The SpaceWire Handbook

Editor: Barry M Cook, (4Links Limited, UK)

Note to readers:
This is a second draft containing some initial content and placeholders/very brief notes on proposed content.

Comments and (offers of) contributions are welcome:
Email Barry@4links.co.uk (subject "SpaceWire Handbook", please)

Introduction / Abstract / Executive summary

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Priority: medium

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1. A History of 40 years' evolution towards SpaceWire, bringing out key principles and concepts

1.1 Introduction

SpaceWire is a data communication technology, having been standardized by ECSS (European Cooperation for Space Standardization) in January 2003[1] and re-issued as ECSS-E-ST-50-12C on 31 July 2008. Early versions of SpaceWire are flying on several missions, and it is planned for use on many missions worldwide. As a simple interface that can be used for a wide variety of different purposes, SpaceWire appears to offer an enabling technology for a "Building Block Architecture" such as described in NASA's Vision for Space Exploration[2], for rapid deployment, such as DoD's PnPSat[19], and for cost reduction as a result of architecture and subsystem re-use as practiced by ESA[]. While standardized in the 21st century, SpaceWire has evolved over many years, following a few key principles and concepts that are the foundation of its wide application and use.

This note describes that evolution and draws from it those key principles and concepts.

1.2 1960+ A Modular Computer

In the 1960s, a computer would be built from several different boxes, such as processor, memory, disc controller and communications controller. One way to connect the boxes together was to use a simple standard interface between any of these boxes, so that they could each access the others independently of each other.

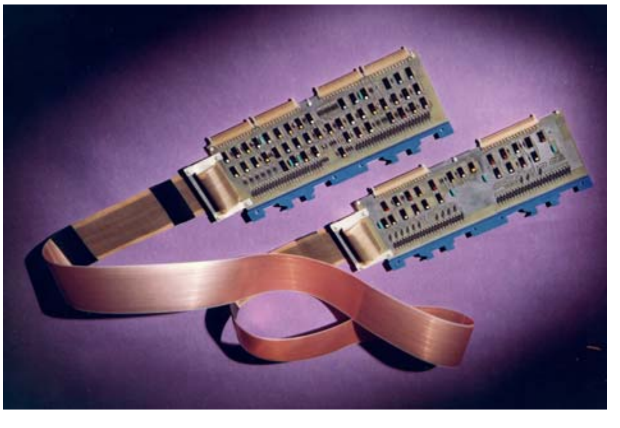

Figure 1.1. Standard Interface on Modular One Computer

One example was the interface of the Modular One computer, shown in Figure 1.1. The key concepts of this standard interface were:

- Keep the bus inside each box, so that the whole system is not sharing a single bus;
- Use an asynchronous interface, so that each box can run at its optimum speed and there is no need for global synchronization;
- Use a symmetrical interface, so that any box can be connected to any box;

- Have flow-control across the interface so that data is not lost even if buffers are full (but this may result in reduced performance if a communication is blocked).

These key principles resulted in a number of benefits:

- The system was scalable, so that systems could be built with any number of processors, memories, and peripherals;
- There were few constraints on the topology of the system, so that systems could be built with any shape as well as any size;
- Multiple units could be configured for redundancy and fault-tolerance;
- The system was truly modular, in that a huge variety of systems could be built from a comparatively small number of building blocks.

While the Modular One computer systems built with these interfaces were never used in space, they were used by the European Space Agency for Ground Support and Operations. The chips described in the next section were flown in space, on a number of missions.

1.3 1980+ System on Chip, Serial Interfaces

During the 1980s, it became clear that it would be possible to put a complete computer on a single silicon chip, including processor, memory, and interfaces. One of the first examples of this was the INMOS transputer[3]. This had the conventional external memory bus similar to other microprocessors, but it also had four serial interfaces or "links" that inherited the key principles of the Modular One interfaces.

The block diagram in Fig. 1.2 is taken from early publicity material that INMOS produced for the transputer (the IMS T424), clearly showing the significance of the four serial links. Fig. 1.3 shows a packaged die of the later T800 floating-point transputer, with the four links on the left towards the top.

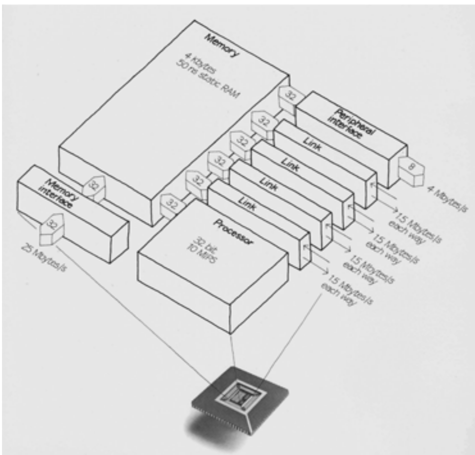

Figure 1.2: Block diagram of the transputer, with its four serial interfaces

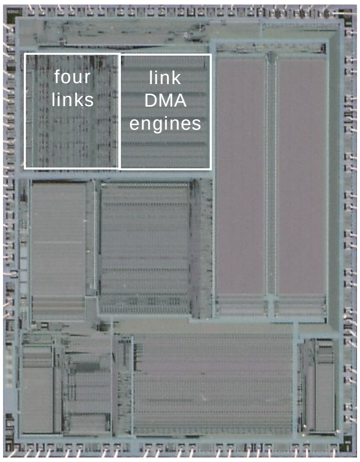

Figure 1.3: Chip photo of the T800 transputer,
showing the area taken by the serial links

The cost benefits are clearly visible from Fig. 3. Overall, the four links, including the physical layer interface, all the serializing and de-serializing (SERDES) and DMA logic for each direction for each link, take up about the same space as the fixed-point processor. By comparison the on-chip RAM, the floating-point processor and the memory interface (including all its pins) each take up significantly more chip area.

At the time the transputer was introduced, a 10Mb/s Ethernet interface needed a chip-set of three chips, whereas a serial link needed around 2% of a single chip on the transputer and its DMA engine another 2%.

Performance of the early transputer links was modest, but at 20Mbits/s in each direction (full-duplex) a single link was well over twice the performance of an Ethernet connection. With the four links per transputer running full-duplex at 20Mbits/s, total serial throughput was 160Mbits/s per transputer.

As well as keeping the key principles of the Modular One interfaces, the transputer links added the following:

They were serial interfaces, to reduce pin count and to simplify connections between chips;
They used DMA to access the transputer's memory, with very low processor overhead per packet.

1.4 Transputer serial links in space

The space industry recognized the potential of the transputer and its links for building fault-tolerant networks on-board spacecraft.

Missions included the Cluster group[4] from ESA, many satellites from SSTL[5] and from CNES, and the SOHO[6] collaboration between ESA and NASA. In fact the transputers used in these missions were not specifically designed as Rad-Hard, but they were from batches selected for radiation tolerance and designed into fault-tolerant networks.

The SOHO satellite continues to send back images of solar corona discharges, such as the image in Figure 4.

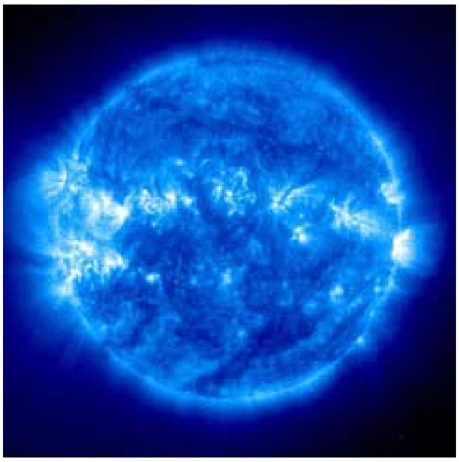

Figure 1.4: Image taken by the EIT instrument on SOHO

1.5 Modularity

In the early days of the development of the transputer, it was found that a useful way to explain the ideas was to compare the transputer with toy building blocks such as Lego™ and K'Nex™ [7]. These use a very simple standard interface that can be used to connect a wide variety of different building blocks, in order to build an even wider variety of constructions. The serial links of the transputer were such a simple and easily usable interface, and they encourage modularity.

The opportunity was taken to propose a standard TRAnsputer Module, or TRAM, which used the serial links as their interface. These were printed circuit boards about half the size of a credit card, with just sixteen pins. In effect they were 16-pin Dual-Inline-Packages (DIPs) with 3.3" between the pins instead of the conventional 0.3" between pins. These modules were very popular and were made by INMOS and by a number of other companies.

1.6 1990+ Transputer links to IEEE 1355

Towards the end of the 1980s, a new generation of the transputer was planned, taking the links to 200Mbits/s and adding some important new principles:

Adding a minimalist packet protocol, consistent with the general move towards packet communication and switching;
Adding a network protocol so that the packets could be routed through a network of routing switches;
Adding virtual channels, so that a variety of different communications can share the same physical links.

The TRAM standard had been popular as a way to construct systems inside a box. The new 200Mb/s links provided the opportunity to create a standard for connections between boxes, and an internal standard was proposed in the late 1980s. Colleagues at INMOS, together with other contributors in Europe, took this forward to create the IEEE

1355 standard. To keep the standard simple, we left out the network and virtual channel protocols, but all the previous principles that have been outlined were included in IEEE 1355.

Notable among the contributors was CERN, who built a large test system with 1024 links, over which they ran a soak test for three months, logging 10^{17} bits transferred without a data error on a link (At one point during the test, a thunderstorm upset the computer and network that were controlling the test, but there was no failure on the links.)[8].

Also among the contributors, even in the early 1990s, were Dornier SatellitenSysteme (DSS, subsequently EADS-Astrium, in Munich).

The IEEE 1355 standard was confirmed in 1995, after which the European Space Agency and a number of other organizations in the space industry joined the activity.

