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SPACEWIRE FOR PAYLOAD AND PLATFORM CONTROL APPLICATIONS

Abstract

SpaceWire is a widely used onboard data-handling network for spacecraft which connects together instruments, mass-memory, processors and telemetry sub-systems. It provides high-speed (2 Mbits/s to 200 Mbits/s), bi-directional, full-duplex, data links which connect SpaceWire enabled equipment. Networks can be built to suit particular applications using point-to-point data links and routing switches. Application information is sent along a SpaceWire link in discrete packets. Since the SpaceWire standard was published in January 2003, it has been adopted by ESA, NASA, JAXA and RosCosmos for many missions, and is being widely used for commercial and other spacecraft. High-profile missions using SpaceWire include: Bepi-Colombo, James Webb Space Telescope, ExoMars, Gaia, Astro-H, GOES-RT, Lunar Reconnaissance Orbiter, Swift, PnPSat, and TacSat. Higher level protocols have been, and are being, developed by the SpaceWire Working Group including the Remote Memory Access Protocol (RMAP). SpaceWire was designed to support payload data-handling applications using point-to-point links or networks. Data transfer is asynchronous and need not be deterministic. For spacecraft control applications, both payload and platform control, it is essential that data delivery is deterministic. SpaceWire includes an important feature for the support of determinism: time-codes. Time-codes are broadcast over the SpaceWire network providing a periodic synchronisation signal. A new protocol for SpaceWire (SpaceWire-D) uses time-codes to synchronise and control traffic flowing over the network to provide deterministic data delivery. SpaceWire-D uses the SpaceWire RMAP protocol which is a transaction based protocol with one node, the Initiator, sending an RMAP command to read or write data to registers in another node, the Target. Time-codes broadcast periodically over the network separate time into discrete time intervals or time-slots. A schedule table is used to specify which nodes on the network are allowed to initiate RMAP transactions in any time-slot. When a particular time-slot arrives, allowed Initiators can initiate an RMAP transaction by sending an RMAP command. The Target device then responds, returning an RMAP reply to the Initiator. The entire transaction must finish within the single time-slot. Several transactions can be initiated in one time-slot provided that they all finish within that time-slot. SpaceWire-D offers the potential for integrated payload data-handling and control networks, which are particularly attractive for small satellites. The full paper will describe SpaceWire-D in detail and provide the results of analysis and prototyping.