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Author: Dr. Mauro Valeri
Thales Alenia Space Italia (TAS-I), Italy

Dr. Gabriele Riccardi
Thales Alenia Space Italia, Italy
Mr. Riccardo Lazzaro
Thales Alenia Space Italia (TAS-I), Italy
Mr. Emanuele Cerqueti
Thales Alenia Space Italia (TAS-I), Italy
Ms. Martina Ottavi
Thales Alenia Space Italia (TAS-I), Italy
Dr. Andrea Geraldi
Thales Alenia Space Italia (TAS-I), Italy
Ms. Laura Trotta
Thales Alenia Space Italia (TAS-I), Italy
Mr. Enrico VARRIALE
Thales Alenia Space Italia, Italy
Mr. Paolo Conforto
Thales Alenia Space Italia (TAS-I), Italy
Mr. Alessandro Pisano
Thales Alenia Space Italia (TAS-I), Italy

SPACE SOLUTIONS AND CHALLENGES TO ENABLE SECURE AND GLOBAL QUANTUM COMMUNICATIONS

Abstract

Quantum technologies applications are emerging in sensing, metrology, security and computing, showing potential to enabling new solutions or boost classical ones. In this context, the role of quantum communications is two-fold: on the one hand, they allow to bring a new level of security, also counteracting some of the threat QT themselves introduced, aiming at providing a so-called Information-Theoretic Security (ITS); on the other hand, they can allow full exploitation of quantum enabled applications by allowing native connection of devices at quantum level, with applications such as distributed and cloud quantum computing as well as quantum sensing.

Space offers a great opportunity to quickly bring quantum communications on a global scale and support development and interconnections of terrestrial networks; while Space quantum communications allow overcoming inherent limitations of global ground infrastructures, there are still engineering challenges in the definition and realization of constellations and satellites for both key distribution and fully quantum communications.

This paper presents, from a system perspective, the role and the main benefits of a space based quantum communication infrastructure as well as its key architectural and technological areas that have been subject of Thales Alenia Space Italia research and development initiatives. The focus will be on the design and dimensioning of constellation-based solutions and on the development of enabling sub-systems necessary to bridge the technological gaps that still exist for space applications. In particular the paper

will address tools, methodologies and technologies development initiatives covering: constellations and application driven end-to-end performance evaluations, for both quantum enabled cryptography and distributed quantum processing, architectures and critical building blocks with a focus on critical payloads systems and related functions like on-board processors and synchronization solutions.