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CHALLENGES IN DESIGNING SATELLITE CONSTELLATION FOR PROVIDING UNINTERRUPTED NETWORK SECURITY THROUGH QUANTUM KEY DISTRIBUTION AT A LARGER GEOGRAPHIC REGION

Abstract

Quantum Key Distribution (QKD) is an emerging technique for providing network security. There is a growing global interest in this research area because QKD has theoretically proved to be unconditionally secure. QKD in fiber optical channel has its own limitation. QKD in this channel at 300 km distance has been demonstrated with a very low key exchange rate. For providing uninterpreted security as service using QKD, a longer range is essential. Micius mission by China has successfully demonstrated long-range QKD using satellite. Hence space-based QKD is required for providing network security in a larger geographic region. Also, it is imperative that a dedicated constellation of satellites must be deployed for providing seamless QKD-based network security with minimal time delay. This paper focuses on identifying requirements and challenges in designing such constellation. Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Geostationary Earth Orbit (GEO) and hybrid structures are considered for the constellation. Advantages and disadvantages of each case are delineated. Uplink and downlink attenuation and Signal to Noise Ratio (SNR) are also considered in this study. Various aspects of the overall system architecture i.e. types of ground segments (master control station, signal quality and satellite health monitoring stations), communication protocols among ground and space segments are discussed. Emphasis is given on designing a protocol agnostic architecture to ensure of interoperability with other future QKD constellations.