditions at much earlier stages. For instance, quantum-enhanced medical imaging could detect tiny tumors or minute changes in brain activity, revolutionizing early diagnosis and treatment strategies. Rapid analysis of patient DNA, molecular modeling and drug discovery could enable personalized medicines. By detecting subtle variations in a patient's biology, quantum sensors could pave the way for customized and tailored treatment plans.

**Environmental Monitoring**: Quantum sensors can detect changes in environmental conditions, offering superior data for climate modeling, pollution tracking, and natural disaster prediction. The technology can help monitor volcanic activity, track sea-level rise, or detect pollutants at incredibly low concentrations.

**Energy, Resources Management and Sustainability:** For oil and gas exploration, quantum gravimeters can detect variations in the Earth's gravitational field, helping to identify oil and gas reservoirs more efficiently, thereby reducing the environmental impact of exploration activities. Just as quantum computers can help with the optimization of renewal energy, quantum sensing can also provide detailed environmental data to drive greater efficiency of renewable energy sources.[14] Atomic clocks situated at data centers can promote lower energy consumption by more efficiently processing data.

[14] https://www.nextgov.com/emerging-tech/2023/04/energy-looks-quantum-sensors-grid-optimization/384755/

Quantum gravimeters can provide crucial data for climate change models by detecting slight changes in water distribution or ice melt by measuring variations in the Earth's gravitational field. Quantum sensors designed to detect single molecules can monitor air and water quality in real-time, thereby identifying pollutants at incredibly low concentrations. These data points can help address environmental health risks more effectively.

## National Security Value

According to the Congressional Resource Service[15], the Defense Science Board, an independent Department of Defense (DoD) board of scientific advisors, highlights how quantum sensing can provide several enhanced national security capabilities.

**Surveillance and Intelligence**: Quantum sensors can detect stealth aircraft, submarines, or other vehicles that traditional radar might miss. When mature, quantum-enabled surveillance devices are considered to be able to eavesdrop on electronic communications passively without emitting detectable signals that conventional surveillance techniques rely on. They could also detect electromagnetic emissions which could assist with locating concealed adversary forces, thereby enhancing electronic warfare capabilities.

**Secure Communications**: Through highly accurate timing and synchronization capabilities, quantum sensors are expected to enhance the security and reliability of communication networks. This is especially critical in scenarios where secure, jam-proof communication is essential, such as military operations or critical national infrastructure control.

**Detection of Underground Structures**: With their enhanced sensitivity, quantum sensors can detect hidden underground structures, including bunkers and tunnels, from a distance, providing a strategic advantage in military operations and border security.

**Enhanced Domain Awareness:** The alternative positioning, navigation, and timing options provided by quantum sensing could allow warfighters to continue operating at full performance in environments with low or no GPS accessibility.[16] Quantum magnetometers can detect explosives and other hidden threats with unmatched sensitivity, enhancing security measures at airports, borders, and other critical infrastructure.

## Research Value

Beyond commercial and national security, quantum sensing adds value to the advancement of foundational scientific research. Quantum interferometers can test the limits of general

[15] https://crsreports.congress.gov/product/pdf/IF/IF11836

[16] https://crsreports.congress.gov/product/pdf/IF/IF11836

relativity and quantum mechanics, potentially leading to new discoveries about the universe. Scientists are also using quantum interferometers to study magnetic and electric fields at the atomic scale to further the development of new materials with tailored properties for electronics, computing, and aeronautics.

## Implementation and Challenges

The potential of quantum sensing is vast, but its implementation comes with challenges. Rapid progress of quantum sensing technology is being made to develop portable and robust sensor technology capable of operating in hard environments outside a lab. However, supply chain issues threaten the possibility of high-volume production. If unable to produce at commercial scale, this will limit the ability of quantum sensors to be broadly manufactured and limit their availability for end users.

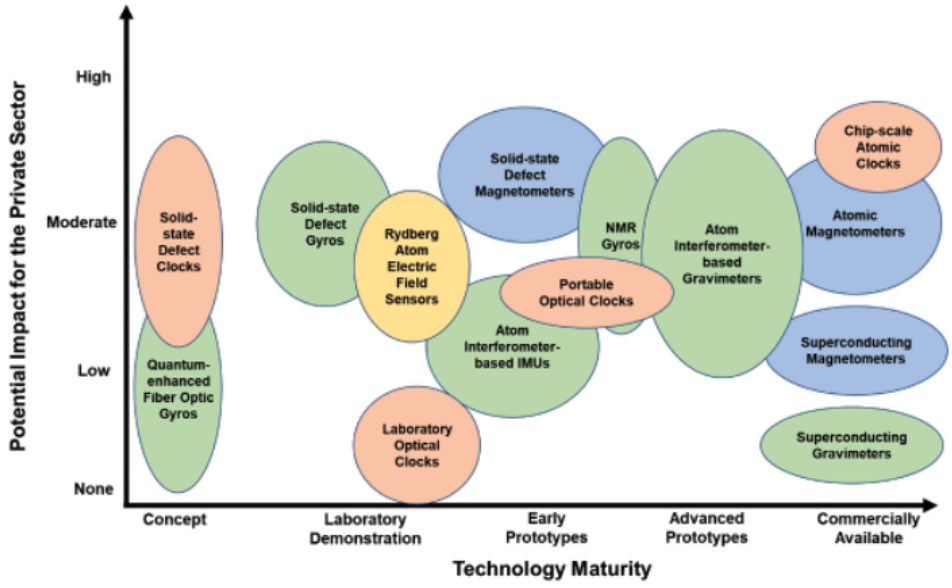
The supply chain of materials, components, and equipment needed to build quantum sensors is widely distributed and possesses multiple points of failure. There may only be a single vendor for a certain element, causing concern over the health of the supply chain. Another challenge is if vendors offer low volume, such that even if a customer had the funding to order thousands of a particular product, the supply chain might not be able to support the order.

