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Technology Roadmaps for Space Exploration (09)
Enabling Technologies for Exploration (3)

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# SUPPORTING SPACE COMMUNICATIONS WITH QUANTUM COMMUNICATIONS LINKS

**Abstract**

One of the major problems in space exploration programs is how we can transfer huge amount of information in a safe and effective way. Quantum information processing and quantum communications offer an answer for these questions. This future and emergency technology changes the current used information science to the 'classical' one by classical bits and classical algorithms. Quantum computing is based on various quantum effects in physics and offers revolutionary solutions for different problems e.g. prime factorization, searching in unsorted database, key distribution and information coding. The power of quantum parallelism allows us to solve classically complex problems, and the quantum entanglement leads to quantum communication algorithms like teleportation (transmitting a quantum bit by sending only two classical bit over the channel) and superdense coding (sending two classical bits using only one quantum bit). The quantum cryptography provides new ways to transmit information with unconditional security by using different quantum key distribution protocols.

The quantum communication offers secure and reliable communication link for short and long distances and promises distortion-free channels and lower losses than in the nowadays used systems. The physical realization of free-space quantum communications started in 1991 with the first free-space quantum key distribution experiment over a 30 centimeter long path. Since that a distance of 144 km was reached by an international research group.

We briefly summarize how quantum communications have left the laboratories in the past years and show how it can support the free-space communications. We show how the quantum protocols and algorithms can support future missions and mission planning, and we present a possible roadmap for Near-Earth and deep-space quantum space communications. We deal with redundancy-based and redundancy-free coding techniques and pilot quantum bit based approaches to support communication over a noise channel. We show our performance calculations for current and future deep-space quantum links and loss-analyzes for different quantum key distributions protocols (e.g. BB84, B92, E08).