SpaceWire Active Backplanes

Presented at:	**11th SpaceWire Working Group**
Date:	**11th June 2008**
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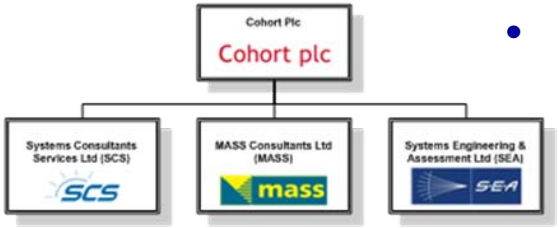
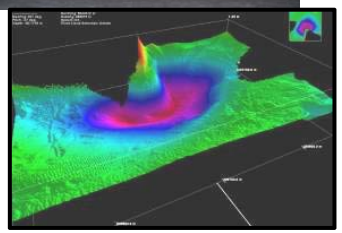
About SEA…..

SEA:

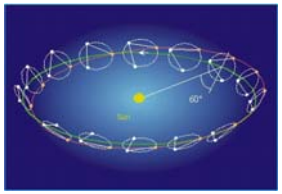
- **a UK company**
- **250 staff**
  - SME status to May 09
- **markets:**
  - **defence**
  - **civil and military aerospace**
  - **offshore**
  - **transport**
  - **space**

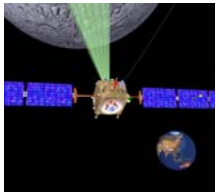


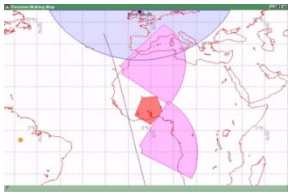


- **Naval equipment**
  - Secure communications
  - Sonar systems
  - Autonomous UAV technology
- **Airborne equipment**
  - Vibration monitors (helicopters)
  - Small radars
  - EW systems
- **Traffic systems**
  - Enforcement systems
  - Traffic management systems
- **Offshore equipment**
  - Sea bed mapping and characterisation systems
- **Simulations**
  - Physics-based
- **Human Factors consultancy**
- **Training Systems**

Space and ground systems







- **Space Systems**
  - Hardware
  - Studies and developments
  - Planetary Protection
  - Project management; PA support
  - Human factors engineering
- **Ground Systems**
  - EGSE/SCOE
  - Radar calibration transponders (CALtran):
  - Compact active transponders (REFLEcX)
  - S-UMTS test bed

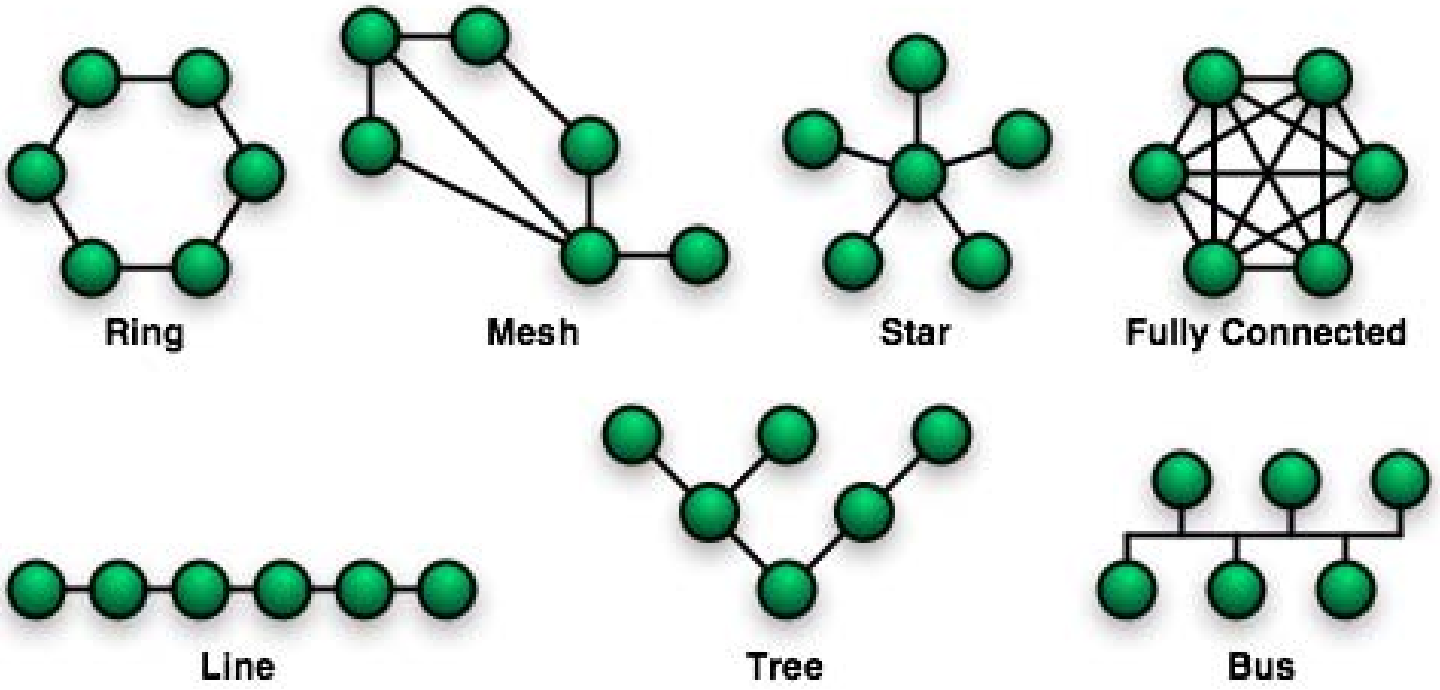
The MARC project

- This SpaceWire backplane presentation is based on work performed on the MARC (Modular Architecture for Robust Computation) project
- The objective of the MARC project is to design and develop a demonstration system with a HW distributed architecture based on a SpaceWire network as the communication medium
- The MARC project is currently in the definition phase

Why an active backplane?