For what at the time were probably correct commercial and political decisions, the new transputer and the 1355 standard were abandoned by the company that had taken over INMOS. The standard was used by Canon, who needed to adapt some aspects of the standard for a networking application. A number of small adaptations were also required for Space and so a new standardization activity was launched by the European Space Agency. This activity became SpaceWire.

1.7 IEEE 1355 AND EARLY SpaceWire in Space

During the development of the SpaceWire standard, there was clearly an interest in using the 1355 standard and in drafts of the SpaceWire standard for space applications. EADS-Astrium Munich commissioned a couple of chips that were available in a RAD-Hard version, and these chips is flying on Rosetta[9], on Mars Express[10] and on Venus Express[11] in Europe, on Solar Dynamics Observatory and STEREO for NASA, and on the commercial Broadband Global Area Network satellites Inmarsat4. As well as the Data-Strobe (DS) version of 1355 that has carried through to SpaceWire, Rosetta is also carrying the “Three of Six” (TS) version of IEEE 1355, which has the benefit of AC coupling at a slight penalty in available bandwidth. Early versions of SpaceWire are also flying on SWIFT[12] and on other missions classified for commercial or other reasons.

1.8 2000+ SpaceWire

Compared with IEEE 1355, the SpaceWire standard:

- Evolves the DS (Data/Strobe) Physical alternative of 1355
- Corrects an initialization bug in 1355
- Removes some ambiguities in 1355
- Removes the End of Message token, using it instead for Error End of Packet
- Removes the TS (galvanically isolated) and HS (Gbit/s) Physical alternatives
- Uses LVDS rather than PECL, for low power
- Uses space qualified connectors and cable
- Includes a simple Network Layer protocol
- Adds Time Code distribution

Apart from these changes, the SpaceWire standard embodies the key principles that have been outlined:

- Bus kept inside each unit, not over entire system;
- Serial interface;
- Asynchronous interface;
- Symmetrical interface;
- Flow-control across the interface;
- Minimalist packet protocol;

And these qualities, as before, bring the benefits of scalability, topological flexibility, fault-tolerance and modularity

The standard is cleanly layered, with minimal overlap or interaction between the levels. The levels defined are:

Physical level: two signal pairs in each direction, PCB traces, connector and cable;
Signal level: LVDS including failsafe, terminations, Data-Strobe signal encoding on the two pairs, signalling rate, skew and jitter;
Character level: Data characters, Control characters, Time Codes, parity, character(s) to be sent at initialization or after error, host interface encoding;
Exchange level: Normal Characters (that are passed through the network) and Link Characters (that are local to a single physical connection), flow control, clock recovery, initialization state machine, errors and error recovery, Time Code distribution;
Packet level: destination address, cargo, end-of-packet markers;
Network level: Wormhole routing, path addressing, logical addressing, header deletion, group adaptive routing, how to do broadcast or multicast, network errors and recovery

It is useful to summarise a few of the main characteristics, particularly those that are different from some other networking standards:

- Data-Strobe encoding
- Low-level flow-control
- Packets
- Packet routing
- Time Codes and their distribution

1.8.1 Data-Strobe encoding

There is a need in any communication system for a means of recovering the clock from the received signals. In long-distance communication, this tends to be with a phase-locked loop per channel, which would be possible for space but which needs analog circuitry that is undesirable in space electronics. An alternative is to send a clock signal on a separate wire, but this has tight demands on skew between the signals. SpaceWire uses a Strobe signal on a separate wire, which is Gray-coded with the signal wire so that for each bit transmitted, there is a transition on either the Data or the Strobe signal. This still needs the skew to be controlled, but is more relaxed in this respect than separate clock and data. The technique was originated in IEEE 1355 and was subsequently adopted by IEEE 1394/FireWire. It is one of the contributing factors in SpaceWire being a simple, digital, circuit, without needing analog electronics.

1.8.2 Low-level flow-control

Flow-control is often seen as a high-level protocol, and indeed for long-distance communication needs to be so. The lack of flow-control at a low level, however, requires buffers large enough that they (almost) never overflow. SpaceWire permits low-cost circuits with small buffers, and the flow-control ensures that data is preserved and that the buffers never overflow. Having larger buffers than the minimum permitted improves overall network performance, but the flow-control allows implementations of SpaceWire that can have less logic and less buffering than conventional RS232/422 UARTs, even though SpaceWire runs orders of magnitude faster than these UARTs.

1.8.3 Packets

SpaceWire uses minimalist packet format, with header, cargo, and packet termination. For a point-to-point connection not via a routing switch the header can be zero length; for a routed packet, the header is a destination address that can be as long as necessary. The cargo can similarly be as long as necessary, and no limit is defined in the standard. In practice, most systems will benefit from imposing a form of Maximum Transfer Unit (MTU) to prevent a long packet blocking other traffic in the network. The packet termination is a single control character, either End-of-Packet (EoP) or Error-End-of-Packet (EEP).

After the standard was issued, it was agreed to include a protocol identifier (PID) as part of the header, between the destination address and the cargo. As in other standards such as Ethernet and Internet Protocol, the PID allows a variety of different higher-level protocols to interoperate on the SpaceWire network without interfering with each other.

The minimalist packet protocol of SpaceWire provides what is absolutely necessary and no more. If extra information is required in a header, such as the source of the packet, a checksum, or a protocol to be encapsulated on SpaceWire, these can all be added at a higher level. All that is added, however, needs to be generated and checked for each packet, which can impose substantial delays in processing each packet. The simple raw SpaceWire packets provide a very efficient communication system with very low processing overheads as well as low overheads on packets.

1.8.4 Packet routing

SpaceWire can be used with or without routing switches, and satellites can include point-to-point connections as well as a network (or networks) with routing-switches.

When using routing switches, SpaceWire packet switching uses “Wormhole Routing” so that the front of a packet can have left the routing switch before the end of the packet has arrived.

The SpaceWire standard *requires* that routing switches provide what the standard calls Path Addressing, and *permits* them to provide what it calls Logical Addressing. In each case, the first data character of a packet seen by the routing switch is used as a routing header to determine which output port of the routing switch the packet is routed to.

In Path Addressing, values of the first data character from 1 to 31 result in the packet being output to port 1 to 31 respectively. The special value of zero results in the packet being used internally by the configuration/management port of the routing switch. After the character has been used to address a particular output port, the character is no longer required and so is deleted.

In Logical Addressing, values of the first data character of a packet are used to index a look-up table to determine the output port. In this case the character is not normally deleted, as the same character can be used in several routing switches to steer a route through the network. For small networks such as tend to be used on satellites, logical addressing can provide an exceptionally low overhead for routing the packets.

1.8.5 Time Codes and their distribution

It is useful for all the subsystems on a satellite to have a reasonably consistent view of time, and SpaceWire provides a means of distributing such a consistent view. Time Codes are special sequences of characters which take priority over the normal data in a packet and are distributed to all nodes in the SpaceWire network. A small amount of jitter is normally introduced, both in the generation and distribution of Time Codes, resulting in a few microseconds variation in the view of time from different nodes in the network. A scheme has been proposed[13] that is completely compatible and interoperable with the standard, where the jitter in Time Code generation and distribution can be reduced to a few tens of nanoseconds[5].

1.9 Where SpaceWire is being used

SpaceWire is planned for use on a wide variety of different missions, throughout the world. The European Space Agency plans to use SpaceWire for most, if not all, of its future missions. A number of national missions, such as Taiwan's Argos satellite, are using SpaceWire. Key US missions are the James Webb Space Telescope[14], the Lunar Reconnaissance Orbiter[15], and GOES-R[16].

DoD's Operationally Responsive Space activity[19] has shown keen interest in SpaceWire, because they see it as an enabling technology for the modularity, scalability and reconfigurability required for Responsive Space.

1.10 The future, 1: How SpaceWire will develop

The SpaceWire Working Group has already defined the Protocol Identifier so that multiple protocols can interoperate on a SpaceWire network, and has defined a Remote Memory Access Protocol (RMAP). A number of other protocols are being defined, particularly to encapsulate CCSDS and IP packets in SpaceWire, and we can expect to see more such encapsulation. A new protocol for SpaceWire has been developed in the US for reliable data transfer, like TCP but much simpler than TCP because it does not have to run over a global network with billions of nodes.

There are several examples of SpaceWire running at 400Mbits/s or faster, whereas must current uses are between 10Mbits/s and 200Mbits/s. The current RAD-Hard silicon imposes limits on the speeds that can be used but new ASIC chips, and PHY chips which handle just the high-speed front end, will make it easier to use SpaceWire at higher speeds.

A current ESA project is SpaceFibre, which aims to take the SpaceWire protocols up to between 1Gb/s and 10Gb/s, using a different physical layer that might include versions for both fibre and copper.

New capabilities will evolve. NASA have suggested extending the use of Time Codes such as to include, for example, a 1pps signal for time and a trigger signal for a number of instruments. Such suggestions provide enhanced capability but there is concern in some quarters if they would not be interoperable with chips and instruments that have been built to the standard. It is clear that improvements will be more welcomed if, like the low-jitter Time Code proposal, they are fully interoperable with all existing devices.

In 2002, a Plug and Play system over SpaceWire[17], was demonstrated that extended to modularity to system configuration. The demonstration was shown many times around the world and undoubtedly contributed to the wide adoption of SpaceWire. It was argued at the time that satellites are fixed configurations with no need for Plug and Play. Once such a plug-and-play capability is used, however, it can be used for the unexpected changes in system configuration and hence can assist Fault Detection Isolation and Recovery (FDIR). There may also be benefits from plug-and-play for the manned space program, where configurations are expected to change over time. And for Responsive Space, launching a satellite in a few days from mission definition means there is no time for system configuration or software development. The system must just plug together and work, so plug and play is necessary and DoD’s Air Force Research Laboratory (AFRL) have designed a plug-and-play system for SpaceWire[18,19] (unfortunately different from the one originally demonstrated).

