

Product Note

PikeOS 4.2

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1. Introduction

The Internet of Things consists of billions of highly integrated, multi-functional smart devices in a digital network. Application software, cloud services and critical control tasks have to collaborate seamlessly. Hence, the underlying operating system must act as a catalyst and bring together general IT and Embedded capabilities.

That's why SYSGO developed PikeOS. This real-time operating system offers a separation kernel based hypervisor with multiple partitions for many other operating systems and applications. It enables customers to build smart devices for the Internet of Things according to the quality, safety and security standards of different industries.

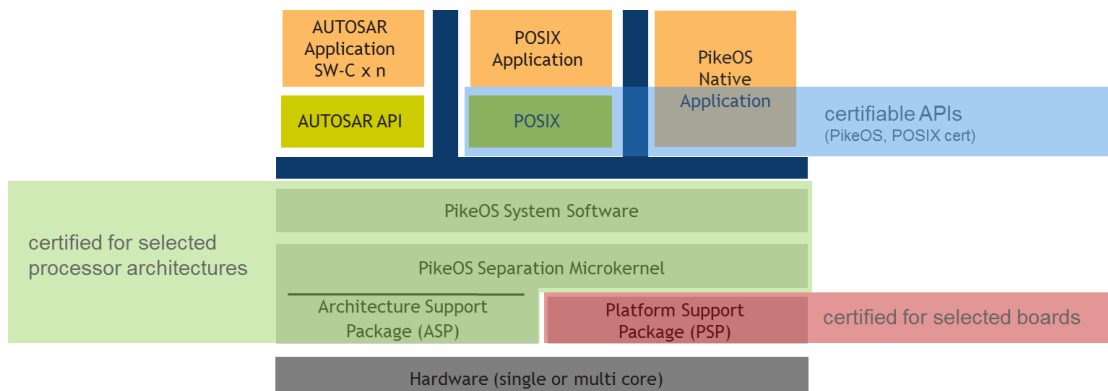
The concept of PikeOS combines real-time operating system (RTOS), virtualization platform and Eclipse based integrated development environment (IDE) for embedded systems. The PikeOS real-time operating system has been developed for safety and security-critical applications with certification needs in the fields of Aerospace & Defense, Automotive & Transportation, Industrial Automation & Medical, Network Infrastructures and Consumer Electronics.

One of the key features of PikeOS is the capability to safely execute applications with different safety and security levels concurrently on the same platform. This is achieved by the strict spatial and temporal segregation of these applications by means of software partitions. A software partition can be seen as a container with pre-allocated privileges that can have access to memory, CPU time, I/O, but also a predefined list of PikeOS services. With PikeOS, the term application refers to an executable linked against the PikeOS API library and running as a process inside a partition. Due to the nature of the PikeOS API, applications can range from simple control loops up to complete Para virtualized guest operating systems like Linux or hardware virtualized guests.

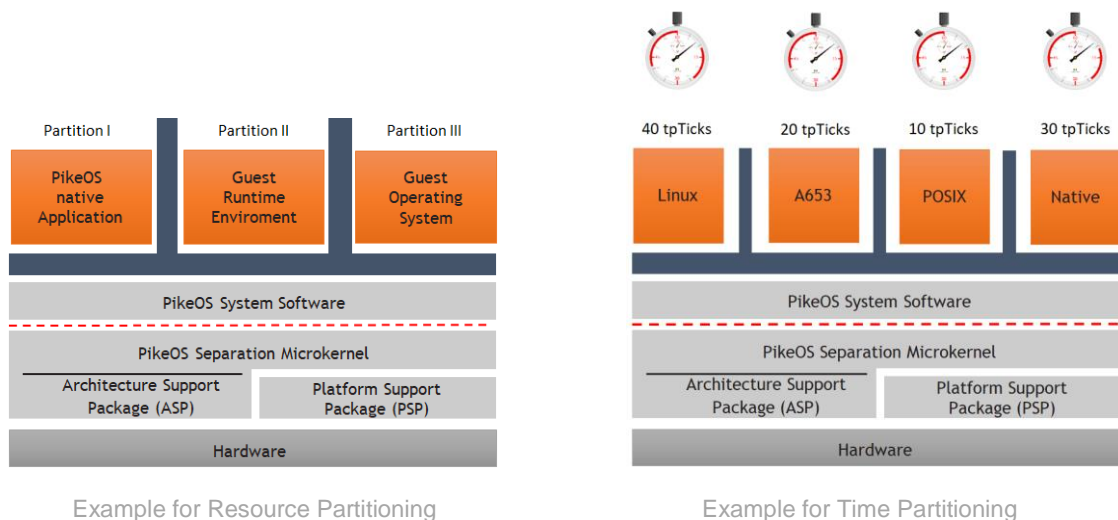
Software partitions are also called Virtual Machines (VMs), because it is possible to implement a complete guest operating system inside a partition which executes independently from other partitions. PikeOS can be seen as a Type 1 Hypervisor.