- Decouples SpaceWire network and power distribution architecture from the Module design
- Scalable to suit module count and bandwidth requirements
- Modules do not need to be powered in certain combinations to provide the connectivity required
- Permits a common backplane interface
- Improved FDIR hierarchy

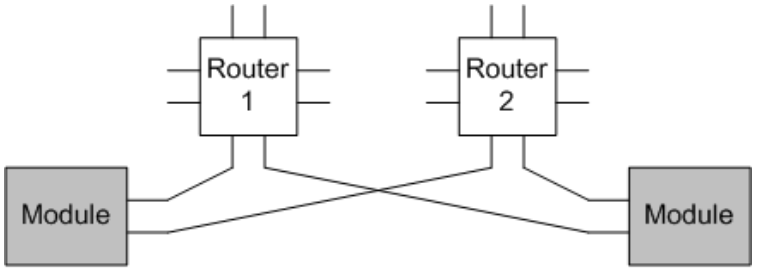
Which network topology?



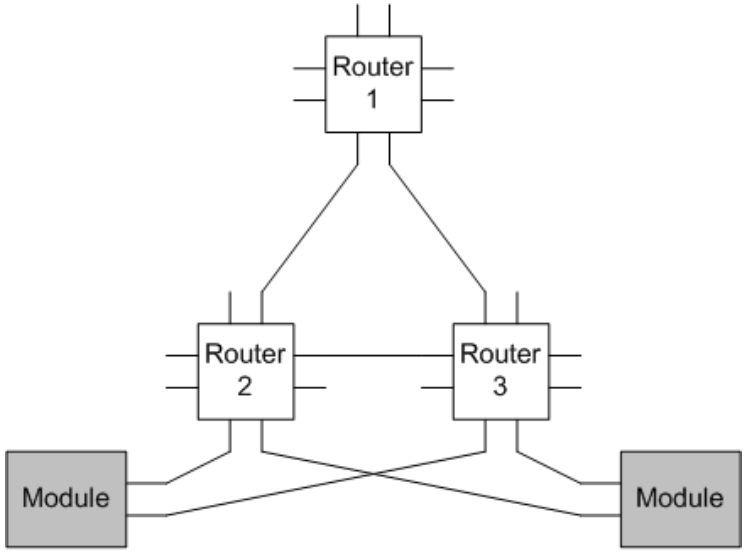
Network topology constraints

- SpaceWire network is to connect Modules
- Network is built from 8 port routers
- Need to avoid single point failures and failure propagation, this means that each Module must interface to at least 2 routers
- Should not rely on a Module to provide routing capability between ports (otherwise that Module must be powered)
- Links from a Router must also connect to other Routers to provide scalability
- Need “Spare” ports for EGSE connection and network expansion

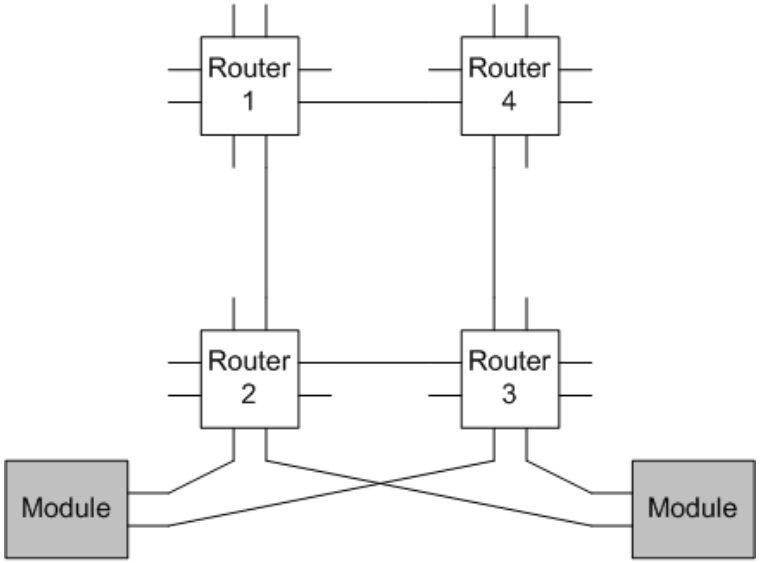
Simple network topologies (1)



