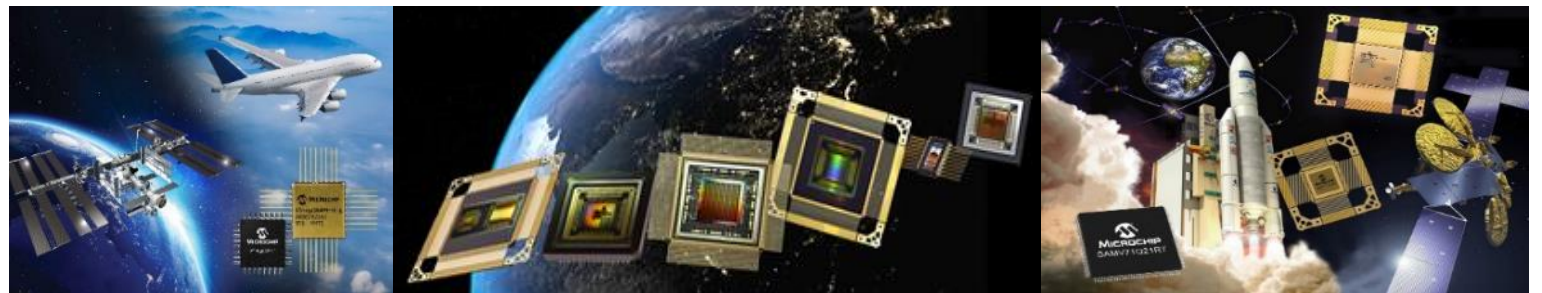




Ethernet Solutions for Space Applications



A Leading Provider of Smart, Connected and Secure Embedded Control Solutions



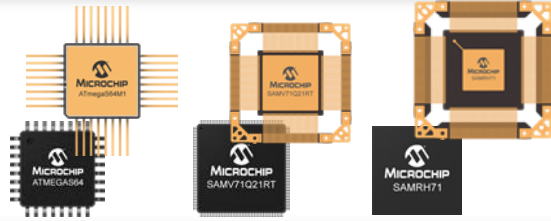
SMART | CONNECTED | SECURE

Microchip France
EDHPC – October 2023

Largest Space Semiconductors Portfolio

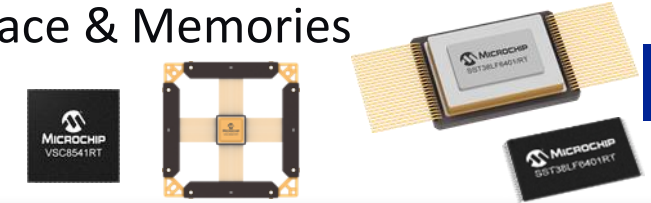
MPU and MCUs

32-bit arm M3 & M7 and SPARC V8
8-bit AVR
GNSS SoC



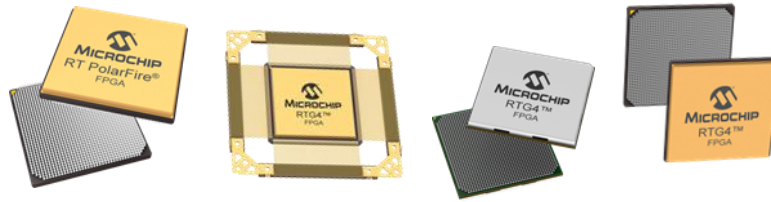
Communication Interface & Memories

Ethernet, SpaceWire
SRAM Memories
NVM Memories



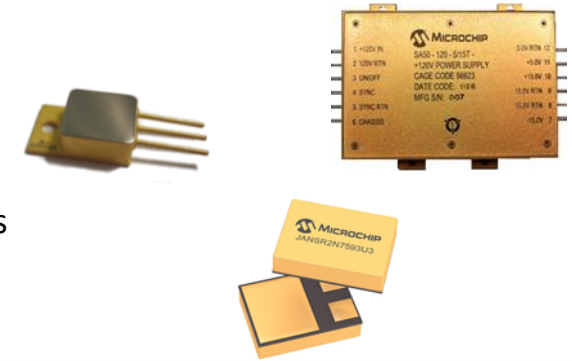
FPGAs

RT PolarFire
RTG4
RT ProASIC3
RTAX, RTSX-SU



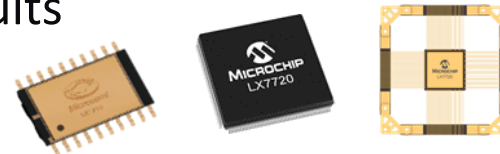
Power Solutions

JANS Diodes
Bipolar Small Signal Transistors
MOSFET
Isolated DC-DC Converter Modules
Point of Load Hybrid Solutions
Electromechanical Relays



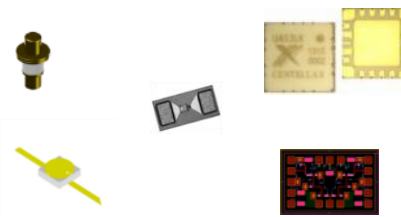
Mixed Signal Integrated Circuits

Telemetry Controller
Motor/Position Controller
Power Supply protection



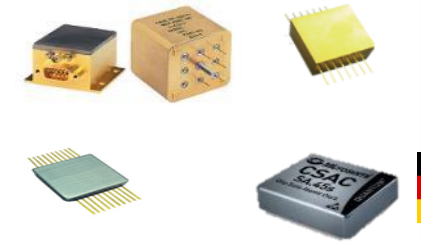
RF Solutions

Packaged and Chip Silicon GaAs RF Diodes
Surface Acoustic Wave (SAW) filters
GaAs MMICs
GaN on SiC HEMT transistors



Timing solutions & Oscillators

Ovenized Quartz Oscillators
Voltage Controlled Crystal Oscillators
Temperature Compensated Crystal Oscillators
Cesium Clocks
Chip Scale Atomic Clock (CSAC)



A&D Product Lines in Europe



Nantes, France



Rousset, France

Aerospace & Defense Group (France)

- ✓ Mixed Signal ASIC
- ✓ Processors and Microcontrollers
- ✓ Communication Interfaces and Memories



Bordeaux, France

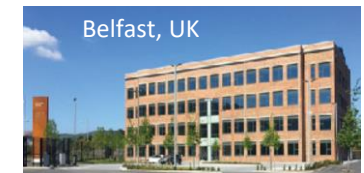
Power Module (France)

Hi-Rel Discrete & Power Module (Ireland)



Ennis, Ireland

Oscillators & SAW Filters (Germany)



Belfast, UK

RF Microwave Amplifiers (UK)



Advanced Packaging (UK)

