Building SpaceWire Systems

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Outline of presentation

1. Topological Freedom
2. The Bus Problem
3. A Better RS232/422 Serial Port
4. Less complexity with Small Routers
5. Scalable systems with Large Routers
6. Examples with the 4Links Demo System
7. Modularity, Re-use, Time-Codes, FDIR
8. Rad-Hard by System Design
The Bus Problem

• 3 nodes: Bandwidth per node = X/3
The Bus Problem

• 3 nodes: Bandwidth per node = X/3
• 5 nodes: Need X/3 per node
  Only get X/5 per node
The Bus Problem

- 3 nodes: Bandwidth per node = X/3
- 5 nodes: Need X/3 per node
  Only get X/5 per node

- **Bus is single point of failure**
Cross-strapping with point-to-point RS232/422

- 2 Instruments: 4 Connections

Instruments

Processors/ Data recorders

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Cross-strapping with point-to-point RS232/422

- 2 Instruments: 4 Connections
- 3 Instruments: 9 Connections
Cross-strapping with point-to-point RS232/422

- 2 Instruments: 4 Connections
- 3 Instruments: 9 Connections
- 4 Instruments: 16 Connections
Cross-strapping with point-to-point RS232/422

- 2 Instruments: 4 Connections
- 3 Instruments: 9 Connections
- 4 Instruments: 16 Connections

**Connections = (No. of Instruments) squared**
Rings with small routers

- 2 Instruments: 4 Connections (was 4)
Rings with small routers

• 2 Instruments: 4 Connections
• 3 Instruments: 6 Connections (was 9)
Rings with small routers

- 2 Instruments: 4 Connections
- 3 Instruments: 6 Connections
- 4 Instruments: 8 Connections (was 16)
Rings with small routers

- 2 Instruments: 4 Connections
- 3 Instruments: 6 Connections
- 4 Instruments: 8 Connections (was 16)

Connections = Twice (Number of Instruments)
Routers with Three Links

- With three links per node, system can be tolerant of two faults

Instruments

Processors/
Data
recorders

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Fully scalable systems with Multi-port Routers

- 2 Instruments: 8 Connections
Fully scalable systems with Multi-port Routers

- **Instruments**
- **Processors/ Data recorders**

- **2 Instruments:** 8 Connections
- **3 Instruments:** 12 Connections
Fully scalable systems with Multi-port Routers

- 2 Instruments: 8 Connections
- 3 Instruments: 12 Connections
- 4 Instruments: 16 Connections (was 16)
Fully scalable systems with Multi-port Routers

- 2 Instruments: 8 Connections
- 3 Instruments: 12 Connections
- 4 Instruments: 16 Connections

Connections = 4 * (Number of Instruments)
Rings and Routers

• Rings via Routers
Rings and Routers

• Ring via Routers

• Nodes directly connected to Routers
Rings and Routers

- Ring via Routers
- Nodes directly connected to Routers
- Bandwidth where needed
- No Single Point of Failure
Examples with 4Links demonstration

- **Uncompressed video, no frame buffer**
- **High bandwidth provided even by ring**
- **No Single Point of Failure**

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Examples with 4Links demonstration

- **Enough bandwidth for two cameras**
- **But no redundancy**
Examples with 4Links demonstration

- Add one more link:
- Remove any link and displayed pictures recover
Examples with 4Links demonstration

- Add another link:
- Group Adaptive Routing gives almost instantaneous recovery
Examples with 4Links demonstration

- Dual-port nodes with small routers,
- Connected via routers in Ring
- Tolerant of failure of any link or router

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Examples with 4Links demonstration

- More dual-port nodes with small routers,
- Connected via routers
- Tolerant of failure of any link or router

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• Network Management via EtherSpaceLink
• Intuitive user interface
• Simple enough to distribute to each node
• **Autonomous**

• **Distributed between nodes**
Modularity and re-use

- Possible with SpaceWire just as with Transputer
- Platform as well as Payload
Processor Performance, Reduced Dependency

- Commercial, State of art microprocessors
- Batch tested to find best batches for space
- Use redundant network of SpaceWire Links
Processor Performance, Reduced Dependency

- Commercial, State of art microprocessors
- Batch tested to find best batches for space
- Use redundant network of SpaceWire Links

- Rad-Hard by System Design
- But need to minimise I/O latency
Conclusions

- SpaceWire makes it easier to build systems
- Point-to-point without routers is like fast RS422
- Subsystem nodes with two SpaceWire ports reduce harness, reduce complexity
- Larger routers give more bandwidth
- Mix and match routers as best for system
- 4Links have been demonstrating that it works!
- More opportunity for modularity and re-use
- Improved Time Codes help real-time systems
- Could use commercial processors with SpaceWire for reduced dependency