2 router architecture,
supports 8 Modules

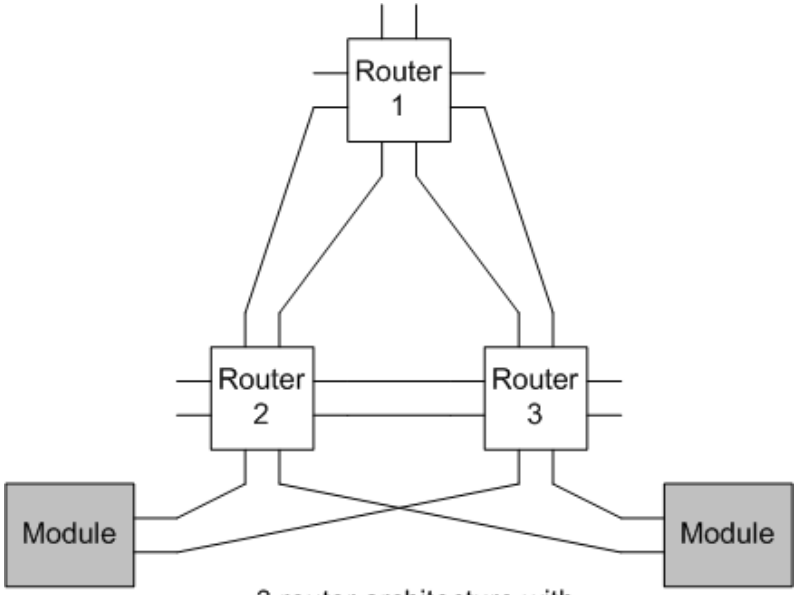


3 router architecture,
supports 9 Modules

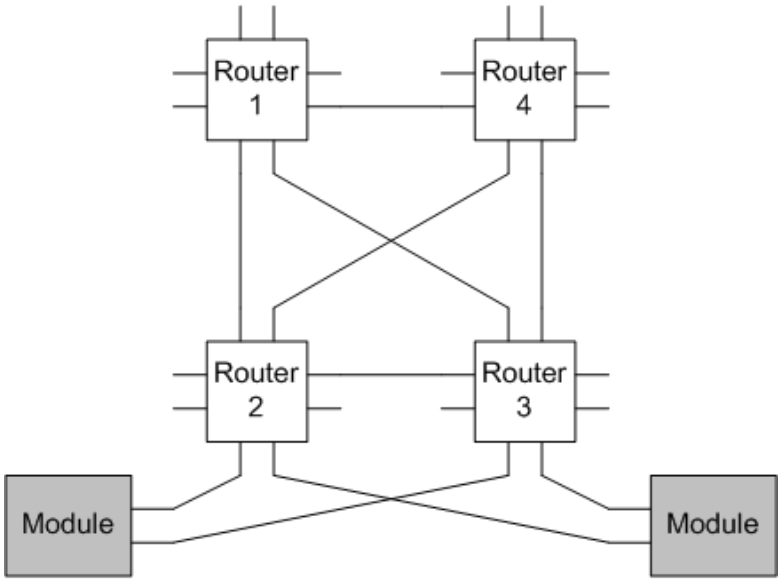


4 router architecture,
supports 12 Modules

Simple network topologies (2)



