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Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

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A RECONFIGURABLE COMMUNICATION ARCHITECTURE FOR MODULAR SATELLITES

Abstract

The concept of modular satellites is a new approach in space engineering. Such an approach promises high potential and great benefits in mid term future. Multifunctional interfaces connect the building blocks mechanically and transfer data, power and heat through the satellite. The standardization of the building blocks and the interfaces enable time and cost saving in development and qualifying processes as well as rapid-production-on-demand capabilities. Accordingly to that, modular satellite design can be seen as a sustainable, flexible and future-oriented solution compared to conventional monolithic design. The approach of modular satellite design is actually addressed by several projects and research groups, e.g. DLR's iBOSS (intelligent Building Blocks for On-Orbit Satellite Servicing and Assembly), DARPA's PHOENIX or the EU funded SIROM interface.

However, from the data network point of view the modular design of a satellite implicates a highly complex, distributed, safety-critical system with decentral control architecture and mixed criticality requirements. The system intelligence is partitioned in several locally distributed processors and whose performance is indicated by the inter-process and inter-processor communication of information. To fulfill the requirements of determinism and real-time behaviors of that safety-critical system with varying criticality levels, the chosen communication architecture must provide mechanisms and functions for the coordination of locally distributed devices and components and for the prevention of fault propagation from one application into another one.

In this paper a time-triggered communication architecture based on TTEthernet is presented as the main data bus on the modular satellite concept that was developed in the iBOSS project. A comparison of several standard communication architectures with respect to the requirements of the modular satellite design of iBOSS shall illustrate the rationales for the chosen time-triggered communication architecture. To assure reconfigurability and extendability of the modular design, an approach to reconfigure a time-triggered data network in operation is also presented. The approach also incorporates a concept to increase the flexibility of the implemented TTEthernet network to satisfy the requirements of a modular satellite especially without affecting its performance and robustness.