PIKEOS FOR GR740 IN SPACE RIDER

Thierry Maudire, Dec 2022

PRESENTER

Thierry Maudire

Head of Technical Sales

- Management and coordination of Solution Architects team to address customers technical requirements in different industries such as Aerospace & Defense, Automotive, Railway, and Industrial.

- About 30 years of experience specifying and developing solutions for embedded systems. Prior to SYSGO, he held different positions at Wind River Systems Inc.

- Education:
  - Postgraduate Degree, in Robotics, from University Pierre et Marie Curie (Paris)
  - Master of Sciences in Signal Processing and Telecommunication from University of RENNES

ABOUT SYSGO

- **Leading European OS vendor** for embedded systems.

- **+30 years certification experience** of Safety-critical systems.

- Products:
  - PikeOS certifiable hard RTOS + Type 1 Hypervisor
  - PikeOS for MPU
  - ELinOS embedded Linux Distribution

- PikeOS supports the highest Safety and Security standards, like ECSS Cat. A and CC EAL5+.

- BSPs, certification kits and consulting services.

- Part of the Thales Group.

SYSGO Headquarters Germany

ISO 9001:2015

ISO 27001 Certified

Common Criteria

ITAR free

EMBEDDED PERFORMANCE
FOR CRITICAL SYSTEMS

- **PikeOS**
  - Certified hard real-time OS (separation kernel with type-1 hypervisor)
- **PikeOS for MPU**
  - Certified hard real-time OS for MPU processor
- **ELinOS**
  - Embedded Linux distribution
- **CODEO**
  - Integrated Development Environment based on Eclipse
- **Field proven**
  - Avionics, Automotive, Defense, Industrial, Medical, Railway and Space applications
- **Seamless customer product development** and management:
  - System architecture and Security approach
  - Hardware integration
  - Long term customer support
 - Tools and services to cover the full product life cycle

PRODUCTS & SERVICES
PIKEOS - EMBEDDED RTOS & HYPERVISOR

- **Hard Real-Time Operating System and Hypervisor**
- **Guest operating systems**
  - Linux, POSIX, ARINC-653, AUTOSAR
- **Wide range of CPU supported**
  - PowerPC, ARM, x86, LEON3 & 4, RISC-V
- **Mixed criticality**
- **Without any export restriction**
- **Common Criteria EAL 5+ certified* Separation Kernel Architecture**
  - – **Certifiable to the strictest Safety Standards**
    - DO178C DAL A, ECSS Category A, IEC 61508 SIL 3, EN 50128 SIL 4 and ISO 26262 ASIL D
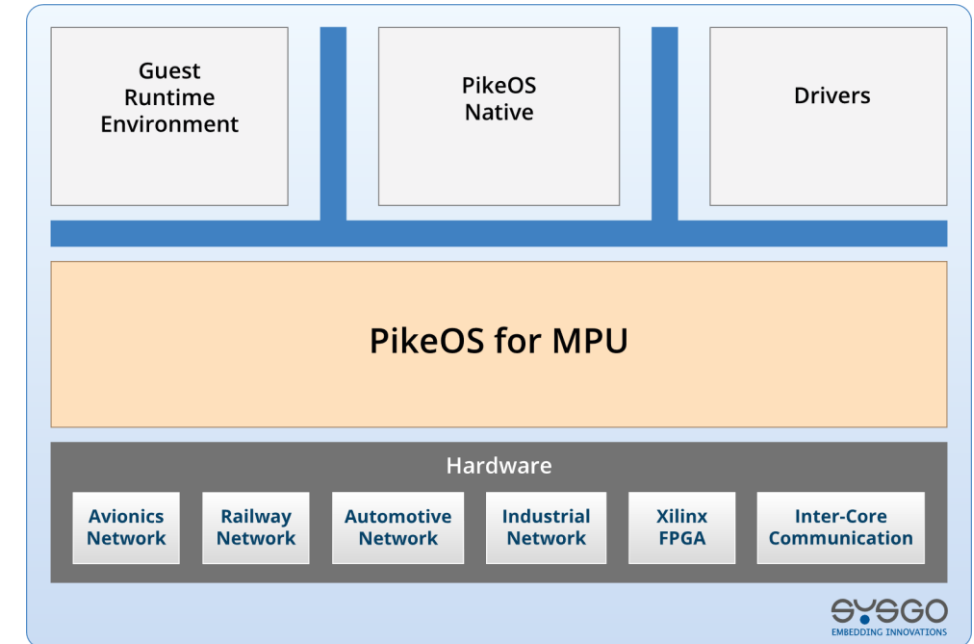   - Multi-Core certification
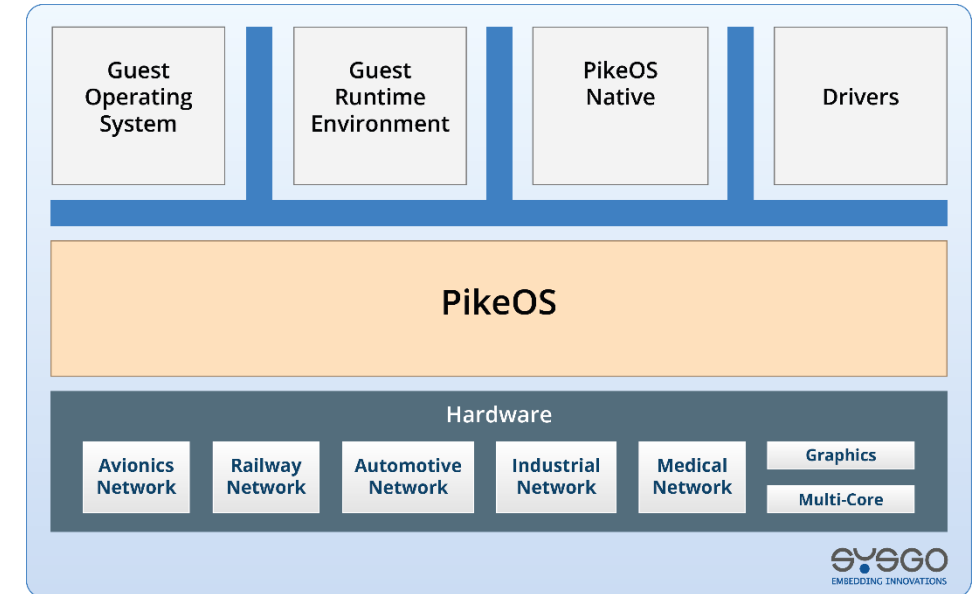
*The PikeOS Separation Kernel Version 5.1.3 (build S6510) is currently the only Separation Kernel worldwide that holds a Common Criteria certification for its separation performance.

