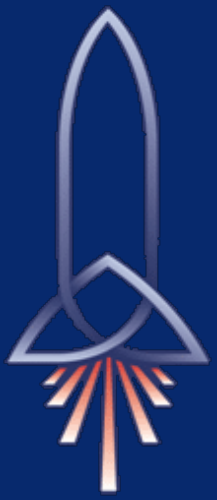

SpaceFibre

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Albert Ferrer[2], Alberto Gonzalez[2]

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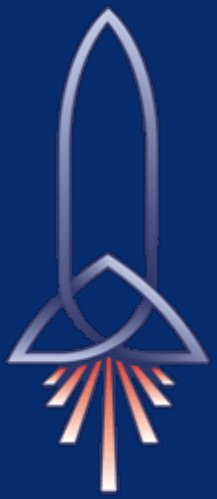
[2]STAR-Dundee Ltd, UK

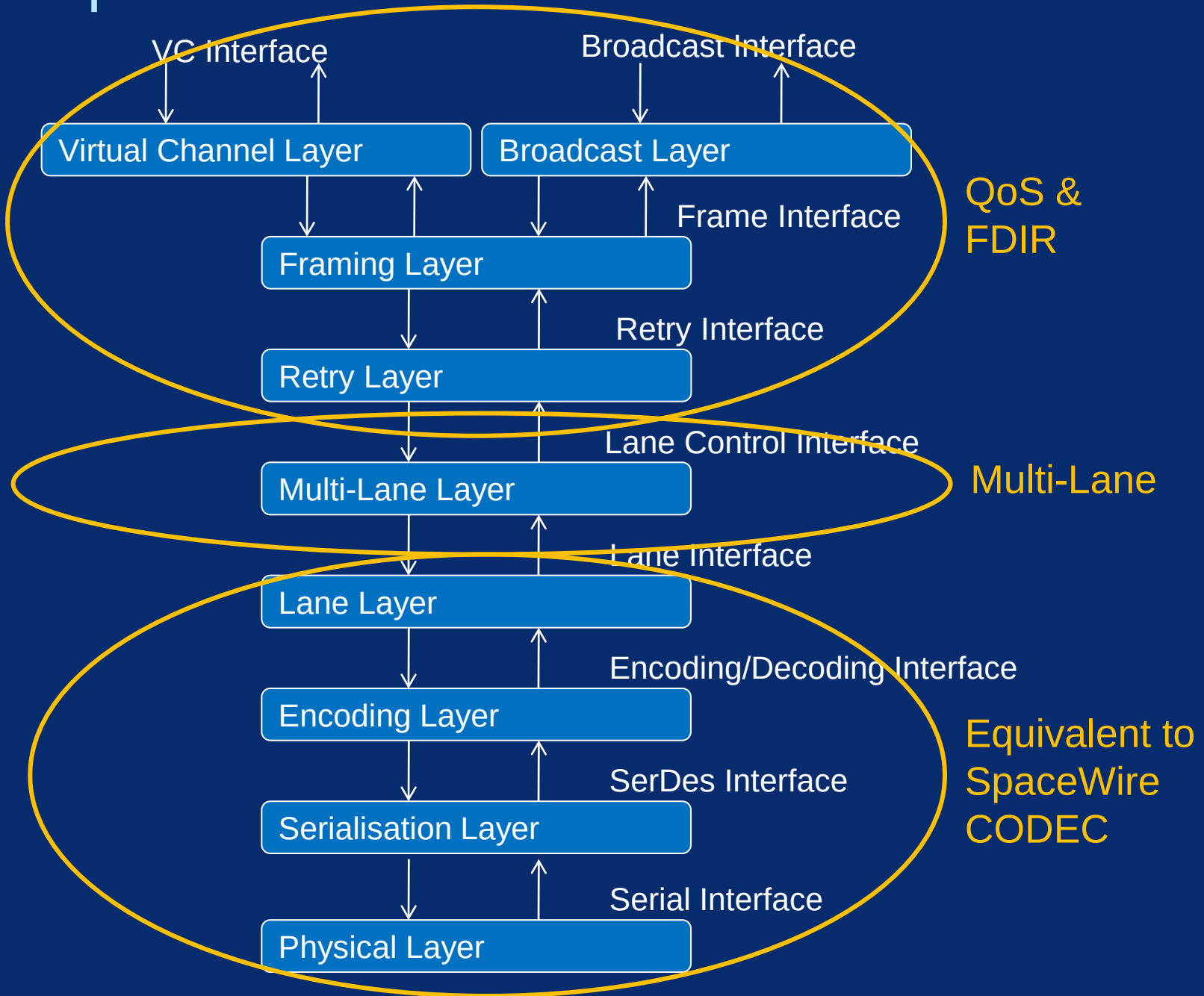
[3]ESA, ESTEC, The Netherlands



Contents

- SpaceFibre Overview
- SpaceFibre Applications
- SpaceFibre Network Layer
- SpaceFibre Status

SpaceFibre Overview



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SpaceFibre Layers

- **Virtual Channel:**
  - Quality of service and flow control
- **Broadcast:**
  - Broadcasts short messages across network
- **Framing:**
  - Frames information to be sent over link
  - Scrambles SpaceWire packet data
- **Retry:**
  - Recovers from transient and persistent errors
- **Multi-Lane:**
  - Runs several SpaceFibre lanes in parallel
  - Provides higher data throughput and redundancy with graceful degradation

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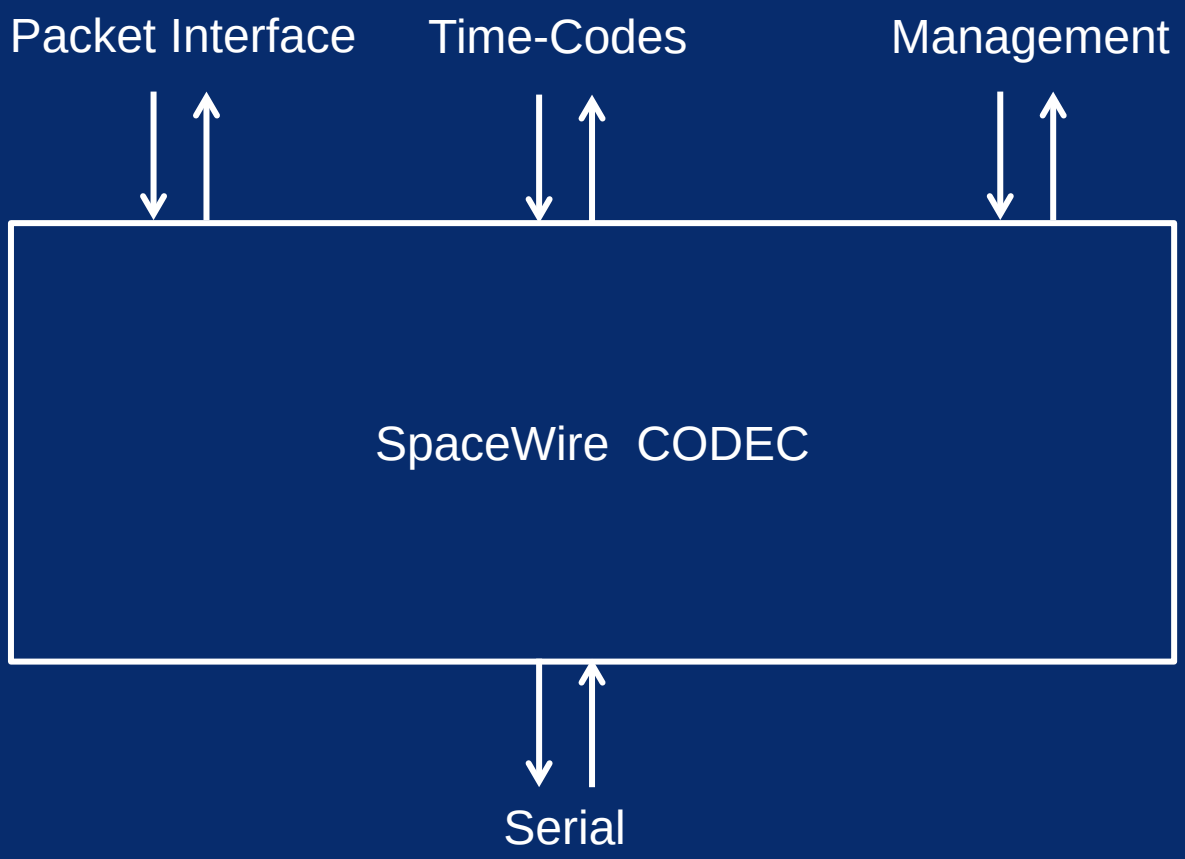
SpaceFibre Layers

- **Lane:**
  - Lane initialisation, error detection and re-initialisation
- **Encoding/Decoding:**
  - Encodes data into symbols for transmission
  - 8B/10B encoding
    - DC balanced
- **Serialisation:**
  - Serialises SpaceFibre symbols
- **Physical:**
  - Fibre optic or copper medium.

