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SpaceWire and SpaceFibre

Steve Parkes,
Albert Ferrer Florit, Alberto Gonzalez Villafranca,
Chris McClements and Bruce Yu
STAR-Dundee Ltd.

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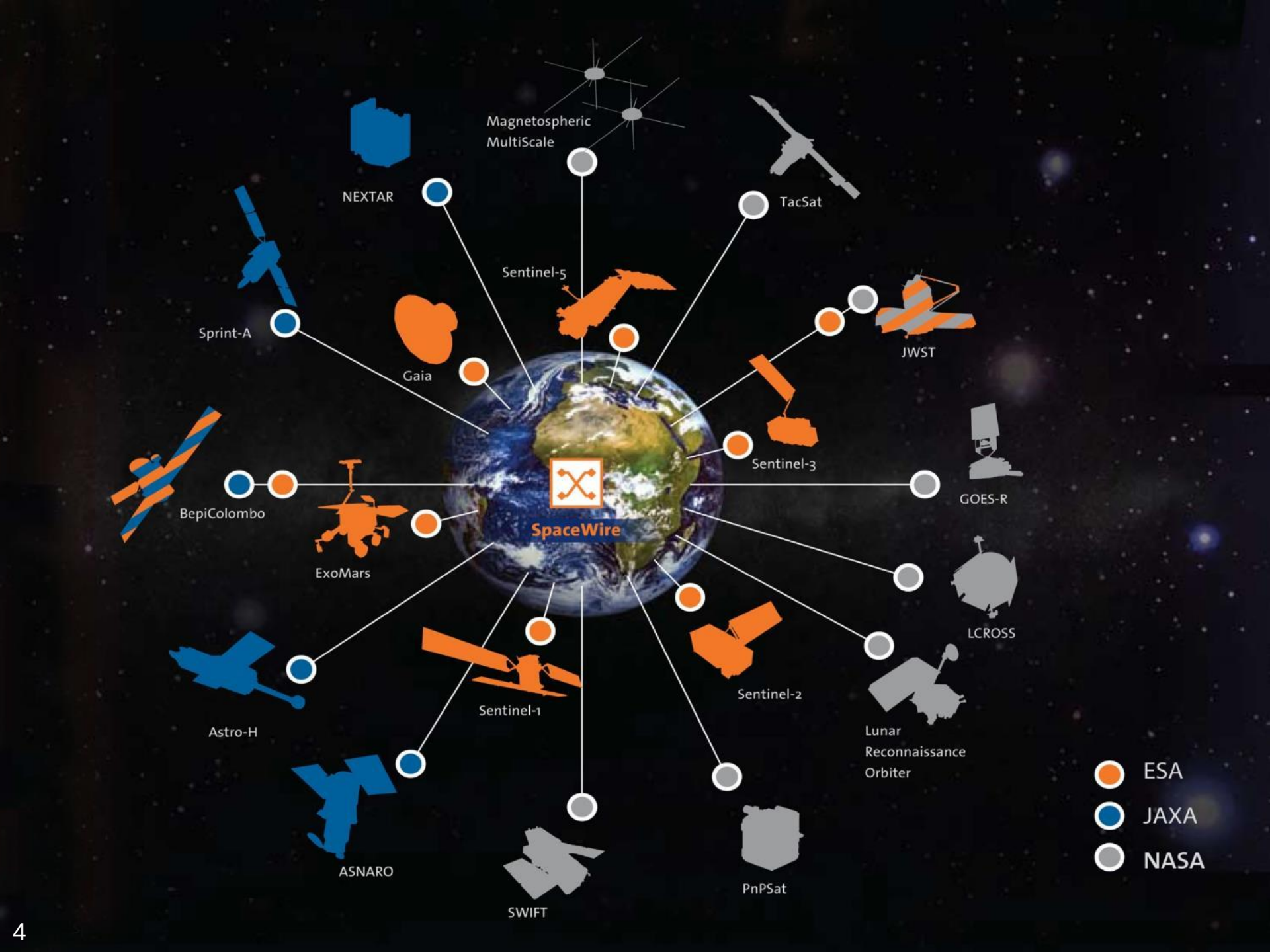
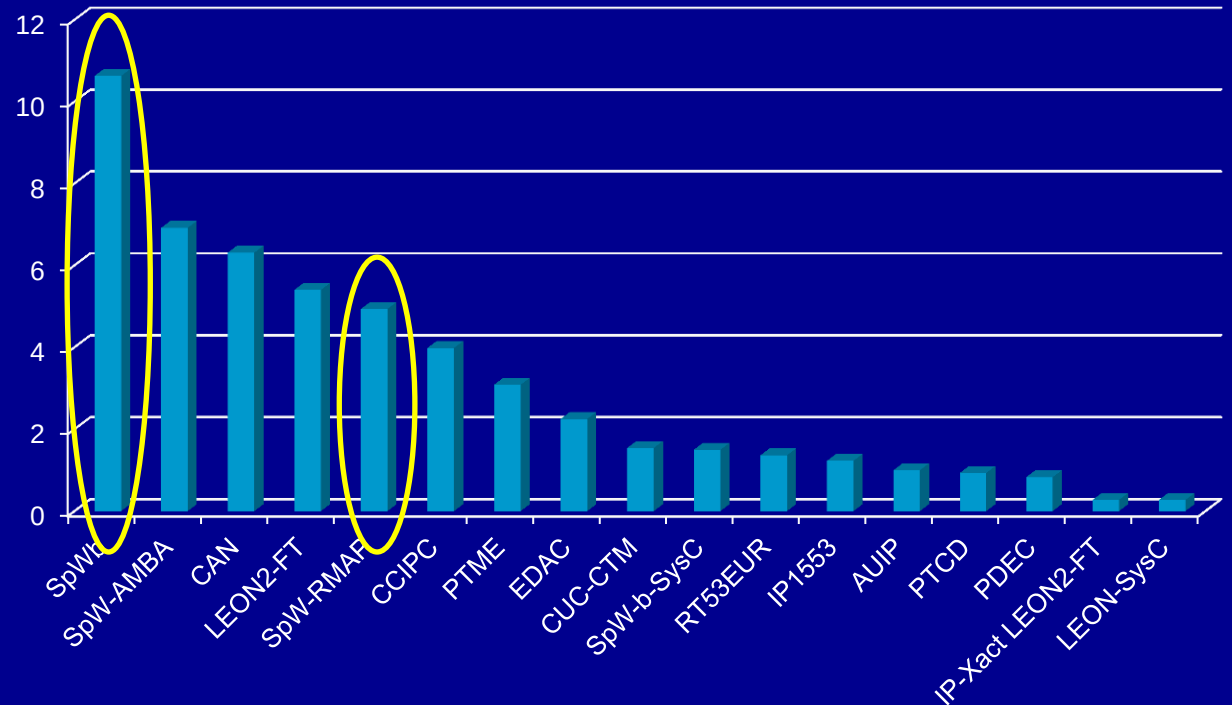
SpaceWire

