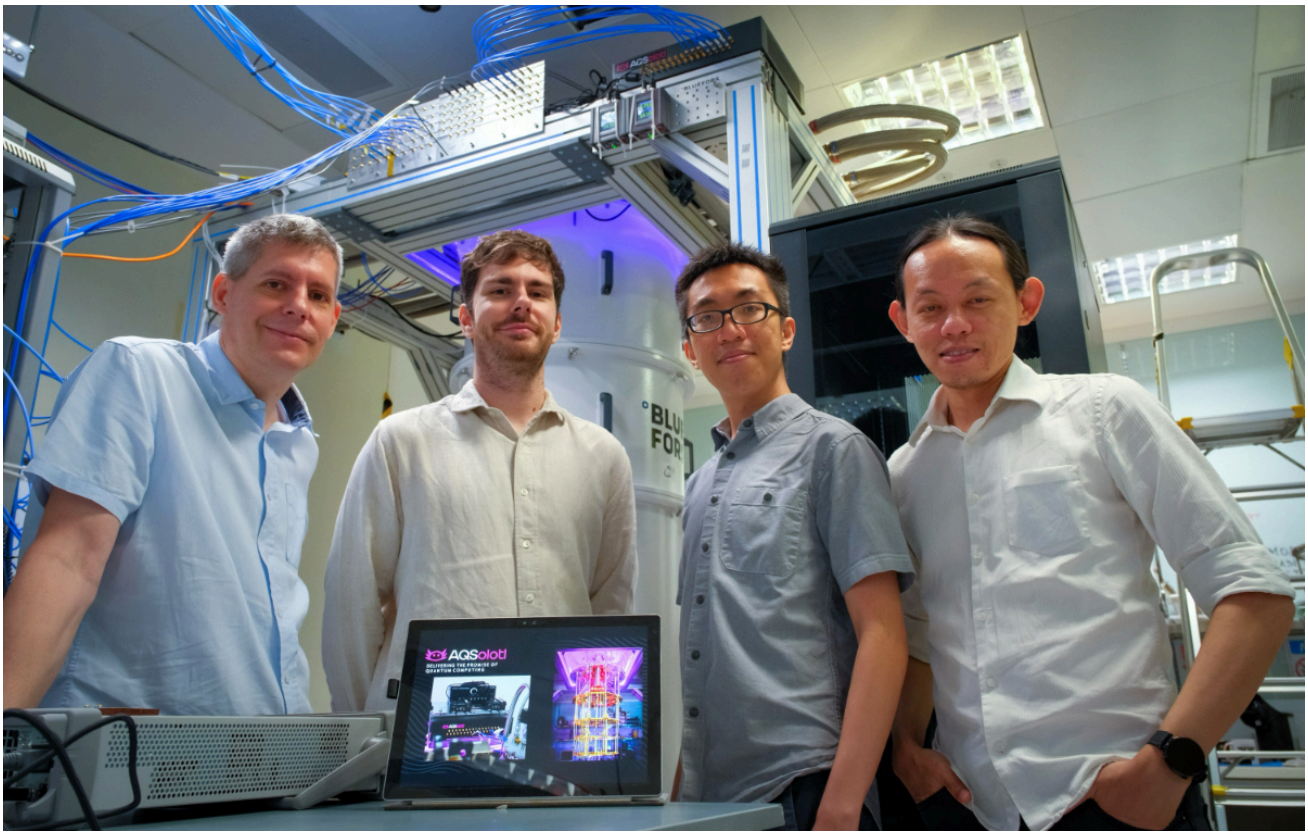
NTU and NUS spin-off to develop and sell cutting-edge quantum technology