SpaceWire CODEC



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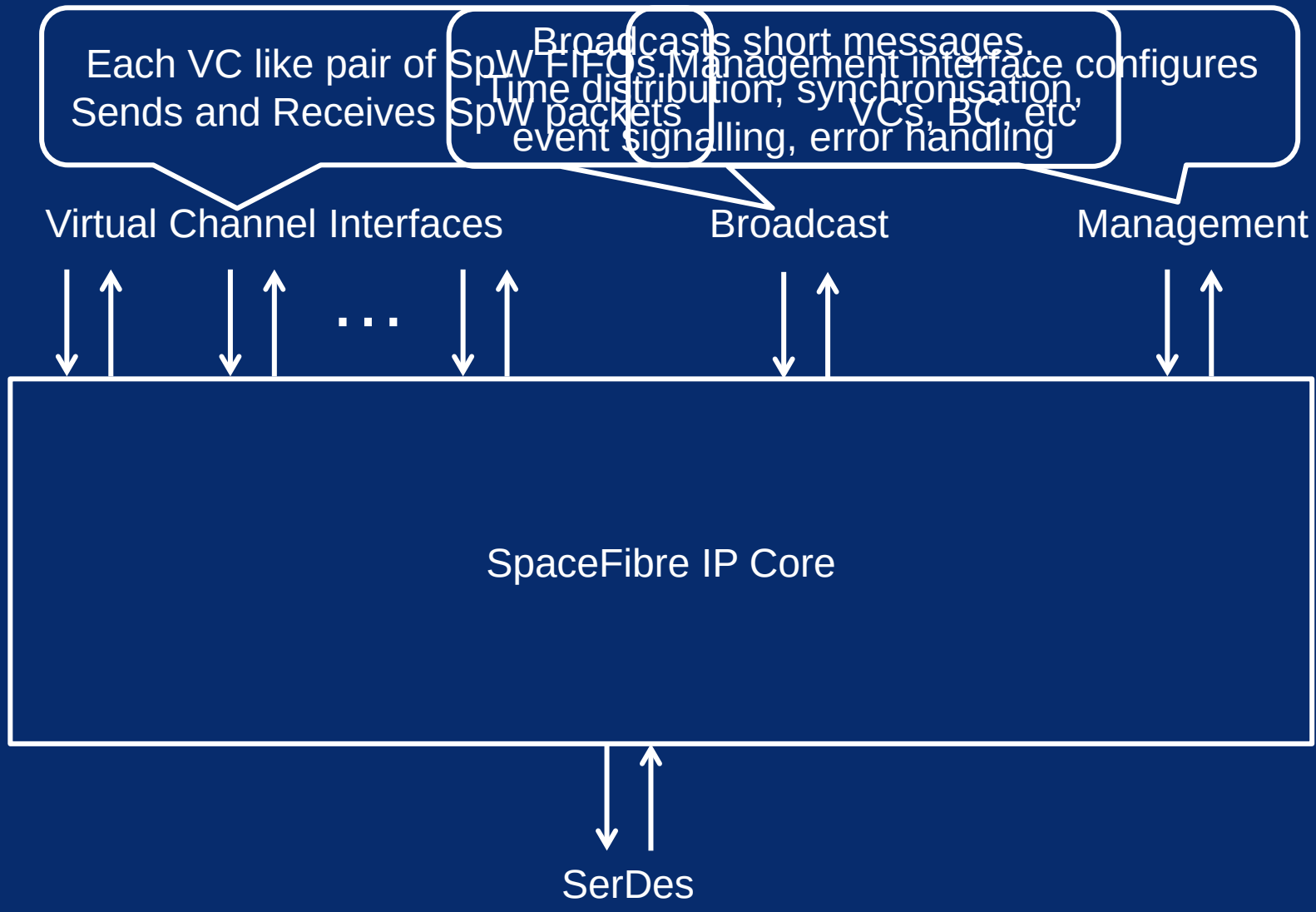
SpaceFibre IP Core



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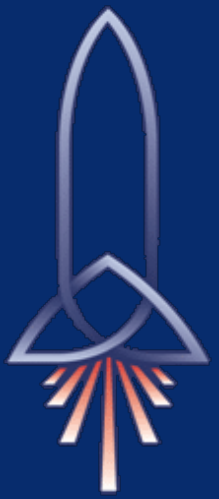
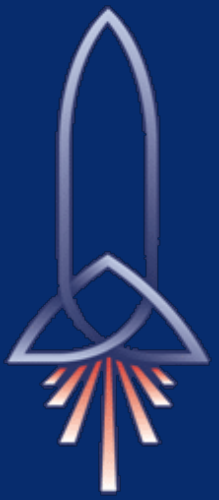


SpaceFibre Network Level

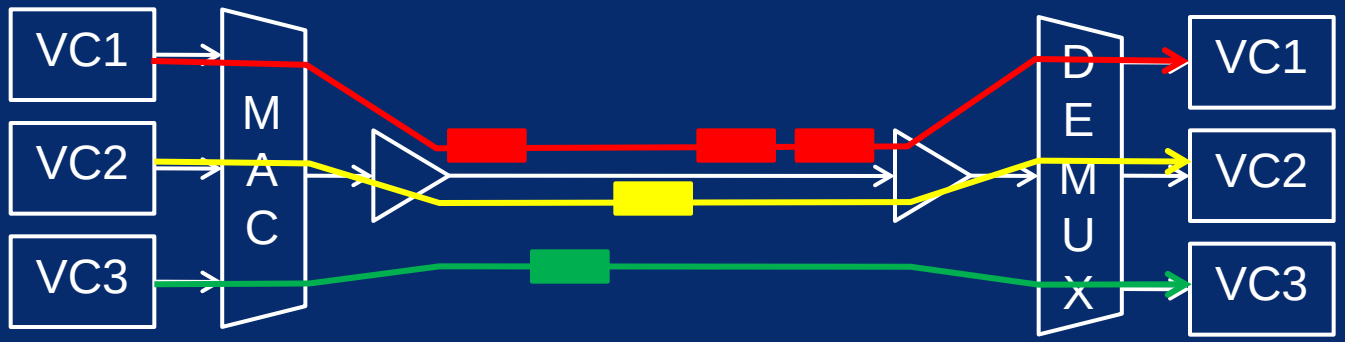
- SpaceFibre transfers SpaceWire packets
  - Destination address
  - Cargo
  - EOP
- Path and logical addressing can be used
- Routing concept identical to SpaceWire
- VCs can be used to provide
  - Virtual networks – like SpaceWire
  - Constrained virtual networks
  - Virtual point to point links



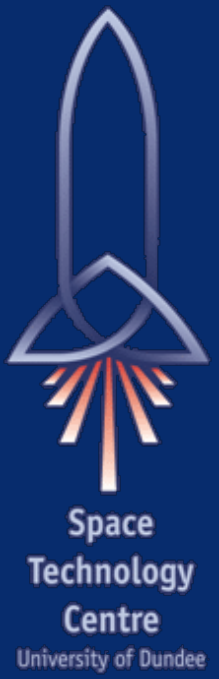
SpaceFibre Virtual Channels

- Virtual Channel Interface
  - Used to send and receive SpaceWire packets
  - Comprises a number of virtual channel buffers
    - Output VCBs for sending SpaceWire packets
    - Input VCBs for receiving SpaceWire packets
    - Conceptual FIFO type interface
    - Accepts SpaceWire N-Chars (data + EOP/EEP)
  - Application
    - Loads packet information sequentially into VCB
    - Addressing and routing is identical to SpaceWire

Virtual Channels



- VC sends when
  - Source VC buffer has data to send
  - Destination VC buffer has space in buffer
  - QoS for VC results in highest precedence
- A SpW packet flowing through one VC does not block another packet flowing through another VC



SpaceFibre QoS

- Integrated QoS scheme
  - Priority
    - VC with highest priority
  - Bandwidth reserved
    - VC with allocated bandwidth and recent low utilisation
  - Best Effort
    - VC can send when no other VC ready to send
  - Scheduled
    - Time-slots sychronised by broadcast messages
    - VCs allocated to specific time-slots
    - In allocated time-slot, VC allowed to send

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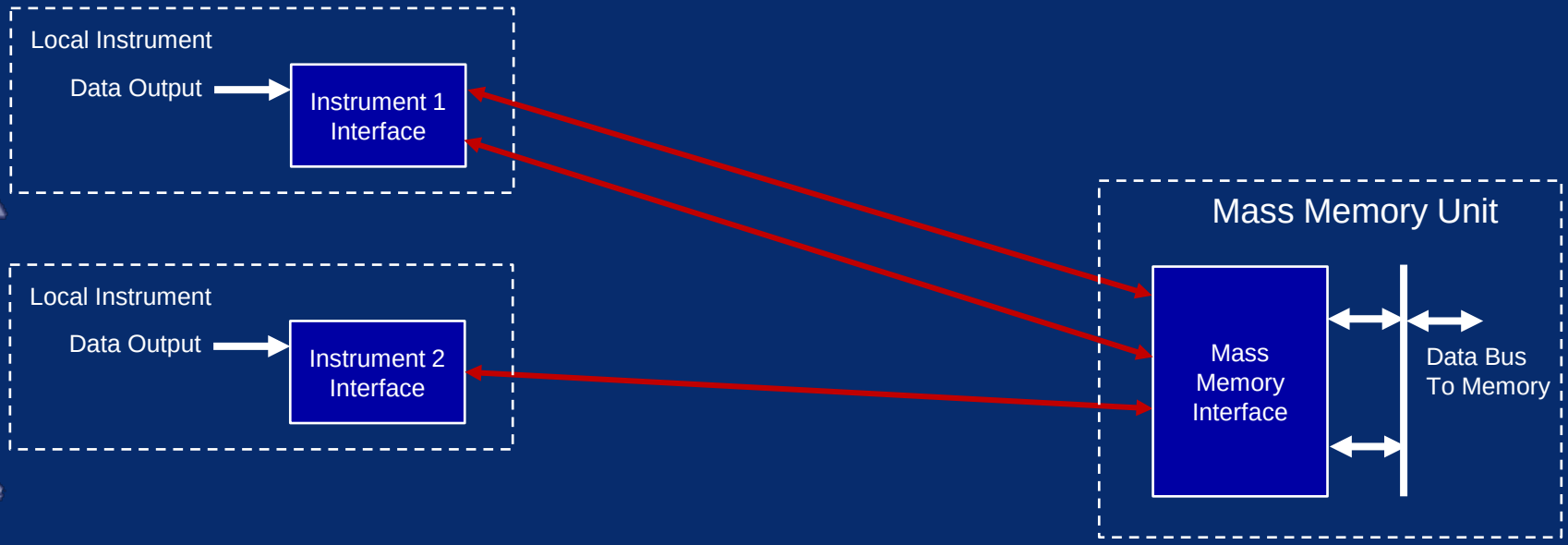
SpaceFibre FDIR