- ✓ Expertise in miniaturisation vs. size, power and reliability



Teltow & Neckarbischofsheim, Germany



Part of European Space Ecosystem

Our customers



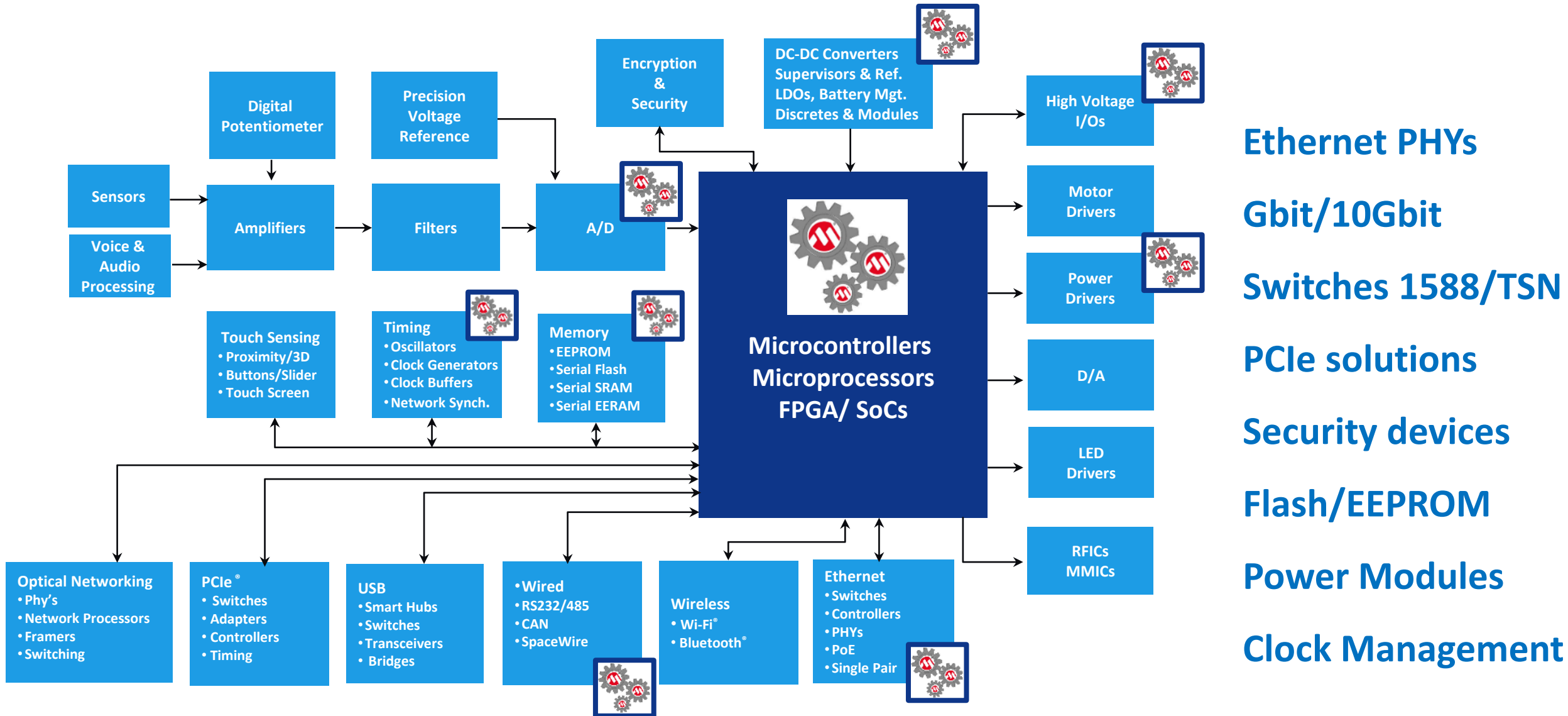
Our partners



- More than 35 years history and unrivalled flight heritage
- Member of different ESA control boards and working groups
- Supported by local agencies CNES, DGA (FR), DLR (GER), UK Govt
- Contributing to European Commission funded programs
- ESCC / DLA Qualified Supply Chain in France, Ireland & Germany (target)



