EMBEDDING INNOVATIONS





# **PIKEOS FOR GR740 IN SPACE RIDER**

Thierry Maudire, Dec 2022

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### 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.







### **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:

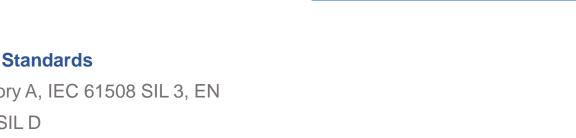
- System architecture and Security approach
- Hardware integration
- Long term customer support
- Tools and services to cover the full product life cycle



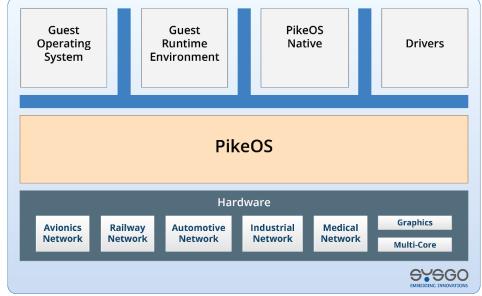
### PRODUCTS & SERVICES PIKEOS - EMBEDDED RTOS & HYPERVISOR



- 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





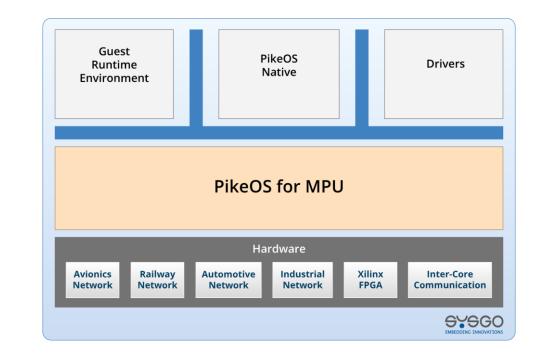




### PRODUCTS & SERVICES PIKEOS FOR MPU



- 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





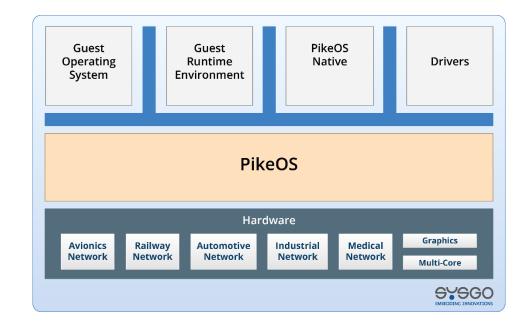
### PRODUCTS & SERVICES PIKEOS AND GR740



- 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

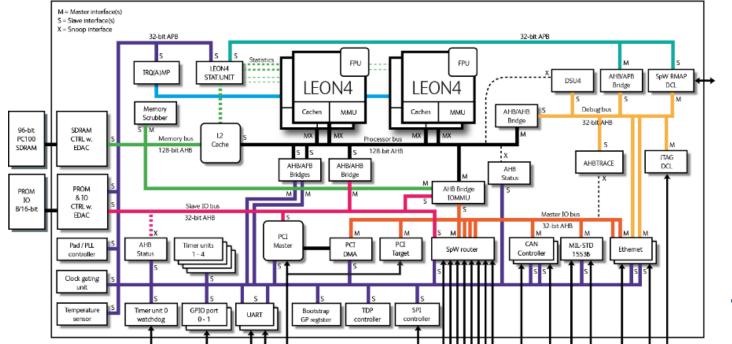
- Target : ECSS Category A
- Approach
  - Re-use existing experience and knowledge from Avionics Multicore DO178C/AMC 20-193 standard and outcome of ESA contract No.4000125316/18/NL/AF with a mapping between Avionics and Space Safety standards
  - Source/Object Code Traceability : ESA approach in document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

### **TOOLING** 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

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P cpu2 (Power down mode)	66-ts calibrati	P4 uint64 t	0+00000300300	0.05100		<ul> <li>status</li> </ul>	80008855		UART Status registe .0xFF900	
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🕨 🧬 Sysgo (Suspended)		ep ev 0x20, %o2		<p4_main+1872> <p4_main+1875></p4_main+1875></p4_main+1872>					P4 taskdosc t	
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🕨 🧬 service (Suspended)		r %01, 8x3e8, %c	1	<p4_main+1884></p4_main+1884>				MP taskno	PM tank t	
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🕨 📌 ieon3-uart (Suspended)		ev 0. tot		<pre>spin=1900&gt;</pre>				OP unused	6 P4 unt6 t	
🕨 🧬 fop_0_0 (Suspended)		all 0x80027f34		<p4_main+1904></p4_main+1904>				04 unused	7 P4 uint8 t	
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#fop_0_2 (Suspended)		all 0x8083a398 r 308.0x238.3x		<p4 main+1912=""> <p4 main+1916=""></p4></p4>				+ + parent	struct P4k taskinfo st	
Image: Prop. 0 _3 (Suspended)		r 108, 98238, 10 ev 9, 102	~	<p4_main+1920> <p4_main+1920></p4_main+1920></p4_main+1920>				0x08000601		
fop_0_4 (Suspended)	83628c38: a	dd Nfp, -4, Nol		<p4_main+1924></p4_main+1924>				Hex: 00600061, Dec: 1, O Bin: 0602,6000,8000,800		
§ P 5Y5_irq_29 (Suspended)		all 0x800358e4		<p4_main+1928></p4_main+1928>				Size: 4 bytes, Type: P4 t	ssk.t	
Fys_irg_30 (Suspended)		ov 0, hoB		<p4_main+1932></p4_main+1932>				Offset: 0. Address: 6x80	00000	
# Pfirst_process (Suspended)	83628e44: 0	np %s0, 8		<p4_main+1936></p4_main+1936>						
E hoead 123456 (Suspended)										



### 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?**

## EMBEDDING INNOVATIONS

### SYSGO GmbH

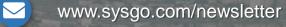
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