# SpaceWire – a New Challenge for Networking a Space Operating Equipment

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*In the last years a new standard for networking different scientific space payloads emerged. It was elaborated as response of the requirement to develop new generation of reliable and robust networked space instruments for the upcoming ESA missions in Space exploration. The purpose is to provide engineers with proven and consistent tools in the design and development process of the sensor systems for space experiments*

## Introduction and scope

The need for standard networking different devices (especially sensors) operating onboard space platforms was realized not long ago. The SpaceWire standard is facilitating the construction of high-performance onboard data acquisition systems, helping to reduce the overall system integration costs, promoting the compatibility between data handling equipment and subsystems, and providing possibilities to re-use data handling equipment across several different missions.

Implementation of the SpaceWire standard into new data acquisition ensures such equipment is compatible with all other interconnected instruments at both the component and sub-system levels. Processing units (i.e. processors, microcontrollers) and mass-memory units using SpaceWire interfaces developed for one mission can be readily used on another mission. This way: the development phase cost less and takes less time since only the new part of the system should be constructed from the scratch. Moreover implementing standard protocols the reliability is increased which is crucial for space missions with budget several M€.

From the communication point of view the key features of the SpaceWire standard could be summarized as follows - bi-directional, full-duplex serial communication between the networked devices with selectable speed (2 Mbits/sec to 200 Mbits/sec).

In the SpaceWire specification the physical connectors and cables, electrical properties, and logical protocols that comprise the SpaceWire data link are outlined. From logical point of view the SpaceWire simply grants a procedure for sending data packets from one node to another node in the network, but does not imposes any requirements about the content of the data packets.

The standard covers the following protocol levels:

- ✓ Physical level: Defines connectors, cables, cable assemblies and printed circuit board tracks.
- ✓ Signal level: Defines signal encoding, voltage levels, noise margins, and data signaling rates.
- ✓ Character level: Defines the data and control characters used to manage the flow of data across a link.
- ✓ Exchange level: Defines the protocol for link initialization, flow control, link error detection and link error recovery.
- ✓ Packet level: Defines how data for transmission over a SpaceWire link is split up into packets.
- ✓ Network level: Defines the structure of a SpaceWire network and the way in which packets are transferred from a source node to a destination node across a network. It also defines how link errors and network level errors are handled.

A general overview of the system incorporating SpaceWire technology is presented on the figure below:

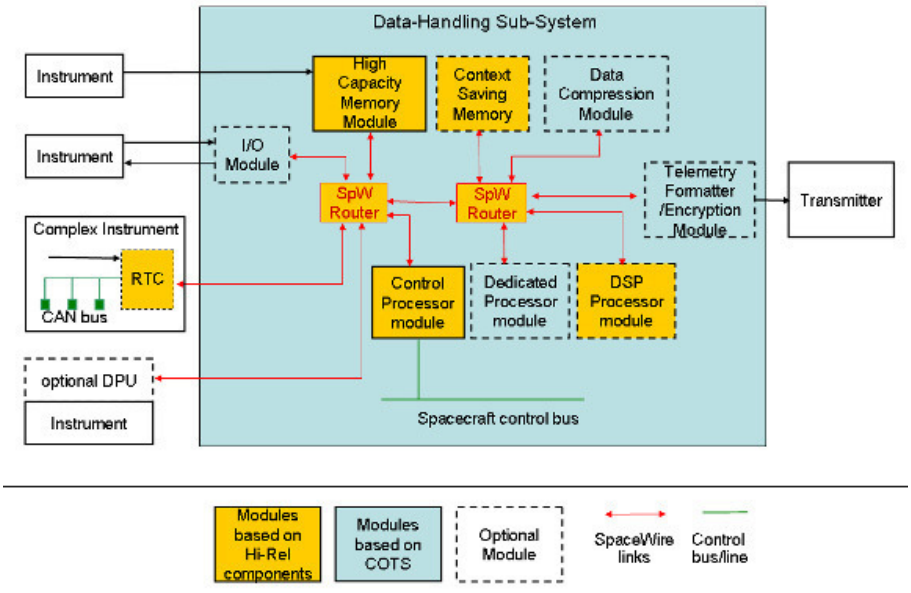


*Fig.1 Detailed configuration for SpaceWire implementation*

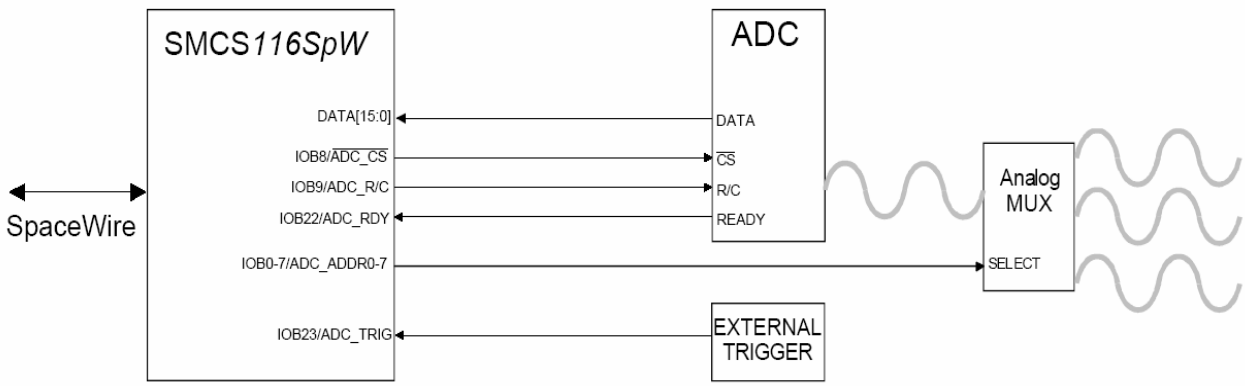


*Fig.2 Sample configuration for SpaceWire-enabled node*

As seen the data parsing mechanism is flexible enough to include instruments capable to their data directly to the central processing or the instrument could interface to the system via separate I/O lines. The modules shown in the shadowed region are COTS which leads to increased reliability and productivity.

## Sample node implementation

In the next paragraphs a simple implementation of a single node accessing a SpaceWire shall be introduced. As physical phenomenon that shall be measured the temperature at the node was chosen since there is simple and reliable manner to measure it in a wide range by variety of sensors. The practical task was to set up a low powered single node for measurements with small amount of buffer memory (16KB) and high speed transmission link for immediate data transfer. The network node structure we propose consists of:

- three thermocouples or semiconductor sensors in regard of the temperature range that needs to be measured;
- 12 bit ADC controlled externally;
- one controller SMCS116SpW, who provides one SpaceWire serial communication link with 2,5 to 200 Mbit/s data transmit rate, dedicated ADC interface and shred GPIO/UART interfaces.

## Conclusions

The SpaceWire networking technology is rapidly developing and is seen as standard for many new missions by ESA. In order to develop modern space borne instruments one should consider SpaceWire first and for this reason simple data acquisition system has been proposed based on COTS components.

## REFERENCES

[1] http://spacewire.esa.int/content/Home/Purpose.php and http://spacewire.esa.int/ content/Home/KeyFeatures.php
[2] http://www.atmel.com/dyn/resources/prod_documents/doc4166.pdf
[3] http://spacewire.esa.int/content/Devices/documents/SMCS116SpW%20Flyer%201-0a.pdf
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