Drive innovation around processing solutions



Ethernet PHYs

Gbit/10Gbit

Switches 1588/TSN

PCIe solutions

Security devices

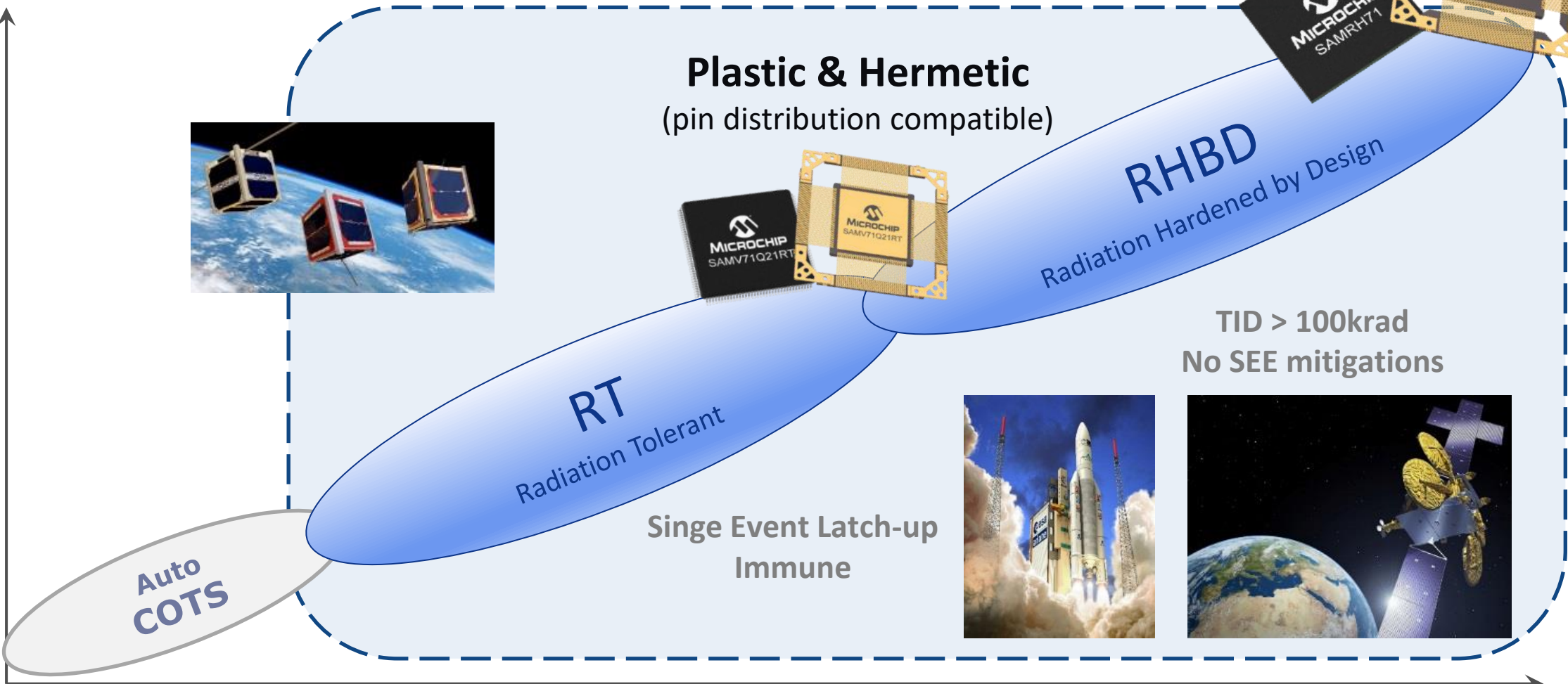
Flash/EEPROM

Power Modules

Clock Management

Scalable Solutions - COTS to ESCC/QML

Quality Grade

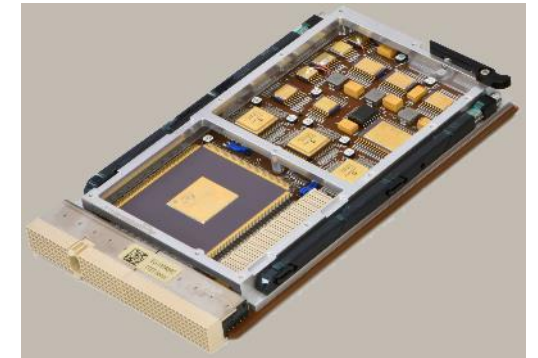
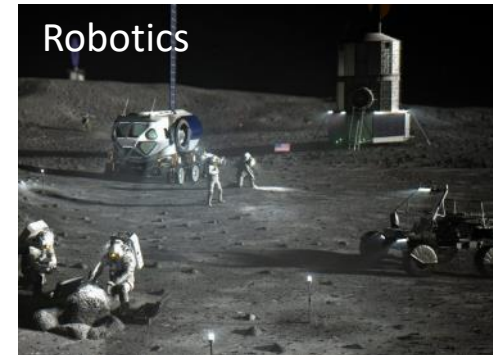
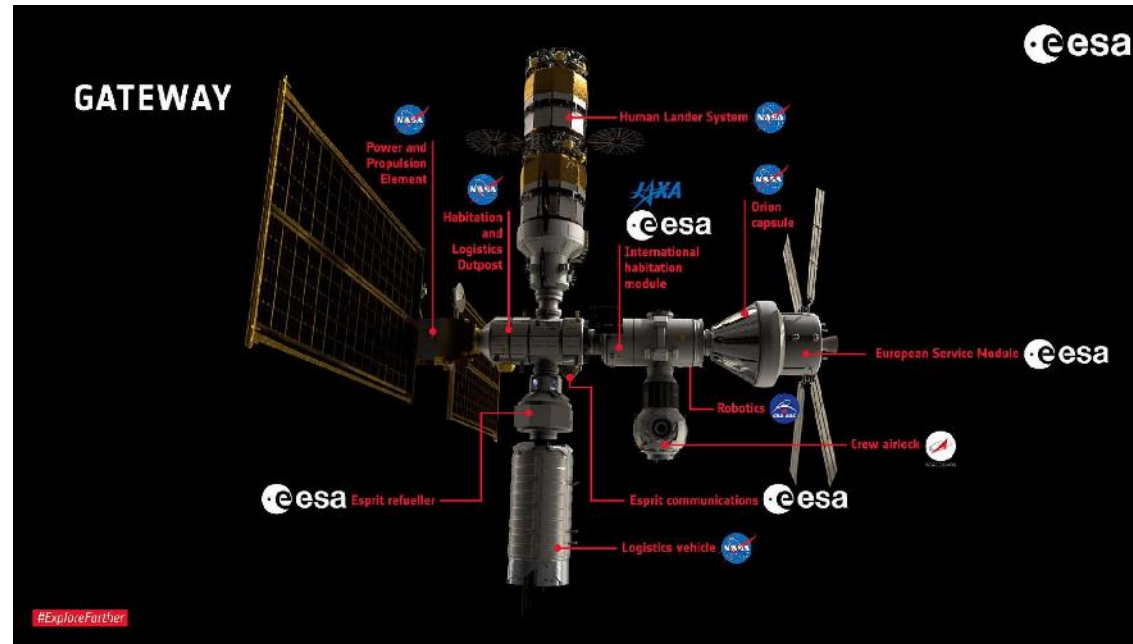
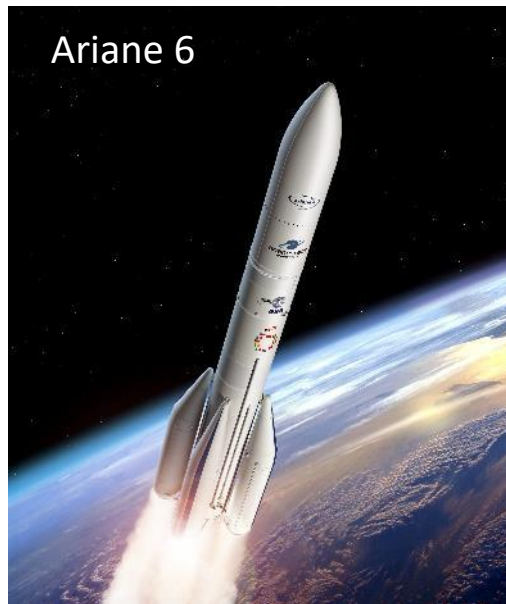


Temperature performances

Radiation performances



Ethernet more & more used in Space



TTEthernet Switch

TTEch
beyond gravity



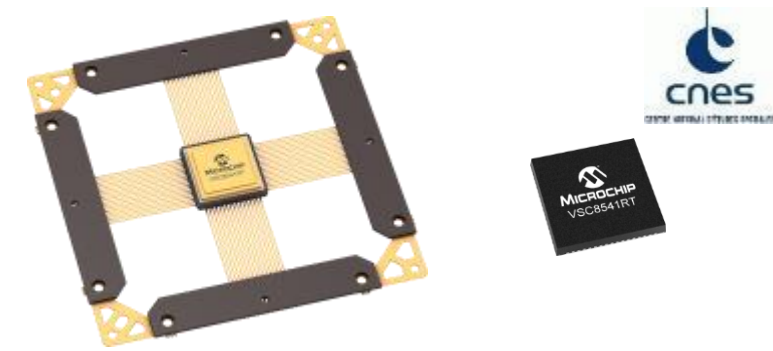
CX5-1000 Transceiver

Already thousands of Ethernet Flight Models delivered worldwide

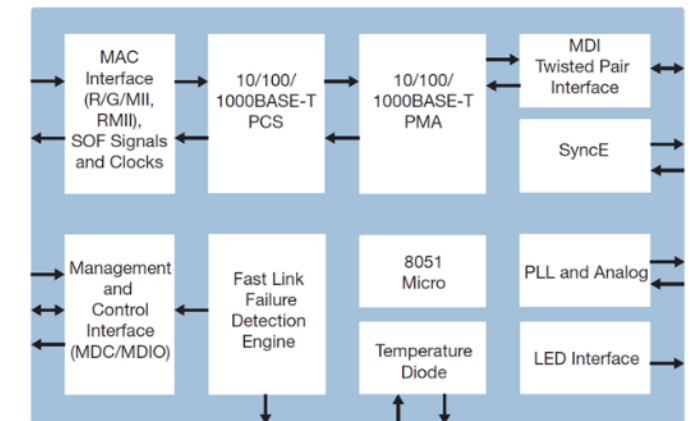
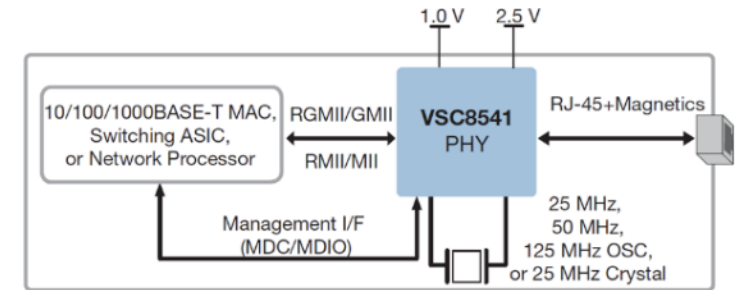
VSC8541RT (& VSC8540RT)

Rad Tolerant Fast/Gigabit Ethernet PHY

Samples & Flight Models available
ESCC Detail Specification No. 9405/020



- 10/100/1000BASE-T Ethernet copper transceiver (IEEE 802.3ab compliant)
- RGMII/GMII/MII/RMII MAC interface
- Synchronous Ethernet and IEEE 1588 Start of Frame identification
- Patented line driver with low EMI voltage mode
- Wake-on-LAN
- Supports clocking from 25 MHz crystal or 25/50/125 MHz oscillator
- Host-free configurability through hardware strapping
- Best-in-Class power consumption
- Extended temperature range -55°C to 125°C
- CQFP68 and VQFN68 packages