PIKEOS FOR MPU

- Re-use for PikeOS and adapt for **MPU processors**
- RTOS and separation kernel-based hard real-time operating system
  - Robust time & resource partitioning
  - **AMP multi-core** processor support
  - Hardware abstraction
  - First level exception and interrupt processing
  - Thread management & scheduling
  - Health monitoring
  - Inter-partition communication and synchronisation
  - **ICCOM (Inter-Core Communication)**
  - I/O device abstraction and access control
- CODEO, Eclipse-based IDE
- PikeOS compatibility
- Large software & hardware eco system
- First implementation in Space on **DAHLIA NG_ULTRA** SoC in Space Inspire

- ## ASP (Architecture Support Package)
  - SPARC LEON4
- ## PSP (Platform Support Package)
  - Compatible with GR740 and TSIM (v3)
- ## Drivers
  - Ethernet, Serial
  - Additional drivers being developed by Thales Alenia Space
- ## Add-ons
  - Dynamic Ticker
  - IOMMU Support
  - Configurable Reset Mode
  - MAF Synchronization on external event
  - Overrun Management
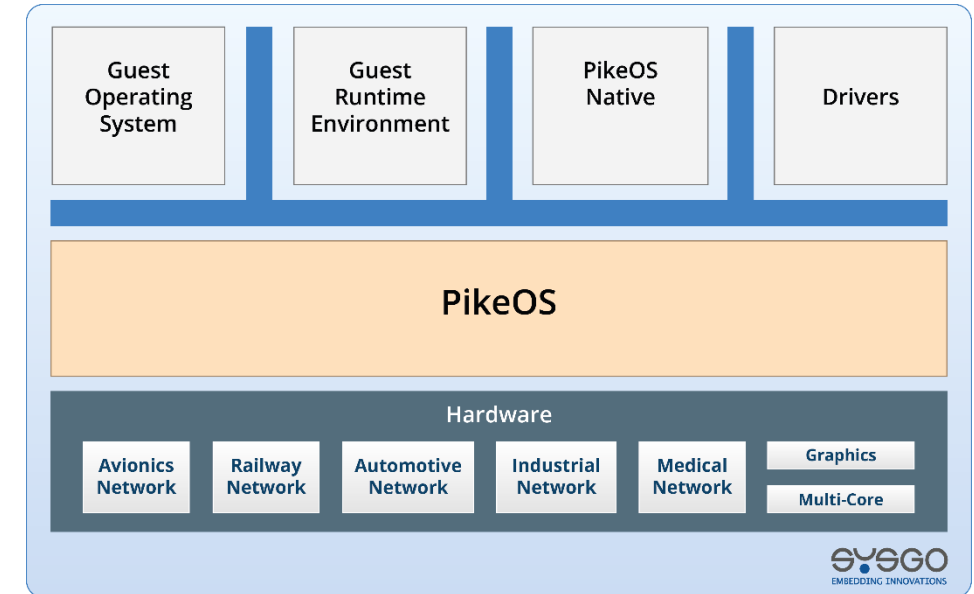
PRODUCTS & SERVICES
CERTIFICATION

