

# Space-based quantum security

**Miniature satellites developed in the UK are promising to provide ultra-secure communications using quantum technology: tapping out secret keys encoded in single photons sent down from orbit.**

- System exploits UK expertise in lightweight, low power, low cost spacecraft
- Satellites enable robust and rapid key distribution
- Quantum key distribution (QKD) can deliver security for critical national infrastructure

Quantum technology can provide encryption that is highly secure. Cryptographic keys are shared using quantum states of light, or photons. Any eavesdropping activity is exposed, because it disturbs these delicate states.

This quantum key distribution (QKD) is already running over fibre networks, such as the UK Quantum Network. But using fibre limits its range, and currently the technology comes with a high price-tag.

So the Quantum Research CubeSat (QUARC) project has taken steps towards delivering QKD from space with a small, cheap satellite: a CubeSat measuring just 30x20x10cm. "We want to take the UK's world leadership in terrestrial QKD and translate it into the space domain," says Daniel Oi at the University of Strathclyde, who leads the QUARC team – a collaboration that also involves the University of Bristol and the Glasgow-based space engineering company Craft Prospect.

QKD requires a precisely focused beam of light, and QUARC achieves this using an array of microscopic mirrors – a lightweight, low power and affordable technology that the team have shown can achieve the required pointing, aiming the beam to within one ten thousandth of a degree.

While the quantum nature of the photon link makes eavesdropping futile, QKD does retain some vulnerabilities.

Hackers could tamper with transmitters or receivers, for example. So one aim of this project will be to reduce those vulnerabilities. "It will help to make such systems more secure through data gathered on real-world performance," says Oi.

QUARC was funded through the UK space agency. In 2018 the Quantum Communications Hub (part of the UK National Quantum Technologies Programme, UKNQTP) funded a follow-on project until late 2019, enabling the team to develop an engineering model to demonstrate the technology. This will feed into proposed space QKD activity during Phase 2 of the UKNQTP, when the Hub plans an in-orbit-demonstration of QKD, with a new UK-based ground station.

The in-orbit-demonstration may also exploit technology development at QUANTIC, the UKNQTP's Imaging Hub, as well as building on the UK-Singapore Bilateral QKD space mission, being developed by RAL Space in the UK and CQT in Singapore. "Our new cubesat-specific system will be an evolution of technologies that have been developed in the programme," says Oi.

This will be a first step towards UK national capability in QKD from space, and has great potential for commercialisation. For example:

- Craft Prospect are developing the commercial side of CubeSat QKD. Their project "Augmentation of Future Quantum Key Distribution Networks with CubeSat Systems" is funded by Innovate UK and EPSRC, and involves BT and academic Hub partners from Strathclyde and Bristol.
- ArQit are developing the commercial side of QKD ground stations through an Innovate UK ISCF project: "Towards A New UK Industry for Novel Quantum Receivers in Nascent Satellite QKD Global Markets (3QN)". They are working with BT and other industrial and academic Hub partners from Cambridge, Heriot-Watt and York.

For more information, visit [uknqtp.epsrc.ac.uk](http://uknqtp.epsrc.ac.uk) or contact [quantumtechnologies@epsrc.ukri.org](mailto:quantumtechnologies@epsrc.ukri.org)

The UK National Quantum Technologies Programme aims to ensure the successful transition of quantum technologies from laboratory to industry. The programme is delivered by EPSRC, Innovate UK, BEIS, NPL, GCHQ, Dstl and KTN.