

# High Performance 64-bit HPSC Microprocessor (MPU) New Era of Autonomous Space Computing

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Microchip Technology Nantes

DFTS October 9th, 2024



SMART | CONNECTED | SECURE

# Microchip At a Glance



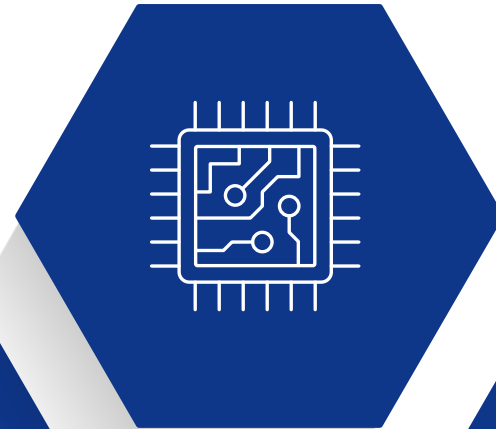
**Founded  
February 14, 1989**



**Headquartered in  
Chandler, AZ  
'The Silicon Desert'**



**22,000+  
Employees**



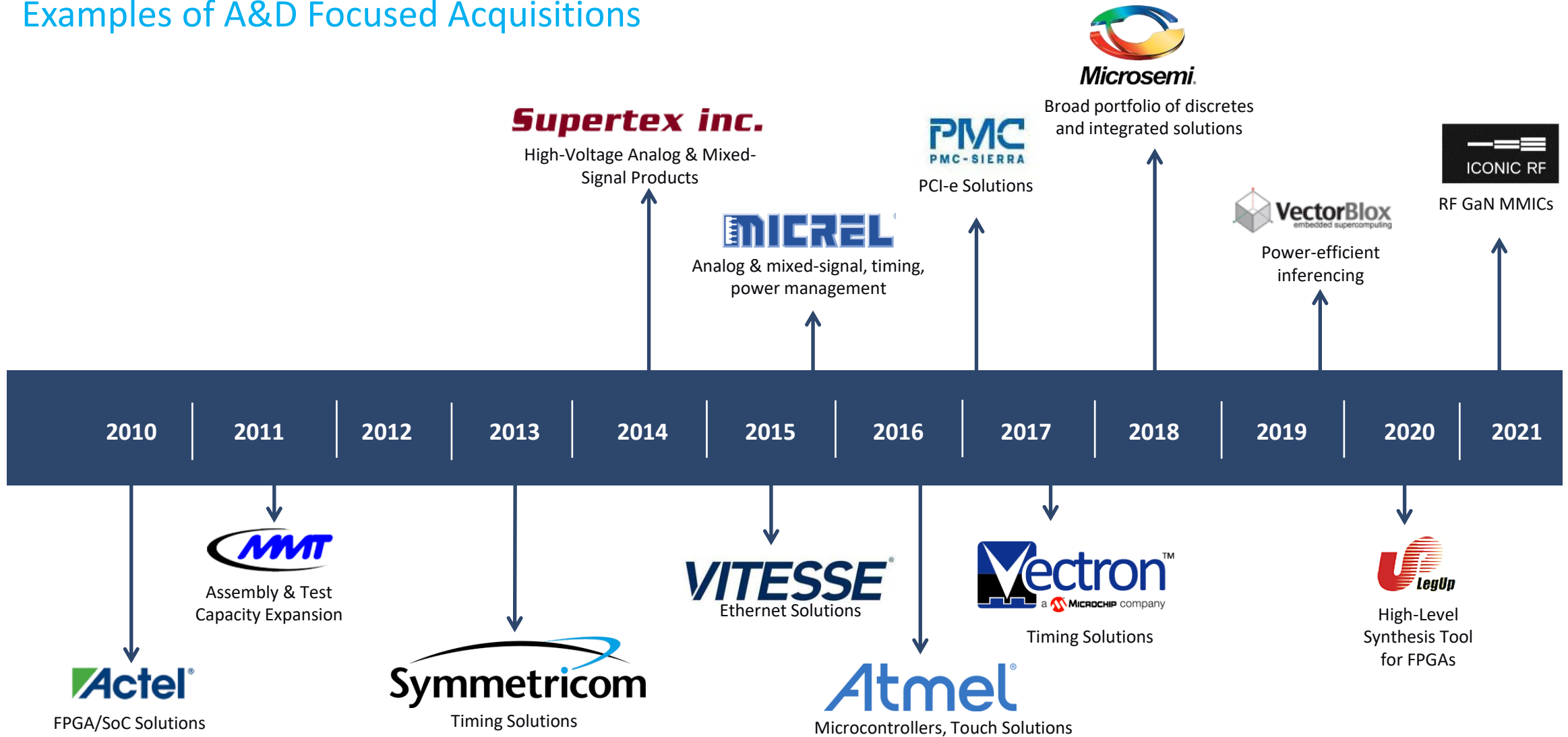
**100,000+  
Product Offerings**



**\$7.6B revenue  
FY2024**

# Expanding Microchip Solutions Through Acquisitions

## Examples of A&D Focused Acquisitions



# Microchip In A&D By The Numbers



## 60+ Years

of Space Innovation & Heritage

- **NASA:** Atlas ('57), ISS, Cassini, Rover
- **ESA:** ATV, Gaia
- **Commercial:** Globalstar 2, OneWeb, SpaceX
- **Mil:** F-35, F-16, AIM9X, Hellfire, Bradley
- **Aero:** Boeing, Airbus, Bombardier

## >40,000

Space Flight Qualified  
Microchip Processors  
Shipped

## #1

Market Share - A&D Semi

\$839M Annual A&D Revenue (FY24)