- FDIR
  - Fault detection
    - Parity/disparity ✓
    - Invalid 8B/10B codes ✓
    - Enhanced Hamming distance ✓
    - CRC ✓
    - Over and under utilisation of expected bandwidth ✓
  - Fault isolation
    - Galvanic isolation ✓
    - Data framing – time containment ✓
    - Virtual channels – bandwidth containment ✓
  - Fault recovery
    - Link level retry ✓
    - Graceful degradation on lane failure
    - Babbling idiot protection
    - Error reporting

SpaceFibre Applications



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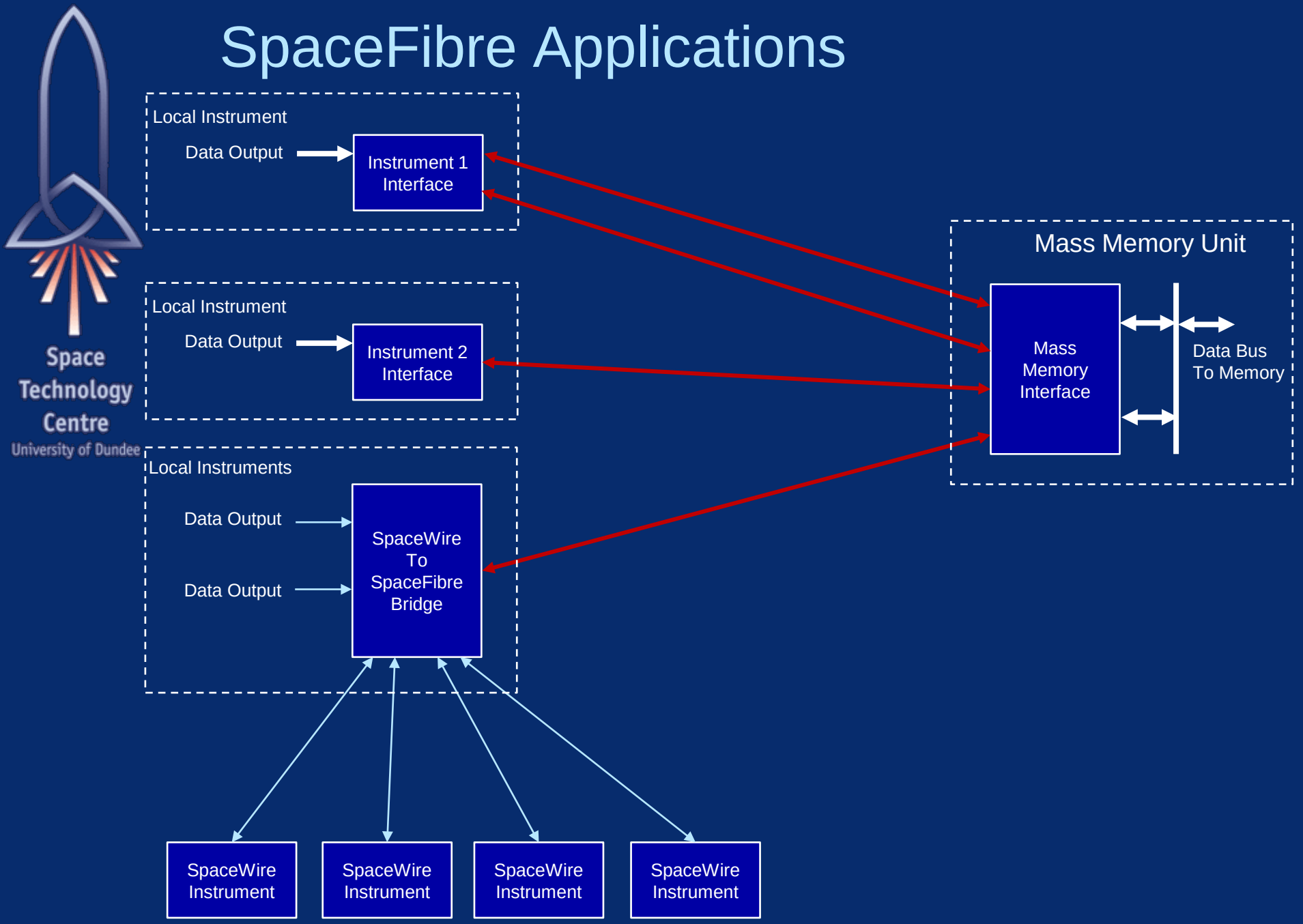
SpaceFibre Applications



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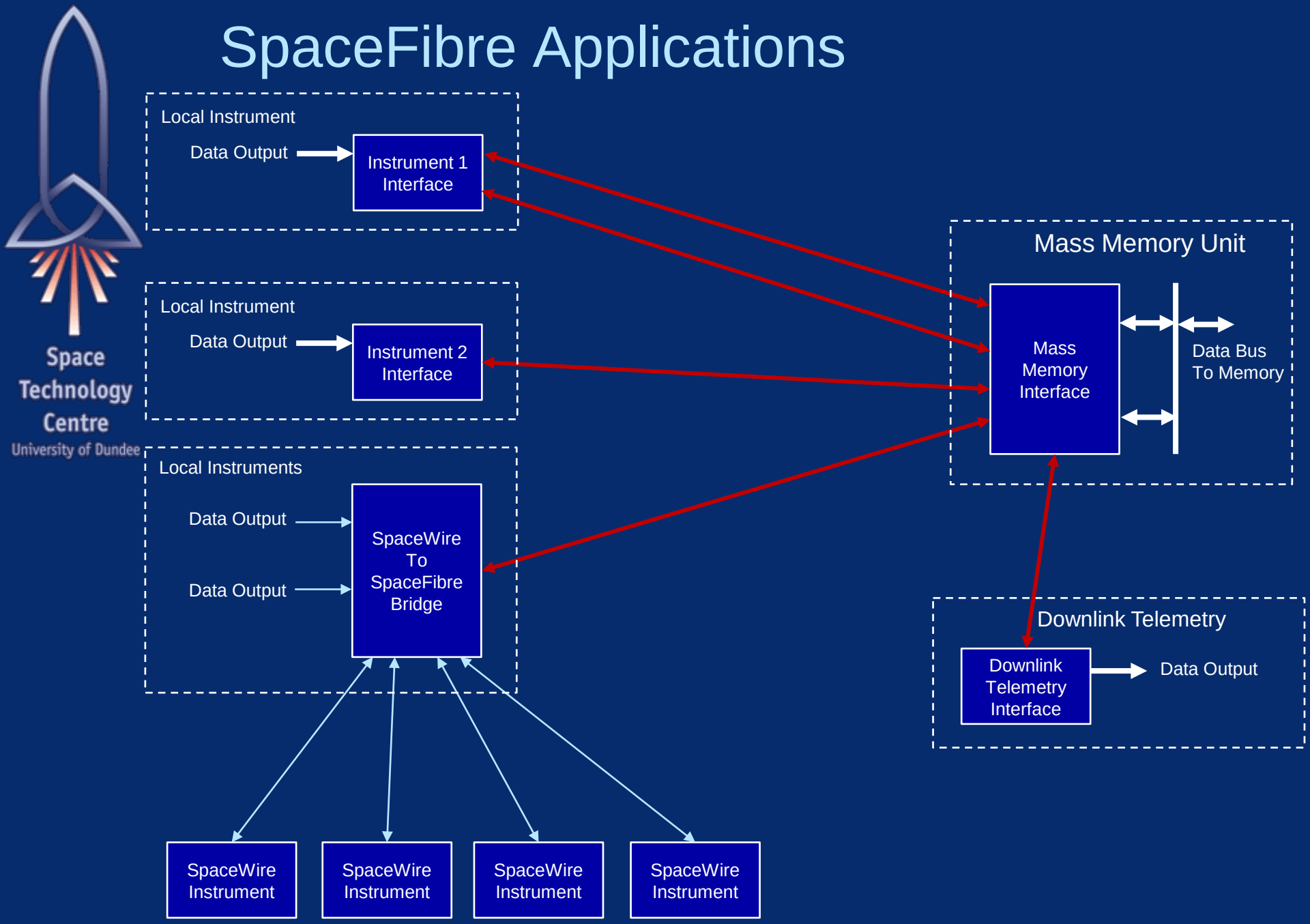
SpaceFibre Applications