Radiation
TID 100krad
SEL immune up to 78 MeV

VSC8574RT

Rad Tolerant 4 Port GbE Cu/Fiber PHY with (Q)SGMII & IEEE1588

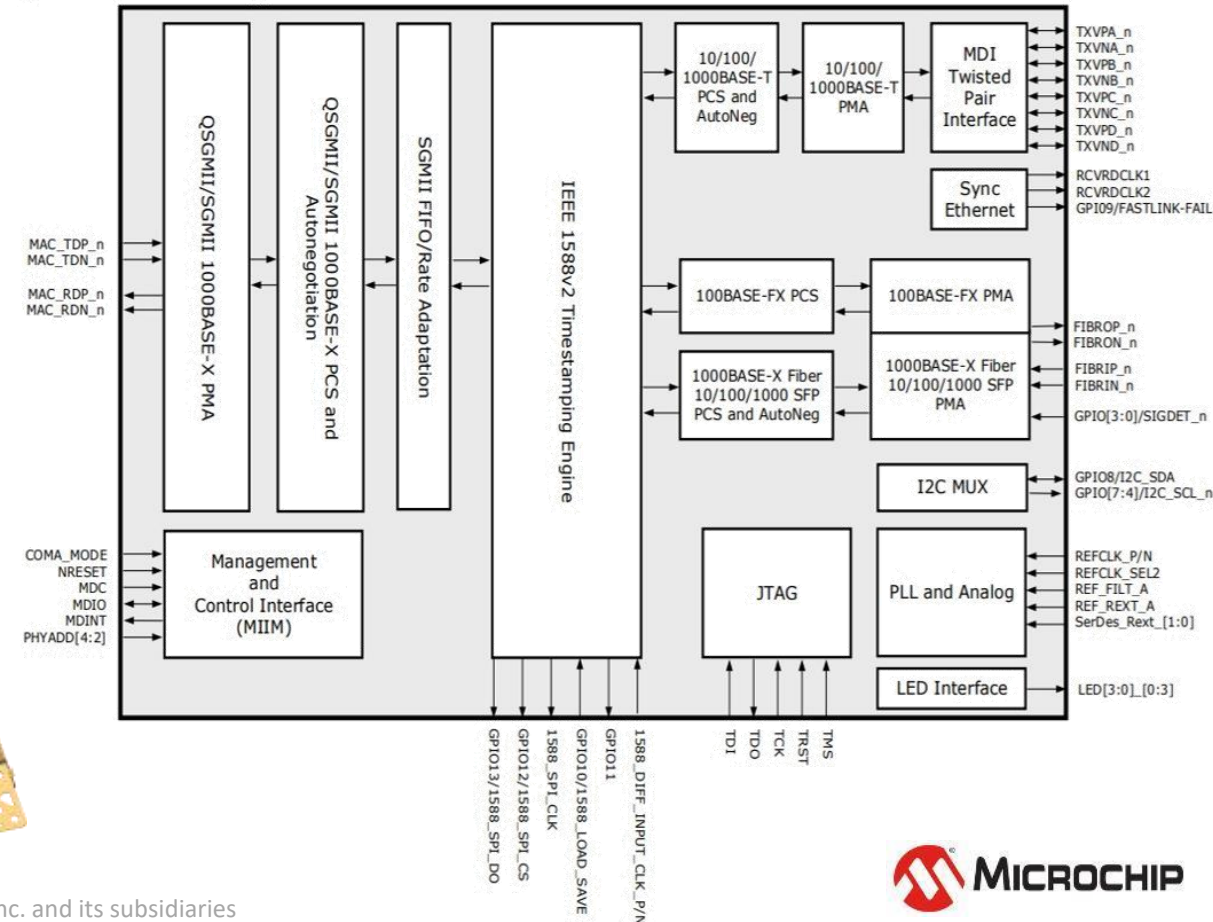
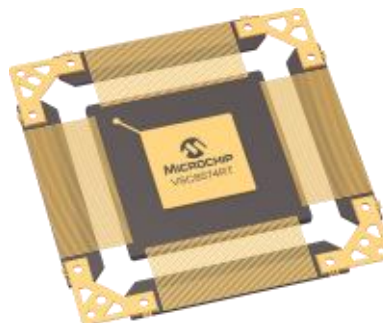
Samples available

Radiation

TID 100krad

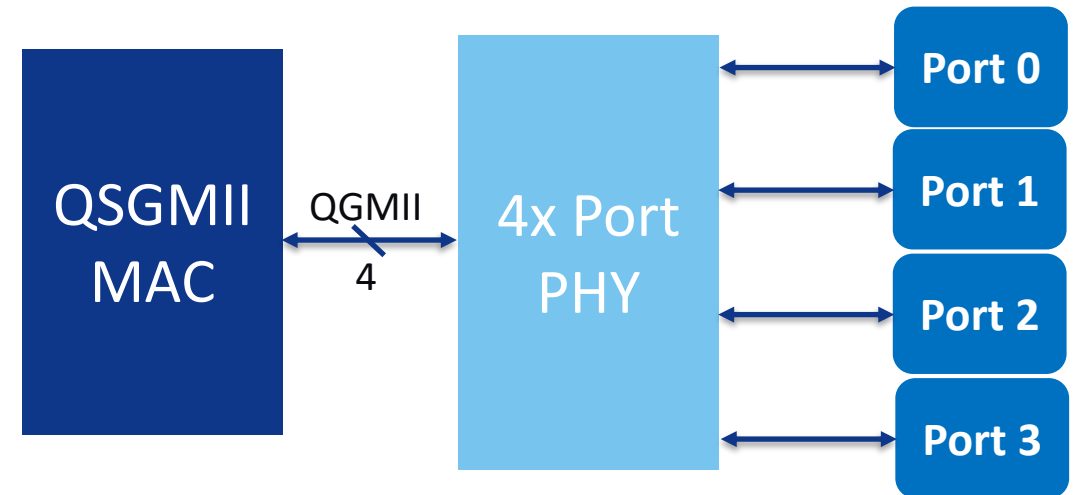
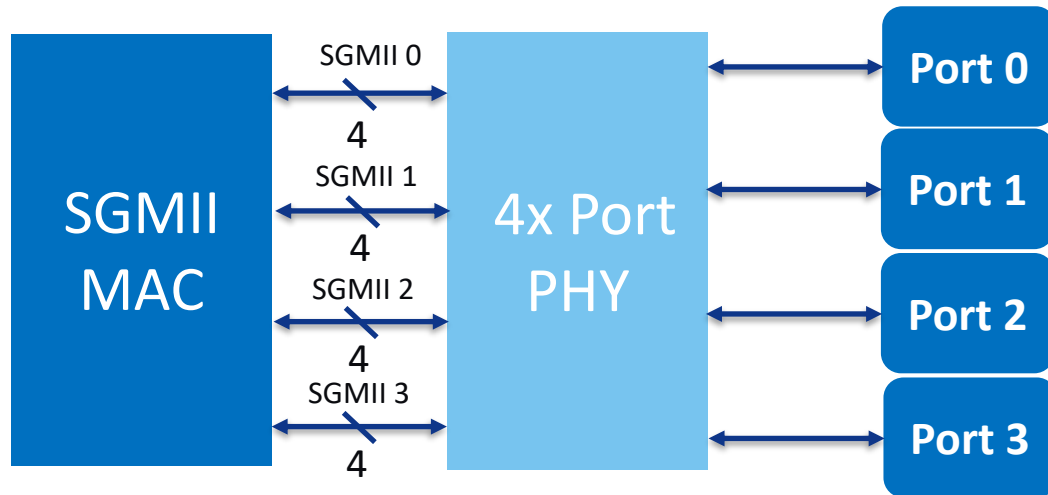
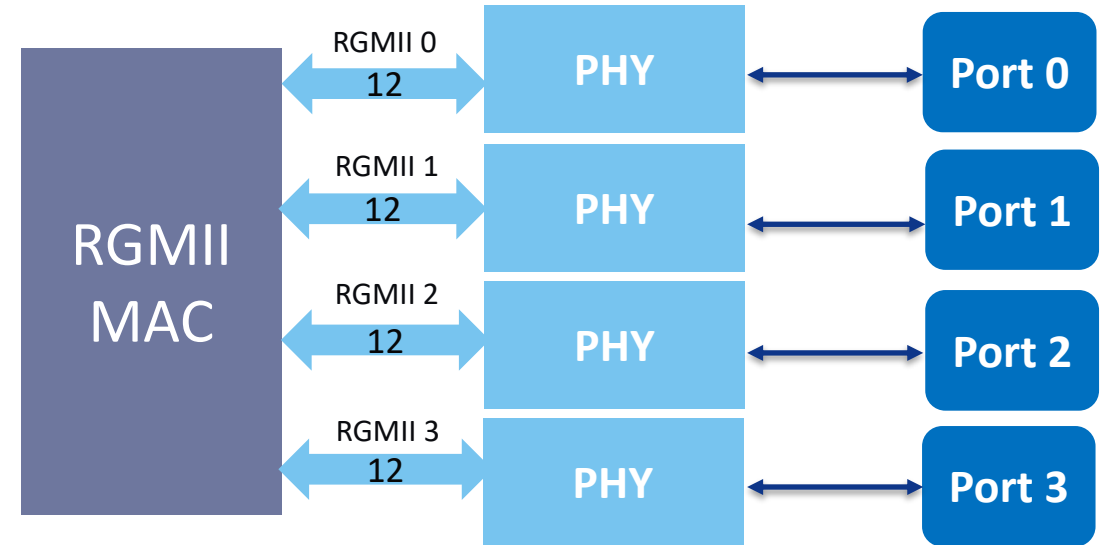
SEL immune up to 78 MeV

- 10/100/1000 Base-T copper, 100 Base-FX, 1000 Base-X fiber transceiver
- 4 ports
- SGMII / QSGMII interface
- QSGMII 5 Gbps SerDes
- IEEE 1588v2 High Accuracy (8 ns)
- Dual Media
- Extended temperature range -55°C to 125°C
- CQFP 256 and BGA 256 packages



4 Port PHY - RGMII / SGMII / QSGMII Examples

- **RGMII - Separate data path for each port**
 - Each port takes 12 RGMII lines
- **SGMII- Separate data path for each port**
 - Each port takes 4 SGMII lines
- **QSGMII – All ports muxed onto one data path**
 - QSGMII combines 4 SGMII lines into a single 4 pin interface.