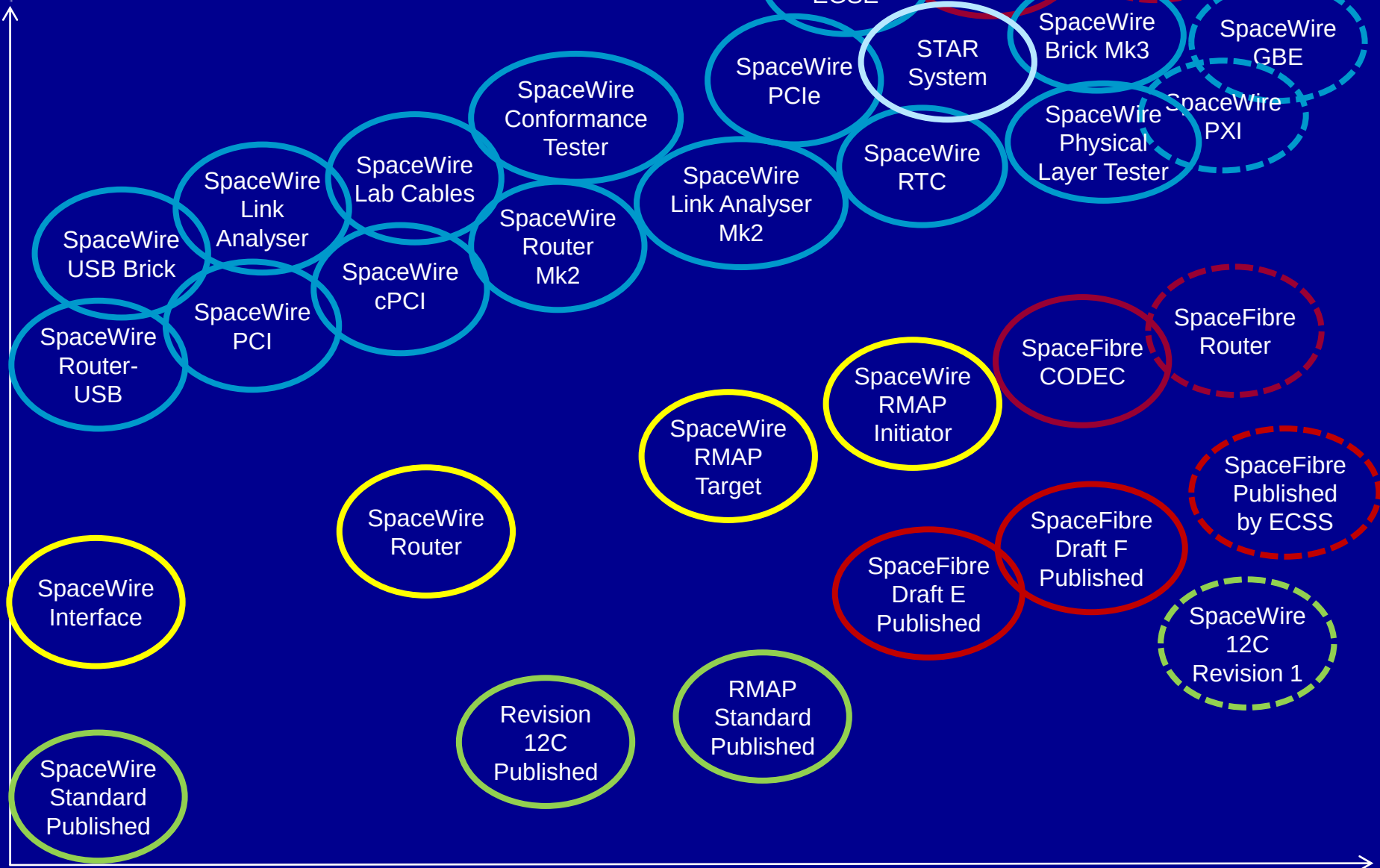

Magnetospheric
MultiScale
NEXTAR
TacSat
Sentinel-5
Sprint-A
Gaia
JWST
Sentinel-3
BepiColombo
GOES-R
SpaceWire
ExoMars
LCROSS
Sentinel-2
Sentinel-1
Astro-H
Lunar
Reconnaissance
Orbiter
ASNARO
PnPSat
SWIFT
ESA
JAXA
NASA

SpaceWire IP Cores

- SpaceWire IP
  - SpaceWire Interface
  - SpaceWire Router
  - SpaceWire RMAP Target
  - SpaceWire RMAP Initiator
- Running in RTAX, ProASIC and RTG4



STAR-Dundee Product Roadmap



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SpaceFibre

SpaceFibre

- SpaceFibre is
  - A spacecraft on-board data link and network
- SpaceFibre runs over
  - Electrical and fibre optic cables
- SpaceFibre initially targeted at
  - Very high data rate instruments
    - Synthetic Aperture Radar
    - Multi-spectral imaging instruments
- SpaceFibre meets the needs of
  - Most spacecraft onboard network applications
  - Because of its built-in capabilities
    - Quality of Service (QoS)
    - Fault detection, isolation and recovery (FDIR)
    - Compatibility with SpaceWire

SpaceFibre Benefits

- Very high data rates
- Reduction of harness mass
- Simplification of redundancy
- Increase in reliability
- Straightforward error recovery
- Deterministic data delivery
- Long distance
- Galvanic isolation

SpaceFibre Key Features

- High performance
  - 2.5 Gbits/s current flight qualified technology
  - 3.125 Gbits/s soon (6.25 Gbits/s coming)
  - Multi laning of up to 16 lanes (40 Gbits/s)
- Innovative integrated QoS
  - Priority
  - Bandwidth reservation
  - Scheduling
- Novel integrated FDIR support
  - Transparent recovery from transient errors
  - Error containment in virtual channels and frames
  - “Babbling Idiot” protection
- Low latency
  - Broadcast codes
- Compatible with SpaceWire at packet level

SpaceFibre Target Applications

- SpaceFibre now targeted at
  - Most spacecraft onboard network applications
    - SAR and multi-spectral, high resolution optical
    - Any system where SpaceWire is used
      - Interfacing to existing SpaceWire equipment
    - AOCs/GNC and other control systems
    - Launchers
- Single integrated network
  - Carrying
    - Instrument data
    - Configuration and control information
    - Deterministic traffic
    - High resolution time information
    - Event signals
  - Improves reliability, mass, cost

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SpaceFibre Integrated QoS

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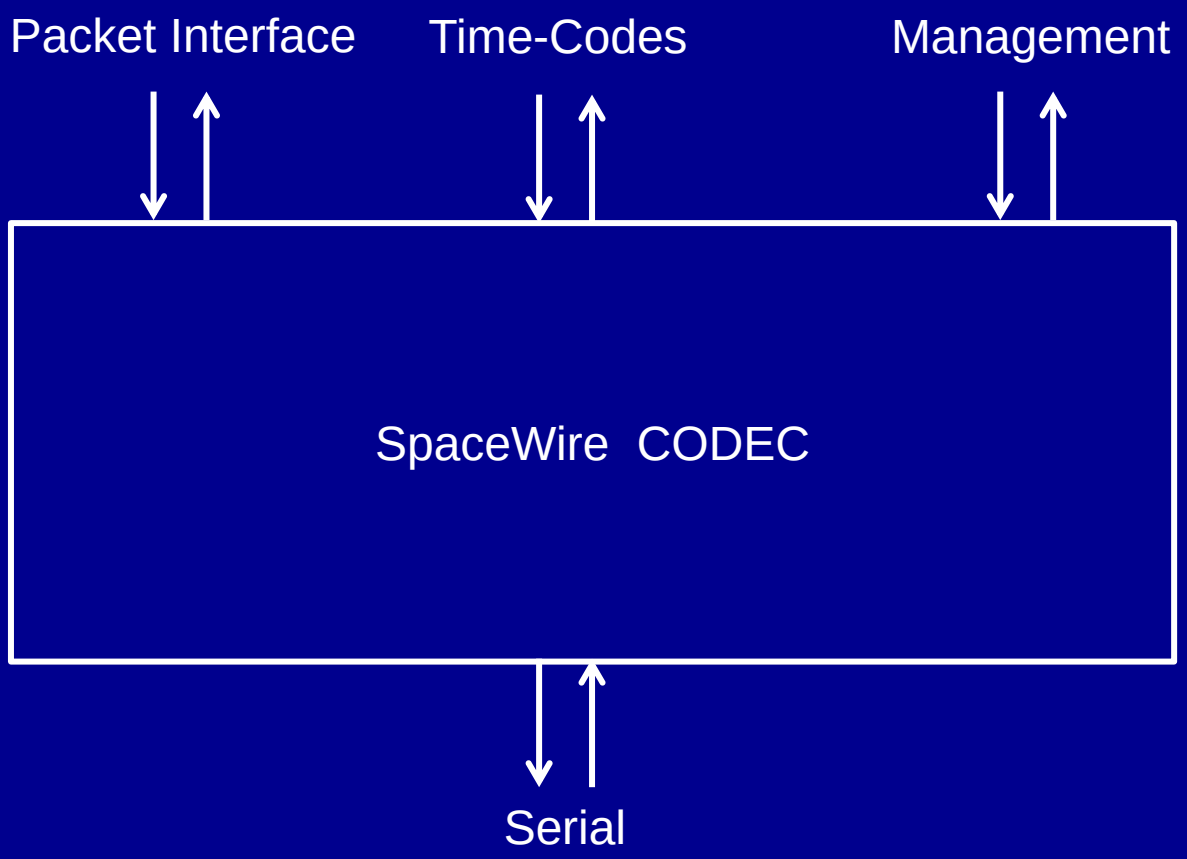
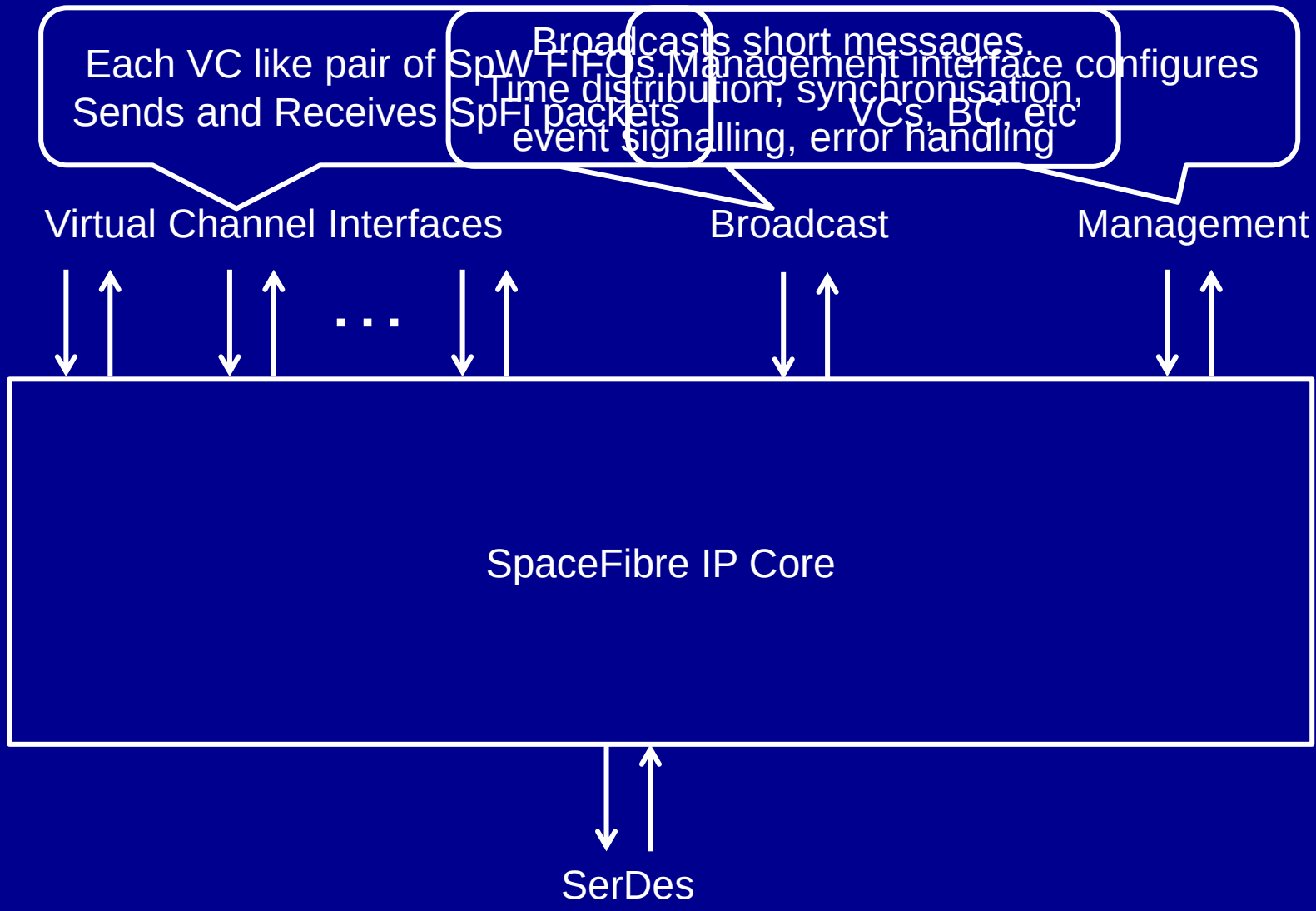
SpaceWire CODEC



