SpaceWire Evolution

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Overview

- The discussion of proposals for updates of the SpaceWire standard are grouped according to the effected level:
  - General comments
  - Physical Level,
  - Signal Level,
  - Character Level,
  - Exchange Level,
  - Network Level.
- Propositions are presented by a number of working group members
- The discussion today shall lead to a decision if the proposed standard modification shall be further pursued.

Introduction

- The SpaceWire standard ECSS-E-50-12A was first published in 2003.
- Since then many groups all over the world worked on the development of SpaceWire links, nodes, routers and networks and on the application of this technology in space systems.
- In the past years the standardization effort aimed at higher level communication protocols such as RMAP.
- In parallel new concepts and additional protocols like SpW-PnP and SpW-RT have been discussed in the SpaceWire Working Group.
- Through the experience gained with real systems and through the development of new concepts several issues have been identified to be considered for the update of the standard.
- This SpaceWire Evolution session aims to identify all issues with the current standard which deserve to be reviewed for the coming SpaceWire standard update.

Objectives for the Standard Update

- The following type of update proposals are to be considered with this order of priority:
  1. Correction of errors in the present standard.
  2. Replacement of design specifications through performance specification to allow alternative designs where applicable.
  3. Introduction of features that are needed to support functions and higher level protocols which have been discussed in the WG in the past.
  4. Introduction of additional features that offer new functions which are of general interest and require standardisation in order to assure compatibility.
- In order to secure investments made in the past the modifications shall be backwards compatible to the current standard
- Some of the issues raised might be better suited for inclusion in the handbook rather than the standard.
- Accepted proposals shall be then further detailed and reviewed in the coming SpW WG meetings.

Following Actions

- The proposers of modifications shall provide additional information which is to b reviewed in the coming meetings
  - Details on reasoning and justification for change
  - Discussion of backwards compatibility to the current standard
  - Identify paragraphs to be changed / added
  - Proposed text for the changed / added paragraphs

General Comments

Overview – General Comments

- Limits for the SpaceWire standard evolution	Yuriy Sheynin
- SpaceWire outside Space applications	Yuriy Sheynin
- SpaceWire Network Management with RMAP	Takahiro Yamada

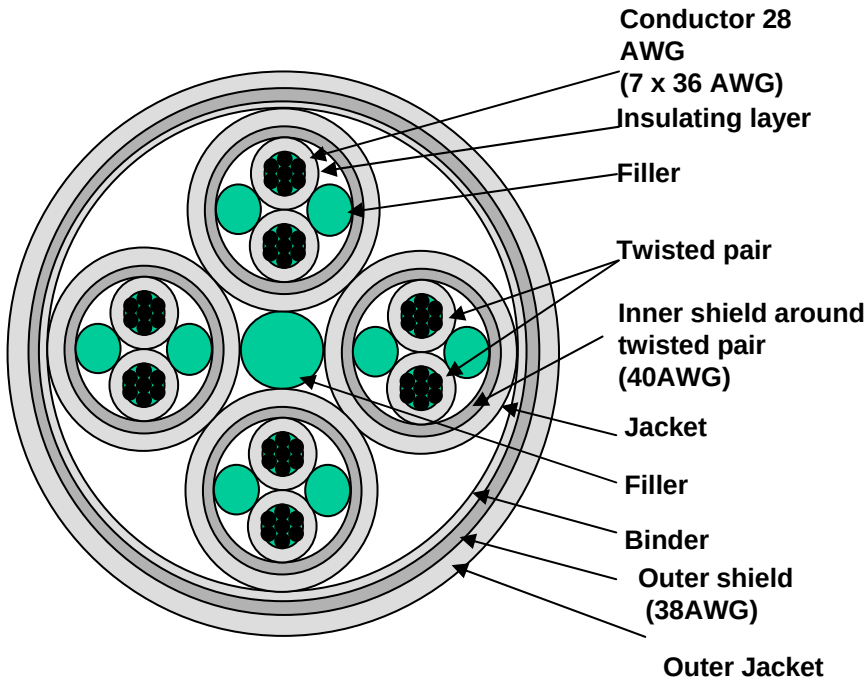
1. Physical Layer

Overview – Physical Level

- Cables	Martin Suess
- Connectors	Martin Suess
- Cable Assembly	Martin Suess
- Variety of cables	Yuriy Sheynin
- Variety of distances	Yuriy Sheynin
- Cable assembly with cable/cable connectors inside	Yuriy Sheynin
- SpaceWire Cable Conductor	Masuharu Nomachi
- Other points	

