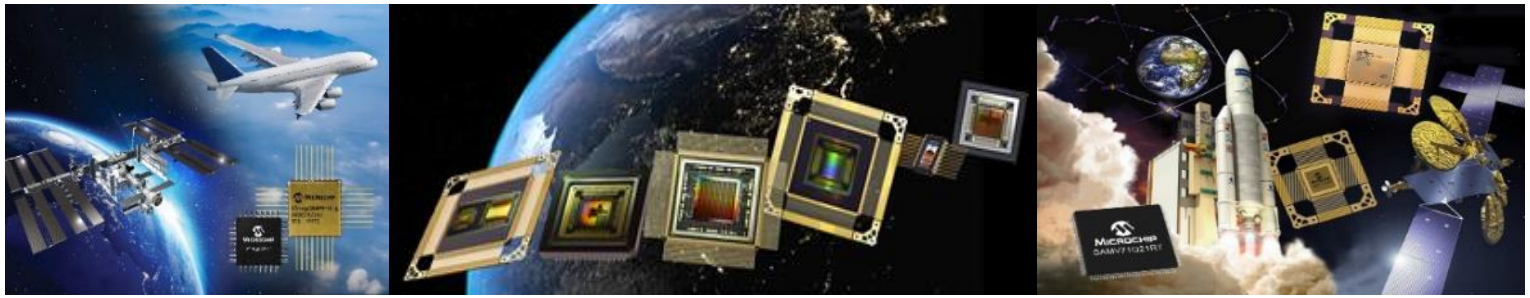
Microchip Processing Solutions for Space

MICROCHIP
Aerospace & Defense

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



SMART | CONNECTED | SECURE

Nicolas GANRY

27th October 2022

Microchip Space Processing Solutions

- **Microchip in Europe**
- **Space processing applications**
- **Space Microchip solutions available**
- **High processing solutions initiatives**
  - RISC-V Polarfire® SoC
  - Arm® Multicore MPU
  - HPSC

Microchip Space Processing Solutions

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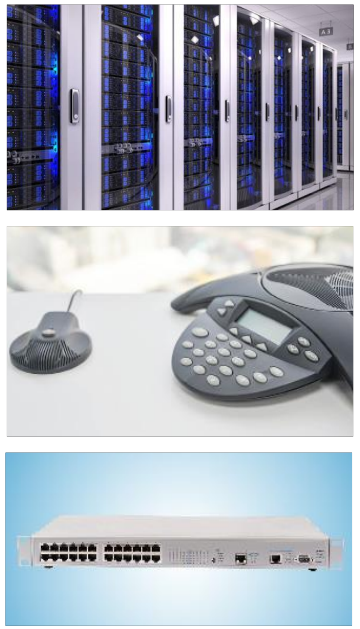
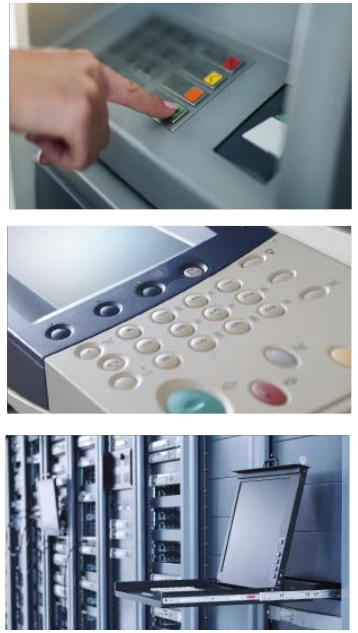
  - HPSC

Microchip's Broad Portfolio & Market Coverage

MCUs	Analog	Mixed Signal	Interface	Memory	Power Management	Switches & Controllers	High-Rel Discrete	Enterprise Storage	FPGA

Industrial 28%	Automotive 15%	Consumer 13%	Communications 14%	Data Center & Computing 18%	A&D 12%




 # 1 Semiconductor Supplier in Aerospace and Defense

Microchip in Europe

Headcount	Country	Activity
623	Germany	Auto, Analog, ADG, RF,
438	France	MCU32, MPU32, ADG
293	Ireland	Analog, RF, ADG
277	Romania	All BUs
264	United Kingdom	HMID, ADG
114	Norway	HMID, MCU8
96	Israel	FPGA
55	Italy	Memories
49	Spain	MPU32, Meetering
32	Denmark	UNG
19	Switzerland	Analog
15	Austria	
13	Sweden	
7	Belgium	
7	Netherlands	
4	Poland	
3	Finland	
2309	Total	

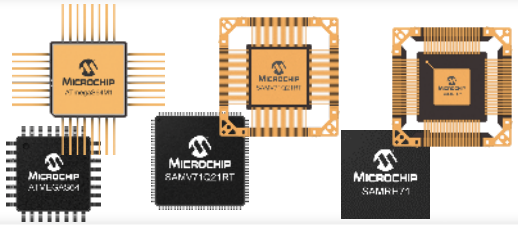
>2300 employees
>20 design centers
in 17 countries
Auto / A&D Supply Chain

MPU AUTO RF Memories HMID
A&D MCU Analog FPGA Ethernet

Largest Space Semiconductors Portfolio

MPUs and MCUs

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

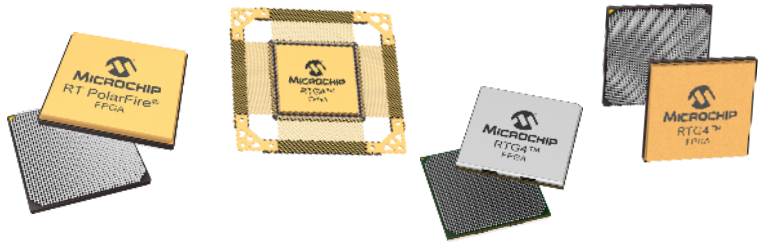


Communication Interface and memories

SpaceWire, Ethernet, CAN
SRAM
NVM memories

FPGAs

RT PolarFire®
RTG4™
RT ProASIC3®
RTAX™, RTSX-SU

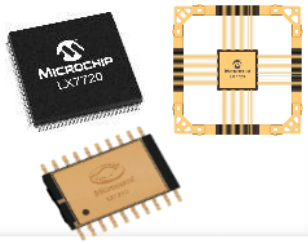


Power Solutions

Rad-hard JANS Diodes, Bi-Polar Small Signal Transistors
Rad-hard Isolated DC-DC Converter Modules
Custom Power Supplies 2 W to > 5 KW
Point of Load Hybrid Solutions
Electromechanical Relays

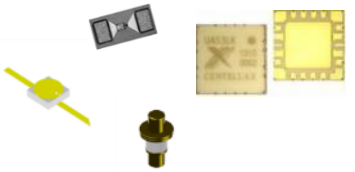
Mixed Signal Integrated Circuits

Telemetry and Motor Control Space System Managers
Power Supply protection



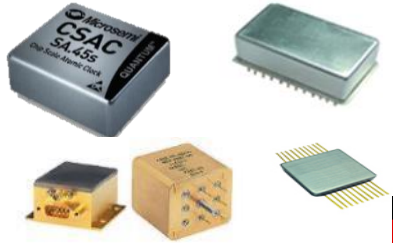
RF Products

Packaged and Chip Si and GaAs RF Diodes,
SAW filters,
Packaged and bare die GaN and GaAs MMICs
GaN on SiC HEMT transistors

