Singapore's quantum ecosystem gets a boost from three national platforms

Singapore's Quantum Engineering Programme (QEP) has launched three national platforms to grow the country's capabilities in quantum computing, quantum-safe communication and the manufacturing of quantum devices.

Deputy Prime Minister, Coordinating Minister for Economic Policies, and Chairman of the National Research Foundation (NRF), Mr Heng Swee Keat, spoke on the initiatives in his opening address at the Asia Tech x Singapore (ATxSG), the region's flagship tech event, on 31 May 2022.

The three national quantum platforms, which are hosted across the National University of Singapore (NUS), Nanyang Technological University, Singapore (NTU Singapore), the Agency for Science, Technology and Research, (A*STAR), and the National Supercomputing Centre (NSCC) Singapore, will coordinate activities across research organisations and build public-private collaborations to put Singapore at the cutting edge in quantum technologies. The platforms are:

- **National Quantum Computing Hub** - which will develop quantum computing capabilities and explore applications through industry collaborations;
- **National Quantum Fabless Foundry** - which will support microfabrication techniques for quantum devices and enabling technologies;
- **National Quantum-Safe Network** - which will conduct nationwide trials of quantum-safe communication technologies that aim to enhance network security for critical infrastructure.

Singapore has made steady investments in research in quantum technologies over two decades. Launched in 2018, the QEP is a national programme that applies quantum technologies for solving user-defined problems. QEP is supported by the NRF and A*STAR.

NRF Chief Executive Officer Professor Low Teck Seng said, "The launch of the three national platforms signals the intent and ambition of Singapore to build upon our past investments in quantum technologies, and take it further through close industry development with our partner agencies. The platforms will leverage strengths from each participating institution to develop critical capabilities across the pillars of quantum computing, communication, and devices, enhancing our vibrant quantum research ecosystem."

"Quantum technologies are attracting global interest thanks to their potential impacts across industries. The creation of three national quantum platforms in Singapore allows us to act as a bigger player in the key areas of computing, communication and manufacturing. The Quantum Engineering Programme supports these initiatives and other efforts to reap the benefits of Singapore's strong heritage in quantum research," said **Dr Alexander Ling, Director of the QEP**. **He is an Associate Professor in the NUS Department of Physics and Principal Investigator at the Centre for Quantum Technologies.**

The programme is committing $23.5 million to the three platforms for up to 3.5 years under Singapore's Research, Innovation, and Enterprise 2020 (RIE2020) plan. These platforms will receive further support from across the research landscape.

National Quantum Computing Hub (NQCH)

The NQCH will pool expertise and resources from the Centre for Quantum Technologies' (CQT) teams at NUS and NTU Singapore, A*STAR's Institute of High Performance Computing (IHPC) and the National Supercomputing Centre (NSCC) Singapore in building a quantum computing ecosystem in Singapore.

Quantum computers have the potential to outperform today's supercomputers in speed and energy efficiency on some kinds of problems.

Researchers at CQT and IHPC will develop quantum computing hardware and middleware. They will also explore applications with industry collaborators in fields such as finance, supply chain, and chemistry. Meanwhile, NSCC will host a quantum computing facility and provide the supercomputing power needed to develop and train the algorithms that could eventually be used on quantum computers.

The hub will also build international collaborations and train new talent to address a skills shortage in this emerging industry.

"Quantum computing is coming. The question is not about 'when', but about 'who' will be ready to use this technology. The approach taken in Singapore is to combine the expertise from our researchers with the needed support to achieve such a mission. The NQCH goals, as a collective effort of CQT, IHPC and NSCC, are to provide the infrastructure for a production quantum computer, the middleware to run it and the quantum algorithms that solve relevant practical tasks. This effort extends to produce quantum talent beyond physicists and to provide trustworthy information to the community," said **Professor José Ignacio Latorre, Director, CQT, NUS and Lead Principal Investigator, NQCH.**

"Quantum computing is a revolutionary technology that promises a significant shift in how information is processed and analysed to solve complex problems traditionally limited by classical computers. We are pleased to contribute our expertise in computational science, high performance computing, artificial intelligence and optimisation to this ecosystem effort to develop quantum ready algorithms and software. Working alongside CQT and NSCC, we strive to enable many diverse quantum and classical hybrid computing applications in collaboration with industry partners," said **Dr Su Yi, Executive Director, IHPC, A*STAR, and a Co-Principal Investigator, NQCH.**