1.11 The future, 2: How use of SpaceWire will evolve

Most of the early uses of SpaceWire have been as medium- to high-speed replacements of point-to-point links such as RS422. A typical configuration would be to connect an imaging instrument to a DSP processor, or to cross-connect a pair of instruments to a pair of processors.

To some extent, this use of point-to-point links without routing switches has been because there have not been Rad-Hard routing switches available. These have now been developed, however, by ESA, by NASA, and by a number of companies, and we can expect to see them used to construct simple networks.

NASA’s James Webb Space Telescope is using routing switches to build quite a large but simple network.

Routing switches can be used to build in the appropriate level of fault-tolerance, allowing different parts of the system to tolerate different numbers of faults. For example a daisy-chain (without the ends joined together or any cross-connections) does not tolerate some single faults. Connecting the two ends of the daisy-chain so that there is a ring is a simple way to provide tolerance of a single failure, whether the failure is in a node or a link. With three links per node, networks can be constructed which tolerate two failures, and in general, for n links per node, networks can be constructed to tolerate n-1 failures.

Many of the SpaceWire systems being built are modelling earlier systems based on a bus and a global memory access model. Hence the first protocol to be defined is the memory mapping protocol, RMAP. For many applications this model is appropriate and minimal cost. For other applications, a network model such as Ethernet or the Internet is appropriate. These different models and their protocols can happily co-exist over a SpaceWire network, just as private Microsoft and other protocols co-exist with TCP/IP over Ethernet.

There is a growing consensus that SpaceWire is the one interface standard that comes closest to meeting the widest variety of application needs for the space industry, and so it must be seen as a prime candidate as the interface of choice for modular systems and responsive lead-times. It will be some years before the full benefits of the modularity are used and, at the time of writing, the DoD Operationally Responsive Space activity probably exploits more of SpaceWire's benefits than other satellites and missions. To what extent the details of modularity will be internationally agreed or will be private within national organizations and companies, and to what extent evolutions to SpaceWire will adhere to the key principles and concepts outlined in this history, are yet to be seen.

1.12 Conclusions

SpaceWire has been an outstanding success in international collaboration, which has resulted in its use worldwide.

While apparently new technology, SpaceWire has a legacy going back 40 years, and a significant element of that legacy has proved itself in space missions that have been flying for many years.

The legacy, of a simple interface that can be used for almost anything, has been retained by preserving a number of key principles. These key principles provide modularity, scalability, and reconfigurability, and are far more important than the implementation details.

Early uses of SpaceWire have been evolutionary and have not therefore exploited the full benefits that might be available from using SpaceWire. As more experience and confidence is gained, we can expect more of the benefits to be realized.

Benefits should also be realized from evolution of SpaceWire itself. But if the key principles and concepts which underpin the SpaceWire standard are lost in that evolution, then many of the benefits of SpaceWire will also be lost.

1.13 References

[Several new ones needed]

1) European Cooperation on Space Standardization, ECSS-E-50-12A SpaceWire - Links, nodes, routers and networks, 24 January 2003
2) NASA, The Vision for Space Exploration, February 2004
3) INMOS Limited, IMS T424 Transputer Reference Manual, Bristol, England, 1985
4) http://www.sussex.ac.uk/space-science/missions.html#CLUSTER%20II

5) http://www.ee.surrey.ac.uk/SSC/CSER/UOSAT/missions/posat1.html
6) http://sohowww.nascom.nasa.gov/
7) Paul Walker The Transputer: a Building Block for Parallel Processing. Byte Magazine, Volume 10, Number 5, May, 1985.
8) S Haas, D A Thornly, y Zhu, R W Dobinson and B Martin, The Macramé 1024-Node Switching Network Microprocessors and Microsystems, IEEE 1355 Special Issue, V21, Nos 7,8, 30 March 1998
9) http://sci.esa.int/rosetta/
10) http://mars.esa.int/
11) http://sci.esa.int/venusexpress/
12) http://swift.gsfc.nasa.gov/docs/swift/swiftsc.html
13) Barry Cook, Reducing time code jitter, International SpaceWire Seminar, ESTEC, November 2003, available at http:// www.4Links.co.uk/reducing-time-code-jitter.pdf
14) http://www.jwst.nasa.gov/
15) http://lunar.gsfc.nasa.gov/missions/
16) http://science.hq.nasa.gov/missions/satellite_67.htm
17) Barry M Cook, C Paul H Walker, SpaceWire Plug-and-Play: An Early Implementation and Lessons Learned, AIAA Infotech@Aerospace 2007 Conference and Exhibit, Rohnert Park, California May 2007
18) Jim Lyke, Scott Cannon, A Plug and Play system based on USB for spacecraft components, 19^{th} AIAA/USU Small Satellite Conference, Logan UT, August 2005
19) Don Fronterhouse, Jim Lyke, Plug-and-Play Satellite (PnPSat), International SpaceWire Conference, Dundee, September 2007

2. Context and concepts

Status: To be written
Priority: high

2.1 Comparison with existing standards

Briefly describe MIL1553 and indicate its limitations (speed, poor scaling, fault tolerance …). Do same for CANbus and also (very briefly) for USB/firewire.
Describe SpaceWire (without too much detail) in contrast to busses (higher speed, good scaling, enhanced fault tolerance, …).

2.2 Concepts

SpaceWire links and networks in more detail:
Data: Packets, routing, addressing
Time: time code broadcast

2.3 Performance

Link/network latency and throughput
Time code accuracy (limit due to NULL/Data skew)

3. Guide to ECSS standards

Include the useful material no longer in the standard(s) due to tighter rules. (Already removed from the Protocols standard and expected to be removed from the revised SpaceWire standard).

Describe meanings of terms used as aid to understanding the standards (e.g. normative/informative, shall/may, …)

Status: To be written
Priority: ?

3.1 SpaceWire ECSS (was ECSS)

Status: To be written (now or wait for revision?)
Priority: ?

3.2 SpaceWire Protocols

Status: To be written, any volunteers? (Steve Parkes / WG members?)
Priority: middle

4. Components

What are available

Status: To be written
Priority: high
Action: Compile list – may be problems with ESA document referencing commercial products/ sites

5. Network architectures

Possibilities, merits and problems

Status: Some material available, more required
Priority: middle

6. Verification and Validation

Status: ?
Priority ?

7. Mission views

Reasons to choose SpaceWire
Benefits of choosing SpaceWire
Challenges from using SpaceWire

Status: Some material offered, more required
Priority: middle

8. Future evolution

Ongoing and possible

Status: To be written (RT / SpF: by group members?, other topics by ?)
Priority: middle

9. Contributors

Thanks go to the following contributors to this document:
Josep Rosello
Philippe Armbruster
Paul Walker

Appendix A. Papers On or Relating-To SpaceWire

Status: Incomplete (Known to be missing: many DASIA, …)
Priority: high
Action: All readers: email Barry@4links.co.uk (subject: SpaceWire Handbook) with any missing items.
Action: All readers: comment on / suggest other topic headings

(Roughly) Sorted by topic, most recent first.

Abbreviations used

CPA	Communicating Process Architectures (conference)
DASIA	Data Systems in Aerospace
IAC	International Astronautical Congress
ICAED	International Conference on Advanced Engineering Design
IGARSS	???
ISC	International SpaceWire Conference
ISWS	International SpaceWire Seminar
MAPLD	Military and Aerospace Programmable Logic Devices
NPSS	IEEE-NPSS Real Time Conference
SDSS	??? Satellite Data Systems Symposium ???
SmallSat	AIAA/USU Conference on Small Satellites
Spaceops	International Conference on Space Operations
SpW	SpaceWire
WG	working group

Reference Documents

- ECSS-E-ST-50-12C(31July2008)
- ECSS-E-ST-50-11C(…)
- CCSDS SOIS Services Green Book (CCSDS 850.0-G-0b, November 2006)
- SpW-SnP-PID (Draft B, January 2005)
- SpW-SnP-RMAP (Draft F, 4th December 2006)
- GOES-R Reliable Data Delivery Protocol (GRDDP), (1st of July 2005)
- SpaceWire Router Data Sheet, UoD_SpW-10X_DataSheet (Issue 2.0, 18th August 2006)

Backplanes

- SpW Backplanes
  A. Senior (SEA) SpW WG #12 2009-02
- Evaluation and Analysis of Connector Performance for the SpaceWire Back Plane
  K. Shibuya, K. Yamagashi, H. Oh-hashi, S. Saito, M. Nomachi Abstract - Presentation
  ISC 2008-11
- Introduction (to session on backplanes)
  M. Nomachi (University of Osaka) SpW WG #11 2008-06
- SpaceWire Active Backplanes & Backplanes-Hypertac-Connectors
  A.Senior (SEA) SpW WG #11 2008-06
- Serial Backplane for SpaceWire Abstract - Presentation
  Masaharu Nomachi, Shuuhei Ajimura, ISC 2007-09
- JAXA presentation on Backplanes
  M. Nomachi SpW WG #6 2006-05

Cable / Connectors

- SpaceWire Cabling in an Operationally Responsive Space Environment
  Derek Schierlmann, Paul Jaffe, Abstract - Presentation
  ISC 2007-09
- Mapping of SpaceWire signals into a 38999 series 4 circular connector,
  Schierlmann, NRL SpW WG #8 2007-01
- Cables and Connectors
  M. Wahl, GORE SpW WG #6 2006-05
- ECSS-E50-12A Maintenance Specific issues on cables
  Shaune.S.Allen, NASA SpW WG #1 2004-09