3 router architecture with higher router to router rates, supports 6 Modules

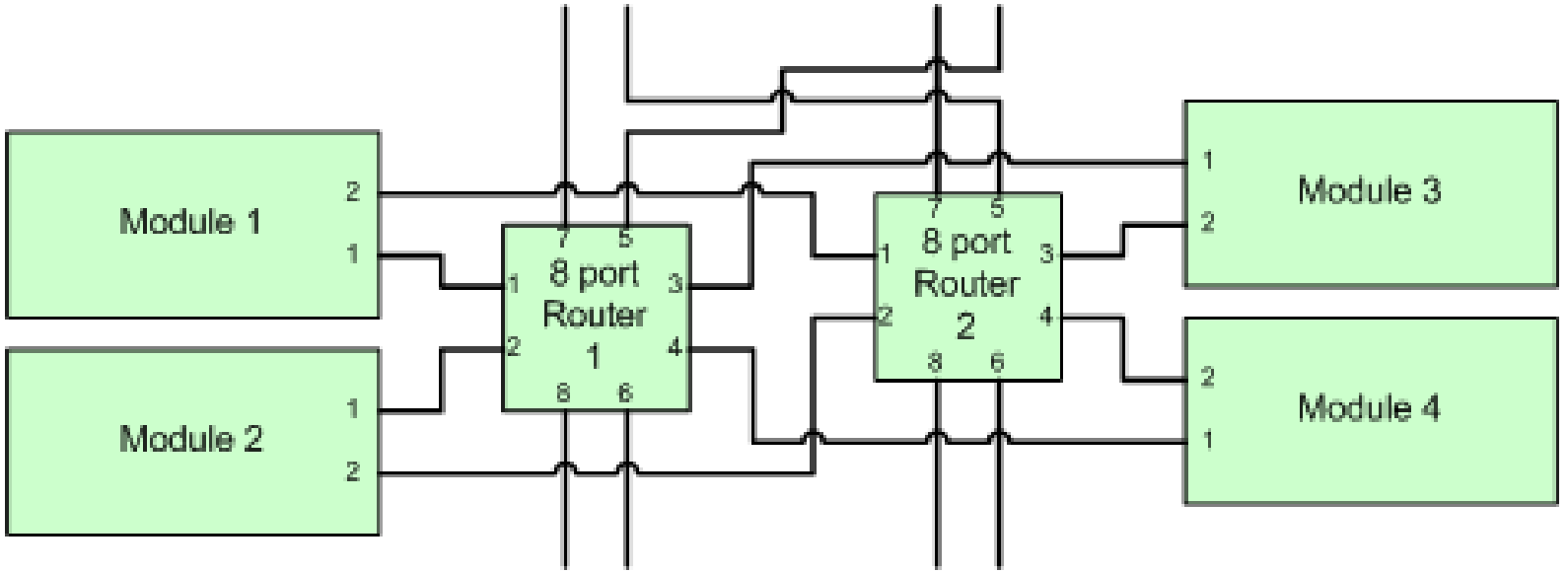


4 router architecture with lower latency, supports 10 Modules

Module to Router ratio

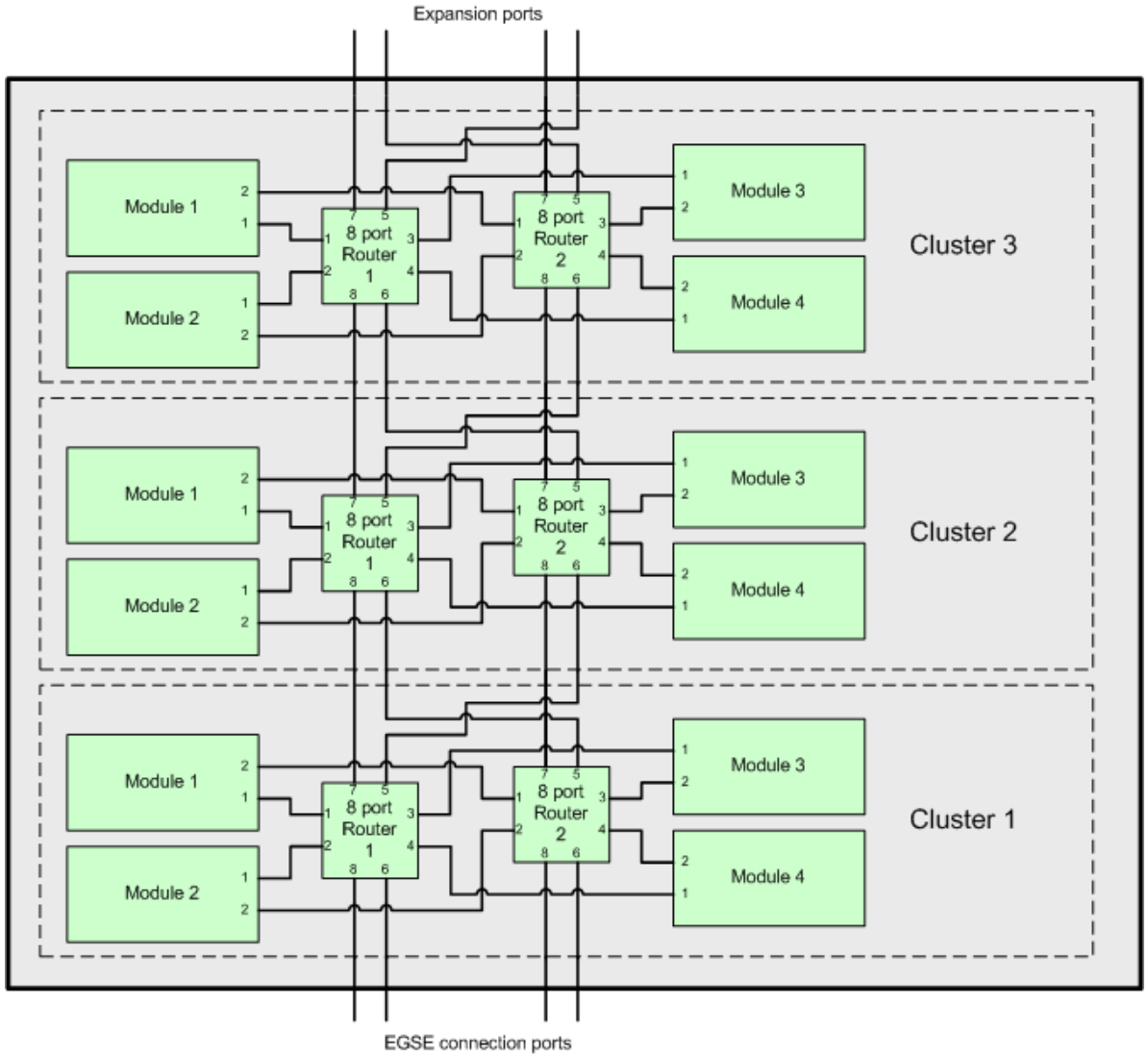
- **Simple topologies:**
  - 2 router = 4:1
  - 3 router = 3:1
  - 4 router = 3:1
  - “N” router = 3:1
- **Higher connectivity topologies:**
  - 3 router = 2:1
  - 4 router = 2.5:1
- **Matrix and hypercube topologies => 1:1**

Network building block



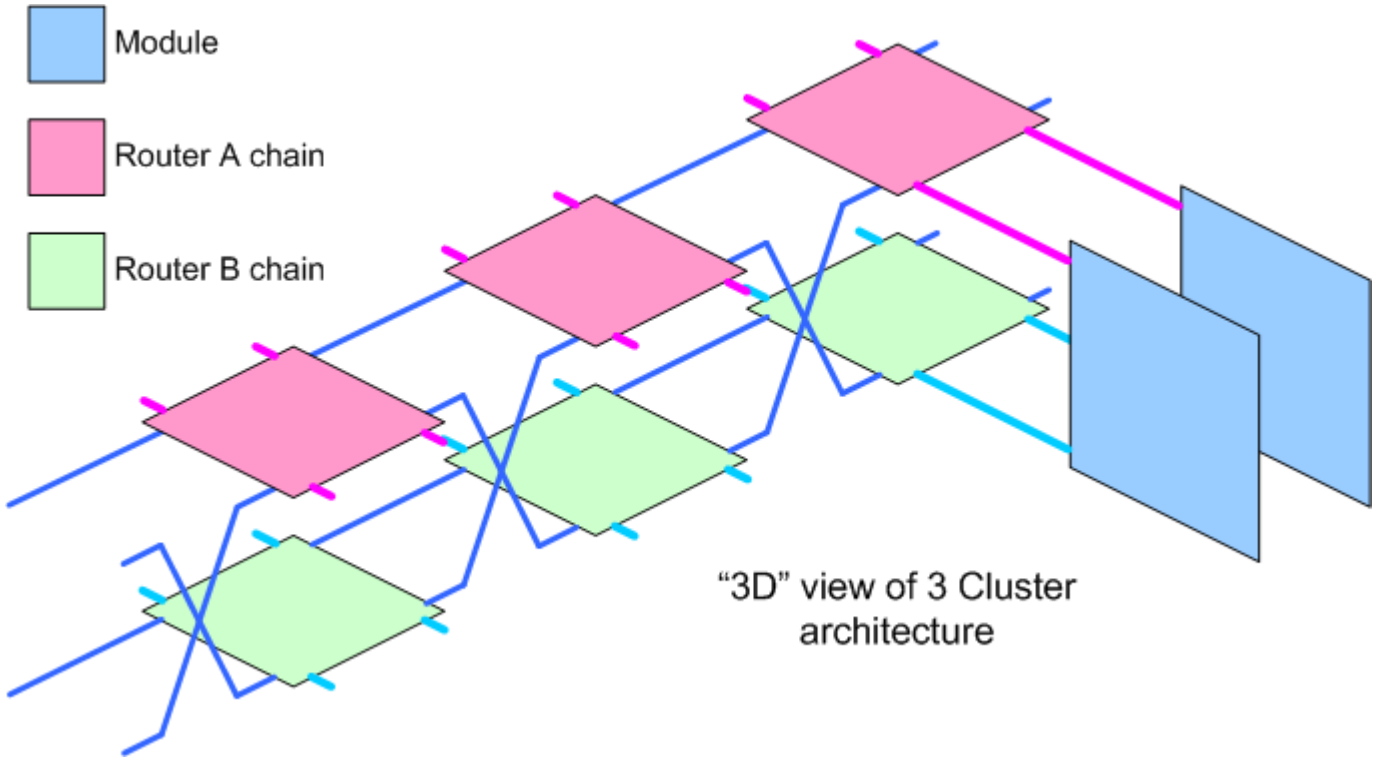
Proposed modular SpaceWire network building block (4:2 Cluster)