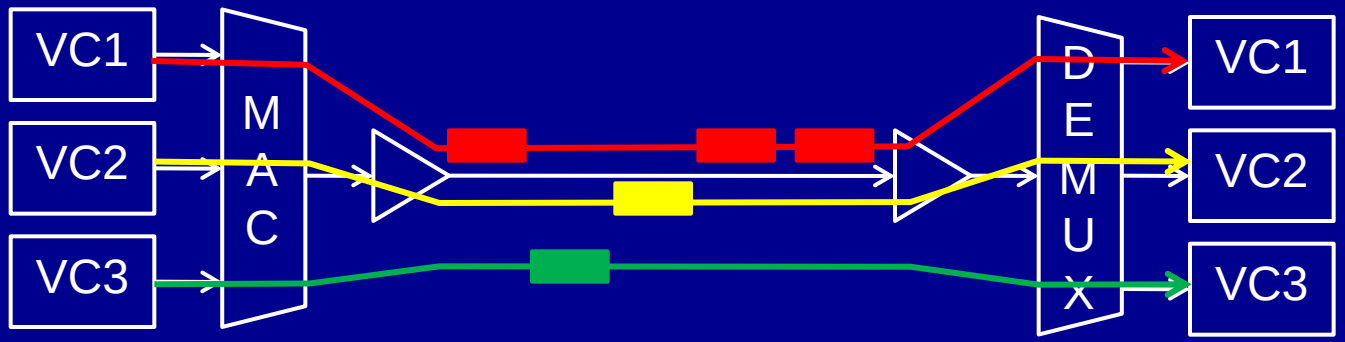
SpaceFibre IP Core



SpaceFibre Quality of Service

- Integrated QoS scheme
  - Priority
    - VC with highest priority
  - Bandwidth reserved
    - VC with allocated bandwidth and recent low utilisation
  - Scheduled
    - Synchronised time-slots
      - E.g. by broadcast messages
    - VCs allocated to specific time-slots
    - In allocated time-slot, VC allowed to send
- “Integrated” because
  - All three QoS work together
  - QoS is implemented in the hardware of the SpaceFibre interface

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

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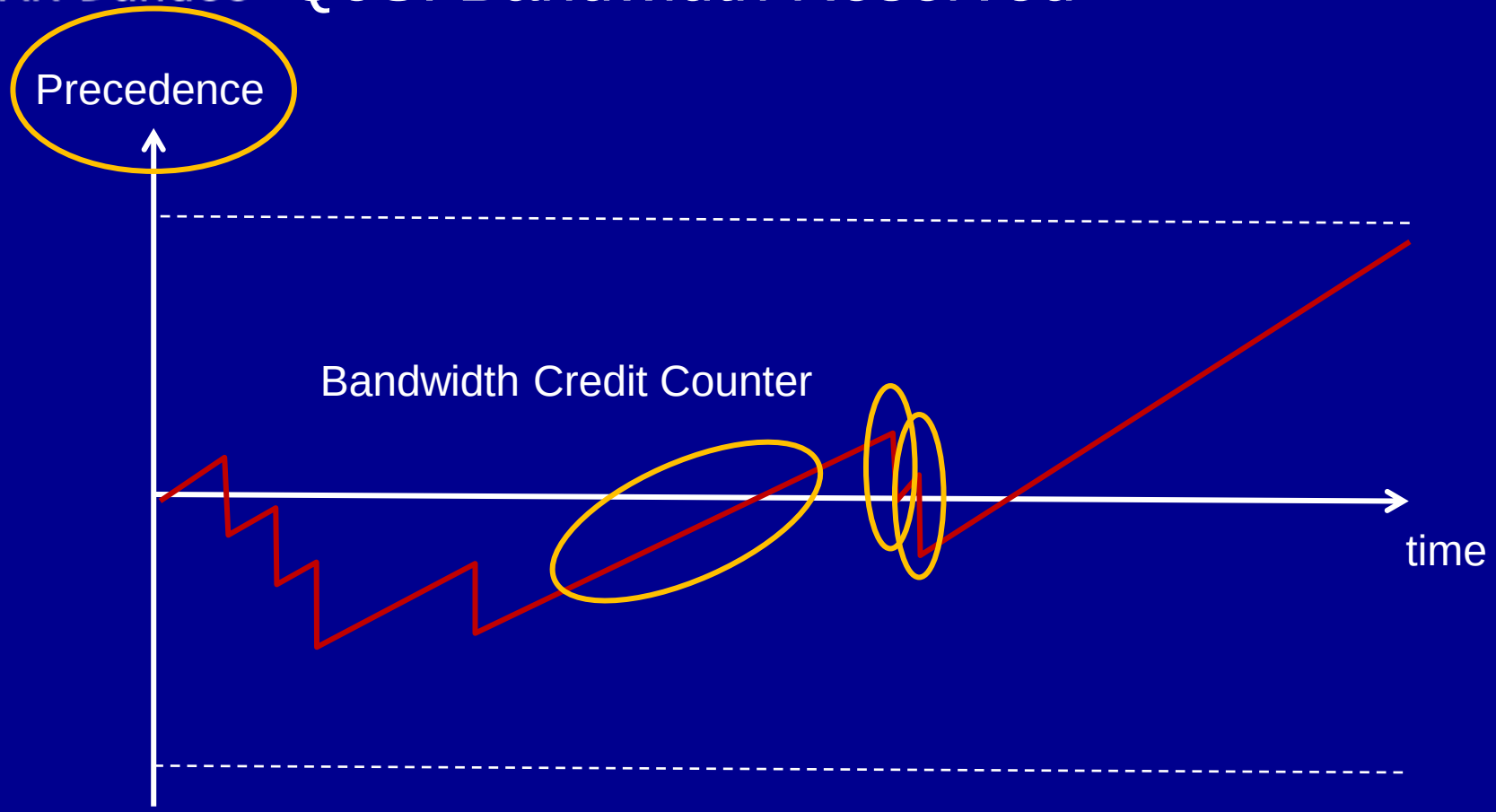
QoS: Bandwidth Reserved



