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IMPLEMENTATION OF A DETERMINISTIC WIRELESS BUS FOR INTRA-SPACECRAFT COMMUNICATIONS USING THE ISA100 WIRELESS PROTOCOL

Abstract

There are many advantages of using wireless communication technologies on-board spacecrafts. Such advantages include the following: reduction of dry mass, simplified AIT operations, compact form factor, increased design flexibility and increased reliability. In recent years several communication protocols have been designed and developed for the implementation of Wireless Sensor Networks (WSN's), the vast majority of them being based on the IEEE 802.15.4 specification which is designed specifically for WSN's. One of the several wireless protocols built on top of the IEEE 802.15.4 specification is ISA100 Wireless, an open standard developed by the ISA organization, later standardized under IEC62734 and recommended by the Consultative Committee for Space Data Systems (CCSDS) for implementation on-board spacecrafts. The ISA100 protocol was developed for demanding applications in extreme environments and by its very design it addresses critical requirements such as determinism, reliability, low power and security.

The ISA100 communication protocol is built upon a stack of open standards, starting with the physical layer which is 802.15.4. The Data Link Layer (DLL) is implemented using TDMA (Time Division Multiple Access) a technique that restricts communication between devices to certain, preconfigured time slots. For ISA100, the standard of a time slot is configurable depending on the needs of the application, with a standard value of 10ms. The use of a TDMA medium access scheme ensures the deterministic characteristic of the communication. By using 6LowPAN, ISA100.11a devices can receive real IPv6 addresses and UDP datagrams can be used at the transport layer, which allows applications to use IP based communication techniques with the low power, energy efficient 802.15.4 devices used in ISA100.11a networks.

With the many advantages that wireless technology can bring to intra-spacecraft communications, it is of the utmost importance to compare it objectively with standardized wired bus technology such as MIL-STD-1553 and SpaceWire. The work presented in this paper is a performance comparison between a SpaceWire standard wired bus and an ISA100 Wireless standard implementation of a Point to Point communication link that models the connection between a Command Data Handling Unit (CDHU) and a Payload Data Handling Unit (PDHU) in a typical spacecraft. Advantages and disadvantages derived from the TDMA medium access scheme are analyzed and limitations in terms of data throughput and latency are calculated through modelling, then results are validated through experimentation.