## >1000

A&D Customers WW

## >71,000

Hi-Rel Products  
For A&D Market

## >100

Microchip components on NASA  
Perseverance Rover & Ingenuity  
Helicopter



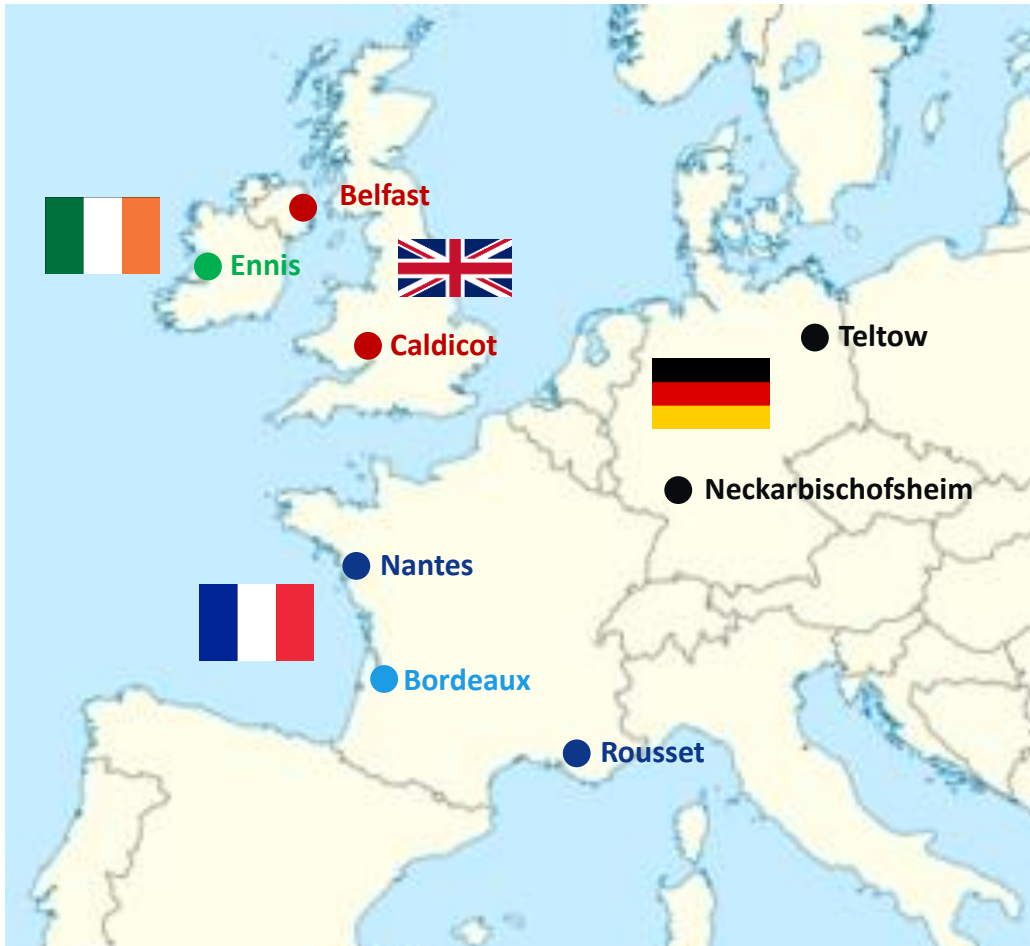
# A&D Product Lines in Europe



Nantes, France



Rousset, France



- **Advanced Packaging UK**
  - ✓ Expertise in miniaturisation vs. size, power and reliability

- **ADG France**
  - ✓ Mixed Signal ASIC
  - ✓ Processors and Microcontrollers
  - ✓ Com interfaces and Memories



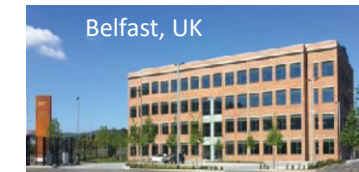
Bordeaux, France

- **DPM France**
  - ✓ Power Modules



Ennis, Ireland

- **DPM Ireland**
  - ✓ Hi-Reliability Discrete
  - ✓ Power Modules



Belfast, UK

- **Vectron Germany**
  - ✓ Oscillators
  - ✓ RF SAW Filters



- **RF Microwave UK**
  - ✓ Amplifiers

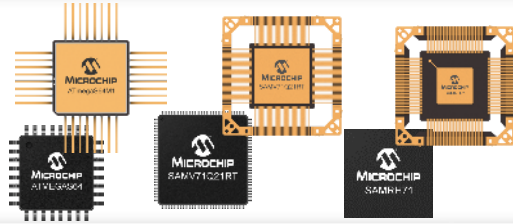


Teltow & Neckarbischofsheim, Germany

# Largest Space Semiconductors Portfolio

## MPUs and MCUs

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



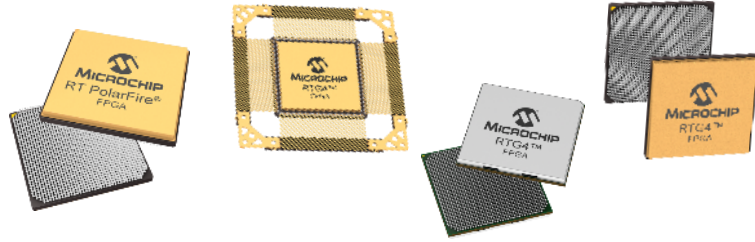
## Communication Interface and memories

SpaceWire, Ethernet, CAN  
SRAM  
NVM memories



## FPGAs

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



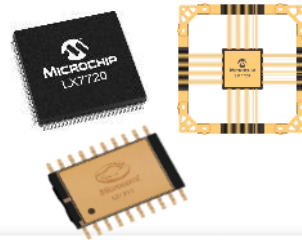
## Power Solutions

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



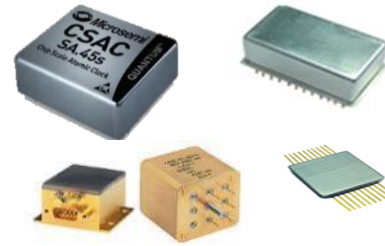
## Mixed Signal Integrated Circuits

Telemetry and Motor Control Space System Managers  
Power Supply protection



## Timing solutions and Oscillators

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



## 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



# Part of European Space Ecosystem

## Our customers



## Our partners



- More than 40 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)