Cluster to Cluster connections



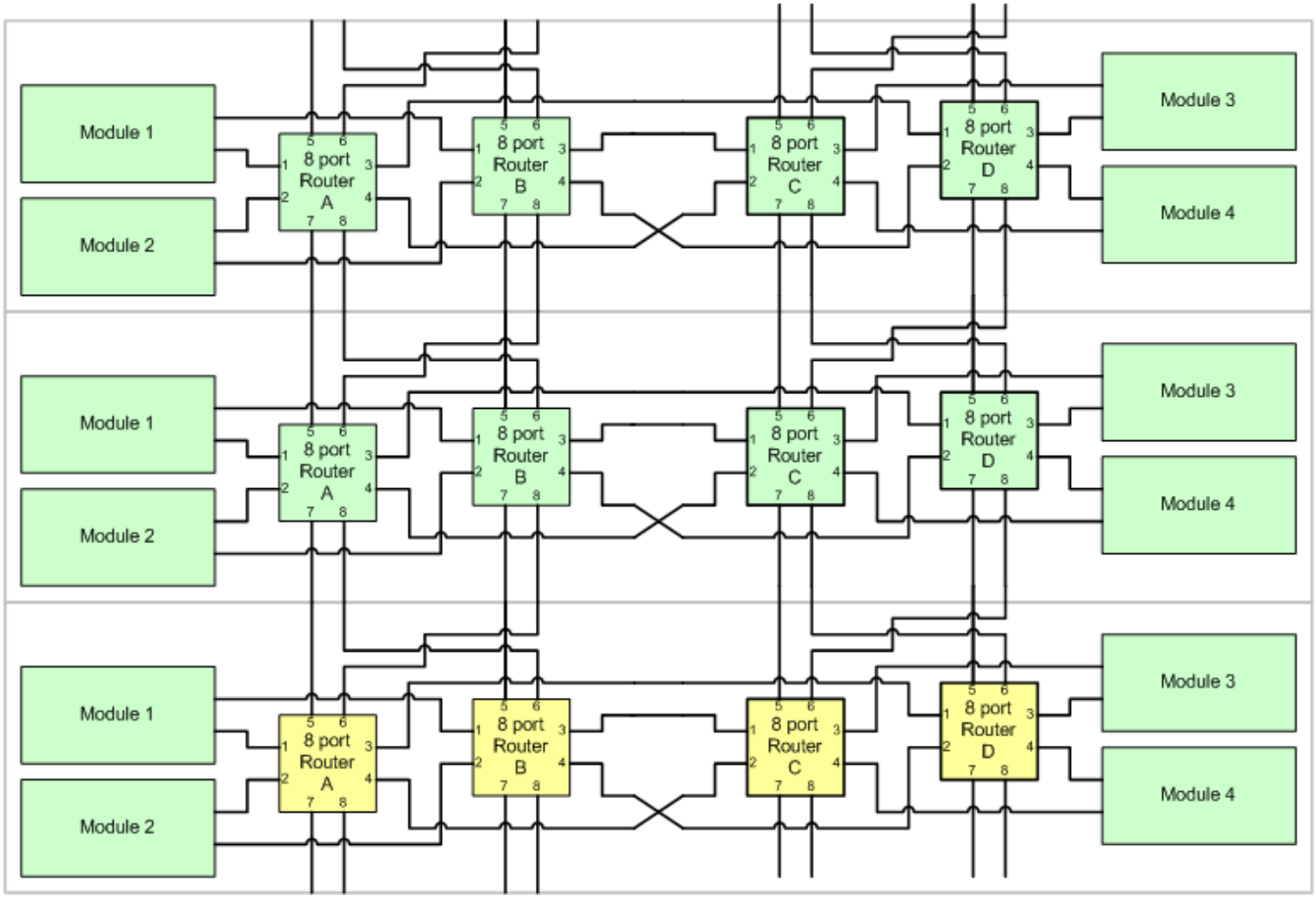
Example Cluster SpaceWire network for 12 Modules