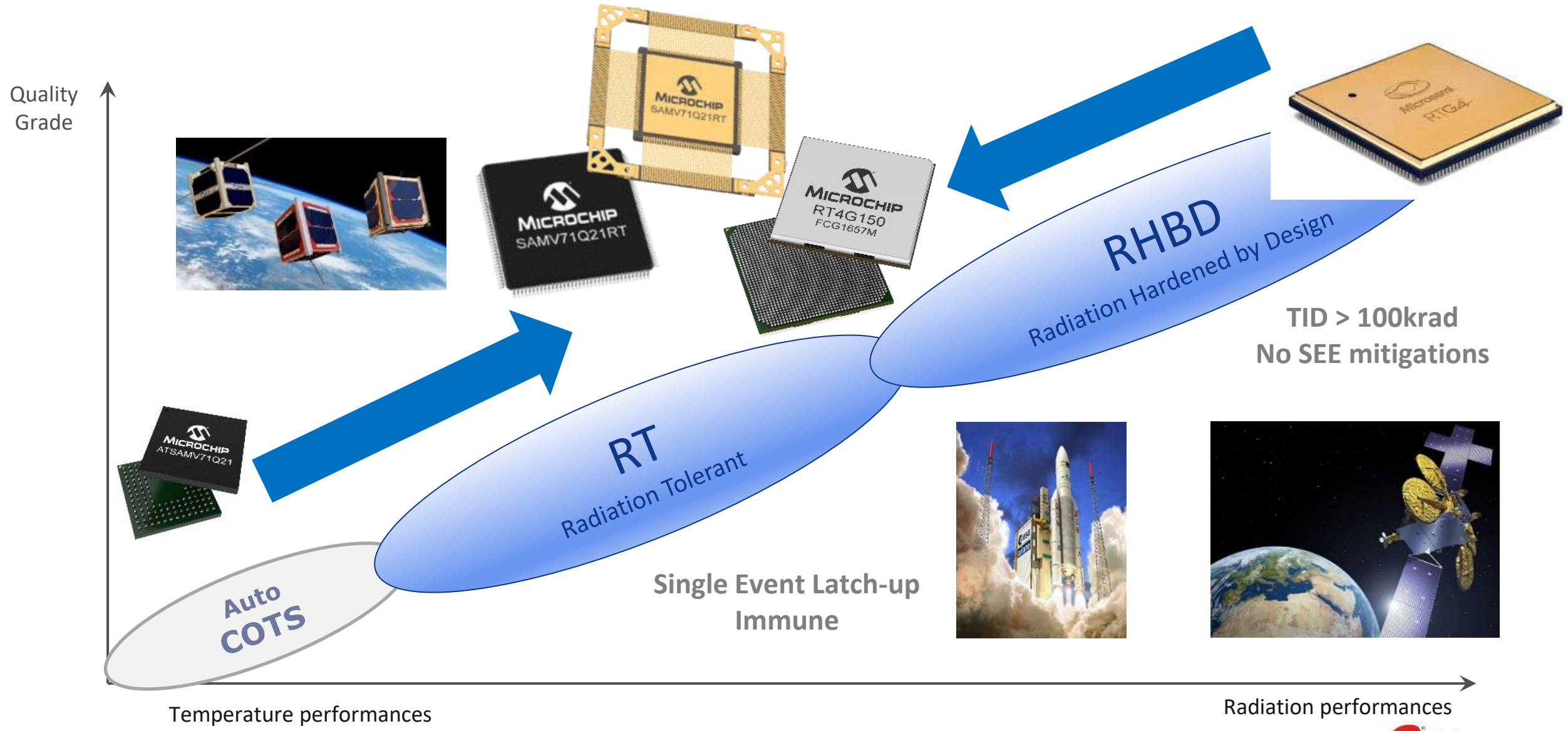


Timing solutions and Oscillators

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



Microchip Scalable Solutions for Space



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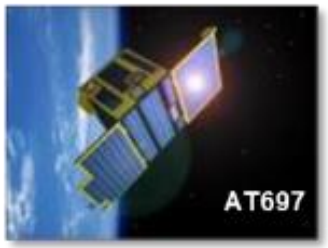
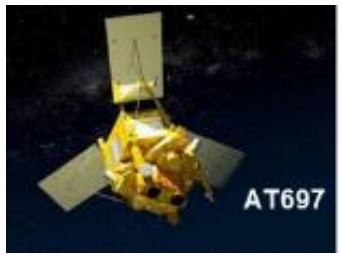
Processing : An Unrivalled Flight Heritage

Colombus
2008

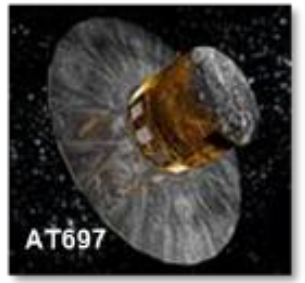


Proba2
2009

JUNO (Nasa)
2011



SPOT6
2012



Gaïa
2013

Sentinels &
Alphasat
2013

SVOM/Eclair
2013

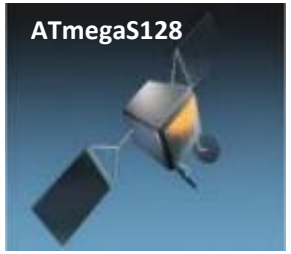
MMS (Nasa)
2014

Exomars
2016

Solar Obiter
2017

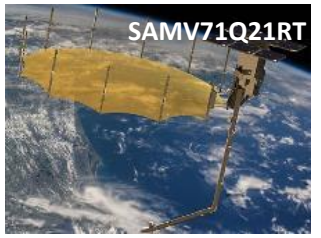
Bepi-Colombo
2018

Perseverance 2021



Mega Constellation
LEO Sat -2019

Thousands of flight models delivered worldwide



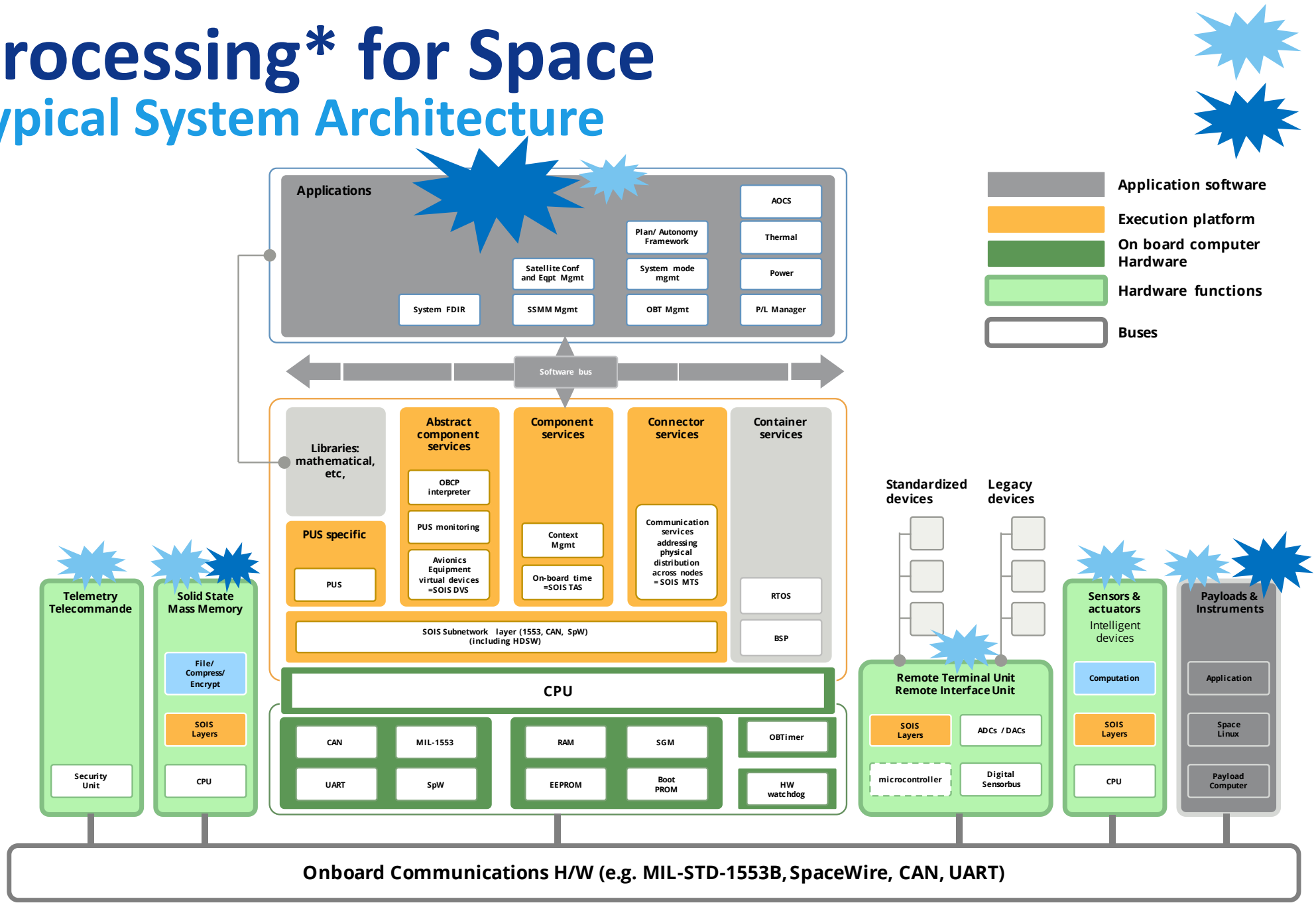
Capella Sequoia
Earth Obs 2020

ANGELS nanosat
2020

MICROCHIP

Processing* for Space

Typical System Architecture



* Including FPGA w IP CPU core

Typical Processing Space Applications

High MPU/SoC

HIGH

- On board computer
- Flight computing
- Rich OS applications
- Image processing
- AI/ML
- Data handling
- Transponders
- Processing payloads
- Radar/SAR
- Datapath cryto
- Mass data and memory
- Navigation
- Decommissioning
- Interconnect / switches
- …

Low MPU/MCU

LOW

- Remote Terminal Units (RTUs)
- Motor control
- Mixed signal processing
- Propulsion system control
- Sensor / actuator control
- Robotics applications
- Mechanisms and motor control
- Magnetometer
- Reaction wheels
- Star tracker
- Power control
- OBC for nanosatellites
- Connectivity gateway
- Security gateway
- Thermal control
- …

MICROCHIP

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MICROCHIP

Space Microcontroller and Processors

- **COTS Radiations-Tolerant**

Products	Type	Summary / Highlights	Flight Models
ATmegaS128	AVR8	~10 DMIPS, SPI,TWI, UART, ADC	**Available**
ATmegaS64M1	AVR8	~10 DMIPS, CAN, DAC and Motor Control	**Available**
SAMV71Q21RT	ARM32 M7	600 DMIPS, CAN FD, Ethernet TSN, DSP	**Available**
SAM3X8ERT	ARM32 M3	100 DMIPS, CAN, Ethernet, Dual CAN	**Available**

