SpaceWire Standard Evolution

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Overview

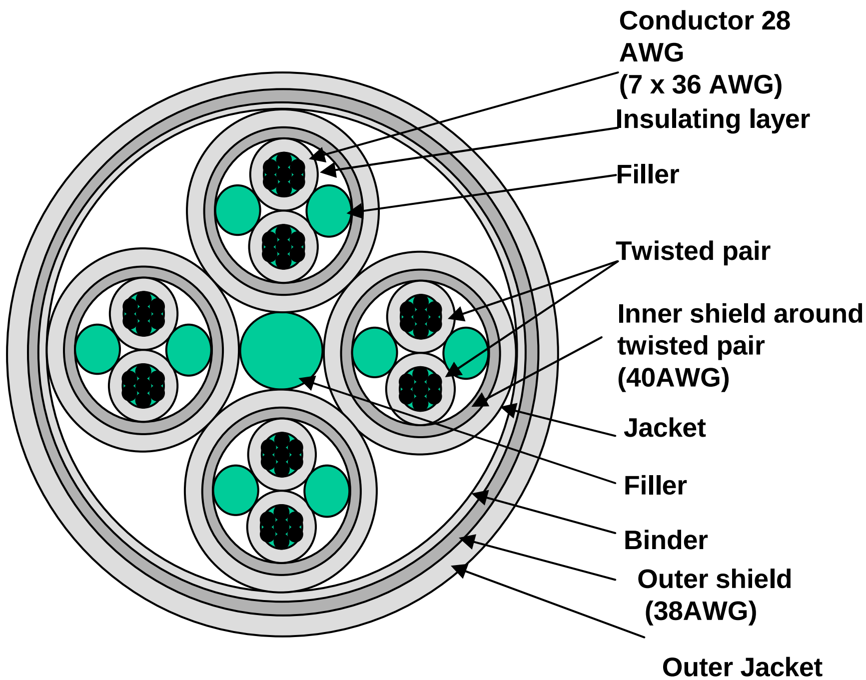
- Introduction
- Proposed updates to the SpaceWire Standard on:
  - Physical Level,
  - Character Level,
  - Exchange Level,
  - Network Level.
- Conclusion

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 the SpaceWire Working Group is discussing new concepts and additional protocols like SpW-PnP and SpW-RT.
- 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 presentation summarizes updates to the SpaceWire standard which have been proposed during the past years in the SpaceWire Working Group.

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)



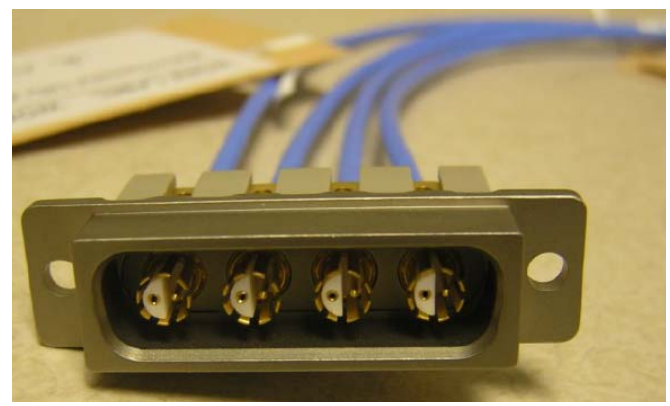
Section though a SpaceWire cable as defined in the standard

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.

