



# Embedded Safety & Security Solutions for Aerospace Applications

## SPACE INDUSTRY CHALLENGES

- Ground segment activities require significant investment
- Safety, reliability and entertainment drive demand in mobility
- Low production volume of satellites, so it's important to ensure maximum reliability Earth observation with high demand for data with need for big data analytics
- Low latency and high throughput applications
- Technology need for SPACE 4.0
  - New technologies need more processing power, storage and data management
  - Adopted technology trends
- Multiple domains with different trends and specificities
- An ever evolving regulatory and policy environment
- Long lifetime with a need for software update and maintainability
- Need for hardware consolidation to reduce weight, space and power
- Need for "always on"
- Fault tolerant computing is paramount
- Complex systems have a high need for certification
- Looking for a GPOS handling data processing, visualization, and integration of applications

## TECHNOLOGY CO-OPERATION

Jointly, we can address new or critical embedded certification use cases with multi-level criticality in the space market by combining SYSGO's PikeOS mixed criticality and Frontgrade Gaisler NOEL-V (RISC-V) or LEON (SPARC) SoCs as well as tool solutions.

## JOINT CUSTOMER VALUE

- Merged technology solutions adapted for the space market
- Secure certified communication to ground station including software updates
- Large experience for Safety requirements in manned space equipment
- Possible long-term support for 30 years or more
- Low power
- Support for FPGA and ASIC development boards
- Fault-tolerant computer design
- Software debugger and simulation tools
- Reduced development time by
  - Use of COTS based RTOS
  - RISC-V technology
  - Provision of SW and HW certification artifacts up to DO-178C DAL A or ECSS level B in Safety and Common Criteria EAL5+ for Cybersecurity
  - Consolidation of development tools
- Full European solution (ITAR free) aligned to ESA needs

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**FRONTGRADE GAISLER PRODUCTS**


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- **LEON** is a family of VHDL models of 32-bit processors compliant with the SPARC V8 architecture. They are highly configurable and particularly suitable for system-on-chip (SoC) designs. LEON processors support both asymmetric and symmetric multiprocessing (AMP/SMP) and they offer fault tolerant features.
- The **NOEL-V** is a VHDL model of a processor that implements the RISC-V architecture, which can be configured to conform to the RV32 or RV64 architectures. NOEL-V supports both asymmetric and symmetric multiprocessing (AMP/SMP). It offers advanced fault tolerant features and is already integrated with the RISC-V interrupt controllers and with an optional L2 Cache.
- The **GR740** device is a radiation-hard system-on-chip featuring a quad-core fault-tolerant LEON4 SPARC V8 processor, 8-port SpaceWire router, PCI initiator/target interface, CAN 2.0 interfaces and 10/100/1000 Mbit Ethernet interfaces. The GR740 device is targeted at high-performance general-purpose processing. The architecture is suitable for both symmetric and asymmetric multiprocessing. Shared resources can be monitored to support mixed-criticality applications.
- **GRBOOT** is a flight system bootloader targeting LEON based systems. The boot software provides initialization, self-test and application loading functionality to payload and on-board computers. GRBOOT is an implementation of the ESA requirements document SAVOIR Flight Computer Initialisation Sequence (SAVOIR-GS-002). The software is developed in accordance with European Space Agency software engineering standards ECSS-E-ST-40C and ECSS-Q-ST-80C, tailored software criticality category B. **GRBOOT-STANDY** is a SpaceWire/PUS standby extension for GRBOOT, which is compatible with the Standby function as described in SAVOIR-GS-002.
- **GRMON3** is a hardware monitor optimized for SPARC/LEON and RISC-V/NOEL-V systems, providing a non-intrusive debug environment. The target system can be monitored and controlled by the graphical user interface with scripting support. A large number of debug link interfaces are supported.

TSIM3 is a high-performance behavioral simulator of the LEON processors. It is developed for accurate behavior and timing in terms of simulation time. Using the simulators, it is possible to develop and debug target applications before the real hardware is available, thereby shortening the product development cycle. TSIM3 can simulate GR740, GR712RC, GR716, UT699, UT700 and generic, configurable LEON systems. Gaisler's GRBOOT boots PikeOS on GR-CPCI-GR740 board and on TSIM3-LEON4 (GR740).