By **Ken Wong** - on 27 Dec 2024, 1:45pm



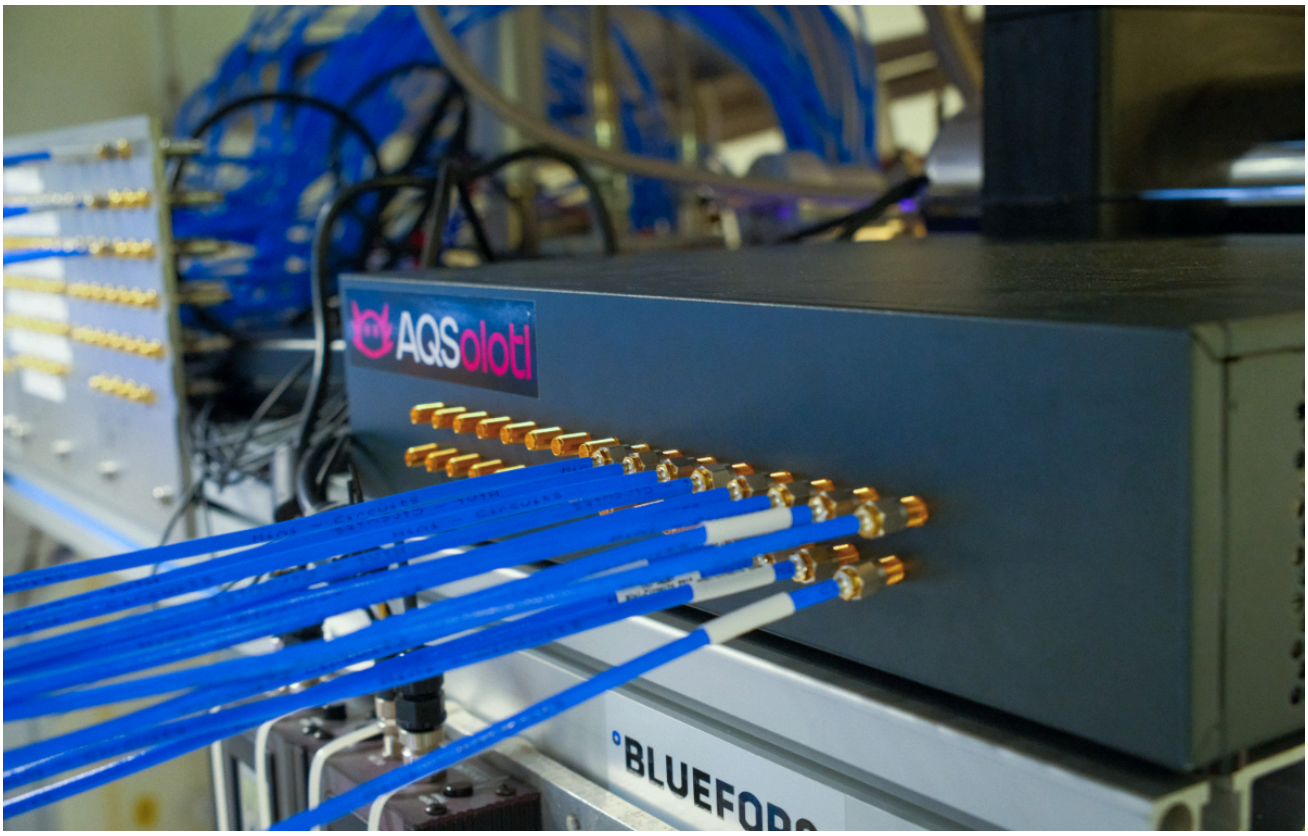
(left to right) NTU Assoc Prof Rainer Dumke with his other co-founders of AQSolotl, Chief Executive Officer Mr Patrick Bore; Head of Quantum Algorithms Mr Paul Tan; and Chief Technical Officer Dr Yap Yung Szen, who is also a Senior Lecturer at the Universiti Teknologi Malaysia. The start-up's flagship product, Chronos-Q, can be seen at the top right corner of the quantum computer at NTU. Photo: NTU.

NTU Singapore and NUS have spun off a new deep tech startup – AQSolotl, that focuses on Quantum technology - with the company already having one product under its belt.

Quantum computers will solve problems once considered unsolvable by conventional computers, opening new possibilities in fields like cryptography, advanced simulations and AI. They are theorised to be many thousands of times more powerful than today's fastest silicon processors for some complex computational tasks.