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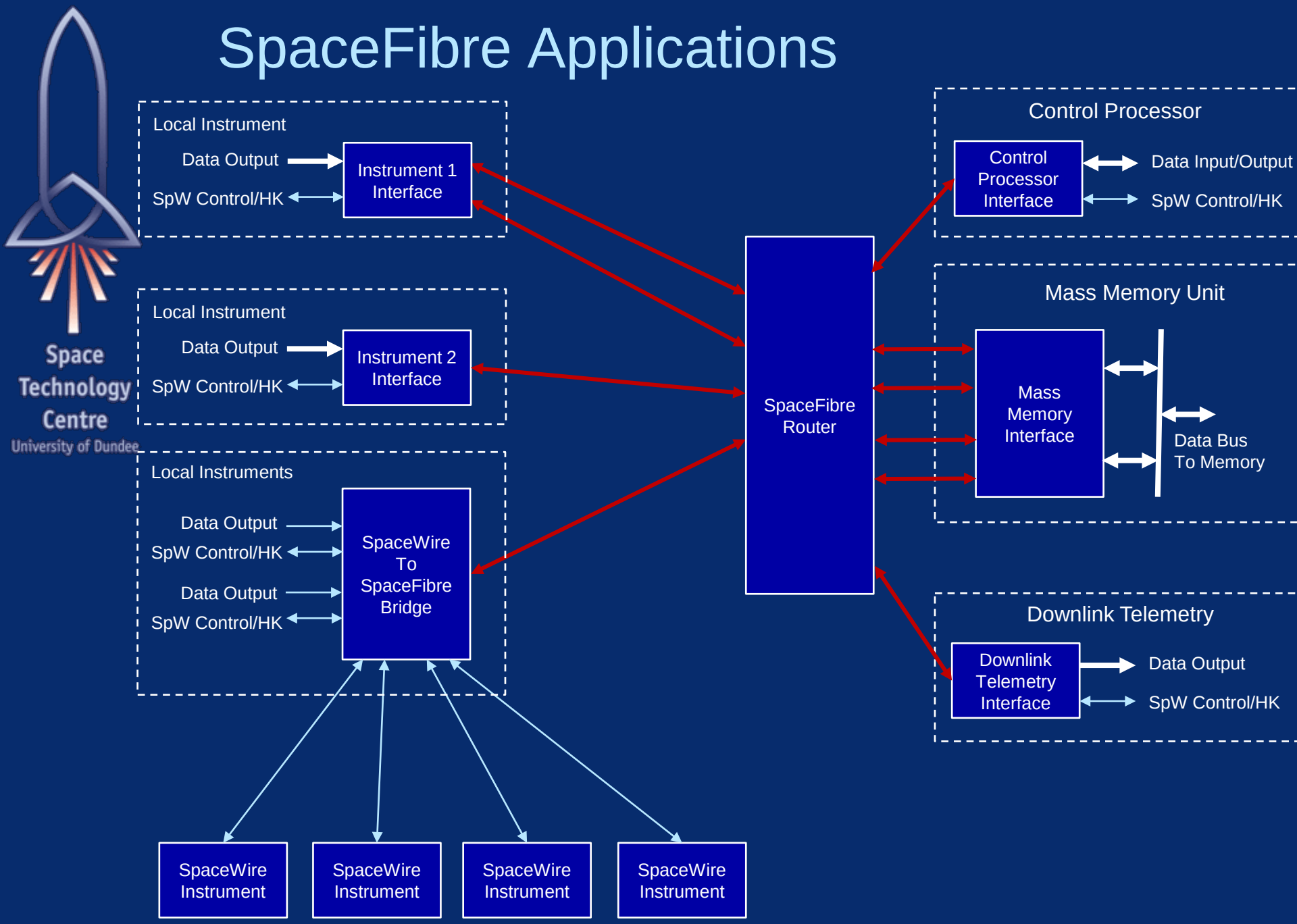
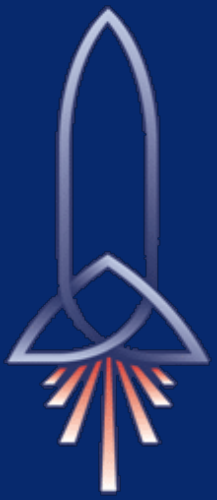
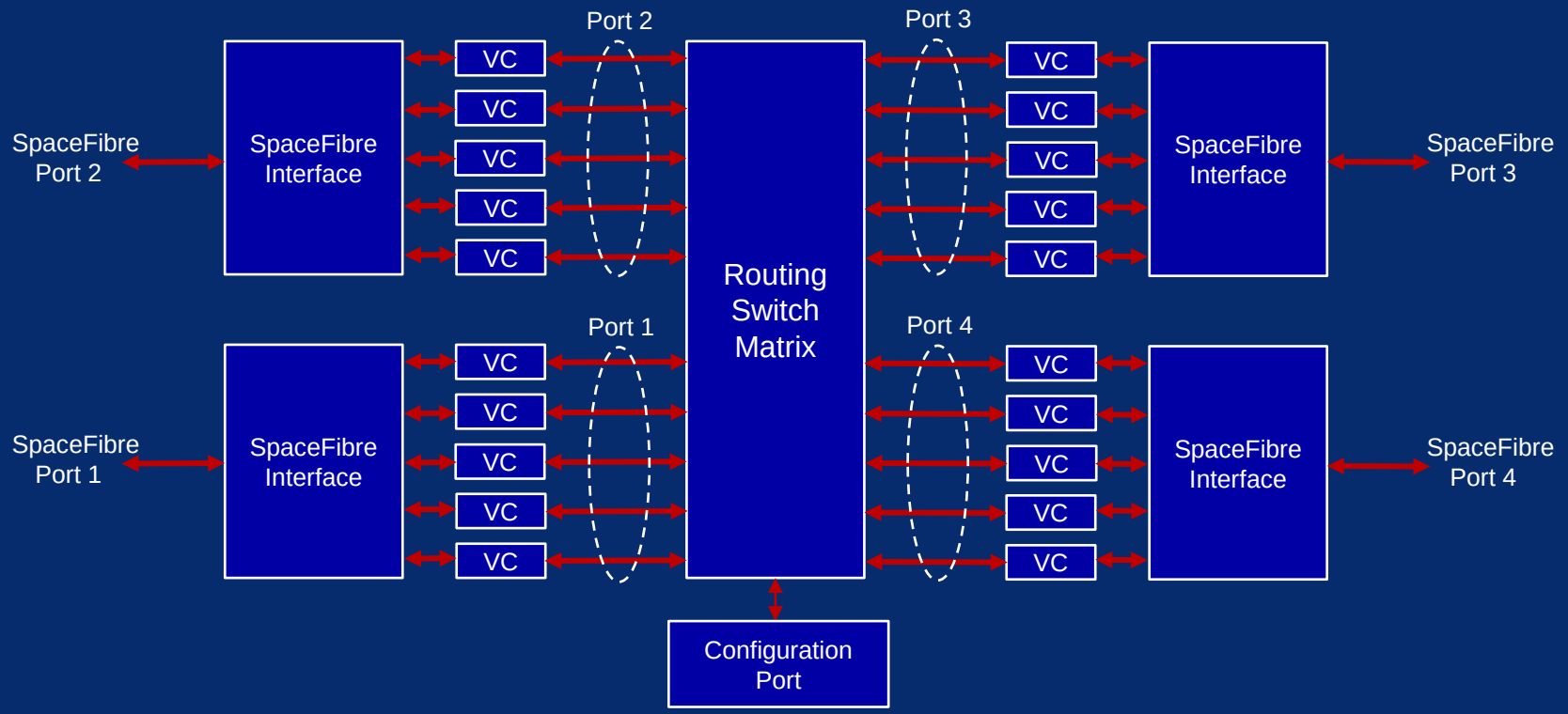
SpaceFibre Applications





SpaceFibre Network Layer

SpaceFibre Routing Switch



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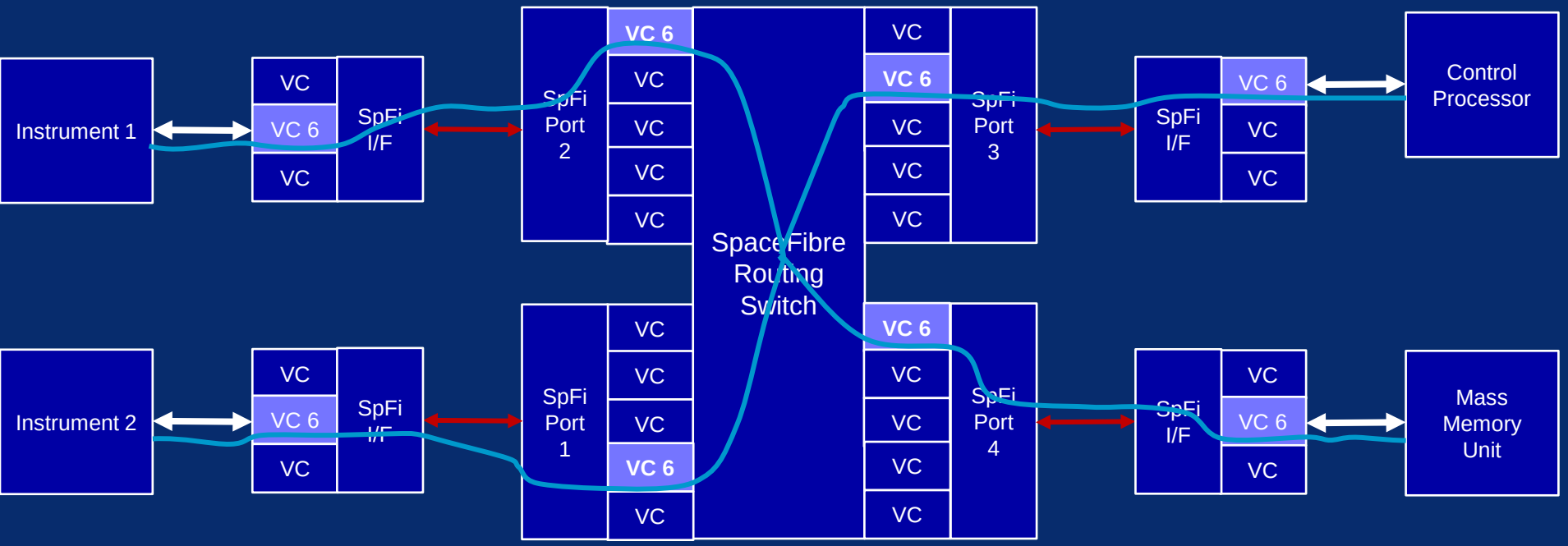
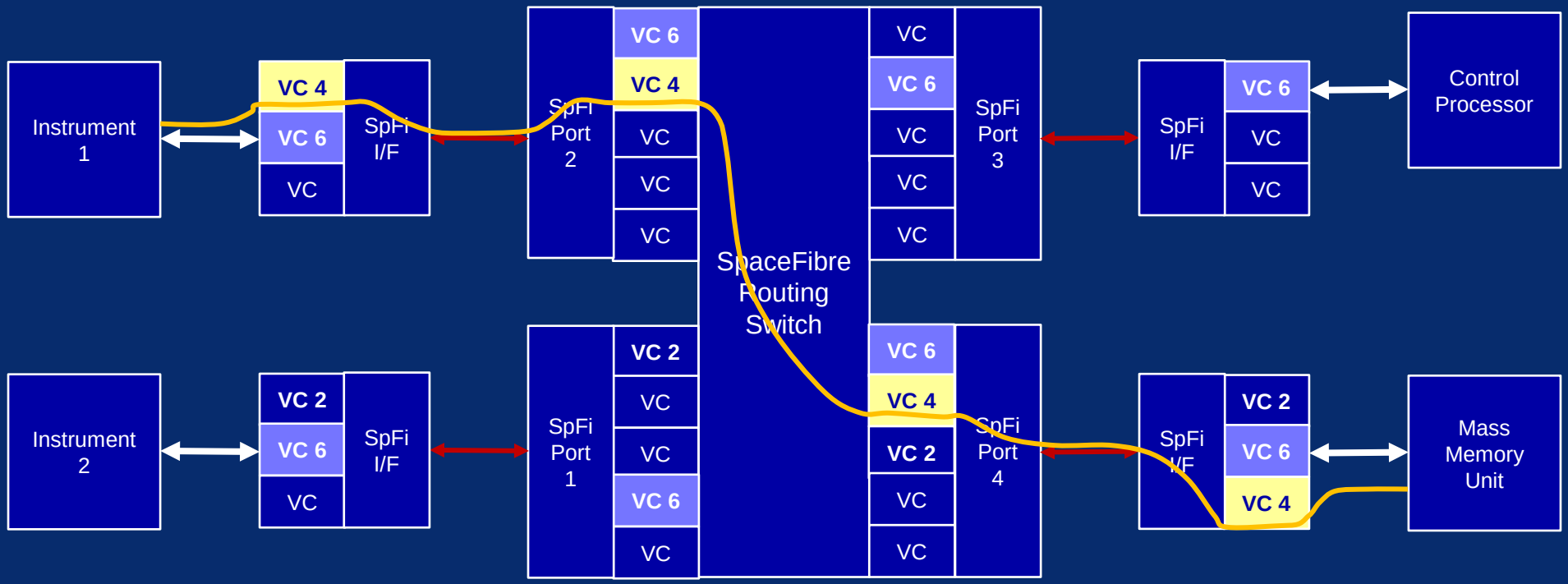
SpaceFibre Virtual Network

