

# Recording SpaceWire Traffic

## SpaceWire Test and Verification, Short Paper

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To support the validation and debugging of complete SpaceWire systems, STAR-Dundee Ltd have developed a SpaceWire Recorder. Using STAR-Dundee SpaceWire technology and the latest solid state data storage technology, the SpaceWire Recorder is capable of unobtrusively recording traffic on up to four links in both directions at a maximum aggregate data rate of 600Mbit/s. The maximum amount of data that can be recorded is limited only by the size of the solid state disks used. A Traffic Viewer software application provides a simple means of operating the recorder, as well as displaying and managing the large volume of SpaceWire traffic that can be recorded.

**Index Terms**— Relevant indexing terms: SpaceWire, Networking, Spacecraft Electronics, Recorder

### I. INTRODUCTION

Viewing SpaceWire traffic on a complete SpaceWire system for validation and debugging purposes can be challenging. One solution may be to use multiple SpaceWire Link Analyser Mk2s, each connected on a different link and each configured to capture data at the same time via external triggers.

A SpaceWire Link Analyser Mk2 will unobtrusively capture very detailed information regarding SpaceWire traffic on a single SpaceWire link. The timing information of every SpaceWire character is captured along with a trace of the data and strobe signals. The amount of data captured however is limited by the Link Analyser memory size, the units are not time synchronized and each Link Analyser will have a separate instance of software running, making it very difficult to interpret the operation of the SpaceWire system.

To resolve this problem STAR-Dundee has developed a SpaceWire Recorder. The SpaceWire Recorder is a standalone unit capable of recording SpaceWire traffic on multiple links unobtrusively to a hard disk. It is supplied with software that controls recording and displays the recorded traffic in a single application, allowing data on all links to be viewed simultaneously. The recording size is limited only by the hard disk size meaning large volumes of SpaceWire traffic can be recorded over long periods of time. Entire recordings can be viewed in software as opposed to only part of the recording.

### II. HARDWARE

The SpaceWire Recorder is a standalone PC. It consists of a CompactPCI rack containing a power supply, one solid state disk (SSD) carrier, a processor board and the STAR-Dundee SpaceWire Recorder cPCI card.



Fig. 1. SpaceWire Recorder

By default the SpaceWire Recorder comes with two 480GB solid state disks. One disk is responsible for storing SpaceWire traffic recordings and the other holds the system files such as the operating system. The recordings disk is held within a SSD carrier providing easy access. The system files disk is attached directly to the processor board.

A powerful processor board accompanies the SpaceWire Recorder with an Intel Core i7 and 8GB RAM. Amongst the I/O there are two DisplayPort ports and a VGA port allowing three monitors to be used, plus gigabit Ethernet making remote connection possible. A rear transition module accompanies the processor board. This allows access to I/O from the back of the system.

### III. SPACEWIRE RECORDER cPCI CARD

STAR-Dundee have developed a cPCI card capable of many different configurations. The SpaceWire Recorder is one of the first products to make use of this. The SpaceWire Recorder cPCI card has eight SpaceWire interfaces used to

unobtrusively record SpaceWire traffic in both directions on four links. Memory on-board the SpaceWire Recorder cPCI card allows the traffic to be captured and spooled very quickly to disk. Four external triggers allow the recorder to integrate with external equipment. Each external trigger can be configured as either an input or output trigger. These allow the user to control recording in response to an input signal or generate an output signal when an event of interest occurs. A dedicated trigger button allows the user to force a trigger providing further control over recording. The status of the SpaceWire interfaces, external triggers and trigger button are indicated by LEDs.



Fig. 2. SpaceWire Recorder cPCI Card

#### IV. SOFTWARE

The SpaceWire Recorder comes with all the necessary software pre-installed. This consists of Windows Embedded Standard 7, the board support packages required by the processor board, STAR-System (including the STAR-System PCI Driver) and the Traffic Viewer GUI software.

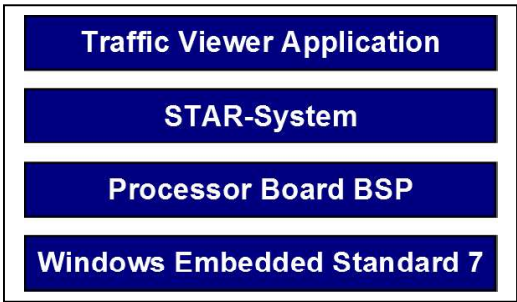


Fig. 1. Software Layers

Windows Embedded Standard 7 delivers the performance, reliability and flexibility of Windows 7 in a form specific to the requirements of the SpaceWire Recorder.