- **Safety**
  - Target : ECSS Category A
  - Approach
    - Re-use existing experience and knowledge from Avionics Multicore DO178C/AMC 20-193 standard and outcome of ESA contract No.4000125316/18/NL/AF with a mapping between Avionics and Space Safety standards
    - Source/Object Code Traceability : ESA approach in document Prepared by Thanassis Tsiodras TEC-SWE Reference TEC-SWE/17-945/TT

  - Rerun test suites on TAS hardware
  - ISVV Kit
    - Ready to deliver PC with Qualification Data Package, source code access and consulting hours
  - ESA participation to Reviews

- **Cyber Security**
  - Based on PikeOS 5.1.3 separation kernel with CC EAL5+
    - CC Certificate for x86, ARMv8, PPC could be extended to incorporate SPARC LEON4 ASP

  - ITT CYBERSECURITY BY DESIGN FOR MIXED CRITICALITY EMBEDDED SYSTEMS
    - On-going activity on PikeOS for MPU for Cortex R52 (ARMv8-R) architceture

RETEX ON GR740 EXPERIENCE
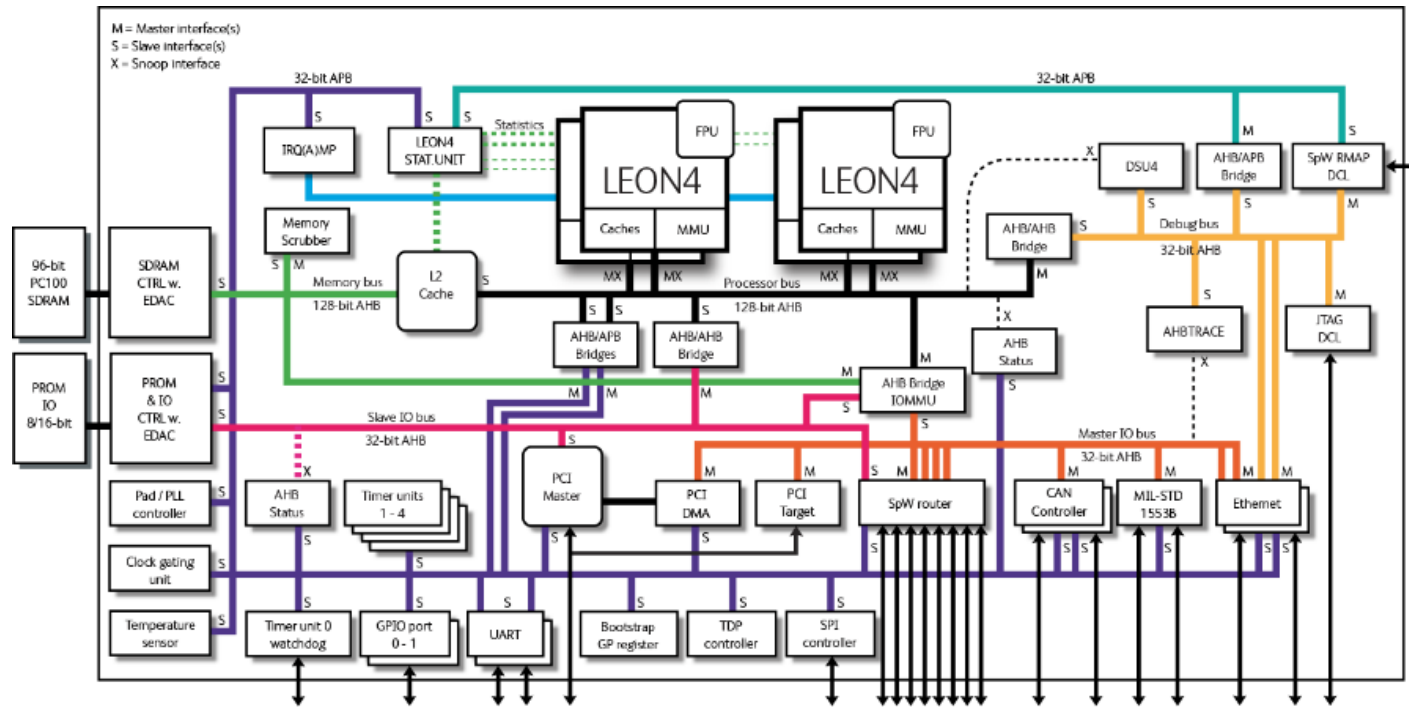
- **Pros**
  - Well defined architecture:
    Cache coherency between cores,
    IOMMU, DRAM Scrubbing in HW
  - Improve performance compared to
    LEON 3, while still retaining IPs (IO)
  - GRMON debugger, PikeOS integration
    in GRMON (in progress)
 - Simulation environment via TSIM