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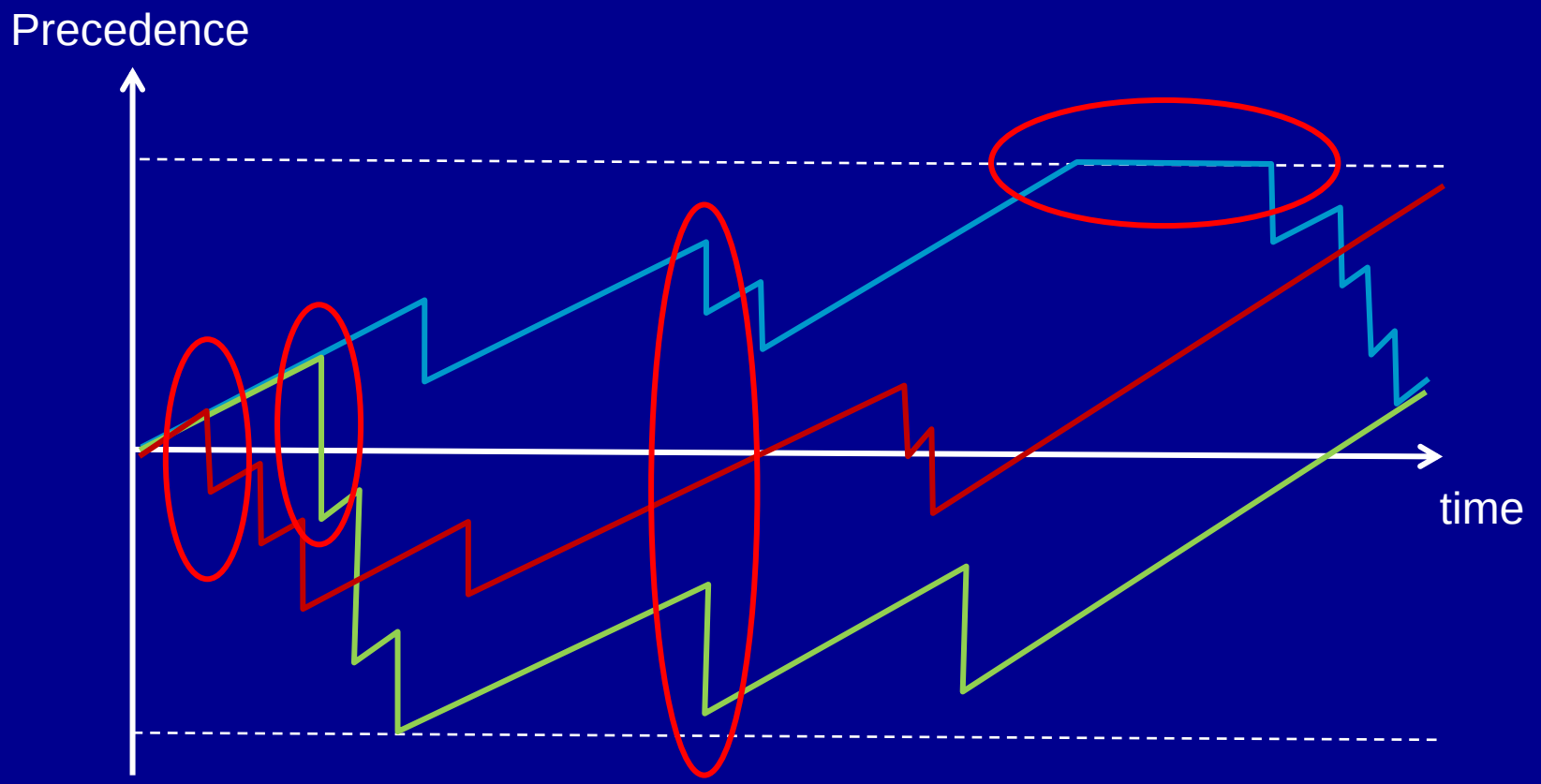
QoS: Bandwidth Reserved



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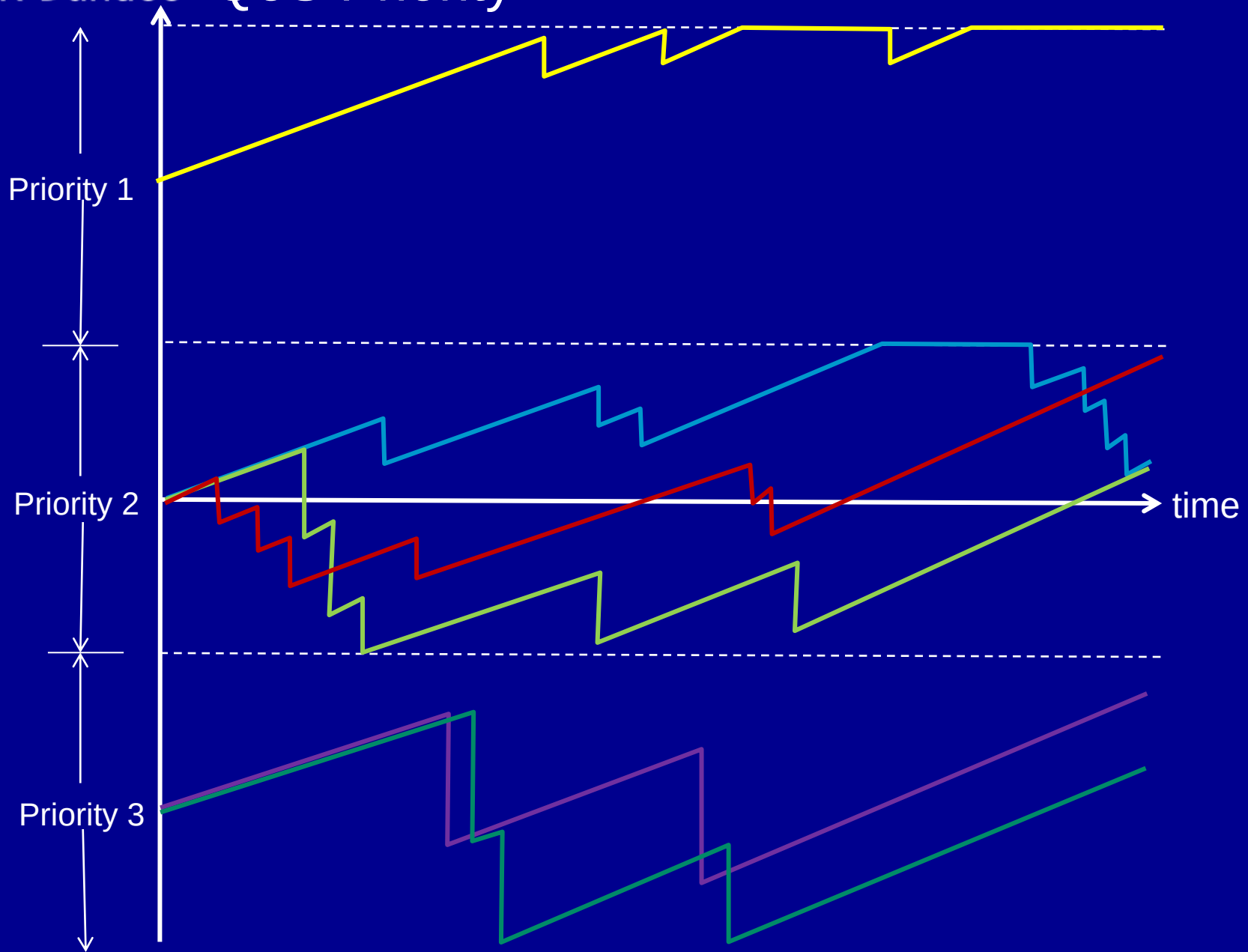
QoS Priority