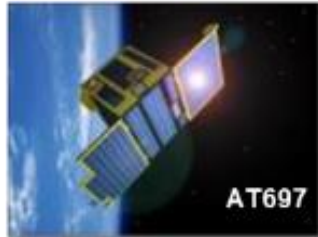




# Processing : An Unrivalled Flight Heritage



**Colombus**  
2008



**Proba2**  
2009



**JUNO (Nasa)**  
2011



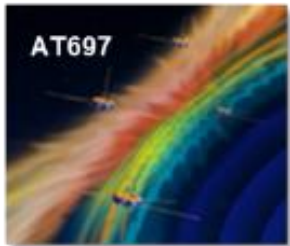
**SPOT6**  
2012



**Sentinels &  
Alphasat**  
2013



**SVOM/Eclair**  
2013



**MMS (Nasa)**  
2014



**Exomars**  
2016



**Solar Orbiter**  
2017



**Bepi-Colombo**  
2018



**Perseverance** 2021



**Mega Constellation  
LEO Sat** -2019



**ASBM** 2024

**Thousands of flight models  
delivered worldwide**



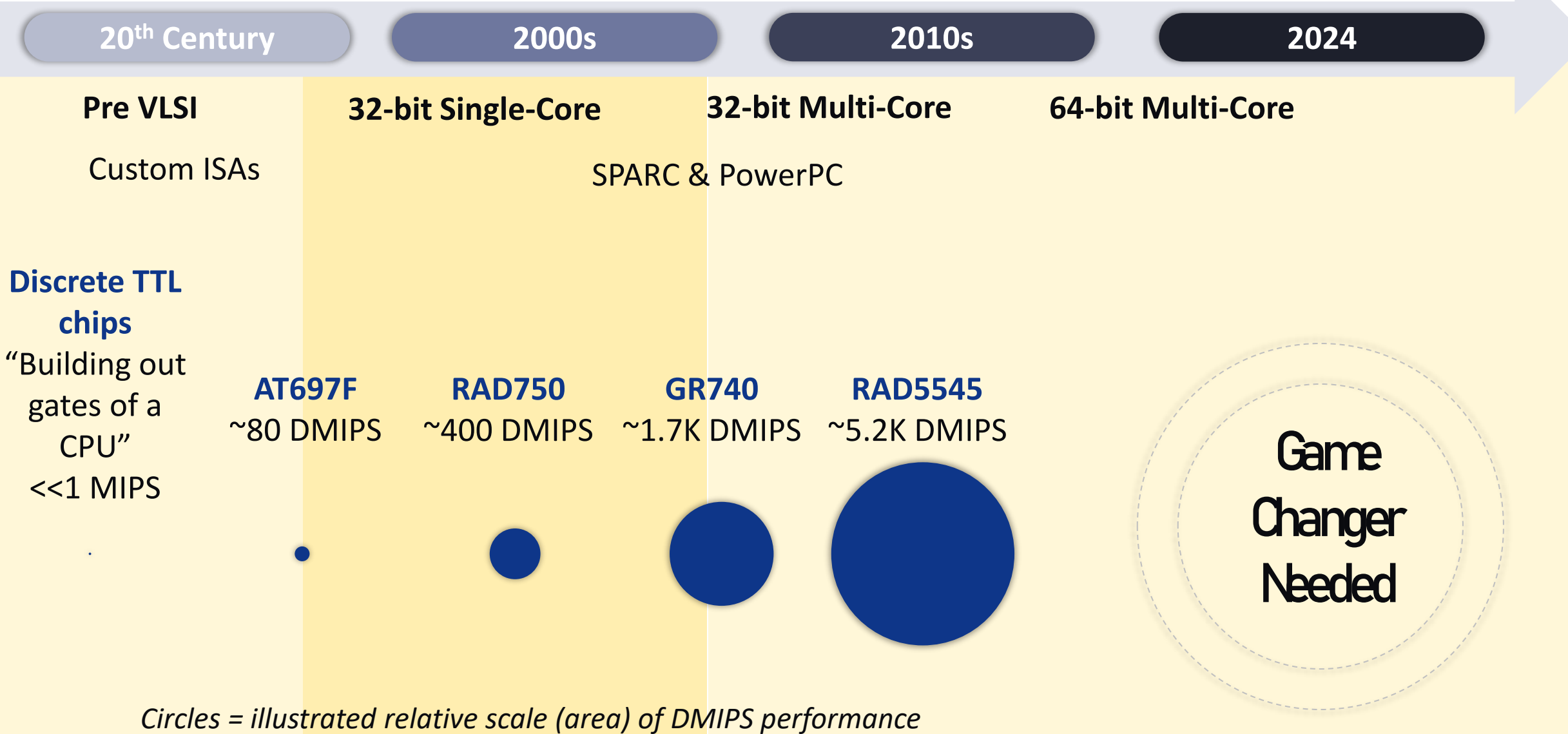
**Capella Sequoia  
Earth Obs** 2020



**ANGELS Nanosat**  
2020



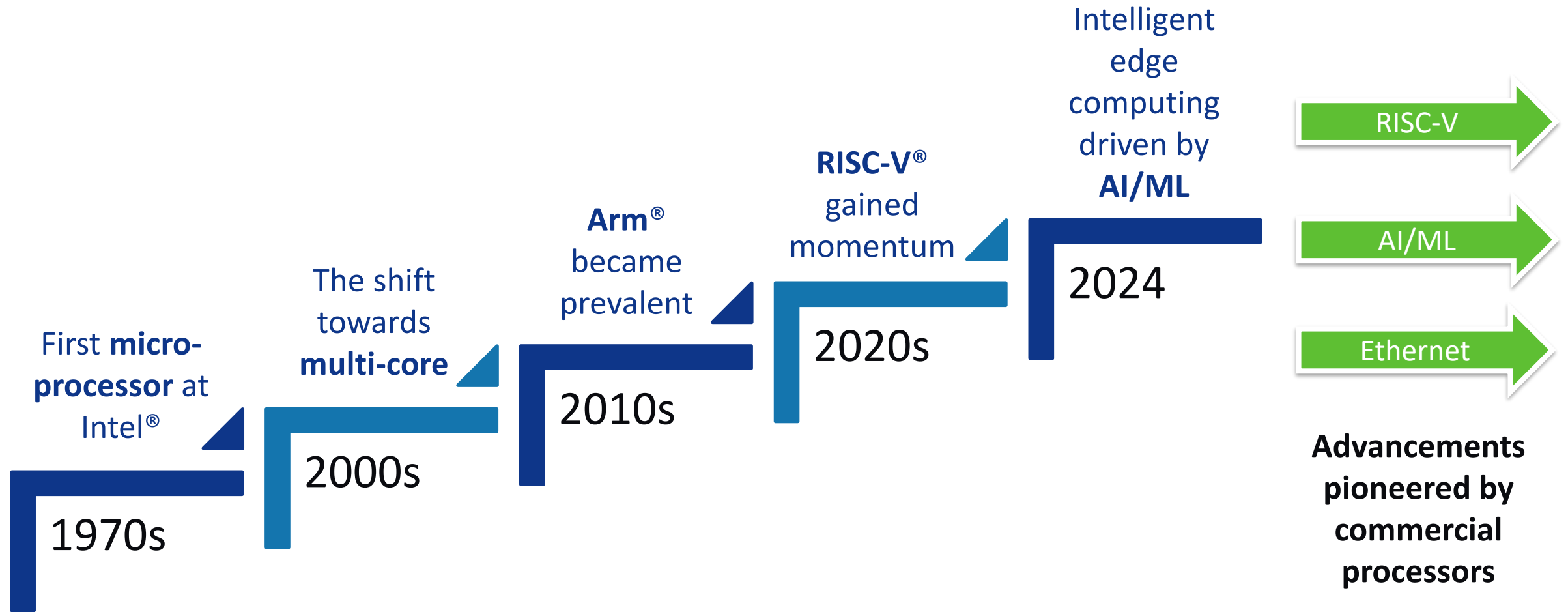
# Evolution of Space Qualified Processors



