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QUOLLSAT: QUANTUM OPTICAL LASER LINK SATELLITE FOR SPACE-TO-GROUND QUANTUM ENCRYPTION DEMONSTRATION

Abstract

Quantum key distribution systems enable theoretically secure communication links. This makes them attractive for the exchange of encryption keys, which may be used in conjunction with Post-Quantum encryption techniques. The result is a secure communication system, which is resilient towards attacks from quantum computers. When applied to satellites, quantum key distribution enables world-wide and secure key exchange and communications.

Several options exist to implement quantum key distribution via satellites. For instance, when low Earth orbit satellites are used, the satellite may be implemented as a trusted node, and single links between the satellite and optical ground stations on Earth are used to perform key exchange. Alternatively, entangled photon sources can be used to set up simultaneous links between the satellite and two ground stations. This removes the requirement of the satellite being a trusted node. However, when applied on a low Earth orbit satellite, the range of key exchange becomes limited, as two ground stations need to be in the field of view of the satellite at the same time.

In order to implement a world-wide quantum key distribution system with low Earth orbit satellites without the satellite being a trusted node, quantum memories onboard the spacecraft can be used. These memories are capable of storing quantum states of light and recalling them on-demand for later use. Incorporating quantum memories onboard a satellite enables the entanglement to be maintained between a ground station and the satellite while it orbits. Once over the target ground station, the entangled state can be recalled from the quantum memory and transmitted to the ground, thereby directly entangling

the two ground stations. Recent advances in quantum memory development suggest that an application on satellites will be possible over the coming decade.

The Australian National University and the German Aerospace Center (DLR) are cooperating to investigate the application of quantum memories onboard a satellite mission. As a stepping stone, we have done a concept study for a satellite mission capable of trusted-node quantum key distribution and quantum channel measurements. This mission will be used to test the interface between light from a satellite and a ground-based quantum memory. This paper will give an overview of the satellite mission design including the quantum memory capabilities, potential ground segment designs and further development of DLR's OSIRIS optical terminals to support the satellite-to-ground application.