"The potential for quantum computing is enormous and a scientific game-changer. Supercomputers will be a key resource in accelerating quantum computing research and

developing the tools and algorithms needed to support the new technology. The partnership between NSCC, IHPC and CQT reflects a whole-of-research commitment that covers the entire value chain for the development of the quantum computing ecosystem in Singapore," said **Associate Professor Tan Tin Wee, Chief Executive, NSCC, and a Co-Principal Investigator for NQCH.**

National Quantum Fabless Foundry (NQFF)

The National Quantum Fabless Foundry (NQFF), hosted at A*STAR's **Institute of Materials Research and Engineering** (IMRE), will support micro and nanofabrication of quantum devices in QEP's three pillars of quantum computation, communication and sensing. It will also develop enabling devices related to Singapore's strategic needs in the quantum technology ecosystem.

"The National Quantum Fabless Foundry looks forward to supporting the quantum research community by developing enabling quantum devices and a quantum-based economy, and facilitating the development of quantum systems in Singapore," said **Dr Manas Mukherjee, Director, National Quantum Fabless Foundry. He is a Senior Scientist at IMRE, A*STAR, and Principal Investigator at CQT**. "We want to act as a bridge between R&D and industry to help shape the future of microelectronics, and forge more partnerships with the best fabrication facilities in Singapore," he added.

National Quantum-Safe Network (NQSN)

The NQSN, which was announced in February 2022[1], will conduct nationwide trials of quantum-safe communication technologies that promise robust network security for critical infrastructure and companies handling sensitive data. The initiative, led from CQT, as well as NUS and NTU, has over 15 private and government collaborators. The Infocomm Media Development Authority (IMDA) is one of the collaborators.

"IMDA is working closely with our Institutes of Higher Learning, industry and research partners to collaborate on the operation and implementation of the National Quantum-Safe Network (NQSN) on Singapore's fibre network infrastructure. This is to ensure that Singapore's communications networks and systems remain futureproof and secure as quantum computing technologies are developed. We will continue to push the boundaries of such frontier technologies so both consumers and businesses in Singapore can benefit from them," said **Wee Sain, Director, Communications and Connectivity Engineering, IMDA**.

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[1] https://news.nus.edu.sg/national-quantum-safe-network-that-provides-robust-cybersecurity/

Note to Editor: Some further details of the national platforms will be shared during TechXLR8 Asia, the enterprise technology-focused anchor event of ATxSG, in its Quantum Technology Summit, 1-3 June. ATxSG is presented by IMDA and Informa Tech. QEP is co-organiser for the Quantum Technology Summit. The event agenda is available at https://asiatechxsg.com

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About Quantum Engineering Programme

Singapore's Quantum Engineering Programme (QEP) aims to realise the benefits of quantum technologies for society. Launched in 2018, it supports translational research focused on industry challenges and initiatives to nurture a quantum ecosystem. The QEP supports R&D projects in three pillars: quantum sensing, quantum communication and security, and quantum computing and processors. The programme also involves three national platforms – the Quantum-Safe Network, Quantum Computing Hub and Quantum Fabless Foundry – and grows the ecosystem through public-private collaborations and events. Coordinated nationally across various research organisations, it is supported by the National Research Foundation, Singapore and the Agency for Science, Technology and Research, Singapore and hosted by the National University of Singapore. Learn more at www.qepsg.org.

About National Research Foundation

The National Research Foundation (NRF) is a department within the Prime Minister's Office. The NRF sets the national direction for research, innovation and enterprise (RIE) in Singapore. It seeks to invest in science, technology and engineering, build up the technological capacity of our companies, encourage innovation by industry to exploit new opportunities that drive economic growth, and facilitate public-private partnerships to address national challenges.

For more info, please visit www.nrf.gov.sg.

About National University of Singapore (NUS)

The National University of Singapore (NUS) is Singapore's flagship university, which offers a global approach to education, research and entrepreneurship, with a focus on Asian perspectives and expertise. We have 17 faculties across three campuses in Singapore, with more than 40,000 students from 100 countries enriching our vibrant and diverse campus community. We have also established our NUS Overseas Colleges programme in more than 15 cities around the world.