Lastly, as with other quantum technologies, there is a need for skilled personnel to operate sensors and interpret sensor data, necessitating substantial investment in education and training. Developing a skilled workforce to build and utilize quantum sensors is needed.

Despite these challenges, the near-term applicability and transformative potential of quantum sensing technology have led to significant public and private investments. Countries and companies are racing to develop and deploy these technologies to capitalize on potential commercial and strategic advantages. As research progresses, and quantum technologies mature, quantum sensing will redefine the landscape of sensing and measurement, with wide-reaching implications across multiple domains.

## Technology Readiness of Quantum Sensing

Figure 6: Notional Projected Impact for the Private Sector for Select Quantum Sensors



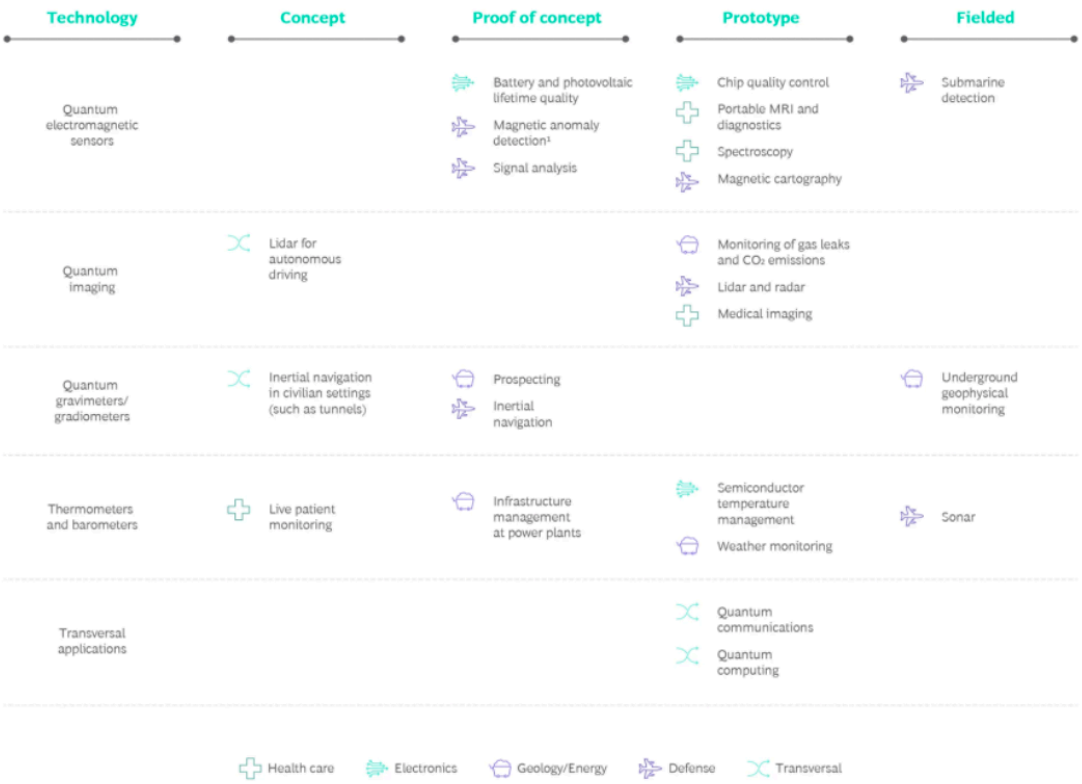

As with quantum computing, a globally recognized, objective technology readiness level assessment for quantum sensing technology does not currently exist. As such, this section highlights the state of the industry as identified by trusted third parties. QED-C released a quantum sensing report in 2022[17] (*see Figure 6*) which showcased the maturity levels of selected quantum sensors. While still in early development, many quantum sensing technologies have already progressed beyond theoretical concepts. Prototype devices are being tested in both laboratory and controlled commercial environments, such as data centers and aircrafts. The current focus of the quantum sensing industry is to develop practical solutions for specific industries. Companies and research institutions are collaborating to address real-world healthcare, navigation, and security challenges using quantum sensing technology.

According to Boston Consulting Group[18], quantum sensing prototypes for many applications in these industries are emerging (*see Figure 7*), while defense and medical applications appear to be the closest to market maturity.

