



TELECOM Paris AADL tools portfolio for real-time systems virtual integration

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Virtual integration for real-time systems

■ Virtual integration:

- Functional integration → focus on “software in the loop” simulation (including the OS)
- Timing analysis → model-based computation of worst-case response time, communication delays, end-to-end latency

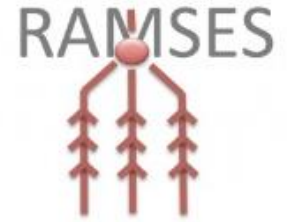
■ Methods and tools (not all shown on website):

- **RAMSES: Refinement of AADL Models for the Synthesis of Embedded Systems**
- **MC-DAG: Mixed-Criticality scheduling of Directed Acyclic Graph of tasks**
- **SEFA: Switched Ethernet Flows Analysis**
- AADL -BA: Behavior Annex frontend
- OSATE-CLI: Command Line Interface for OSATE
- Workflow management tool for model processing
- RDAL: Requirements Definition and Analysis Language

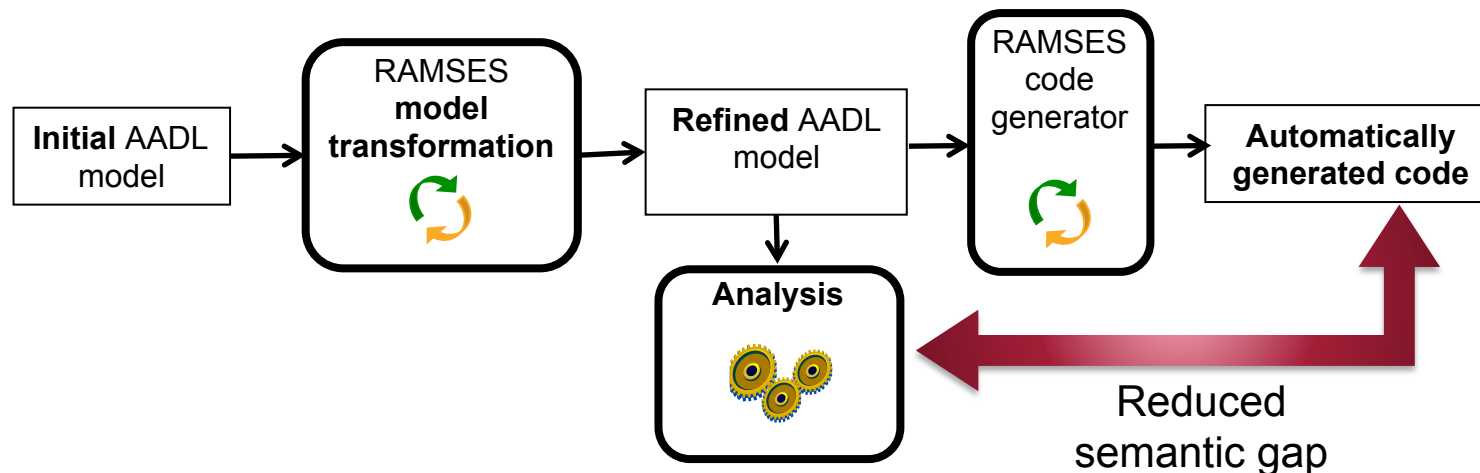
■ Tools webpage:

<https://mem4csd.telecom-paristech.fr/>

RAMSES: Refinement of AADL Models for the Synthesis of Embedded Systems



■ RAMSES approach

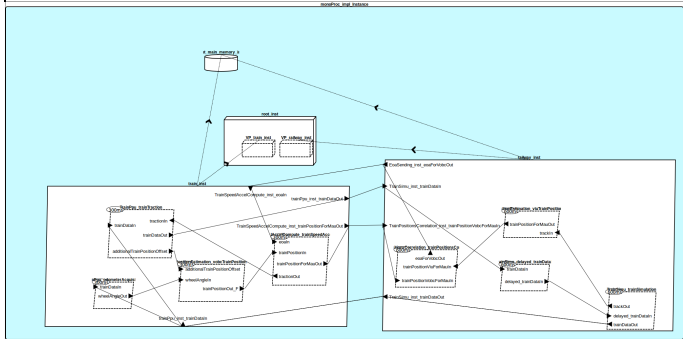


■ Add-on tool to OSATE (latest version)