Ethernet Precision Timing, PTP & gPTP



- Synchronize time between different nodes on an Ethernet network.
- **IEEE Std 1588 is the base standard for the Precision Timing Protocol (PTP)**
 - Defined for use over different transport protocols (Ethernet, IP/UDP, OTN, etc)
 - Profiles defined for use in telecommunications, enterprise, broadcast, power, and other applications
- **IEEE Std 802.1AS is a profile of PTP (gPTP)**
 - Defined for use with Ethernet TSN
 - Originally targeted for audio/video applications but now used in industrial automation and automotive applications
 - Branching out into space and other industrial applications via draft standards IEEE P802.1DP/SAE AS6675 and IEC/IEEE 60802.
- **All Ethernet RT PHY solutions ready for PTP (IEEE 1588) / gPTP (IEEE 802.1AS)**

SoC w Embedded Ethernet for Space

COTS Rad Tolerant

Products	Type	Summary / Highlights	Flight Models
SAMV71Q21RT	ARM32 M7	600 DMIPS, CAN FD, Ethernet TSN, DSP	Available
SAM3X8ERT	ARM32 M3	100 DMIPS, CAN, Ethernet, Dual CAN	Available

100Mbit TSN
1AS/gPTP



100Mbit



Rad Hard by Design

Products	RH Techno	Summary / Highlights	Flight Models
SAMRH71	150nm Mixed	Arm Cortex-M7, >200 DMIPS Spw/1553/CAN FD/Eth, TCM/FPU/MPU/ECC	Available

100Mbit TSN
1AS/gPTP



Contributing to Ethernet TSN for Space

• 2019 :



- First evaluation to demonstrate TSN gPTP precision timing.
- Demonstrates gPTP traffic running <100ns jitter w SAMV71RT & industrial Ethernet AVB switch (KSZ9477).
- Same Ethernet MAC reused for SAMRH71.

• 2021 :



- Support EDEN IRT Saint Exupery evaluation activity with LAN9668 industrial TSN Switch for several critical use cases.
- Federates several domain (automotive, aviation & space) around critical embedded system.
- Evaluation results expected in September 2023.

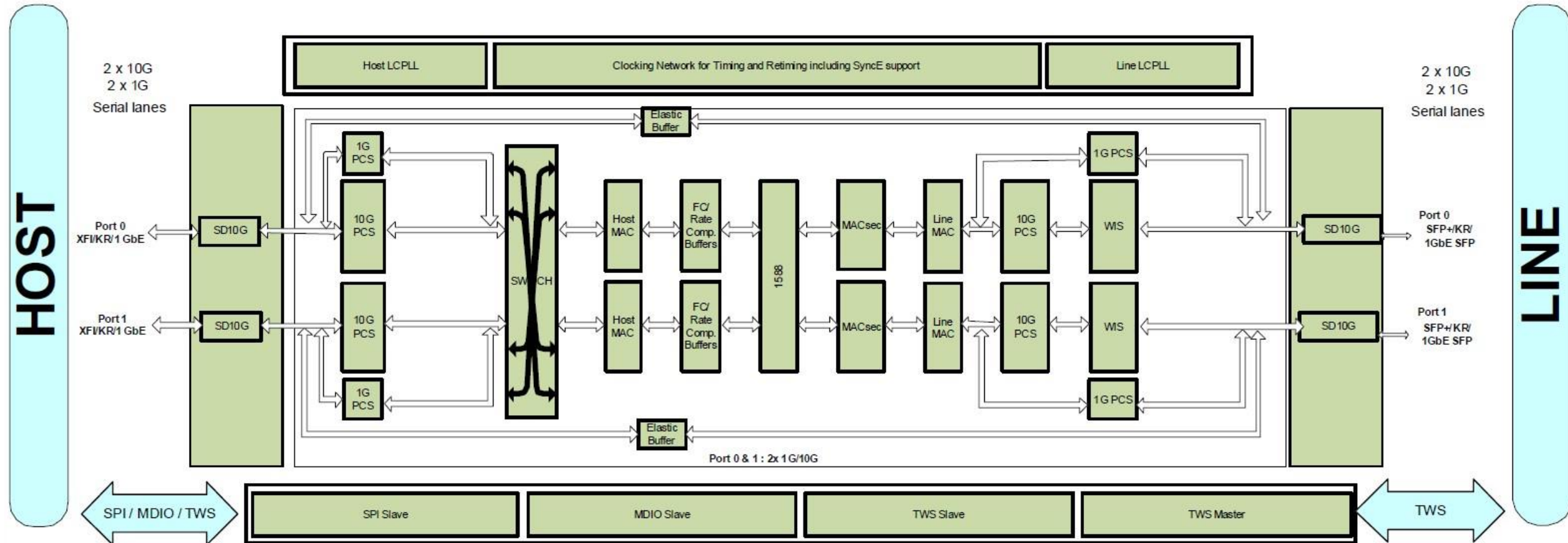
• **Microchip Ethernet TSN design center in Danemark (ex Vitesse)**



Ethernet roadmap

Rad Tolerant 2 Port 10GbE XFI/SFI PHY with IEEE1588 & MACsec

- SerDes Mac and Line interface : XFP/SFP modules (No direct Cu interface)
- Advanced features such as IEEE 1588v2 (4ns) and the MACsec engine with no loss of precision



Ethernet Switches roadmap for Space

Rad Tolerant Ethernet Switches

Ethernet switches under evaluation to assess their capability to be introduced in the radiation tolerant portfolio

Targeted product characteristics are:

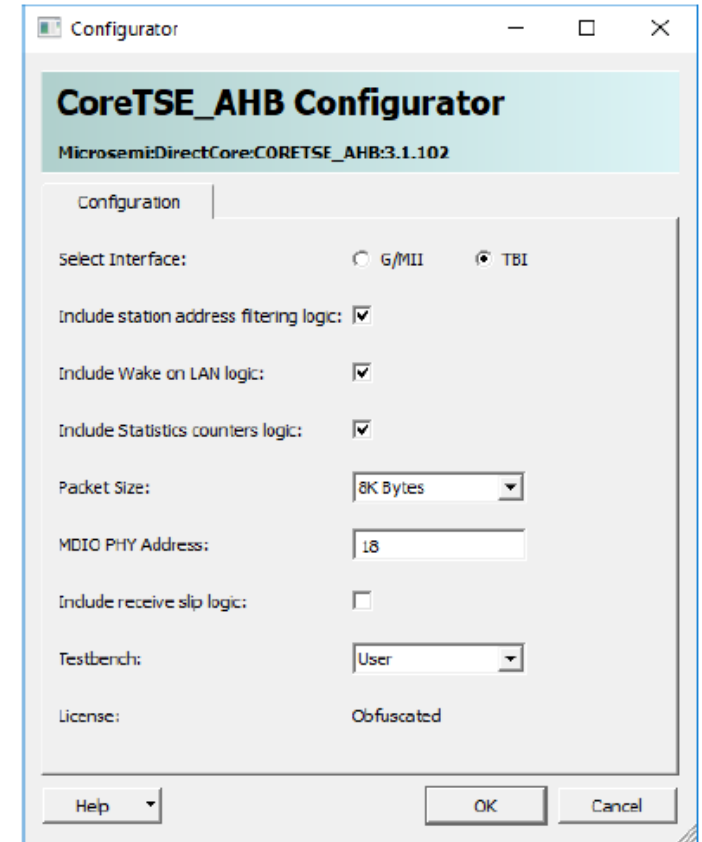
- Plastic and ceramic package availability
 - Pin count \leq 256 pins
- Operating Temperature Range
 - -55°C to 125°C
- No SEL for LET $<$ 62MeV
- 50krad capability