Circles = illustrated relative scale (area) of DMIPS performance

Game Changer Needed

# At the Same Time... Commercial Processor Advancements



# Space Computing Demands a Gamechanger

Face to New Space Challenges

## Space Agencies

Need for advanced computing

Autonomous Missions

Advanced sensors

Moon to Mars

Growing Threat

Faster dev cycles

More Compute & AI

More I/O Bandwidth &  
Efficient Data Transfer

Rad-Hard &  
Fault Tolerance

Cybersecurity

Adopt Industry Standards  
and Open Technology

## Commercial Space

Follow the trend of terrestrial  
computing

Intelligent Edge

Secure compute

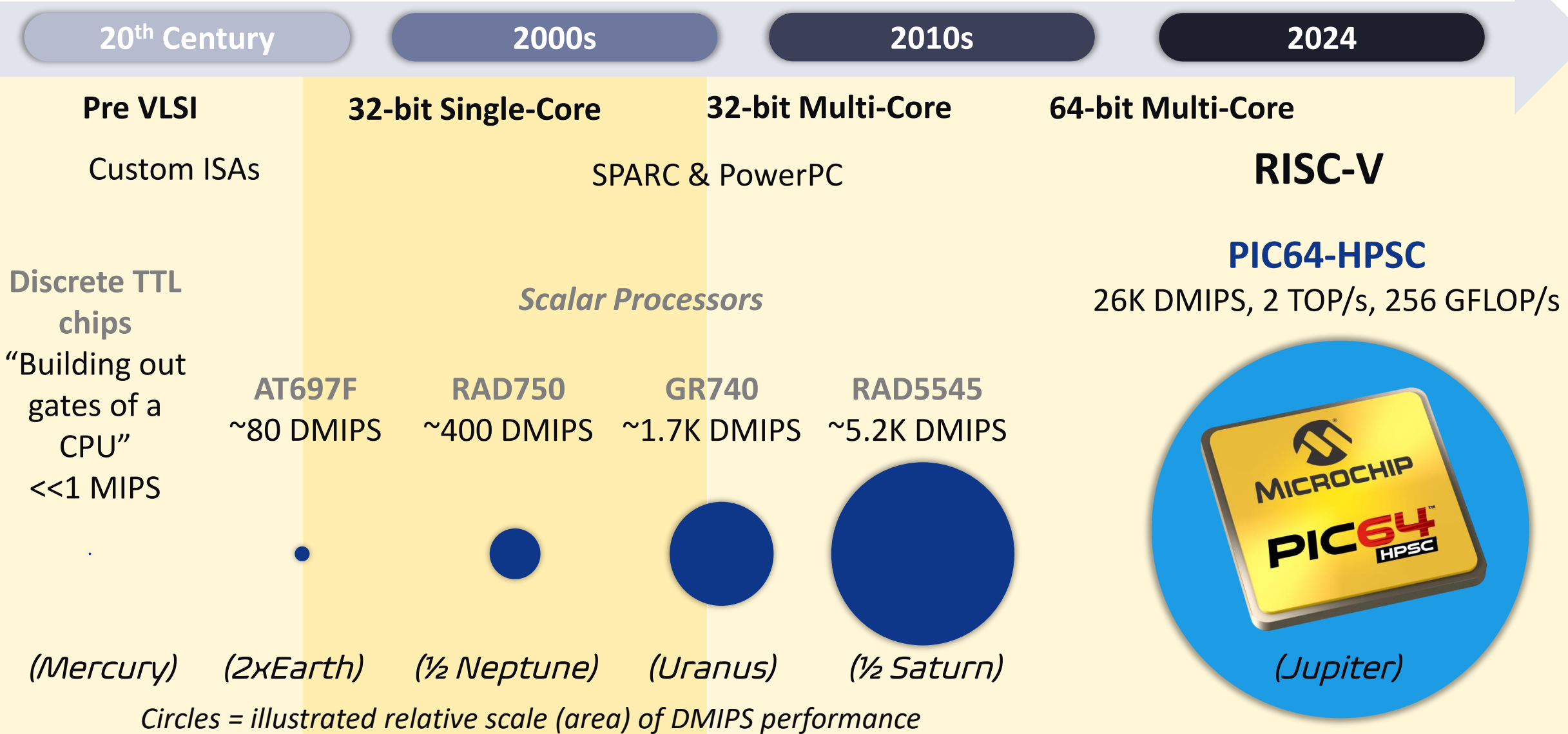
RISC-V ISA



Microchip's Response To Delivering on the Enabling Capabilities: **PIC64-HPSC**



# HPSC: Game Changing Space Compute Solution



# HPSC – Enabling the Next-Generation of Spaceflight

Microchip was awarded a contract by NASA JPL to develop the next-generation **High-Performance Spaceflight Computing (HPSC)** processor



**Canada**  
Architecture, Design, Test  
Management



**France**  
Radiation, Qual, Manufacturing



**USA**  
Foundry, IP, NASA/JPL Sponsorship



**EU**  
IP



- **High Performance 64-bit Computing**
  - Up to 26k DMIPs
  - Virtualization
  - Artificial Intelligence
- **TSN Ethernet Integration**
  - 240G TSN Ethernet Switch
  - Comprehensive TSN Feature Set
  - Up to 20 ports with speeds from 10M to 10Gbps
- **Exceptional Fault-Tolerance**
- **Defense-Grade Security**
- **Radiation-Hardened and Radiation-Tolerant**

Industry's Highest-Performance Processor for Space → EM Devices H1 2025

# PIC64 HPSC Builds On Microchip's MCU & FPGA Heritage

## Commercial

8-bit



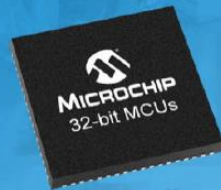
PIC® MCUs  
AVR® MCUs

16-bit



PIC® MCUs  
dsPIC® DSCs

32-bit



arm  
MIPS



arm

64-bit



RISC-V®

Rad-Hard and COTS  
Dual Quad-Core MPU  
Vector Engine, TSN, PCIe, CXL, RDMA

SoC FPGAs

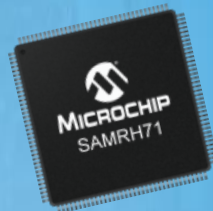
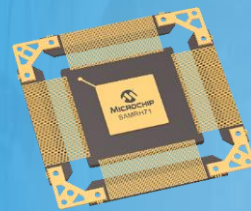
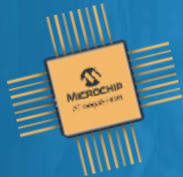


arm  
w/ embedded  
32-bit MCU



RISC-V®  
w/ embedded  
quad core  
64-bit MPU

## Space





# PIC64-HPSC Joins Microchip's Expanding Compute Portfolio

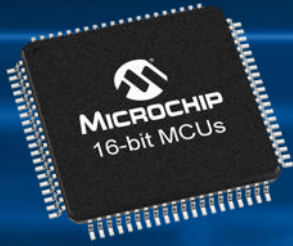
Scalable Computing at the Intelligent Edge