■ Webpage (installation instructions, examples...):

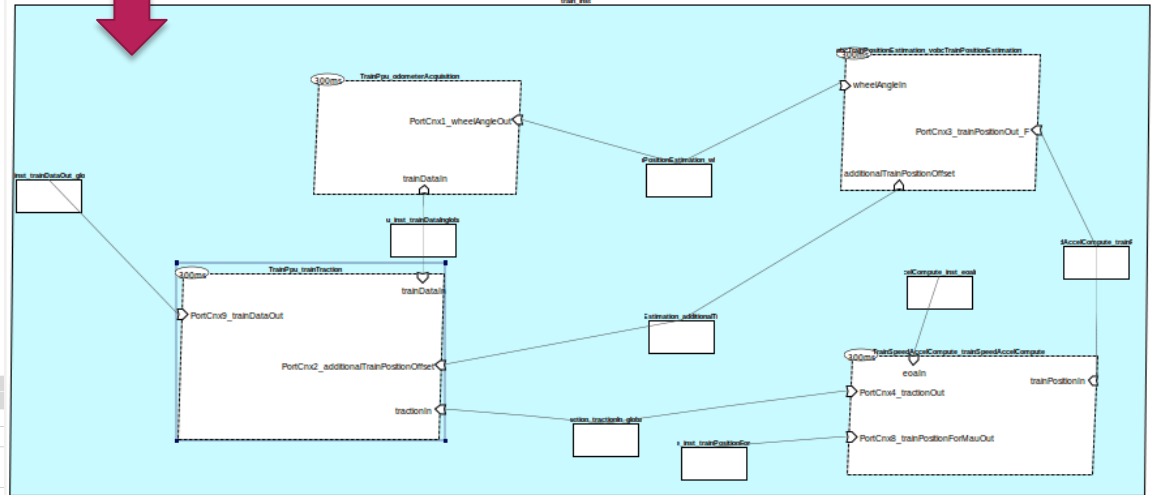
<https://mem4csd.telecom-paristech.fr/blog/index.php/ramses/>

Virtual integration: combine model transformations and analysis

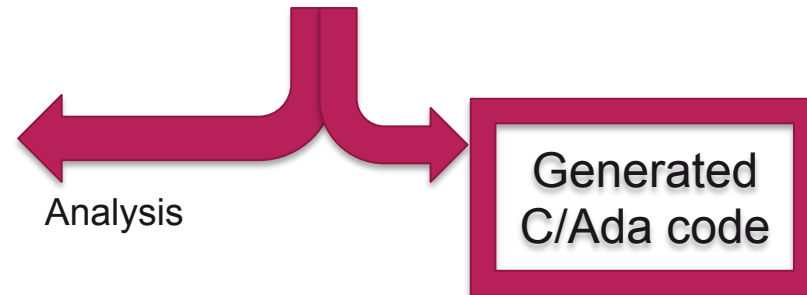
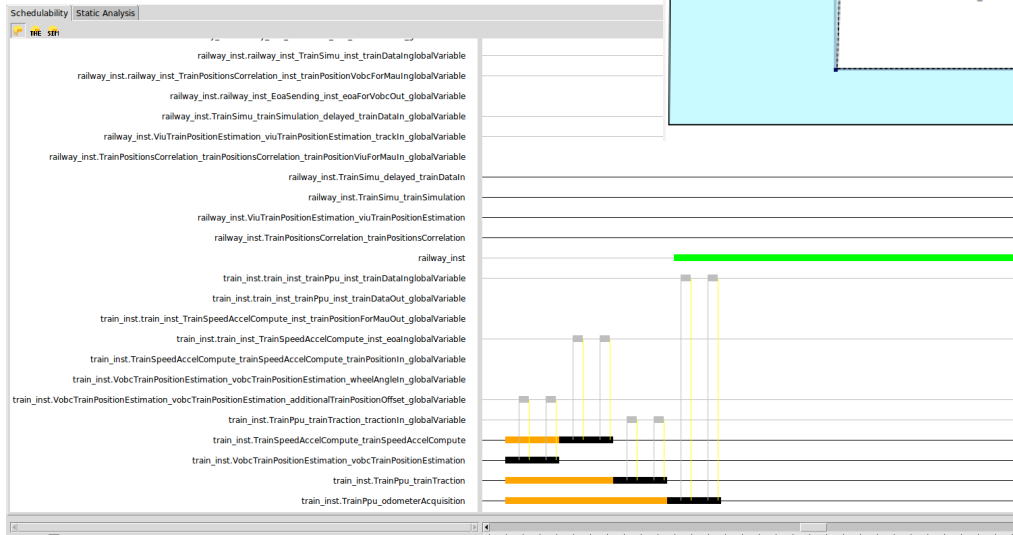


