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INCREASE QUANTUM COMPUTING TECHNOLOGY READINESS LEVEL THROUGH EXPERIMENTATION IN SPACE

Abstract

The exploitation of quantum physics and of quantum states superposition and entanglement properties has been studied since 1980s [review paper] for their disrupting potential in the evolution of information theory. Although quantum computing is still in its infancy, experiments have been carried out and prototypes have been developed. Research in both theoretical and practical areas continues at a frantic pace, and many national governments, research institutions and military funding agencies support quantum computing research to develop quantum computers for both civilian and national security purposes, such as cryptanalysis, genetics, drugs and disease research, materials science and design and so on. Thanks to its computing power, the usage of quantum computing capabilities in orbit would bring priceless benefits to space and enable novel methodologies and technologies to improve both on ground and in space applications. On-board cyber-security, satellite AI, advanced autonomous life support systems for human exploration are only few of the domains which could be dramatically boosted by the availability of this technology. The paper discusses an early study about an experimentation of a quantum computer in orbit as a first step for a future fully qualified flight-ready payload. It discusses the major benefits of a flight experimentation, focusing from one hand on the objectives and the expected benefits that it will bring to the development of the spaceborne and on-ground technology, from the other on the open questions like the effect of microgravity on the computer. It analyses the currently available implementation solutions of quantum computers on ground which are currently prototyped (e.g. IBM Q System One, and provides early results on the identified main technical aspects to be considered to improve the technology readiness level. It highlights the most important challenges to be considered in the design and the added value that the space environment will bring as scientific feedback. Finally, it describes possible scenarios and mission profiles analysed and identified as potential hosting platform candidates, focusing on pros and cons of each of them.