- **Rad Hard by Design**

Products	RH Tech	Summary / Highlights	Flight Models
AT697F	180nm	**SPARC V8** 100MHz,FPU/UART/PCI	**Available**
AT7913	180nm	**SPARC V8** 50MHz, Spw/CAN/SRAM 64K	**Available**
AT7991	180nm	**SPARC V8, GNSS Control** Spw/CAN/1553	**Available**
SAMRH71	150nm Mixed	**Arm Cortex-M7**, >200 DMIPS Spw/1553/CAN FD/Eth, TCM/FPU/MPU/ECC	**Available**
SAMRH707 “Jaguar”	**150nm Mixed**	**Arm Cortex-M7, 100 DMIPS** Spw/1553/CAN FD, **ADC/DAC, NVM+, small package**	**Samples available FM early 2023**

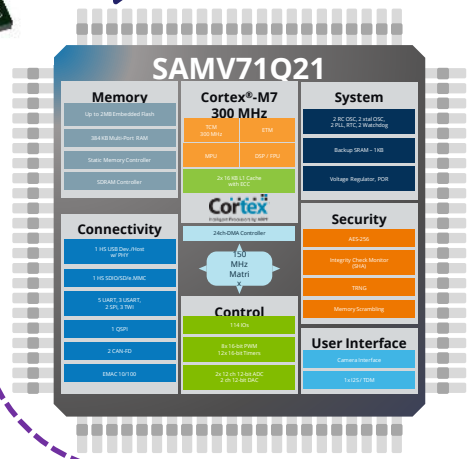
Arm® M7 SoC => COTS to RHBD

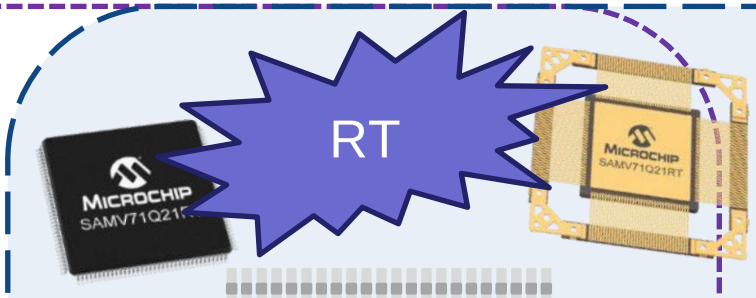
Unique Scalable Solution

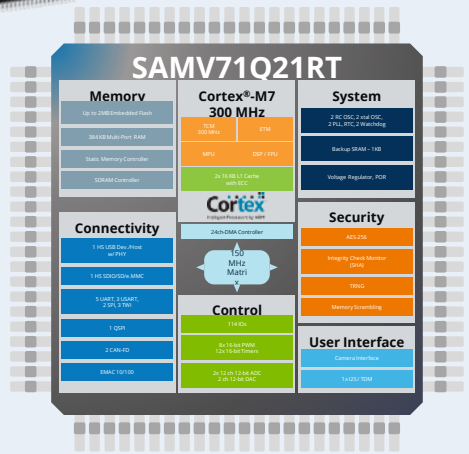
Qualification Level

Temperature performances

Radiations performances



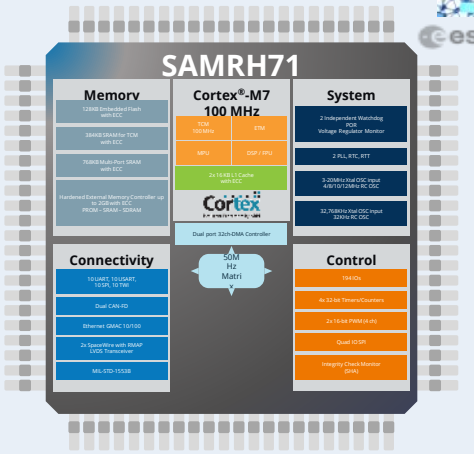




SAMV71Q21RT
600DMIPS
Latch-up Immune

1553

SpaceWire



SAMRH71
>200DMIPS
TID > 100krad

ESCC 9512006

SAMRH707 – Rad-Hard Microcontroller

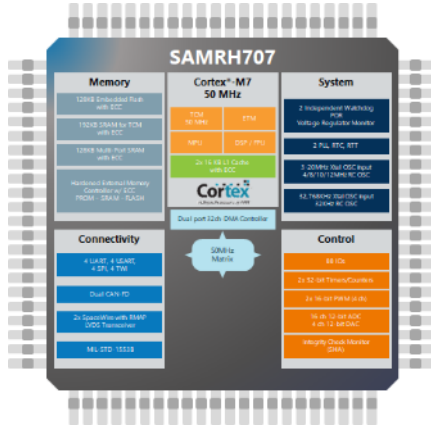
CQP256

BGA625

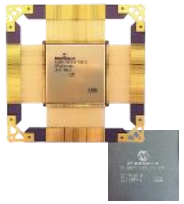
> 200DMIPS

Sampling NOW
FM early 2023

- ECC 128KB Flash
- ECC 320KB SRAM
- ECC (192KB TCM)
- ECC Int/Ext Mem



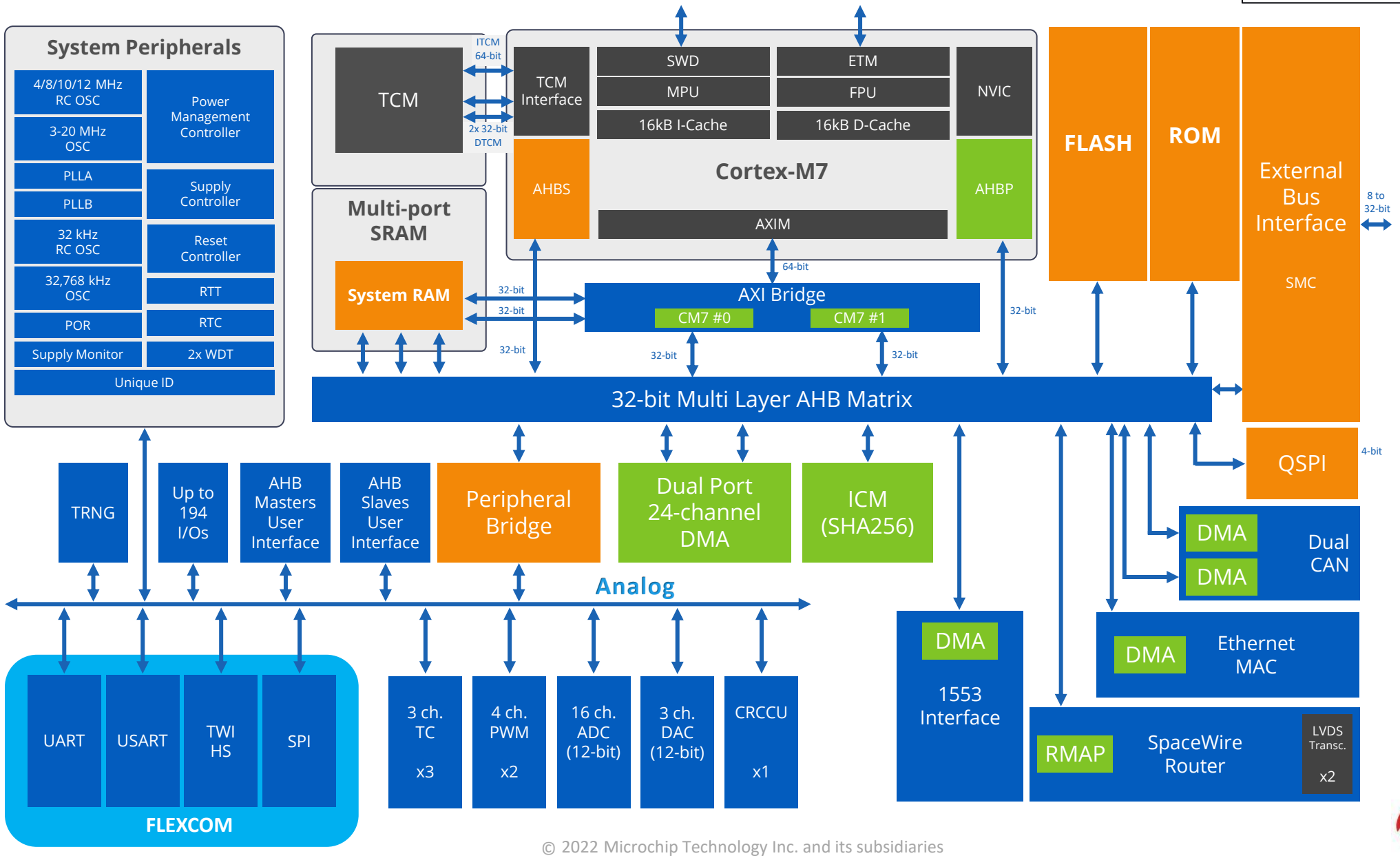
- **Smaller footprint, Power Saving**
- **Embedded Analog ADC/DAC 12-bits**
- **Enhanced embedded NVM 50Krad**
- **Still integrating LVDS**



