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Author: Dr. Mathias VAN DEN BOSSCHE  
Thales Alenia Space France, France, mathias.van-den-bossche@thalesaleniaspace.com

SATELLITE-BASED QUANTUM INFORMATION NETWORKS: USE CASES, ARCHITECTURE,  
AND ROADMAP

**Abstract**

Quantum Information Networks (QIN) currently represent a major goal in the field quantum communication technologies. Such QINs will allow connecting quantum devices (computers, sensors, communication stations, etc) over long distances, thus improving significantly their intrinsic processing, sensing, and security capabilities. The core mechanism of a QIN is quantum state teleportation, demonstrated more than two decades ago, that consumes quantum entanglement which can be seen in this context as a new kind of network resource. This paper is the result of the collaboration under the auspices of the French Space agency (CNES) of academic research and a Space telecom industry actor that has defined and now executes a long term roadmap towards operational QINs. Here, we address the key elements of this roadmap and describe the stage we have reached in its execution. First, we identify and quantitatively describe use cases per activity sector as a reference for the requirements on the QINs, including key performance targets. Second, we define a high-level architecture of a generic QIN so as to introduce structuring elements such as resource, layers, governance, etc. We then focus on the architecture on the Space part to identify its main design drivers and critical elements. A survey of the state-of-the-art of these critical elements, as well as issues related to standardisation is then presented. Based on these elements, we explain our 3-stage roadmap. Finally, we detail the already concluded first step of this roadmap, that is the design of a Space-to-ground entanglement distribution demonstrator, which relies on detailed simulations so as to allocate efficiently the performance requirements on each subsystems. We invite relevant entities to join our roadmap to progress together towards the ambitious goal of operational QINs in the next decade.