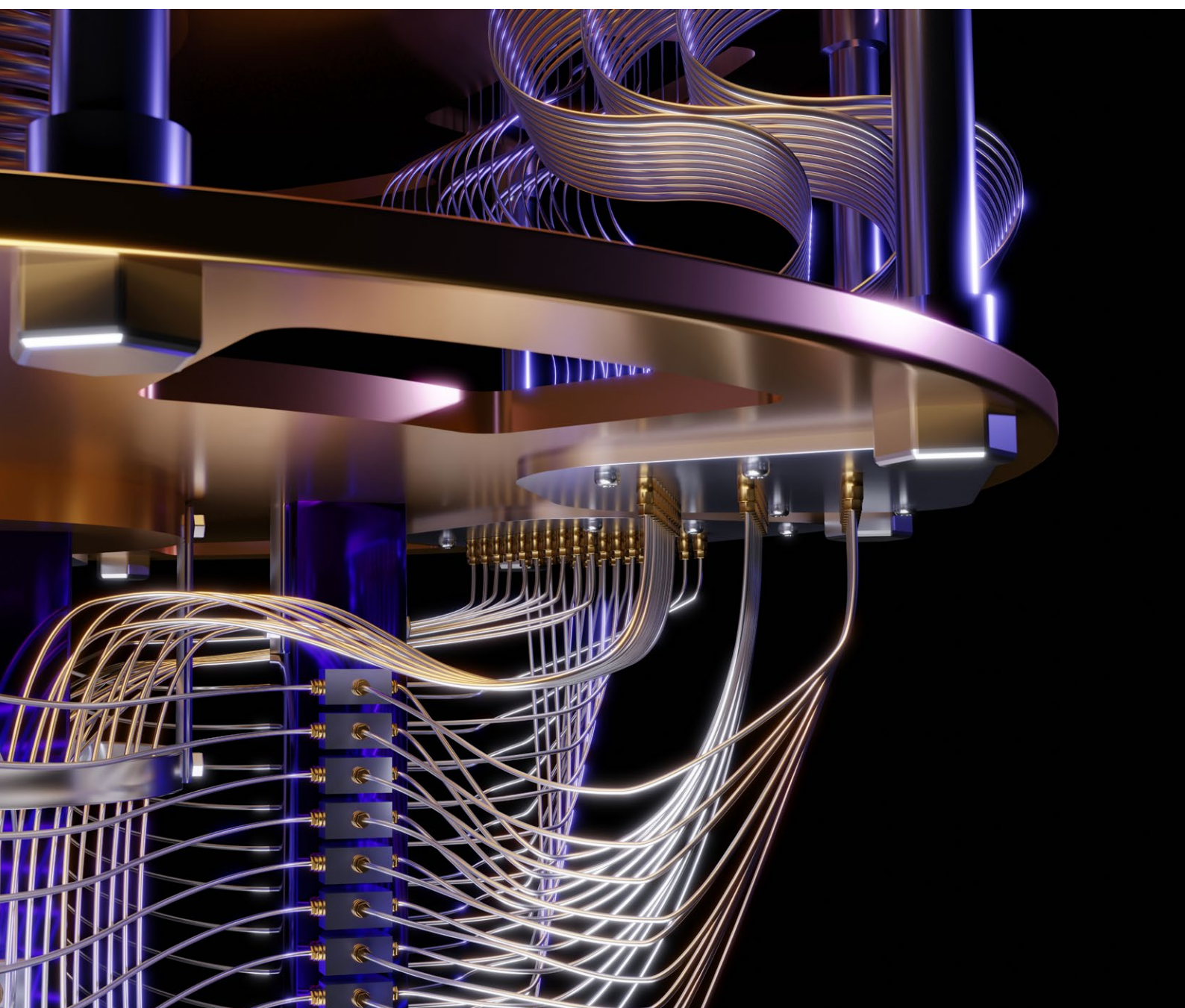


Advancing Quantum Technologies through Standards Readiness in the APEC Region

Background Paper for the APEC Workshop
August 2026



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Abbreviations and Acronyms

APEC	Asia-Pacific Economic Cooperation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CEN-CENELEC	European Committee for Standardization and European Committee for Electrotechnical Standardization
ETSI	European Telecommunications Standards Institute
EMR	Electronic Medical Record
GPS	Global Positioning System
ISO	International Organization for Standardization
IEC	International Electrotechnical Commission
ITU	International Telecommunication Union
IEEE	Institute of Electrical and Electronics Engineers
NIST	National Institute of Standards and Technology
NSB	National Standards Body
QKD	Quantum Key Distribution
QKDN	Quantum Key Distribution Networks
SCSC	Sub-Committee on Standards and Conformance

Acknowledgements

This *Advancing Quantum Technologies through Standards Readiness in the APEC Region – Background Paper* was prepared by a Standards Australia project team led by Ms Alexandra Dunn-Delvaen, Strategic and International Delivery Lead; Mr Alistair Tegart, Manager – Critical Technology; Mr Jamal Waqar, Head of Research, Experience, Data and Analytics; Ms Adneya Wadetiwar, Research Analyst; Mrs. Janelle Cranwell, Senior Research Analyst; and Ms Rose Gonzales, Experience Insights Lead at Standards Australia.

Standards Australia would like to take this opportunity to thank the project Point of Contact Group and APEC Sub Committee on Standards and Conformance (APEC SCSC) project co-sponsors, who have generously provided their time, thoughts and contributions to the Advancing Quantum Technologies through Standards Readiness project. The Project co-sponsors include the following APEC member economies: New Zealand, Singapore, Thailand, the United States and Viet Nam.

Our sincere appreciation to the APEC Sub-Committee on Standards and Conformance Secretariat for its assistance, ongoing support, and continued interest in this project. The Secretariat played an important role in promoting the project and the survey across APEC economies and stakeholders, helping to raise awareness of its objectives and encourage participation throughout the project.

Financial support from the Australian Government Department of Foreign Affairs and Trade under the APEC Support Program is gratefully acknowledged and appreciated.

The team thanks Dr Cathy Foley, Chair of QT-001 Quantum Technologies Australian standards committee, and Mr Michael Egan, Chair of IEC/ISO JTC 3/JSC 3A Quantum Computing and QT-001 member, for their contributions to this report.

This background research report does not reflect the views of Standards Australia, Dr Cathy Foley, Mr Michael Egan, the Australian Government or APEC. Neither Standards Australia nor any person acting on its behalf is responsible for any errors, omissions in, or the correctness of the information contained in this document. The background research report is not presented as standards or innovation policy per se, but with a view to inform and stimulate wider consideration of the current and future role of standards in supporting quantum collaboration in the APEC region.

Executive Summary

Quantum technologies are advancing rapidly from research to real-world deployment, creating new opportunities across sectors including healthcare, finance, transport, manufacturing, and critical infrastructure. Globally, governments have committed an estimated \$55.7 USD billion to quantum science and technology since 2013¹. As these technologies mature, international standards will play an increasingly important role.

“Catalysing the quantum revolution requires a shared language. Standards provide the framework to turn diverse quantum efforts into a unified force, driving progress, ensuring reliability, and paving the way for a quantum future that is secure, interoperable and globally accessible.” – Sergio Mujica, Secretary-General, International Organization for Standardization (ISO).²

International standards are a key enabler of the emerging quantum technology ecosystem. They provide common frameworks, technical specifications, and best practices that support the design, development, testing, and deployment of quantum technologies. By promoting interoperability, consistency, and compatibility across jurisdictions, international standards facilitate innovation, strengthen global supply chains, reduce technical barriers to trade, and foster greater confidence among governments, industry, academia, and standards development organisations.

As quantum technologies continue to evolve, coordinated action across APEC economies will become increasingly important. Collaborative policy development, cross-border research and innovation, and active participation in international standardisation activities can help address standardisation needs across sectors such as research, finance, healthcare, transport, space, and mining while supporting the responsible and inclusive growth of the regional quantum ecosystem.

This report examines the current state of quantum technology maturity across APEC economies by identifying representative use cases within the three core quantum technology domains: quantum computing, quantum communications, and quantum sensing. For each domain, the report identifies key use cases and assesses their current technology maturity level. It then examines the existing international standards landscape by mapping relevant standards applicable to each technology and use case, including those developed through IEC/ISO JTC 3 and other relevant standards development organisations. Building on this analysis, the report identifies key standards gaps and opportunities for future standards development, providing insights to support regional collaboration, inform standardisation priorities, and accelerate the responsible adoption of quantum technologies across APEC economies.

The findings presented in this report are based on a mixed-methods approach combining a comprehensive literature review, the Advancing Quantum Technologies through Standards Readiness in APEC survey 2026, and case study evidence. The use cases presented are illustrative rather than exhaustive, and are based on survey responses. Survey findings should be interpreted as indicative of stakeholder perspectives and priorities rather than statistically representative of all stakeholders across APEC economies. Drawing on perspectives from industry, academia, and standards development organisations, the report provides a balanced assessment of

1 OECD, “Executive summary: An overview of national strategies and policies for quantum technologies”, accessed on July 7, 2026; https://www.oecd.org/en/publications/an-overview-of-national-strategies-and-policies-for-quantum-technologies_5e55e7ab-en/full-report/component-3.html

2 ISO, “IEC and ISO launch new joint technical committee on quantum technologies”, accessed on July 22, 2026; <https://www.iso.org/news/new-joint-committee-quantum-technologies>.

the current state of quantum standards readiness across the APEC region and identifies practical opportunities to strengthen collaboration, advance standards development, and support the responsible growth of quantum technologies.

Please note: This background report is intended to support discussion and gather feedback on quantum technology standards readiness across the APEC region. The scope of the report focuses on selected quantum technology domains and does not necessarily include detailed consideration of all potential quantum related topics. Additional and evolving areas of the quantum ecosystem including quantum random number generation and other enabling technologies may be considered in greater detail in future phases of the project. Feedback received on this background report, including suggestions relating to additional topics and areas of focus, will be reviewed and incorporated where appropriate in the development of the final report.

1. Introduction to Quantum Technology

1.1 Purpose and Objective

This Background Paper builds on the outcomes and recommendations of Standards Australia's 2025 APEC project *Strengthening Collaboration on Standardisation for Quantum Technologies in the APEC Region*, which identified international standards as a critical enabler for the development, adoption, and commercialisation of quantum technologies across APEC economies. While the previous project established a strategic roadmap for strengthening regional collaboration on quantum standardisation, this report advances that work by examining the maturity of quantum technologies across different sectors and the supporting international standards landscape within the APEC region.

The purpose of this report is to provide an evidence-based assessment of quantum technology readiness to support future standardisation efforts and enhance regional alignment. Its primary objectives are to identify representative use cases across the three core quantum technology domains: quantum computing; quantum communications;³ and quantum sensing; and map the existing and emerging international standards applicable to each technology.

The scope of the report is informed by findings from the Advancing Quantum Technologies through Standards Readiness in APEC survey 2026, stakeholder consultations, and desktop research. It analyses representative use cases across the three quantum technology domains and maps existing and emerging standards developed by the following organisations:⁴

- **International Electrotechnical Commission (IEC)**
- **International Organization for Standardization (ISO)**
- **IEC/ISO JTC 3, Quantum Technologies**
- **International Telecommunication Union (ITU)**
- **Institute of Electrical and Electronics Engineers (IEEE)**
- **European Committee for Standardization and European Committee for Electrotechnical Standardization (CEN-CENELEC)**
- **US National Institute of Standards and Technology (NIST)**
- **European Telecommunications Standards Institute (ETSI)**

The mapped standards are analysed to establish the current standards landscape for each technology, identify standards gaps and highlight opportunities for future standards development. The findings provide an evidence base to support APEC collaboration on standardisation activity, and contribute to the responsible adoption of quantum technologies throughout the region.

3 Note: This background paper covers quantum communication in the sense of QKD and quantum networks; post quantum cryptography (PQC) is a classical cryptographic response to the quantum threat, not itself a quantum technology, and is only discussed where it intersects directly (hybrid QKD/PQC architectures, entropy sourcing).

4 Note: IETF and JTC1/SC27 lead PQC standardisation specifically which is out of scope per the note above.

1.2 Maturity Level Definition

This section outlines a simple but consistent framework for maturity level definitions for quantum technologies to allow assessment of the development and adoption of quantum technology use. The maturity levels will be used throughout this report to evaluate and compare quantum technology use cases and potential standardisation needs across different sectors within APEC economies. This model is evolving as part of ongoing standardisation readiness level work undertaken by NIST and IEC/ISO JTC 3.

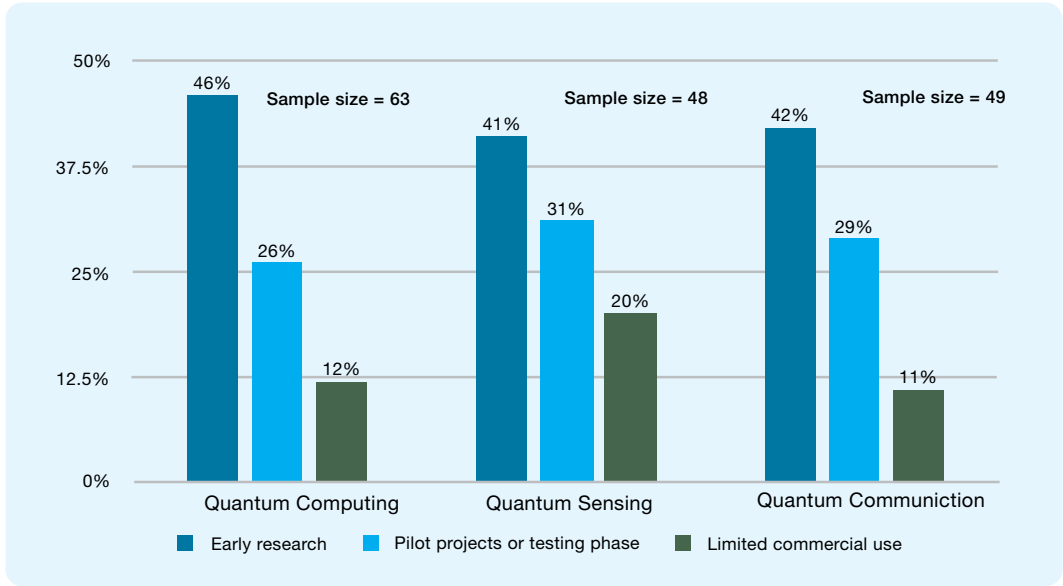
Table 1: Definition of Maturity Levels for Quantum Technologies⁵

Level	Definition	Standards Needed
Quantum Maturity Level 1 - Early Stage (Inventing)	The technology is being researched and tested. It has shown promise but has not yet proven its value in real-world applications.	• Terminology • Test & measurement • Characterization & performance • Metrics & benchmarks
Quantum Maturity Level 2 - Middle Stage (Preparing for wider adoption)	The technology has been successfully applied to real-world use cases and is starting to be adopted by organisations.	• IT Security, privacy • Interface • Interoperability • Testbeds
Quantum Maturity Level 3 - Late Stage (Thriving market)	The technology is commercially available, widely used, and supported by a mature ecosystem that enables large-scale deployment.	• Certification • Procurement • Supply chain communications • Risk management • Governance • Procurement

The Advancing Quantum Technologies through Standards Readiness in APEC survey 2026 findings indicate that the three core quantum technology domains (quantum computing, quantum sensing, and quantum communications) remain at relatively early stages of maturity across APEC economies. Most respondents identified all three technology domains as being in the early research stage, followed by pilot projects or testing phases, suggesting that quantum technologies are continuing to transition from research into practical deployment. While some respondents identified technologies as being at commercial deployment stage, these responses were less common, indicating that commercialisation is currently limited to selected applications and markets.