The reliability of a system is more and more determined by software. Consequently software certification is becoming mandatory for many industries. Avionics started with DO-178, railway came up with EN-50128 and other industries followed with IEC-61508 and also automotive industry has implemented its own standard, called ISO-26262.

A certified operating system is the foundation for critical systems. It provides both, the technology and the certification artifacts ready for approval by the authorities. Pre-approved PikeOS software components are available for EN50128, IEC61508 and ISO 26262



Example for a certifiable software architecture in automotive with key components in use



2. Key Users

PikeOS is an RTOS that includes a Hypervisor type 1 with bare metal functionalities. The software can be used as foundation for safe and secure systems. The Key users are:

- Platform developers
- Application developers
- BSP Developers

3. Most visible Use Cases

The supported use cases are manifold. An extract is listed below:

- Reduction of Space, Weight and Power through merge of hardware devices on a single processing platform
- Re-use of legacy code in virtualized containers
- Fast boot on an RTOS to access a data bus, while booting Linux in parallel
- Certification support and artifact availability for certification authorities
- Defining safe and un-safe partitions with management of data flows
- Support for security targeted developments
- Guaranteed separation of open source and other critical functionality
- Failsafe mode (Functional error containment for separated partitions)

4. Key Benefits of PikeOS

- Real Time Operating System including type 1 hypervisor defined for highly flexible configuration
- Supports Fast or secure booting times
- Supporting mixed criticality via separation kernel in one system
- Configuration of partitions with time and hardware resources
- Hardware independence between processor types and families
- Easy migration processes and High portability on single- and multi-core
- Developed to support certification according to multiple safety & security standards
- Reduced time to market via standard development and verification tools
- Wide range of supported Guest OS types (APIs)
- No export restriction (European solution)

5. Where can PikeOS help reducing total cost of ownership?

- Re-use Legacy Code in a safety critical environment (separated by the PikeOS Hypervisor)
- Use low-cost and/or convenient open source code (drivers, connectivity, libraries) and Linux or Android in a safety critical environment (separated by the PikeOS Hypervisor)
- Mixing of Guest OS like ARINC-653 and POSIX or AUTOSAR and Linux in a certification context
- Save hardware costs by consolidation of several functions in one hardware, using the PikeOS Hypervisor
- Save hardware costs by efficiently using modern multicore processors (PikeOS can be certified for multicore)
- Save certification time, efforts and costs by using commercial-off-the-shelf PikeOS Certification Kits
- Save certification costs by utilizing a MILS (Multiple Independent Levels of Safety & Security) architecture, where each application is certified to its individual safety/security level only
- Save licensing and certification costs by using PikeOS both for safety and security
- Utilize SYSGO services for time to market, efforts and costs optimization (training, consulting, engineering services)
- Reduce software obsolescence problems by SYSGO's Long Term Support and Certification Support, supporting long product lifecycles
- Secure your software investments as SYSGO's PikeOS supports many processors (ARM, PowerPC, X86) and offers a broad feature set, allowing you to use it in a wide range of applications covering many different requirements

6. How can PikeOS help reducing risks?

- Reduce certification risk with PikeOS as a firm and certifiable basis
- Reduce development time and success risks using the real-time capabilities, flexible scheduler, robust time and resource separation and reliability of PikeOS
- Utilize SYSGO support and services for quickly solving problems or adding experience in certification management and execution
- PikeOS is fielded in multiple avionics applications and has been designed for safety and security certification from the beginning, and such applications are SYSGO's main focus
- SYSGO is owned by Thales, a leading European Aerospace, Space, Defense, Security and Transportation systems vendor, ensuring supplier stability
- Reduce export restriction risks - PikeOS is free of export restrictions

7. Guest OS Types

Supported Guest OS types are:

- Linux or Android (ideally SYSGO Linux distribution ELinOS)
- POSIX PSE51 with PSE52 extensions
- ARINC653
- RTEMS
- JAVA
- AutoSAR
- ADA (including Ravenscar profile)
- and others

8. Standard Drivers

The drivers in the standard portfolio of supported product BSPs are

- Ethernet
- Serial
- Timer

9. Optional Drivers

Optional available drivers are

- CAN
- DIO
- I2C
- RTC
- Watchdog
- SPI
- PCI/PCle
- QSPI
- NAND Flash
- NOR Flash
- MMC Mass Storage
- SATA
- GPU
- USB Mass Storage
- AFDX
- and others

10.IDE: CODEO (also with QEMU)

The Eclipse based IDE CODEO supports system architects with graphical configuration tools, provides all the components software engineers need to develop embedded applications and includes comprehensive little helpers to finish embedded projects in a time-saving and cost-efficient way:

- guided configuration
- remote debugging (down to the hardware instruction level)
- target monitoring
- remote application deployment
- and timing analyses

Of course, CODEO provides standard application development features such as compiler, assembler and linker.

CODEO offers Simulation Targets, a QEMU based hardware simulation. Simulation Targets for all available architectures can be managed and configured through graphical wizards, directly in the IDE. This enables a rapid software development, early testing and debugging even without a real target hardware on the table. Simulation Targets are available for all hardware architectures supported by PikeOS.

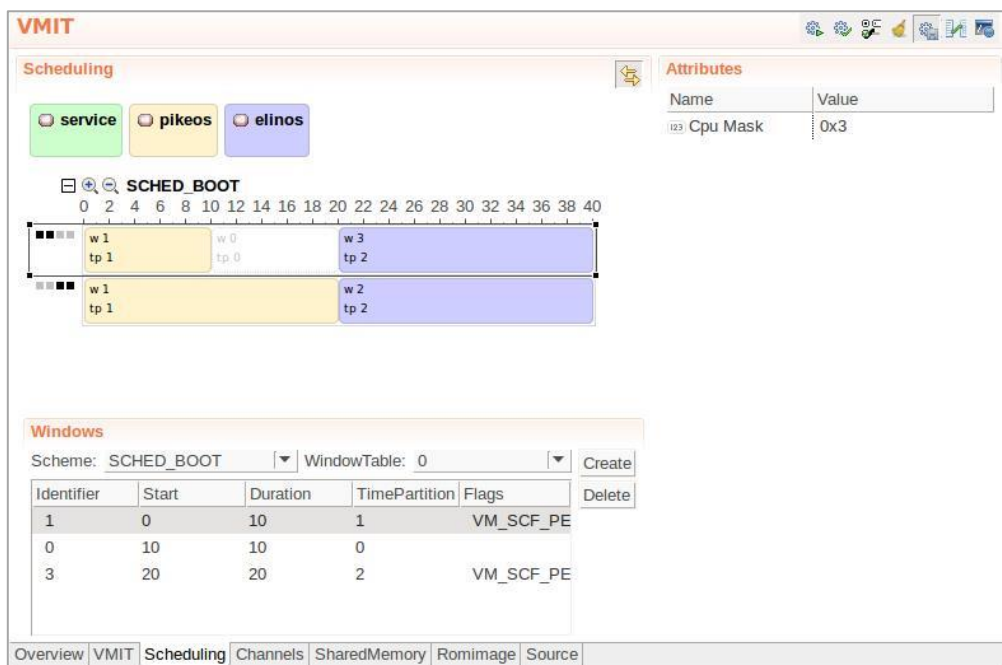
The ROM file editor allows an efficient management of files and system properties. Files can be added and removed directly to the ROM file system. Additionally it offers a dynamic preview of the final layout that updates automatically when changing related configuration that affects the ROM file system indirectly.

Several dedicated graphical editing views are supporting the system Integrator to always keep the overview on important aspects of the PikeOS system configuration like scheduling, communication channels and shared memory.

Projects can be easily defined with the help of reusable templates and distributed to the development groups. Customers can configure pre-defined components for their project and can also define and add other components during the development process.