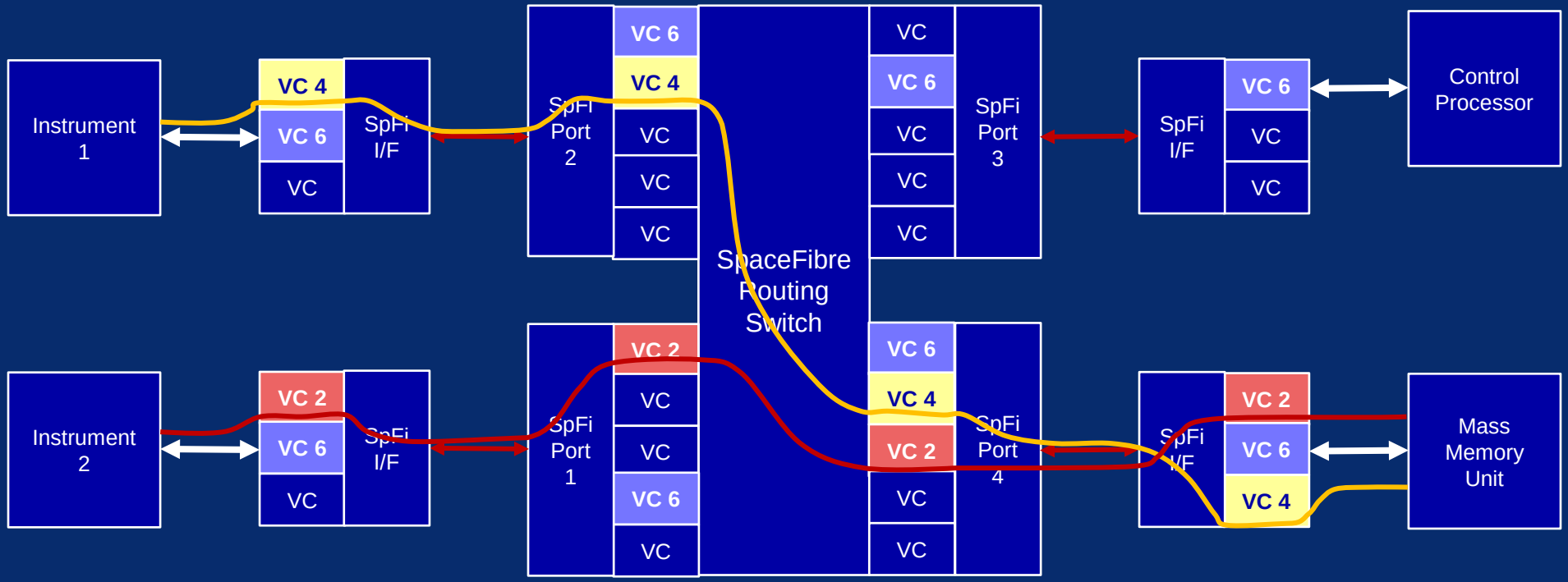


Virtual channel buffers are configured to support specific virtual channels
One set of buffers is always configured to support VC 0, the Configuration Virtual Network