- CQFP 164
- BGA 484

- 100 DMIPS
- 200Mb/s SpW
- CANFD, 1553

Arm® M7 SoC – SoC Architecture



Arm® Cortex®-M7 SoC

Same ecosystem from COTS to RT/RHBD

Evaluation Board

Xplained Ultra
Evaluation Kit
(ATSAMV71-XULT)

SAMRH71 Evaluation Kit
(SAMRH71F20-EK)

Programmer and Debugger

MPLAB® PICkit 4 In-Circuit Debugger (PG164140)
or MPLAB® ICD 4 In-Circuit Debugger (DV164045)
or J-32 Debug Probe (DV164232)

Microchip Software Tools Suite

MPLAB X IDE

MPLAB XC COMPILER

MPLAB HARMONY

Ready-to-use Software, Example Projects

Already ported OS for M7 SoC (V71)

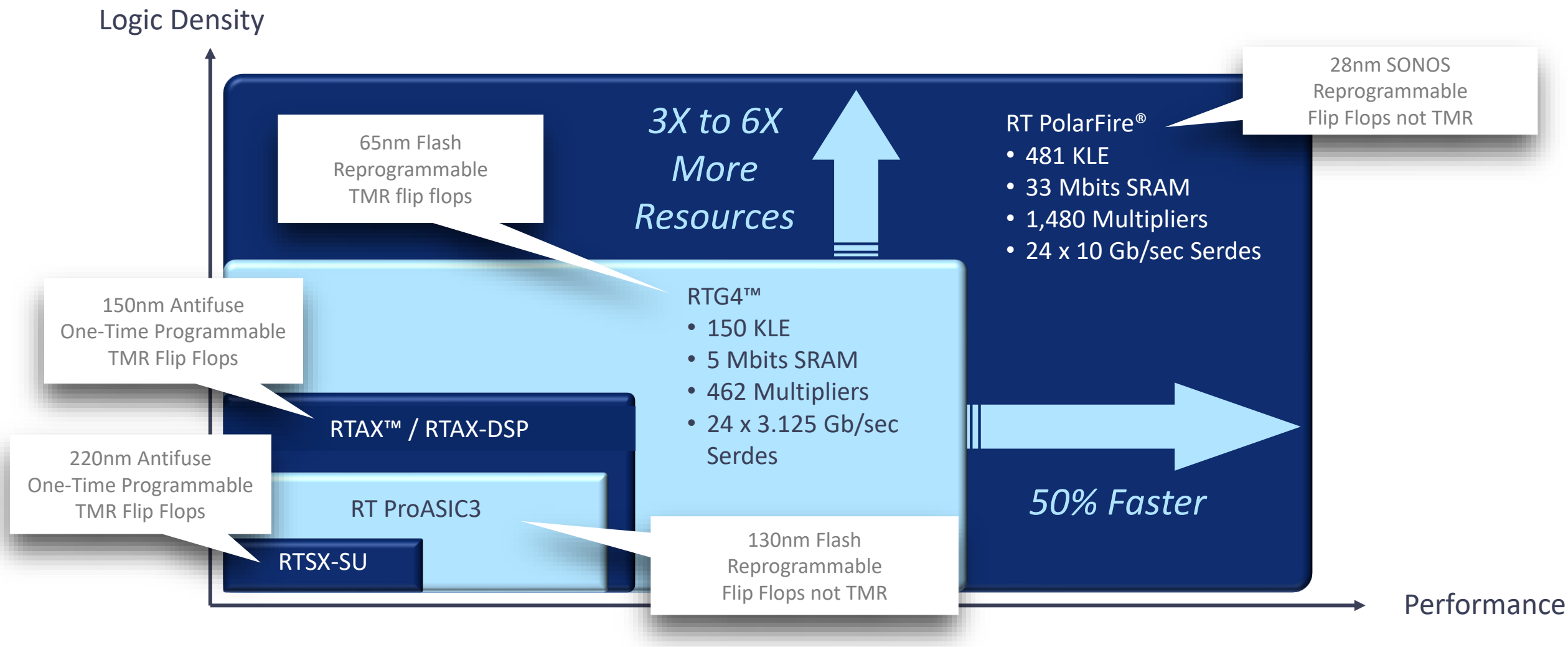
IAR SYSTEMS
KEIL Tools by ARM
SEGGER www.segger.com
HCC embedded
freeRTOS
µLinux
expresslogic
Micro Digital YOUR RTOS PARTNER
Micriμm

A&D BSP/SW on-going projects with:

N7 SPACE
AdaCore
RTEMS
EDISOFT DEFENCE & AEROSPACE TECHNOLOGIES A THALES Group Company

MICROCHIP

RT FPGA Families



RT PolarFire® Plan

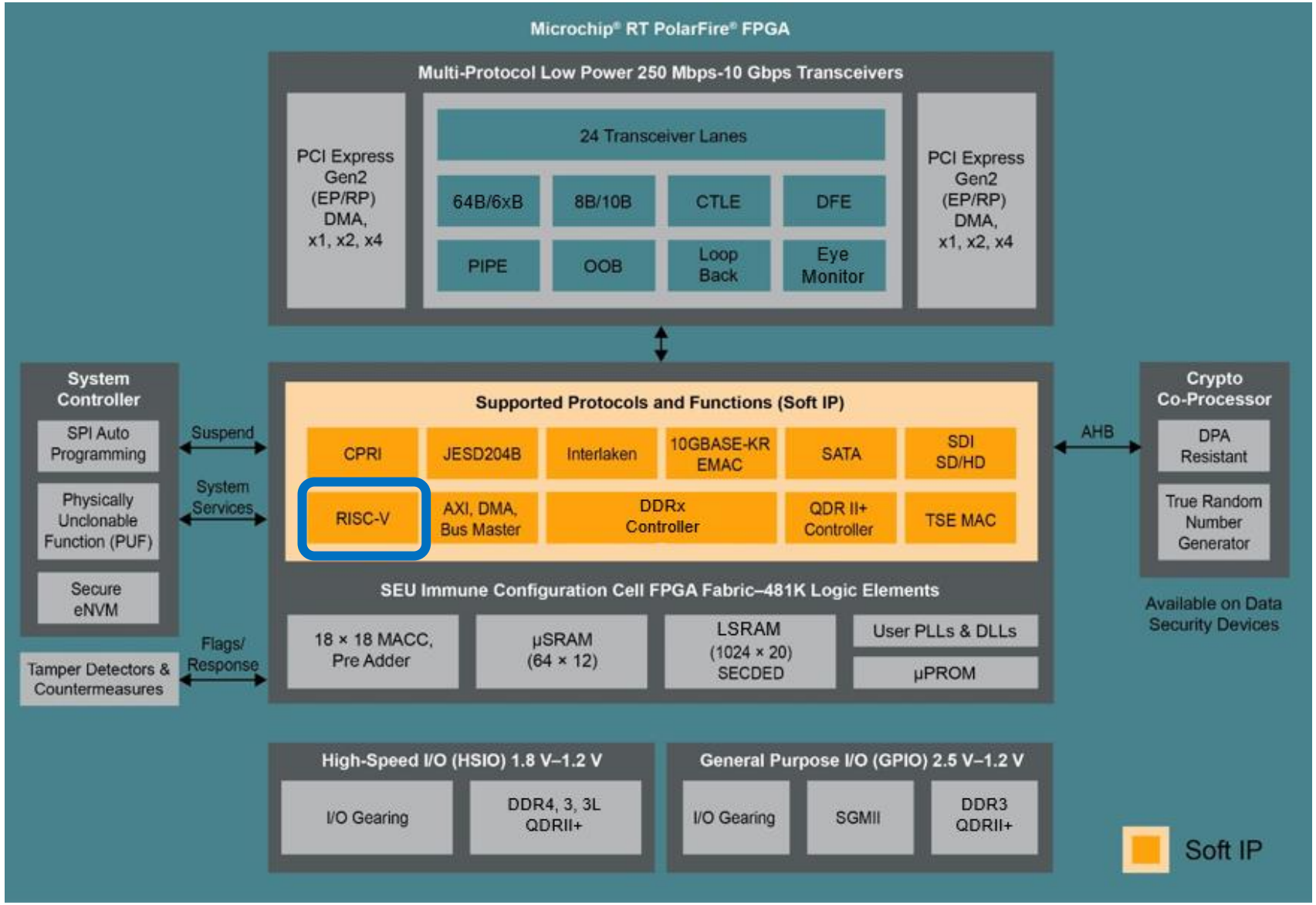
- **Commercial 28nm SONOS non-volatile and reprogrammable PolarFire die**
  - Metal layer change to facilitate ceramic package integration (wider C4 bump spacing)
  - Radiation behavior characterized and reported, report available today
  - Synthesized TMR, deploy where needed, available today in Libero® SoC
  - devices and development kits available today for prototyping

- **Hermetically sealed, ceramic column grid array package**
  - 1509 solder columns (Six Sigma copper spiral columns)
  - QML qualification to class Q, E and ultimately class V

- **Qualification status**
  - Engineering Models (ES, EM) available today
  - Mil Std 883 class B completed,
    - Lead time for B-flow and E-flow applies
  - QML class Q 1H CY2023
  - QML class V CY2024

MICROCHIP

RT PolarFire® FPGA Architecture



Why RISC-V?