⁵ Barbara Goldstein, NIST, "SRL Overview ", accessed on July 22, 2026.

Figure 1: Maturity levels of quantum technology domains based on Advancing Quantum Technologies through Standards Readiness in APEC survey 2026



Source: Advancing Quantum Technologies through Standards Readiness in the APEC Region Survey (2026)

Figure 1 illustrates respondents’ perceptions of maturity for each quantum technology domain. Responses varied by domain, with 63 responses recorded for quantum computing, 48 for quantum sensing, and 49 for quantum communication. For quantum computing, 46% (31 respondents) identified the technology as being in the early research stage, followed by 26% (18 respondents) who indicated pilot projects or testing phases, and 12% (8 respondents) who considered it to have reached limited commercial use. Similarly, 41% (24 respondents) identified quantum sensing as being in the early research stage, while 31% (18 respondents) reported pilot projects or testing phases, and 20% (12 respondents) considered it to have achieved limited commercial use. For quantum communication, 42% (26 respondents) identified the technology as being in the early research stage, 29% (18 respondents) indicated pilot projects or testing phases, and 11% (7 respondents) reported limited commercial use. Overall, the findings suggest that while quantum technologies are progressing towards commercial deployment across the APEC region, the majority of activity remains concentrated in early research and pilot-scale implementation, highlighting the continued importance of investment, collaboration, and standards development to support future adoption.

The following sections examine quantum technology use cases across selected priority sectors within APEC economies, based on the findings of the survey and secondary research. For each use case, the analysis provides a brief overview of the application, assesses key gaps and challenges, and highlights the standards that are most relevant to its implementation.

Together, these use cases provide an insight into current quantum technology developments across APEC economies and help identify opportunities for future standards adoption and deployment.

“APEC has an important opportunity to play a leadership role in shaping the future quantum ecosystem by promoting harmonized standards, cross-border

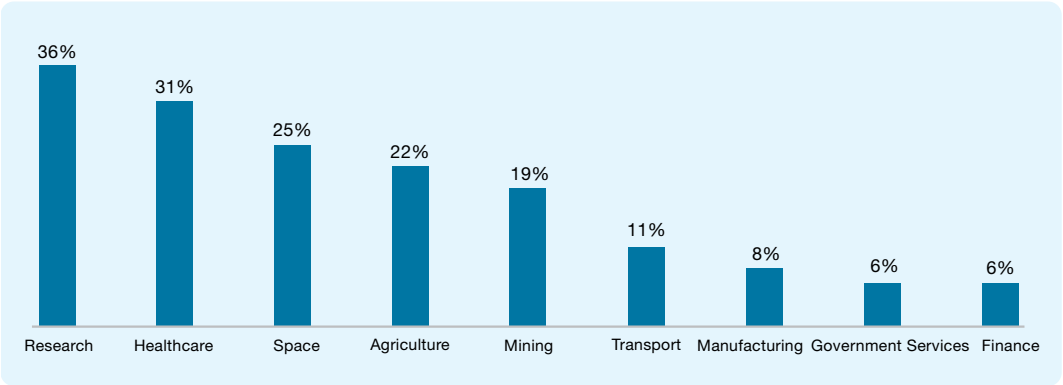
collaboration, and knowledge sharing. Given that quantum technologies are still in the early stages of commercialization, early alignment on standards for interoperability, security, testing, and metrology will help reduce fragmentation and accelerate adoption.” – Survey respondent from Thailand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026.

2. Quantum Sensing Use Cases

Quantum sensing uses the principles of quantum mechanics to measure physical quantities such as time, gravity, magnetic fields and motion with greater precision than conventional sensors. This enhanced sensitivity has the potential to enable new capabilities and improve existing applications across sectors including healthcare, navigation, environmental monitoring, and resource exploration.⁶ Of the 37 respondents that responded to the question on the importance of quantum sensing standards across sectors, research emerged as the highest-priority area, with 36% of respondents identifying it as a key sector for future standards development. Healthcare accounted for 31% of responses, while space was identified by 25% of respondents. Agriculture (22%) and mining (19%) also received notable levels of support, reflecting the growing role of quantum sensing technologies in environmental monitoring, resource exploration, and scientific applications. These findings suggest that respondents see the strongest opportunities for the application and adoption of quantum sensing technologies in activities where high-precision measurement, monitoring, and detection capabilities are critical.

Figure 2 below highlights the sectors identified as priorities for quantum sensing standards. These results helped inform the selection of representative use cases and areas where future standards development may support the adoption and deployment of quantum sensing technologies across APEC economies.

Figure 2: Perceived Importance of Quantum Sensing Standards Across Sectors



Sample size of 37

Source: Advancing Quantum Technologies through Standards Readiness in the APEC Region Survey (2026)

6 NIST, “Quantum Sensing Explained”, accessed on July 27, 2026; <https://www.nist.gov/quantum-information-science/quantum-sensing-explained>

2.1 Use cases

2.1.1 Chinese Academy of Sciences – Deep earth exploration using quantum sensing (2024)

Use case summary

Category	Details
Sector	Research, Energy
Economy	People's Republic of China
Quantum Technology	Quantum Sensing
Maturity Level	Quantum Maturity Level 2 – Middle Stage
Geographic Relevance	Global
Lead Organisations	The Chinese Academy of Sciences

Context

The demand for more accurate subsurface exploration has grown significantly as the People's Republic of China seeks to strengthen domestic supplies of critical minerals and energy resources. China's investment in geological exploration reached RMB 115.994 billion in 2024, continuing a four-year trend of growth.⁷ Since the commencement of the 14th Five-Year Plan, cumulative investment in geological prospecting has totalled nearly RMB 450 billion.⁸ These efforts contributed to the discovery of 150 new mineral deposits across the economy in 2024, supporting China's long-term strategy to strengthen domestic mineral resource exploration and supply.⁹ As exploration extends into deeper and more geologically complex environments, conventional geophysical techniques, including gravimetry, seismic surveys, and electromagnetic sensing, face reduced sensitivity, lower resolution, and greater susceptibility to environmental interference.¹⁰ These limitations increase uncertainty, extend survey times, raise operational costs, and reduce confidence in identifying subsurface geological structures.

Use Case

In October 2024, the Chinese Academy of Sciences (CAS), through its Institute of Geology and Geophysics, established the Deep Earth Exploration and Technology Experimental Centre to advance the application of quantum sensing technologies for deep earth exploration.¹¹ The initiative focuses on advancing deep-earth precise exploration technologies and equipment, including the development of deep probe sensors, geophysical exploration technologies and equipment, and technologies for the efficient development of deep oil and gas resources, in support of deep-earth resource exploration and scientific research.¹² By integrating these quantum sensors with mobile platforms and advanced data fusion techniques that combine quantum and conventional

7 Xinhua News Agency, "The China Mineral Resources Report has been released: 150 newly discovered mineral sites nationwide in 2024", accessed on July 7, 2026; <https://www.xinhuanet.com/government/20251024/093d8ba9a98546f3a96482035775154e/c.html>

8 Ibid

9 Ibid.

10 OECD, "Critical minerals and clean energy applications: The role of innovation across the supply chain", accessed on July 22, 2026; https://www.oecd.org/en/publications/critical-minerals-and-clean-energy-applications_e3b08f4d-en.html

11 Institute of Geology and Geophysics, Chinese Academy of Sciences, "Research Center of Deep Earth Technology and Equipment," accessed on July 7, 2026; https://igg.cas.cn/jgsz/kyxt/shencengkantan/shendi_center/

12 Ibid

geophysical data, the initiative enhances the accuracy and resolution of subsurface imaging while maintaining compatibility with existing exploration workflows. Compared with conventional sensing technologies, quantum sensors can detect extremely small changes in physical quantities such as magnetic fields, gravity, acceleration, and rotation with significantly greater sensitivity and precision. These capabilities have the potential to improve applications in mineral exploration, underground mapping, navigation, and environmental monitoring by enabling the detection of signals that may be difficult to measure using conventional sensors.¹³ This enables improved detection of geological structures, mineral deposits, and tectonic features, while supporting applications such as oil and gas exploration, mineral prospecting, earthquake research, geodynamic modelling, and real-time underground infrastructure monitoring.

2.1.2 CSIRO – Cold Atom Quantum Platform

Use case summary

Category	Details
Sector	Research
Economy	Australia
Quantum Technology	Quantum Sensing
Maturity Level	Quantum Maturity Level 1 – Early Stage (Inventing)
Geographic Relevance	Global
Lead Organisations	Commonwealth Scientific and Industrial Research Organisation (CSIRO), Next Generation Quantum Graduates Program, Swinburne University of Technology, Inflection Australia

Context

Australia has identified quantum technologies as a priority, with the CSIRO report on quantum technology in Australia estimating that the domestic quantum industry could contribute almost \$ 6 AUD billion to the economy and create more than 19,000 jobs by 2045.¹⁴ A key challenge, however, is translating laboratory-based quantum sensing research into practical, deployable systems for applications such as GPS-independent navigation and geophysical exploration.

Classical sensing technologies are limited by long-term drift, accuracy, and stability, particularly in applications where precise measurements directly affect operational outcomes. While cold atom quantum sensors offer significantly improved precision, they remain largely confined to laboratory environments because of their size, complexity, and sensitivity to environmental conditions. Developing compact, robust, and manufacturable quantum sensing platforms is therefore critical to enabling large-scale deployment and commercial adoption.¹⁵

13 Quantum Frontiers, “Success Story: Quantum sensing for geodesy and environmental monitoring”, accessed on September 25, 2026; <https://www.quantumfrontiers.de/en/sharing-science/public-outreach/stories/quantumfrontiers-success-stories-quantum-sensing-for-geodesy-and-environmental-monitoring>

14 CSIRO, “Growing Australia’s quantum technology industry”, accessed on July 22, 2026; <https://www.csiro.au/en/work-with-us/services/consultancy-strategic-advice-services/CSIRO-futures/Future-Industries/Quantum>.

15 CSIRO, “Developing an integrated, miniaturised experiment platform for cold atom quantum technologies”, accessed on September 25, 2026; <https://www.csiro.au/en/work-with-us/funding-programs/funding/Next-Generation-Graduates-Programs/Awarded-programs/Developing-an-integrated-miniaturised-experiment-platform-for-cold-atom-quantum-technologies>

Use Case

The CSIRO Cold Atom Quantum Platform initiative focuses on advancing cold atom technologies, a leading approach for high-precision sensing, timing, and navigation, with the objective of transitioning these capabilities from laboratory-scale experiments to compact, deployable platforms.¹⁶

To address the size, complexity, and cost limitations that have constrained the deployment of quantum sensing systems, the project is developing a fully integrated, miniaturised experimental platform incorporating custom-designed vacuum cells that enable lightweight, configurable, and portable quantum sensing architectures while maintaining the stringent environmental and stability requirements needed for quantum operation. This approach supports rapid prototyping, shorter development cycles, and lower material costs, enabling quantum sensors to be deployed beyond laboratory environments. By delivering improved sensitivity, long-term stability, and operational flexibility compared with classical sensing technologies, the platform supports new applications in advanced navigation, geophysical exploration, and other industrial sectors where highly precise measurements are critical.

2.1.3 Quantum Economic Development Consortium (QED-C) – Quantum sensing for biomedical diagnostics and imaging

Use case summary

Category	Details
Sector	Healthcare
Economy	United States of America
Quantum Technology	Quantum Sensing
Maturity Level	Quantum Maturity Level 1 – Early Stage (Inventing)
Geographic Relevance	Global
Lead Organisations	QED-C

Context

The demand for more sensitive and precise biomedical diagnostics continues to grow as chronic diseases place increasing pressure on healthcare systems. According to the American Cancer Society, an estimated 2.04 million new cancer cases are expected to be diagnosed in the United States in 2025, highlighting the need for technologies capable of detecting disease at earlier stages and with greater precision.¹⁷ Classical sensing and imaging technologies often struggle to detect extremely weak biological signals, while many existing diagnostic systems are expensive, complex, and limited in their ability to provide high-resolution measurements at cellular and subcellular scales.¹⁸ These constraints can reduce diagnostic sensitivity, delay disease detection, and limit the ability to support personalised and precision medicine.

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- 16 CSIRO “Developing an Integrated, Miniaturised Experiment Platform for Cold Atom Quantum Technologies,” accessed on July 2022, <https://www.csiro.au/en/work-with-us/funding-programs/funding/Next-Generation-Graduates-Programs/Awarded-programs/Developing-an-integrated-miniaturised-experiment-platform-for-cold-atom-quantum-technologies?start=&count=&keyword=&cat=>
- 17 National Cancer Institute, “Understanding Cancer”, accessed on July 15, 2026; <https://www.cancer.gov/about-cancer/understanding/statistics>
- 18 Nature reviews physics, “Quantum sensors for biomedical applications”, accessed on September 25, 2026; <https://www.nature.com/articles/s42254-023-00558-3>

Use Case

In October 2024, the Quantum Economic Development Consortium (QED-C) published a program bringing together industry, academic, and government stakeholders to evaluate practical applications of quantum sensing for biomedical diagnostics and imaging.¹⁹ The initiative focuses on overcoming the sensitivity and resolution limitations of conventional diagnostic and imaging technologies by applying quantum sensing techniques capable of detecting extremely weak biological signals with high precision and minimal noise. To achieve this, the program explores technologies such as nitrogen-vacancy (NV) centres in diamond, which enable non-invasive, nanoscale sensing, subcellular imaging, and biochemical detection in complex biological environments that are difficult to measure using classical sensors.²⁰ By providing higher spatial resolution, richer biological data, and reduced system complexity, these quantum sensing platforms support earlier disease detection, improved diagnosis of conditions such as cancer and neurological disorders, enhanced clinical decision-making, and the potential to reduce healthcare costs over time.