8-bit



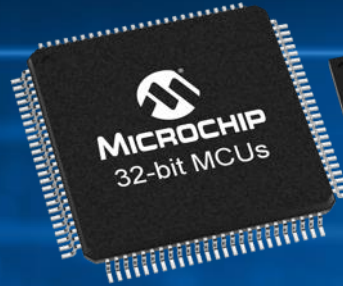
PIC® MCUs  
AVR® MCUs

16-bit

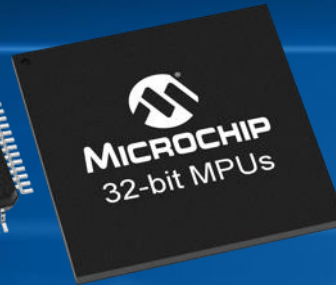


PIC® MCUs  
dsPIC® DSCs

32-bit MCUs & MPUs



PIC® MCUs



SAM MPUs

PIC64 Family of 64-bit MPUs



Quad-Core  
5K DMIPS




Octal-Core  
TSN Switch, Vectors  
Space-Grade  
26K DMIPS

Scalable Processing to Enable the Intelligent Edge

Performance levels from 8-to 64-Bits

Unified software tool MPLAB®, supports migration across compute landscape and agnostic to ISA

# Addressing Space Industry Needs with PIC64-HPSC

	General Market MPUs	 HPSC	Traditional Space Processors
High Performance Processing	✓	✓	
Virtualization	✓	✓	
Ethernet up to 10GE	✓	✓	
PCIe®	✓	✓	
Secure Boot	✓	✓	
SpaceWire		✓	✓
Fault Tolerance		✓	✓
Radiation Performance		✓	✓
SEL and SEU Performance		✓	✓
<b>Differentiating Features</b>			
Post-Quantum (ML-KEM, ML-DSA)		✓	
TSN Ethernet Switching		✓	
RDMA / RoCEv2		✓	

Bridging the Gap between Commercial General Market MPUs & Space Processors

# Feature Highlights

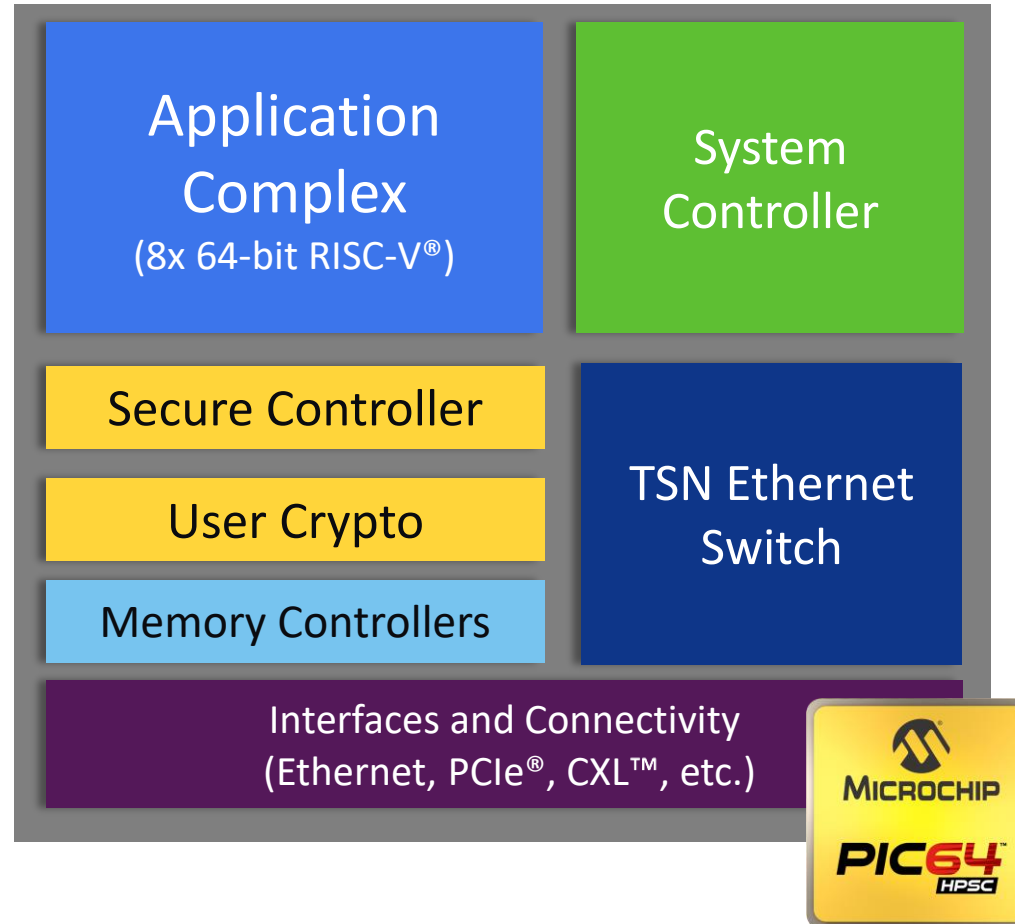
Radiation-Hardened and Radiation-Tolerant Versions Enable a Spectrum of Mission Profiles

## Compute

Groundbreaking **64-bit RISC-V<sup>®</sup> Vector** processing with virtualization targeting Edge AI (SiFive X288/X280)

## Security

Defense Grade Security Enclave supporting **Post-Quantum** Cryptographic algorithms



## Fault Tolerance

Unprecedented **Fault-Tolerance** capabilities for Mission Critical Applications (DCLS, Split-Mode, WorldGuard)