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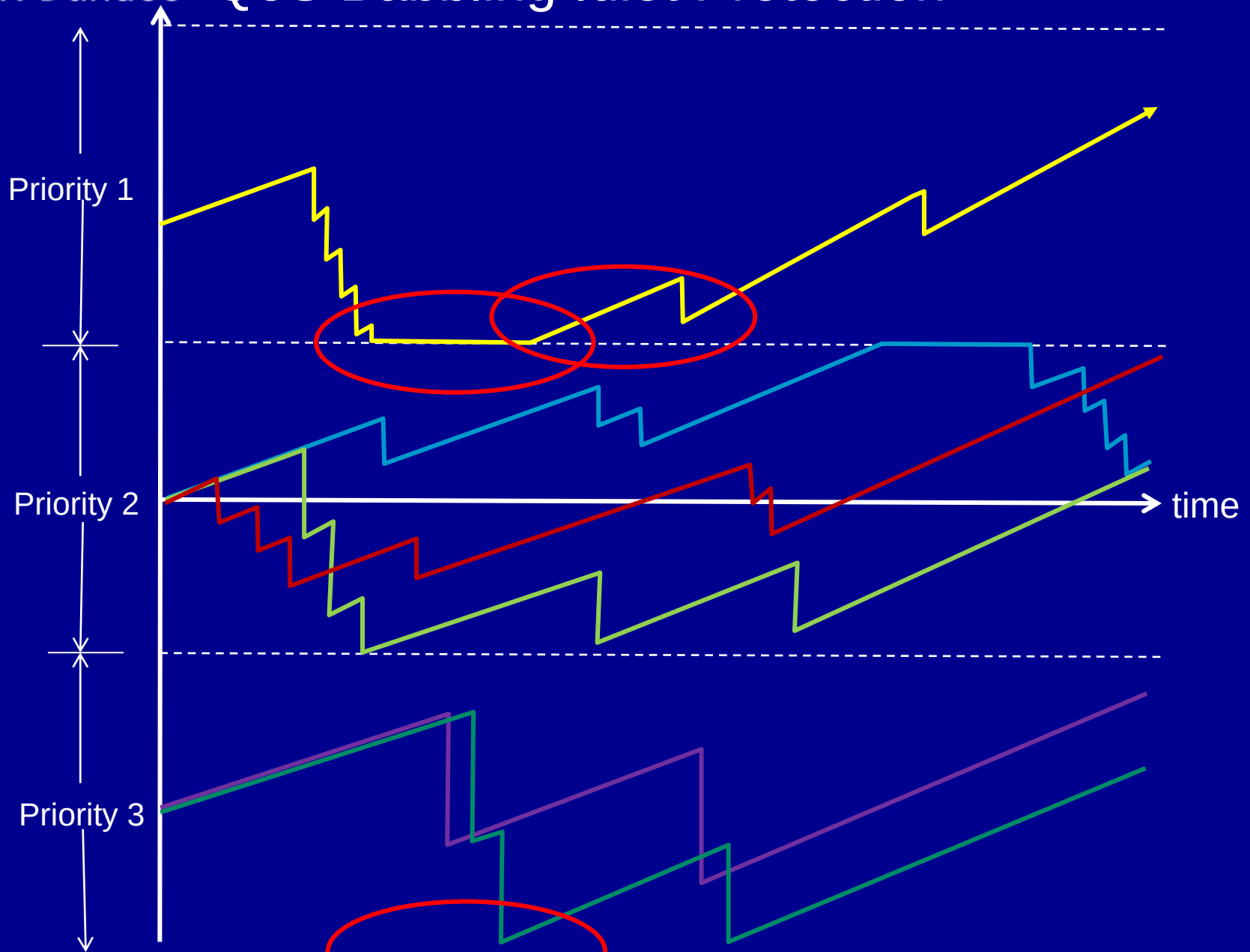
QoS Babbling Idiot Protection



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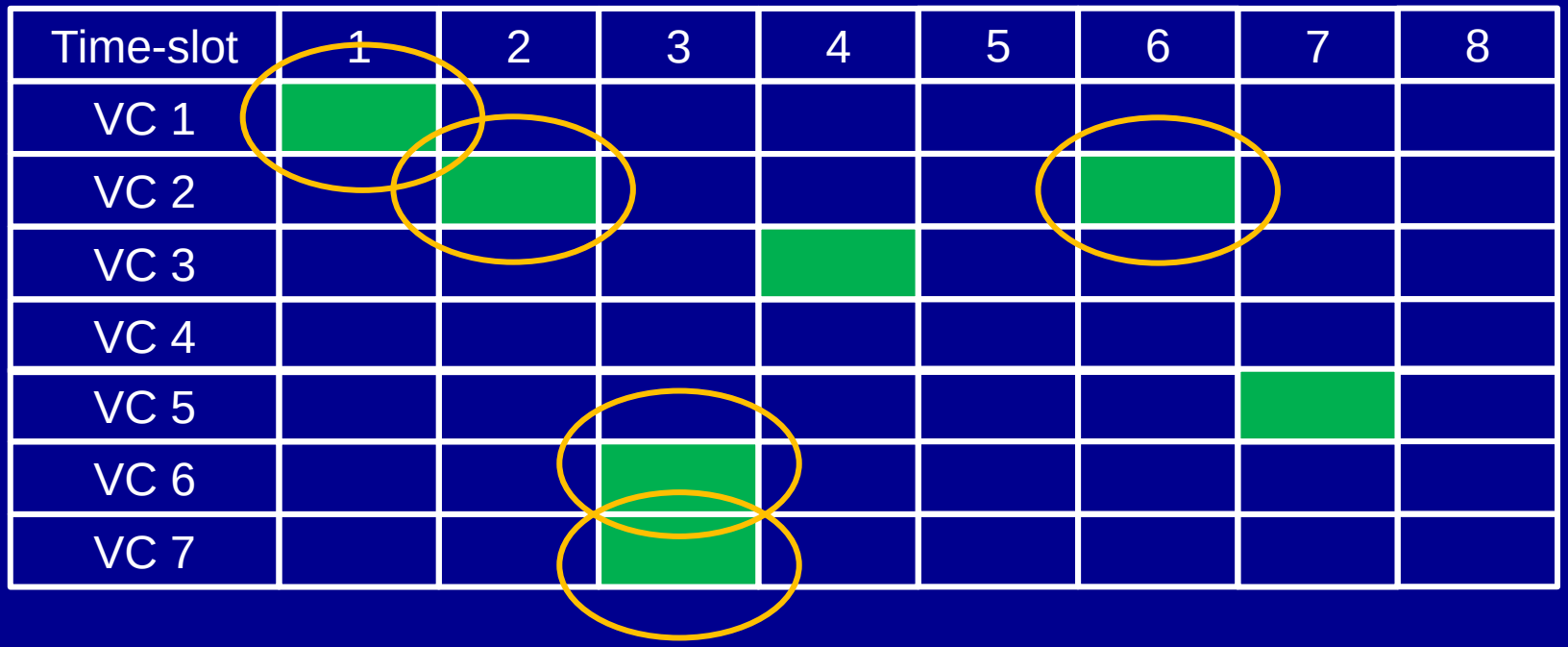
Scheduled Precedence



Configured for Priority and BW Reserved Only

Time-slot	1	2	3	4	5	6	7	8
VC 1								
VC 2								
VC 3								
VC 4								
VC 5								
VC 6								
VC 7								

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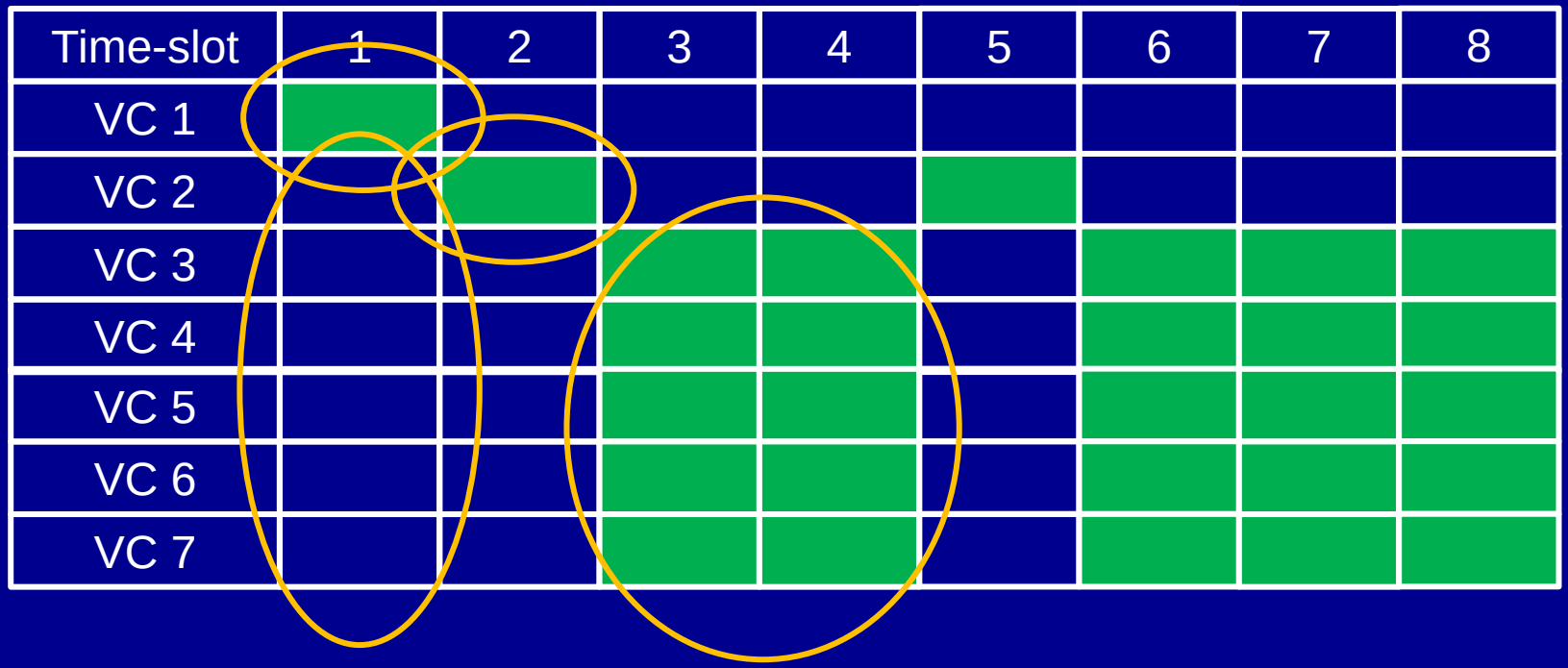
Simple Mixed QoS