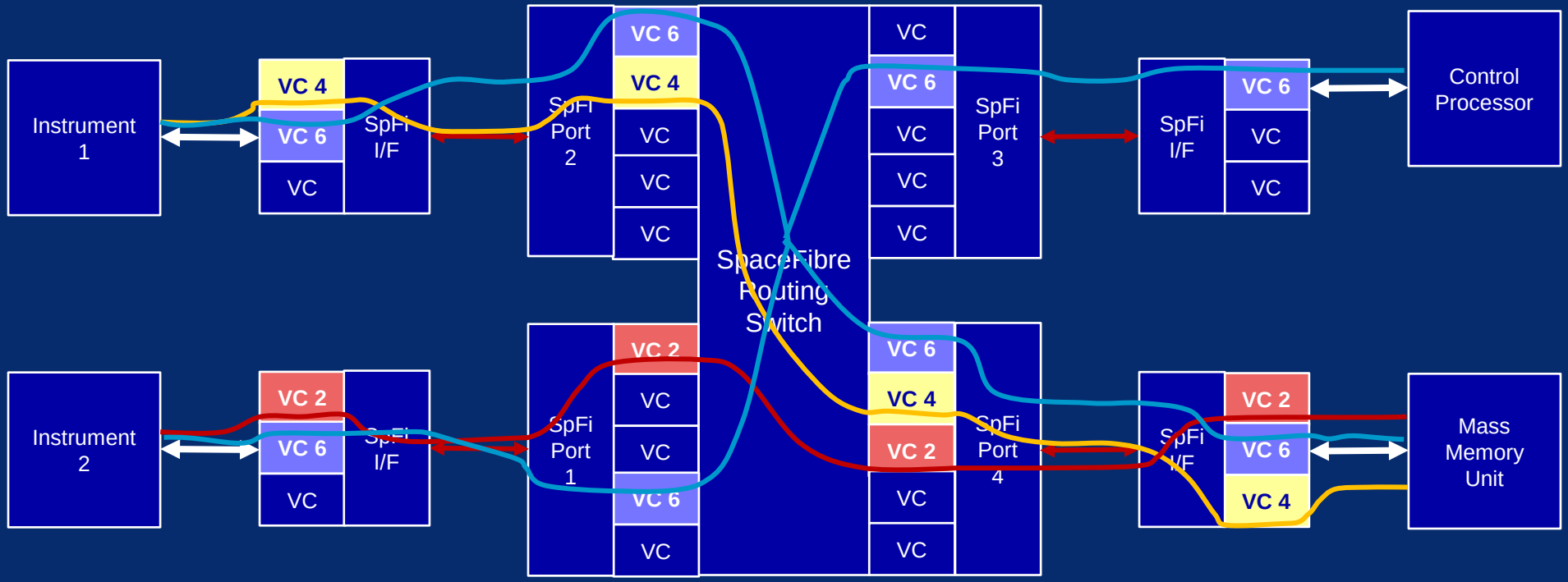
SpaceFibre Virtual Point to Point Link



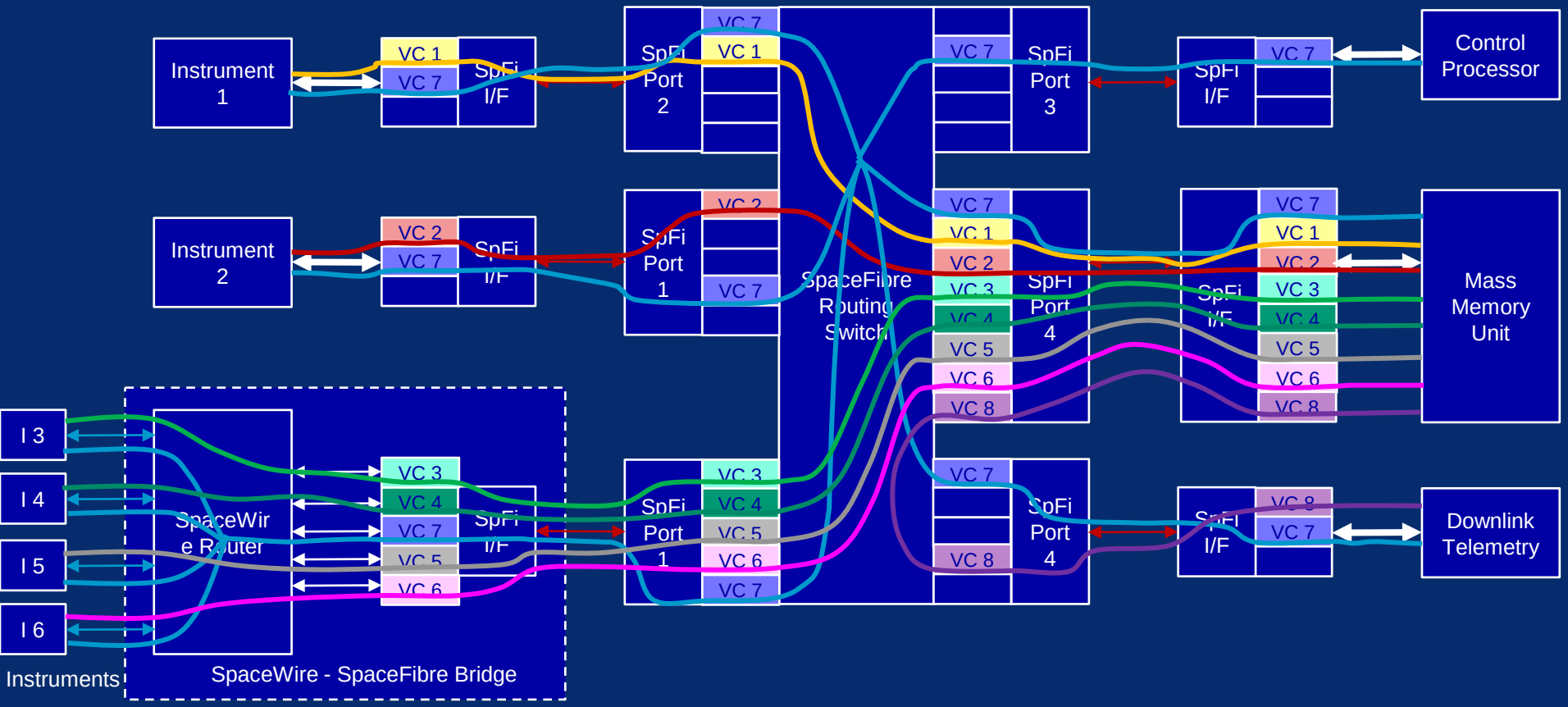
SpaceFibre Virtual Point to Point Link



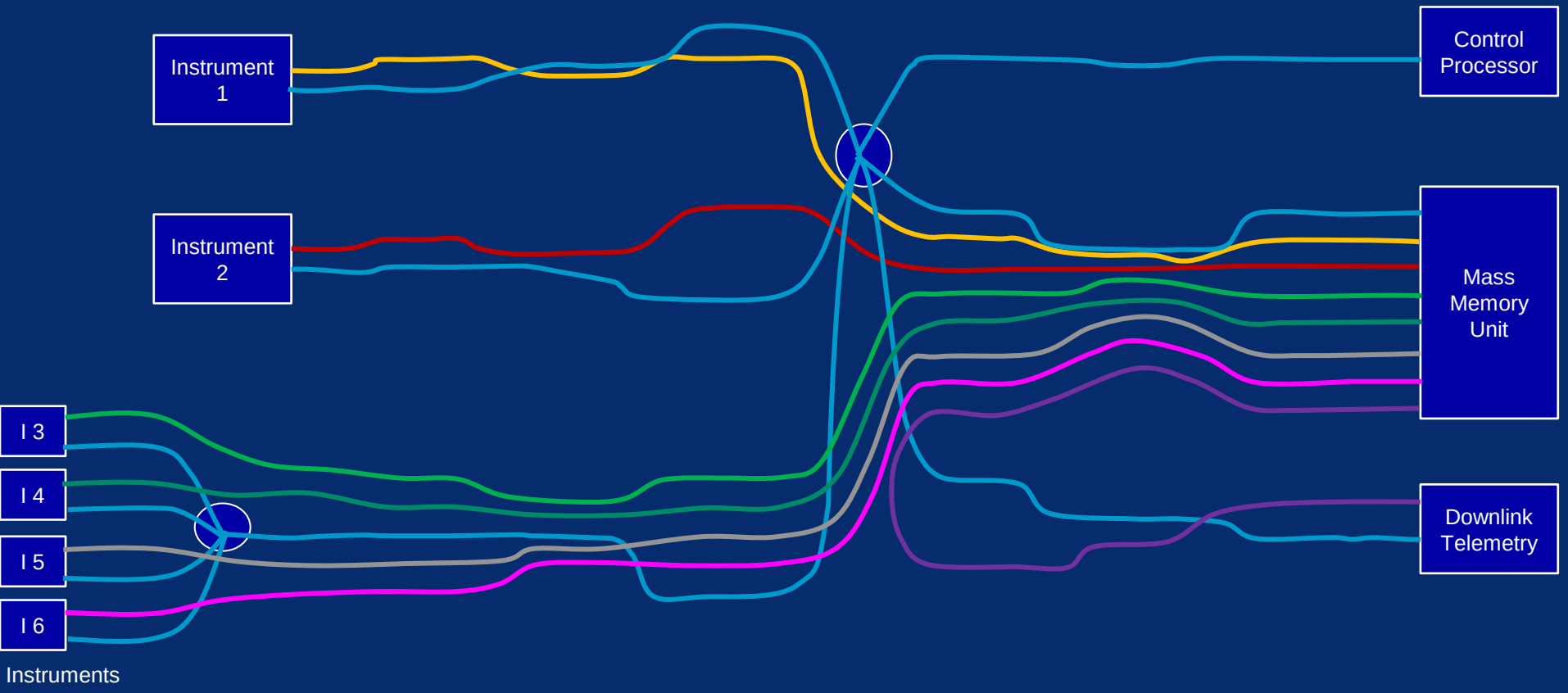
Simple SpaceFibre Network



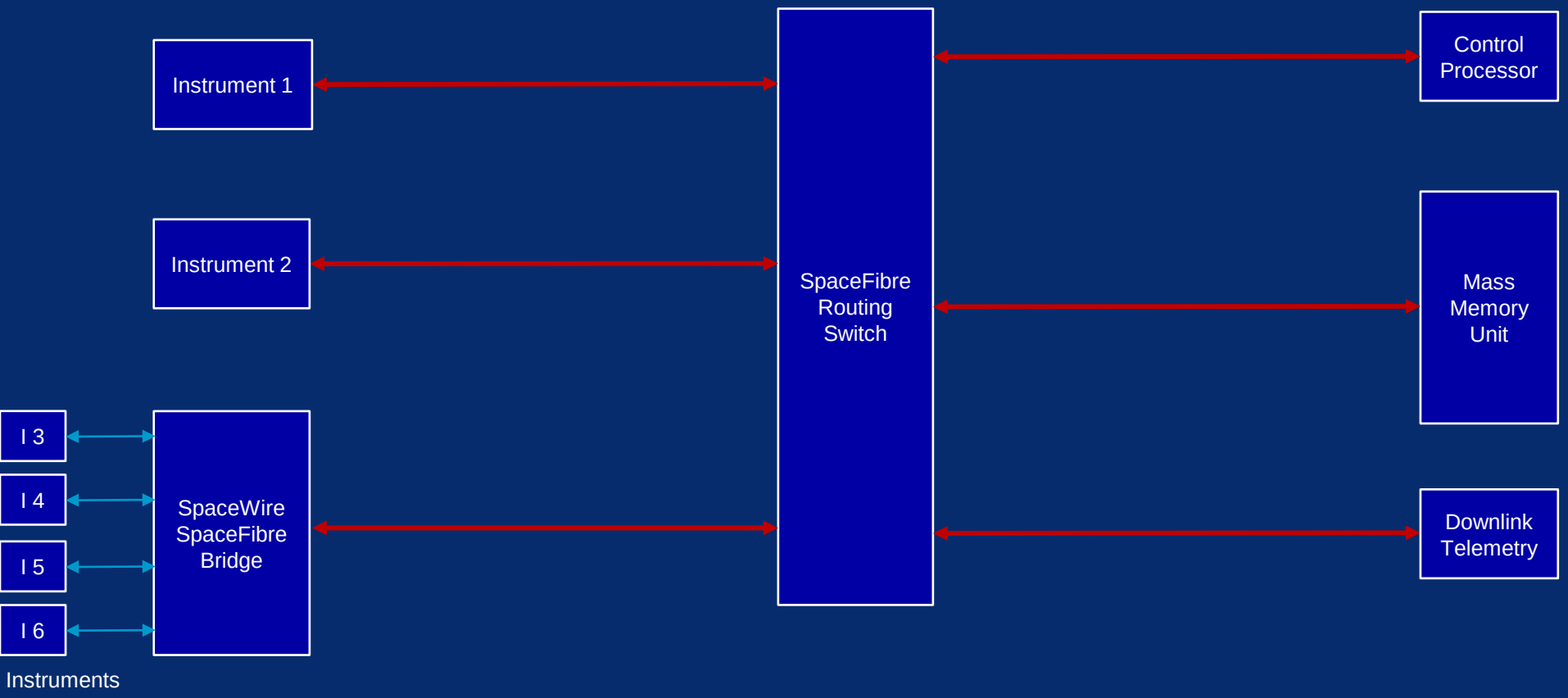
Spacecraft Data Handling Application



Spacecraft Data Handling Application



Spacecraft Data Handling Application



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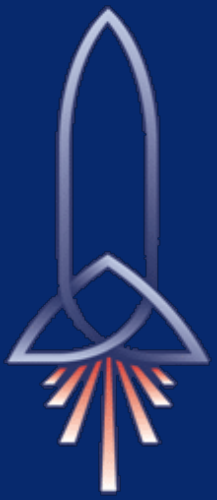
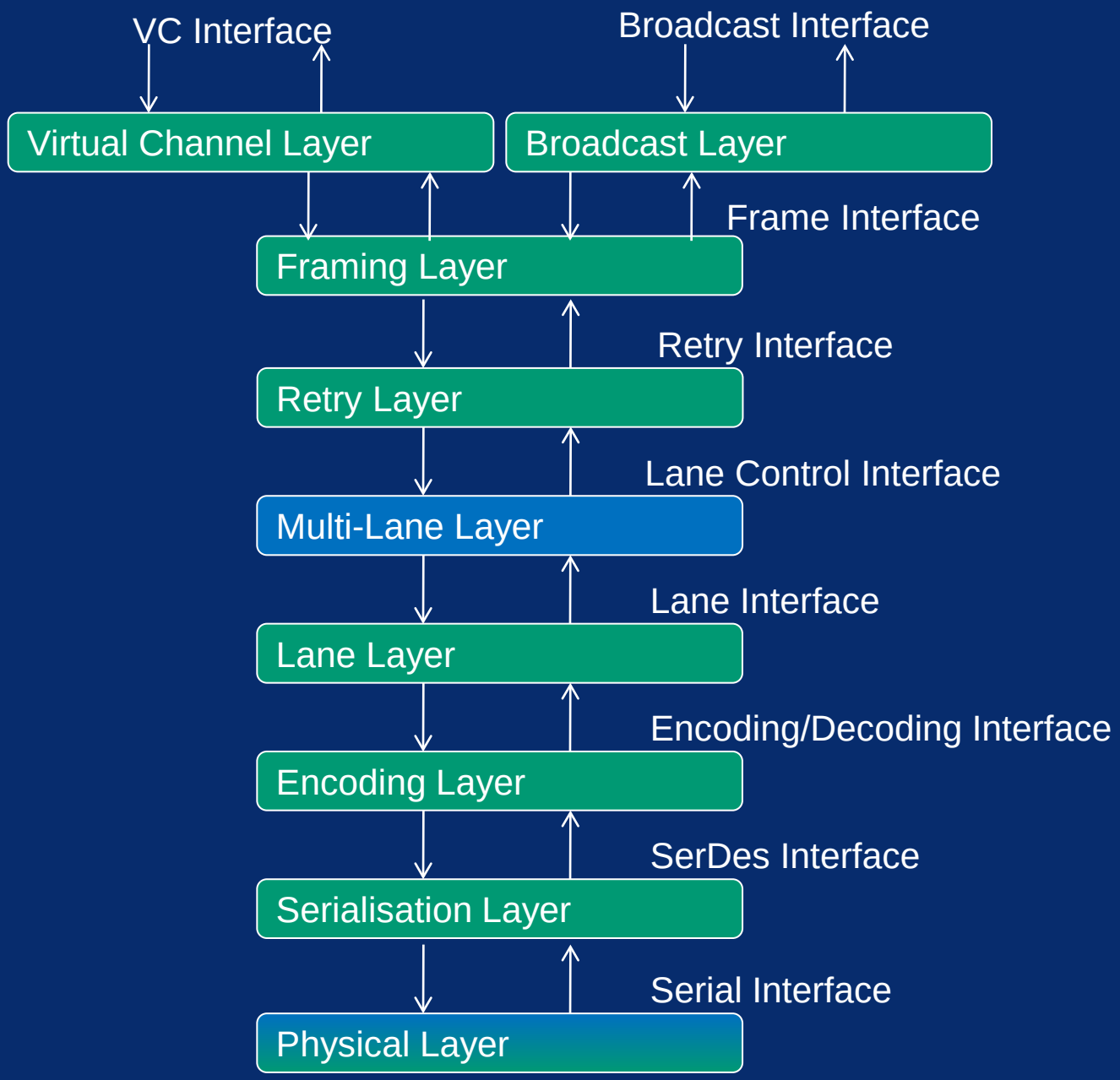
Impact on spacecraft mass

- Mass saving
  - 13 cables 2m each 90g = 2.34 kg
- Replaced with
  - 6 cables 2m each 60g = 0.72 kg
  - Saving of 1.6 kg
- Plus redundancy
  - Saving of 3.2 kg



SpaceFibre Status

SpaceFibre Standard and IP Core



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SpaceFibre Flight/EGSE Cable Assembly