CCSDS / SOIS

- Proposed SOIS Plug-and-Play Architecture and Resulting Requirements on SpaceWire Mapping Abstract - Presentation
  Stuart D. Fowell, Chris Taylor, ISC 2007-09
- Introduction on SOIS
  C. Taylor, ESA/ESTEC, SpW WG #9 2007-04
- Overview and Specific Topics on Subnetwork Services
  Keltik, D. Stanton SpW WG #9 2007-04
- Overview and Specific Topics on Application layer support Services
  Scisys, S. Fowell SpW WG #9 2007-04
- Analysis of the CCSDS, SOIS services
  T. Yamada, JAXA, SpW WG #9 2007-04
- SpW and SOIS services–Overview
  S. Parkes, UoD SpW WG #9 2007-04
- SpW Implementation of SOIS SubNet Services assessment
  D. Jameux, ESA/ESTEC, SpW WG #9 2007-04

- SOIS Services and SpaceWire Features
  Y. Sheynin, UoStPb — SpW WG #9 2007-04
- Major outcomes and Way forward
  C.Taylor, ESA/ESTEC — SpW WG #9 2007-04
- Status of CCSDS SOIS Services definition
  Ph. Armbruster, ESA/ESTEC, — SpW WG #8 2007-01
- CCSDS SOIS Services Green Book (CCSDS 850.0-G-0b, November 2006)
  SpW WG #8 2007-01
- Mapping of CCSDS services on Mil1553B
  O. Notebaert, ECSS-E50-13 Convenor, Astrium, — SpW WG #8 2007-01
- ESA Presentation on CCSDS SOIS Status
  C. Taylor — SpW WG #6 2006-05
- UoD Presentation on CCSDS SOIS TCONS/OBL
  S. Parkes — SpW WG #6 2006-05
- CCSDS Time-critical Onboard Networking Service
  S. Parkes, R. Schnurr, J. Marquart, G. Menke, M. Ciccone — Spaceops 2006
- SpaceWire and CCSDS SOIS
  Parkes, UoD — SpW WG #5 2005-11
- CCSDS SOIS and SpW
  S Parkes, UoD — SpW WG #4 2005-07
- CCSDS related activities
  Steve Parkes, UoD — SpW WG #1 2004-09

Components

- Evolution and Applications of System on a chip SpaceWire Components for Spaceborne Missions J. Marshall — Abstract - Presentation
  ISC 2008-11
- SpW-10X Router ASIC Testing and Performance — Abstract - Presentation
  S. Parkes, C. McClements, G. Kempf, C. Gleiss, S. Fischer, P. Fabry
  ISC 2008-11
- Design and Implementation of Synthesizable SpaceWire Cores — Abstract - Presentation
  P. Aguilar-Jiménez, V. López, S. Sánchez, M. Prieto, D. Meziat, — ISC 2007-09
- The GRSPW SpaceWire Codec IP Core and Its Application — Abstract - Presentation
  Sandi Habinc, Marko Isomäki, Jiri Gaisler — ISC 2007-09
- SpaceWire IP for Actel Radiation Tolerant FPGAs — Abstract - Presentation
  Steve Parkes, Chris McClements, Zaf Mahmood, — ISC 2007-09
- Monolithic Radiation Tolerant Multi-Gigabit SpaceWire Fiber/Copper Transponder with Minimal Delay Synchronization — Abstract
  Vladimir Katzman, Glenn P. Rakow, Vladimir Bratov, Sean Woyciehowsky, Jeb Binkley
  ISC 2007-09
- ATMEL SpaceWire Products Family — Abstract - Presentation
  Nicolas Renaud, Yohann Bricard, — ISC 2007-09

- SpaceWire Router ASIC — Abstract - Presentation
  Steve Parkes, Chris McClements, Gerald Kempf, Stephan Fischer, Agustin Leon,
  ISC 2007-09
- SpaceWire Remote Terminal Controller — Abstract - Presentation
  Jorgen Ilstad, Wahida Gasti, Peter Sinander, Sandi Habinc, ISC 2007-09
- SpaceWire Device Driver for the Remote Terminal Controller — Abstract - Presentation
  Albert Ferrer Florit, Wahida Gasti, ISC 2007-09
- 'Multibort'--the Chipset for Distributed Signal Processing and Control with SpaceWire Interconnections — Abstract - Presentation
  Tatiana Solokhina, Alexander Glushkov, Ilya Alexeev, Yuriy Sheynin, Elena Suvorova, Felix Shutenko, ISC 2007-09
- A System-on-chip Radiation Hardened Microcontroller ASIC with Embedded SpaceWire Router — Abstract - Presentation
  Richard Berger, Laura Burcin, David Hutcheson, Jennifer Koehler, Marla Lassa, Myrna Milliser, David Moser, Dan Stanley, Randy Zeger, Ben Blalock, Mark Hale,
  ISC 2007-09
- A Hardened One Chip Solution for High Speed SpaceWire System Implementations
  Joseph R. Marshall, Richard W. Berger, Glenn P. Rakow — Abstract - Presentation
  ISC 2007-09
- MCFlight™ - MULTICORE platform based chipset with SpaceWire links for distributed Aerospace systems — SpW WG #8 2007-01
  T. Solokhina, Elvees,
- Remote Terminal Controller
  T. Hult, Saab Ericsson — SpW WG #6 2006-05
- SpaceWire Interface products
  D. Stevenson, Aeroflex — SpW WG #6 2006-05
- SpW Router Status
  Estec — SpW WG #6 2006-05
- SMCS332-SpW and SMCS116-SpW Status
  Estec for Astrium — SpW WG #6 2006-05
- SpW Devices Development Status in Russia
  Y. Sheynin, St.Petersburg, UoAI — SpW WG #6 2006-05
- SpaceWire developments performed at Gaisler Research
  J. Gaisler — SpW WG #6 2006-05
- SpW based Intelligent Camera for Navigation
  S. Parkes, UoD — SpW WG #6 2006-05
- SpW/RMAP based Video Processing Chain
  K. Grange and F. Lachaud, Sodern — SpW WG #6 2006-05
- Space Cube
  M. Nomachi — SpW WG #6 2006-05
- SpaceWire Codec status and validation
  S. Parkes UoD (UK) — SpW WG #5 2005-11
- SpW router ASIC development
  G Kempf, AAe — SpW WG #4 2005-07
- RTC ASIC
  T. Hult, Saab Ericsson — SpW WG #4 2005-07

- Status of the SMCS332SpW validation and the SMCS116WpW development
  P. Rastetter, Astrium GmbH SpW WG #4 2005-07
- SpaceWire Router Asic, features and status
  G. Kempf, Austrian Aerospace SpW WG #3 2005-02
- Differences between SMCS332/SMCS332-SpW, SMCS116/SMCS116-SpW
  L. Tunesi, ESA SpW WG #1 2004-09
- Summary of the Remote Terminal Controller preliminary specifications
  L. Tunesi, ESA SpW WG #1 2004-09
- Status of the SpW Router development
  S. Fischer, Astrium SpW WG #1 2004-09
- Short presentation of devices under development by NASA
  R. Schnurr, G. Rakow SpW WG #1 2004-09
- Short Presentation on design activities by Xilinx
  Fancesco Contu SpW WG #1 2004-09
- Router Configuration port access/configuration management
  S. Parkes, UoD SpW WG #1 2004-09
- The SpaceWire CODEC
  Chris Mc Clements ISWS 2003-11
- Procurement of the ESA-UoD SpaceWire CODEC
  Agustin Fernandez-Leon ISWS 2003-11
- SpaceWire Router
  Steve Parkes ISWS 2003-11
- MCFlight-SOC Based Chipset with SpaceWire Links for Aerospace Applications
  Tatiana Solokhina ISWS 2003-11
- The ASTRIUM-Velizy SpaceWire IP core
  Jean-Francois Coldefy ISWS 2003-11
- SpaceWire-PCMCIA Card Development
  Jaakko Toivonen ISWS 2003-11
- The New SMCS332 / SMCSLite SpaceWire ASIC
  Stephan Fischer ISWS 2003-11
- Intervention from ATMEL
  Dominique de Saint-Roman ISWS 2003-11
- Customisable-off-the-shelf Digital Signal Processing Board for Space Applications
  H Reichinger & M Sust, Austrian Aerospace DASIA 2003-06
- Development and Test Results of a System On A Chip for a Data Handling System
  Christian Boleat, Jean-Francois Coldefy, Marc Lefebvre, Marc Souyri DASIA 2003-06
- MCM ERC32 Integrated SPARC Computer Core
  Christian Boleat, Jean-Francois Coldefy, Marc Souyri DASIA 2003-06

Distributed Interrupts

- Distributed Interrupts Mechanism Verification and Investigation by Modelling on SDL and SystemC — Abstract
  L. Onishchenko, A. Eganyan, I. Lavrovskaya — ISC 2008-11
- Distributed Interrupts in SpaceWire networks — Presentation
  Y. Sheynin, UoStP, — SpW WG #8 2007-01
- StP-UoAI presentation on Distributed Interrupts
  Y. Sheynin — SpW WG #6 2006-05
- SpaceWire Interrupt Codes
  Y. Sheynin and S. Gorbachev, SUAI — SpW WG #2 2004-11

Electrical

- SpaceWire Physical Layer Fault Isolation — Abstract - Presentation
  B. Cook, W. Gasti, S. Landstroem — ISC 2008-11
- SpaceWire Link interface: LVDS, Power & Cross-strapping Aspects
  W.Gasti & S.Landstroem (ESTEC) — SpW WG #11 2008-06
- Reducing Electromagnetic Emissions from SpaceWire — Presentation
  Barry M Cook, C Paul H Walker, 4Links — DASIA 2007-05
- Use of Fast Digital Interfaces on Satellites and their relationship with EMC aspects
  Giorgio Magistrati — IEEE EMC-S IT Chapter, Milan (22 April 2008) — 2008-04