- **Free and open ISA**
  - Clean Slate Design
  - Simple, Stable
  - Modular, Extendable

- **RISC-V owned by everyone**

- **RISC-V extends Moore's Law**
  - Provides a free “architectural” license enabling innovation
  - Customers can, now, influence the micro-architectural design
  - **Provides lower power & higher performances capabilities**

MICROCHIP

What is Mi-V?

"Mi-V" (pronounced My-Five) = Microchip's RISC-V Ecosystem

- A continually expanding, comprehensive RISC-V Ecosystem

- Supporting client application development using Microchip's soft-CPUs and RISC-V SoC FPGAs

- Full solution since 2016
- Microchip is a RISC-V "pioneer"
- Exploding with more than 50 partners today

MICROCHIP

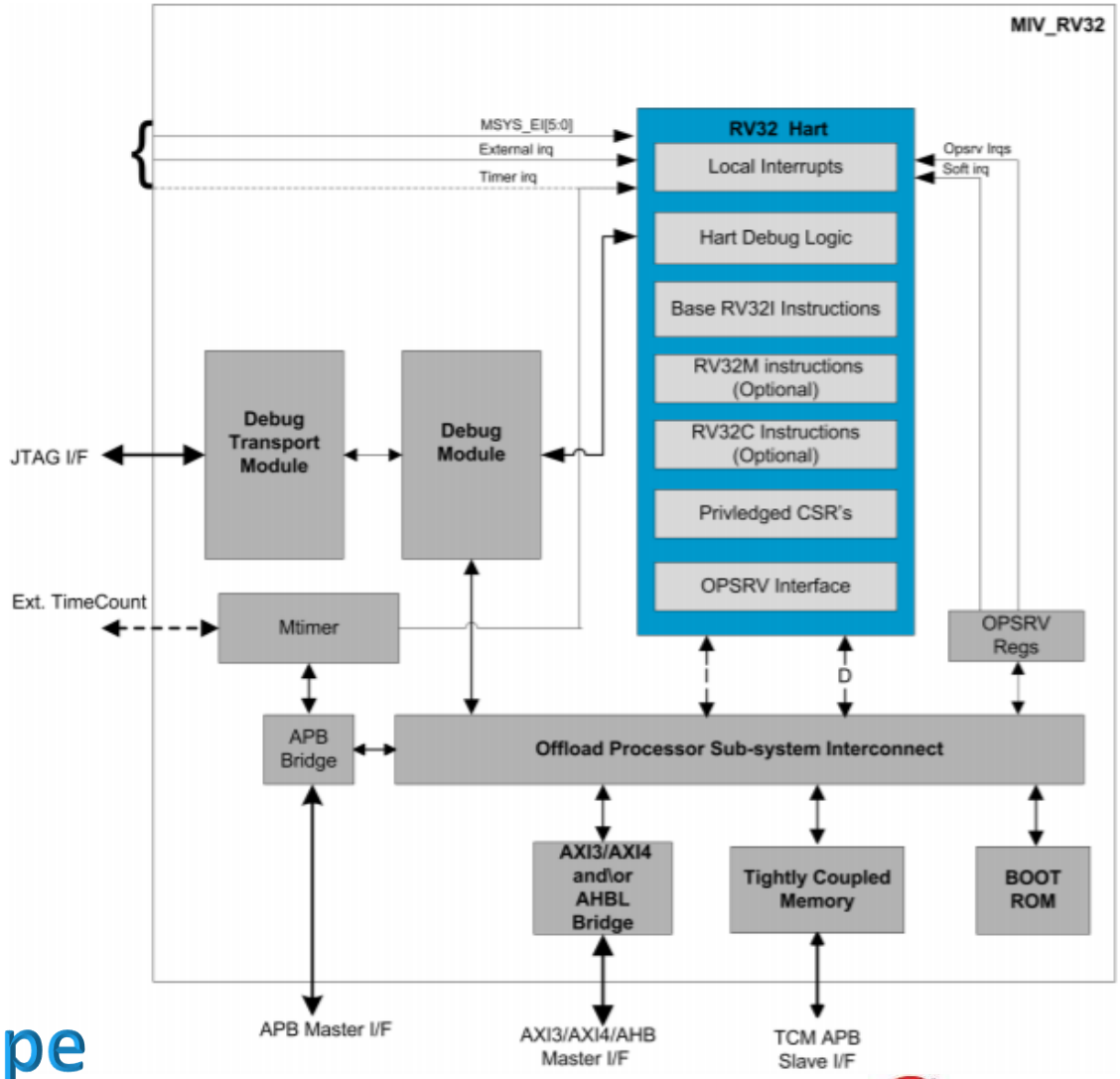
Mi-V Ecosystem Solutions

Mi-V_RV32 Configurable Soft CPU

RT-PolarFire® / RTG4™ / PolarFire® / IGLOO2®

Features

- 2.77 Coremarks / MHz
- HW breakpoint - 1
- Interrupts - 13
- Timer / Counter - 1
- 50 MHz–150 MHz (Product dependent)
- Optional / Configurable Features
  - AHB/AXI3/AXI4/APB Bus Interfaces
  - Integer mul/div
  - Tightly coupled memory
  - Debug
  - Error Correction



Soft IP developed in Europe

MICROCHIP

RISC-V Multicore on RT FPGAs

- **RISC-V Multi-Processors Subsystem**
  - Extensive list AMBA Based IP cores available

    AMBA Buses, LSRAM, UART, GPIO, SPI, I2C, Timer, WDOG, 1553B, Ethernet MAC 10/100/1000

- **RT PolarFire®, RTG4™ FPGA**
  - RISC-V Lockstep System AN4228
  - Single RISC-V System TU0775, AC490

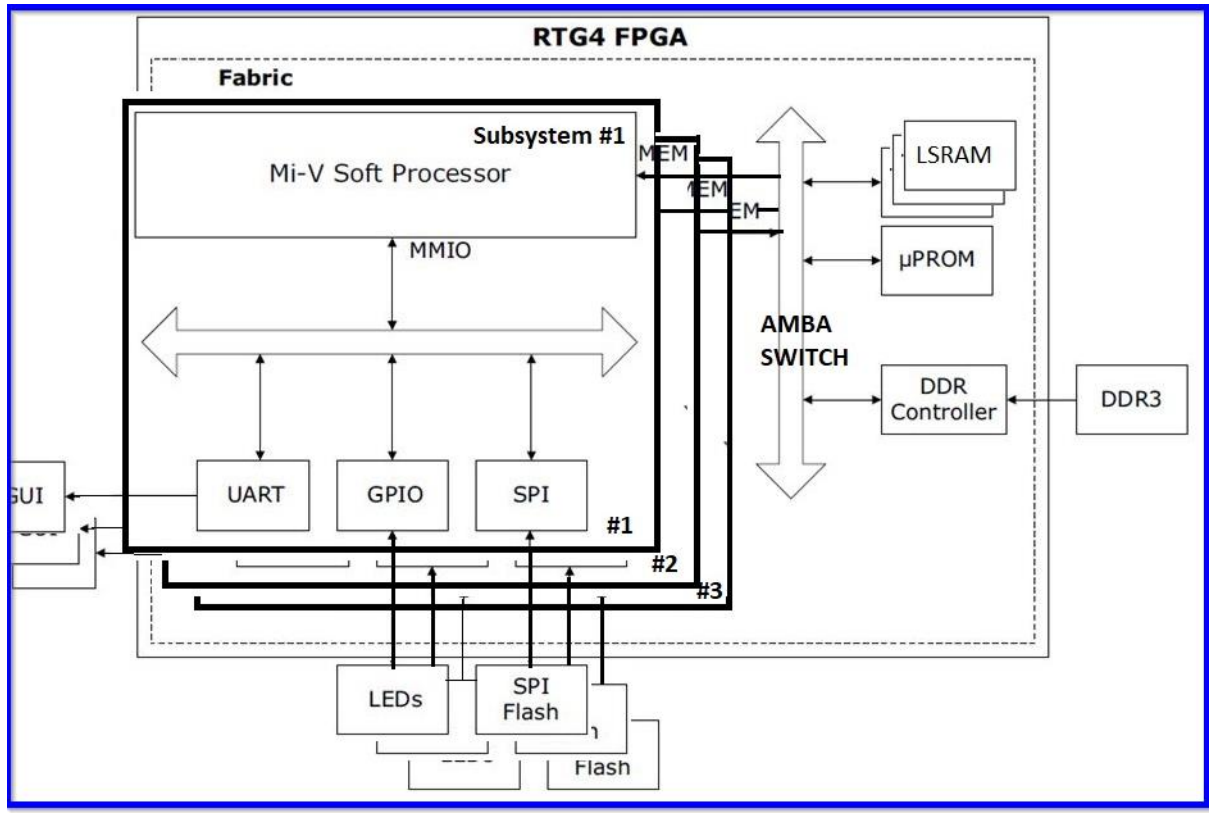
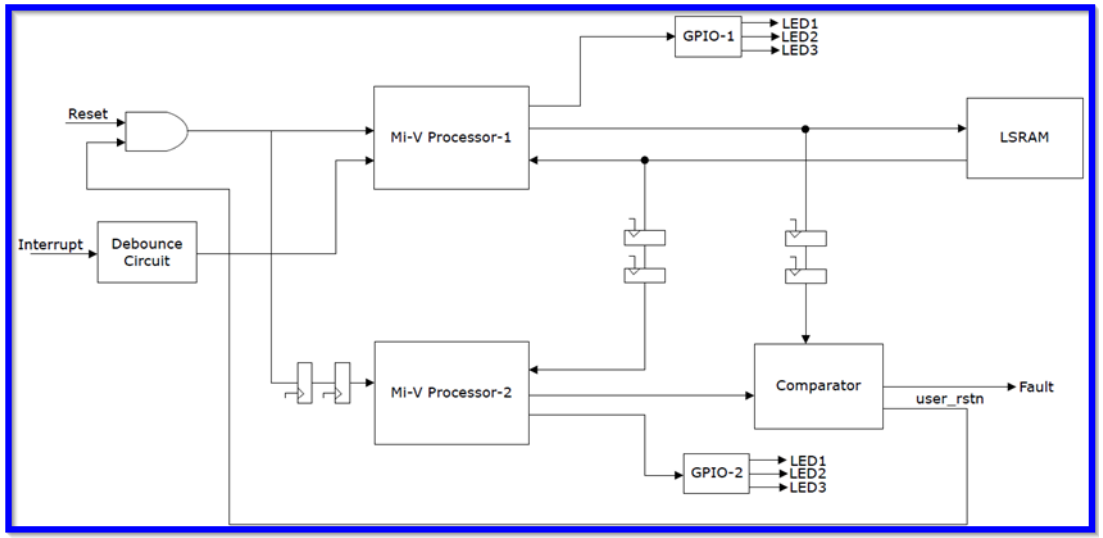