2.1.4 SBQuantum – Optimising global navigation systems

Use case summary

Category	Details
Sector	Space
Economy	Canada, United States of America
Quantum Technology	Quantum Sensing
Maturity Level	Quantum Maturity Level 2 – Middle Stage
Geographic Relevance	Global
Lead Organisations	SBQuantum, U.S. National Geospatial-Intelligence Agency, Spire Global

Context

The demand for accurate and resilient navigation continues to grow as industries such as aviation, defence, transportation and critical infrastructure become increasingly dependent on reliable positioning and navigation services. According to the European Union Agency for the Space Programme (EUSPA), the global navigation satellite system downstream market is projected to exceed EUR 580 billion by 2033, reflecting the growing economic importance of satellite-enabled navigation.²¹ Earth’s magnetic field changes continuously over time, requiring regular updates to geomagnetic models used for navigation. The World Magnetic Model (WMM), which is derived from satellite observations and other geomagnetic measurements, is updated every five years because its accuracy degrades as the magnetic field evolves. This periodic update cycle can limit navigational accuracy, particularly as the model ages between releases.²² These limitations, combined with the vulnerability of GPS signals to interference, jamming and spoofing, highlight the need for more accurate and resilient navigation technologies that can operate reliably in challenging environments.

19 Quantum Economic Development Consortium (QED-C), “Quantum Sensing for Biomedical Applications,” accessed on September 28, 2026; <https://quantumconsortium.org/publication/biomedical2024/>.
20 ibid
21 European Union Agency for the Space Programme (EUSPA), “The new EUSPA EO and GNSS Market Report is out, time to know more”, accessed on July 13, 2026; <https://www.euspa.europa.eu/newsroom-events/news-archive/new-euspa-EO-and-gnss-market-report-out-time-know-more>
22 National Centers for Environmental Information, “World Magnetic Model”, accessed on July 22, 2026; <https://www.ncei.noaa.gov/products/world-magnetic-model>

Use Case

SBQuantum, in collaboration with the U.S. National Geospatial-Intelligence Agency (NGA), is advancing the use of quantum sensing to enhance global navigation infrastructure through the deployment of a space-qualified diamond quantum magnetometer.²³ The initiative addresses the need for more accurate, resilient, and GPS-independent navigation by improving the continuous monitoring of the Earth's magnetic field, which underpins magnetic navigation and positioning systems.²⁴ To achieve this, the project uses a compact diamond-based magnetic sensor that can detect extremely small magnetic fields with high accuracy. Designed to operate in the extreme conditions of space, the sensor provides continuous, high-resolution magnetic field measurements and near real-time analysis, enabling more frequent and accurate updates to geomagnetic models. Following its launch into orbit in March 2026, the initiative demonstrated the operational deployment of quantum sensing in aerospace environments, supporting improved navigation accuracy across land, sea, and air, while enabling reliable positioning in contested or GPS-denied environments.²⁵

2.2 Standards landscape for quantum sensing

While quantum sensing is progressing across applications such as reconnaissance, positioning, navigation and timing, the international standards landscape remains in the early stages of development.²⁶ International standardisation activities are primarily led by IEC/ISO JTC 3 – Quantum Technologies, which includes Working Group 10 Quantum Sensors responsible for developing standards for quantum sensing. Current activities within IEC/ISO JTC 3/WG 10 focus on developing standards for quantum sensing terminology, quantities, and measurement methods to support consistent characterisation and future deployment of quantum sensing technologies.²⁷ In parallel, CEN-CLC/JTC 22, Quantum Technologies, which is currently under development, is coordinating European standardisation activities for quantum technologies. Its programme is expected to include standards for quantum sensing that address terminology, benchmarking, interoperability, and performance evaluation, helping to align quantum sensing technologies across Europe and complement international standardisation efforts.²⁸

Published standards directly relevant to quantum sensing are currently limited. IEC 61788-13:2012, *Superconductivity, Part 13: AC loss measurements, Magnetometer methods for hysteresis loss in superconducting multifilamentary composites*, specifies measurement methods using superconducting quantum interference device (SQUID) magnetometers, an established quantum sensing technology, while ISO/TS 80004-12:2016, *Nanotechnologies Vocabulary Part 12: Quantum phenomena in nanotechnology*, provides terminology relating to quantum phenomena in nanotechnology that is relevant to the broader quantum technology ecosystem.²⁹ These

23 SBQuantum, "SBQuantum Launches Quantum Sensor into Space as Part of U.S. Government's MagQuest Challenge," SBQuantum, accessed on September 28, 2026, <https://sbquantum.com/sbquantum-launches-quantum-sensor-into-space-as-part-of-u-s-governments-magquest-challenge/>.

24 ibid

25 ibid

26 OECD, "A Quantum Technologies Policy Primer", accessed on July 22, 2026; https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/01/a-quantum-technologies-policy-primer_bdac5544/fd1153c3-en.pdf.

27 IEC, "IEC/ISO JTC 3 Dashboard", accessed on July 27, 2026; https://www.iec.ch/dyn/www/?p=103:23:400830434036827:::FSP_ORG_ID,FSP_LANG_ID:49854,25

28 CENELEC, "Quantum Technologies", accessed on July 27, 2026; <https://www.cenelec.eu/areas-of-work/cen-cenelec-topics/quantum-technologies/>

29 IEC, "IEC 61788-13:2012", accessed on July 24, 2026; <https://webstore.iec.ch/en/publication/5913>, ISO, "ISO/TS 80004-12:2016", accessed on July 24, 2026; <https://www.iso.org/standard/63095.html>

standards establish technical guidance that supports ongoing standardisation activities and provides a basis for the future development of more application-specific quantum sensing standards.

Table 2: Standards landscape for quantum sensing technologies

Designation	Standard Title	Abstract/Scope
ISO/TS 80004-12:2016	Nanotechnologies — Vocabulary — Part 12: Quantum phenomena in nanotechnology	It is intended to facilitate communication between organizations and individuals in industry and those who interact with them.
IEC/ISO AWI 63607	Quantum technologies — Terminology and quantities — General quantities	Names, symbols, definitions and units for general quantities in the field of quantum technologies.
IEC/ISO AWI 63655	Quantum technologies — Terminology and quantities — General vocabulary	Definitions for general vocabulary in the field of quantum technologies
IEC 61788-13:2012	Superconductivity — Part 13: AC loss measurements – Magnetometer methods for superconducting composites	Specifies measurement methods using SQUID (Superconducting Quantum Interference Device) magnetometers to determine AC losses in superconducting materials. While developed for superconductivity testing, it is one of the few IEC standards that explicitly references a quantum sensing technology.
PWI TR JTC 3-1	Measurement methods for the characterization of NV-diamonds for magnetometers	Under development

Note: The standards listed in this table are indicative only. A comprehensive list is provided in the appendices.

2.3 Standards gaps and opportunities for quantum sensing

A number of standards gaps were identified through the Advancing Quantum Technologies through Standards Readiness in APEC survey 2026 and supported by a review of the international standards landscape and relevant literature. This section highlights common areas where additional standardisation may facilitate the development, evaluation and deployment of quantum sensing technologies. Identified gaps are grouped into five priority areas: terminology; performance characterisation and benchmarking; testing and measurement; interoperability and interfaces; and certification and assurance.

Terminology

International standardisation activities for quantum sensing are currently focused on establishing foundational terminology to support consistent communication across research, industry and standards development. A common vocabulary is essential to facilitate collaboration, reduce ambiguity and provide a foundation for future technical standards. This need was also reflected in the survey findings, where respondents emphasised the importance of developing foundational standards, including terminology, vocabulary and basic metrology, to support early-stage research and future standardisation efforts.

“Foundational standards such as terminology, vocabulary, and basic metrology to support early-stage research and the National Institute of Metrology.” – Survey respondent from Thailand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026.

Performance Characterisation and Benchmarking

Quantum sensing technologies operate using different physical principles and performance characteristics depending on the application. Consistent approaches for characterising and benchmarking sensor performance can support objective comparison between technologies, improve confidence in reported performance, and facilitate technology adoption across sectors. Survey respondents reinforced this need by identifying harmonised standards that support measurement accuracy, interoperability, safety and trust as priorities across a range of quantum sensing applications.

“APEC should prioritise international standards for healthcare diagnostics, environmental monitoring, navigation and positioning, critical infrastructure monitoring, precision agriculture, disaster risk reduction, and scientific metrology. Harmonised standards will improve interoperability, measurement accuracy, safety, and trust, while accelerating the adoption of quantum sensing technologies across APEC economies.” – Survey respondent from Thailand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026.

Testing and Measurement

Existing international standards primarily provide foundational guidance or support enabling technologies rather than comprehensive testing methodologies for quantum sensing systems. As technologies continue to mature, standardised testing and measurement methodologies will support reproducible performance evaluation, consistent validation approaches and comparable measurement results across different application areas.

Interoperability and Interfaces

Quantum sensing technologies are expected to be integrated with existing digital infrastructure, positioning systems, healthcare technologies and industrial monitoring platforms. Harmonised interfaces and data exchange approaches can facilitate integration between quantum sensing devices and conventional systems while supporting broader adoption across multiple sectors.

Certification and Assurance

As quantum sensing technologies progress towards wider deployment, internationally recognised approaches for certification and assurance can support verification of performance claims and provide greater confidence for technology developers, end users and regulators. Survey feedback indicated that while many application-specific standards already exist for the implementation and use of quantum sensing technologies, certification is seen as a priority area where additional standardisation may be required.

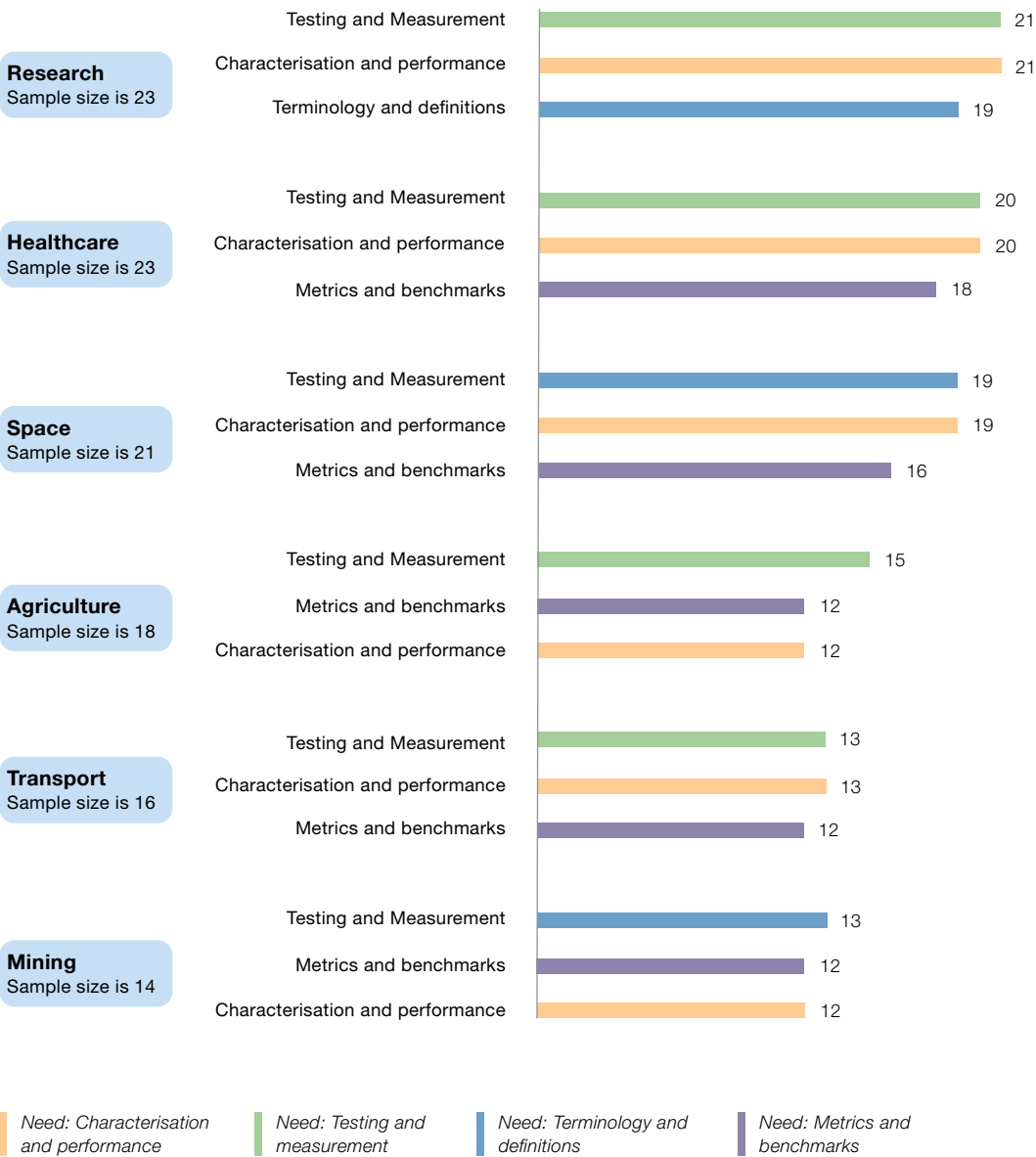
Priority Areas for Quantum Sensing Standards Development

Respondents from across APEC member economies were asked to identify the standards needed to support the development and deployment of quantum sensing across the APEC region, with multiple responses permitted. Several key themes emerged from the responses. As participation varied across survey questions, the sample size (n) is reported in each figure to indicate the number of respondents on which the results are based.

Across the research, healthcare and space sectors, respondents consistently identified the following as the highest-priority areas for standardisation:

- Testing and measurement
- Characterisation and performance
- Metrics and benchmarking

Figure 3: Types of standards most needed to support the implementation of quantum sensing in each sector.



n = number of responses

Source: Advancing Quantum Technologies through Standards Readiness in the APEC Region Survey (2026)

As shown in Figure 3, testing and measurement was identified as the highest priority in the research sector (n=23), with 21 respondents (91%) selecting it as very important, followed by performance characterisation with 21 respondents (91%) and terminology and definitions with 19 respondents (83%). This indicates that stakeholders view reliable evaluation methods, consistent measurement approaches and a common technical

foundation as key requirements to support early-stage quantum sensing research and development.

In the healthcare sector (n=20), testing and measurement and performance characterisation were both identified as priorities by 20 respondents (100%), followed by metrics and benchmarking with 18 respondents (90%). These results indicate the emphasis placed on ensuring accuracy, reliability and comparability of quantum sensing technologies in healthcare applications where measurement confidence is highly important.

Similarly, in the space sector (n=21), testing and measurement and performance characterisation were prioritised by 20 respondents (95%) each, followed by metrics and benchmarking with 18 respondents (86%). This reflects the importance of robust validation and benchmarking approaches for quantum sensing applications operating in highly precise and demanding environments.

Across the sectors assessed, respondents consistently prioritised foundational standards such as testing, measurement and performance, suggesting that many quantum sensing applications are still at a stage where stakeholders are seeking confidence through performance metrics and benchmarking, as opposed to prioritising interoperability or certification standards.