Design model

Refinement
AADL to AADL/ARINC653 model transformation



Implementation model



Virtual integration: automated code generation (simulation and deployment)

■ Supported platforms

- POSIX (Linux)
- ARINC653
 - POK: <https://pok-kernel.github.io/>
 - VxWorks: <https://www.windriver.com/products/vxworks/>
- OSEK
 - nxtOSEK: <http://lejos-osek.sourceforge.net/>

■ Supported for distributed systems on POSIX and ARINC653 (POK) systems

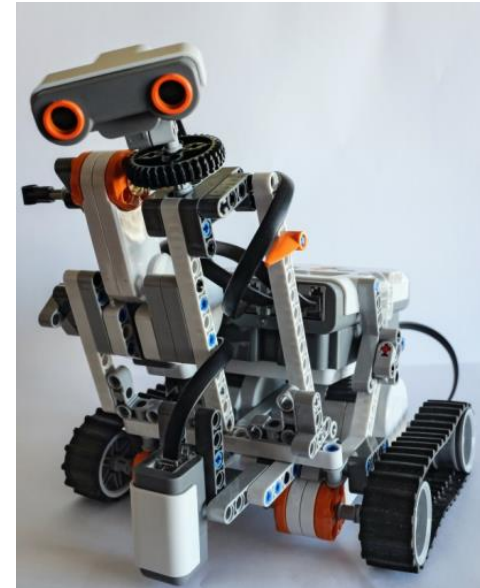
■ Support for local modes management

■ Used by SAFRAN in R&D activities; potential technological transfer.

- Experimented on a distributed system (6 processors, 21 applications)
- Support for most of the concepts of AADL (thread group, feature groups, etc.)

Demo with a toy example: Lego Mindstorm Robot

- **Automatic C code generation from AADL models with RAMSES**
 - NXT OSEK OS
- **Analysis**
 - Model based execution time extraction
 - Response-time analysis with *AADL Inspector*
- **Well documented example**
 - Tutorial¹ (MPM4CPS training school)
 - Mindstorm hardware developer kit
 - OS: NXT OSEK (<http://lejos-osek.sourceforge.net/>)