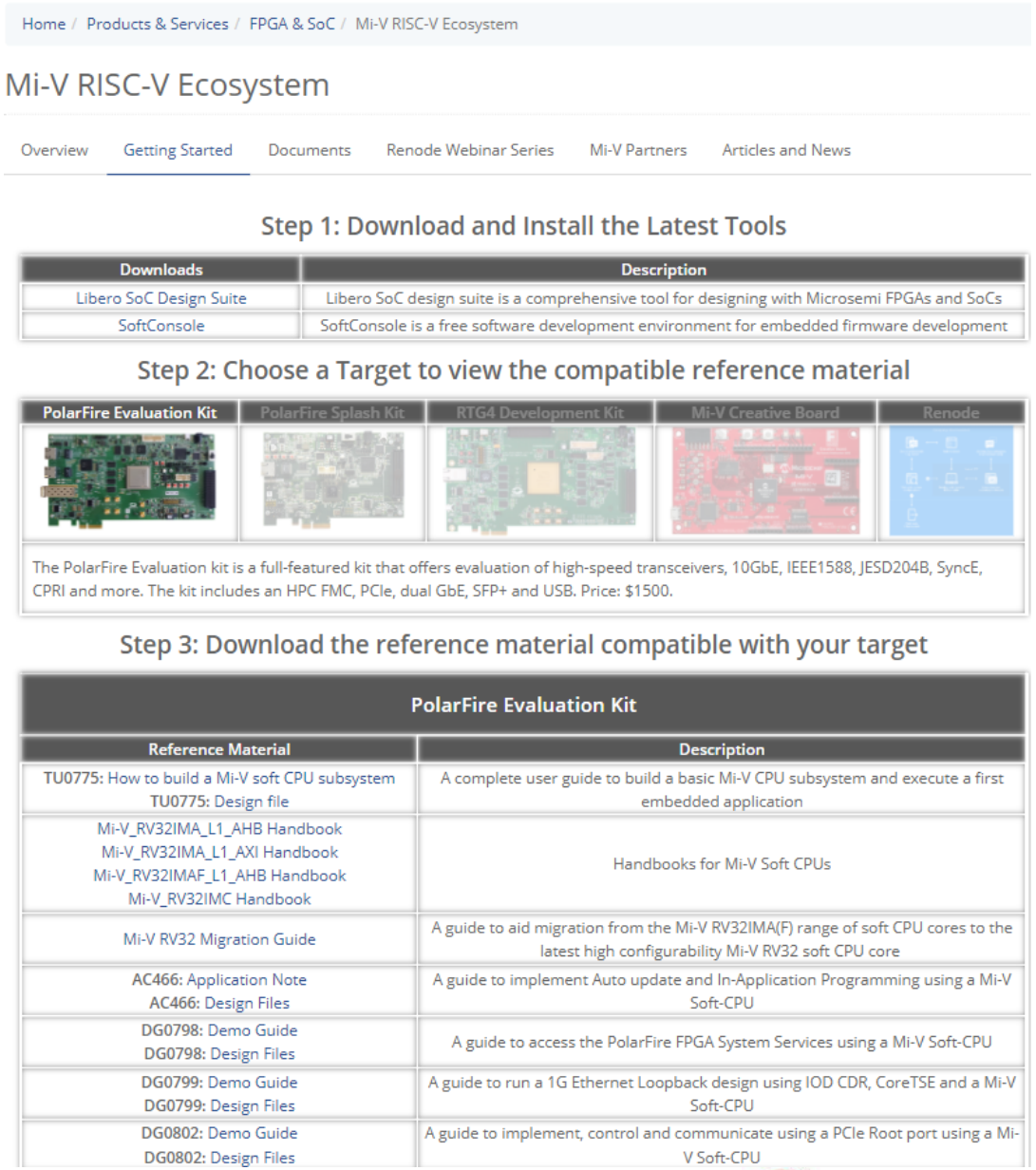
Figure 1-1. Lockstep Design High-level Block Diagram



Getting Started

- www.mi-v.org
  - Design Tools
  - Supported hardware
  - Documentation:
    - Tutorials
    - Application notes & User guides

- **GitHub page:**
  - https://github.com/RISCV-on-Microsemi-FPGA
  - Reference designs
    - Libero Projects
    - SoftConsole projects
  - RTOS Ports
  - Documentation and Sample Designs



Home / Products & Services / FPGA & SoC / Mi-V RISC-V Ecosystem

Mi-V RISC-V Ecosystem

Overview | Getting Started | Documents | Renode Webinar Series | Mi-V Partners | Articles and News

Step 1: Download and Install the Latest Tools

Downloads	Description
Libero SoC Design Suite	Libero SoC design suite is a comprehensive tool for designing with Microsemi FPGAs and SoCs
SoftConsole	SoftConsole is a free software development environment for embedded firmware development

Step 2: Choose a Target to view the compatible reference material

PolarFire Evaluation Kit | PolarFire Splash Kit | RTG4 Development Kit | Mi-V Creative Board | Renode

The PolarFire Evaluation kit is a full-featured kit that offers evaluation of high-speed transceivers, 10GbE, IEEE1588, JESD204B, SyncE, CPRI and more. The kit includes an HPC FMC, PCIe, dual GbE, SFP+ and USB. Price: $1500.

Step 3: Download the reference material compatible with your target

PolarFire Evaluation Kit	
Reference Material	**Description**
TU0775: How to build a Mi-V soft CPU subsystem TU0775: Design file	A complete user guide to build a basic Mi-V CPU subsystem and execute a first embedded application
Mi-V_RV32IMA_L1_AHB Handbook Mi-V_RV32IMA_L1_AXI Handbook Mi-V_RV32IMAF_L1_AHB Handbook Mi-V_RV32IMC Handbook	Handbooks for Mi-V Soft CPUs
Mi-V RV32 Migration Guide	A guide to aid migration from the Mi-V RV32IMA(F) range of soft CPU cores to the latest high configurability Mi-V RV32 soft CPU core
AC466: Application Note AC466: Design Files	A guide to implement Auto update and In-Application Programming using a Mi-V Soft-CPU
DG0798: Demo Guide DG0798: Design Files	A guide to access the PolarFire FPGA System Services using a Mi-V Soft-CPU
DG0799: Demo Guide DG0799: Design Files	A guide to run a 1G Ethernet Loopback design using IOD CDR, CoreTSE and a Mi-V Soft-CPU
DG0802: Demo Guide DG0802: Design Files	A guide to implement, control and communicate using a PCIe Root port using a Mi-V Soft-CPU

Microchip Space Processing Solutions

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- Space Microchip solutions available
- **High processing solutions initiatives**
  - RISC-V Polarfire® SoC
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PolarFire® SoC Overview