Table 3: Quantum Sensing: Standards Gap Analysis by Use Case

Use Case	Application Area	Identified Standards Gaps	Analysis
Chinese Academy of Sciences – Deep Earth Exploration Using Quantum Sensing (2024)	Geophysical exploration and earth sciences	• Performance • Testing and measurement • Interoperability and interfaces	Quantum sensing approaches for deep earth exploration rely on highly sensitive measurements, such as magnetic field and gravitational sensing, where consistent performance evaluation and measurement methodologies are important for comparing results across different environments. Future standardisation approaches may support benchmarking of sensor capabilities, validation of measurements and integration with existing geophysical monitoring systems.
CSIRO – Cold Atom Quantum Platform	Precision sensing and scientific research	• Terminology • Performance characterisation and benchmarking • Testing and measurement	Cold atom-based quantum sensing platforms involve emerging technologies where common terminology, measurement approaches and benchmarking methodologies can support collaboration between researchers, technology developers and potential end users. Standardised approaches may assist in evaluating sensor performance and supporting transition from research platforms towards practical applications.

Quantum Economic Development Consortium (QED-C) – Quantum Sensing for Biomedical Diagnostics and Imaging	Healthcare and biomedical applications	• Performance characterisation and benchmarking • Testing and measurement • Certification and assurance	Biomedical quantum sensing applications require reliable evaluation of sensitivity, accuracy and measurement performance to support confidence in potential clinical applications. Future standards may support validation methodologies, performance comparison and assurance approaches while complementing existing healthcare standards and regulatory requirements.
SBQuantum – Optimising Global Navigation Systems	Positioning, navigation and timing (PNT)	• Performance characterisation and benchmarking • Interoperability and interfaces • Certification and assurance	Quantum sensing technologies for navigation applications require consistent approaches for assessing accuracy, stability and operational performance. Standardised performance metrics and integration approaches may support compatibility with existing navigation infrastructure and confidence in deployment across different operating environments.

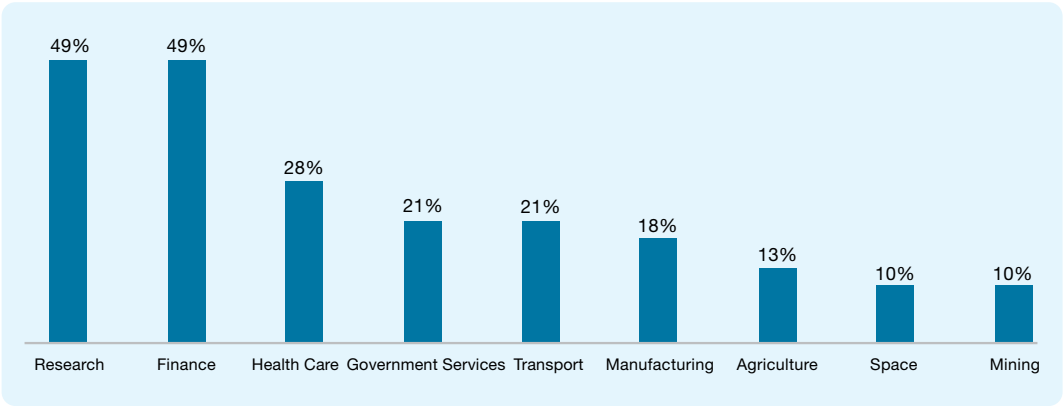
The standards gaps identified in Table 3 point to a common set of needs relating to the testing, measurement and validation of sensor performance across each of the use cases. For APEC economies and National Standards Bodies (NSBs), priority areas of focus for standardisation include supporting the development of common terminology, performance benchmarks, testing methodologies and assurance approaches that are specific to quantum sensing technologies. Collaboration through international standardisation activities can help ensure that future standards support reliable evaluation and adoption of quantum sensing solutions across emerging application areas. Procurement guidance and future conformity assessment frameworks will also be important to help economies assess quantum sensing technologies, verify performance claims and support trusted adoption.

3 Quantum Computing Use Cases

Quantum computing is an emerging field of computer science and engineering that harnesses the unique qualities of quantum mechanics to solve problems beyond the ability of current classical computers.³⁰ Around 46% of survey respondents (31 out of 63) indicated that quantum computing is currently at an early stage in terms of technological maturity. With the development of quantum computing and its range of real-world applications, there is a need to establish common standards and frameworks to support interoperability, consistency and reliability.

Figure 4 below highlights the sectors most frequently identified by survey respondents as priorities for quantum computing standards.

Figure 4: Perceived Importance of Quantum Computing Standards Across Sectors



Sample size of 39

Source: Advancing Quantum Technologies through Standards Readiness in APEC survey 2026

Of the 39 respondents that provided feedback on the importance of quantum computing standards across sectors, research and finance emerged as the highest-priority areas, with 49% of respondents identifying these sectors as key areas for future standards development. Healthcare followed at 28%, while government services and transport were each selected by 21% of respondents. Manufacturing (18%), agriculture (13%), and space and mining (10% each) received comparatively lower levels of support. The perceived importance of standards for the research and finance sectors suggests that respondents view standardisation as a key mechanism for supporting the continued development of quantum computing, and for enabling its application in areas where confidence in computational outcomes are particularly important. Comparatively lower results in other sectors, such as space and mining, may reflect differences in the maturity or perceived near-term relevance of quantum computing applications within these fields.

30 IBM, “What is quantum computing”, accessed on July 25, 2026; <https://www.ibm.com/think/topics/quantum-computing>.

3.1 Use Cases

3.1.1 Cleveland Clinic, RIKEN and IBM – Using quantum technologies to advance complex biological systems

Use case summary

Category	Details
Sector	Research
Economy	United States of America, Japan
Quantum Technology	Quantum Computing
Maturity Level	Quantum Maturity Level 1 – Early Stage (Inventing)
Geographic Relevance	Global
Lead Organisations	Cleveland Clinic, RIKEN, IBM

Context

Simulating biological systems such as proteins and their interactions with drug candidates represents one of the most computationally complex challenges in life sciences.³¹ Classical computing methods struggle to accurately model quantum-mechanical behaviour in large molecular systems, particularly as the number of atoms and interactions increases. This leads to significant trade-offs between computational feasibility and simulation precision, limiting the ability to predict outcomes reliably. Current approaches often require extensive laboratory validation, resulting in high costs, long development cycles (often exceeding a decade), and increased risk of failure. Additionally, scaling traditional simulations to larger, biologically relevant molecules becomes prohibitively resource-intensive, constraining innovation and slowing research progress.

Use Case

In 2026, Cleveland Clinic, RIKEN, and IBM collaborated to demonstrate the application of quantum computing in life sciences through the simulation of complex biological systems.³² The initiative used a quantum-centric supercomputing approach, combining IBM quantum processors with classical high-performance computing resources to model protein ligand interactions at an unprecedented scale. The collaboration demonstrated the potential of hybrid quantum workflows by simulating biologically relevant protein systems, including protein complexes containing up to 12,635 atoms, representing one of the largest known biologically relevant molecular simulations involving quantum computing.³³ By integrating quantum and classical computational methods, the initiative aims to improve molecular modelling accuracy, accelerate drug discovery, reduce experimental costs, and provide deeper insights into biochemical processes that remain challenging for conventional computing approaches. While quantum computing has not yet replaced classical methods for large-scale drug discovery applications, this initiative demonstrates a practical pathway for integrating quantum technologies into future life sciences research and pharmaceutical development pipelines.

31 DistillINFO Publications, “IBM Simulates 12,635-Atom Protein with Quantum Computing”, accessed on September 25, 2026, <https://distillinfo.com/2026/05/05/ibm-simulates-12635-atom-protein-with-quantum-computing/>.

32 IBM, “Cleveland Clinic, RIKEN, and IBM Model a 12,635-Atom Protein – the Largest Known to Be Simulated with Quantum Computers”, accessed on July 22, 2026; <https://newsroom.ibm.com/2026-05-05-cleveland-clinic-riken-and-ibm-model-a-12,635-atom-protein-the-largest-known-to-be-simulated-with-quantum-computers>

33 Ibid.

3.1.2 Deloitte Canada and D-Wave Quantum – Solving operational systems using quantum computing

Use case summary

Category	Details
Sector	Research, Government Services
Economy	Canada
Quantum Technology	Quantum Computing
Maturity Level	Quantum Maturity Level 1 – Early Stage (Inventing)
Geographic Relevance	Global
Lead Organisations	Deloitte Canada, D-Wave Quantum

Context

Urban traffic management is a large-scale optimisation challenge that requires transport authorities to continuously coordinate traffic signals, vehicle routing, road capacity, public transport operations, and incident responses under constantly changing traffic conditions. Traffic congestion remains a significant economic and operational issue in Canada. A Transport Canada study estimated that recurrent congestion across Canada's nine largest urban areas costs between CAD \$2.3 billion and CAD \$3.7 billion annually (2002 values), with more than 90% of these costs attributed to travellers' lost time, alongside increased fuel consumption and greenhouse gas emissions.³⁴

From a computational perspective, each change in traffic conditions including accidents, road closures, weather events, or fluctuations in travel demand creates a new optimisation problem involving thousands of interconnected variables and constraints. As transport networks increase in size and complexity, the number of possible routing and traffic signal coordination scenarios grows exponentially, making it increasingly difficult for classical optimisation algorithms to identify high-quality solutions within operational timeframes. This limits the ability of transport authorities to dynamically re-optimize network operations in near real time, resulting in longer travel times, increased operational costs, reduced network efficiency, and greater environmental impacts. These computational limitations demonstrate the need for advanced optimisation approaches capable of solving complex combinatorial problems more efficiently as transportation systems continue to evolve.

Use case

In January 2024, Deloitte Canada and D-Wave Quantum announced a strategic alliance to accelerate the adoption of quantum computing across government and enterprise operations.³⁵ Their initial focus is on complex optimisation challenges in transportation, infrastructure planning, energy systems, and emergency response.³⁶ The initiative applies quantum annealing and hybrid quantum-classical algorithms through D-Wave's cloud-based Leap platform, integrating quantum computing with artificial intelligence, cloud technologies, and classical optimisation methods to solve large-scale combinatorial

34 Government of Canada, "Transport Canada Releases First, Systematic Analysis Of Cost Of Urban Traffic Congestion In Canada", accessed on July 8, 2026; <https://www.canada.ca/en/news/archive/2006/03/transport-canada-releases-first-systematic-analysis-cost-urban-traffic-congestion-canada.html>

35 "D-Wave Joins Forces with Deloitte Canada to Advance Quantum Adoption," D-Wave Quantum Inc., accessed on September 28, 2026; <https://www.dwavequantum.com/company/newsroom/press-release/d-wave-joins-forces-with-deloitte-canada-to-advance-quantum-adoption/>

36 *ibid.*

optimisation problems more efficiently than conventional approaches.³⁷ This use case is particularly relevant as traffic congestion and operational inefficiencies continue to impose significant economic costs. By improving the speed and quality of optimisation for complex operational systems, the collaboration demonstrates the potential of hybrid quantum computing to enhance decision-making, increase operational efficiency, and support more adaptive and resilient public services.

3.1.3 JPMorgan Chase and QC Ware – Financial modelling through quantum computing

Use case summary

Category	Details
Sector	Finance
Economy	United States of America
Quantum Technology	Quantum Computing
Maturity Level	Quantum Maturity Level 2 – Middle Stage
Geographic Relevance	Global
Lead Organisations	JPMorgan Chase, QC Ware, Quantinuum

Context

Financial institutions like JPMorgan Chase operate in increasingly complex markets where traditional models struggle to capture real-world factors. Deep hedging approaches attempt to address these limitations by using advanced data-driven models. However, these models require processing vast, high-dimensional datasets and involve computationally intensive optimisation tasks. As the number of variables and scenarios increases, classical methods face scalability issues, leading to long training times and suboptimal solutions. There are also limitations in the ability of financial institutions to fully optimise hedging strategies and respond quickly to market changes. This growing gap between model complexity and computation feasibility creates a need for more powerful computing capabilities.

Use Case

In November 2024, JPMorgan Chase and QC Ware demonstrated how quantum technologies can enhance financial modelling – specifically in the area of “deep hedging.” The initiative focused on improving risk management strategies for complex financial portfolios by combining quantum computing techniques with machine learning and stochastic modelling to optimise trading decisions under real-world constraints, including market volatility and transaction costs.³⁸ The collaboration implemented a hybrid quantum-classical approach, applying quantum machine learning methods such as quantum deep learning and quantum reinforcement learning to improve model training and optimisation while maintaining compatibility with current computing infrastructure. This application is particularly relevant as financial institutions manage increasingly complex portfolios and large-scale risk calculations; according to the Bank for International Settlements (BIS), the global over the counter derivatives market reached USD \$ 667 trillion in notional value in the second half of 2023, highlighting the scale of financial systems that require advanced modelling and risk management

37 D-Wave Quantum Inc, “The Real-Time Quantum Cloud Service Built for Business”, accessed on September 25, 2026, <https://www.dwavequantum.com/solutions-and-products/cloud-platform/>

38 Arxiv, “Quantum computing for finance”, accessed on September 25,2026; <https://arxiv.org/pdf/2307.11230>.

capabilities.³⁹ The use case demonstrates the potential for quantum-enhanced approaches to support faster, more accurate financial decision-making and future risk optimisation.

3.1.4 University of Western Australia – Enhanced medical imaging through quantum computing

Use case summary

Category	Details
Sector	Healthcare
Economy	Australia
Quantum Technology	Quantum Computing
Maturity Level	Quantum Maturity Level 1 – Early Stage (Inventing)
Geographic Relevance	Global
Lead Organisations	University of Western Australia, Q-CTRL, Quantinuum, North Metropolitan Health Service, Australia's National Imaging Facility, AWS, First Nations X

Context

Healthcare providers in remote and regional areas experience many challenges in delivering high-quality diagnostic imaging. While portable ultrasound devices are increasingly available, they often produce low-resolution or noisy images that limit clinical usefulness and diagnostic confidence.⁴⁰ These limitations lead to slower processing times, reduced image clarity, and difficulty detecting subtle patterns that may indicate early-stage disease.⁴¹ Additionally, patients in remote communities frequently need to travel long distances to access advanced imaging technologies, leading to delays in diagnosis and treatment.⁴² This creates inefficiencies in healthcare delivery, higher operational costs, and poorer health outcomes. The combination of computational constraints, data complexity, and accessibility challenges underscores the need for new approaches capable of processing large-scale imaging datasets more efficiently while enhancing diagnostic accuracy in remote environments.

