



Singapore: Singapore invests in quantum-ready future

Netherlands Innovation Network Singapore, 14 OCT 2021

[Introduction](#)

Singapore keeps transforming into a Smart Nation and invests via well-aligned policies and budgets in the digital and green economy. It has a strong and strategic position as technological hub and gateway to the region with far-developed digital infrastructure and R&D capabilities. The National Research Foundation (NRF) will invest \$25 billion (€ 15.9 billion) over the next five years via the Research, Innovation and Enterprise 2025 Plan, further expanding research and development, including in quantum computing and communications as part of the Smart Nation and digital economy pillar.

[Strategy on quantum](#)

Singapore invested in quantum technology early on. In 2002 a research group was set up which five years later grew into the Centre for Quantum Technologies (CQT). This national Research Centre of Excellence conducts basic quantum research and builds devices based on quantum technologies. The city-state has two major research programs on quantum technology: the Quantum Engineering Program (QEP) and the Quantum Technologies for Engineering Programme. The latter is hosted by A*STAR - the Singaporean equivalent of the Dutch applied research institute TNO - and aims for establishing long term capabilities on using quantum phenomena for new concept devices and translatable technologies. The \$121.6 M (€77.5 M) QEP aims to leverage quantum technologies to solve real-world problems. The R&D programme is supported by the NRF and hosted by the National University of Singapore (NUS) and provides research grants and builds a quantum ecosystem of researchers in quantum information, photonics devices, and system engineering together with industry partners. By linking engineering capabilities in device fabrication, imaging, system design and communication, the program focusses on the commercialization of quantum cryptography, ground-basis time network, enhanced imaging and sensing technology and advanced manufacturing capability.

[Research](#)

Singapore has renowned universities and research institutions, which perform research on quantum technology. The CQT has several research areas focussing both on basis science and quantum foundations and areas of application:

- Quantum Communication & Security
The Centre performs research on quantum-safe communication by building expertise on post-quantum cryptography and quantum key distribution. It works on communication of quantum keys via fibre and satellite and on mathematical cryptography schemes.
- Quantum Computation & Simulation
CQT works on quantum algorithms, error correction and developing quantum devices.
- Quantum Sensing & Metrology
It works on using quantum technologies for the development of measurement tools and unlock new applications.



- Advanced instruments
The Centre designs and builds equipment to support the research and exploitation of quantum technology.
- Basis science
CQT deepens research on the behaviour of light, matter and the universe.

A*STAR's Quantum Technologies for Engineering Programme focusses on quantum sensors, qubits, and software and applications. It builds expertise to scale up quantum processors by addressing challenges in qubit preparation, manipulation and measurement. In terms of software, it works on developing a use-case driven innovation platform for algorithms, software and applications.

Other research groups include the Quantum and Complexity Science Initiative at Nanyang Technological University, which is the largest quantum theory group in Singapore and focusses on quantum information, complexity science, quantum resources and quantum computation. Another program at the School of Information Systems focusses on developing algorithms and applications, and on quantum finance and quantum block chain.

Quantum ecosystem

Important public parties in the field on quantum technology are the National Research Foundation, Ministry of Education, and SGINnovate. They support the building of an ecosystem in which companies and start-ups can commercialize applications of quantum technology. As of now, several start-ups in Singapore are active in the field on quantum technology: Atomionics focuses on applications for quantum sensing, S-Fifteen Instruments manufactures quantum control instruments, SpeQtral works on space-based quantum communication, Horizon Quantum Computing makes a software layer to compile conventional code to quantum algorithms, and Entropica Labs develops quantum optimisation models, algorithms and techniques.

There are several (international) companies involved in the research on quantum technology. Recently Thales and QEP have partnered up to develop and test quantum security and quantum sensors for industry use. IBM and AWS work together with NUS on research and training on quantum computing. SingTel works together with CQT to develop quantum key distribution for Singtel's fibre network and T-Systems Singapore and ST Engineering are working with NUS on standards and technical requirements for quantum security technologies.

National quantum network

Being a small Republic, roughly half the size of the province of Utrecht, with a nearly total coverage of fibre connections to households, Singapore has the potential to **establish the world's** first national quantum network. Several research institutes, such as the public-private partnership between the NUS-Singtel Cyber Security Research and Development Laboratory, and CQT are working on fibre-bases quantum cryptography systems. To allow for global quantum internet data exchanges as well, an international team is working on satellite based quantum communication. Together with the **Science and Technology Facilities Council's RAL Space in the UK, the CQT has launched the** quantum based CubeSat SpooQy-1. The next version of SpooQy aims to allow send signals from space to earth. Part of the work is done by SpeQtral.



[International collaborations](#)

Singapore has an active and highly regarded RD&D community and seeks to maintain this status by connecting local and international expertise. Besides the partnership with the UK on a quantum space programme, there are several international collaborations. The Centre for Quantum Technologies is working together with French and Singaporean universities in the Majulab, and has a partnership with the Australian University of New South Wales. The Centre has an MoU as well with several universities and research centres in India, Italy, Japan, New Zealand and Thailand. Together with international partners, researchers in Singapore have contributed to more than 2,000 scientific papers world-wide. They co-authored with researchers mainly from China, USA, Japan, Australia, the UK and EU-member states including France, Germany, Italy, Spain as well as some from the Netherlands.

Singapore is a particularly interesting partner for association in view of its high R&D expenditure that is heavily invested in industry-driven research and well-aligned policy priorities on becoming a technology driven Smart Nation.

[Contact](#)

For more information on developments and opportunities in Singapore within the area of quantum technology, e-mail the Netherlands Innovation Network at the Netherlands Embassy in Singapore at sin-ia@minbuza.nl.

[Sources](#)

Information retrieved from several internet sources, such as newspaper articles and reports.