Developed by STAR-Dundee, STAR-System is a high performance suite of software designed to work with all future and a range of current STAR-Dundee devices. STAR-System includes numerous modules used by the SpaceWire Recorder, including the STAR-System PCI Driver. The fast data rates at

which the SpaceWire Recorder can record are partly achievable thanks to the performance of the STAR-System PCI Driver.

#### V. TRAFFIC VIEWER

The Traffic Viewer is a GUI application that allows the user to control the SpaceWire Recorder and display and manage recordings.

The user can configure the recording directory, the maximum recording size and the maximum recording time. Start and stop buttons control recording. Once a recording is complete it is displayed. Each column in the view represents the SpaceWire traffic in one direction of a SpaceWire link. The left most column shows the recording time.

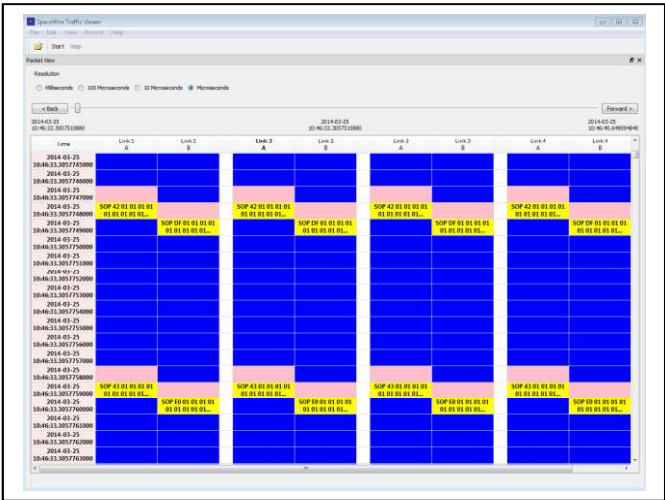


Fig. 2. Traffic Viewer

10ms of recorded SpaceWire traffic is loaded into the display at any one time. The user can specify the timing resolution of the display: 1us, 10us, 100us and 1ms. To seamlessly load another section of the recording, the time slider at the top of the view is used. Left and right of the time slider is the recording start and end time. To quickly navigate the recorded traffic the user can specify a specific time relative to the start of the recording or use the built-in search capabilities. Users can search for a data pattern, a time-code value, a specific error, the start of a packet, an EOP or an EEP.

Double clicking a packet opens a dialog that shows the packet in greater detail. It shows the time at which it was captured, the packet duration and the packet data.

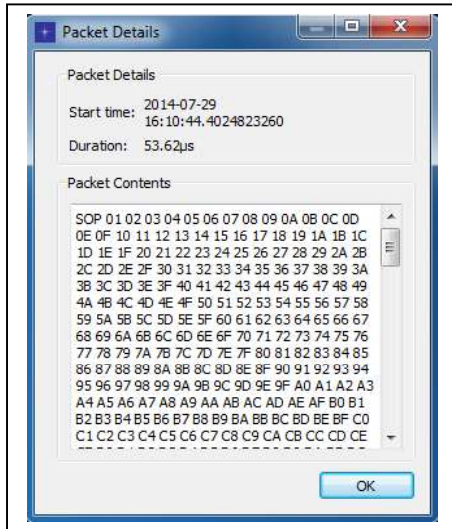


Fig. 3. Packet Dialog

## VI. CAPABILITIES

Using the SpaceWire Recorder SpaceWire Traffic can be recorded at high speed on many links over a long period of time. The maximum amount of data that can be recorded is only limited by the size of the solid state disks in use.

The SpaceWire Recorder records data, time-codes and link errors. Using the Traffic Viewer application, recording can start and stop at the click of a button. Alternatively a recording can automatically stop when the recording disk is full, a specified amount of data has been recorded to disk or a pre-defined period of time has elapsed since the recording was started.

Recorded SpaceWire traffic is displayed in the Traffic Viewer. Search capabilities make it easy to navigate large recordings and identify the SpaceWire traffic of most interest. Recordings are automatically saved to be viewed at a later date.

## VII. PERFORMANCE

To measure the recording performance of the SpaceWire Recorder a SpaceWire EGSE was used to generate data in both directions of all four links. The SpaceWire EGSE is a SpaceWire equipment emulator capable of full real-time performance. Once configured using a unique SpaceWire specific scripting language, it operates independent of software, capable of saturating a SpaceWire link with data at a 200Mbit/s link speed, i.e. no Nulls between data characters.

