



Innovative tool suite and real-time kernel for mixed-critical embedded applications on multi-core

The only engineering solution enabling to reduce the hardware/software integration time by up to 90%

Hardware/software integration has become the bottleneck of real-time applications development. In fact, with the current RTOS programming models, it is very complicated to guarantee a predictable and reproducible execution. With parallel architectures, it becomes almost impossible to prove the

execution correctness because these programming models are too complex, non-deterministic and not scaling with the number of cores. They incur runtime overheads and often require tedious and costly handcrafted fine-tuning or micro-design of the scheduling.

ASTERIOS is the only engineering solution enabling to reduce the hardware/software integration time by up to 90% thanks to 3 major innovations: **a new formalism** to express parallelism and partitioning, **a new approach** to guarantee determinism and performance, and **a new tool suite** to automatically configure the real-time kernel.

A new formalism to express parallelism and partitioning

ASTERIOS provides a specific annotation to express timing constraints (e.g. deadline, jitter, etc.), spatial and temporal confinement, data flows and data exchange synchronization. These constraints can be periodic or non-periodic, regular or not.

Different clocking schemes, time based or event-based, can be combined to drive these temporal constraints. It has been demonstrated with industrial partners that as much as 95% of legacy C code can be reused.

AT A GLANCE

Integrated tools

- Project manager
- Exhaustive simulator
- Debugger
- Time budget configurator
- Formal timing description
- Target profiling
- ANSYS SCADE connector (MBSE)

Automatic runtime computation

- Optimal scheduling
- Data synchronization
- Time & memory partitioning
- Memory sizing
- Allocation of cores
- Margins availability

Real-Time Kernel

- No semaphore, no mutex
- Lock-free, wait-free
- ROM: 10 kB
- RAM: 2 kB
- ~5,000 SLOC
- Context switch: 200 cycles
- Preemptive without priority
- Guest-OS (e.g. Linux) cohabitation

Hardware support

- ARM, PowerPC, Aurix TriCore
- Single-core, Multi-core
- SMP, AMP architectures

Safety relevance

- DO-178C
- IEC-61508
- ISO-26262
- EN-50128



A new approach to guarantee determinism and performance

ASTERIOS includes a new generation Real-Time Kernel (no semaphore, no mutex, no priority) that produces top performances in all operational areas: low latencies, fast context switching, small memory footprint.

ASTERIOS RTK is a certifiable microkernel based on a pre-emptive and partitioned real-time kernel implementing lock-free and wait-free

communications, optimal calculated scheduling and scalable synchronized exchange of data.

Thanks to all these unique characteristics of **ASTERIOS RTK**, any applications always have a predictable and reproducible behaviour. Freedom from interference and determinism of the application are both ensured by construction.

A new tool suite to automatically configure the real-time kernel

ASTERIOS uses its specific annotations and hardware information (number of cores, MPU/MMU descriptors and timing budgets or CPU load margin) in order to automatically build, for single and multi-core processors, the complete configuration of **ASTERIOS RTK**. This is achieved through the generation of the runtime tables according to the temporal dynamic behaviour, budget information, task decomposition, etc.

This configuration covers the scheduling (locally optimal), the memory partitioning (tasks, buffers, and stacks), the memory sizing (buffers) and the core allocation. Moreover, the runtime table properties can be automatically checked to address certification objectives. Therefore, safety-critical real-time applications can be developed faster and certified easier with **ASTERIOS**.

As an option, the coupling of **ASTERIOS** with ANSYS SCADE (MBSE) is a unique solution on the market providing an integrated flow able to automatically calculate – from the Open System Description (OSD) – the dynamic behaviour of a multi-rate critical real-time application running on single- or multi-core platform.

ASTERIOS includes also a project manager, a code editor, an exhaustive simulator, a debugger, a scheduling editor and a target profiling tool. These rich features enable to create applications which can be incrementally architected, enriched, modified and verified, all on a desktop computer with simulation.

In particular the **ASTERIOS** simulator enables the validation of the runtime tables and the real-time architecture of the embedded application without the need for hardware target or emulator. It can also be used to simulate and debug the underlying applicative functional C code. The simulator provides detailed timing information in order to validate temporal behaviours that are guaranteed to be identical to those on the real target.



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Use case benefit examples with ASTERIOS

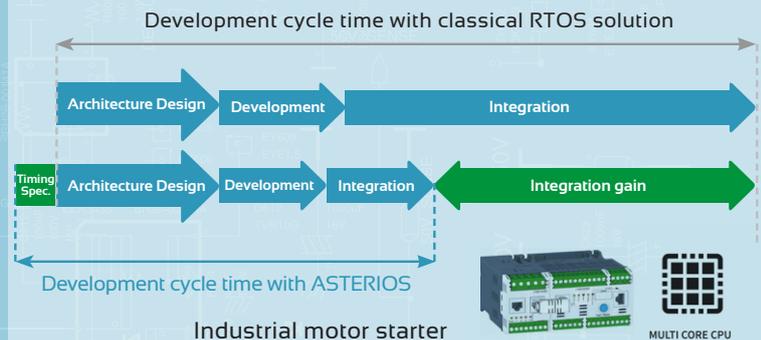
AEROSPACE

- 1 Typical development cost per aircraft program and per system \$8m to \$60m
- 2 Integration and Validation costs 25%
- 3 KRONO-SAFE cost reductions on I&V with ASTERIOS 90%
- 4 Total savings per system \$1.8m to \$13.5m

Command & Control systems for engine (FADEC)



INDUSTRIAL IOT



KRONO-SAFE serves markets in need for a safer and more efficient solution to develop complex real-time embedded applications. These extend to both well established markets such as aerospace, defense, automotive, industrial automation, transportation and new markets springing up where safety and security converge like the Industrial IoT.

ASTERIOS is the result of more than fifteen years of technology research with the French atomic energy commission (CEA). It builds upon an original technology

certified at the highest level of the IEC 60880 safety standard for the atomic energy

The ASTERIOS certification process for DO-178C DAL A is underway with a major aerospace industry partner.

This technology has been successfully validated over the past years with major industry leaders such as AREVA NP, DELPHI, SCHNEIDER ELECTRIC and SAFRAN on a variety of critical real-time multi-core systems.



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