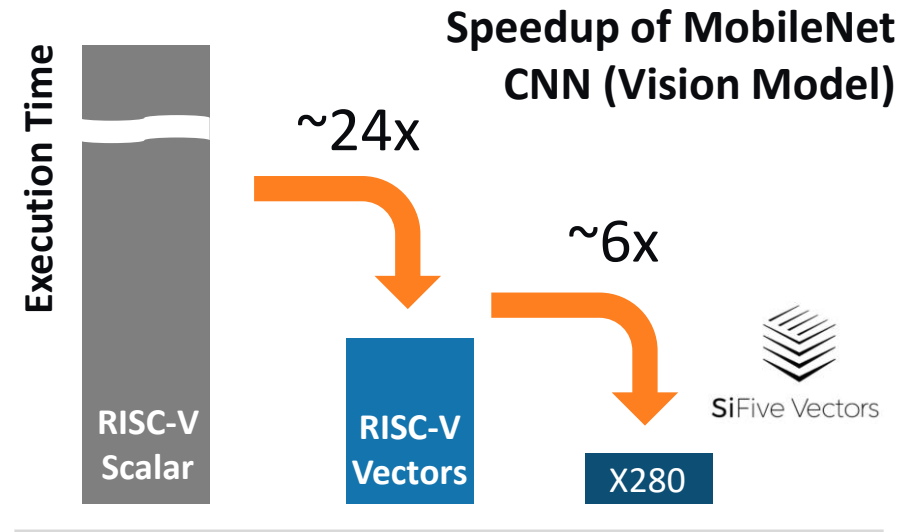
## Massive Connectivity

Integrated **240G TSN Ethernet Switch, 10GbE, PCIe/CXL and RDMA** for Networking & Deterministic Connectivity



# Enables Fast & Efficient AI/ML at the Edge (of Space)

- Next-gen space missions require extensive **autonomous** capabilities with workloads that can significantly benefit from AI & ML acceleration
  - Vision processing, Hazard Avoidance, Situational Awareness, Spaceflight guidance, Data analysis, Navigation, etc.
- PIC64-HPSC leverages SiFive's proven X280 RISC-V processor cores **with vector extension**, optimized for AI/ML applications
  - Accelerates matrix multiplication for AI/ML operations
- Enabling the use of **industry standard** AI/ML tools and frameworks (TensorFlow Lite, OpenXLA, etc.)



Delivering Greater Autonomous Compute Capabilities

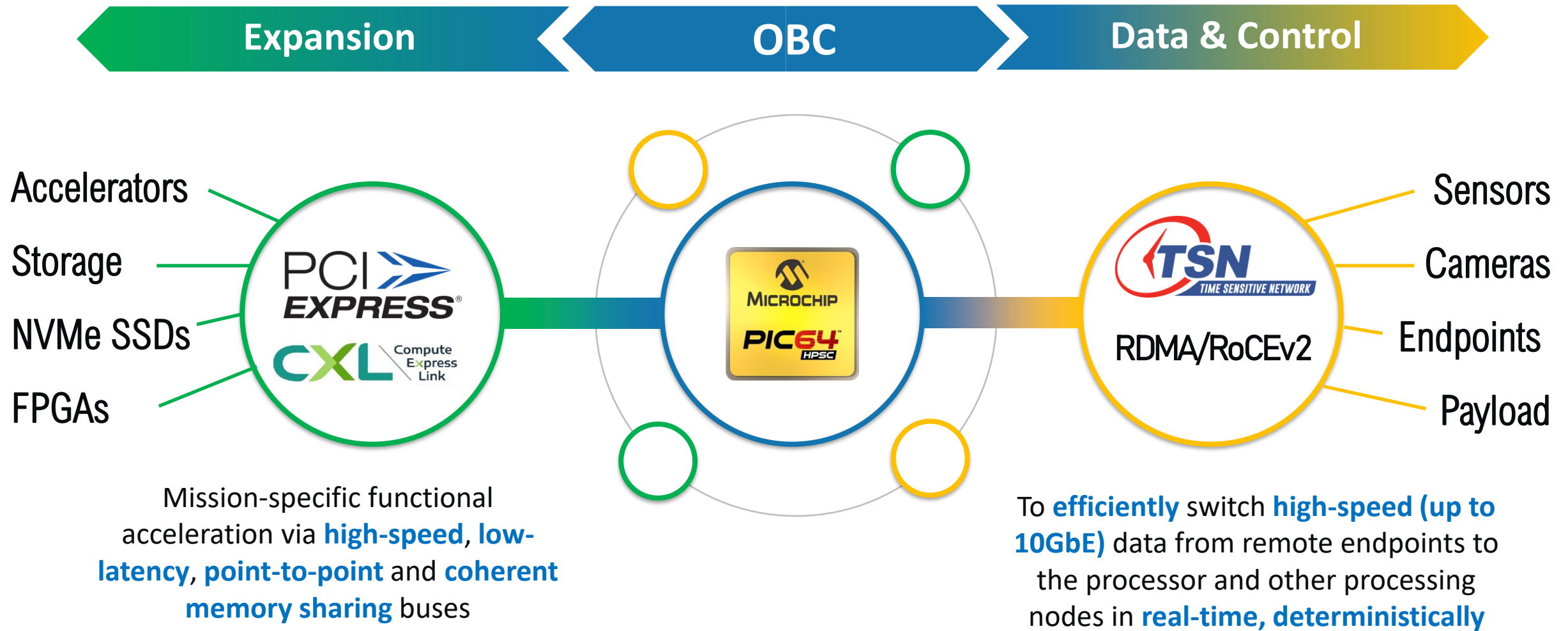
# Data Ingestion: PIC64-HPSC Delivers TSN Ethernet

## PIC64-HPSC: TSN Ethernet Benefits for Space



Supports IEEE TSN for Aerospace Onboard Ethernet Communications

# Enables On-Board Computing (OBC) Extensibility



System Extensibility with Field Proven Industry Standard Connectivity



# Enable Applications with Mixed-Criticality

## Mission-Critical Workload

- Terrain Relative Navigation
- Hazard Avoidance
- Command and Control
- Certified Software
- Lockstep Operation
- Trusted Execution Environment

## Less-Critical Workload

- Science missions
- Sample collection and analysis
- High performance computing
- Experimental software



## Flexible Application Cores Partitioning, Virtualization & WorldGuard

- Hypervisor support, Cache Isolation,
- Complete isolation and fault containment,
- Prohibited resource sharing

# PIC64-HPSC Design Philosophies



## Industry Standard & Proven Technologies

- Ethernet
- TSN
- RDMA, RoCEv2
- PCIe<sup>®</sup>
- Etc.



