SpaceFibre Requirements

A collated set of requirements presented at previous SpW WG meetings, with (very few) additions from the SpaceFibre sub-group

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Sources

- ESA
- NASA
- UoD
- Honeywell
- LANL

Types of requirements

- Conceptual
- Performance
- Physical
- Practical
- (Implementation)

Conceptual

- Viability
- Compatibility with SpW
- Symmetry
- Simplicity
- Error Handling
- Asynchronicity
- SpW-SpF Switches/Bridges

Viability

- Is SpaceFibre a Viable network technology in its own right, independent of SpW? (Honeywell)
  - Currently it is described entirely as a high-bandwidth backbone for SpaceWire
  - It needs to have all the benefits of SpW, without the baggage of the complex standards, but faster than SpW

Compatibility with SpW 1

- Backwards compatible to SpW (NASA)
- Compliant with protocols and routing mechanisms of SpW standard (ESA)
- Transparency (Honeywell)
  - SpW to SpW via SpF is transparent (completely)
  - SpF to SpF via SpW is transparent

Compatibility with SpW 2

- Able to integrate with SpaceWire (UoD)
- Full Duplex (NASA)
- Packet protocol as SpW, no streaming (NASA)
- Packet size minimum one Byte, no maximum (NASA)
- No channel multiplexing, except for priority packets (NASA)
  - Not supported by SpW standard. Priority packet used for time code?

Symmetry

- Symmetrical, bi-directional point-to-point connection (ESA)
- Symmetric and asymmetric operation (NASA)
  - Allows different rates in each direction
- All interfaces must be capable of loop-back (Honeywell)

Simplicity

- Use a single lane (NASA)
  - Simplifies design *(SerialLite Fig 3)*
- Consider multi-lane for future (NASA)
  - If bandwidth becomes a limitation
- No lane reversal, LSB transmitted first (NASA)
  - Less confusion
- Take advantage of K codes for logical characters to simplify implementation (NASA)
  - Is error coding required on K codes?

Error Handling

- Similar bit error rates as specified for SpW (ESA)
- Check errors on fly without waiting till end of packet (NASA)
- How do we place ECC on data?
  - At what boundary - Byte, field (size?), packet?
- Data field integrity protection using CRC8 (NASA)
  - Better for Wormhole routing
- Rugged (UoD)

Asynchronicity

- Asynchronous operation (NASA)
  - Necessary for inter-box operation with independent oscillators *(SerialLite Page 8)*

SpW-SpF Switches/Bridges

- Allow mixed SpaceWire-SpaceFibre networks (via special routers) (ESA)
- Bridge between protocols in switch (NASA)
- Scalable number of virtual SpW links over one SpF (ESA)
- Maintain wormhole routing capability (NASA)
- If we use Frames to segment large packets, the frames must be routable through switches (Honeywell)

Performance

- Data Rate 1
- Data Rate 2 (start-up)
- Latency
- Quality of Service

Data Rate 1

- Data rates 1 to 10Gbps (ESA)
- High data rate, 2.5Gbps plus (UoD)
- Variable Signalling rates (ESA)
- Maintain bandwidth efficiency as much as possible (NASA)
  - Should FCT represent more than 8 characters?
  - Should N-Chars be replaced with data characters?

Data Rate 2 (start-up)

- Fast start-up (ESA)
- Minimize synchronization sequence (NASA)
  - Is it necessary? How often? How long?

Latency

- Minimize routing switch latency (Honeywell)
  - Preserve wormhole routing
  - If we use Frames (for segmenting large packets), recognize that they increase latency

Quality of Service

- Intrinsic support for Quality of Service (ESA)
- Nesting priority packet within data packet for a time-critical packet (NASA)
- Use packet and priority packet types –Priority packets for Time Codes (NASA)

Distance

- Distance up to 100 metes at max data rate (on Fibre) (ESA)
- 100m plus over fibre, 1m only over copper (UoD)
- Copper version for shorter distances (ESA)
- Use copper or fibre depending upon requirements (NASA)
  - How much is variable rate possible? Changeable on the fly?

Physical

- Isolation
- EMC
- Cable mass
- Power
- Radiation tolerance

Isolation

- Capable of galvanic isolation (ESA)
- Galvanically isolated (UoD)
- Use DC Balanced code (NASA)

EMC

- Payload and idle scrambling??? (NASA)

Cable mass

- Light-weight cables (UoD)

Power

- Fine-grained power management (ESA)
- Low power per Gbps (UoD)
- Low power, and must be able to control power (NASA)

Radiation Tolerance

- Radiation tolerant (UoD)

Practicality

- Deadline
- Conflicting requirements

Deadline

- Sounding Rocket flight for NASA Orion, using commercial components, 2008-09 (NASA)

Conflicting requirements

- Is similar Bit Error Rate achievable at 100 times the data rate?
  - If that requires forward error correction or retry mechanisms, do we justify the cost and complexity?
- Is Radiation Tolerance achievable?
  - SpaceWire is currently performance limited by Rad-Hard processes
  - Can such processes realistically go at 100 times the data rate?

(Implementation)

- Flow control
- Encoding, signalling

Flow Control

- SerialLite flow control not used (NASA)
  - SerialLite uses pause commands (XOn, XOff)
- Flow-control represents Rx buffer space but only for Data, not Eop/EEP (NASA)
- Flit more than 8 Characters (NASA)
  - suggest 32 characters per FCT

Encoding, Signalling

- 8B10B physical encoding (ESA, NASA, UoD)
- 64/66 or 64/67 scrambling codes may be more efficient, may not suffer excessively from long run-length (LANL)

- In-band control signalling using K codes (NASA)
  - Assumes 8B10B

Conclusions

- Lots of requirements
  - Still probably some missing (cost?)
- Broad agreement on many requirements
  - But subtle differences that need to be resolved
- As always, some requirements conflict or may be wishful thinking, beyond actual needs
  - These need to be identified and resolved asap
- The proposed design needs to be justified against the agreed requirements