[17] https://quantumconsortium.org/sensing22/

[18] https://www.bcg.com/publications/2023/making-sense-of-quantum-sensing

Figure 7: BCG Assessment of Application Development Levels




Ongoing research and development efforts by innovative technology companies and research institutions are pushing the boundaries of this transformative technology.

## Leading Players:

**Tech Giants:** Large technology companies like IBM, Google, and Honeywell invest heavily in quantum technologies, including quantum sensing.

**Start-ups and Spin-offs:** A wave of innovative start-ups and spin-offs from research institutions are emerging, specifically focused on accelerating the commercialization of quantum sensing technologies. Some include Infleqtion, SBQuantum, LI-COR, QuantaLogic, SandboxAQ, and Apogee Instruments.

**Academic and Research Institutions:** Universities and research labs worldwide play a crucial role in advancing fundamental research and developing quantum sensor concepts and materials. Some research institutions working on quantum sensing include MITRE and the Los Alamos National Laboratory, etc. National Science Foundation (NSF) funded 18 research groups in the U.S. dedicated to quantum sensing.[19]

These efforts highlight the dynamic nature of quantum sensing research. With continued investment and collaboration, we can expect to see significant breakthroughs leading to the development of powerful and versatile quantum sensors that will transform various aspects of our lives.

### Select Examples of Ongoing Efforts

**Miniaturization and Portability:** Companies like QuantaLogic and Infleqtion are developing miniaturized and portable sensors suitable for field applications which can be used for a variety of use cases including medical diagnostics, ordinance detection, telecommunications, etc.

**Stability and Scalability:** NIST and Harvard are exploring methods to improve the stability and scalability of miniature quantum sensing technologies to integrate with quantum computing and enhanced sensitivity for high-resolution biological sensing.

**Room-Temperature Operation:** Honeywell and Los Alamos National Laboratory are developing quantum gyroscopes that function at room temperature, eliminating the need for complex cryogenic cooling systems.

**Advanced Navigation Systems:** Infleqtion, along with researchers from the University of Colorado, demonstrated the world's first software-configured, quantum-enabled high-performance accelerometer by combining machine learning with quantum sensing designed for positioning, navigation, and timing applications.

**Enhanced biomedical diagnostics:** SandboxAQ is developing quantum and AI technology to increase the sensitivity for diagnosis of cardiovascular disease.

[19] https://thequantuminsider.com/2024/04/13/nsf-invests-29-million-in-18-research-teams-for-quantum-sensing-investigations/

## Quantum Sensing Policy and Recommendations

As the field of quantum sensing matures, governments will need to consider various policy issues. This working group recommends the following policy initiatives:

**Funding and research grants**: Continued government funding will be crucial for sustained research and development efforts. Additionally, incentives for private sector investment are needed to translate research into practical applications.

**Collaboration between government and private sector**: Fostering solid partnerships between the public and private sectors is vital for commercialization. Governments and private companies should form joint ventures to co-develop and commercialize quantum sensing technologies to expedite the development and deployment of the technology.

**Standardization efforts**: Establishing standards will ensure device compatibility and interoperability as quantum sensing technologies mature.

**Workforce development:** A skilled workforce with expertise in quantum mechanics and related fields is crucial for successfully developing and deploying quantum sensing technologies. Government programs should continue to focus on workforce development for quantum technologies.

**Quantum supply chains:** Governments should consider allocating funding to support the development of robust quantum supply chains. Doing so will protect national security and enable the growth of a robust quantum ecosystem.

**Enhanced international agreements:** To ensure a robust and safe supply chain, international quantum agreements should include provisions to protect supply chains.

Continued government support, international collaboration, and effective policy frameworks will be crucial to unlock the full potential of this transformative technology in the years to come.

# Chapter 2: Conclusion: A Call to Action for a Future Powered by Quantum Sensing

Quantum sensing stands poised to revolutionize numerous industries with unprecedented measurement capabilities. From revolutionizing healthcare diagnostics to enhancing national security measures, the applications of quantum sensing technology are vast and hold immense potential for economic growth and societal well-being.

However, if we are to reap the full potential of quantum sensors, it is critical to act now while the global race for quantum dominance accelerates. Failing to invest in, develop, and commercialize quantum sensors will result in loss of economic opportunity, harm to national security, and loss of battlefield advantage to adversaries.

> **C-Suite executives:** Explore the potential of quantum sensing for your business. Engage with research institutions and technology companies to understand how this technology can address your industry's challenges and unlock new opportunities. Early adoption positions you as a leader in the emerging quantum economy
>
> **Government policymakers:** Recognize the strategic national security and economic importance of quantum sensing. Increase funding for research and development efforts, help to develop a robust quantum ecosystem and supply chain, incentivize private sector investment, and foster a collaborative ecosystem. By supporting the advancement of quantum technology, you are investing in the nation's future economy, security, and scientific leadership. In the U.S., this means reauthorizing the National Quantum Initiative, which expired in September 2023.

The time to explore the transformative power of quantum sensing is now. We can unlock its potential through collective action and pave the way for a future filled with groundbreaking advancements across all sectors. Let's harness the power of the quantum world and build a better tomorrow.