## Art of Balancing

- Hardening
- Performance
- Power



## Open-Standard Open-Source

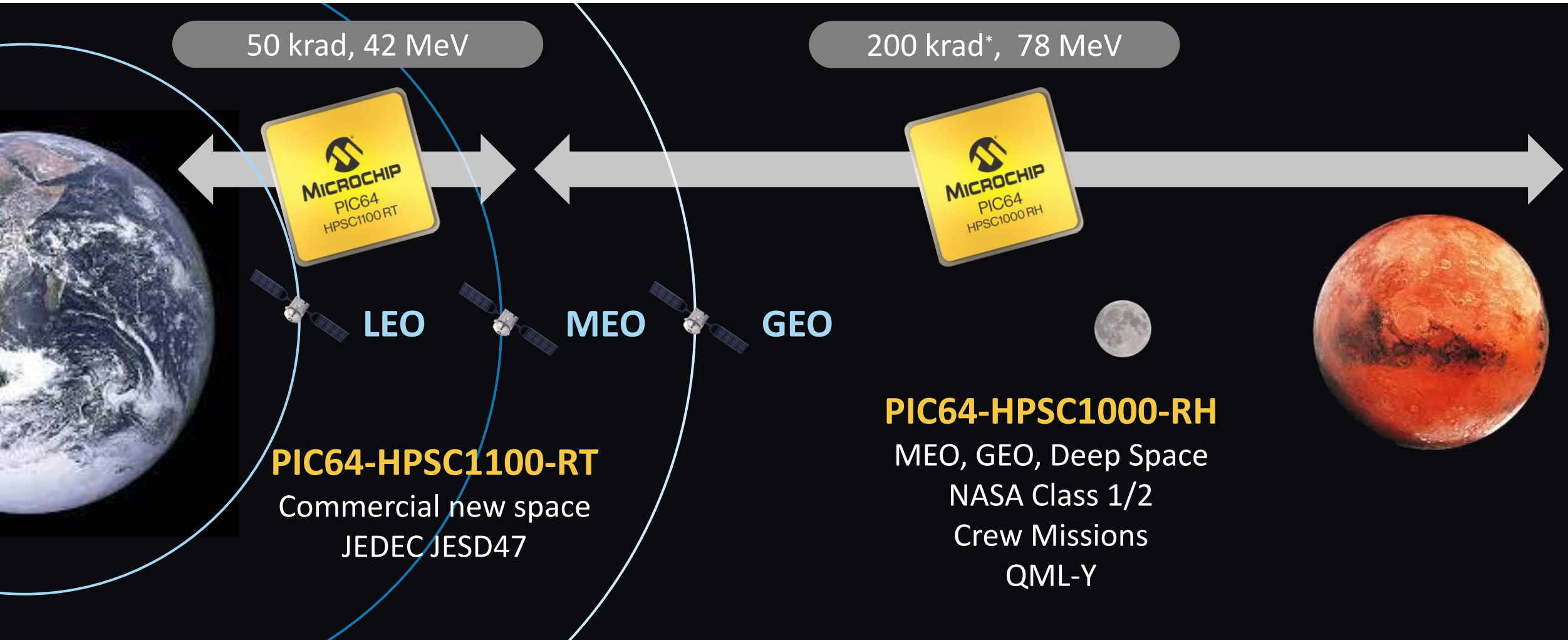
- RISC-V<sup>®</sup> ISA
- Hypervisor
- Software Tools and Libraries

### Considerations when making tough choices

- **Radiation Tolerance:** critical yet least flexibility
- **Compute Performance:** *peak* performance is “baked in”
- **Power Consumption:** tunable against performance/features

# HPSC – From Low-Earth Orbiting to Deep Space

PIC64-HPSC Series: Radiation-Hardened and Radiation-Tolerant Variants for Spectrum of Missions

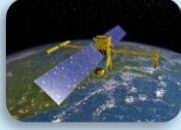





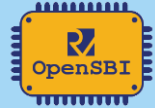


























Common Footprint & Software to Enable Scalable Assurance



# Supporting Open Source & Commercial Software

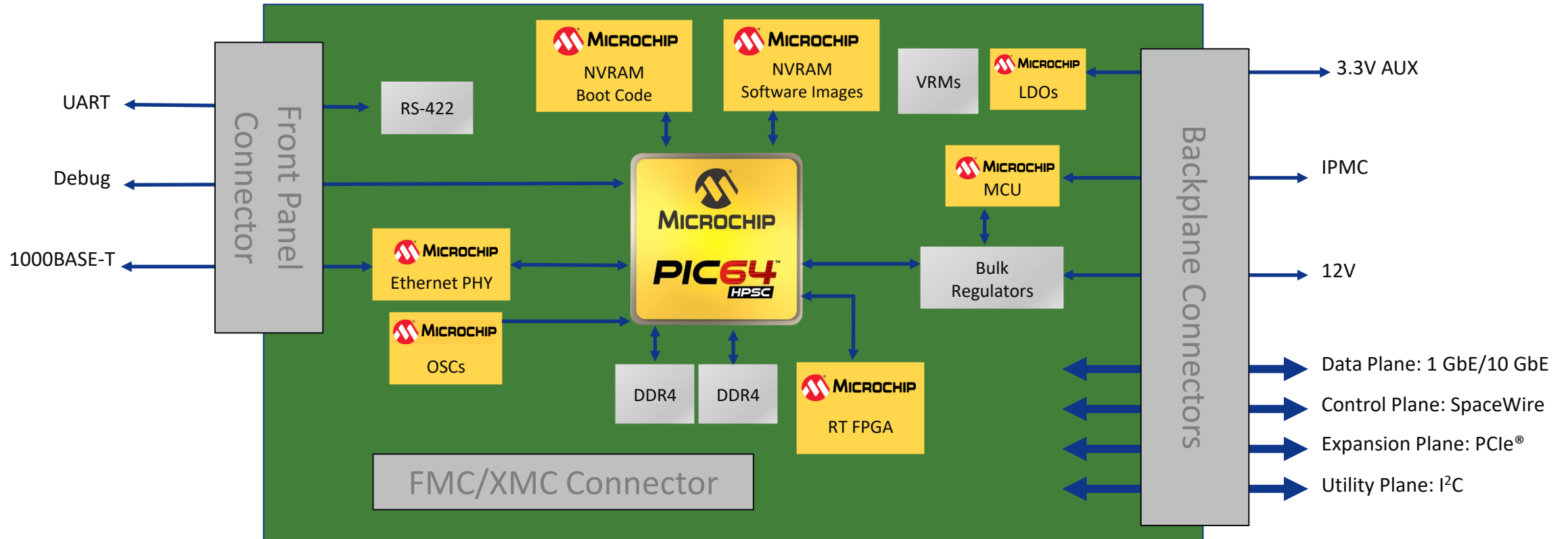
Extensive Development Tools, Libraries and Operating Systems for PIC64-HPSC Series