Cable Specification

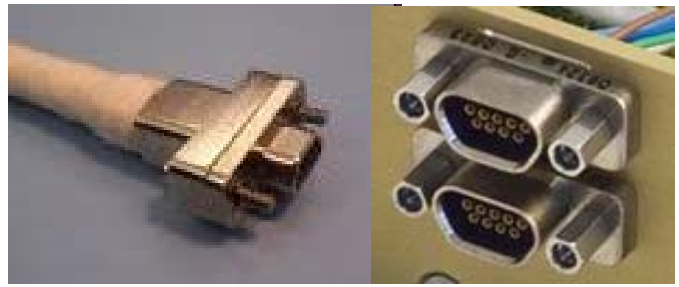
- The standard provides a detailed specification of the construction of the cable.
- The disadvantage is that the standard does not provide freedom to optimise the cable for specific applications.
- The update should only specify some physical and electrical parameters like:
  - Differential Impedance,
  - Signal Skew,
  - Return Loss,
  - Insertion Loss,
  - Near-end Crosstalk (NEXT)
  - Far-end Crosstalk (FEXT)
- ESA will start an activity called “Low mass SpaceWire” to derive the detailed specification



Section though a SpaceWire cable as defined in the standard

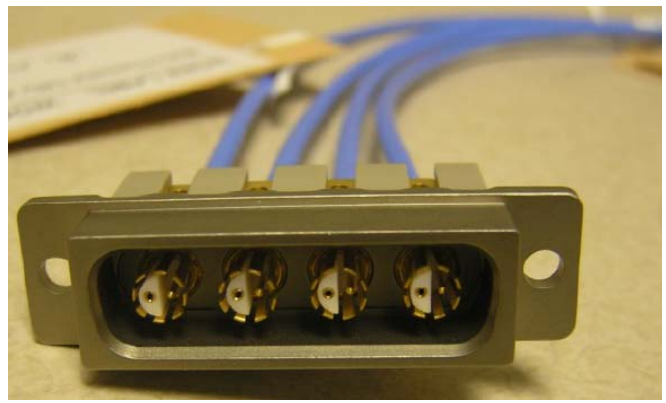
Connectors

- The SpaceWire connector is a nine-pin micro-miniature D-type.
- It is compact and available for space use.
- D-type connectors do not match the 100 Ω differential impedance.
- Distortion introduced by connectors is acceptable in most cases.
- Other connectors have been proposed and investigated:
  - Circular 13 pin 38999 Series II connector,
  - 4-way twinax connector.
- Definition of additional Optional SpaceWire connectors shall be investigated



micro-miniature D-type connector

38999-series connector



4-way Twinax connector

Cable Assembly

- The micro-miniature D-type connector has nine signal contacts.
- Eight contacts are used for the 4 twisted pair cables and one is used to terminate the inner shields at end of the cable from which the signals are being driven.
- The inner shields are isolated from one another.
- This prevents a direct ground connection via the SpaceWire link and provides a symmetrical cable.
- A problem occurs when the cable is broken into several parts due to bulkhead connectors.
- In this case the inner shields on both sides of the bulkhead are not connected to the ground of either side.
- A connection of the inner shield on both sides with the possibility to implement a controlled capacitive decoupling on one side behind the plug should be investigated.

2. Signal Level

Overview – Signal Level

- Correction of Figure 13	Albert Ferrer
- Undetected link errors (informative)	Albert Ferrer
- LVDS definition	Bary Cook
- Higher bit rates for limited distances	Yuriy Sheynin
- Longer distances with lower upper rates limits	Yuriy Sheynin
- Adaptable link rate	Yuriy Sheynin
- Conductivity isolation problems with SpaceWire links	Yuriy Sheynin
- Other points	

3. Character Level

Overview – Character Level

- Additional control codes for Distributed Interrupts	Yuriy Sheynin
- Time-code synchronisation improvement	Frédéric Pinsard
- Time-code definition	Albert Ferrer
- Time-Codes with different control codes (informative).	Albert Ferrer
Other points	

4. Exchange Level

Overview – Exchange Level

- 2 MHz Start-up speed	Steve Parkes
- Providing a robust mechanism for distributed interrupts	Albert Ferrer
- Half-Duplex Link Operation	Barry Cook
- Lower link start rate ?	Yuriy Sheynin
- State machine specification	Yuriy Sheynin
- Simplex Link Operation	Yuriy Sheynin
- System Time Distribution	Masuharu Nomachi
- Disconnect Timing	Masuharu Nomachi
- FCT Transmission	Masuharu Nomachi

5. Network Level

Overview – Network Level

- Configuration Ports in Nodes	Martin Suess
- Router Function in Nodes	Martin Suess
- Packet Spill Function in Routers	Martin Suess
- Virtual channels references	Albert Ferrer
- Chapter Inconsistencies	Albert Ferrer
- The term “Wormhole Switching”	Albert Ferrer
- Router timeout mechanism	Albert Ferrer
- Towards a fault-tolerant Time distribution in SpW networks	Albert Ferrer
- Broadcast/multicast modes in SpaceWire interconnection	Yuriy Sheynin
-SpaceWire nodes with multiple links (nor a router!)	Yuriy Sheynin
- Configuration space (basic) for a router and for a node (with regard to SpaceWire links) specification	Yuriy Sheynin
- Other points	