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

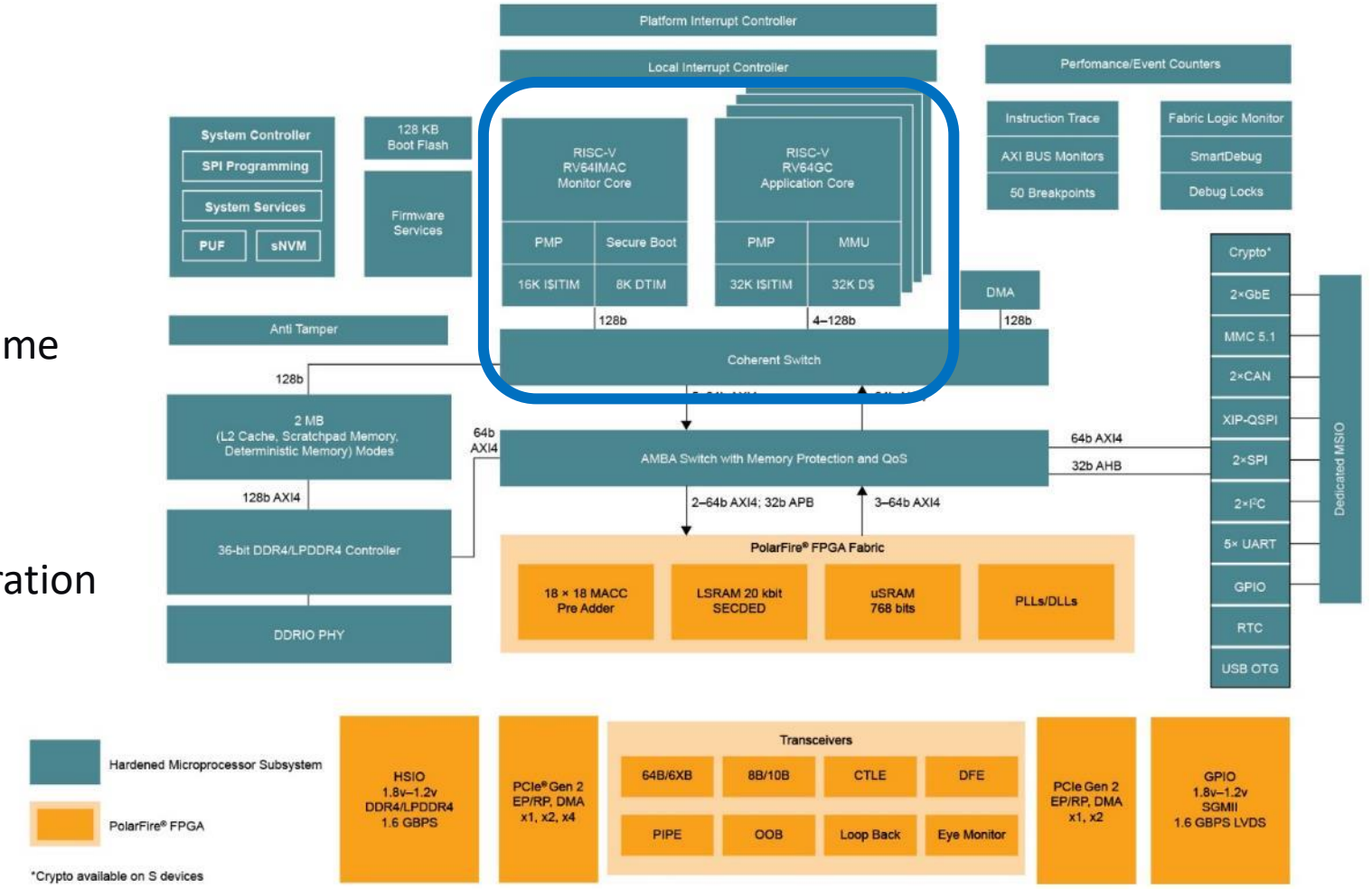
PolarFire® SoC - RISC-V Enabled Innovation Platform

Highly Differentiated

- Low power, high performance SoC
  - Thermal efficiency
  - Solutions ~50% power of competition
- Unique AMP mode for mixed real-time and Linux® operation
- Defense grade security with Spectre/Meltdown immunity
- Exceptional reliability (SEU Configuration Immune)
- Smallest form factors

Freedom to Innovate in

- Linux® and real-time
- Thermal and power constrained systems
- Securely connected IoT systems
- Mixed criticality systems



RT assessment ongoing, results targeted H12023

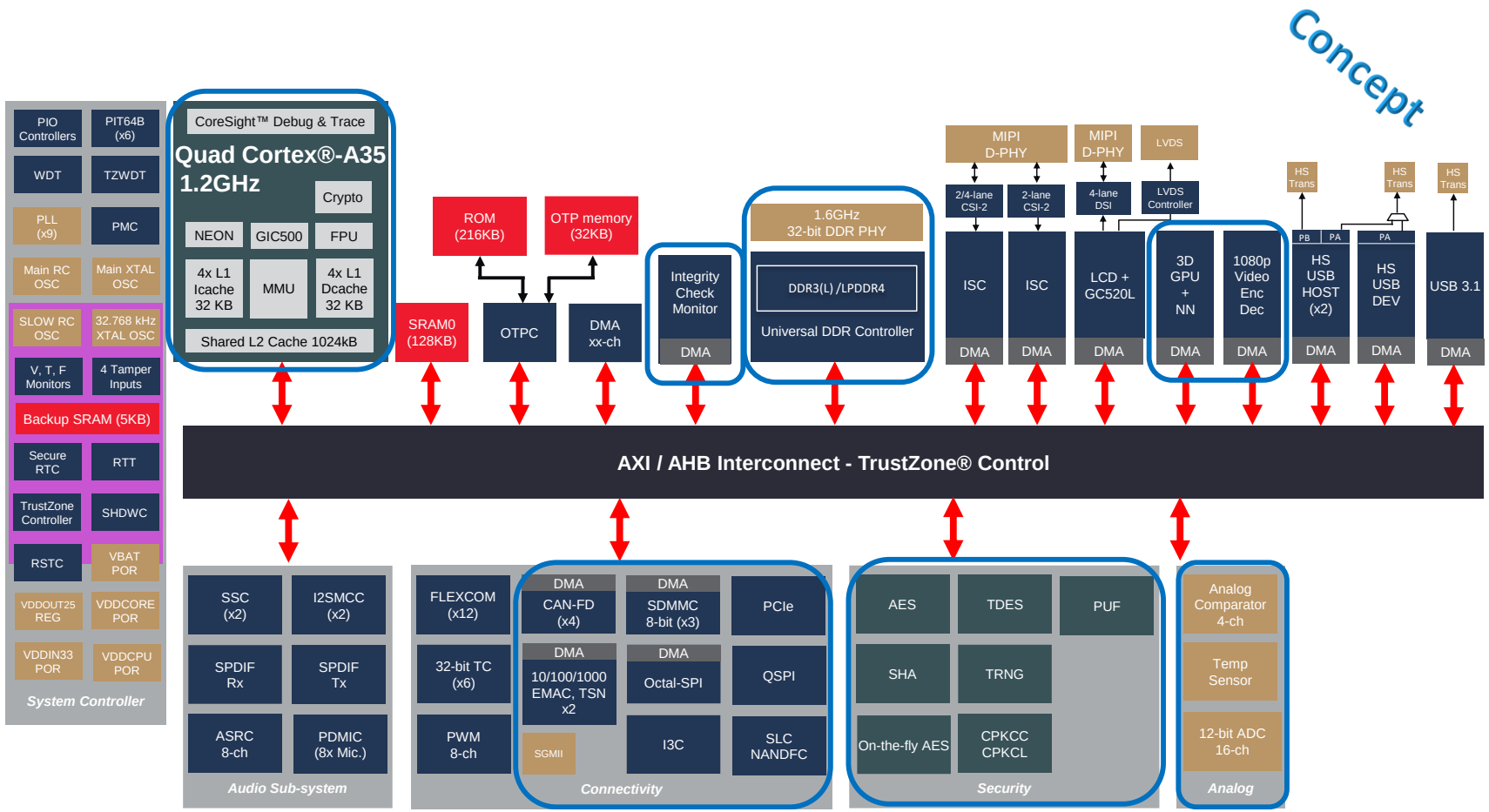
ARM Multicore MPU assessment

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

ARM Multicore MPU Platform

Ongoing development in France for Automotive

- Quad Core Ax >1GHz
- Rad assessment with CNES support
- Target RT version
- Video Codec
- 3D GPU
- MIPI/CSI-DSI
- DDR4
- PCIe
- Gbit Ethernet TSN
- Security



HPSC

High-Performance Spaceflight Computing processor

MICROCHIP

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

SMART | CONNECTED | SECURE

HPSC: Redefining What's Possible For Space

- **NASA JPL** awarded contract to **Microchip** to develop the next-generation **High-Performance Spaceflight Computing (HPSC)** processor
- Provides **>100X** compute over current solutions
  - Based on multi-core, fault tolerant **RISC-V architecture**
- Microchip will architect, design and deliver HPSC integrating **Ethernet**, **AI/ML**, **High-Speed Standards-based Connectivity**, **Fault-Tolerance**, **Defense-in-Depth Security** and **Low Power** capabilities
- **Global** collaboration between Microchip & Industry
  - R&D, IP & Manufacturing in **Canada, Europe, U.S., SE Asia**
- Target device availability in 2024