Our multidisciplinary and real-world approach to education, research and entrepreneurship enables us to work closely with industry, governments and academia to address crucial and complex issues relevant to Asia and the world. Researchers in our faculties, 30 university-level research institutes, research centres of excellence and corporate labs focus on themes that include energy; environmental and urban sustainability; treatment and prevention of diseases; active ageing; advanced materials; risk management and resilience of financial systems; Asian studies; and Smart Nation capabilities such as artificial intelligence, data science, operations research and cybersecurity.

For more information on NUS, please visit www.nus.edu.sg.

About the Agency for Science, Technology and Research (A*STAR)

The Agency for Science, Technology and Research (A*STAR) is Singapore's lead public sector R&D agency. Through open innovation, we collaborate with our partners in both the public and private sectors to benefit the economy and society. As a Science and Technology Organisation, A*STAR bridges the gap between academia and industry. Our research creates economic growth and jobs for Singapore, and enhances lives by improving societal outcomes in healthcare, urban living, and sustainability. A*STAR plays a key role in nurturing scientific talent and leaders for the wider research community and industry. A*STAR's R&D activities span biomedical sciences to physical sciences and engineering, with research entities primarily located in Biopolis and Fusionopolis. For ongoing news, visit www.a-star.edu.sg.

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Staff from A*STAR's Institute of High Performance Computing (IHPC), the National Supercomputing Centre (NSCC) Singapore and the Centre for Quantum Technologies (CQT) at the National University of Singapore are pictured at Singapore's ASPIRE-1 supercomputer. The three organisations are pooling their expertise and resources to create the National Quantum Computing Hub. Pictured from left: Dr Ye Jun, Senior Scientist, IHPC; Mr Papani Venkatesh, Assistant Facilities Manager, NSCC; Dr Han Rui, Scientific Project Coordinator, CQT.

Credit: Quantum Engineering Programme, Singapore

Short caption: Teams from the Institute of High Performance Computing, the National Supercomputing Centre Singapore and the Centre for Quantum Technologies are collaborating in the National Quantum Computing Hub.

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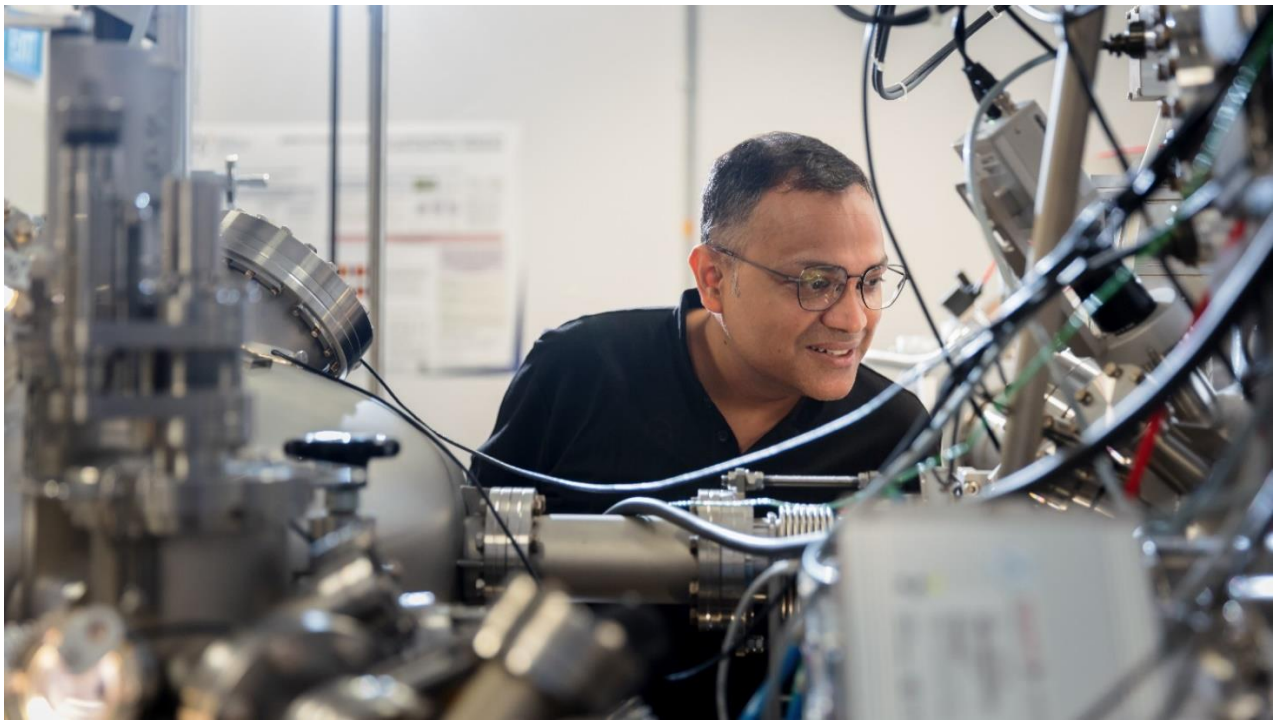