The startup already has a flagship product currently on the market called CHRONOS-Q. As part of the commercialisation process, the intellectual property (IP) for the technology has been transferred to AQSolotl, with both NTU and NUS taking equity shares in the company, while retaining rights for academic, research, and non-commercial use.

What CHRONOS-Q does



Close-up of the Chronos-Q quantum controller, which enables users to control quantum computers easily and efficiently using their laptops and desktop computers. Photo: NTU.

CHRONOS-Q is a quantum controller that acts as a translator between conventional computing systems and quantum computers allowing users to control quantum computers easily and efficiently using just a laptop or desktop computer. It also works to minimise quantum noise by using precise control techniques to manipulate the quantum system. Quantum noise is "noise" that occurs due to the unpredictable nature of the quantum world, impacting the accuracy of quantum calculations.

According to Patrick Bore, a former Research Associate from CQT at NUS, who is now the CEO of AQSolotl, quantum noise comes from many places, the result of which is that quantum noise affects “gate fidelity” which is impacted by the full quantum system (qubit and controller).

Gate fidelity refers to how accurately a quantum gate performs its intended operation, essentially measuring how close the actual result of applying a gate is to the ideal result, while "quantum noise" represents random disturbances or errors that affect the quantum state of a qubit during computation, impacting the fidelity of the gate operations.

“Yes, the control system plays a (potentially) important part in this, but Prof. Rainer and his team showed in the lab that the Chronos-Q technology is not the limiting factor for gate fidelity for currently state of the art qubits,” he said, “So I’ve very confident in saying that Chronos-Q will not limit the Quantum Processing Unit (QPU) capabilities quite the opposite it will most likely enhance it, but a proper comparison paper still doesn’t exist so it’s hard to be sure of which controller have better results on that side. My assumption is most are basically similar.”

Indeed, it is fair to assume similar gate fidelity for everyone at the moment as this is mainly driven by the QPU quality which is much harder to stabilise (one of the main issue of QPU manufacturing is repeatability of the qubit quality).

Compared to other quantum controllers, AQSolotl says that CHRONOS-Q is faster while also keeping costs lower. It is also designed to scale easily and has customisable and upgradable firmware. There are also plans to integrate additional modules in the future.