Use Case

The University of Western Australia (UWA) is leading a collaborative quantum computing initiative to improve medical imaging for remote communities. The project brings together Q-CTRL, Quantinuum, the North Metropolitan Health Service, and Australia's Imaging Facility, with support from AWS and not-for-profit First Nations X, to investigate how hybrid quantum-classical computing can enhance the quality and interpretation of ultrasound images.⁴³

In 2025, the initiative received an AUD \$432,453 feasibility grants through the Australian Government's Critical Technologies Challenge Program, recognising the potential

39 BIS, "OTC derivatives statistics at end-December 2023", accessed on July 13, 2026; <https://www.bis.org/publications/202405-commentary-otc-derivatives>

40 Mirage News, "Project Plots Quantum Leap To Bridge Healthcare Gap," Mirage News, accessed on September 28, 2026; <https://www.miragenews.com/project-plots-quantum-leap-to-bridge-healthcare-1545165/>

41 Ibid

42 Ibid

43 Ibid

of quantum computing to improve medical image reconstruction and analysis.⁴⁴ By applying quantum algorithms for image reconstruction, noise reduction, and feature extraction, the project aims to improve diagnostic accuracy, accelerate clinical decision-making, and expand access to high-quality imaging for remote and First Nations communities.

3.2 Standards landscape for quantum computing

While quantum computing continues to advance across applications such as optimisation, materials science, drug discovery, artificial intelligence and financial modelling, the international standards landscape remains focused on establishing foundational standards to support the development, evaluation and interoperability of quantum computing technologies.

International standardisation activities are primarily coordinated through IEC/ISO JTC 3 – Quantum Technologies. Quantum computing standardisation is led through committees including Joint Subcommittee (JSC) 3A – Quantum Computing, supported by dedicated working groups including WG 11 (Quantum Computing Supply Chain), WG 12 (Quantum Computing Benchmarking) and WG 15 (Quantum Computing Terminology and Quantities).⁴⁵ These groups are progressing standards and technical reports covering terminology, reference architectures, benchmarking methodologies, performance evaluation and supply chain considerations to support the continued development and commercial deployment of quantum computing technologies.

Published standards directly relevant to quantum computing are primarily focused on establishing common terminology and reference architectures. For example, ISO/IEC 4879:2024, *Information technology – Quantum computing – Vocabulary*, provides harmonised terminology for quantum computing.⁴⁶ In Europe, CEN-CENELEC JTC 22 – Quantum Technologies is also progressing quantum computing-related standardisation through work programmes aligned with international activities.⁴⁷ Together, these standards and ongoing work programmes provide the technical foundation for the future development of more application-specific quantum computing standards.

44 The University of Western Australia, “Project plots a quantum leap to bridge healthcare gap”, accessed on July 14, 2026; <https://www.uwa.edu.au/news/article/2025/october/project-plots-a-quantum-leap-to-bridge-healthcare-gap>

45 IEC, “IEC/ISO JTC 3 Quantum Technologies”, accessed on July 24, 2026; https://www.iec.ch/dyn/www/?p=103:23:408372215314116:::FSP_ORG_ID.FSP_LANG_ID:49854,25

46 ISO, “ISO/IEC 4879:2024”, accessed on July 24, 2026; <https://www.iso.org/standard/80432.html>

47 CEN-CENELEC, “Standardization Roadmap on Quantum Technologies”, accessed on July 24, 2026; https://www.cenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN-CENELEC_Topics/Quantum%20technologies/Documentation%20and%20Materials/fgqt_q06_standardizationroadmapquantumtechnologies_release1-1.pdf

Table 4: Standards mapping for quantum computing technologies

Designation	Standard Title	Abstract/Scope
ISO/IEC 4879:2024	Information technology — Quantum computing — Vocabulary	Defines terms commonly used in the field of quantum computing. This document is applicable to all types of organizations (e.g. commercial enterprises, government agencies, not-for-profit organizations) to exchange quantum computing concepts. ⁴⁸
IEC/ISO AWI TR 18157	Information technology — Introduction to quantum computing	Provides an introduction of quantum computing, including background, quantum information basics, quantum computing paradigms and approaches, quantum hardware, software, algorithms and applications.
IEC/ISOAWI 63712	Quantum technologies — Quantum computing — Hardware benchmarking	Specifies measurement and test methods for hardware performance benchmarking in quantum processor units including established benchmarking procedures for quantum computing components and subsystems in hardware platforms which carry out quantum information processing.

Note: The standards listed in this table are indicative. A comprehensive list is provided in the appendices.

3.3 Standards gaps and opportunities for quantum computing

A number of standards gaps were identified through the Advancing Quantum Technologies through Standards Readiness in APEC survey 2026 and supported by a review of the international standards landscape and relevant literature. The analysis highlights common areas where additional standardisation may support the development and implementation of quantum computing technologies. The identified gaps are grouped into five priority areas: terminology and definitions; characterisation and performance; testing and measurement; interoperability and interfaces; and certification.

Terminology and Definitions

Current international standardisation activities for quantum computing include the development of common terminology to support consistent communication across different stakeholder groups. This was also reflected in the survey findings, where respondents identified terminology and vocabulary as a priority for supporting early-stage research, capacity building and future standardisation activities.

“APEC should prioritise standardisation on basic terminology, safety principles, and capacity-building frameworks as a foundational step to foster mutual learning and collaborative experiences across the region.” – Survey respondent from Indonesia, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026

“Foundational standards such as terminology, vocabulary, and benchmarking metrics to support early-stage research and development, as well as security standards for protecting data.” – Survey respondent from Thailand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026

48 ISO, “ISO/IEC 4879:2024”, accessed on July 24, 2026; <https://www.iso.org/standard/80432.html>

Characterisation and Performance

Quantum computing systems use different hardware approaches and performance characteristics, making consistent approaches for characterisation and performance evaluation important for comparing systems. Survey respondents identified vendor-neutral performance benchmarking, reproducibility and comparison with classical computing as priorities for future standardisation.

“APEC should prioritise vendor-neutral performance benchmarking, credible comparison with classical computing, reproducibility, cloud and software interoperability, security and procurement guidance. Relevant applications include materials and molecular simulation, optimisation and scientific computing. Standards should not prematurely prescribe hardware architectures.” – Survey respondent from New Zealand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026

Testing and Measurement

The international standards landscape for quantum computing currently focuses on foundational standards, with limited published guidance on testing and measurement methodologies. As the technology continues to evolve, consistent approaches for testing and measurement may support more comparable and reproducible evaluation of quantum computing systems.

Interoperability and Interfaces

Quantum computing is expected to operate across a combination of hardware, software and cloud environments. Harmonised approaches for interoperability and interfaces may support software portability and integration across different quantum computing platforms. Survey respondents also identified cloud and software interoperability as a priority area for future standardisation.

Certification

Published international standards relating to certification of quantum computing technologies remain limited. Survey respondents highlighted the importance of harmonised standards to support secure and trusted implementation of quantum computing across different application areas.

“Standards that support certification, such as protocol, testing methods; standards for interfaces standards for parameter definitions.” – Survey respondent from Singapore, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026.

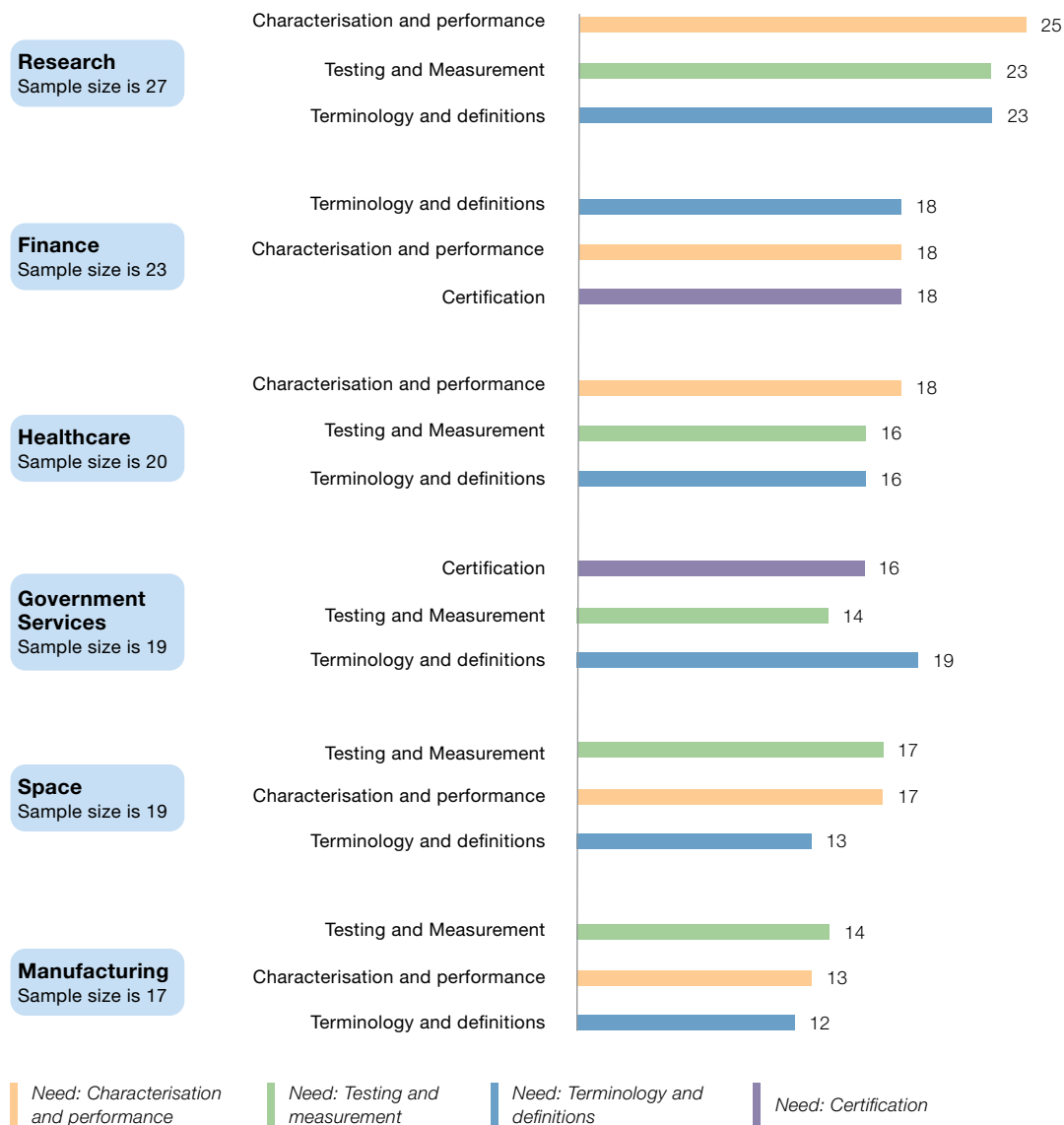
Priority Areas for Quantum Computing Standards Development

Respondents from across APEC member economies were asked to identify the standards needed to support the development and deployment of quantum computing across the APEC region, with multiple responses permitted. Several key themes emerged from the responses. As participation varied across survey questions, the sample size (n) is reported in each figure to indicate the number of respondents on which the results are based.

Across the research, government services, finance and healthcare sectors, respondents consistently identified the following as the highest-priority areas for standardisation:

- Terminology and definitions
- Characterisation and performance
- Testing and measurement

Figure 5: Types of standards most needed to support the implementation of quantum computing in each sector within APEC.



n = number of responses

Source: Advancing Quantum Technologies through Standards Readiness in the APEC Region Survey (2026)

As shown in Figure 5, characterisation and performance was identified as the highest priority in the research sector (n=27), with 25 respondents (93%) selecting it as very important, followed by testing and measurement with 23 respondents (85%) and terminology and definitions with 23 respondents (85%). This suggests that respondents consider consistent approaches for evaluating and comparing quantum computing systems to be important for supporting research and technology development.

In the finance sector (n=23), terminology and definitions, characterisation and performance, and certification were each identified by 18 respondents (78%) as priority areas for standardisation, indicating a balanced emphasis on establishing a common technical vocabulary, consistent approaches for evaluating system performance, and

certification frameworks to support the implementation of quantum computing in financial applications.

In the government services sector (n=19), terminology and definitions was identified as the highest priority by all respondents (100%), followed by certification with 16 respondents (84%) and testing and measurement with 14 respondents (74%). This underscores the importance of establishing a common technical language alongside certification and testing approaches to support the implementation of quantum computing across government service applications.

Across the sectors assessed, respondents consistently prioritised foundational standards, particularly terminology, performance evaluation, testing and certification.

The strong emphasis on terminology standards, particularly within government services, is perhaps reflective of the relatively early stage of standardisation for quantum computing, where foundational frameworks are still being developed.

Table 5: Quantum Computing: Standards Gap Analysis by Use Case

Use Case	Application Area	Identified Standards Gaps	Analysis
Cleveland Clinic, RIKEN and IBM – Using Quantum Technologies to Advance Complex Biological Systems	Life sciences and biomedical research	- Characterisation and performance - Testing and measurement - Terminology and definitions	Quantum computing applications in life sciences require consistent approaches for evaluating computational performance, validating results and establishing common terminology. Standardisation in these areas may support reproducibility of research outcomes and facilitate comparison of quantum computing approaches across research organisations.
Deloitte Canada and D-Wave Quantum – Solving Operational Systems Using Quantum Computing	Optimisation and operations research	- Characterisation and performance - Interoperability and interfaces - Testing and measurement	Optimisation applications require consistent methods for evaluating quantum computing performance and comparing outcomes across different hardware and software platforms. Harmonised approaches for interoperability and testing may support integration with existing computing environments and enable more consistent evaluation of optimisation solutions.
JPMorgan Chase and QC Ware – Financial Modelling Through Quantum Computing	Financial services	- Certification - Characterisation and performance - Terminology and definitions	Financial modelling applications require confidence in computational outputs and consistent approaches for evaluating system performance. Standardisation of terminology, performance evaluation and certification approaches may support greater consistency in assessing quantum computing solutions within financial applications.
University of Western Australia – Enhanced Medical Imaging Through Quantum Computing	Healthcare	- Testing and measurement - Characterisation and performance - Interoperability and interfaces	Quantum computing applications supporting medical imaging require consistent approaches for evaluating computational performance and validating outputs. Standardisation of testing methodologies and interoperability may facilitate integration with existing healthcare computing workflows while supporting consistent evaluation of quantum-enabled imaging applications.

