Paper ID: 80999
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IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Space-based Optical and Quantum Communications (4)

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CONSTELLATION SIMULATION TOOL FOR QUANTUM COMMUNICATION SPACE NETWORKS

Abstract

Space-based quantum communication is at a point where we will soon see satellites be launched to demonstrate complete and usable Quantum Key Distribution (QKD) links between several optical ground-stations in an industrial live environment. Therefore, and given the specificities of Quantum Communication, researchers as well as industrials need tools and models to leverage their existing classical optics heritage to design their future QKD constellations.

Based on our experience of QKD at Fraunhofer IOF, we have developed a centralizing system which capitalize on our QKD models and completes it with the simulation of constellations, the atmosphere, the scheduling of operations and pointing specifications.

This simulation tool is particularly aimed at system engineers, in both research and industry, to assess the performance of their envisioned quantum communication space. This tool encompasses all major design factors of a constellation and quantum channels for the simulation of quantum communication channels which includes optical systems as well as atmospheric propagation. Results are providing important inputs for the design of QKD space missions and systems as well as the expected level of possible services in a real-life environment.

Our QKD models not only incorporate all systems in the quantum channel, and their design parameters from the laser source on the emitting side to the final click on the detectors on the receiving side, but also the post-processing impact and dynamic optimization of the quantum parameters to maximize the final secret key rate.

Furthermore, the evolutive and modular design of the simulation tool itself makes it possible to incorporate different models for all parts of the simulation, for instance the atmosphere, the constellation propagation or the QKD protocols. This architecture makes it possible to interface with other experts of any field of this space system and incorporate their models too. Moreover, this allows for the assessment and comparison of different models and protocols on the final performance of the space QKD system.

Our current implementation uses an in-house BBM92 model and is planned to incorporate further models developed at IOF on BB84, Hyperentangled QKD and High-Dimensional QKD.