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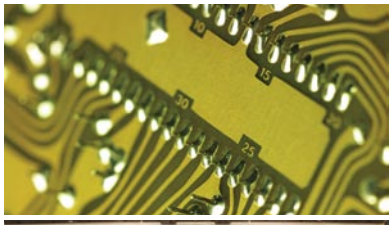
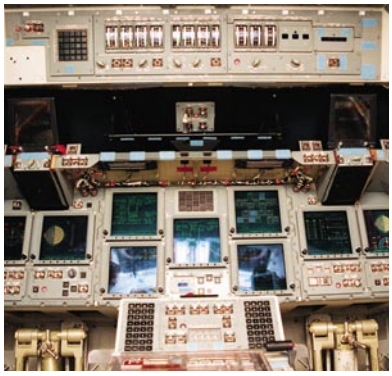
A High-Speed Data Transport Layer for Space Flight Applications

...using the new SpaceWire reliable data delivery protocol





NASA Goddard Space Flight Center has developed a software implementation of a new transport-level reliable data delivery protocol (RDDP). Designed for reliable delivery of data packets across the SpaceWire standard, this protocol uses the new SpaceWire packet format being standardized as ECSS-E-50-11* by the European Cooperation for Space Standardization (ECSS) to complement the existing SpaceWire standard, ECSS-E-50-12. Written in C, the protocol can run on embedded microcontroller applications, enabling a highly reliable command and data handling bus with reduced latency. As the SpaceWire standard continues to grow in popularity as a solution for high-speed satellite data buses, this new transport level adds value by eliminating the need for an additional bus for command and control, like MIL-STD-1553, by enabling reliable transport of SpaceWire high-speed serial links.

Benefits

- **Reliable**: Enables electrical systems to be designed with a reliable packet delivery mechanism for command and control
- **High-speed**: Provides high bandwidth for user data (greater than 200 Mbps)
- **Reusable**: May be used for any user-defined packet cargo with a mean transfer unit (MTU) size of 64 KB and provides for segmentation of up to a 1 Mb packet
- **Accurate**: Ensures user data is delivered to its destination even under fault conditions (physical-level fault) by implementing a time-out and retry mechanism
- **Efficient**: Offers a streamlined approach to eliminating the need for an additional command and control bus (such as MIL-STD-1553), and increases the efficiency of science data through a low-level firmware implementation
- **Low cost/complexity**: Uses less power and has a smaller footprint than MIL-STD-1553 for specific chip sets, and requires fewer system bus standards

*NASA Goddard plans to submit the RDDP to the SpaceWire working group for an application for a permanent protocol ID.

Applications

The SpaceWire RDDP may be applicable to many aerospace microelectronics devices.

- Spacecraft systems
- Bus systems
- Embedded microcontrollers

Technology Details

How it works

The SpaceWire data bus standard (an adaptation of IEEE 1355 with the addition of low voltage differential signaling [LVDS]) was developed to address the need for significantly higher data rates (faster than 200 Mbps) in new space applications, compared to previous standards (such as MIL-STD-1553) that were limited to about 1 Mbps. Goddard's RDDP combines the best of a standard high-speed bus and standard methods for reliable data transport in one streamlined approach optimized for the SpaceWire standard and space applications.

The transport-level protocol defines a low-overhead packet transport header optimized for SpaceWire that, along with data command mechanisms, provides simultaneous high reliability and high speed. Eight bytes long, this packet header size provides for easy stripping of the header for 32- and 64-bit bus systems. The header information allows for an MTU of up to 64 KB and segmented packets up to 1 Mb to be transferred with acknowledgment for each packet. Re-transmission occurs for each packet that does not receive an acknowledgment within a programmable time-out range. The header information also features a destination and source address along with a channel ID to enable further decoding within a single destination and source address pair. The protocol provides for an alternative path to be taken for the packets in the event of a physical-level fault condition. Up to eight outstanding packets may be sent before acknowledgments are received.

Why it is better

NASA Goddard's RDDP offers several advantages over existing alternatives to achieving both simultaneous high-speed and high-reliability data transmission for space applications. Commercial standards have space-application limitations related to topology and data-rate flexibility when compared to SpaceWire. SpaceWire is the only high-speed standard written specifically to address the unique needs of space applications. The RDDP implementation features a low packet overhead, accommodating a large range of variable packet sizes, enabling users to take advantage of the flexibility offered by SpaceWire. The RDDP also helps reduce the cost and complexity for many space applications. For example, in applications in which only command and control functions are required to be reliable, two buses are typically needed (e.g., MIL-STD-1553 plus a high-speed bus). In such scenarios, RDDP simplifies the development steps necessary to achieve reliable data transmission by eliminating the need for two separate buses.

For More Information

If you are interested in more information about this technology (GSC-14761-1), please contact:

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More information about working with NASA Goddard's Office of Technology Transfer is available online:
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