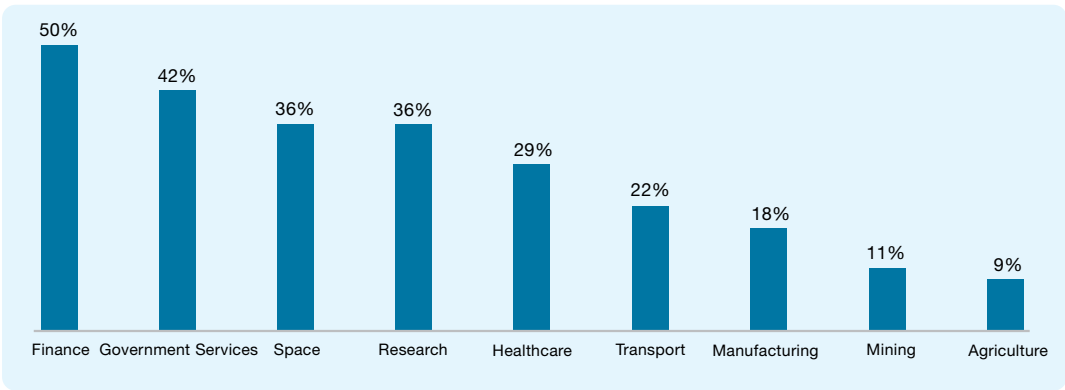
The quantum computing use cases explored in this section demonstrate the importance of standards that support consistent benchmarking, reproducibility and comparison of quantum computing systems across different hardware and software platforms. For APEC economies and National Standards Bodies (NSBs), priority areas include supporting the development of common terminology, performance characterisation, testing methodologies, interoperability between quantum and classical computing environments, and certification approaches that promote trusted implementation. Continued participation in international standardisation activities can help develop harmonised standards that support consistent evaluation, software portability and interoperability as quantum computing technologies continue to evolve. Procurement guidance and future conformity assessment frameworks could be developed to help APEC economies evaluate vendor claims, manage technology risks and support the trusted adoption of quantum computing technologies.

4 Quantum Communication Use Cases

Quantum communication is emerging as a critical technology for enabling secure information exchange and supporting the development of future quantum networks.⁴⁹ Around 42% of survey respondents (26 out of 49) indicated that quantum communication is currently at an early research stage in terms of technological maturity. As the technology matures across APEC economies, the establishment of common standards and testing frameworks will be essential to support interoperability and cross-border implementation.

“APEC should prioritise standards for secure government communications, critical infrastructure protection, financial services, healthcare data security, cross-border digital trade, telecommunications (including Quantum Key Distribution and quantum networks), and interoperability testing and certification. Harmonised international standards will strengthen cybersecurity, enable trusted cross-border communications, and accelerate the adoption of quantum communication technologies across APEC economies.” – Survey respondent from Thailand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026.

Figure 6: Perceived Importance of Quantum Communication Standards Across Sectors



Sample size of 36

Source: Advancing Quantum Technologies through Standards Readiness in the APEC Region Survey (2026)

Figure 6 above highlights the sectors most frequently identified as priorities for quantum communication standards. Finance emerged as the highest-priority area, with 50% of respondents identifying it as a key sector for future standards development. Government services followed at 42%, while space and research were each selected by 36% of respondents. While definitive conclusions cannot be drawn due to the relatively small survey sample, the distribution of responses shown in Figure 6 points to two related drivers for standardisation. The prominence of finance and government services suggests a perceived need for standards in environments where secure and trusted information exchange is important. At the same time, the relatively strong results for the

49 OECD, “Quantum technologies as a new paradigm for digital economies”, accessed on July 20, 2026; https://www.oecd.org/en/publications/quantum-technologies-as-a-new-paradigm-for-digital-economies-and-societies_e6664d58-en.html

research and space sectors indicate a complementary role for standards to support the technical foundations needed to deploy future quantum communication technologies.

4.1 Use cases

4.1.1 Monetary Authority of Singapore, SpeQtral and Singapore Banks – Using quantum communication to secure banking transactions

Use case summary

Category	Details
Sector	Finance
Economy	Singapore
Quantum Technology	Quantum communication
Maturity Level	Quantum Maturity Level 2 – Middle Stage
Geographic Relevance	Global
Lead Organisations	Monetary Authority of Singapore (MAS), DBS Bank, OCBC Bank, UOB, SpeQtral, HSBC, and SPTel

Context

Current cryptographic methods provide strong protection against existing cyber threats but are expected to become increasingly vulnerable as quantum computing capabilities mature.⁵⁰ This creates long-term risks for financial systems, particularly for high-value data that must remain confidential for many years. In addition, financial institutions require communication infrastructure that provides high levels of integrity, confidentiality, and resilience while maintaining compatibility with existing banking systems. While Quantum Key Distribution (QKD) offers a promising approach to strengthening communication security, the absence of widely adopted implementation, interoperability, and certification standards for deploying QKD across operational financial networks creates uncertainty for large-scale adoption.

Use Case

As Singapore’s digital payments ecosystem continues to expand, the need for resilient financial communications has become increasingly important. According to the Monetary Authority of Singapore (MAS), the FAST payment system processed approximately 500 million transactions worth SGD 661.7 billion in 2024, highlighting the scale of critical financial data exchanged across banking networks.⁵¹ In August 2024, the MAS, in collaboration with Development Bank of Singapore, Oversea-Chinese Banking Corporation, UOB, HSBC Bank, SPTel, and quantum technology company SpeQtral, is advancing the use of quantum communication to strengthen the security of financial transactions through QKD.⁵² The initiative focuses on protecting sensitive interbank communications, including payment instructions and settlement data, by integrating QKD into existing banking networks. QKD uses the quantum properties of photons to generate and securely distribute cryptographic keys, enabling any attempted

50 IISS, “QKD governance gap: certification, fragmentation and the cost of delay”, accessed on July 3, 2026; <https://www.iiss.org/online-analysis/online-analysis/2026/04/qkd-governance-gap-certification-fragmentation-and-the-cost-of-delay/>

51 PWC, Singapore Fintech Association, “Payments state of play 2026”, accessed on July 8, 2026; <https://www.pwc.com/sg/en/publications/payments-state-of-play.html>

52 Singapore government, “MAS Collaborates with Banks and Technology Partners on Quantum Security”, published on August 14, 2024; <https://www.mas.gov.sg/news/media-releases/2024/mas-collaborates-with-banks-and-technology-partners-on-quantum-security>

interception to be immediately detected through changes in the quantum state. The solution combines quantum key generation with conventional encryption protocols in a hybrid architecture, demonstrating the practical integration of quantum communication into existing financial infrastructure.⁵³ The initiative also highlights the need for standardisation to enable consistent deployment, certification, and interoperability across financial institutions and international banking networks

4.1.2 NICT Integrated Testbed – Validating quantum-secure financial communications using ICT testbed infrastructure

Use case summary

Category	Details
Sector	Finance
Economy	Japan
Quantum Technology	Quantum communication
Maturity Level	Quantum Maturity Level 1 – Early Stage (Inventing)
Geographic Relevance	Global
Lead Organisations	National Institute of Information and Communications Technology (NICT), NTT Group, Toshiba

Context

As Japan's financial system becomes increasingly digital, the need for secure and resilient financial communications continues to grow. According to Japan's Ministry of Economy, Trade and Industry (METI), cashless payments accounted for 42.8% of total consumer spending in 2024, representing approximately 141 trillion yen in transactions.⁵⁴ The growing volume of digital financial transactions highlights the importance of validating quantum-secure communication technologies that can protect critical financial data exchanged between institutions.

The deployment of quantum communication technologies therefore requires validation beyond controlled laboratory environments to demonstrate reliable performance under realistic operational conditions. Japan wide-scale testbeds enable technologies such as QKD to be evaluated across heterogeneous networks, allowing stakeholders to assess interoperability, scalability, resilience, and integration with existing communication infrastructure before commercial deployment.⁵⁵

For financial institutions, demonstrating the operational readiness of quantum-secure technologies is essential before deployment in mission-critical environments. Although international standards such as the ITU-T Y.3800 Series – *Quantum Key Distribution Networks (QKDN) Recommendations* and the European Telecommunications Standards Institute (ETSI) GS QKD Series – *Quantum Key Distribution Group Specifications* provide foundational guidance on QKD architectures and interfaces, they do not define consistent methodologies for testbed design, interoperability testing, performance

53 PostQuantum, "MAS and Partners Unveil QKD Sandbox Technical Report: Quantum Security in Financial Services", accessed on September 25, 2026, <https://postquantum.com/quantum-policy/mas-qkd-sandbox/>

54 Ministry of Economy, Trade, and Industry, "2024 Ratio of Cashless Payment Among the Total Amount Paid by Consumers Calculated", accessed on September 25, 2026; https://www.meti.go.jp/english/press/2025/0331_001.html

55 National Institute of Information and Communication Technology, "Tokyo QKD Network and Beyond", accessed on September 25, 2026; <https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2023/0724/Documents/Kenyoshi.pdf>.

benchmarking, conformance assessment, and operational validation. This has the potential to limit confidence in deployment readiness and slows the adoption of quantum communication technologies across operational financial networks.

Use Case

Japan’s National Institute of Information and Communications Technology (NICT) operates the Integrated Testbed, a Japan wide scale experimental platform for evaluating advanced communication technologies, including QKD, secure optical networks, and beyond 5G systems.⁵⁶ The testbed provides a realistic operational environment for assessing the performance, interoperability, and security of quantum communication technologies under representative network conditions. Through collaborations with industry and research partners, including organisations such as Nippon Telegraph and Telephone (NTT) Group on related quantum communication initiatives, the testbed supports the validation of quantum-secure communication systems for applications requiring highly secure and reliable data transmission.⁵⁷

The initiative demonstrates how emerging international standards, including the ITU-T Y.3800 Series – *Quantum Key Distribution Networks (QKDN) Recommendations* and the European Telecommunications Standards Institute (ETSI) GS QKD Series – *Quantum Key Distribution Group Specifications*, could be applied to support QKD network architecture, interoperability, and system design. Nonetheless, gaps remain in standardised testing methodologies, performance evaluation, interoperability, and certification for operational quantum communication networks.

4.1.3 DC-QNet Government Quantum Network – Developing a regional quantum network for secure government communications

Use case summary

Category	Details
Sector	Government Services
Economy	The United States
Quantum Technology	Quantum communication
Maturity Level	Quantum Maturity Level 1 – Early Stage (Inventing)
Geographic Relevance	Global
Lead Organisations	Washington Metropolitan Quantum Network Research Consortium (DC-QNet), participating U.S. federal agencies, research institutions and industry partners.

Context

The U.S. Government Accountability Office (GAO) identifies cybersecurity as one of the federal government’s high-risk areas and reported that federal agencies experienced more than 30,000 information security incidents in 2022, highlighting the growing

56 NICT, “Overview of NICT Integrated Testbed”, accessed on July 3, 2026; <https://testbed.nict.go.jp/english/index.html>

57 NNT, “Demonstration of remote robot control via server enhanced by softwarization of industrial Ethernet functions Free choice of robots at factories and lower initial factory investment”, accessed on July 2, 2026; <https://group.ntt/en/newsrelease/2024/05/16/240516a.html>

need for advanced communication technologies capable of protecting mission-critical government services.⁵⁸

Advancing quantum networking from isolated laboratory experiments to operational government communication infrastructure requires an environment where multiple organisations can jointly evaluate quantum technologies under realistic conditions. Limited shared regional quantum networks that enabled federal agencies, research institutions, and industry partners to test quantum communication technologies across geographically distributed sites using operational telecommunications infrastructure exist. This limits the ability to assess multi-organisation interoperability, network performance, operational coordination, and the feasibility of supporting future government services requiring high-assurance communications. In addition, implementation and operational standards for large-scale regional quantum networks are still evolving, making it difficult to establish consistent approaches for network architecture, governance, deployment, interoperability, and operational management across participating organisations. This creates uncertainty for future large-scale government adoption.

Use Case

In June 2022, the Washington Metropolitan Quantum Network Research Consortium (DC-QNet) was established in the United States to develop and operate a regional quantum network connecting multiple federal agencies, research institutions, and industry partners.⁵⁹ The initiative provides a shared operational testbed for evaluating quantum networking technologies beyond laboratory settings, supporting secure government communications, quantum networking research, and future government services requiring high-assurance communications. The initiative also provides a practical platform for validating emerging approaches to quantum network architecture, interoperability, and operational management, generating implementation evidence that can inform future standards development and support the transition of quantum networking technologies from research environments to operational government communication infrastructure.

58 The U.S. Government Accountability Office, “High-Risk Series”, accessed on September 25, 2026; <https://www.gao.gov/products/gao-24-107231>

59 U.S. Naval Research Laboratory, “NRL Announces the Washington Metropolitan Quantum Network Research Consortium (DC-QNet)”, accessed on July 1, 2026; <https://www.nrl.navy.mil/ppd/Article/3060477/nrl-announces-the-washington-metropolitan-quantum-network-research-consortium-d/>

4.1.4 SK Broadband –ID Quantique – Quantum Key Distribution for Secure Electronic Health Record Exchange

Use case summary

Category	Details
Sector	Healthcare
Economy	Republic of Korea
Quantum Technology	Quantum communication
Maturity Level	Quantum Maturity Level 1 – Early Stage (Inventing)
Geographic Relevance	Global
Lead Organisations	SK Broadband, ID Quantique.

Context

Republic of Korea has one of the world's most digitally advanced healthcare systems. According to the Korea Health Information Service's 2020 Survey on the Current State of e-Healthcare, approximately 93.3% of hospitals and higher-tier healthcare institutions have implemented Electronic Medical Record (EMR) systems, including 100% of tertiary general hospitals.⁶⁰ As the exchange of electronic health records (EHRs) and other sensitive patient information between hospitals and healthcare providers continues to increase, maintaining the confidentiality and integrity of this information during transmission has become critical. Healthcare organisations must protect patient privacy while ensuring timely access to clinical data for diagnosis and treatment. Healthcare systems depend on established cryptographic mechanisms to protect sensitive information, including electronic health records and clinical communications. The emergence of quantum computing creates a need to transition towards quantum-resistant security approaches while maintaining interoperability with existing healthcare infrastructure and avoiding disruption to clinical workflows.⁶¹ In addition, there is limited implementation guidance for integrating quantum communication technologies into healthcare information exchange infrastructure while maintaining interoperability with existing health information systems and compliance with healthcare information security requirements.

Use Case

SK Broadband, in collaboration with ID Quantique, demonstrated the application of QKD to secure the transmission of EHRs and other sensitive medical information across healthcare networks.⁶² The initiative integrates QKD quantum-secure key distribution with existing healthcare communication infrastructure to protect patient data exchanged between healthcare facilities, while supporting digital healthcare services. By enabling tamper-evident cryptographic key exchange, the project strengthens the confidentiality and integrity of healthcare communications and demonstrates the practical application of quantum communication technologies in protecting sensitive clinical information. The collaboration deployed a QKD-enabled communication network to secure the exchange of electronic health records between healthcare facilities.

60 Korea Institute for Health and social affairs, "Policy Implications from Selected Countries for Promoting EMR Certification in Korea", accessed on September 25, 2026; <https://www.kihasa.re.kr/en/board/press/view?seq=51627>

61 NIST, "What is post quantum cryptography", accessed on July 22, 2026; <https://www.nist.gov/cybersecurity-and-privacy/what-post-quantum-cryptography>

62 IDO, "IDQ & SK Broadband expand use of QKD to protect critical data in South Korea", accessed on June 20, 2026; <https://www.idquantique.com/id-quantique-and-sk-broadband-expand-the-use-of-quantum-key-distribution-to-protect-critical-information-in-south-korea/>

The healthcare use case included deployment at Yonsei Medical Center, where QKD was applied to enhance the security of medical network communications.⁶³ The project demonstrated the integration of quantum-secure key distribution technologies within operational communication environments and provided practical insights into deployment considerations, interoperability requirements, and future standardisation needs for quantum-secure healthcare communications.