The latest version is called CODEO 6.2 and has the following new highlights:

- Graphical enhancements and improvements in multicore scheduling
- Improved project configurator
- Re-deployment of applications
- Updated to Eclipse 4.6
- Toolchain Update with GCC 5.4



Identifier	Start	Duration	TimePartition	Flags
1	0	10	1	VM_SCF_PE
0	10	10	0	
3	20	20	2	VM_SCF_PE

CODEO scheduling monitor

11. Host system environment for Linux

CODEO supports both 32 and 64-bit Linux distributions. For usage on 64-bit Linux distributions 32-bit compatibility libraries have to be installed.

12. Host system environment for Windows

CODEO can be used on the following variants of the Windows operating system:

- Windows 7 (32 and 64-bit)
- Windows 8 (32 and 64-bit)
- Windows 10 (32 and 64-bit)

13. Other tools

Feature	4.1	4.2
GCC	4.8	5.4
Updated Project Configurator	✓	✓
Project Configurator - Config. Split Support	✓	✓
Advanced hardware debug support	✓	✓
Muxa: monitor to reload running applications	✗	✓
Eclipse version	4.5	4.6
Multicore Support in Schedule Editor	✗	✓

MUXA is a protocol to communicate between the target and the host during target development. Both sides exchange data in the same protocol format. Multiple users such as partitions and the kernel or a debugger can establish a communication channel through the same data stream.

14. Core data used in PikeOS 4.2:

- Kernel version 4.2
- PSSW version 4.2
- CIP version 4.2
- CFS version 4.2
- Compiler GCC version 5.4

15. Key Top Level Features and Key Benefits of PikeOS 4.2

- New Baseline for Certification projects that helps reduce time to market in certification projects. Key certifiable components are:
 - APIs per Guest OS such as e.g. POSIX or ARINC 653
 - PSP (Platform Support Package)
 - Kernel, PSSW (PikeOS System Software) and ASP (Architecture Support Package)
- Improved and widely independent multicore performance
- Enhanced handling for X86 and ARM architectures
- Improved Power Management

16. Partner Ecosystem:

SYSGO is committed to establish the technological and business partnerships that will help its customers to achieve their goals. SYSGO is currently working with about 100 partners worldwide. A list of available partner that help to enhance the value, can be found here:

<https://www.sysgo.com/partners/partner-directory/>.

An excerpt of partners per category is mentioned below:

- Board Vendors: Curtiss-Wright Controls Embedded Computing, Kontron, MEN or ABACO
- Silicon Vendors: NXP, Renesas, TI, Xilinx, Infineon, NVidia or Intel
- Software Partners: CoreAVI, Aicas, AdaCore, Esterel, RTI, PrismTech, Datalight, Systerel, Imagination Technologies or RAPITA
- Tool partner: Lauterbach, Vector Software
- Supported Architectures: ARM, PPC, X86 or Sparc (on request)

17. SYSGO Customer Support

SYSGO provides support in all phases of the product life cycle. Our products and services are used since more than 25 years in embedded devices. Our online SYSGO Support Network is available for standard and certifiable products.

Standard products come with “standard support” that provide analysis of reproducible errors in and malfunctioning of software developed by SYSGO and provision of known error corrections, as well as support in preparing work-around solutions. Optional “premium support” offers additionally direct ac-

cess to a dedicated support engineer and limited hours of consulting. Lastly “long term support” offers additionally a retaining ability to rebuild the selected frozen version, a limited number of consulting hours, a dedicated phone number and access to a wide data base of corrections, updates, demo programs and others.

Certified product versions profit from “product cert support” and “long term cert support” that includes safety and security bulletins that inform the customer of vulnerabilities or safety risks.

Customer support is reserved to customers owning a valid support-contract. For more information, please contact us under <https://www.sysgo.com/company/contact/> .

18.SYSGO Professional Services:

SYSGO is certified according to ISO9001 and ISO27001. Our engineering processes are assessed according to SPICE Level 3 and our professional services organization support customers in the fields of:

- Training
- Consulting
- Certification Services

Experienced in aerospace, defense or automotive our specialists are available to help with implementing or adapting software architectures and processes. Services include guidance for software installation and orientation, architecture design, assistance with creating security- or safety-critical code, BSP and driver migration and creation, software integration, legacy application and infrastructure migration, platform extensions, and process compliance.

For more information, please visit <https://www.sysgo.com>.

19.Available Documentation:

More detailed documentation is available in the SYSGO customer support area and can be provided under NDA. The documents are included in the product delivery and can be provided to customers for evaluation.

The available documents are:

- Release notes
- Installation manual
- User Manual
- Tutorials
- CODEO documentation
- Demonstrations