August 15, 2022 – NASA

NASA Awards Next-Generation Spaceflight Computing Processor Contract

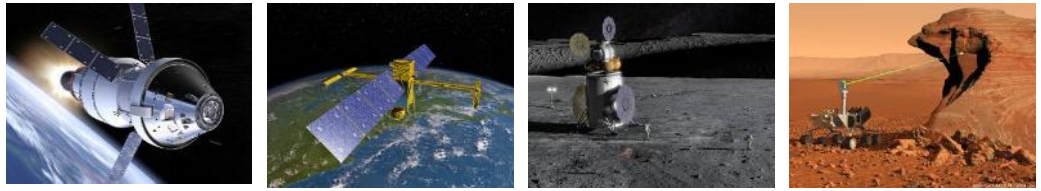


Photo courtesy: NASA

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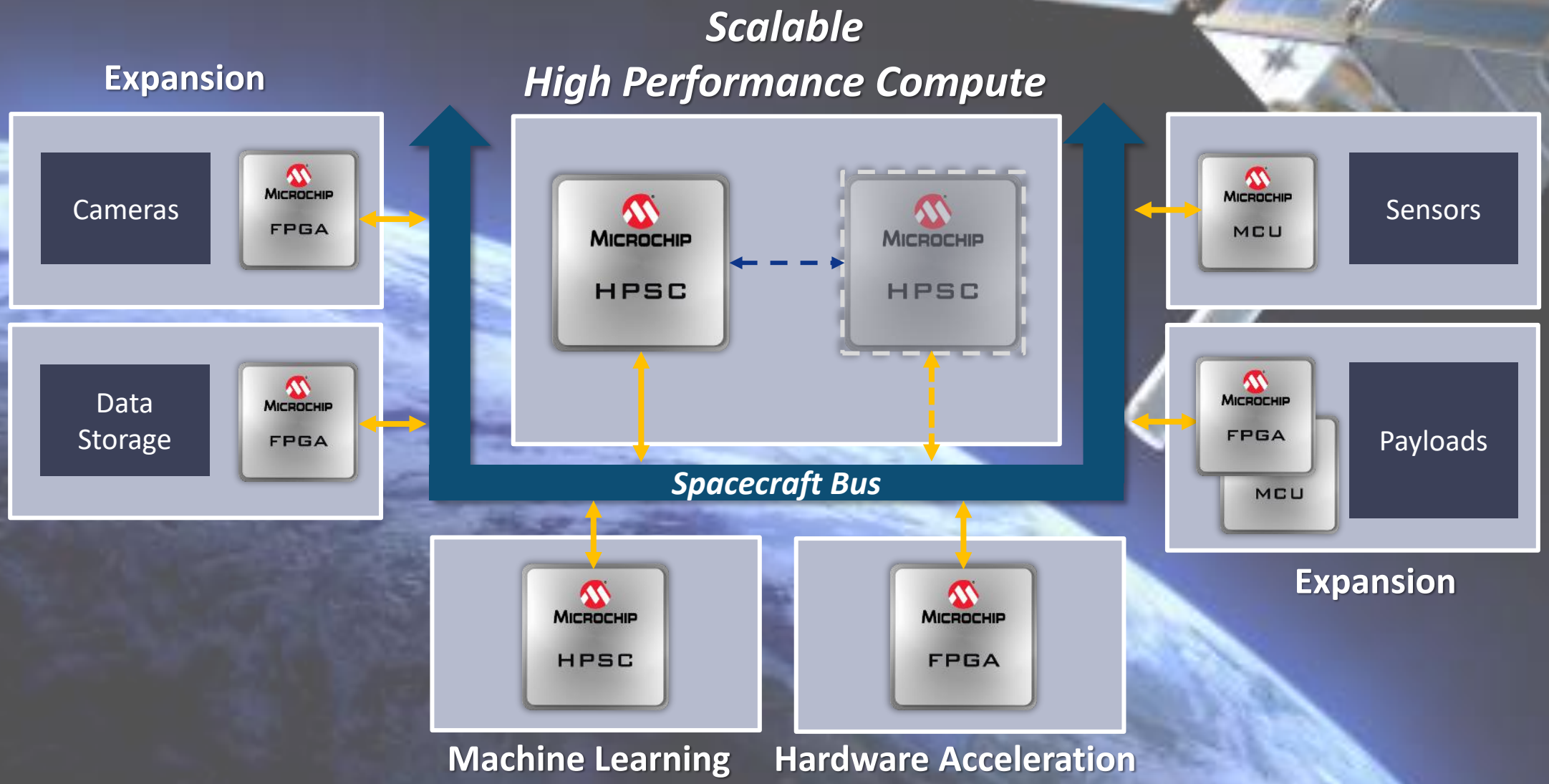
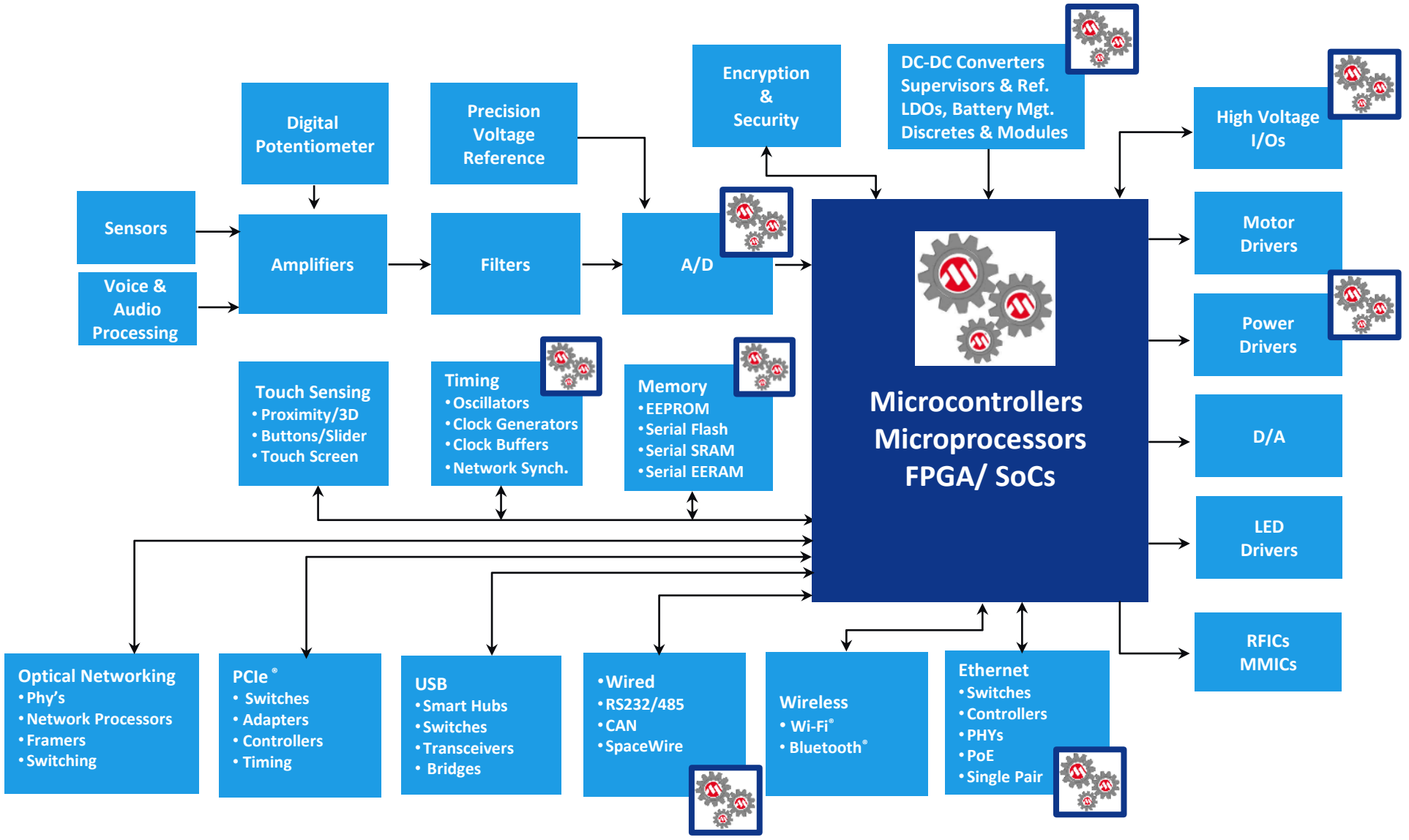
Extensible Space System Solution



Space System Design around processing solutions



Ethernet PHYs

Gbit/10Gbit

Switches 1588/TSN

PCIe Devices

Flash/EEPROM

Power Modules

Clock Management

Space Processing Solutions Summary

- **Go through the Microchip activities in Europe**
- **Unrivaled processors flight heritage**
- **Different type of processing solutions/ applications**
- **Arm® and RISC-V solutions today. Some ESCC qualified**
- **Working towards High Processing future solutions**
  - FPGA RISC-V SoC
  - Arm® Multicore processor
  - HPSC
  - All connected together towards System Solutions

Thank You

microchip.com/spaceforum

More than 30+ presentations available

- Start 2nd November 2022
- Space Market Dynamics
- Product latest news
- System Use Cases and Technical Dives

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