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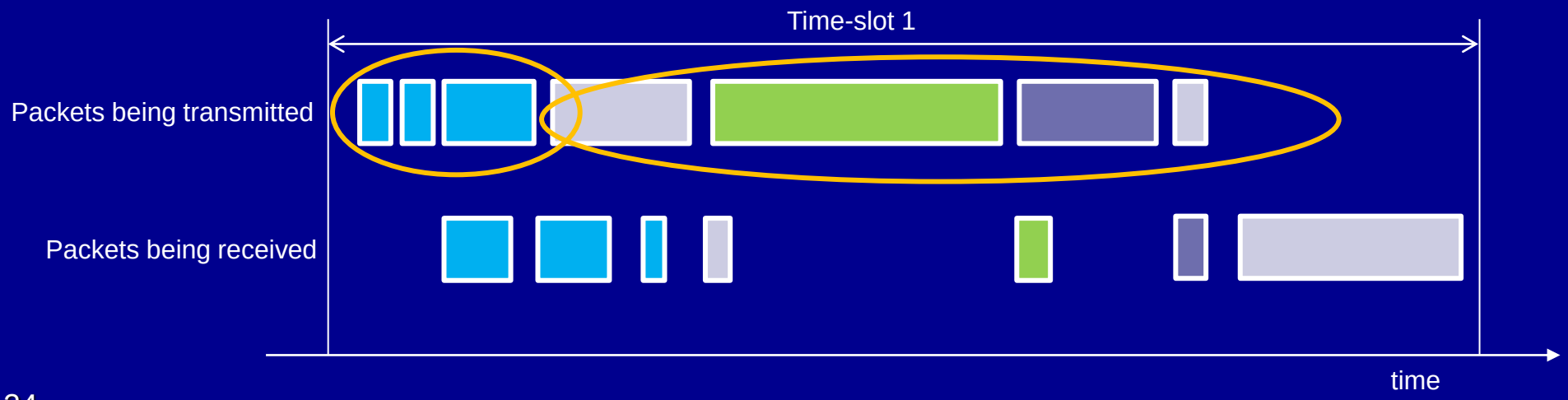
Deterministic Data Delivery

Time-slot	1	2	3	4	5	6	7	8
VC 1 (high priority)								
VC 2 (high priority)								
VC 3								
VC 4								
VC 5								
VC 6								
VC 7								



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SpaceFibre IP Cores

SpaceFibre VHDL IP Core

- SpaceFibre VHDL IP Core
  - Compliant to very latest version of standard specification
  - Extensively tested and validated
- Incorporates all capabilities
  - Full QoS
  - Fault detection, isolation and recovery
  - Low latency broadcast messages
- Available from STAR-Dundee
  - Implemented in a range of FPGAs
    - Microsemi: AX, RTG4
    - Xilinx: V4, V5, Spartan 6, …
  - Full and “lite” versions
    - Full has configurable number of VCs
    - Lite is designed for a simple instrument interface with 2 VCs
      - High rate data VC
      - Low rate, high priority command and control VC

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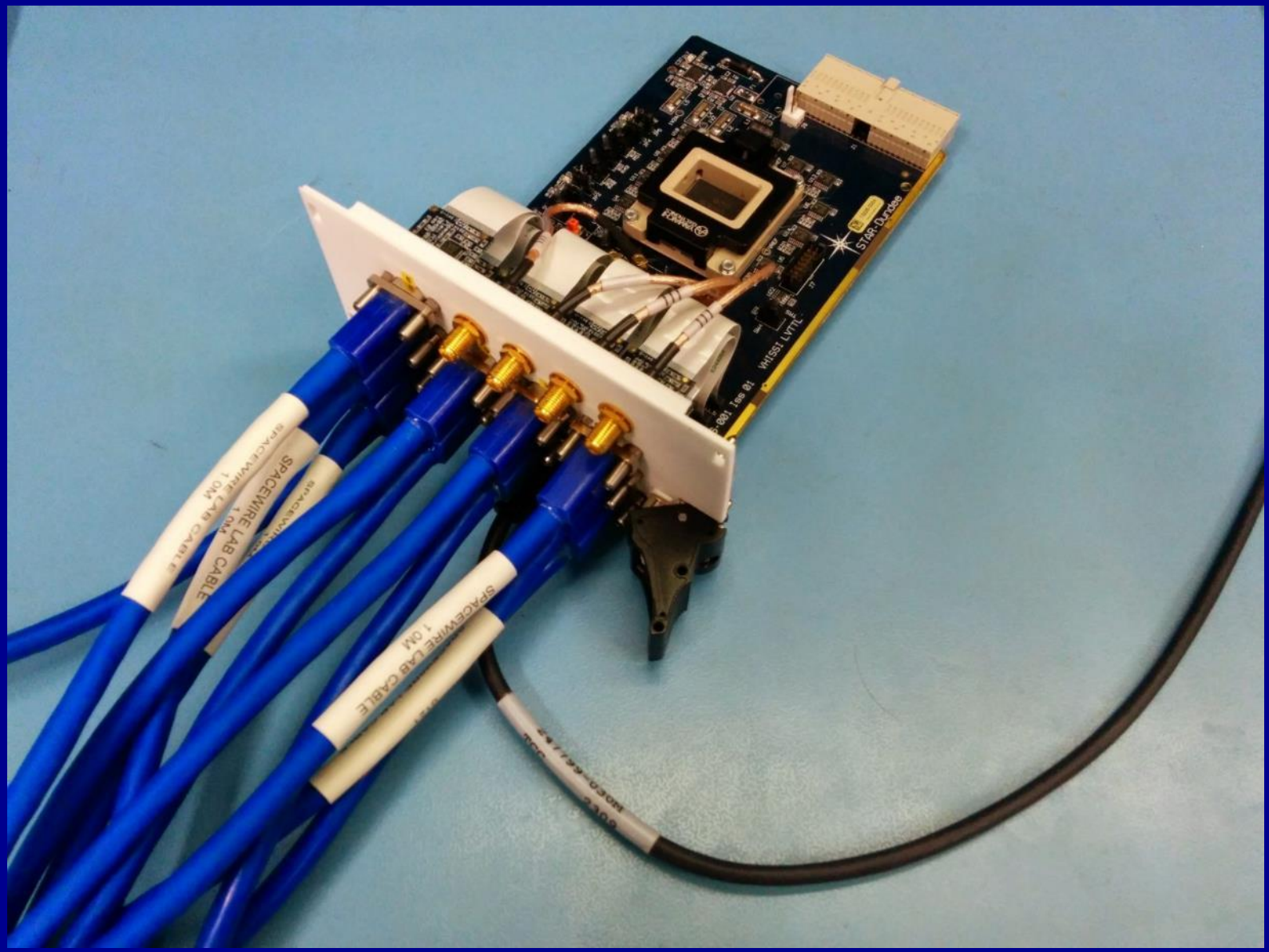
Radiation Tolerant SpaceFibre ASIC



RC64 Many Core DSP Processor

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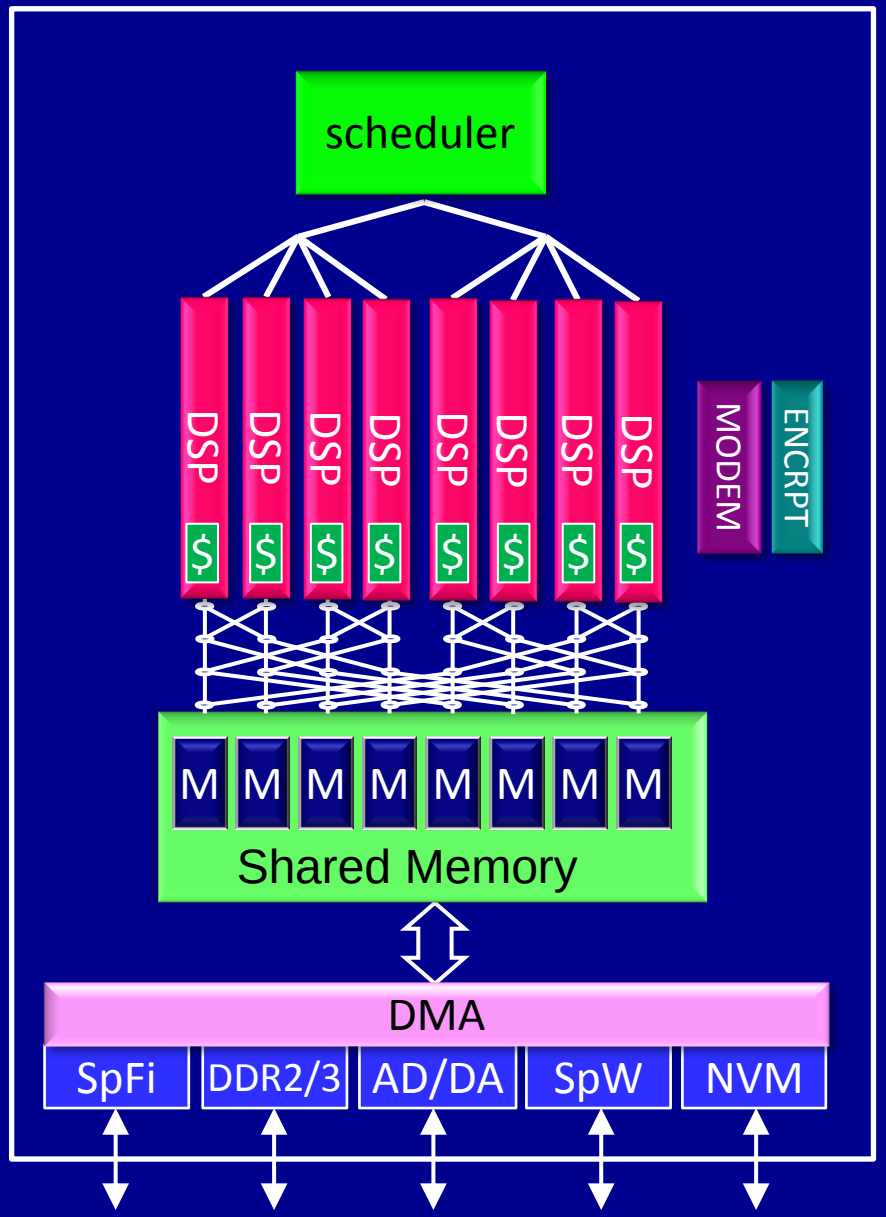
Ramon Chips

