From SpaceWire to SpaceFibre: the evolution of space components in the field of on-board satellite high-speed communications

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Outline

• Evolution of on-board satellite high-speed communications: from SpaceWire to SpaceFibre
• Research/Products on SpaceWire/SpaceFibre
• Conclusions
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Mission requirements for on-board communications

- **SpaceWire** ECSS standard (2000)
- **SpaceFibre** ECSS standard (2020)

Onboard data-rate:
- 20 Gbps
- 2 Gbps
- 200 Mbps

Timeline:
- 2000
- 2010
- 2020
From SpaceWire to SpaceFibre: SpaceWire

Features:

• SpaceWire is the current state-of-the-art for on-board satellite high-speed communications
• ECSS standard since early 2000’s
• Supports data rates up to 200Mbps
• SpaceWire links are widely used in practically all ESA satellite missions
• Often used as the only connection between platform and instruments, therefore used also to carry commands other than data

Limitations:

• Some satellite instruments generate data at significant higher rates exceeding the capability of SpaceWire
• No integrated QoS or FDIR mechanisms
From SpaceWire to SpaceFibre: SpaceFibre

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PROBLEM: Lack of on-board reliable High-Speed data communication

SOLUTION: SpaceFibre

STATUS: Draft available – ECSS standardization formally started

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**SPACEFIBRE**

- FDIR embedded in the protocol
- Quality-of-Service Integrated
- Reduction in mass and power budgets
- Complementary and interoperable with SpaceWire
- Can operate on both optical fibre and copper
- Very High data-rate reliable data link (2-20 Gbps)
Expected impact of SpaceFibre

Key factors for Spacefibre demand:

- Increased dimension and output data-rate of detectors
- Increased speed of science data downlink causing increased Mass Memory speed
- Reduced power and mass budget

Need already present today with ad-hoc non-standardised solutions, e.g., WizardLink SERDES (MTG, Carbonsat, Euclid...)

Spacefibre is expected to have a large market and be used practically in all ESA earth observation and science missions as soon as:

- Hardware is available
- Standard is finalized
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Research/products on SpaceWire/SpaceFibre

- **Spacewire CODEC IP**
  - SLSTR – Sentinel 3
  - Iridium Optical Head

- **Spacewire Router IP**

- **Gigabit Serial Link Controller IP**
  - SpaceFibre

- **SpaceWire/SpaceFibre Analyser**
IngeniArs

- Founded May 2014
- Italian SME company with expertise on Electronic Systems mainly for Aerospace, Telemedicine and Automotive applications
- Innovative Start-Up according to Italian laws
- Spin-off of the University of Pisa
- Winner of Horizon 2020 – SME instrument phase 1 on Space topic
SpaceWire CODEC IP-core

- Validated in ESA space project
- Interoperability with commercial SpW products
- ECSS-E50-12C compliant
- Supports PID and RMAP
- 120 Mbps in Microsemi RTAX FPGA
- Fault tolerant IP with EDAC FIFOs
SpaceWire Router IP-core

- Validated in ESA space project
- Interoperability with commercial SpW products
- ECSS-E50-12C compliant
- Supports PID and RMAP
- 100 Mbps 8 links SpW router in Microsemi RTAX FPGA
- AHB host interface
Digital interface for both simple and complex communication protocols (e.g. SpaceFibre) based on the most used Serializer/Deserializer available on the market.
Gigabit Serial Link Controller IP-core

- Digital interface for communication protocols based on SERDES available on the market (WizardLink, RocketIO, GTX)

- Compliant with the SpaceFibre standard. Interoperable with commercial SpaceFibre product

- Compatible with Microsemi RTAX2000 FPGA + Wizard Link TLK2711 configuration

- Customisable to fulfil user needs

1) TLK2711 (WizardLink)

2) Xilinx RocketIO, GTX

3) SpaceFibre

Dept. of Information Engineering - IngeniArs
Gigabit Serial Link Controller IP-core

SpaceFibre CODEC IP-core interoperability demonstrated at SpaceWire Working Group #22
Gigabit Serial Link Controller IP-core

- SpaceFibre IP-core synthesis results on Microsemi RTAX2000
SpaceWire/SpaceFibre Analyser

- Reference test equipment for SpaceWire/SpaceFibre implementations
  - Link Analyser
  - EGSE functionality
  - Conformance tester
- Word level analysis
- Packet level analysis
- Quality of Service parameters testing
- Ethernet/cPCI host PC interface
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Conclusion

- SpaceFibre will soon complement the functionality of SpaceWire
- SpaceFibre ECSS standardisation has initiated (University of Pisa is part of the SpaceFibre ECSS working group)
- University of Pisa and its spin-off company IngeniArs are working on SpaceWire/SpaceFibre technologies:
  - SpaceWire CODEC
  - SpaceWire Router
  - Gigabit Serial Link Controller (SpaceFibre, WizardLink, GTX, …)
  - SpaceWire/SpaceFibre Analyser
Thanks for your attention!

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