IP

- SpaceWire RMAP IP Core — Abstract - Presentation
  S. Parkes, C. McClements, M. Dunstan, W. Gasti — ISC 2008-11
- SpaceWire CODEC IP Core Update — Abstract - Presentation
  C. McClements, S. Parkes, K. Marinis — ISC 2008-11
- SpaceWire on FPGA – Challenges and Solutions — Presentation
  B M Cook, C Paul H Walker — DASIA 2008-05
- IP Macrocell for SpaceWire I/F Compliant with AMBA-APB BUS
  Luca Fanucci — ISWS 2003-11
- SpaceWire: IP, Components, Development Support and Test Equipment
  S. Parkes, C. McClements, S. Mills, I. Martin — DASIA 2003-06

Low Speed

- SpaceWire Standard: Low Speed Signalling Rates — Abstract - Presentation
  C. McClements, S. Parkes, — ISC 2008-11

Miscellaneous

- Redundancy Mechanism Update
  G. Rakow, NASA GSFC — SpW WG #8 2007-01

- Roscosmos and SpW achievements in Russia
  A. Stepanov, ROSCOSMOS, SpW WG #8 2007-01
- Further SpaceWire Support from 4Links
  P. Walker, 4Links SpW WG #8 2007-01
- Prototyping with SpW in Japan
  M.Nomachi, UoO, SpW WG #8 2007-01
- SpaceWire Data Handling Demonstration System
  S. Mills, S. Parkes, N. O'Gribin DASIA 2007-05
- Unionics Requirements
  D. Durrant, SEA SpW WG #1 2004-09
- Short reminder of SpW packet structure and Addressing modes
  S. Parkes, UoD SpW WG #1 2004-09
- Building SpaceWire Systems
  Paul Walker ISWS 2003-11
- Networks, CCSDS SOIF and Support Tools: SpaceWire Research at Dundee
  S. Parkes ISWS 2003-11

Missions & Applications

- Data Acquisition System of the PoGOLite Balloon Experiment Abstract - Presentation
  H. Takahashi, Y. Umeki, H. Yoshida, T. Tanaka, T. Mizuno, Y. Fukazawa, T. Kamae, G. Madejski, H. Tajima, M. Kiss, W. Klamra, S. Larsson, C. Marini Bettolo, M. Pearce, S. Rydstrom, K. Kurita, Y. Kanai, M. Arimoto, M. Uneo, J. Kataoka, N. Kawai, M. Axelsson, L. Hjalmarsdotter, F. Ryde, G. Bogaert, S. Gunji, T. Takahashi, G. Varner, T. Yuasa
  ISC 2008-11
- SpaceWire in the Simbol-X Hard X-Ray Mission Abstract - Presentation
  C. Cara, F. Pinsard ISC 2008-11
- RMAP over SpaceWire on the ExoMars Rover for Direct Memory Access by Instruments to Mass Memory Abstract - Presentation
  B. Dean, R. Warren, B. Boyes ISC 2008-11
- Standard Onboard Data Handling Architecture based on SpaceWire Abstract - Presentation
  T. Yamada, T. Takahashi ISC 2008-11
- SpaceWire Test and Demonstration Utilising the Integrated Payload Processing Module
  J. Ilstad, D. Jameux Abstract - Presentation
  ISC 2008-11
- SpaceWire Application for the X-Ray Microcalorimeter Instrument onboard the Astro-H Mission
  Y. Ezoe, Y. Ishisaki, T. Ohashi, K. Shinosaki, Y. Takei, N. Yamasaki, Abstract - Presentation
  K. Mitsuda, K. Sato, R. Fujimoto, Y. Terada, M. Tashiro, R.L. Kelley, J. Willem den Herder
  ISC 2008-11
- Digital Signal Processing Systems of an X-ray Microcalorimeter Array for Ground and Space Applications Abstract - Presentation
  T. Hagihara, K. Mitsuda, N. Yamasaki, Y. Takei, H. Odaka, M. Nomachi, T. Yuasa
  ISC 2008-11
- System Aspects of SpaceWire Networks Abstract
  P. Rastetter, S. Fischer, U. Liebstuckel, R. Wiest ISC 2008-11

- PaDaPAr Study and demonstrator
  O. Notebaert, Astrium Satellites SpW WG #9 2007-04
- Magnetospheric MultiScale Mission (MMS) Implementation of SpaceWire
  G. Jackson, D. Raphael and G. Rakow, NASA GSFC SpW WG #8 2007-01
- The Geostationary Operational Satellite R Series SpaceWire Implementation
  William H. Anderson, Alexander Krimchansky, Glenn P. Rakow, Abstract - Presentation
  , ISC 2007-09
- PnPSAT Abstract - Presentation
  Donald Fronterhouse, ISC 2007-09
- Overview of the INTAµSAT's Data Architecture Based on SpaceWire Abstract - Presentation
  D. Guzmán, M. Angulo, L. Seoane, S. Sánchez, M. Prieto, D. Meziat, ISC 2007-09
- SpaceWire for Operationally Responsive Space as Part of TacSat-4 Abstract - Presentation
  Paul Jaffe, Greg Clifford, Jeff Summers, ISC 2007-09
- SWFU: SpW Interface Unit for Versatile Sensor Integration on the ExoMars Chassis Breadboard C. G.-Y. Lee, R. Obstei, Abstract
  ISC 2007-09
- Application of SpaceWire to Future Satellite Data Processing System Abstract - Presentation
  Kenji Matsuda, Kazunori Masukawa, Shigeru Ishii, Yo Watanabe, Yoshikatsu Kuroda, Motohide Kokubun, Masanobu Ozaki, Tadayuki Takahashi, Masaharu Nomachi
  ISC 2007-09
- Development of a SpaceWire-based Data Acquisition System for a Semiconductor Compton Camera Abstract - Presentation
  Hirokazu Odaka, Motohide Kokubun, Takeshi Takashima, Tadayuki Takahashi, Takayuki Yuasa, Kazuhiro Nakazawa, Kazuo Makishima, Masaharu Nomachi, Hiroki Hihara, Takayuki Tohma, ISC 2007-09
- The SpaceWire Interfaces for HERSCHEL/SCORE Suborbital Mission Abstract - Presentation
  M. Pancrazzi, A. Gherardi, M. Focardi, G. Rossi, D. Paganini, E. Pace, M. Romoli, E. Antonucci, ISC 2007-09
- Introduction of SpaceWire Applications for the MMO Spacecraft in BepiColombo Mission
  Abstract - Presentation
  T. Takashima, H. Hayakawa, H. Ogawa, Y. Kasaba, M. Koyama, K. Masukawa, M. Kawasaki, S. Ishii, Y. Kuroda, BepiColombo MMO Project Data-Handling Team, ISC 2007-09
- Development of a SpW/RMAP-based Data Acquisition Framework for Scientific Detector Applications Abstract - Presentation
  Takayuki Yuasa, Kazuhiro Nakazawa, Kazuo Makishima, Hirokazu Odaka, Motohide Kokubun, Takeshi Takashima, Tadayuki Takahashi, Masaharu Nomachi, Iwao Fujishiro, Fumio Hodoshima, ISC 2007-09
- SpW Application at Alcatel Alenia Space
  A. Girard SpW WG #6 2006-05
- SpW Applications for Robotics Applications at Canadian Space Agency
  D. Jameux, Estec SpW WG #6 2006-05
- SpW Activities, update from JAXA
  T. Yoshimitsu, M. Nomachi SpW WG #6 2006-05
- SpW Application to missions: BepiColombo & NeXT
  Y.Kasaba, JAXA/ISAS SpW WG #4 2005-07
- Possible applications of Space Wire standard to Scientific missions
  H. Hayakawa, ISAS/JAXA SpW WG #1 2004-09

- A Data Readout System with High-Speed Serial Data Link
  M. Nomachi, Osaka University SpW WG #1 2004-09
- Highly Integrated Payload Suites and Related Data Link Requirements
  Peter Falkner ISWS 2003-11

Networks / Architectures & Protocols

- Prototype Implementation of a Routing Policy using Flexray Frames Concept over a SpaceWire Network Abstract - Presentation
  S. Gunes-Lasnet, O. Notebaert ISC 2008-11
- SoCWire: A SpaceWire inspired fault tolerant Network-on-chip for Reconfigurable System-on-chip Designs in Space Applications Abstract - Presentation
  Osterloh, H. Michalik, B. Fiethe ISC 2008-11
- Design Considerations for Adapting Legacy System Architectures to SpaceWire
  R. Klar, C.Mangels, S. Dykes, M. Brysch Abstract - Presentation
  ISC 2008-11
- Embedded network architectures for mobile devices
  M. Gillet and S. Balandin, Nokia, SpW WG #9 2007-04
- Different uses of logical addresses: Implementation of bandwidth allocation schemes
  A. Ferrer Florit, ESA/ESTEC SpW WG #9 2007-04
- A Link-Layer Broadcast Service for SpaceWire Networks - Presentation
  S. Dykes, Southwest Research Institute, SpW WG #8 2007-01
- Comparison of Communication Architectures for Spacecraft Modular Avionics Systems
  D.A. Gwaltney and J.M. Briscoe, Marshall Space Flight Center, Marshall Space Flight Center, Alabama SpW WG #8 2007-01
- Network Management and Configuration Using RMAP Abstract - Presentation
  Peter Mendham, Stuart Mills, Steve Parkes, ISC 2007-09
- Benchmarking SpW Networks Abstract - Presentation
  Asaf Baron, Isask'har Walter, Ran Ginosar, Isaac Keslassy, Ofer Lapid,
  ISC 2007-09
- Integration of Internet Protocols with SpaceWire Using an Efficient Network Broadcast
  Robert Klar, Sandra G. Dykes, Allison Bertrand, Christopher C. Mangels,
  Abstract - Presentation
  , ISC 2007-09
- A SpaceWire Implementation of Chainless Boundary Scan Architecture for Embedded Testing
  Omar Emam, Mohammed Ali, Abstract - Presentation
  ISC 2007-09
- SpaceWire Hot Modules Abstract - Presentation
  Asaf Baron, Isask'har Walter, Ran Ginosar, Isaac Keslassy, Ofer Lapid,
  ISC 2007-09
- SpaceWire Network Topologies Abstract - Presentation
  Barry M. Cook, C. Paul H. Walker, ISC 2007-09
- The System Approach for a SpaceWire Network Abstract - Presentation
  Bruno Masson, Stephane Detheve, Bernard Alison, ISC 2007-09
- SpaceWire Network Functional Model Abstract - Presentation
  Elena Suvorova, Liudmila Onishchenko, Artur Eganyan, ISC 2007-09