- 64 fast CEVA X1643 DSP with FP extension and HW scheduler
  - 300 MHz
  - 40 GFLOPS, 384 GOPS
- Modem and Encrypt accelerators
- 4 Mbyte on-chip shared memory
- Fast I/O
  - 12x SpaceFibre,
  - SpaceWire
  - DDR3, AD/DA LVDS I/F, NVM
- Rad-Hard, for space
- Advanced technology
  - TSMC 65nm LP
  - CCGA / PBGA / COB
  - 10 Watt
- Modular
  - Payloads can employ many RC64
- Versatile
  - Designed for all space missions
  - Planned for 2020—2050
- Re-programmable in space



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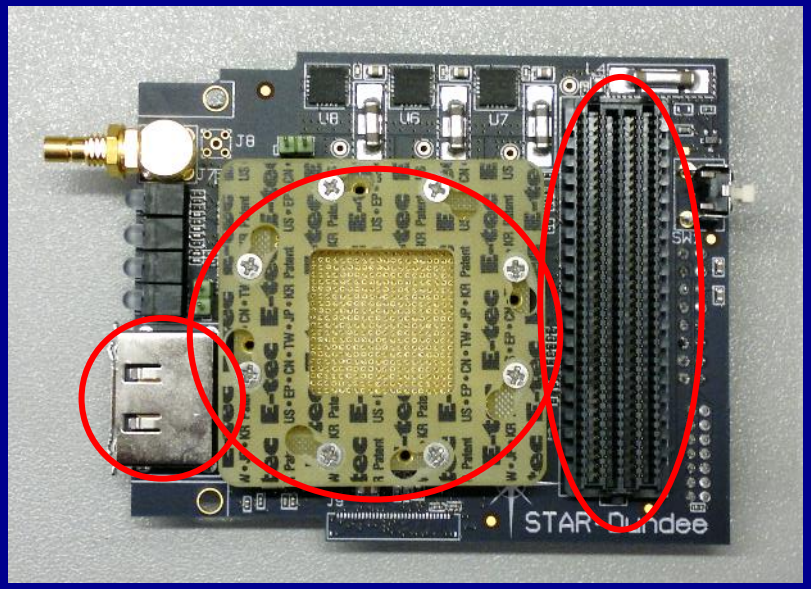
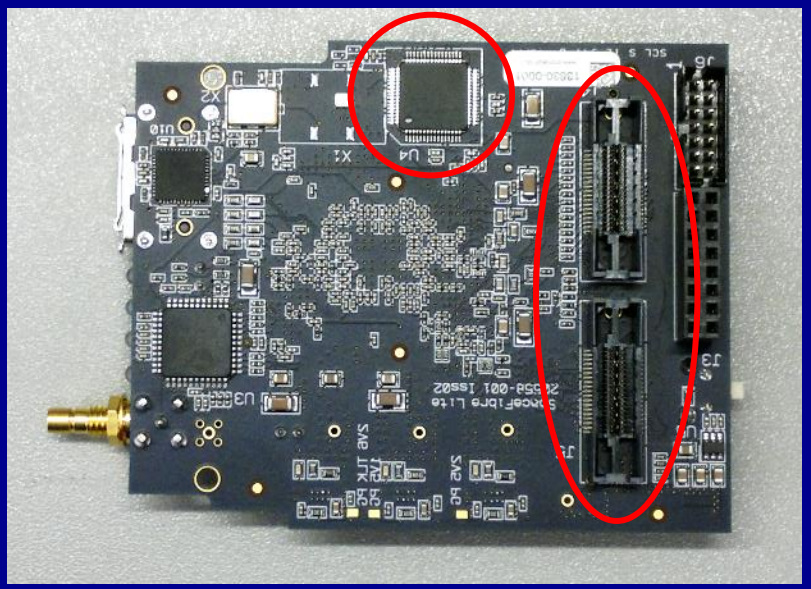
SpaceFibre on RTAX and RTG4