Features	VSC7514	VSC7440
Bandwidth	10/100/1000/ 2500 Mbps	10/100/1000/ 2500 Mbps 10 Gbps
Ports	10	10
Interface	SGMII, QSGMII 1000Base-T	SGMII 1000Base-T XFI
EEE	✓	-
TSN	-	-
Vdd I/O (V)	1.0/1.2/2.5	1.0/1.2/2.5
Cable diagnostics	✓	✓
IEEE 1588	✓	✓

Ethernet for Space w RT FPGA

- **CoreTSE IP core for RTG4™, RT-PolarFire® FPGA families providing following features:**
 - Tri-Speed Ethernet MAC Core
 - 10/100/1000 Mbps Operation
 - Full-Duplex at 10/100/1000 Mbps
 - Half-Duplex at 10/100 Mbps
 - Standard G/MII interface
 - MDIO interface for PHY register access
 - SGMII via SERDES (TBI), for 1000Base-T/1000Base-X support
 - Wake on LAN (WoL) with Magic Packet Detection
 - Frame Statistics Counters
 - Destination Address Based Filtering
- **Several reference designs available**
 - [UG0687 User Guide PolarFire FPGA 1G Ethernet Solutions](#)
 - [DG0799 Demo Guide PolarFire FPGA 1G Ethernet Solutions](#)

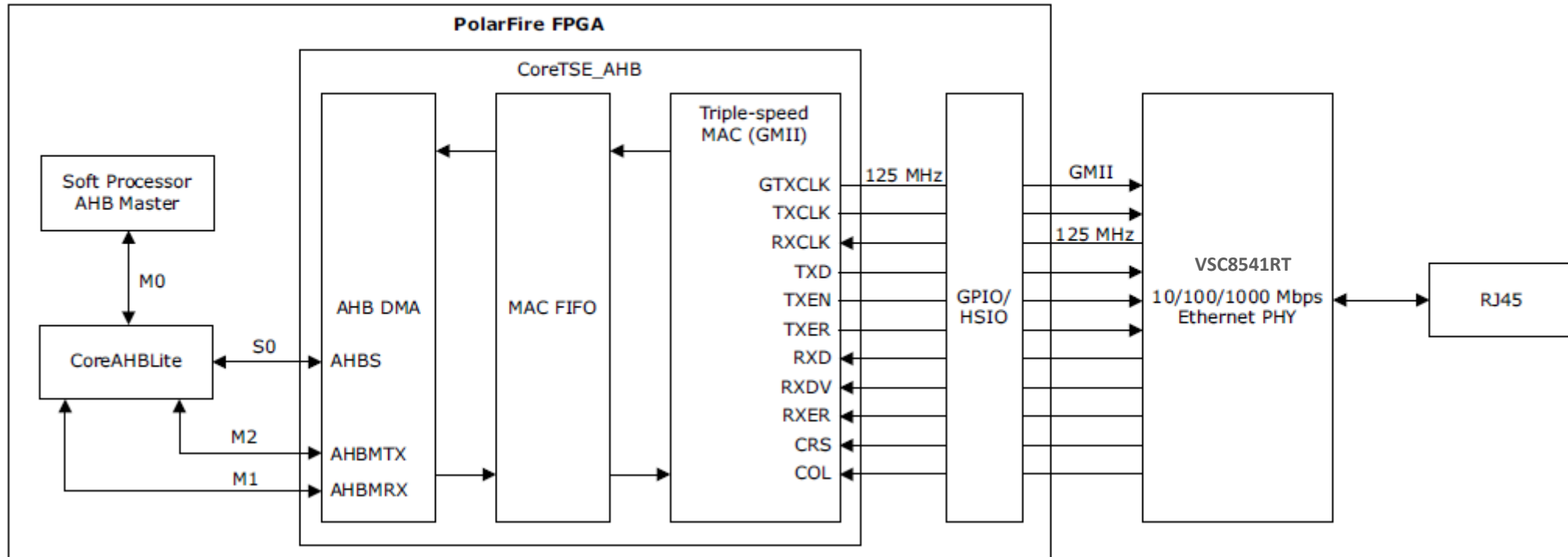
CoreTSE_AHB Configuration in SGMII Mode



GMI Based Design FPGA + VSC8541RT

RT-PolarFire®/RTG4™ FPGAs reference design UG0687

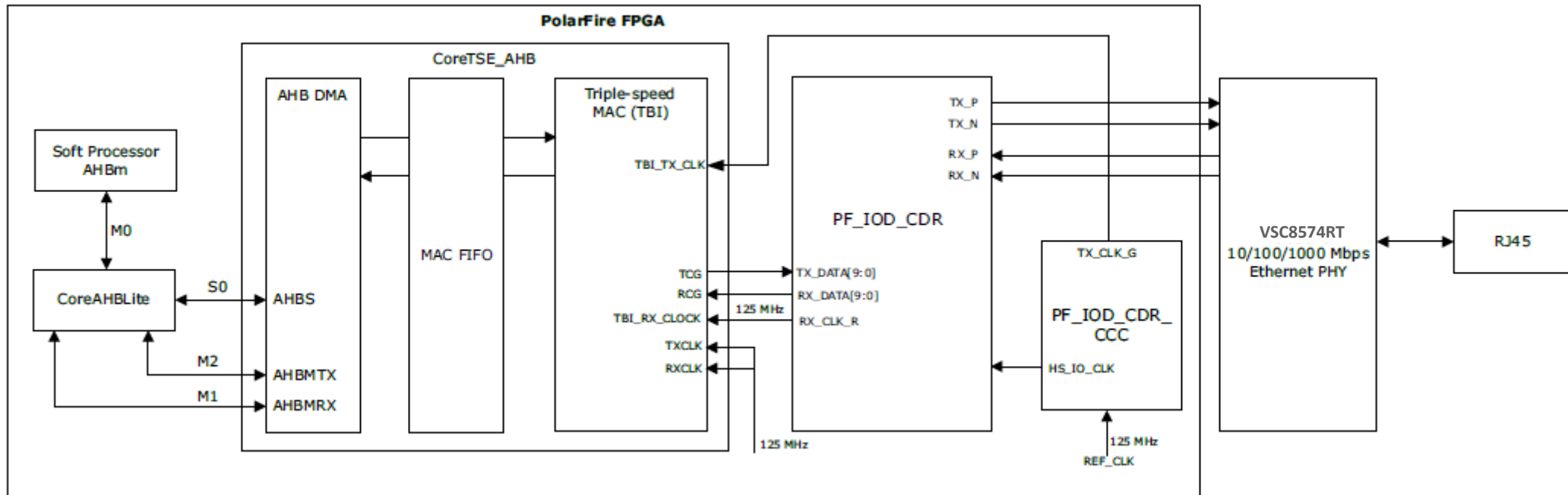
Figure 4 • RJ45 Connections for GMI-Based Designs (AMBA AHB)