<b>Applications</b>	<b>Satellites</b> 	<b>Spacecraft</b> 	<b>Rovers/Landers</b> 	<b>Aviation</b> 	<b>Defense</b> 	<b>Industrial</b> 						
<b>Middleware</b>	<b>System Libraries</b>  OpenSBI		 OpenAMP	<b>OpenMP</b> <b>OpenSSL</b> <small>Cryptography and SSL/TLS Toolkit</small>	<b>Performance Libraries</b> <b>FFTW</b> POCL $\begin{bmatrix} Op \\ BL \end{bmatrix}^T \times \begin{bmatrix} en \\ AS \end{bmatrix}$		<b>AI Frameworks</b>  PyTorch	 TensorFlow	 TensorFlow Lite			
<b>Operating Systems</b>	 <b>Linux</b> Operating System, BSP and Drivers		<b>Real-Time Operating System(s)</b>  RTEMS			 WINDRV	 SYSGO <small>EMBEDDING INNOVATIONS</small>	 Green Hills <small>SOFTWARE</small>	<b>Hypervisors</b>  Xen Project		 KVM	
<b>Design Resources</b>	<b>Simulation Models</b> 	<b>Velocity Switch S/W</b> 	<b>Drivers</b> 	<b>System Controller</b> 	<b>Configuration Tool</b> 	<b>Crypto Tool</b> 						
<b>Tools</b>	<b>Compilers</b>  LLVM <small>COMPILER INFRASTRUCTURE</small>			 OpenXLA	 IREE	 GCC	<b>Development Tools</b>  MPLAB EXT				 LAUTERBACH <small>DEVELOPMENT TOOLS</small>	 ENTRUST <small>SECURING A WORLD IN MOTION</small>

# Microchip Uniquely Enables System Solution

Expansive Portfolio Provides Complete Validated Design to Accelerate Time to Market

## Typical Single Board Computer (SBC) Reference Design



Memories



Teledyne e2v  
Semiconductors

Transceivers



RDMA IP



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# Enabling the Space SBC Ecosystem

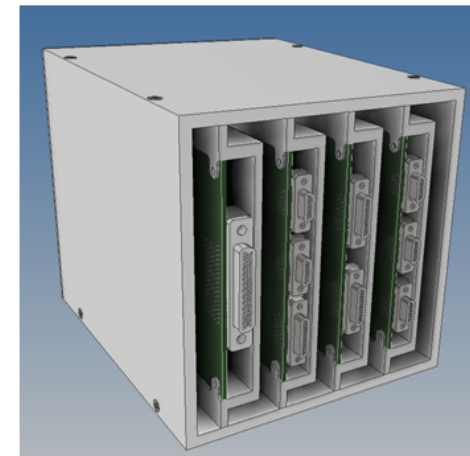
Single Board Computer (SBC) Partners To Fully Address Customer Development Needs

## Innovative Computing Element “ICE”

- ICE program is currently under evaluation in **ESA & ASI**. No formal approval yet
- ICE is proposing to use Microchip’s HPSC with Neat’s **GeminiX-S** Operating System
- ICE will be used to implement Radiation Tolerant High Performances, High bandwidth class of computers to address autonomous **AI based applications**.
- GeminiX-S Operating System is a generic low-level SW that implements a real time OS-like environment. Main characteristics are:
  - 100% Neat’s in-house development. MISRA C 2012, with coding rules
  - SW Defensive Programming (assertion, data check before use, ...)
  - Controlled execution flow (token passing)
  - 64 bit code protection of firmware on Mass Memory (CBC-MAC) for each 1 Kbyte block of data.
  - Stand-alone self-booting executable
  - Configurable isochronous interrupt service (resolution depending on specific timer technology)
  - High coverage diagnostic routine for on-line testing of:
    - CPU (registers, ISA, stack, internal RAM if available)
    - Memories (RAM, Mass Memory)
    - Data path (HW assisted BUS test)



Concept view





# New products Announcements

## PIC64-HPSC

[Microchip Unveils Industry's Highest Performance 64-bit HPSC Microprocessor \(MPU\) Family for a New Era of Autonomous Space Computing](#)

## JANxx Transistors

[Microchip Adds Military-Standard Enhanced Low Dose Radiation Sensitivity \(ELDRS\) Qualification to Its Portfolio of Small-Signal Bipolar Junction Transistors to Ensure High Reliability for Critical Applications](#)

## SAMD21RT

[Microchip Expands its Radiation-Tolerant Microcontroller Portfolio with the 32-bit SAMD21RT Arm® Cortex®-M0+ Based MCU for the Aerospace and Defense Market](#)

## LE50-28

[Radiation-Tolerant DC-DC 50-Watt Power Converters Provide High-Reliability Solution for New Space Applications](#)

## RT PolarFire® system-on-chip (SoC) FPGA

[Radiation-Tolerant PolarFire® SoC FPGAs Offer Low Power, Zero Configuration Upsets, RISC-V® Architecture for Space Applications](#)

## New integrated actuation power solution

[Integrated Actuation Power Solution Aims to Simplify Aviation Industry's Transition to More Electric Aircraft](#)



# PIC64-HPSC: Arriving in H1 2025

Rad-Hard Performance (200krad, 78MeV, QML-Y)

**Vectors for  
Edge AI/ML Acceleration**

(2 TOPS, 256 GFLOP/s)

**Virtualization &  
Mixed Criticality Support**

**High-Performance  
64-bit RISC-V Compute**

(26K DMIPS)

**Massive Connectivity**

(PCIe/CXL, TSN Ethernet, Switch,  
RDMA/RoCEv2, Space Wire)

**Multi-Layered  
Defense Grade Security**

# Where to learn more...

- Web pages to access [Link](#)
  - Products, applications
  - Reference designs on product pages
  - Brochures
  - Newsletters
- A&D BDM's, Sales teams
- [nicolas.ganry@microchip.com](mailto:nicolas.ganry@microchip.com)

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**Design Smarter, More Efficient Aerospace and Defense Applications Using Our High-Reliability Products and Solutions**

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Qualification is a keystone: our products are qualified to the most stringent standards in the industry including AEC-Q100, GEIA-STD-0002-1 Aerospace Qualified Electronic Component (AQEC), MIL-S-19500 (ANx), MIL-PRF 38535 and ESCC9000.

When necessary, you can take advantage of the extended temperature qualification from -55°C to 125°C and radiation hardening to the highest level, including neutrons. We can also give you access to qualification data.

Our controlled manufacturing process is a key differentiator, and we can give you access to full traceability. We also implement specific test screening when necessary.

We commit to supplying products long term and providing excellent customer support.

**Browse Applications**

 Aviation	 Defense	 Space
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PIC64-HPSC  
Product Website



NASA  
HPSC Whitepaper



TSN For Space  
Whitepaper (Microchip)



Securing Space Infrastructure  
Whitepaper (Microchip)







# Thank You

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