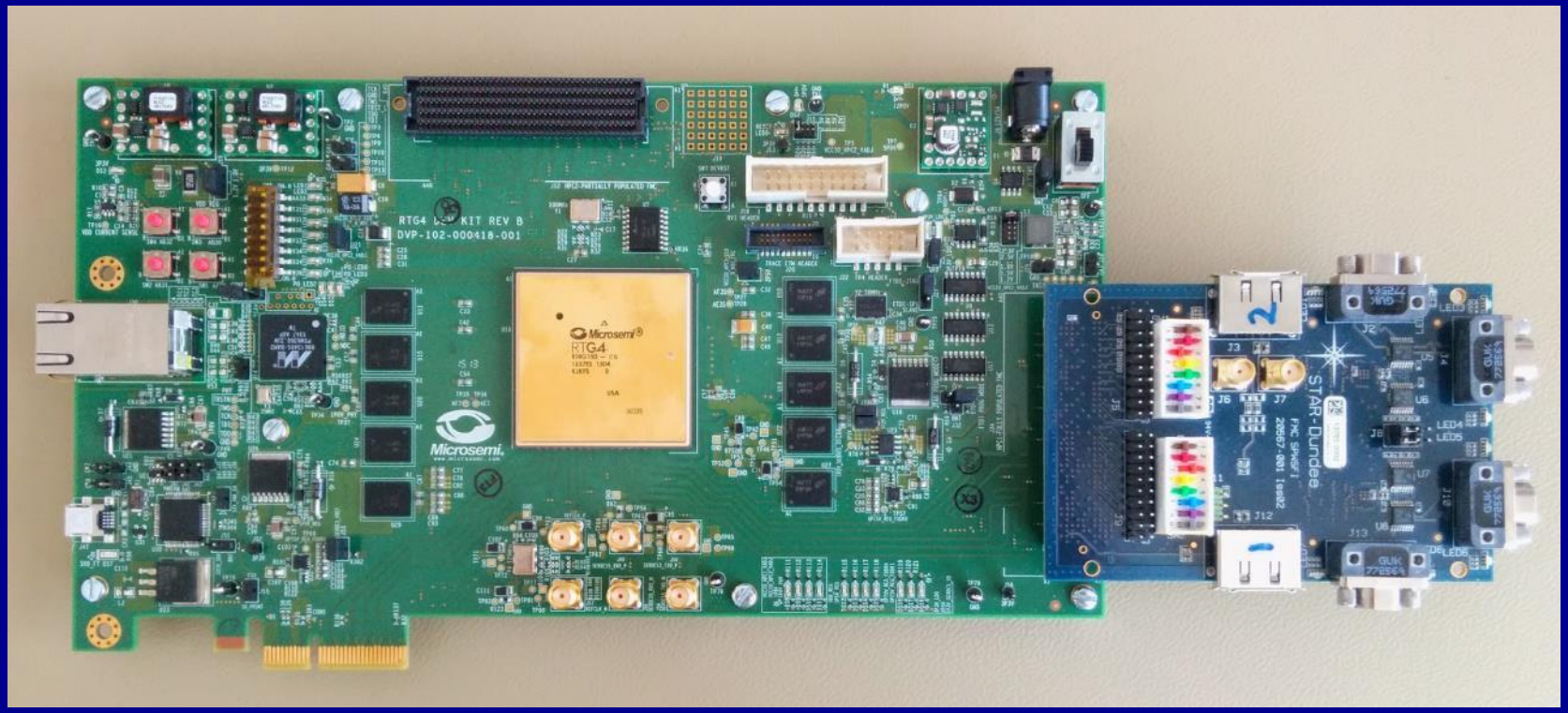
SpaceFibre Lite Evaluation Board





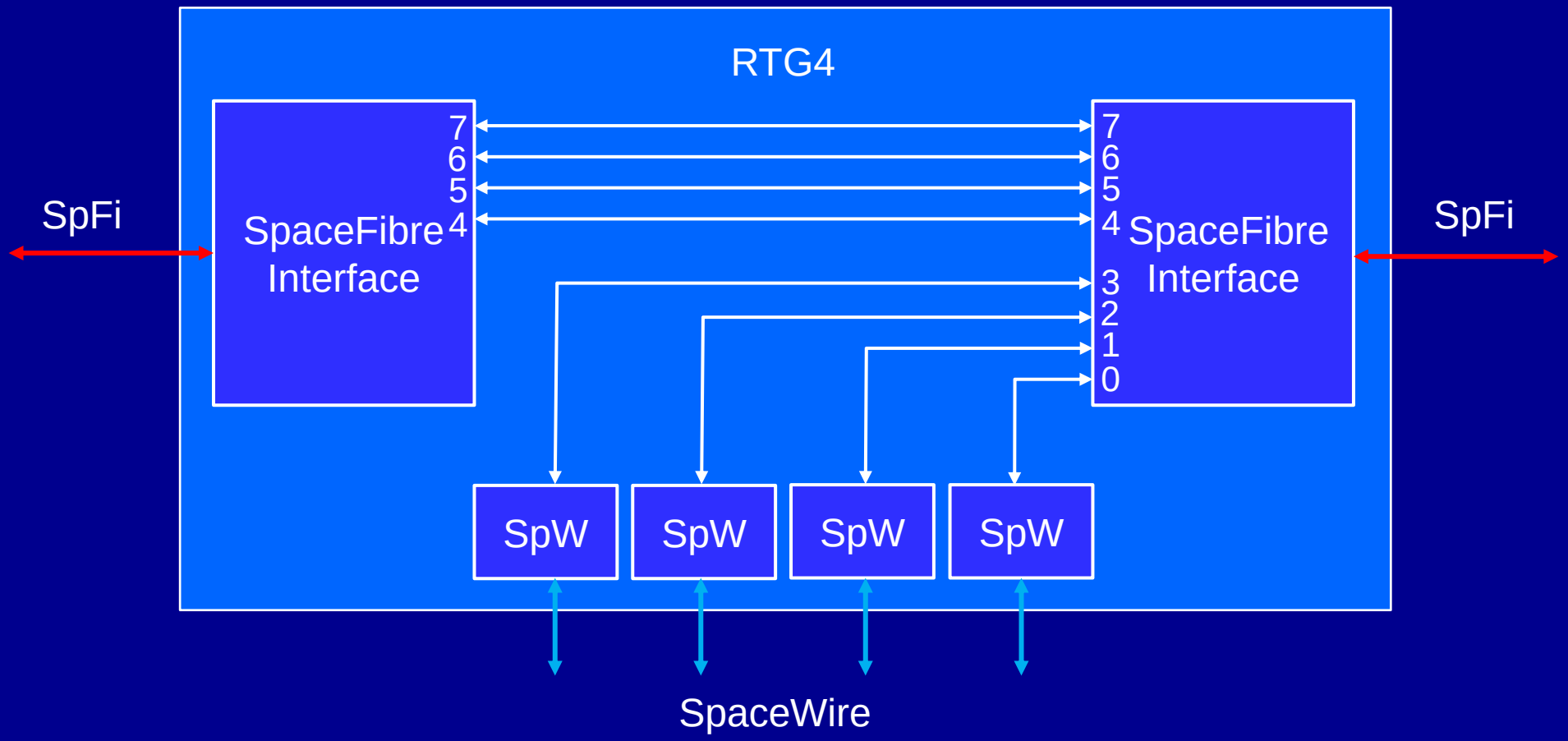
- Commercial equivalent of flight proven parts
  - Microsemi RTAX1000
  - TLK2711-SP SerDes
- Pre-programmed with STAR SpFi IP core
- FMC interface for connection to development boards
- 2.5 Gbits/s with 32-bit interface at 62.5 MHz
- 20% to 25% of AX1000

SpaceFibre on RTG4

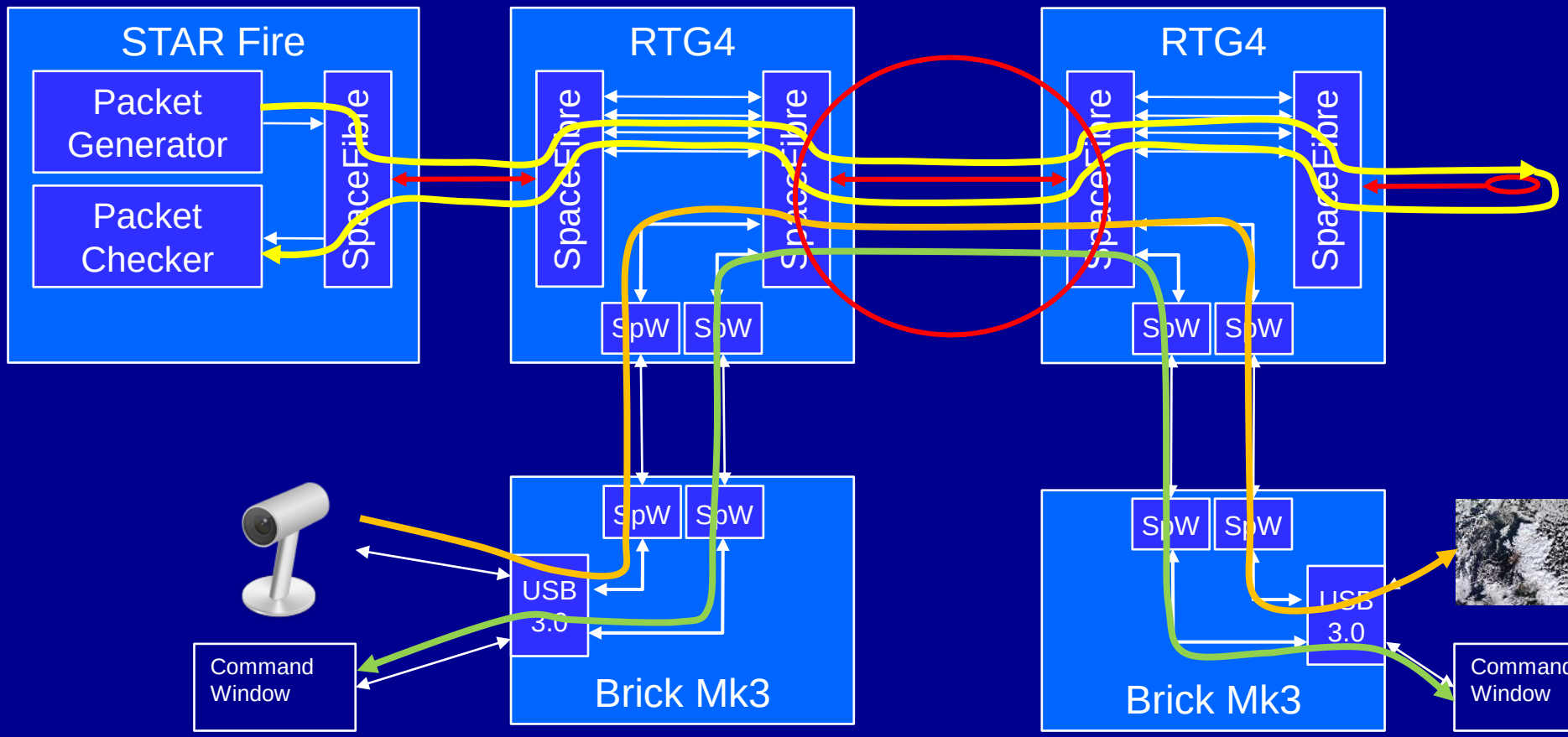


- FMC board to provide SpaceWire and SpaceFibre
- RTG4 SerDes running at 2.5 Gbits/s
- SpaceFibre interface 4% to 6% of RTG4 (2 to 8 VCs)
- SpaceWire interface 1%, RMAP Target 2% of RTG4

Demonstration RTG4 Design



Demonstration




www.star-dundee.com
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DELL
Microsemi
SpaceFibre Link Analyser
SpareWire Destination
SpaceFibre Packet Generator/Checker
SpaceFibre Loop-Back
RTG4™ SpaceWire/SpaceFibre Bridge

Conclusions

- SpaceFibre designed specifically for spaceflight applications
  - Integrated QoS
  - Integrated FDIR capabilities
  - Galvanic isolation
  - Compatible with SpaceWire packet level
  - Efficient design giving very small footprint
- Benefits
  - Very high performance
  - Reduced harness mass
  - Interoperability with existing SpaceWire devices
  - Simplification of redundancy
  - Deterministic data delivery for control applications
  - Single integrated network
- Running on RTAX and RTG4 now

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Thank You
Any questions?

For more information and to see a demonstration please visit

the STAR-Dundee stand

www.star-dundee.com