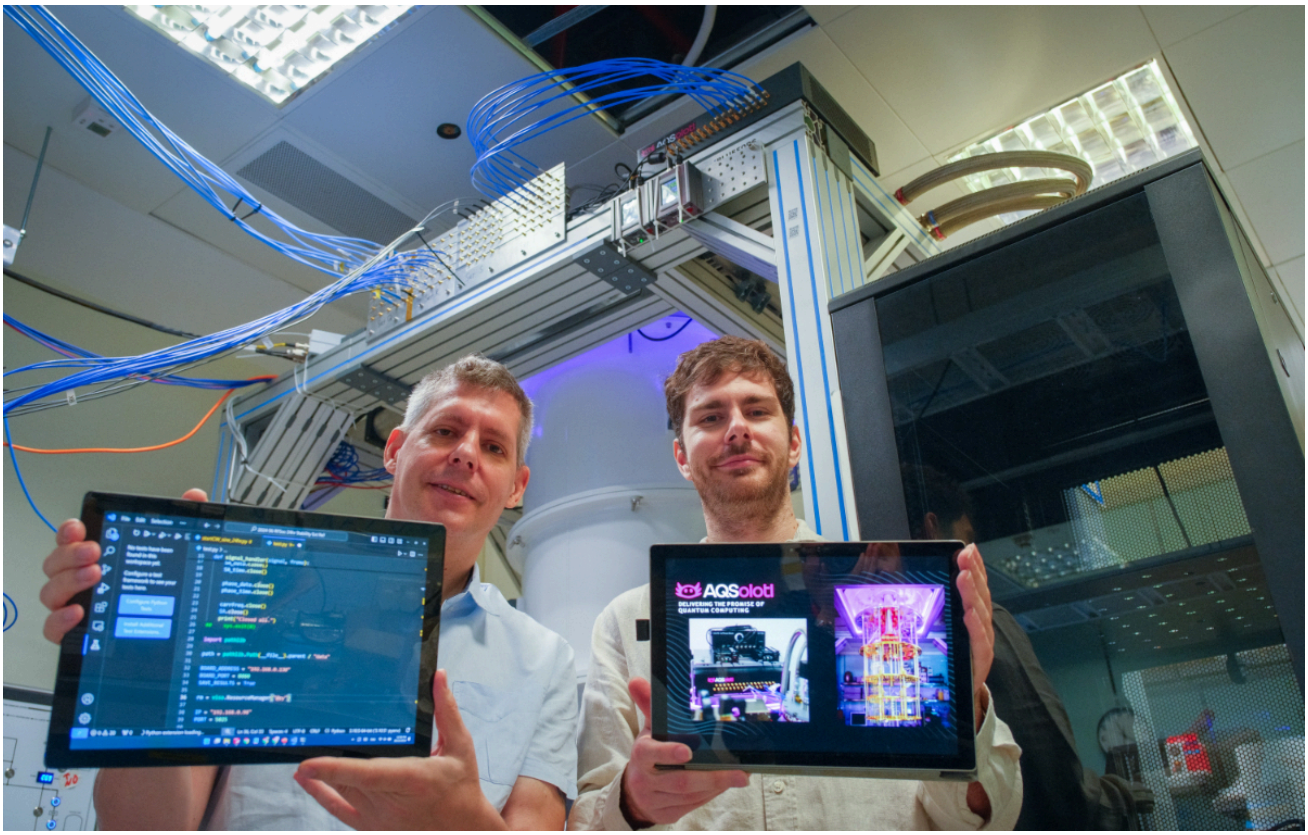
For example, it takes CHRONOS-Q less than 14 nanoseconds (1 nanosecond is 1 billionth of a second) to determine a qubit state, enabling real-time feedback. Real-time feedback in quantum computing allows for immediate adjustments and optimisations to a quantum computation as it's happening, enabling researchers to actively manage the delicate quantum states and maximise the efficiency of the process, especially when dealing with the short coherence times of qubits, ultimately leading to better results and faster development of quantum algorithms.

The proprietary quantum controller technology, developed and refined over three years, is currently being piloted at Singapore’s Centre for Quantum Technologies (CQT) as part of the hardware setup for the National Quantum Computing Hub and NTU’s Nanyang Quantum Hub.

Bore wouldn’t share how AQSolotl’s solution worked as it was proprietary to the company but added that the goal is for the controllers to always be better than the qubits it controls. “This is part of our roadmap and might result in a revision of Chronos-Q design in the future if and when qubit quality improves significantly to insure Chronos-Q stays one step ahead of the qubit capabilities,” he said.

When asked about product roadmap details, bore said that making its own QPU would be head of the list followed by being able to source all the different parts of a quantum computer so that the user only sees the final working quantum computer without having to care who made or what the sub-components are.

Integrating AI down the line



NTU Assoc Prof Rainer Dumke (left) with AQSolotl CEO Patrick Bore (right), with their Chronos-Q quantum controller (in black) seen in the top right corner of the quantum computer at NTU. Photo: NTU.

As a startup and as part of its product roadmap, AQSolotl is currently raising funds for enabling AI integration, with Bore saying the company has a short and long-term goal in mind for AI.

In the short term, using classical AI (on AI accelerators or GPUs) to empower Quantum Computing and enhance it (with smart QPU calibration) and add within Chronos-Q AI acceleration hardware capability for edge AI applications to simplify the overall use of it. “We are taking this approach because the control system is the perfect layer to integrate these hardware specific extra features as Chronos-Q sit in the middle of the technological stack for quantum computing,” Bore said.

Over the long-term, AQSolotl hopes to work towards AI models to be run on QPUs. Bore explained that while this is currently in its infancy, early research shows that Qubits powered AI models could put current AI models to shame in both the quality of results and operating costs.