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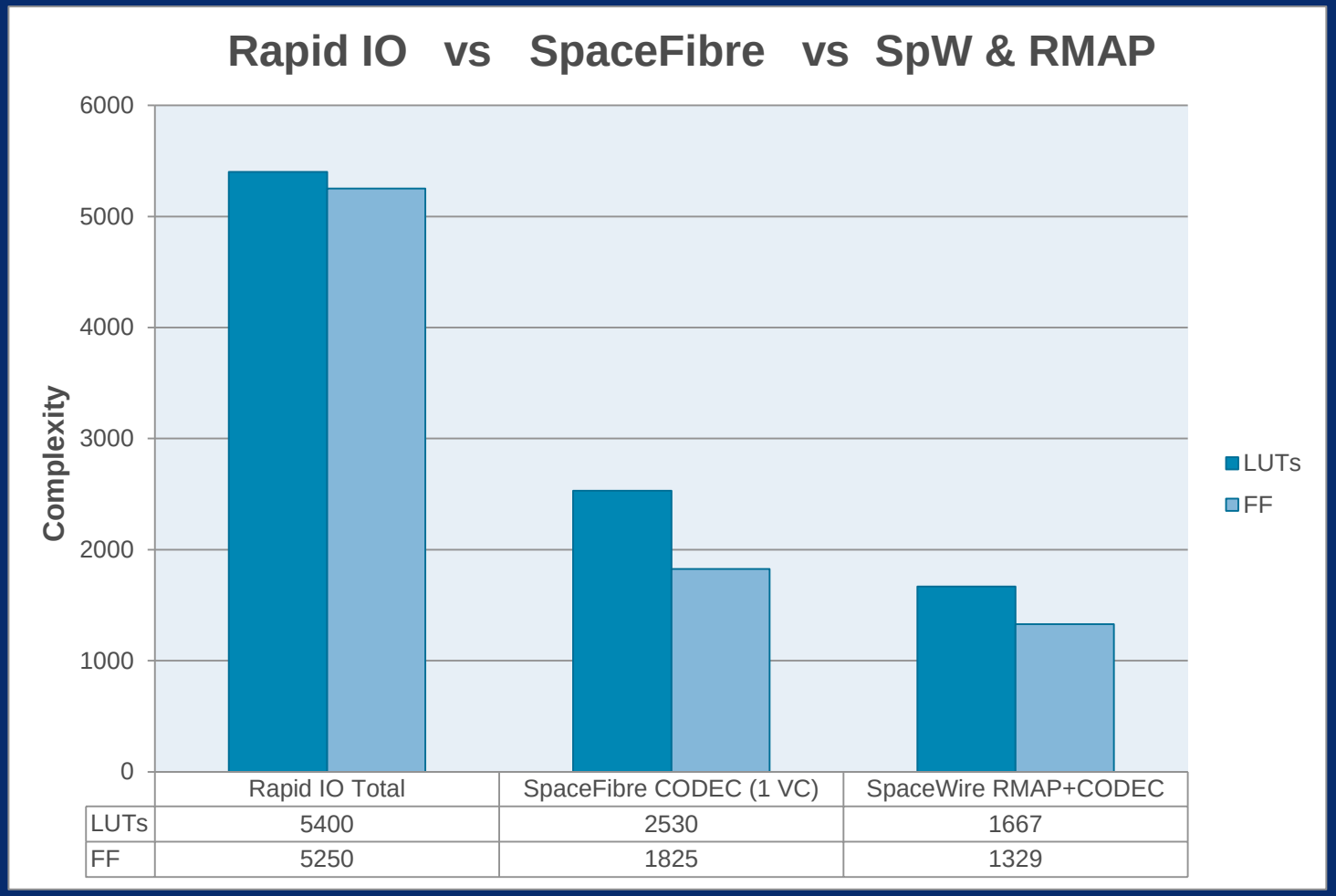
SpaceFibre IP Core

- VHDL IP Core
  - Compliant to current version of standard
  - Interfaces
    - Virtual channel interface
    - Broadcast channel interface
    - Management interface
  - QoS
    - Integrated priority and bandwidth reservation
    - Scheduling with 64 time-slots (TBC)
  - Retry
    - Rapid retry
  - Single lane
    - Multi-lane support will be provided 2Q2013

SpaceFibre smaller than RAPID IO



	Rapid IO Total	SpaceFibre CODEC (1 VC)	SpaceWire RMAP+CODEC
LUTs	5400	2530	1667
FF	5250	1825	1329

Rapid IO v2.1 x1 (Based on Xilinx srio_ds696, Spartan 6 results)

SpaceFibre cost of multiple VCs

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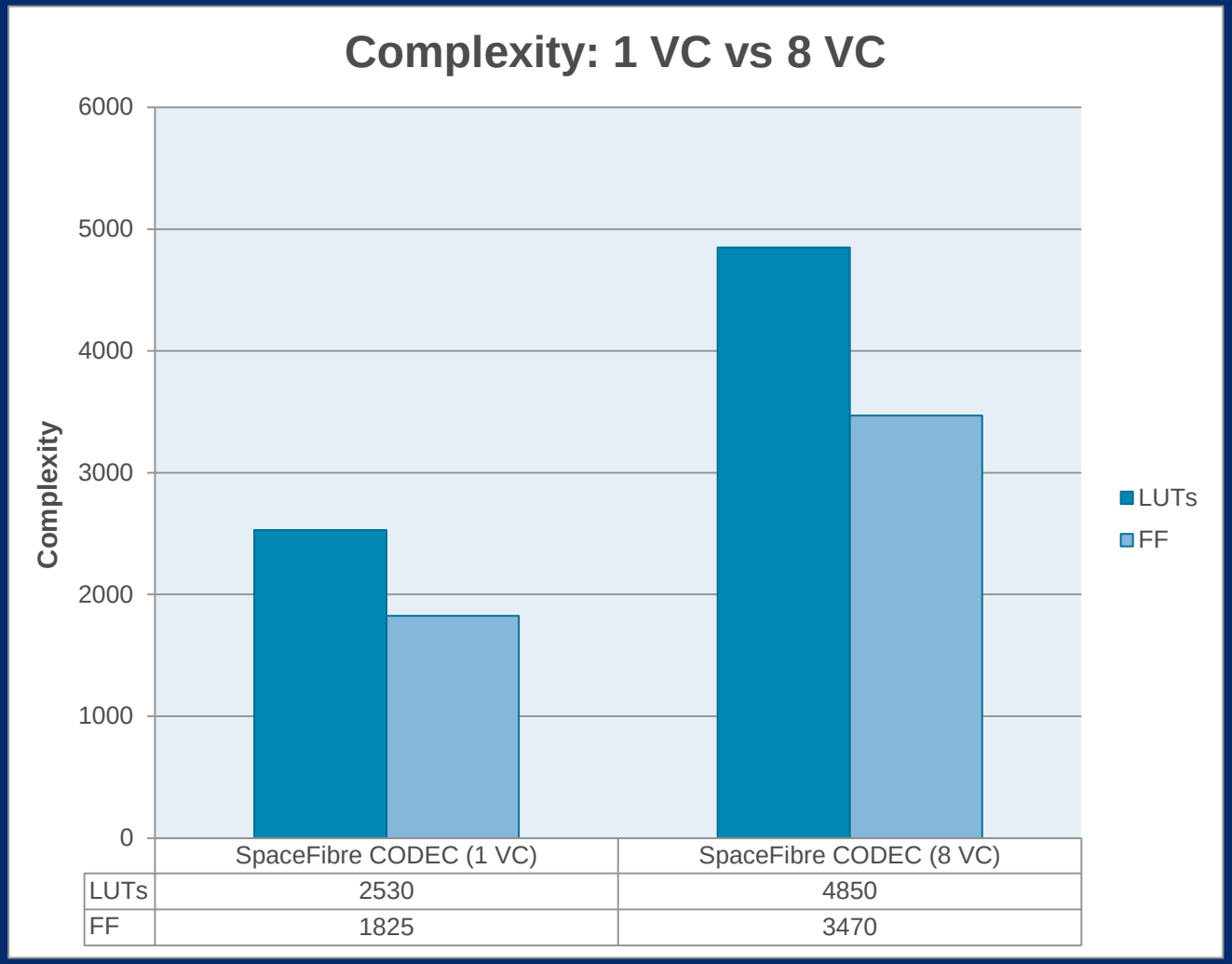