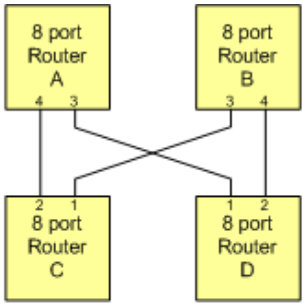
3D view of Cluster connections



"3D" view of 3 Cluster architecture

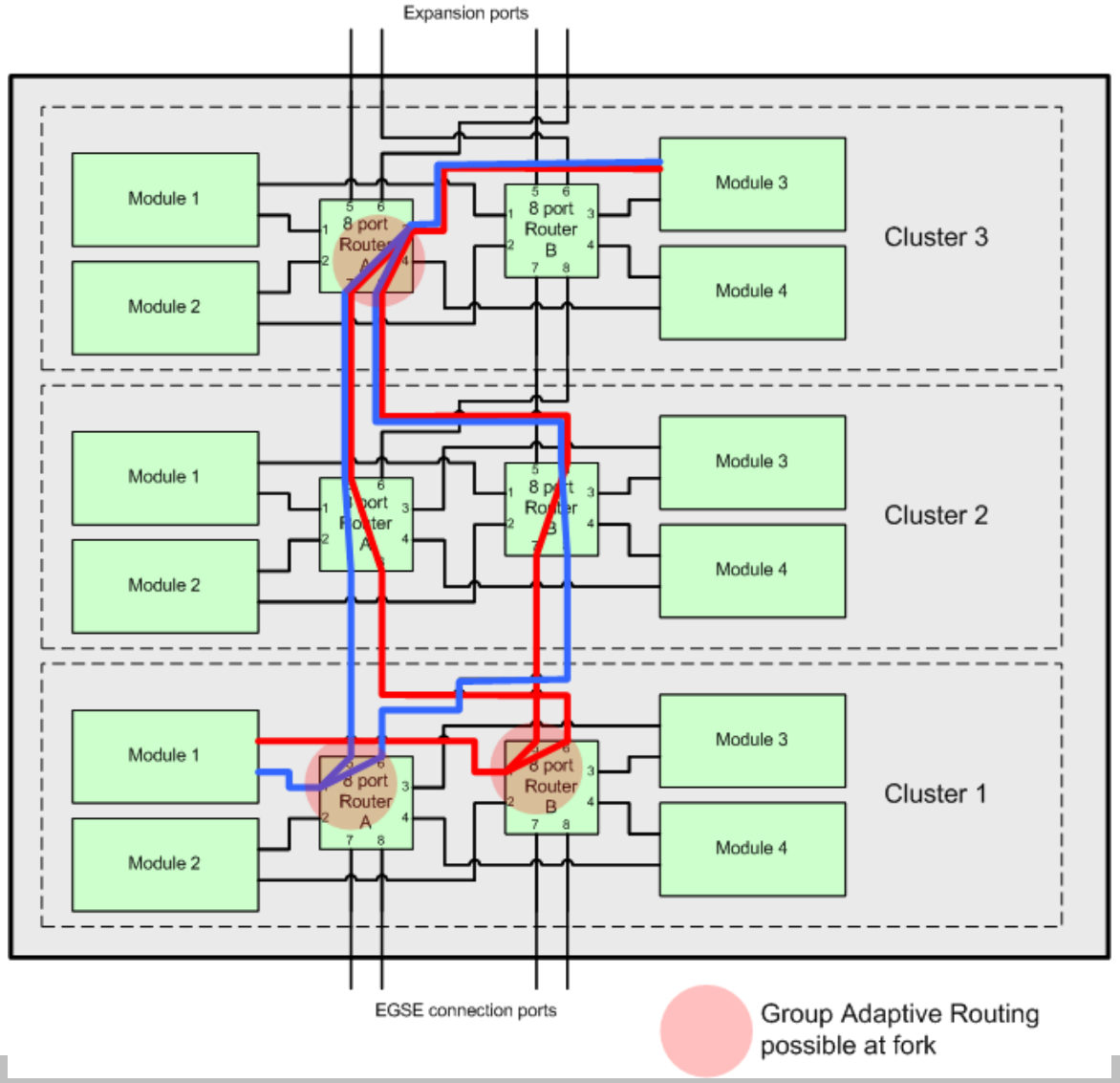
Scalable bandwidth



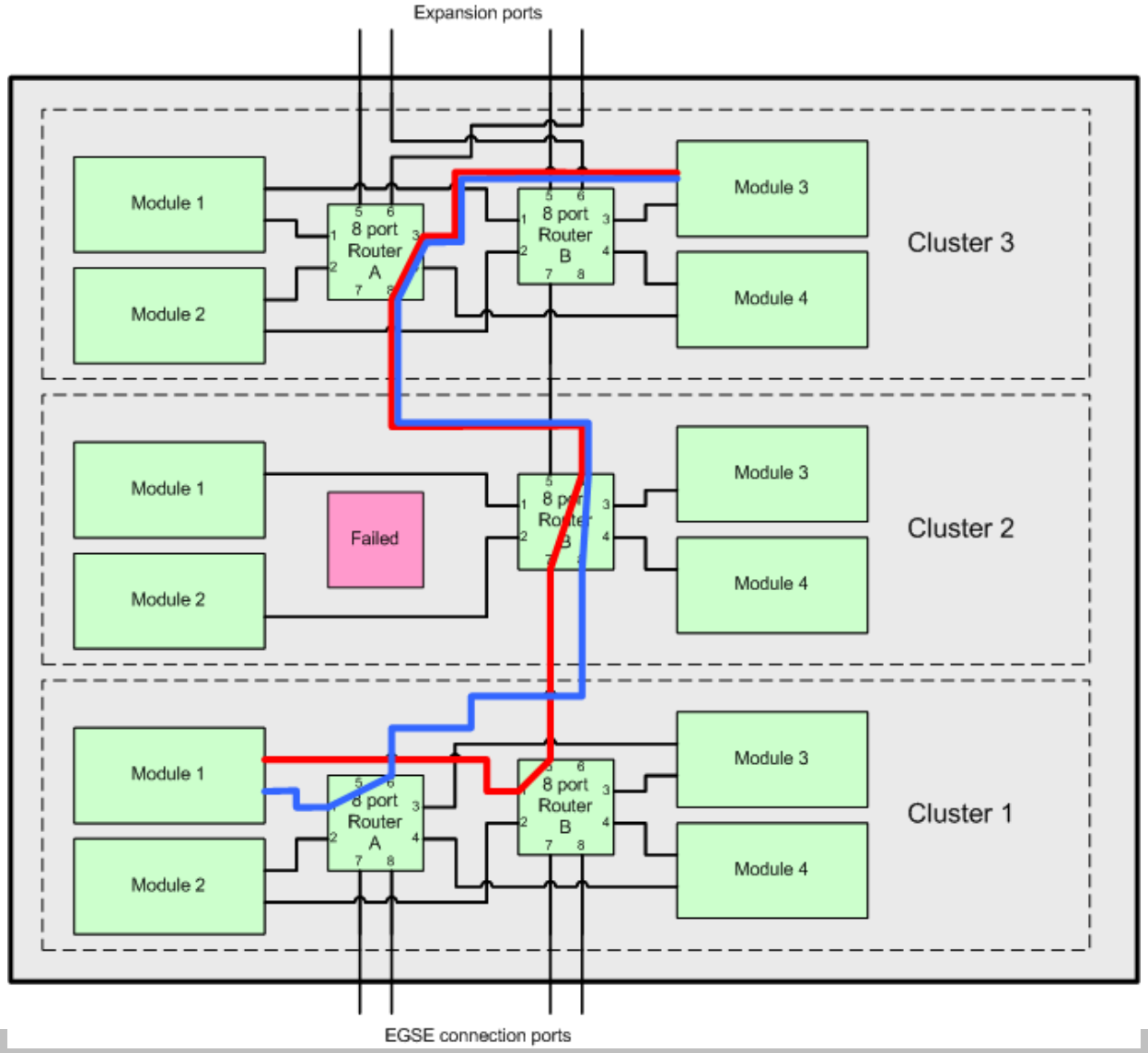


A, B, C, D network wiring

Group Adaptive Routing



Failure tolerance



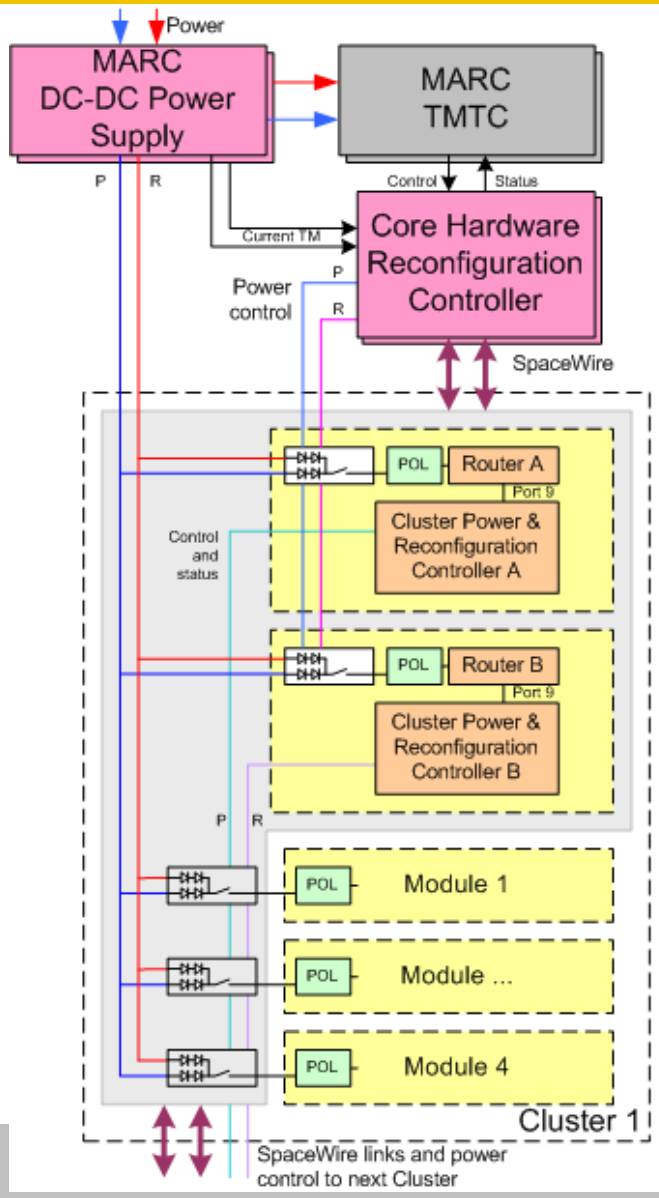
Advantages of this architecture

- Single point failure proof
- Expandable in X and Y directions
- Same number of routers in path after a single router failure
- No failure propagation that stops Modules in other clusters communicating on any port
- Good inter-cluster bandwidth (increase at cost of Module:Router ratio)
- Spare ports for expansion, EGSE or to create a Cluster ring
- Opportunity to use Group Adaptive routing to automatically bypass bad links and routers