SGMII Based Design FPGA + VSC8574RT

RT-PolarFire®/RTG4™ FPGAs reference design UG0687

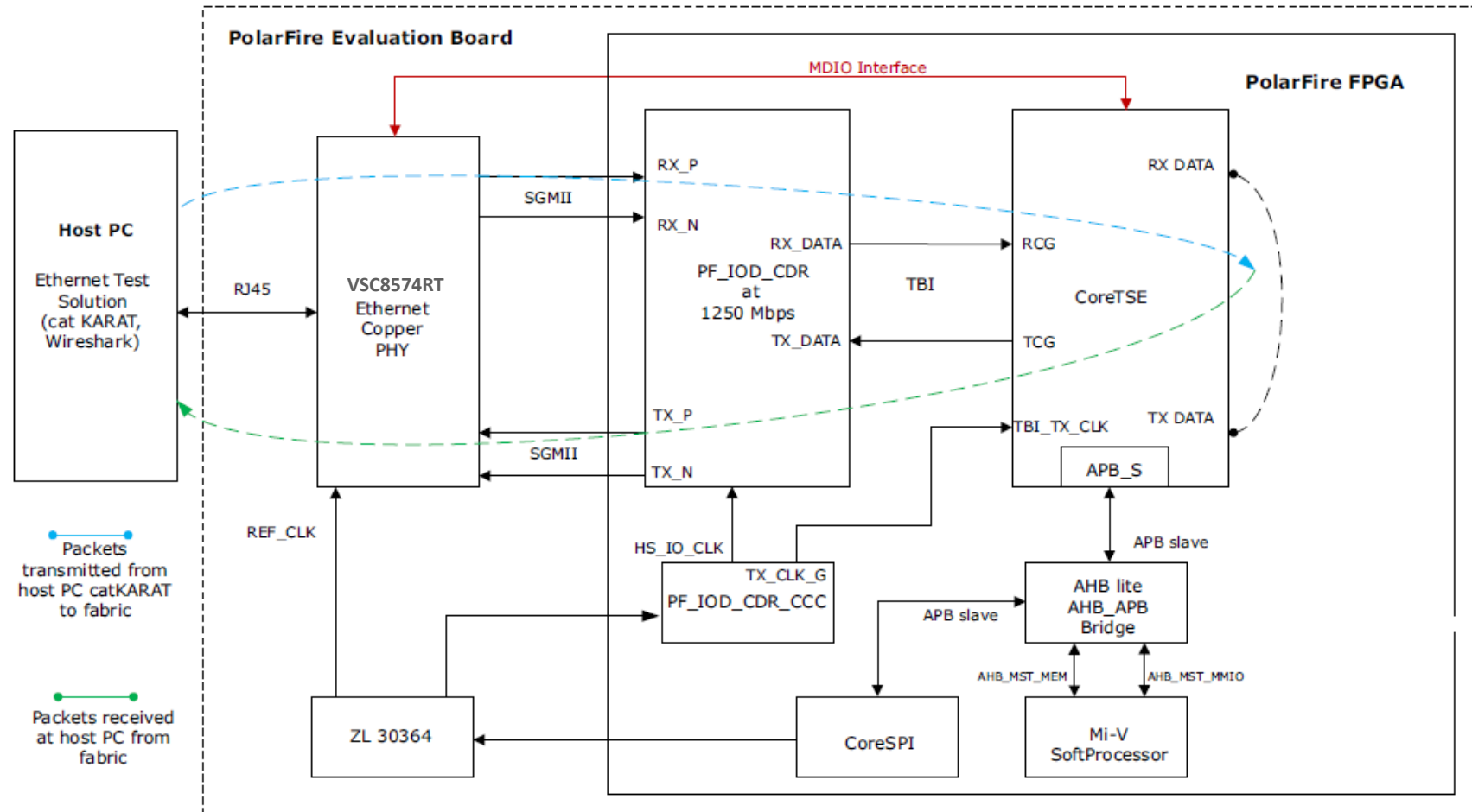
Figure 7 • RJ45 Connections for SGMII-Based Designs (AMBA AHB)



SGMII w IOD Based Design FPGA + VSC8574RT

RT-PolarFire® FPGA reference design DG0799

Figure 1 • Block Diagram



Ethernet for Space w LS1046 RT MPU

Ethernet PHYs with Teledyne e2v Space processors

1

Meeting the requirements of Edge computing applications

- ❖ Typical Edge computing applications: real-time image/video processing, scientific data analysis, communications, autonomous operations, landers...
- ❖ Edge computing require: High processing power & **high-speed interfaces (Gbps)** to exchange data with sensors, other boards,...
- ❖ Teledyne e2v strategy & offer:
 - ❖ Space grade, radiation-tolerant processors and processing modules
 - ❖ Disruptive computing performance for Edge computing applications
 - ❖ Example QLS1046-Space:
 - ❖ Quad Arm CORTEX-A72 @1.8GHz, 30kDMIPs / 56GFLOPs
 - ❖ Integrated 4GB DDR4
 - ❖ Multiple high-speed interfaces, PCIE, and **Ethernet SGMII, RGMII, XFI**



- ❖ **Ethernet PHYs (SGMII, RGMII, XFI, ...) are required to support Edge computing in Space:**
 - ❖ **Teledyne e2v is implementing a Space reference design with Microchip PHYs and QLS1046-Space**

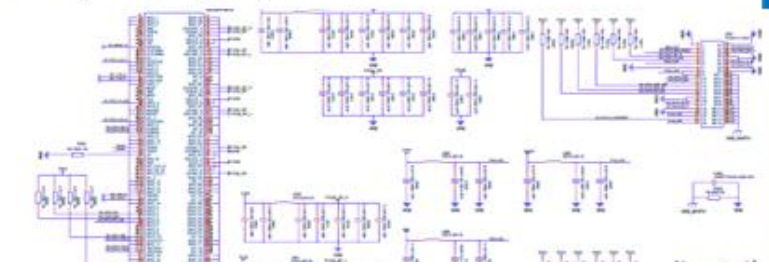
LS1046 RT MPU w Microchip Ethernet PHYs

- Gbit RGMII w VSC8541RT
- Gbit SGMII w VSC8574RT
- 10Gbit XFI w RT PHY to come

Reference Design w LS1046RT Eval Kit

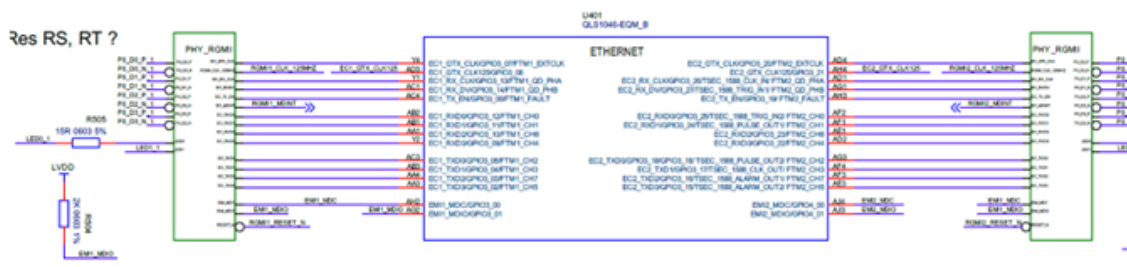
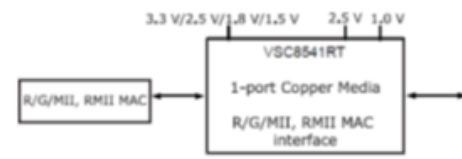
Ethernet PHYs with Teledyne e2v Space processors High Speed Interfaces – XFI

- ❖ 2 x XFI connections :
 - ❖ Using Ethernet PHY from Microchip VSC8254 (Industrial grade)
 - ❖ Up to 10Gbps
 - ❖ XFP cage (copper or optic fiber link)



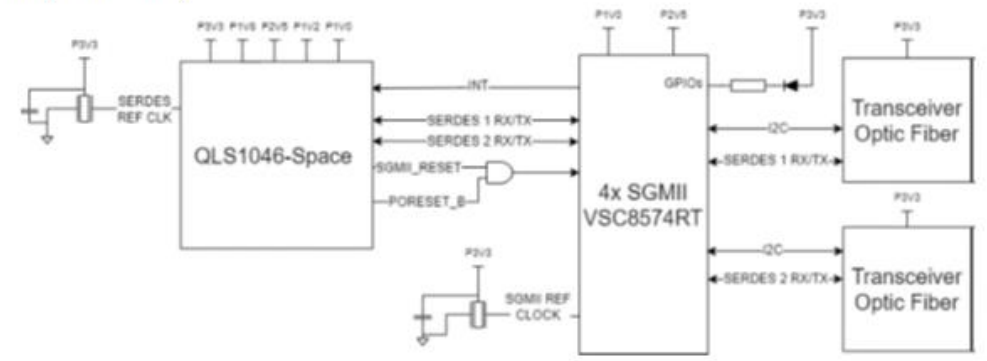
Ethernet PHYs with Teledyne e2v Space processors High Speed Interfaces – RGMII implementation with QLS1046-Space

- ❖ 2 x RGMII connections :
 - ❖ Using Space grade Ethernet PHY from Microchip VSC8541RT
 - ❖ Up to 1 Gbps
 - ❖ RJ45 on the connector on the board



Ethernet PHYs with Teledyne e2v Space processors High Speed Interfaces – SGMII implementation with QLS1046-Space