- **Cons**
  - Unique Processor memory bus could
    generate bottleneck
  - No last level cache partitioning in HW

GRMON PIKEOS AWARENESS INTEGRATION

- Prototyping activity done by Gaisler with SYSGO

  Support

- Visibility of PikeOS threads/tasks, etc

- Stack Backtrace of executing and switched out

  threads

- Support demonstrated on GR740/PikeOS-5.1

- Work in progress but should be available with

  one of next GRMON version

- Work being done also on NOEL-V 32/64-bit
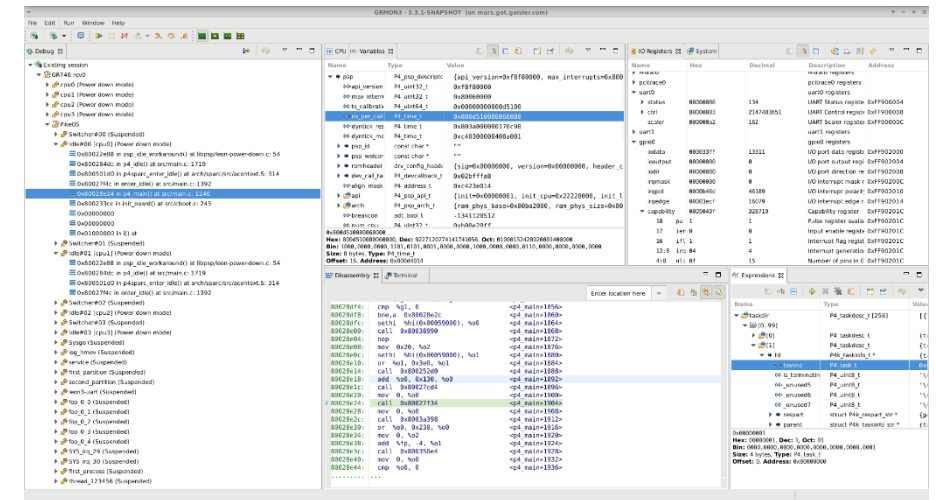
THALES ALENIA SPACE
USE CASE: TAS OBC – GR740 BASED

- **ESA Projects**
  - Main OBC of the satellite for orbit control, ground communication…for
  - **Galileo**
  - **Copernicus**
    - **CHIME**
    - **CIMR**
    - **ROSE-L**
  - **Space Rider**

- **Italian Confidential Project**

SPACE RIDER

- **Uncrewed Robotic Laboratory** will stay in low orbit for about two months.

- At the end of its mission, **Space Rider will return to Earth with its payloads and land** on a runway to be unloaded and refurbished for another flight.

  - ESA signed in December 2020 a contract for delivery of the Space Rider flight model including the reentry module and the AVUM orbital service module, by co-prime contractors: **Thales Alenia Space Italy** and **Avio S.p.A.**

  - In addition, other subcontractor **GMV** is also involved and using PikeOS

  - TAS main **On Board Computer** manages all the spacecraft and is responsible for its safety behavior

  - **ECSS Cat. A** is mandatory because the spacecraft will return to earth and share the sky with civilian airplane

QUESTIONS OR COMMENTS?

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