STAR Fire

- SpaceFibre Diagnostic Interface and Analyser
- SpaceFibre interface
  - 2.5 Gbits/s signalling rate
  - 8 VCs on each SpaceFibre interface
  - 2 VCs connected to internal SpW router
  - 6 VC connected to high speed pattern generators/checkers
- Diagnostics / Link Analysis
  - Full analysis capabilities

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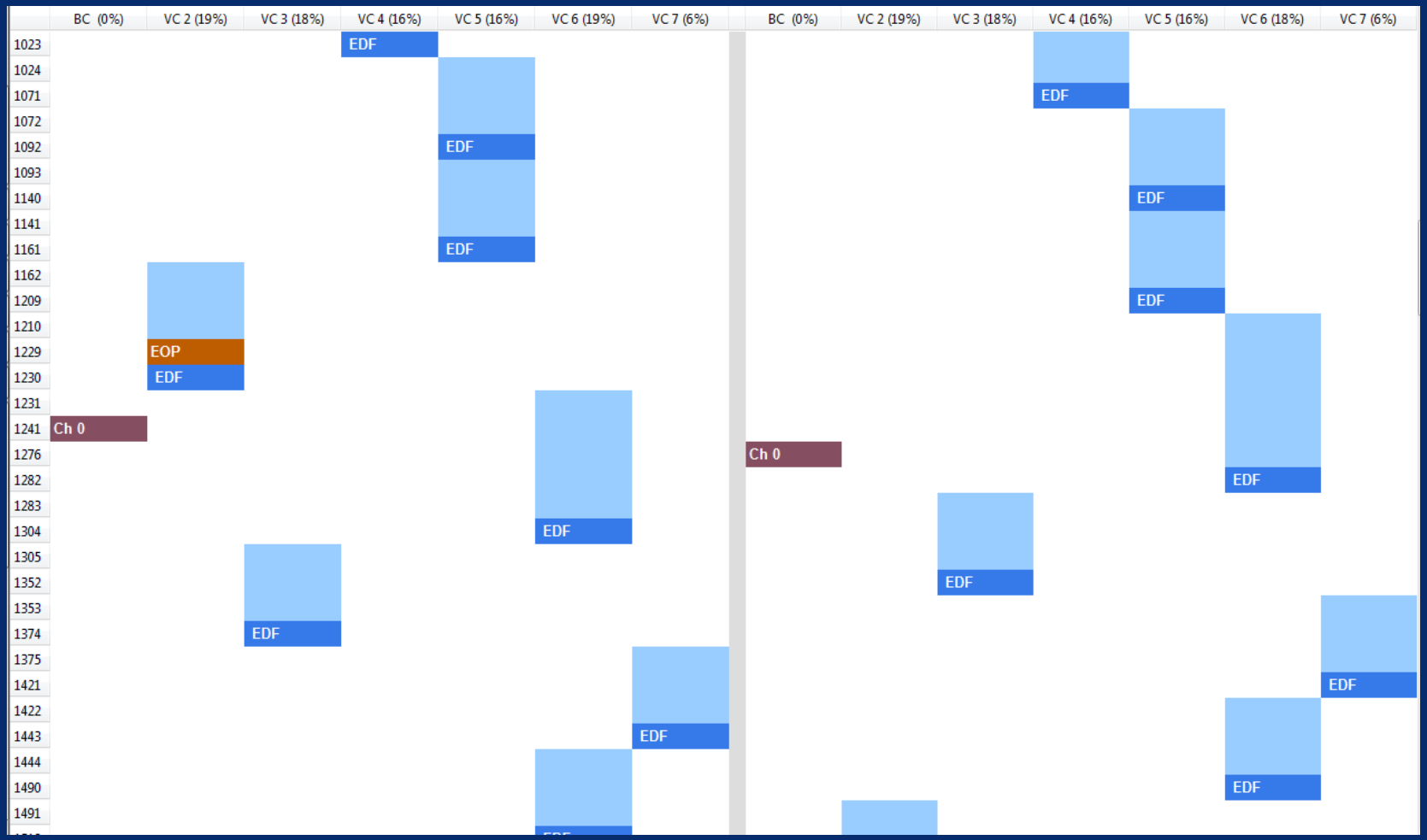
StarFire

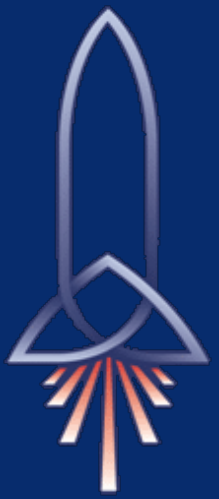
- *Word* viewer

Comalnit	LLCW	INIT3	0	INIT3	INIT2	Comalnit	LLCW	INIT2	INIT2
Comalnit	LLCW	INIT3	0	INIT3	INIT2	Comalnit	LLCW	INIT2	INIT2
Comalnit	LLCW	INIT3	0	INIT3	INIT2	Comalnit	LLCW	INIT2	INIT2
Comalnit	LLCW	INIT3	0	INIT3	INIT2	Comalnit	LLCW	INIT2	INIT2
Comalnit	LLCW	INIT3	0	INIT3	INIT3	Comalnit	LLCW	INIT3	0
Comalnit	LLCW	INIT3	0	INIT3	INIT3	Comalnit	LLCW	INIT3	0
Comalnit	LLCW	INIT3	0	INIT3	INIT3	Comalnit	LLCW	INIT3	0
Comalnit	LLCW	INIT3	0	INIT3	INIT3	Comalnit	LLCW	INIT3	0
Comalnit	LLCW	INIT3	0	INIT3	IDLE	Comma	LLCW	IDLE	IDLE
Comalnit	LLCW	INIT3	0	INIT3	IDLE	Comma	LLCW	IDLE	IDLE
Comalnit	LLCW	INIT3	0	INIT3	IDLE	Comma	LLCW	IDLE	IDLE
Comalnit	LLCW	INIT3	0	INIT3	IDLE	Comma	LLCW	IDLE	IDLE
Comalnit	LLCW	INIT3	0	INIT3	FCT +1 (1)	FCT	1	1	4F
Comalnit	LLCW	INIT3	0	INIT3	FCT +2 (2)	FCT	2	2	8A
Comalnit	LLCW	INIT3	0	INIT3	FCT +3 (3)	FCT	3	3	76
Comalnit	LLCW	INIT3	0	INIT3	FCT +4 (4)	FCT	4	4	C1

STAR Fire

- *Frame* viewer



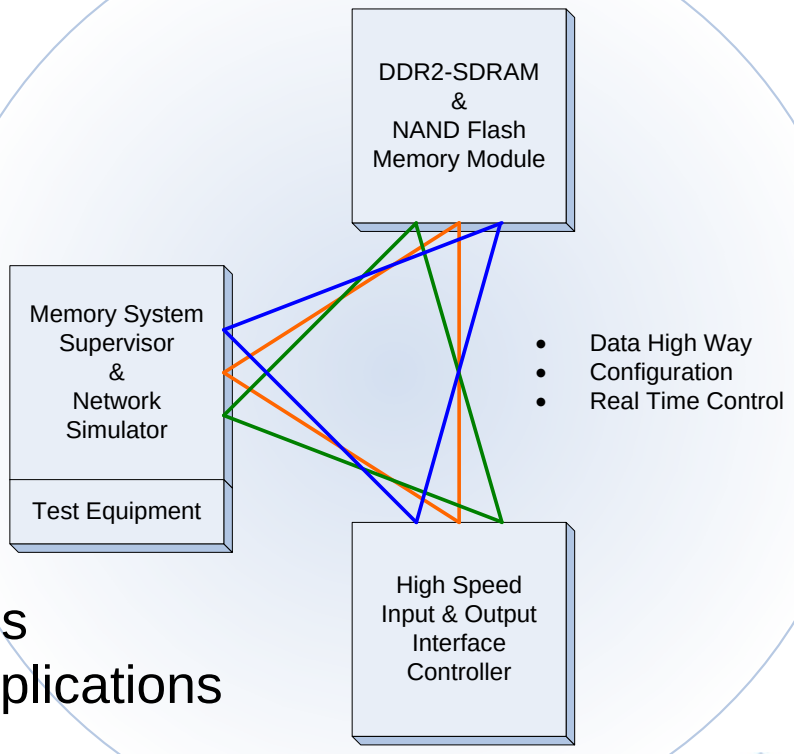


ESA Projects using SpaceFibre

- 2 x High Performance COTS Based Computer, Step 2 (Prototyping and Validation), Astrium (Fr)
- 1 x Leon with Fast Fourier Transform Co-processor, SSBV (NL)
- 1 x FPGA Based Generic Module and Dynamic Reconfigurator, TWT (D)
- 2 x Next Generation Mass Memory, Astrium (D), IDA (D)
- 1 x High Processing Power DSP, Astrium (UK)

Next Generation Mass Memory

- Team
  - Astrium GmbH
  - IDA
  - University of Dundee
- Objective
  - High capacity
  - High I/O bandwidth
  - Flexible architecture
  - Radiation tolerant memory devices
  - Mass memory for future space applications



Next Generation Mass Memory