A FAULT-TOLERANT SPACEWIRE COMPUTER

Session: SpaceWire Onboard Equipment and Software

Long Paper

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ABSTRACT

A study of fault-tolerant on-board computers for satellite and payload control is described. The computer comprises duplicates of six different printed-circuit boards, for a total of 12 boards. Instead of a passive backplane (motherboard), the 12 boards are interconnected with multiple SpaceWire channels, four per board. One possible interconnect topology is based on doubly-connected torus, providing at least two mutually-exclusive paths from each board to any other board. The boards incorporate redundant SpaceWire routers, to support mutual-exclusivity of paths. The physical design of the system is described and analyzed.

Alternative interconnect topologies, including doubly-connected ring and dual-hub star, are considered and compared based on efficiency, cost, reliability, and interconnect throughput and latency.

SpaceWire as the interconnect technology is compared with alternative methods of communications, including backend bit-parallel buses such as PCI, multidrop serial buses such as the dual-redundant MIL-STD-1553B bus, and proprietary parallel and serial interconnects. SpaceWire is found faster, more robust to variations and to disturbances, easier to handle, less expensive to adopt, and enabling future scaling.

The issues associated with using SpaceWire for backend interconnect in a parallel processor are largely due to technical difficulties of the interconnect. Card-to-card SpaceWire cables and connectors may lead to issues caused by the limited reliability of these mechanical devices. Motherboard architectures alleviate some of the mechanical issues but call for the use of non-standard connectors and careful control of inter-wire skew.