Power distribution

- In a SpaceWire network architecture with an "n from m" redundancy approach we need to have some power control over each Module; this permits failed or unneeded Modules to be powered off
- The power architecture has to be similar to the Network architecture and take into account the potential need to switch off Routers
- The electronics on each Module will have different power and voltage needs so a generic architecture needs to take this into account
- The current thoughts are that a regulated voltage (12-15V) will be supplied to each Module and that Point Of Load (POL) converters will be employed on each Module to provide the voltage rails they need
- It is anticipated that a Module would need less than 20 watts
- The POL approach is a typical of commercial hardware due to the range of logic supply rails needed and the availability of high efficiency compact power modules
- The Module power switches need to be under centralised control
- If no master processor appears to be in control then hardware will decide which Modules are powered (with TC over-ride)

Power architecture

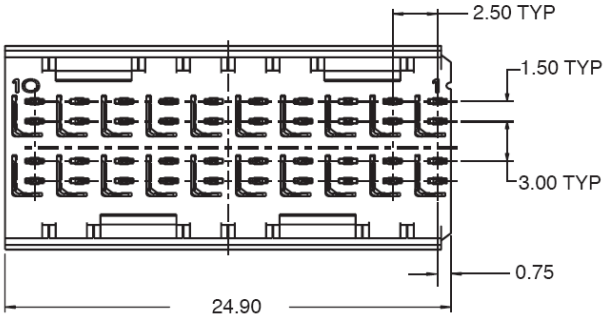


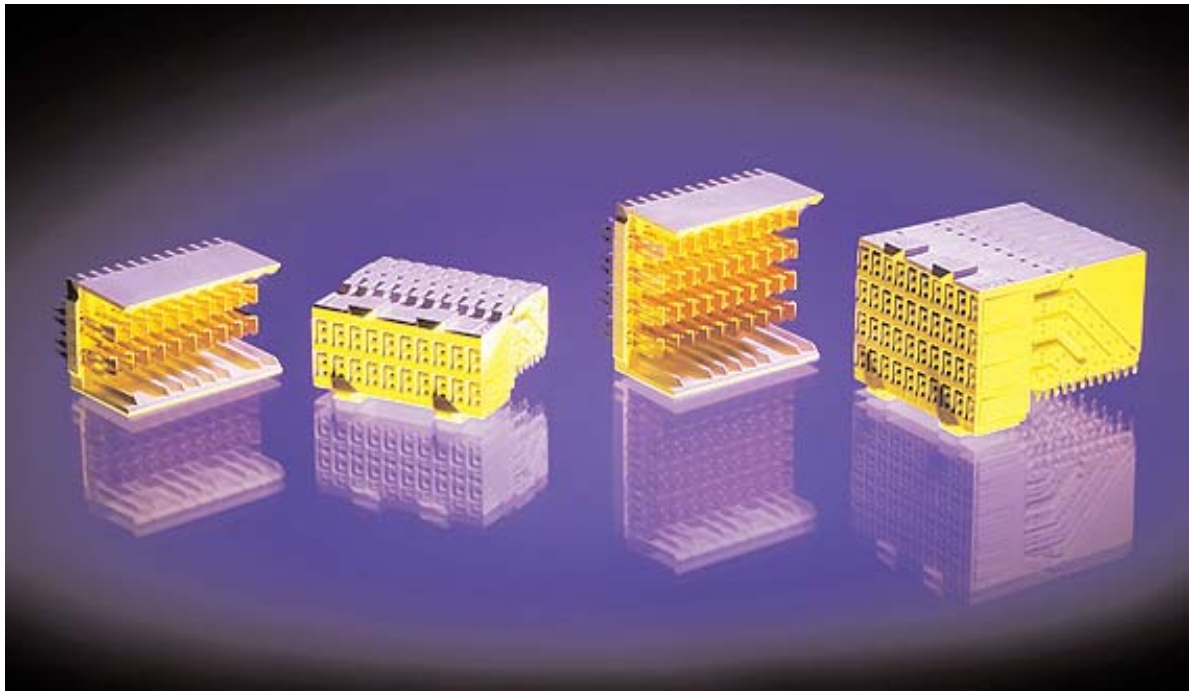
Reconfiguration Controller

- Coupled to TMTC function to permit ground access without the need to power up and configure a SpaceWire network
- Switches power to the Routers in at least 1 master Cluster
- Provides discrete lines or sends RMAP commands to Routers in Clusters to switch on Modules (and potentially Routers in the next Cluster)
- Contains watchdogs that monitor the health messages from the master processor
- Contains a table based sequencer that follows a timed isolation and recovery sequence when watchdog signal failures detected

Backplane connectors

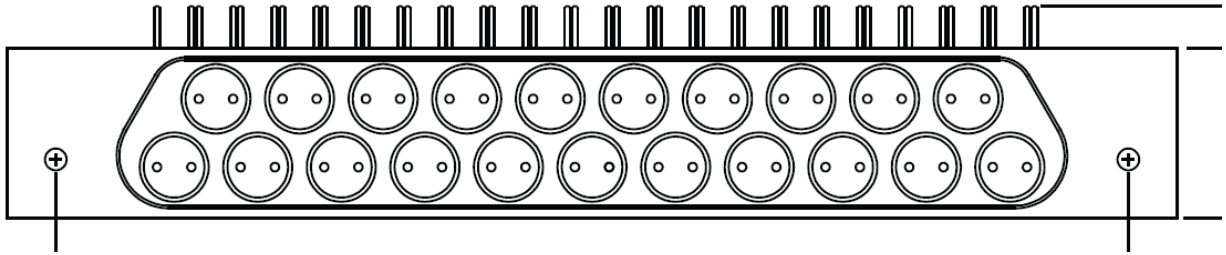
- **Ideally we need a controlled impedance connector to avoid SpaceWire signal degradation**
- **COTS connectors: Tyco AMP HmZd offer solutions up to 10GHz**





Sabritec Twinax

- **Sabritec 100 ohm Twinax based connector is a potential candidate for Space applications**



Question time

Any Questions?