- SpaceWire Networks for Payload Applications — Abstract - Presentation
  Christophe Honvault, Olivier Notebaert, — ISC 2007-09
- Ethernet over SpaceWire – Hardware Issues — Abstract
  Barry M Cook, Paul Walker — IAC 2006
  Vol 61, Numbers 1-6, June/August 2007, ISSN 0094-5765, pp 243-249
  Acta Astranautica (Journal of the International Academy of Astronautics) 2007
- Ethernet over SpaceWire – software Issues — Abstract
  Barry M Cook, Paul Walker
  Vol 61, Numbers 1-6, June/August 2007, ISSN 0094-5765, pp 250-256
  Acta Astranautica (Journal of the International Academy of Astronautics) 2007
- Comparison of Communication Architectures for Spacecraft Modular Avionics Systems
  D.A. Gwaltney and J.M. Briscoe, Marshall Space Flight Center, Marshall Space Flight Center, Alabama — SpW WG #7 2006-09
- Modelling of SpW Traffic
  A. Girard, Alcatel Alenia Space — SpW WG #6 2006-05
- Ethernet over SpaceWire – Hardware Issues — Presentation
  Barry M Cook, Paul Walker — IAC 2006
- Ethernet over SpaceWire – software Issues — Presentation
  Barry M Cook, Paul Walker, 4Links — IAC 2006
- SpaceWire Higher Layer Protocols
  S. Parkes, S. Mills, C. McClements — IAC 2006
- SpaceWire Protocol ID: what does it mean to you?
  G. Rakow, R. Schnurr, S. Parkes — IEEE Aerospace Conference 2006
- Multi Access Communication Protocol
  G. Saldi, Laben — SpW WG #3 2005-02
- SpW WG constitution, PID allocation rules and status — SpW WG #3 2005-02
- SpaceWire Protocol ID
  S. Parkes UoD — SpW WG #2 2004-11
- SpW-SnP Protocol Identifiers
  S. Parkes UoD, All — SpW WG #2 2004-11
- 4Links_Comment-on-protocols-etc — SpW WG #2 2004-11
- Higher-level SpaceWire protocols for distributed on-board computing
  Y. Sheynin, S. Gorbachev, E. Pyatlina, St. Petersburg State University — SpW WG #1 2004-09
- Protocol Identifiers are necessary: What else is necessary?
  P. Walker, 4links — SpW WG #1 2004-09
- Protocol ID proposal and update on the transport layer development
  R. Schnurr, G. Rakow, NASA — SpW WG #1 2004-09
- TCP/IP Over Spacewire
  S. Mills, S. Parkes — DASIA 2003-06
- Architecture of Next Generation Highly Integrated Data Handling Systems
  Torbjorn Hult, Saab Ericsson Space AB — DASIA 2003-06
- SpaceWire Networks
  S. Parkes, C. McClements — DASIA 2002

Onboard Equipment & Software

- Modular Architecture for Robust Computation — Abstract - Presentation
  W. Gasti, A. Senior — ISC 2008-11
- A Portable SpaceWire/RMAP Class Library for Scientific Detector Read Out Systems
  Abstract - Presentation
  T. Yuasa, W. Kokuyama, K. Makishima, K. Nakazawa, M. Nomachi, M. Kokubun, H. Odaka, T. Takashima, T. Takahashi — ISC 2008-11
- Crucial SpaceWire Elements in RASTA — Abstract - Presentation
  S. Habinc, J. Gaisler — ISC 2008-11
- A CPU Module for a Spacecraft Controller with High Throughput SpaceWire Interfaces
  T. Sasaki, M. Nakamura, T. Yoshimoto, M. Yoshida, S. Yoshikawa — Abstract - Presentation
  ISC 2008-11
- Leveraging Serial Digital Interfaces Standardisation: the RASTA Reference Architecture Facility at ESA — Abstract - Presentation
  A. Viana Sanchez, G. Furano, M. Ciccone, F. Guettache, C. Monteleone, C. Taylor, M. Prieto, I. Garcia Tejedor — ISC 2008-11
- RAD750 SpaceWire-Enabled Flight Computer for Lunar Reconnaissance Orbiter
  Abstract - Presentation Richard Berger, Alan Dennis, David Eckhardt, Suzanne Miller, Jeff Robertson, Dean Saridakis, Dan Stanley, Marc Vancampen, Quang Nguyen, — ISC 2007-09
- SpaceWire-RTC Development Suite — Abstract - Presentation
  Sandi Habinc, Jorgen Ilstad, — ISC 2007-09
- Modular Architecture for Robust Computing (MARC) — Abstract - Presentation
  Alan Senior, Phil Ireland, Stuart D. Fowell, Roger Ward, Ben Greene, Omar Emam,
  ISC 2007-09
- SpaceCube 2 -- An Onboard Computer Based on SpaceCube Architecture Abstract - Presentation
  Tadayuki Takahashi, Takeshi Takashima, Satoshi Kuboyama, Masaharu Nomachi, Yasumasa Kasaba, Takayuki Tohma, Hiroki Hihara, Shuichi Moriyama, Toru Tamura, ISC 2007-09

Plug and Play

- SpW PnP
  P. Mendham (UoD) — SpW WG #12 2009-02
- SpaceWire Plug-and-Play: An Early Implementation and Lessons Learned — Presentation
  Barry M Cook and C Paul H Walker
  AIAA Infotech@Aerospace 2007 Conference and Exhibit, 7-10 May 2007, Rohnert Park, California — AIAA 2007-04
- SpaceWire Plug-and-play: a Roadmap — Abstract - Presentation
  P. Mendham, S. Parkes — ISC 2008-11
- SOIS Plug-and-Play
  S.Fowell (SciSys) — SpW WG #11 2008-06
- Adapting SpaceWire PnP to RMAP and Other Recent Changes
  P. Mendham, UoD — SpW WG #10 2008-02
- Plug and Play Technology for SpaceWire: Drivers and Alternatives
  Peter Mendham, Steve Parkes, Stuart Mills, Chris McClements — IAC 2007

- Application of the SpaceWire Plug-and-Play Protocol Abstract - Presentation
  Clifford Kimmery, Patrick McGuirk, Glenn Rakow, Paul Jaffe, Robert Klar, Allison Bertrand, ISC 2007-09
- SpaceWire Plug-and-Play: Fault-Tolerant Network Management for Arbitrary Network Topologies Albert Ferrer Florit, Martin Suess, Abstract - Presentation
  , ISC 2007-09
- SpaceWire Plug 'n' Play - Presentation
  G.Rakow, NASA SpW WG #8 2007-01
- PnP aspects, 4Links contribution
  B. Cook, P. Walker SpW WG #8 2007-01
- PnP aspects, ESA contribution
  A. Ferrer Florit SpW WG #8 2007-01

Posters and Demonstrations

- Providing Guaranteed Packet Delivery Time in SpaceWire Networks Abstract - Presentation
  Y.Sheynin, E. Suvorova ISC 2008-11
- UNIONICS - A New Scalable On-Board Processing Architecture
  Mick Johnson ISWS 2003-11
- UNIONICS - A New Scalable On-board Processing Architecture
  EADSASTRIUM, SEA & SciSys (UK) ISWS 2003-11
- Demonstration of SpaceWire Systems and EGSE
  Paul Walker ISWS 2003-11
- Architecture for using spacewire links in a bus configuration
  Francesco Ricci ISWS 2003-11
- SpaceWire Router Technology Makes ASIC Interfacing Easy
  UoD ISWS 2003-11
- Monitoring & Analysis of SpaceWire Links
  4Links (UK) & NASA-JPL (US) ISWS 2003-11
- SpaceWire DSP
  University of Dundee & SciSys (UK) ISWS 2003-11
- Laben Current Application of SpaceWire Technology
  Laben (I) ISWS 2003-11
- Architecture for using spacewire links in a bus configuration
  XIPHOS (CA) ISWS 2003-11
- Demonstration of SpaceWire Systems and EGSE
  4Links (UK) ISWS 2003-11

Real Time

- SpaceWire-RT: Review of the updated Initial protocol definition
  SpW-RT Initial Protocol Definition v2.1 Steve Parkes (UoD) SpW WG #12 2009-02
  Presentation of UoD proposal Steve Parkes (UoD) SpW WG #12 2009-02
- SpW-RT Initial Protocol Definition v2.1 – Assessment Users view
  Presentation Jaxa T. Yamada SpW WG #12 2009-02

