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Author: Ms. Tiziana Fiori
Sapienza University of Rome, Italy

Dr. Marta Albano
Agenzia Spaziale Italiana (ASI), Italy
Mr. Simone Ciabuschi
ASI - Italian Space Agency, Italy
Dr. Enrico Cavallini
Italian Space Agency (ASI), Italy
Dr. Francesco Giacinto Lavacca
Sapienza University of Rome, Italy
Mr. Matteo Vallone
Sapienza University of Rome, Italy
Ms. Ludovica Siclari
Sapienza University of Rome, Italy
Prof. Vincenzo Eramo
Sapienza University of Rome, Italy

EXPLORING AVIONIC CONNECTIVITY IN MODERN SPACE SYSTEMS: EXPERIMENTAL EVALUATIONS OF THE INNOVATIVE FLEXIBLE TIME TRIGGERED ETHERNET

Abstract

In the ever-evolving landscape of space system development, there is a discernible shift towards creating smaller, more cost-effective satellite constellations. This trend is driven by advancements in electronic miniaturization and the integration of Commercial Off-The-Shelf (COTS) components, paving the way for innovative solutions in satellite design, manufacturing, and launch. This shift brings about challenges in the realm of launch vehicles, prompting exploration into dedicated launchers for small satellites. The current approach often involves launching small satellites as secondary payloads of larger missions, leading to scheduling constraints and limited control over the orbit. However, the industry anticipates a change in this dynamic, focusing on modifying large launchers to simultaneously accommodate multiple small satellites. Additionally, there is a growing emphasis on developing launchers capable of on-orbit servicing. Amidst these developments, the advanced interconnection of avionic devices emerges as a critical consideration. Launch vehicle designs, whether catering to small or large satellites or intended for on-orbit servicing, require state-of-the-art avionic devices. The industry is showing an increasing interest in incorporating COTS components, drawing inspiration from successful experiences in satellite development. However, the existing avionics intra-communication network, primarily based on the MIL-STD-1553B bus, reveals limitations in both bandwidth and flexibility. In response to these challenges, a proposed solution builds upon Ethernet technology, integrating tailor-made functionalities based on the Flexible Time Triggered Ethernet paradigm. This approach aims to optimize bandwidth usage, maintain high quality of service, and minimize costs by enabling the use of COTS switches. To validate the proposed solution, an experimental evaluation is conducted. The study compares the solution with state-of-the-art alternatives, and the experimental test-bed, equipped with Ethernet switches and Hercules boards by Texas Instruments, serves as tangible proof of feasibility. This work addresses the critical need for an al-

ternative avionics intra-communication network, presenting a cost-effective and high-performance option for the evolving landscape of modern space intra-communication networks. An upcoming demonstration of the technology prototype is scheduled for the BEXUS 34 flight (a balloon experiments program realized by the German Aerospace Center (DLR) and the Swedish National Space Agency (SNSA)) within the RETINA mission framework. The purpose of this demonstration is to authenticate the simulated results and assess the feasibility and performance of the system. This initiative aims to advance its Technology Readiness Level (TRL), paving the way for potential applications in future space launch vehicles.