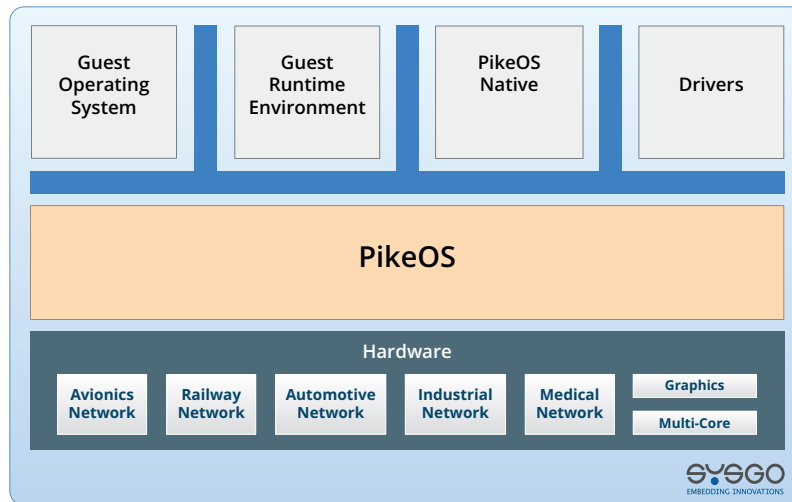
GRMON3 provides OS awareness support for PikeOS, by listing tasks and threads, supporting different MMU contexts and different symbol tables for each thread.

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**SYSGO'S PIKEOS RTOS & HYPERVISOR**


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- PikeOS is a **hard real-time OS and Hypervisor** in one product with a wide range of guest OSs (POSIX, Linux, Android, ARINC, Android, RTEMS, ..., AUTOSAR)
- Software is executed independently from each other via software time and space partitioning used in mixed critical applications
- Fast and efficient separation kernel architecture
- Combined **Safety and Security** in a single product
- Based on a certification approach which is modular and HW-independent to the upmost extend
- Health monitor for fault detection, isolation and recovery
- High availability through redundancy
- Compliancy for ARINC 653 protocol
- Start with feature development, certify later
- PikeOS product line committed to support whole range of embedded RISC-V systems (MMU & MPU) with one development IDE and native API for all
- **Multi-Core support (SMP & AMP)**
- Offers additional certified components such as:
  - CFS (certifiable file system), CIP (certifiable UDP stack), CML (certifiable math library)
- Works with **MMU (memory management units)** and **MPU (memory protection units)** based architectures
- Offers compliance to AFDX networking
- High performance in multi-core Avionics software applications
- Graphics support for OpenGL SC and GPU virtualization including multi partitions
- **Security**
  - The PikeOS 5.1.3 separation kernel is certified against **Common Criteria EAL 5+**
  - Certification Kit available for Security Common Criteria (IEC 15408)
  - Supporting DO 356A/ED 203A
  - Supporting IEC 62443
  - Supporting Airbus SAR (Compliant to Airbus SAR, SAL 3 & 4)
- **Safety**
  - Certification Kits available for Safety-critical
    - Avionics DO-178C
    - Industrial IEC 61508
    - Transportation (EN 50128)
    - Automotive (ISO 26262)
    - Space ECSS
- No export restrictions (ITAR free)
- Long-term support



## THE JOINT SOLUTION

- PikeOS with a PSP (Platform Support Package) compatible with GR740 and TSIM3
- CODEO IDE (Integrated Development Environment) as primary debug
- One environment for PikeOS, PikeOS for MPU and ELinOS (SYSGO's embedded Linux distribution)
- Support for standard drivers and add-ons
- GRMON3 as system level debugger for NOEL-V and GR740
- TSIM3 as simulator for GR740
- GRLIB contains a wide range of peripheral IP cores and provides template designs for several FPGA boards,
- Certifiable components and artifacts for
  - Safety certification up to ECSS Level 1 (or DO-178C DAL A)
  - Security up to Common Criteria EAL 5+ achieved with separation kernel PikeOS 5.1.3
- Both Frontgrade Gaisler and SYSGO are actively supporting the RISC-V consortium
- Both driving the space market including SPARC architecture
- SYSGO is a certification expert with international experience
  - We know how Safety certification standards are interpreted in Europe and in the US
  - We are involved in definition of international Security standards

**Frontgrade Gaisler** - Frontgrade Gaisler is a world leader in embedded computer systems for harsh environments, with footprints in many parts of the solar system. The company provides the complete ecosystem to support digital hardware and software design for mission critical System-on-Chip solutions. We have a long experience in the design of flight quality microelectronic devices: we provide several radiation-hardened standard components.

**About SYSGO** - Founded in 1991, SYSGO became a trusted advisor for Embedded Operating Systems and is the European leader in hypervisor-based OS technology offering worldwide product life cycle support. We are well positioned to meet customer needs in all industries and offer tailor-made solutions with highest expectations in Safety & Security.