4.2 Standards landscape for quantum communication

Quantum communication is progressing across applications including secure communications, critical infrastructure, financial services, healthcare, government and research. International standardisation activities are focused on establishing the technical foundations required to support secure, interoperable and scalable quantum communication networks. Unlike quantum sensing and quantum computing, quantum communication has a comparatively more mature international standards landscape, driven by the development and deployment of QKD and broader quantum network technologies.

International standardisation activities are led by several standards development organisations, including ITU-T, ETSI, IEC/ISO JTC 3 – Quantum Technologies, and CEN-CENELEC JTC 22 – Quantum Technologies. Current activities focus on developing standards for terminology, reference architectures, security frameworks, network interfaces, interoperability, testing methodologies and performance evaluation to support the implementation of quantum communication technologies.

IEEE is developing standards for quantum technologies, including IEEE P1913 on software-defined quantum communication and IEEE P7130 on harmonised quantum technology definitions and terminology.⁶⁴

Published standards are primarily centred on QKD, including reference architectures, security requirements, network architectures and interoperability guidance. More recently, international standardisation activities have expanded to support broader quantum communication technologies, including quantum networks and quantum internet infrastructure. Collectively, these published standards and ongoing work programmes are helping to establish the technical foundation for the continued development and deployment of quantum communication technologies.

63 IDO, “ID Quantique and SK Broadband selected to build a pilot QKD infrastructure in public, medical and industrial sectors in Korea”, accessed on June 20, 2026; <https://www.idquantique.com/id-quantique-and-sk-broadband-selected-to-build-a-pilot-qkd-infrastructure-in-public-medical-and-industrial-sectors-in-korea/>

64 EU Observatory ICT Standardisation, “P1913 - Software Defined Quantum Communication” <https://standict.eu/standards-repository/p1913-software-defined-quantum-communication>. IEEE, “Standard for Quantum Technologies Definitions” accessed on September 25, 2026.

Table 6: Standards mapping for quantum communication technologies

Designation	Standard Title	Abstract/Scope
ISO/IEC 23837-1:2023	Information security — Security requirements, test and evaluation methods for quantum key distribution — Part 1: Requirements	Specifies security requirements and a framework for evaluating the security of Quantum Key Distribution (QKD) modules, including quantum optical and conventional network components.
ISO/IEC 23837-2:2023	Information security — Security requirements, test and evaluation methods for quantum key distribution — Part 2: Evaluation and testing	Specifies evaluation and testing methods for assessing the security of QKD systems and complements the Part 1 security requirements.
ITU-T Y.3800	Overview on Networks Supporting Quantum Key Distribution	Provides the overall framework, concepts and reference model for Quantum Key Distribution Networks (QKDNs).
ITU-T Y.3801	Functional Requirements for Quantum Key Distribution Networks	Defines the functional requirements necessary for the implementation and operation of QKDNs.
ITU-T Y.3802	Quantum Key Distribution Networks – Functional Architecture	Specifies the functional architecture and logical components of Quantum Key Distribution Networks.
ITU-T Y.3803	Quantum Key Distribution Networks – Key Management	Specifies key management functions and processes supporting secure operation of QKDNs.
ITU-T X.1711:2026	Framework of Quantum Key Distribution (QKD) Protocols in QKD Networks	Specifies the framework and architecture of QKD protocols operating within the quantum layer of a QKD network.
ETSI GS QKD 011	Quantum Key Distribution (QKD); Component characterization	Specifies methods for characterising optical components used in QKD systems.
ETSI GS QKD 012	Quantum Key Distribution (QKD); Device and Communication Channel Parameters for QKD Deployment	Defines device and communication channel parameters to support deployment of QKD systems.
ETSI GS QKD 014	Quantum Key Distribution (QKD); Protocol and data format of REST-based key delivery API	Specifies an interoperable REST-based API for delivering cryptographic keys from QKD systems to applications.
ETSI GS QKD 015	Quantum Key Distribution (QKD); Control Interface for Software Defined Networks	Defines control interfaces enabling Software Defined Networking (SDN) integration with QKD networks.
ETSI GS QKD 018	Quantum Key Distribution (QKD); Orchestration Interface for Software Defined Networks	Specifies orchestration interfaces supporting multi-domain management and interoperability of QKD networks.

Note: The standards listed in this table are indicative, a comprehensive list is provided in the appendices.

4.3 Standards gaps and opportunities for quantum communication

A number of standards gaps were identified through the Advancing Quantum Technologies through Standards Readiness in APEC survey 2026 and supported by a review of the international standards landscape and relevant literature. The following analysis highlights common areas where additional standardisation may support the development, integration and deployment of quantum communication technologies. Identified gaps are grouped into five priority areas: terminology and definitions; performance characterisation and benchmarking; testing and measurement; interoperability and interfaces; and security, certification and assurance.

Terminology and Definitions

International standardisation activities for quantum communication are focused on establishing common terminology, concepts and reference models to support consistent understanding around the world. Clear definitions are particularly important as quantum communication technologies develop across different approaches, including QKD, quantum networks and related security technologies. Establishing common terminology can support collaboration, reduce ambiguity and provide a foundation for future technical standards. Survey respondents identified foundational terminology as an important priority area for supporting knowledge sharing, collaboration and future standardisation activities.

“APEC should prioritise standardisation on basic terminology, safety principles, and capacity-building frameworks as a foundational step to foster mutual learning and collaborative experiences across the region.” – Survey respondent from Indonesia, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026

Performance Characterisation and Benchmarking

Quantum communication systems can involve different architectures, protocols, components and deployment environments, creating a need for consistent approaches to characterise and compare system performance. Standardised performance metrics and benchmarking approaches may support evaluation of QKD systems, quantum network capabilities and supporting components. Survey respondents highlighted the importance of establishing approaches for evaluating QKD performance, component characteristics and network capabilities to support future deployment.

“Standards should address QKD performance and security, component characterisation, interfaces, key management, network architecture, interoperability and integration with conventional optical infrastructure. QKD, future quantum networks and post-quantum cryptography should be treated as related but technically distinct technologies.” – Survey respondent from New Zealand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026

Testing and Measurement

Testing and measurement approaches are important for evaluating the functionality and performance characteristics of quantum communication systems. Existing international standards provide guidance in areas such as QKD security evaluation, component characterisation and network requirements. Further development of testing methodologies may support consistent evaluation approaches and comparison between different quantum communication implementations.

“APEC should develop common approaches for testing, certification, conformity assessment and procurement. This is essential to reduce vendor risk, avoid exaggerated claims and help public and private institutions buy trustworthy technologies.” – Survey respondent from Chile, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026.

Interoperability and Interfaces

Quantum communication networks require integration between multiple components, including QKD devices, key management systems, network control systems and existing optical communication infrastructure. Harmonised interfaces and interoperability approaches can support integration between different technologies and vendors while enabling future expansion of quantum communication networks. In the survey, interoperability and integration with conventional infrastructure were highlighted as key areas requiring standardisation.

“Standards should address QKD performance and security, component characterisation, interfaces, key management, network architecture, interoperability and integration with conventional optical infrastructure.” – Survey respondent from New Zealand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026.

Security, Certification and Assurance

Security and assurance are central considerations for quantum communication technologies, particularly for applications involving secure data transmission and QKD-based communication systems. International standards activities are developing security requirements, testing approaches and evaluation methodologies to support assessment of quantum communication solutions.

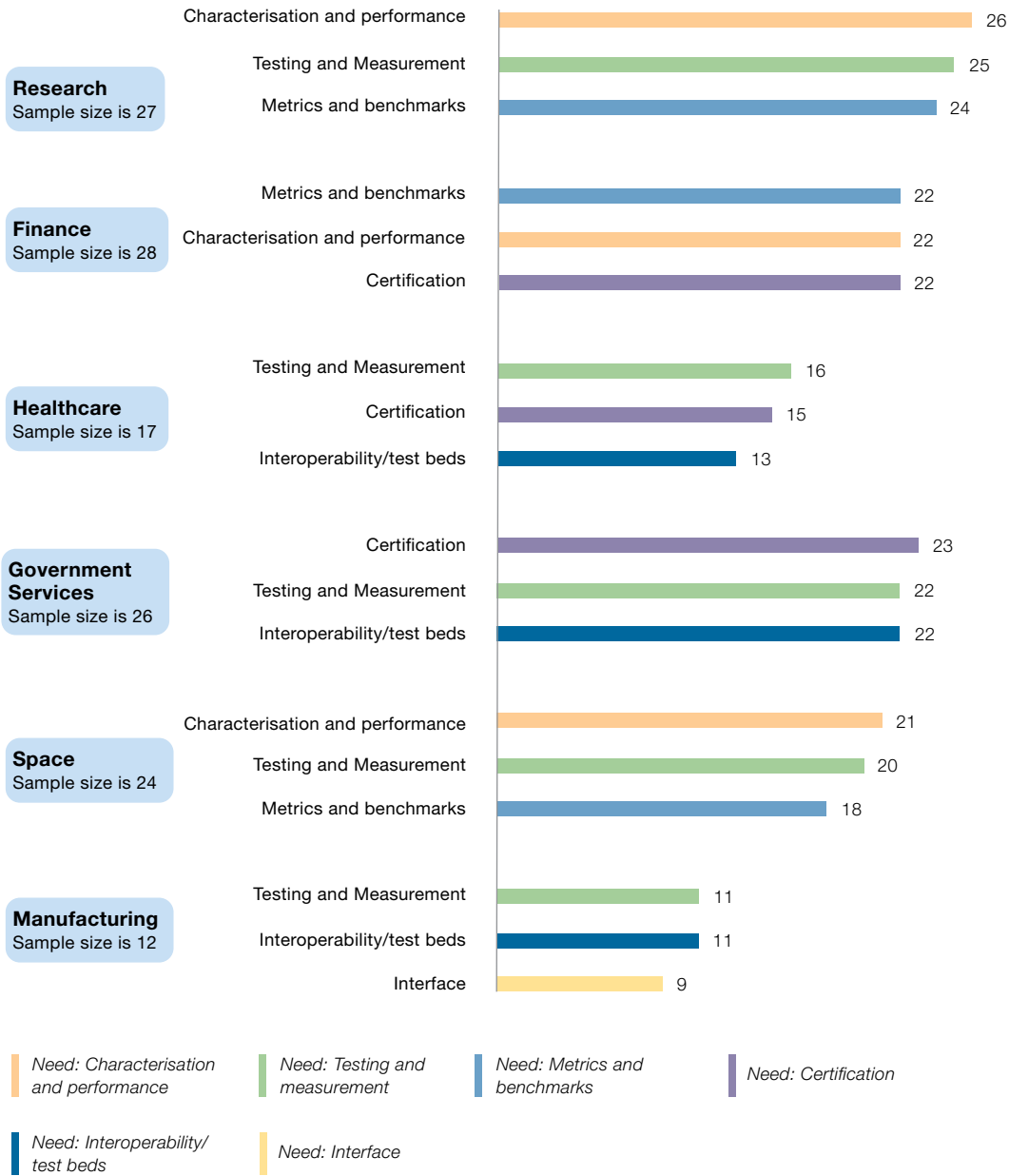
“Standards for quantum-secure encryption, post-quantum cryptography, and Quantum Key Distribution (QKD) should be a top priority to protect sensitive data against future quantum-enabled cyber threats.” – Survey respondent from Thailand, Advancing Quantum Technologies through Standards Readiness in APEC survey 2026.

Priority Areas for Quantum Communication Standards Development

Respondents from across APEC member economies were asked to identify the standards needed to support the development and deployment of quantum communications across the APEC region, with multiple responses permitted. Several key themes emerged from the responses. As participation varied across survey questions, the sample size (n) is reported in each figure to indicate the number of respondents on which the results are based. Across the government services, finance and healthcare sectors, respondents identified the following as the highest-priority areas for standardisation.

- Characterisation and performance
- Testing and measurement
- Certification
- Implementation security
- QKD protocol and theoretical security
- Interoperability and testbeds

Figure 7: Types of standards needed to support the implementation of quantum communication in each sector.



n = number of responses

Source: Advancing Quantum Technologies through Standards Readiness in the APEC Region Survey (2026)

As shown in Figure 7, characterisation and performance was identified as the highest priority in the research sector (n=27), with 26 respondents (96%) selecting it as important, followed by testing and measurement with 25 respondents (93%) and metrics and benchmarks with 24 respondents (89%). These findings suggest that consistent approaches for evaluating quantum communication system performance and establishing comparable metrics are seen as key requirements to support research and technology development.

In the finance sector (n=28), metrics and benchmarks, characterisation and performance, and certification were each identified by 22 respondents (79%) as

priority areas for standardisation. This highlights the importance placed on establishing consistent methods for evaluating system performance, comparing quantum communication solutions and developing assurance approaches to support trusted implementation within financial applications.

In the government services sector (n=26), certification was identified as the highest priority by 23 respondents (88%), followed by testing and measurement and interoperability/testbeds, each selected by 22 respondents (85%). Given the nature of the sector, these results reflect the need for trusted evaluation, conformity assessment and interoperability approaches to support the implementation of quantum communication technologies in government-related applications.

Collectively, these results suggest that quantum communication technologies are entering a transitional phase. While characterisation and performance standards are seen as a priority for the research sector, the increasing importance placed on certification in sectors such as government and finance indicates a growing need for standards that support trusted implementation in critical environments.

Table 7: Quantum Communication: Standards Gap Analysis by Use Case

Use Case	Application Area	Identified Standards Gaps	Analysis
Monetary Authority of Singapore – SpeQtral	Secure financial communications and Quantum Key Distribution (QKD) networks	- Performance characterisation and benchmarking - Interoperability and interfaces - Security, certification and assurance	QKD deployments in financial environments require consistent approaches for evaluating system performance, assessing security characteristics and integrating quantum communication solutions with existing communication infrastructure. Standardisation approaches for performance evaluation, interoperability and assurance may support confidence in the implementation of QKD solutions across financial communication environments.
NICT Integrated Testbed (Japan)	Quantum communication research networks and QKD network experimentation	- Testing and measurement - Performance characterisation and benchmarking - Interoperability and interfaces	Quantum communication testbeds support evaluation of network technologies, components and communication approaches under different operating conditions. Standardised testing methodologies, performance metrics and interface approaches may support consistent evaluation of quantum communication systems and facilitate collaboration between different research and technology environments.
DC-QNet (United States)	Quantum networking and distributed quantum communication research	- Interoperability and interfaces - Performance characterisation and benchmarking - Testing and measurement	Quantum network demonstrations involve the integration of quantum communication components with conventional network infrastructure. Common approaches for interfaces, performance evaluation and testing may support compatibility between network components and enable more consistent assessment of quantum networking approaches.
SK Broadband – Yonsei University Health System – ID Quantique	Healthcare data security and QKD-enabled secure communications	- Security, certification and assurance - Interoperability and interfaces - Testing and measurement	Healthcare communication applications require reliable protection of sensitive information and integration with existing communication environments. Standardised security evaluation, certification approaches and interoperability methods may support the assessment and integration of QKD-based communication solutions within healthcare settings.