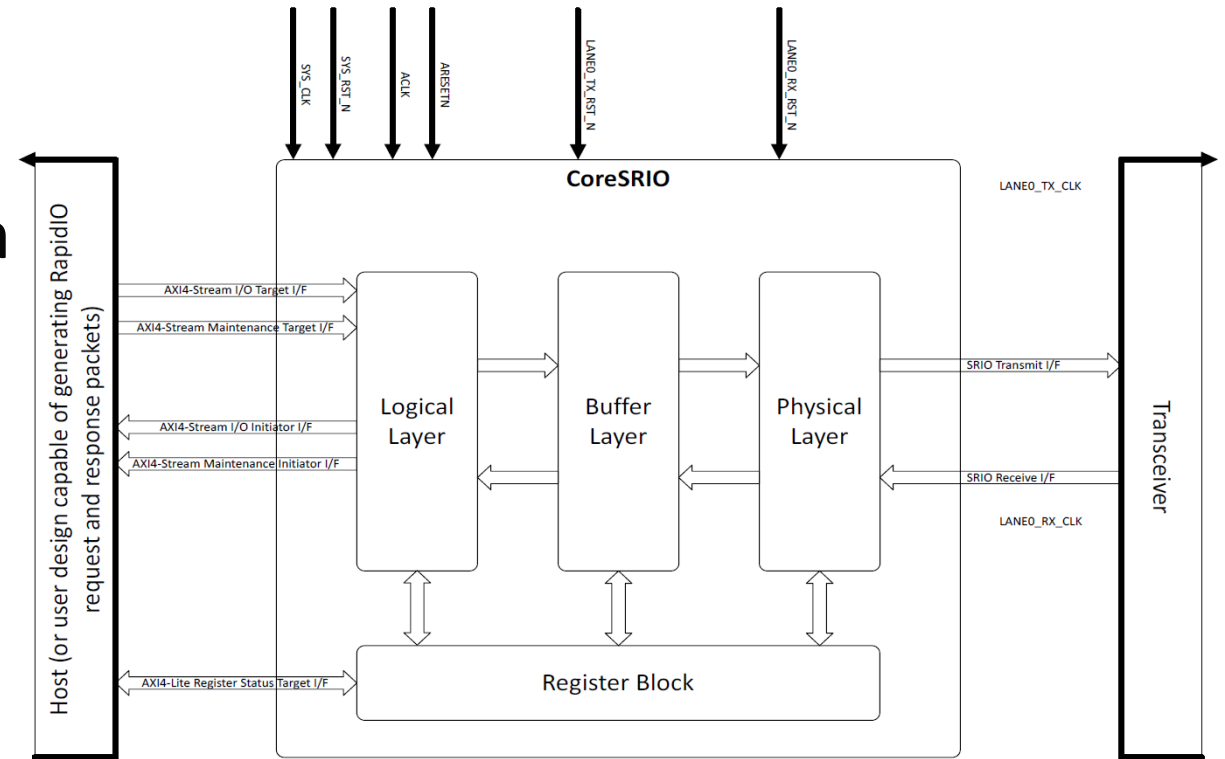
- ❖ 2 x SGMII connections :
 - ❖ Using Space grade Ethernet PHY from Microchip VSC8574RT
 - ❖ Up to 1 Gbps
 - ❖ SFP cage (copper or optic fiber link)



SRIO Connectivity Use Case

- CoreSRIO IP is compliant with Rapid I/O v2.0 Specifications supporting features:

- Input-Output Logical Specification
- Common Transport Specification
- LP-Serial Physical Specification

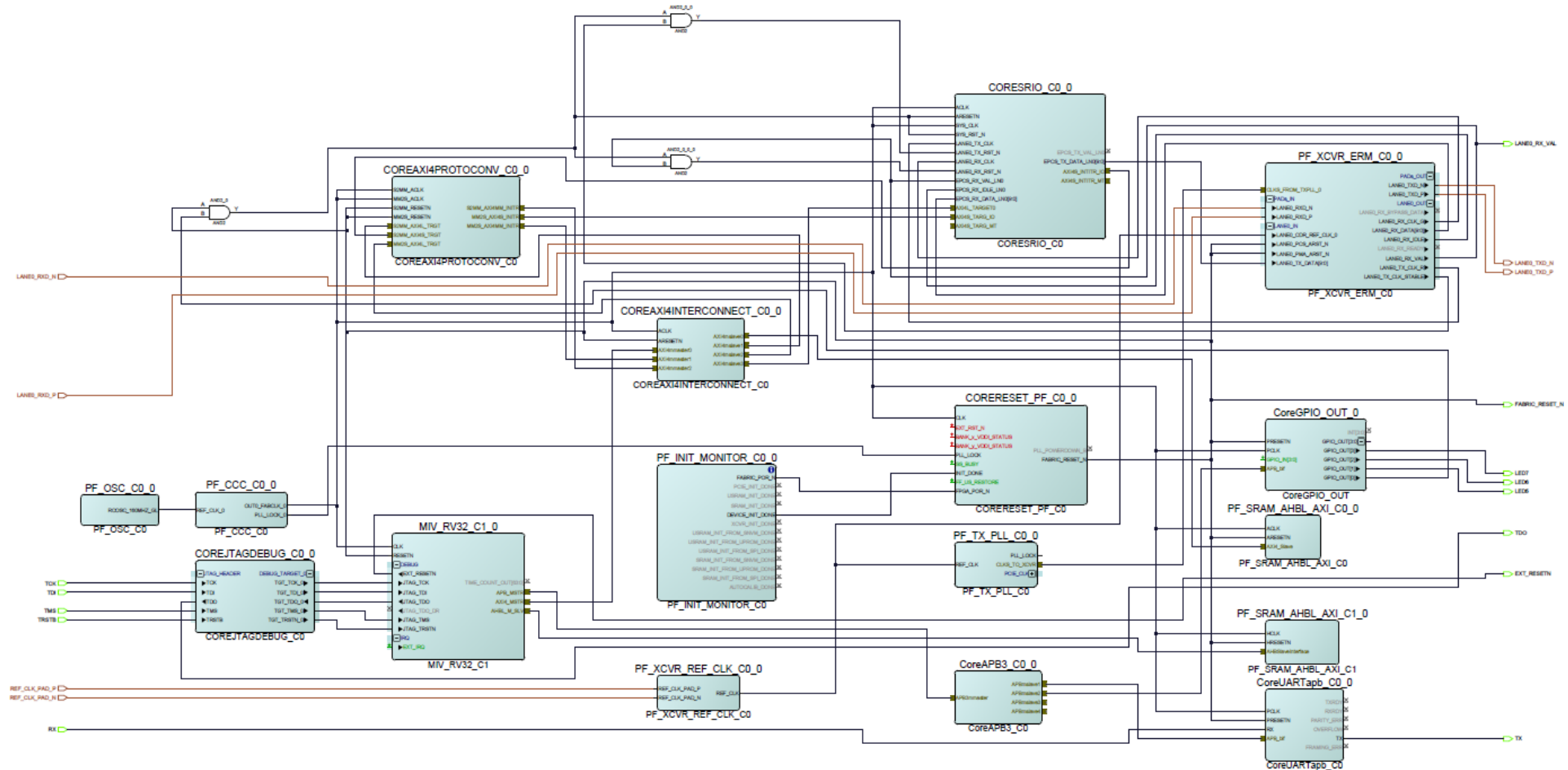


- Equipped with AXI4-Lite and AXI4-Stream interfaces

Serial Rapid IO Based Design FPGA + VSC8574RT

RT-PolarFire® Eval Kit reference design

Figure 5-5. CoreSRIO System Integration



Summary – Ethernet Solutions

- **Microchip A&D product lines in Europe**
 - Contributing to largest space products portfolio
 - Drive space system innovation around processing solutions
- **Ethernet for Space & Microchip Solutions**
 - New SGMII / Fiber Ethernet PHY VSC8574RT on top of VSC8541RT
 - On going activities around 10Gbit PHY, Ethernet Switches & TSN
- **Space end system ethernet solutions & use cases**
 - Processing & FPGA solutions for Ethernet in Space applications
 - PHY solutions to enable some other high-speed links like SRIO

Thank You !

Aerospace & Defense Group - Product Marketing
Microchip Technology Nantes S.A.S.

Microchip Aerospace & Defense Website:

<https://www.microchip.com/design-centers/aerospace-and-defense>

Microchip Technical Support: <https://microchipsupport.force.com/s/>