Dr Manas Mukherjee, Director, National Quantum Fabless Foundry at A*STAR's Institute of Materials Research and Engineering (IMRE), working on a photoelectron spectroscopy system.

Credit: Quantum Engineering Programme, Singapore

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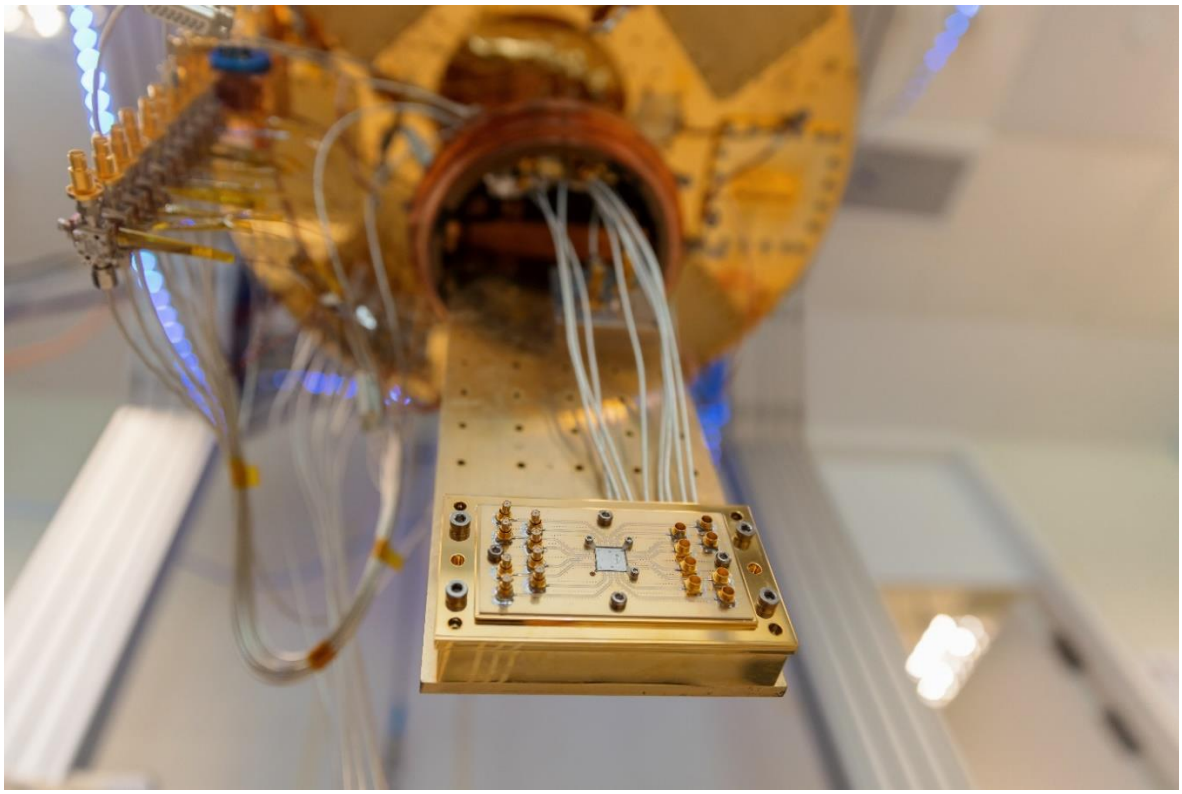

A quantum processor measuring less than 2cm across sits in the centre of the golden plate extending from this structure in the Centre for Quantum Technologies' research labs at Nanyang Technological University. The chip was made in facilities coordinated by the National Quantum Fabless Foundry. The hardware will be developed under the National Quantum Computing Hub towards being offered for cloud access.

Credit: Quantum Engineering Programme, Singapore

Short caption: A quantum processor made in Singapore sits in the centre of the golden plate extending from this structure.

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