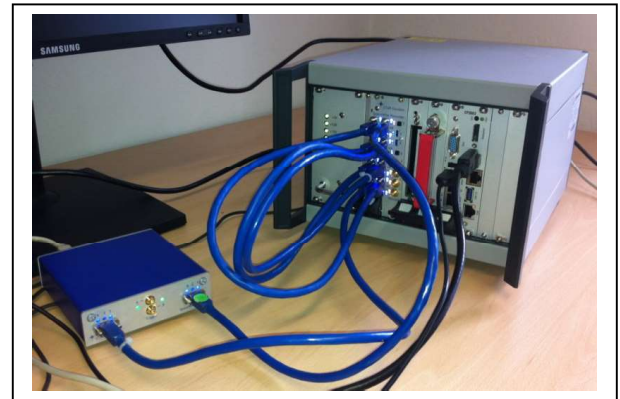
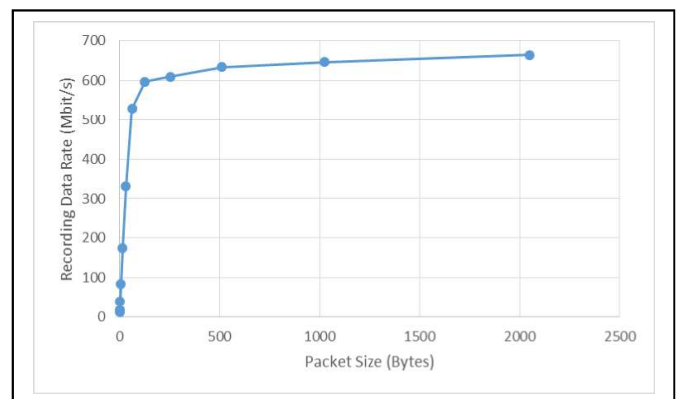


Fig. 4. Performance Test Setup

The SpaceWire EGSE was used to generate packets of a specific size consisting of random data at a fixed link speed over a prolonged period whilst recording was enabled. If no hardware buffer overflow was detected, the test was started again with an increased link speed. This incremental process was performed until a hardware buffer overflow was detected signifying the maximum recording speed was exceeded. Internal statistics monitoring within the SpaceWire Recorder software provided detailed information regarding the recording data rates achieved and the usage of the SpaceWire Recorder spooling buffers.

The SpaceWire Recorder is capable of recording to disk at an aggregate data rate of 600Mbit/s. However the speed at which it can record to disk differs depending on the size of the recorded SpaceWire packets. The table below plots the aggregate recording data rate achieved for different packet sizes.



main reason for this is the recording time-stamp overhead associated with each packet.

If the rate at which data is transmitted from the SpaceWire devices connected to the SpaceWire Recorder exceeds the rate at which it can be recorded then a capture overflow will occur. If this happens, the Traffic Viewer application will stop recording automatically and alert the user.

#### VIII. FUTURE WORK

The SpaceWire Recorder hardware has capabilities currently not fully implemented in software. The Traffic Viewer application currently does not support:

- Triggering: start recording when an event of interest occurs e.g. link error
- Filtering: disable or enable recording of time-codes and specific errors (currently enabled by default)
- Link statistics: view the average bit rate of each bi-directional link

New views of recorded SpaceWire traffic will also be added to the Traffic Viewer. The SpaceWire Recorder is currently being used to help validate the SpaceWire Plug and Play (PnP) protocol. Feedback from this and other users will be used to improve existing features and guide the development of new features.

#### IX. CONCLUSION

The SpaceWire Recorder is an essential tool for the validation and debugging of an entire SpaceWire network. It serves a different purpose from a SpaceWire Link Analyser

Mk2, which is designed to capture a much smaller, yet more detailed, amount of SpaceWire traffic on a single SpaceWire link.

The SpaceWire Recorder unit is built around a high performance SpaceWire Recorder cPCI card complimented by solid state disks and a powerful processor board. Combined with the STAR-System PCI Driver and the Traffic Viewer software application, the SpaceWire Recorder has impressive capabilities and delivers exceptional recording performance. Large quantities of SpaceWire traffic over multiple links can be recorded for long periods of time. The maximum aggregate recording data rate achieved whilst testing performance was 664.78Mbit/s with 2048 byte packets. Recorded SpaceWire traffic can be viewed and managed using the Traffic Viewer application.

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