The quantum communication use cases and standards gaps explored in this section demonstrate that future deployment will require standards that support secure, interoperable and measurable integration of quantum communication technologies with existing communication infrastructure. For APEC economies and NSBs, priority areas include supporting common approaches for QKD performance evaluation, security assessment, network interfaces, interoperability testing and assurance frameworks. Continued collaboration through international standardisation activities can also help establish consistent approaches for integrating quantum communication components, evaluating system capabilities and supporting trusted adoption of quantum communication technologies across different application environments.

5.0 Conclusion

According to the Organisation for Economic Co-operation and Development (OECD), quantum technologies represent a new paradigm for digital economies and societies. They have the potential to transform the way information is processed, transmitted and measured while driving innovation across a wide range of industries.⁶⁵ As quantum technologies continue to mature, their successful adoption will depend not only on scientific and technological breakthroughs but also on the development of internationally recognised standards that promote interoperability, trust, safety and global collaboration.

The APEC economies have a unique opportunity to strengthen their collective readiness for the quantum era. This APEC Quantum Standards Readiness Background Paper has examined the current state of quantum computing, quantum sensing and quantum communications across the region through stakeholder survey findings, technology maturity assessments for the use cases and a comprehensive analysis of the standards landscape.

The report highlights that while many quantum technologies remain at the research and pilot stage, the pace of technological advancement is creating an increasing need for standards that provide common terminology, measurement methods, interoperability frameworks, performance benchmarks and guidance for implementation. At the same time, the standards mapping undertaken in this report identifies areas where existing international standards are supporting technology development, as well as important gaps where further standardisation activities will be required as technologies mature.

These findings reinforce the importance of collaboration across government, industry, academia and standards development organisations to strengthen regional quantum readiness. Building technical capability, increasing participation in international standards activities, supporting knowledge sharing and encouraging collaboration between economies will be critical to addressing current capability gaps and accelerating the responsible adoption of quantum technologies throughout the region.

As quantum technologies continue to evolve, standards must evolve alongside them. By proactively engaging in international standardisation, APEC economies can help shape a trusted and globally connected quantum ecosystem. Through continued collaboration and a shared commitment to international standards, APEC is well positioned to support the responsible development and adoption of quantum technologies while enhancing regional economic growth and long-term technological competitiveness.

65 OECD, “A quantum technologies policy primer”, accessed on July 15, 2026; https://www.oecd.org/en/publications/a-quantum-technologies-policy-primer_fd1153c3-en.html

Appendices

Appendix 1: Standards Mapping

Table 8: IEC/ISO JTC 3 Quantum Standards Activity

IEC/ISO JTC 3 Quantum Standards Activity		
Focus Area	Standard	Status
Quantum Computing	ISO/IEC 4879:2024, <i>Information technology – Quantum computing – Vocabulary</i> This document defines terms commonly used in the field of quantum computing.	Published (under revision)
Quantum Computing	ISO/IEC AWI TR 18157, <i>Information technology – Introduction to quantum computing</i> Provides an introduction of quantum computing, including background, quantum information basics, quantum computing paradigms and approaches, quantum hardware, software, algorithms and applications.	Under Development
Quantum Computing	IEC/ISO 63607 ED1, <i>Quantum technologies – Terminology and quantities – General quantities</i> This document gives names, symbols, definitions and units for general quantities in the field of quantum technologies.	Under Development
Quantum Computing	IEC/ISO 63622 ED1, <i>Quantum Photonics Vocabulary</i> This document provides definitions and terms in the field of quantum photonics. The scope includes terms related to the type, operation, and characterization of single-photon sources, single-photon detectors, optical quantum memories, quantum repeaters, photonic entanglement, and quantum frequency conversion.	Under Development
Quantum Computing	IEC/ISO 63655 ED1, <i>Quantum technologies – Terminology and quantities – General vocabulary</i> This document gives definitions for general vocabulary in the field of quantum technologies. The terms described here include supporting terms needed to define general quantities and those that are widely used throughout quantum technologies, especially including fundamental terms from quantum information science.	Under Development

Table 9: IEC/ISO JTC 3 Subgroups Involved in Quantum Standards Activity⁶⁶

Working Groups under IEC/ISO JTC 3	
Working Group Code	Working Group Title
WG 9	Working Group 9 – Terminology and quantities
WG 10	Working Group 10 – Quantum sensors
WG 11	Working Group 11 – Quantum computing supply chain
WG 12	Working Group 12 – Quantum computing benchmarking
WG 13	Working Group 13 – Quantum random number generators
AG 1	Advisory Group 1 – Strategic planning
AG 8	Advisory Group 8 – Chair's Advisory Group

Table 10: IEEE Quantum Standards Activity

IEEE Quantum Standards Activity		
Focus Area	Standard Title	Status
Quantum Computing; Quantum; Communication; Quantum Sensing	IEEE P7130, Standard for Quantum Technologies Definitions Addresses quantum technologies specific terminology and establishes definitions necessary to facilitate clarity of understanding to enable compatibility and interoperability.	Under Development
Quantum Computing	IEEE P3329, Standard for Quantum Computing Energy Efficiency Defines energy efficiency metrics for quantum computing (gate-based, quantum annealing, quantum simulation). It compares the performance of the computation to its energy consumption.	Under Development
Quantum Communication	IEEE P1943, Standard for Post-Quantum Network Security Defines a method to implement optimised post-quantum version of existing network security protocols. It is based on a multi-layer protocols approach and allows data packets and/or data encapsulated to be quantum resistant to future cryptographically relevant quantum computers (CRQCs).	Under Development
Quantum Communication	IEEE P1947, Standard for Quantum Cybersecurity Framework This standard describes a Quantum Cybersecurity Framework composed of two categories: 1) threat vectors to information processing (data) security including new vectors due to quantum computing, and 2) defense mechanisms of advanced technologies tailored to the threat vectors.	Under Development

⁶⁶ IEC, "IEC/ISO JTC 3 – Quantum technologies: Structure: Subgroups," accessed June 28, 2026, https://www.iec.ch/ords/f?p=103:29:11909904048435:::FSP_ORG_ID,FSP_LANG_ID:49854,25#1.

Table 11: IEEE Committees Involved in Quantum Standards Activity

Committee Title (Code)	Committee Scope
IEEE Computer Society Standards Activities Board Standards Committee (C/SABSC)	Standards development that supports theory, design, practice, and application relating to computer and information processing science and technology, including quantum computing. ⁶⁷
IEEE Virtualised and Software Defined Networks, and Services Standards Committee (COM/NetSoft-SC)	Standards development that relates to operations, administration, management, services, softwarisation, virtualisation of communication networks, including quantum communication. ⁶⁸
IEEE Software & Systems Engineering Standards Committee (C/S2ESC)	Standardisation of notations, nomenclatures, methods, processes, products, resources, solution, and techniques for the engineering of software and systems dependent on software, including a standardised method for the design of quantum algorithms. ⁶⁹
IEEE Cybersecurity & Privacy Standards Committee (C/CPSC)	Development and maintenance of cybersecurity and privacy standards including information security management systems, network security, cryptographic techniques and post-quantum cryptography among others. ⁷⁰

Table 12: ITU-T Quantum Standards Activity

ITU-T Quantum Standards activity		
Focus Area	Standard	Status
Quantum Communication	ITU-T Y.3804 (04/2025), <i>Quantum key distribution networks – Control and management</i> Specifies functions and procedures for quantum key distribution network (QKDN) control and management to realise secure, stable, efficient, and robust operations of and services by a quantum key distribution (QKD) network as well as to manage a QKDN as a whole and support user network management.	Published
Quantum Communication	ITU-T Y.3818 (09/2024), <i>Quantum key distribution network interworking – Architecture</i> Specifies functional architecture models for quantum key distribution network interworking (QKDNI), i.e., functional architectures with gateway and interworking nodes.	Published
Quantum Communication	ITU-T Q.4160 (12/2023), <i>Quantum key distribution networks – Protocol framework</i> Specifies a framework for signalling and protocols for quantum key distribution network (QKDN).	Published
Quantum Sensing	ITU-T X.1702 (11/2019), <i>Quantum noise random number generator architecture</i> Defines a generic functional architecture of a quantum entropy source, a common method to estimate and validate the entropy of a noise source under evaluation, and a common method to specify randomness extractors when they are part of the implemented system.	Published

67 IEEE SA, "IEEE Computer Society Standards Activities Board Standards Committee", accessed June 25, 2026, <https://sagroups.ieee.org/csabsc/>; "About the IEEE Computer Society," IEEE Computer Society, accessed June 25, 2026, <https://www.computer.org/about>.

68 IEEE SA, "NetSoft," accessed June 25, 2026, <https://sagroups.ieee.org/netsoft/>.

69 IEEE, "Software & Systems Engineering Standards Committee," accessed June 25, 2026, <https://www.computer.org/volunteering/boards-and-committees/standards-activities/committees/s2esc>.

70 IEEE Computer Society, "Cybersecurity & Privacy Standards Committee," accessed June 25, 2026, <https://www.computer.org/volunteering/boards-and-committees/standards-activities/committees/cybersecurity-privacy>.

Table 13: ITU-T Study Groups Involved in Quantum Standards Activity

Study Group Title (Code)	Study Group Scope
Study Group 11: Signalling requirements, protocols, test specifications and combating counterfeit telecommunication/ICT devices (ITU-T SG11)	ITU-T SG11 is responsible for developing standards that define how telephone calls and other ICT services are handled in the network, as well as on the security of signalling protocols and global interoperability testing specifications. ⁷¹ ITU-T SG11 have developed standards on the protocol aspects for quantum key distribution networks.
Study Group 13: Future networks and emerging network technologies (ITU-T SG13)	ITU-T SG13 is responsible for developing standards related to information-centric networking (ICN), intersecting with various critical and emerging technologies such as artificial intelligence, cloud computing, as well as quantum networks and their related technologies including networking aspects of quantum key distribution networks (QKDN). ⁷²
Study Group 17: Security (ITU-T SG17)	ITU-T SG17 is responsible for developing standards that enhances confidence, security and trust in the use of telecommunications/ICTs, including areas around cybersecurity and data protection among others, as well as quantum-based security, including quantum key distribution (QKD) and post-quantum cryptography algorithms.

Table 14: Examples of CEN-CLC/JTC 22 Quantum Standards Activity

Examples of CEN-CLC/JTC 22 Quantum Standards Activity		
Focus Area	Standard Title	Status
Quantum Computing	CEN/CLC/TR 18202:2025 , <i>Layer model of Quantum Computing</i> This document defines a layer model that covers the entire stack of universal gate-based quantum computers. The scope of this Technical Report is restricted to a universal gate-based quantum-computing model, also known as a digital or circuit quantum-computing model, on multiple physical systems such as transmon, spin-qubit, ion-trap, neutral-atom, and others.	Published
Quantum Communication	JT022003 , <i>Gap analysis of current quantum communication and quantum cryptography standards</i> This document provides a comprehensive comparative analysis of current quantum communication and quantum cryptography standards.	Under Development
Quantum Communication	JT022011 , <i>Standardisation needs for satellite based QKD</i> The “Standardisation needs for satellite-based QKD” work item will provide insights that will influence future standardisation efforts.	Under Development
Quantum Communication	JT022002 , <i>QKD and PQC – An equitable analysis and comparison of both technologies</i> This document provides an equitable analysis of how the Quantum Key Distribution (QKD) and Post-quantum Cryptography (PQC) technologies relate to each other.	Under Development
Quantum Computing	JT022006 , <i>Hybridisation of Quantum Computing</i> The scope of this project is to develop a technical report that defines requirements, interfacing protocols and software for hybridisation of quantum computing, i.e., integrating quantum computers within the classical high-performance computing (HPC) infrastructure.	Under Development

71 ITU, “About SG11 (2022-2024),” accessed June 25, 2026, <https://www.itu.int/en/ITU-T/about/groups/2022-2024/Pages/sg11.aspx>.

72 ITU, “About Study Group 13”, accessed June 25, 2026, <https://www.itu.int/en/ITU-T/about/groups/2025-2028/Pages/sg13.aspx>.

Table 15: ETSI Committees involved in Quantum Standards Activity

Committee Title (Code)	Committee Scope
Industry Specification Group on Quantum Key Distribution (ISG QKD)	Standardisation around quantum key distribution system interfaces, implementation security requirements and optical characterisation of Quantum key distribution systems and their components – to support quality and safe deployment of Quantum key distribution. ⁷³

Table 16: Examples of ETSI ‘Industry Specification Group on Quantum Key Distribution’ Quantum Standards Activity

ETSI ‘Industry Specification Group on Quantum Key Distribution’		
Focus Area	Standard Title	Status
Quantum Communication	ETSI GS QKD 012 V1.1.1, Quantum Key Distribution (QKD); Device and Communication Channel Parameters for QKD Deployment Describes the main communication resources involved in a QKD system and the possible architectures that can be adopted when performing a QKD deployment over an optical network infrastructure. The scope of the present document is restricted to QKD deployments over fibre optical networks.	Published
Quantum Communication	ETSI GS QKD 015 V2.1.1, Quantum Key Distribution (QKD); Control Interface for Software Defined Networks Provides a definition of management interfaces for the integration of QKD in disaggregated network control plane architectures, in particular with Software-Defined Networking (SDN). It defines abstraction models and workflows between an SDN-enabled QKD node and the SDN controller, including resource discovery, capabilities dissemination and system configuration operations.	Published

Table 17: Examples of ETSI ‘Technical Committee on Cyber Security’ Quantum Standards Activity

ETSI ‘Technical Committee on Cyber Security’		
Focus Area	Standard Title	Status
Quantum Communication	ETSI TR 103 965 V1.1.1, CYBER; Quantum-Safe Cryptography (QSC); Impact of Quantum Computing on Cryptographic Security Proofs The present document is intended to provide an overview of the impact of quantum computing on the security proofs of several cryptographic protocols.	Published
Quantum Communication	ETSI GR QSC 006 V1.1.1, Quantum-Safe Cryptography (QSC); Limits to Quantum Computing applied to symmetric key sizes The present document gives information on the long-term suitability of symmetric cryptographic primitives in the face of quantum computing.	Published

73 ETSI, “Quantum Key Distribution (QKD)”, accessed on June 26, 2026; <https://www.etsi.org/technical-groups/qkd/>