Presentation Astrium	C. Honvault	SpW WG #12 2009-02
Presentation 4 Links	B. Cook	SpW WG #12 2009-02
Presentation Scisys	S. Fowell	SpW WG #12 2009-02
Presentation UoStPg	Y. Sheynin	SpW WG #12 2009-02
SpW-RT Protocol Validation	Teletel/ V. Kollias	SpW WG #12 2009-02
SpW-RT Wrap-up	C. Taylor (ESTEC)	SpW WG #12 2009-02

- Providing Guaranteed Packet Delivery Time in SpaceWire Networks — Abstract - Presentation
  Y.Sheynin, E. Suvorova — ISC 2008-11

- SpaceWire-RT — Abstract - Presentation,
  S. Parkes, A. Ferrer Florit, — ISC 2008-11

- SpaceWire-RT Prototyping — Abstract - Presentation
  Ferrer Florit, S. Parkes — ISC 2008-11

- Time-triggered Services for SpaceWire — Abstract
  W. Steiner, R. Maier, D. Jameux, A. Ademaj — ISC 2008-11

- SpW-RT Initial Protocol Definition-v1.1 — Presentation
  S. Parkes (UoD) — SpW WG #11 2008-06

- SpaceWire-RT Requirements — Presentation
  UoD — SpW WG #10 2008-02

- On-board SpW Networks and Real-time aspects
  W. Gasti (ESA) — SpW WG #10 2008-02

- SpW for Command & Control
  D. Jameux (ESA) — SpW WG #10 2008-02

- Time-Triggered Techniques for Quality of Service over SpaceWire
  W. Steiner (TTTech Computertechnik AG) — SpW WG #10 2008-02

- Use Case Study for SpaceWire-RT — T.
  Yamada (JAXA/ISAS) — SpW WG #10 2008-02

- Real-Time Signalling in SpaceWire Networks — Abstract - Presentation
  Yuriy Sheynin, Sergey Gorbatchev, Liudmila Onishchenko, — ISC 2007-09

- A software development methodology for distributed real-time systems that shares the simplicity and applicability of SpaceWire
  K. Matsui, Prominent Network — SpW WG #5 2005-11

- SpaceWire: a Spacecraft Onboard Network for Real-time Communications
  S. M. Parkes, P. Armbruster — NPSS 2005

- Real-Time embedded CORBA over SpaceWire
  S. Parkes, S. Mills, S. Fowell, R. Ward — ISWS 2003-11

Reduced Mass (Simplex, Half-Duplex)

- Half-Duplex SpaceWire: Reducing Harness Mass While Retaining Full Compatibility With SpaceWire's Modularity, Configurability and Adaptability
  B M Cook, P Walker — IAC 2008-09

- Half Duplex SpW
  B. Cook — SpW WG #12 2009-02

- Simplex Mode in SpW Technology — Abstract - Presentation
  Eugenue Yablokov, — ISC 2007-09

Remote / Virtual Integration

- TopNet pilot demonstrations: First returns of experience
  R. Vitulli, ESA — SpW WG #10 2008-02
- TopNet - IP tunnel, R. Vitulli Estec
  S. Mills UoD — SpW WG #4 2005-07
- SpaceWire Internet Tunnel
  S. Mills, S. Parkes, R. Vitulli — DASIA 2005
- SpaceWire Networks Implementation, Validation & Remote Integration:TopNet
  Alberto Donadoni — ISWS 2003-11
- Virtual Satellite Integration
  S. Parkes — DASIA 2001
- Virtual System Integration
  S. Parkes — ICAED 2001

Software

- Introduction to Standardised Programming support
  E. Verhulst, Open Lic. Soc. — SpW WG #2 2004-11
- SpaceCommRTOS
  E. Verhulst, Open License Society — SpW WG #1 2004-09

SpaceFibre

- Mixed SpaceWire - SpaceFibre Networks — Abstract - Presentation
  M.Suess, S. Parkes, — ISC 2008-11
- SpaceFibre Virtual Channels — Abstract - Presentation
  C. Kimmery, — ISC 2008-11
- SpaceFibre Status Update
  M.Suess (ESTEC) — SpW WG #11 2008-06
- MLAS mission use of SpaceFibre
  G. Rakow, NASA — SpW WG #10 2008-02
- SpaceFibre optical physical layer
  J.Toivonen, PATRIA — SpW WG #10 2008-02
- Details of the SpaceFibre CODEC
  S. Parkes, UoD — SpW WG #10 2008-02
- Comments on the SpaceFibre outline specification
  G. Rakow, NASA — SpW WG #10 2008-02
- Collation of SpaceFibre Requirements
  P. Walker, 4Links — SpW WG #10 2008-02
- SpaceFibre Outline Specification — SpW WG #10 2008-02
- SpaceFibre — Abstract - Presentation
  Steve Parkes, Chris McClements, Martin Suess, — ISC 2007-09

- SpaceFibre: A Very High Speed Network For Space Flight Applications
  S. Parkes, M. Suess, C. McClements, M. Dunstan, P. Mendham
  DASIA 2007-05
- SpaceFibre Introduction
  M. Suess, ESA/ESTEC, SpW WG #8 2007-01
- SpaceFibre status
  S. Parkes, UoD, SpW WG #8 2007-01
- SiGe Interconnect Solutions
  V. Katzman, ADSANTEC, SpW WG #8 2007-01
- Future focus on SpaceFibre
  M. Suess, ESA SpW WG #7 2006-09
- UoD presentation on SpaceFibre
  S. Parkes SpW WG #6 2006-05
- NASA presentation on evolutions and SpaceFibre
  G. Rakow SpW WG #6 2006-05
- SpaceFibre development status
  M.Suess & Iain Mckenzie, Estec SpW WG #4 2005-07
- Space Fibre
  Martin Suess ISWS 2003-11

SpaceWire (general)

- SpaceWire Evolution : Discussion of the SpaceWire Standard evolution on the basis of the paper presented at the International SpaceWire Conference 2008
  SpaceWire Evolution – Overview
  M. Suess (ESA) SpW WG #12 2009-02
  Proposed changes to ECSS-E-ST-50-12C
  S.Parkes (UoD) SpW WG #12 2009-02
  Comments on ECSS-E-ST-50-12C
  A. Ferrer Florit (UoD) SpW WG #12 2009-02
  Proposed Modifications for ECSS-E-ST-50-12C
  M. Nomachi (UoO) SpW WG #12 2009-02
  SpaceWire evolution Y. Sheynin (UoStPg) SpW WG #12 2009-02
  Half Duplex SpW B. Cook (4Links) SpW WG #12 2009-02
  Network Management T. Yamada (JAXA) SpW WG #12 2009-02
  Power over SpaceWire P.Walker (4Links) SpW WG #12 2009-02
  Accurate Synchronisation mechanism
  F. Pinsard (CEA) SpW WG #12 2009-02
- SpaceWire Standard Evolution Abstract - Presentation
  M. Suess, ISC 2008-11
- Proposed updates and modifications of ECSS-E50-12A in InterAgency Steering Committee Dispositions
  SpW WG #8 2007-01
- SpaceWire and IEEE 1355 Revisited Abstract - Presentation
  Barry M. Cook, C. Paul H. Walker ISC 2007-09
- SpaceWire origins and purpose, From IEEE 1355 to ECSS-E-50-12
  Ph. Armbruster ESA SpW WG #7 2006-09

- UoD presentation on SpW Evolution
  S. Parkes SpW WG #6 2006-05
- SpaceWire – DS Links Reborn
  Barry Cook, Paul Walker
  in Communicating Process Architectures 2006, Eds Peter Welch, Jon Kerridge and Fred Barnes, IOS Press 2006, ISBN 1-58603-671-8, pp 1-12 CPA 2006
- SpaceWire – Key Principles brought out from 40 year history
  Paul Walker, Barry Cook SmallSat 2006
- SpaceWire - Improvements in Support of Mission Requirements
  Barry M Cook, Paul Walker SDSS 2005
- SpaceWire in future Spacecrafts
  O. Notebaert, Astrium SpW WG #5 2005-11
- Other needs, Very high speed, Low speed links, PowerLinks
  Ph. Armbruster, ESA/ESTEC SpW WG #5 2005-11
- SpW in Data systems Equipment
  S. Asserhall, Saab Ericsson SpW WG #5 2005-11
- SpW based On-board Computers
  P. Rastetter, Astrium SpW WG #5 2005-11
- SpaceWire Standard: SpW links, routers & networks (Tutorial)
  S. Parkes, UoD SpW WG #5 2005-11
- SpaceWire in future Spacecrafts
  O. Notebaert, Astrium SpW WG #5 2005-11
- Activities in NASA & USA
  G. Rakow & S. Allen, NASA/GSFC SpW WG #5 2005-11
- Roadmap for space applications
  T.Takahashi (ISAS/JAXA) SpW WG #5 2005-11
- Technologies for commercial systems
  M. Kobayashi (U. Tokyo) SpW WG #5 2005-11
- Proposed Changes to SpaceWire Physical Layer
  S. Allen, NASA/GSFC SpW WG #5 2005-11
- Video Processing Chain with SpW Interface
  F. Lachaud, Sodern SpW WG #4 2005-07
- SpW as seen by Astrium - system issues
  O. Notebaert, Astrium SpW WG #4 2005-07
- NASA SpW Activities
  G. Rakow, NASA SpW WG #4 2005-07
- SpW Development activities
  M. Nomachi, Osaka University SpW WG #4 2005-07
- Galvanically Isolated SpaceWire EGSE Building Blocks
  P. Walker, 4links SpW WG #4 2005-07
- Development Tools and Support Equipment
  Star Dundee SpW WG #4 2005-07
- SpW related activities by NASA SpW WG #3 2005-02
- SpW related activities by ESA SpW WG #3 2005-02