micro-miniature D-type connector

38999-series connector



4-way Twinax connector

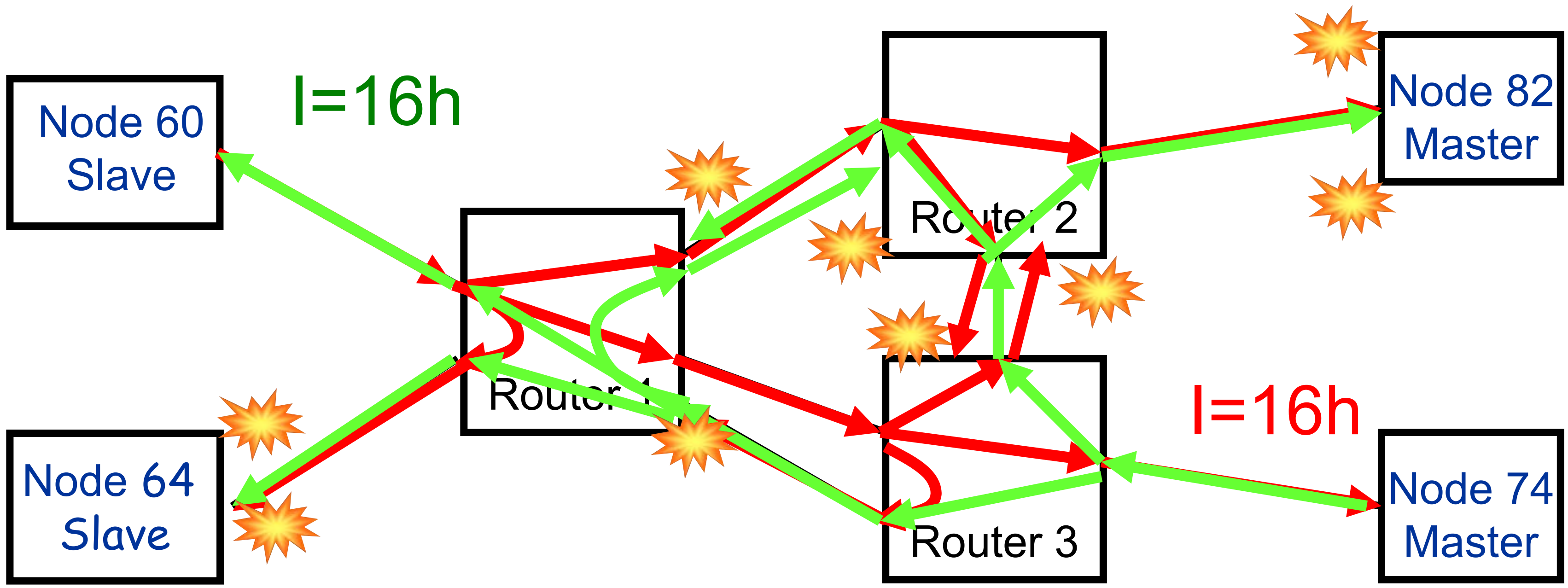
Cable Assembly

- 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 could be investigated.

Distributed Interrupts

- Two control flags of the time-codes are reserved for future use.
- It has been proposed to use one of the reserved states to distribute interrupts through the network.
- They will propagate on the same side channel as time-codes independent of the normal traffic.
- This mechanism will allow to define 32 Interrupts Codes and 32 Interrupt-Acknowledge Codes.
- Routers and nodes propagate the interrupts only once unless:
  - a timeout has expired
  - they have received the corresponding Interrupt-Acknowledge Code

Distributed Interrupts



- Interrupt-code: interrupt request, IRQ vector I=16h
- Interrupt Acknowledge: interrupt acknowledgment

Multi-Time-Code Master Mechanism

- Only one node in network is allowed to act as time-code master.
- It is the only to should provide the active TICK_IN signal which triggers the broadcast of the Time-Codes.
- This is required to avoid collisions of Time-Codes within the network.
- For fail safety and redundancy reasons it could be useful to have simultaneous Time-Codes from different time-code masters in a system.
- Up to two additional time signals could be implemented by using the two remaining reserved states of the control flag.

Simplex Link Operation

- Many high speed payload data applications require only a simplex connection.
- This could be for example a direct connection from a high rate instrument to the memory.
- For these simple applications the back of SpaceWire is sometimes regarded as complex and of cable mass.
- A proposal has been made to modify the SpaceWire codec and the state machine to support simplex operation.
- Also the possibility of a half-duplex SpaceWire implementation has been suggested.
- The details and consequences of these proposals remains to be investigated.

