SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Space Systems and Architectures Featuring Cross-Platform Compatibility (7)

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MULTI-PURPOSE MODULAR PLUG AND PLAY ARCHITECTURE FOR SPACE SYSTEMS: DESIGN, INTEGRATION AND TEST

Abstract

Space systems have to face the need to design high performance subsystems limiting costs by providing a high capability of reconfiguration in order to fulfil different mission requirements. In order to meet these needs, the research of the Department of Aerospace and Mechanical Engineering of the Second University of Naples is focused on the design and conception of a modular architecture for a versatile, reconfigurable and re-adaptable space vehicle. The idea consists in integrating a complex system by simply connecting smart subsystems capable of configuring themselves at their connection. This need implies the development of smart modules equipped with standard interfaces and protocols by which plug and play performances can be achieved. The concept of modularity has been investigated resulting in the best choice since the overall design complexity can be decoupled dividing the system into simpler elements and focusing on a specific module development. This decoupling allows concurrent design of different subsystems and the possibility to repair or upgrade the system by simply replacing one of its components. Furthermore, if modularity is coupled with the concept of distributed intelligence, it can bring even more advantages such as avoiding the necessity to rewrite code when a new module is connected implying fewer configuration problems thanks to the on-board autonomy, thus reducing the on-board computer workload too. To validate these concepts, a small rover has been modified to be a test bed for modular components. Modules and their subsystems have been interconnected through a data and power bus that has been integrated using Controller Area Network and SpaceWire that have been selected to realize a parallel and redundant bus configuration. A decentralized topology distributed architecture has been achieved thanks to micro-controllers installed on each subsystem to control its operations, working modes, communications and health status. Modules have been designed with the same mechanical interface and to obtain a 2D repetitive pattern without limiting the maximum number of modules possibly connected. In order to test this architecture, some basic subsystems, such as the power control unit, the battery control unit, the engines control unit and a PC104-based computer have been integrated. Internal data bus is based on CAN for telemetry and Spacewire for payload data, whereas wireless CAN is under integration to guarantee inter-platform communications.