- SpW related activities by JAXA — SpW WG #3 2005-02
- Use Cases of SpaceWire Connections by JAXA — SpW WG #3 2005-02
- Test and diagnostics tools and safety aspects
  P. Walker, 4 Links — SpW WG #3 2005-02
- SpaceWire development tools and support equipments
  S. Parkes, Star Dundee — SpW WG #3 2005-02
- Presentation of Jaxa Developments
  T. Takahashi, JAXA — SpW WG #2 2004-11
- NEC_Toshiba_SpaceWire Developments — SpW WG #2 2004-11
- The SpaceWire Onboard Network for Spacecraft
  S. Parkes, C. McClements — Spaceops 2004
- The Origins of SpaceWire
  Paul Walker — ISWS 2003-11
- SpaceWire Standard ECSS-E50-12A
  Steve Parkes — ISWS 2003-11
- SpaceWire Developments & Test Equipment
  Steve Parkes — ISWS 2003-11
- SpaceWire Standard Problems and Evolution Lines
  Yuriy Sheynin — ISWS 2003-11
- The SpaceWire Transport Protocol
  Stuart Mills — ISWS 2003-11
- Experience from Using SpaceWire in a Spacecraft Telemetry System
  Torbjorn Hult — ISWS 2003-11
- SpaceWire - Links, Nodes, Routers and Networks
  S. Parkes, J. Rosello — DASIA 2001
- SpaceWire: a Satellite On-board Data-handling Network
  S. Parkes ???
- SpaceWire: the Standard
  S. Parkes — DASIA 1999
- From IEEE 1355 High Speed Serial Links to Spacewire
  J. R. Guasch, S. Parkes, A. Christen — DASIA 1999
- Wide Bandwidth BAW for On-board Compression of Raw SAR Data
  S. Parkes — DASIA 1999
- Data Compression and SpaceWire
  S. Parkes — IGARSS 1999

SpaceWire Protocols (including RMAP)

- RMAP IP Core:ESA Introduction
  K. Marinis (ESTEC) — SpW WG #12 2009-02
- RMAP IP Core:IP Core Presentation
  McClements (UoD) — SpW WG #12 2009-02

- ECSS-E50-11 Status
  M Suess (ESA) SpW WG #11 2008-06
- ECSS SpaceWire Protocols v0.8 SpW WG #11 2008-06
- Bepi Colombo MMO Data Handling System SpaceWire-RMAP Interface
  S. Davy et al SpW WG #11 2008-06
- RMAP over SpaceWire on the ExoMars Rover for Direct Memory Access by Instruments to Mass Memory Abstract - Presentation
  B. Dean, R. Warren, B. Boyes ISC 2008-11
- RMAP Standardization, ECSS-E50-11
  M. Suess and E. Gonzalez Conde, ESA/ESTEC SpW WG #9 2007-04
- RMAP implementation issues
  S. Habinc, Gaisler Research, SpW WG #9 2007-04
- Evolution from Draft E to Draft F
  S. Parkes, UoD, SpW WG #8 2007-01
- RMAP Multi-master Network configuration
  A. Ferrer Florit, ESA/ESTEC SpW WG #8 2007-01
- RMAP CRC IMPLEMENTATION, submitted by ESA
  prepared by A. Ferrer Florit SpW WG #7 2006-09
- RMAP Presentation
  S. Parkes (UoD) SpW WG #5 2005-11
- Application for PID 239 for legacy device: SMCS116SpW
  P. Rastetter, Astrium GmbH SpW WG #4 2005-0
- CRC implementation variants
  T. Hult, Saab Ericsson Space SpW WG #4 2005-07
- Overview and review of ECSS-E50-12A Part 2 (RMAP) SpW WG #4 2005-07
- Technical presentation supporting the Request for a Legacy PID for the SMCS116-SpW
  P. Rastetter, Astrium GmbH SpW WG #3 2005-02
- SpaceWire Remote Memory Access Protocol
  S. Parkes, C. McClements DASIA 2005
- SpW-SnP-RMAP
  S. Parkes UoD, All SpW WG #2 2004-11
- SpaceWire RMAP Protocol
  S. Parkes UoD SpW WG #2 2004-11

Task Synchronization

- JAXA presentation on Synchronization over SpW
  M. Nomachi SpW WG #6 2006-05
- Task synchronization over SpaceWire networks using RMAP
  M. Nomachi University of Osaka SpW WG #5 2005-11

Test / Verification / Certification

- Proposal of CSP based Network Design and Construction Abstract - Presentation
  K. Tanaka, S. Iwanami, T. Yamakawa, C. Fukunaga, K. Matsui, T. Yoshida
  ISC 2008-11
- The SpaceWire Internet Tunnel and the Advantages it Provides for Spacecraft Integration
  S. Mills, S. Parkes, R. Vitulli
  Abstract - Presentation
  ISC 2008-11
- SpaceWire Margins Tester Abstract - Presentation
  A. Kisin, G. Rakow ISC 2008-11
- Using SpaceWire as an EGSE Interface Abstract - Presentation
  A. Petersen, T. Hult ISC 2008-11
- Improvements in SpaceWire Test Abstract - Presentation
  P. Walker, B. Cook ISC 2008-11
- Toolset for Test and Verification of IP-blocks with SpaceWire Interface Abstract - Presentation
  E. Suvorova ISC 2008-11
- Designing SpaceCube 2 with Elegant Framework Abstract - Presentation
  H. Hihara, S. Moriyama, T. Takezawa, Y. Nishihara, M. Nomachi, T. Takahashi, T. Takashima
  ISC 2008-11
- Lessons Learned from Implementing non-standard SpaceWire Cabling for TACSAT-4
  D. Schierlmann, E. Rossland, P. Jaffe Abstract - Presentation
  ISC 2008-11
- Implementation of a Very Low Cost Portable SpaceWire Monitor and Debugger
  P. Jaffe, K. Leisses
  Abstract - Presentation
  ISC 2008-11
- Some Methodology and Tools for Test and Verification
  Y. Sheynin (UoStPg) et al SpW WG #11 2008-06
- SpaceWire Test, Verification and Certification Requirements and Approaches
  Y. Sheynin, St. Petersburg State University of Aerospace Instrumentation.
  SpW WG #10 2008-02
- SpaceWire – Test, Validation and Certification: Experiences, Thoughts, and Ideas for Discussion SpW WG #10 2008-02
  B.Cook & Paul Walker, 4Links Limited
- An innovative method for SpaceWire Test and Verification
  G. Magistrati, Carlo Gavazzi Space S.p.A SpW WG #10 2008-02
- SpaceWire Conformance Tester and Validation Software
  Star Dundee SpW WG #10 2008-02
- SpaceWire Cable and Connector Variations Abstract - Presentation
  Shaune S. Allen, ISC 2007-09
- Virtual Satellite Integration and the SpaceWire Internet Tunnel Abstract - Presentation
  Stuart Mills, Steve Parkes, Raffaele Vitulli, ISC 2007-09
- SpaceWire Cable and Connector Characterisation Abstract - Presentation
  Martin Suess, Steve Parkes, Paul Crawford, ISC 2007-09

- Measuring Time and Time-Related Aspects of SpaceWire — Abstract - Presentation
  Barry M. Cook, C. Paul H. Walker, — ISC 2007-09
- Debugging SpaceWire Devices using the Conformance Tester — Abstract - Presentation
  Steve Parkes, Martin Dunstan, — ISC 2007-09
- Integrated Development Tools Suite for the SpaceWire RTC ASIC — Abstract - Presentation
  Walter Errico, Jorgen Ilstad, Annamaria Colonna, Fabrizio Bertuccelli, — ISC 2007-09
- SpaceWire Protocol Analyser on SpaceCube — Abstract - Presentation
  Hiroki Hihara, Shuichi Moriyama, Toru Tamura, Takayuki Tohma, Kenji Kitade, Steve Parkes, Stuart Mills, Masaharu Nomachi, Tadayuki Takahashi, Takeshi Takashima
  ISC 2007-09
- SpaceWire-cPCI vxWorks Support Software — Abstract - Presentation
  Iain Martin, Steve Parkes, Stuart Mills, — ISC 2007-09
- SpiNSAW--The SpaceWire Network System Administrator Workstation
  Elena Suvorova, Liudmila Onishchenko, Alexander Cherny, — Abstract - Presentation
  ISC 2007-09
- A Methodology and the Tool for Testing SpaceWire Routing Switches — Abstract - Presentation
  Elena Suvorova, — ISC 2007-09
- SpW Standard Problems
  Y. Sheynin, St.Petersburg University of Aerospace Instrumentation — SpW WG #6 2006-05
- Update on SpW related developments
  P. Walker, 4 Links — SpW WG #6 2006-05
- New SpaceWire Tools
  S. Parkes, M. Dunstan, S. Mills, I. Martin, C. McClements, R. Vitulli, P. Fabry
  DASIA 2006-05
- Verifying the Temporal Behaviour of SpaceWire Components and Systems — Presentation
  Barry M Cook, Paul Walker, 4Links — DASIA 2006-05
- Validation of SpW links with the Conformance Tester
  G. Kempf, Austrian Aerospace — SpW WG #5 2005-11
- New capabilities in 4Links' Gbit Ethernet based family of modular test and simulation equipment for SpaceWire
  K. Matsui, Prominent Network (JPN), (presented on behalf of 4Links, UK)
  SpW WG #5 2005-11
- SpaceWire Conformance Tester
  Gerald Kempf — ISWS 2003-11

Time Codes

- Time-code Enhancements for SpaceWire
  Barry Cook, Paul Walker — MAPLD 2006
- Usage of Time codes and potential extensions
  Y. Sheynin — SpW WG #2 2004-11
- Reducing SpaceWire Time-Code Jitter
  Barry Cook — ISWS 2003-11
- The Operation and Use of the SpaceWire Time Codes
  Steve Parkes — ISWS 2003-11