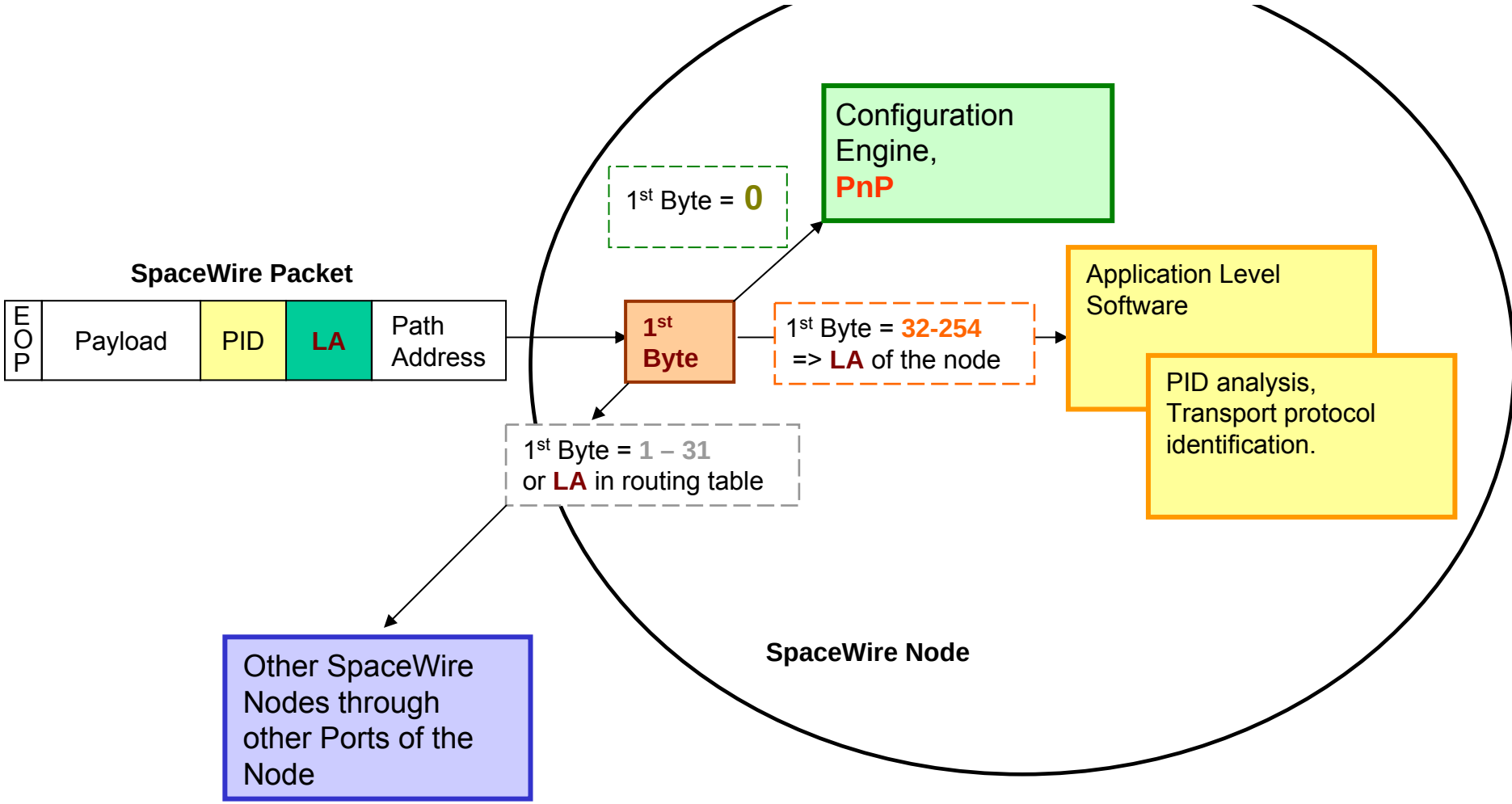
Configuration Port 0 in Nodes

- SpaceWire routing switches have an internal configuration port with address zero.
- It is used to configure the routing switch and to access status information.
- This is an important feature for network discovery and PnP.
- Currently this port zero is only required in routing switches and not in nodes.

Routing Function in Nodes

- What has been described before corresponds to a very simple router with:
  - one external port,
  - one internal configuration port and
  - one node internal port accessed through LA.
- This concept can be extended to several external ports by introducing path addressing and a routing table.
- Benefits:
  - Suits the needs of network discovery
  - Can provide means for cross strapping and redundancy switching
  - Allows the construction of direct networks with easy packet routing by nodes
  - Fully backwards compatible for simple nodes with a single port

Harmonisation of Node Function with Router Function



Packet Spill Function in Routers

- SpaceWire networks never drop a packet
- In case of temporary congestion of a required link the blocked packet waits until the path becomes free
- This is great for reliable delivery but the latency is a statistical value
- For scheduled traffic like SpaceWire-RT congestions only occur in case of error
- In order to contain the error and to avoid failure propagation it is better to drop not routable packets
- It shall be specified in the routing table if a packet shall be dropped when the destination port is not available.
- This shall be applicable for path and logical addressing

Following Actions

- The initiators of modification proposed shall provide additional information which is to be reviewed before and discussed during in the coming SpW Working Group meetings
  - Details on reasoning and justification for change
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  - Identify paragraphs to be changed / added
  - Proposed text for the changed / added paragraphs