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SpaceWire developments for on-board data systems

Issues and Priorities

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Session 4: System views (Convenor D. Jameux, ESA/ESTEC)

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All the space you need



Outline

- SpaceWire utilization
 - Current and Foreseen
- SpW developments issues
- Priorities

SpaceWire current utilization

Science

- GAIA
 - Direct links between focal plane to Video Processing Unit and from VPU to the Payload Data Handling Unit - Cold redundancy
 - Command and Control with 1553
- LISA Pathfinder
 - 3 independent direct links
- BEPI-Colombo
 - SpW Network between instruments, Mass Memory and OBC
 - Command and control on SpW with RMAP
- SOLO
 - Heritage from BEPI architecture with differences
 - higher number of instruments – no cmd/ctrl requirement
- Exomars-Rover
 - SpW Network with strong requirements on mass, power and autonomy

Observation

- Depend on instrument data bandwidth - direct links

Telecom

- AlphaSat Processor
 - “Backplane” type between processing units using routing and RMAP.
 - Non standard physical layer (CMOS links instead of LVDS)

SpaceWire foreseen utilization

- Hybrid Platform avionics with dedicated SpW links to new sensors
 - Star-Trackers, Lidar or an Entry Descent and Landing camera
- SpW as a small spacecraft/vehicle main data network
- SpW/SpF for Telecom Payload
- SpW/SpF for instrument to first processing stage
- Scalable Inter-processor communication network
- SpW Deterministic network
 - Payload: avoid low speed buses such 1553 or Can for units command & control
 - Platform: supporting an IMA / Time and Space Partitioning concept (e.g. as AFDX on aircraft)
- SpW on future launchers
- SpW Network to NoC protocol continuity
- SpF Network for Payload distributed data processing
- ...

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AIV needs

SpaceWire Standard does not cover AIV needs

- Galvanic isolation
 - All the EGSE interfaces must be isolated
 - 1 MOhm under 10 V isolation between signal and chassis
 - Ground loop must be avoided
 - EGSE failure mode must be taken into account
- Cables and Connectors
 - Frequent mating/demating
 - Very long cable for thermal and EMC test
- ▶ Astrium developed 1KV SpW isolation for EGSE supporting traffic up to 200 Mbps

Half duplex / Simplex

Reduction of Mass

- When data flow is mostly unidirectional

SpaceWire Evolution study feedback:

- Simplex: lack of health status is an issue
- Half duplex is more promising

Interest for future Launchers

- Harness mass reduction
- Need for very long wiring
- Recommendation to characterize data rate vs. cable length (also for full duplex)

SpaceWire Backplane

Active Backplane

- Used in ESA/COTS Based Computers between IO and CPU boards
- Allows fault isolation
- Limited bandwidth : possible use of several SpW links (aggregation)
- Standardization : which level ?
 - Connector
 - Form factor
 - Redundancy handling
 - Miscellaneous signals (interrupts, JTAG, power control, watchdogs...)

SpW Test, verification and certification

- High Interest for a standard qualification kit for SpaceWire (as existing on 1553)
 - Insures interoperability
 - Electrical characteristics (eye diagram measurement,...)
 - Connection layer characteristics
 - Standard Protocol compliance verification
 - Higher level protocols verification

SpW for Command control

(1/3) Determinism

Issues for a deterministic network

- SpW wormhole routing
 - Unlimited packets: network congestion could not be solved
 - Babbling idiot syndrome
- A “guaranteed bandwidth” QoS is needed
- Estimation of the maximum propagation time

SpaceWire-RT, SpaceWire-D, Virtual channels...

- Several protocols with issues on complexity, flexibility, compatibility with current standard and devices, network management,...
- Network router need to support protocol functions
- Trade-off required vs. systems needs from typical use-cases

→ Avoid unnecessary features

SpW for Command control

(2/3) Interruptions

SpaceWire Evolution study feedback:

- Efficient to reduce the number of discrete signals
- Reduce the status polling traffic
- 32 interruptions for the whole network is foreseen as a limitation. An instrument may use more than one interruption.

SpW for Command control

(3/3) Time & Communications Synchronisation

Needs

- SpW network nodes synchronisation
- Time distribution
- Deterministic performance (time accuracy)
- Mapping to SOIS Subnetwork Synchronisation service (time and events)

Elements

- PUS service 9 (time distribution service) used on Bepi-Colombo
 - PPS: TimeCode
 - (re)Synchronisation using data part of Time code
 - Time code format: CCSDS CUC
- SpW interruptions for events
- communications synchronisation and time distribution dependency
- Use of RMAP for read-write functions

SpaceWire-D protocol ?

SpW Network management

- SpaceWire evolution study recommendation:
 - Network discovery and configuration
 - Standard terminology

- SpW Network Management issues
 - System FDIR level of delegation to Network Management
 - Network Management actors
 - Managed by one Master
 - Active role of the routers
 - Network monitoring protocol elements
 - Time distribution, Interruptions
 - Health status acquired at all SpW nodes
 - Protocol error reports (e.g. RMAP)
 - Use of RMAP Protocol for NMP data exchanges
 - Watchdog
 - Network (re)configuration
 - Redundancy concept
 - Mapping on CCSDS/SOIS Subnetwork Device Discovery Service

- Plug and Play
 - PnP is not considered the best terminology toward our customers...
 - Not seen as a priority vs. Network Management (but a possible evolution)

Very High Bandwidth data link: SpaceFiber

- Evolution toward Gigabits is necessary for Payload Processing
 - Covered by the development of SpF
 - Understood as compatible/interoperable with SpW networks
 - Issues
 - Use of existing reliable and popular standards for the lower layers (e.g. wizard link)
 - SpaceWire evolutions (ECSS) should be taken into account
 - SpF level Interrupt Mechanism to handle high priority messages
 - SpF backplane use case

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Priorities

ID	Issues	Priority	Users	Term
1	SPW test/verification/certification	High	All	Short
2	SpaceFiber / Very High Bandwidth data link	High	Payload Processing	Short
3	AIV needs	High	Integration	Short
4	Network management / FDIR	High	All	Medium
5	SPW backplane	Medium	Equipments	Short
6	SpW for command and control	Medium	Platform processing	Medium
7	Half duplex/simplex	Low	Instruments Launchers	Medium
8	Plug and Play	Low	Science Manned missions	Long

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Thank you for your attention !

Questions ?