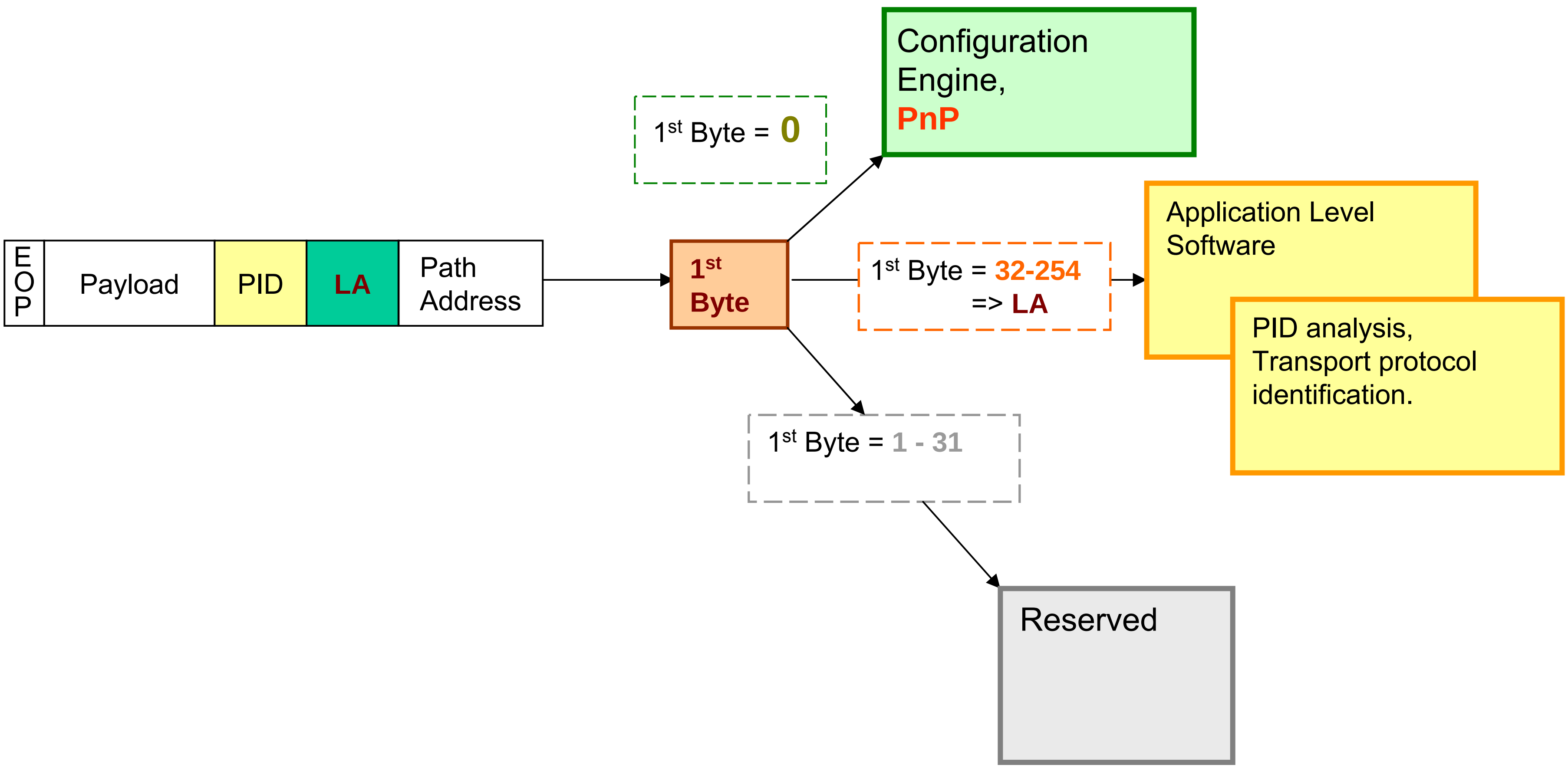
2 Mbit/s Link Speed at Start-up

- The standard currently requires a link speed of 10 Mbit/s at start-up.
- In some applications data rates of less than 2 Mbit/s are required.
- For power saving and simplicity reasons the start-up at 2 Mbit/s is desirable for these systems.

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.
- It is intended that in the update the definition of SpaceWire Node addressing will be aligned with the SpaceWire Routing Switch.

Configuration Port 0 in Nodes



Router 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.
- This concept can be extended to several external ports by introducing path addressing and a routing table.
- This would fulfil the needs of network discovery
- Could provide an elegant method for cross strapping and redundancy switching
- Enable easy packet routing through nodes.

Conclusion

- A non exhaustive list of the modifications proposed to the SpaceWire standard has been presented.
- Additional proposals are welcome and can still be submitted to the author.
- The different options will be discussed and consolidated within the SpaceWire working group starting next year.
- In many cases breadboard implementations of the modifications already exist.
- Results of the discussions on modifications will be included in the next update of the SpaceWire standard.
- The review and update of the SpaceWire standard is planned to be started in 2010.