¹ <https://mem4csd.telecom-paristech.fr/blog/index.php/mpm4cps-training-school/>

Mixed-Criticality DAG Scheduling on Multi-Core Architectures

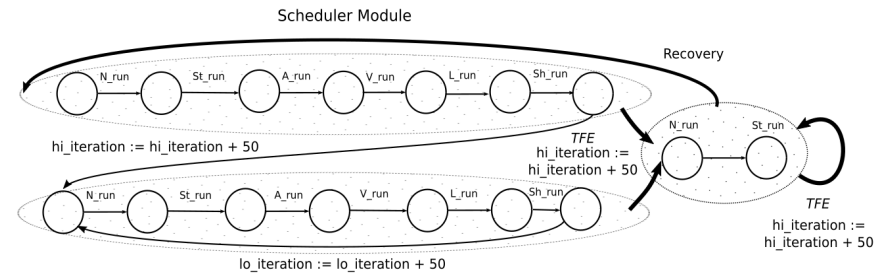
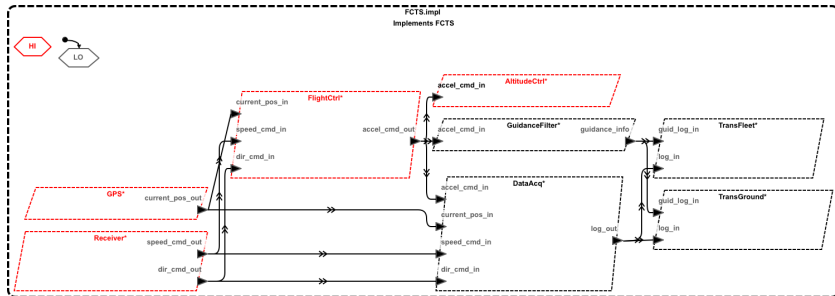
- Mixed Criticality DAGs representation in AADL:
 - Immediate connections
 - Modes
 - Criticality levels properties

- Associated publications:
 - *Scheduling Multi-Periodic Mixed-Criticality DAGs on Multi-Core Architectures*, Medina et al., RTSS 2018.
 - *Availability enhancement and analysis for mixed-criticality systems on multi-core*. Medina et al., DATE 2018

- Integrated into RAMSES (simulation on POSIX)

- Other deterministic MOCC supported with a lock free implementation:
Periodic delayed communications
 - *Deterministic Implementation of Periodic-Delayed Communications and Experimentation in AADL*. Cadoret et al., ISORC 2013

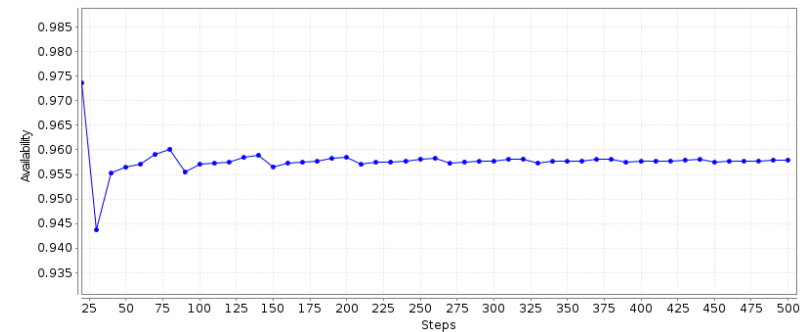
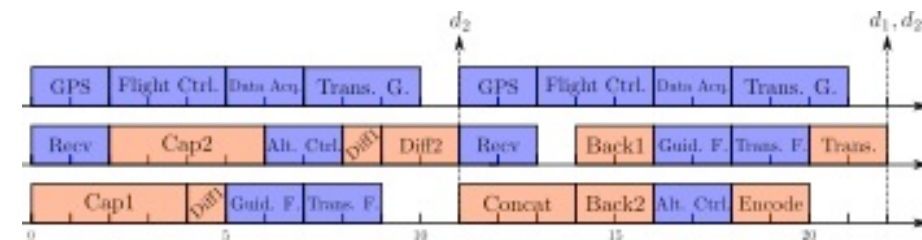
MC-DAG Scheduling: Mixed-Criticality UAV Example



1. Schedule tables production

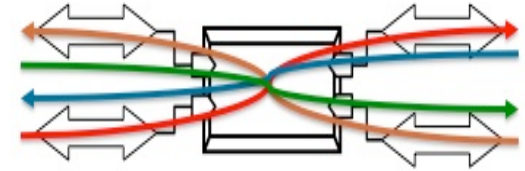
RAMSES

2. Probabilistic automaton

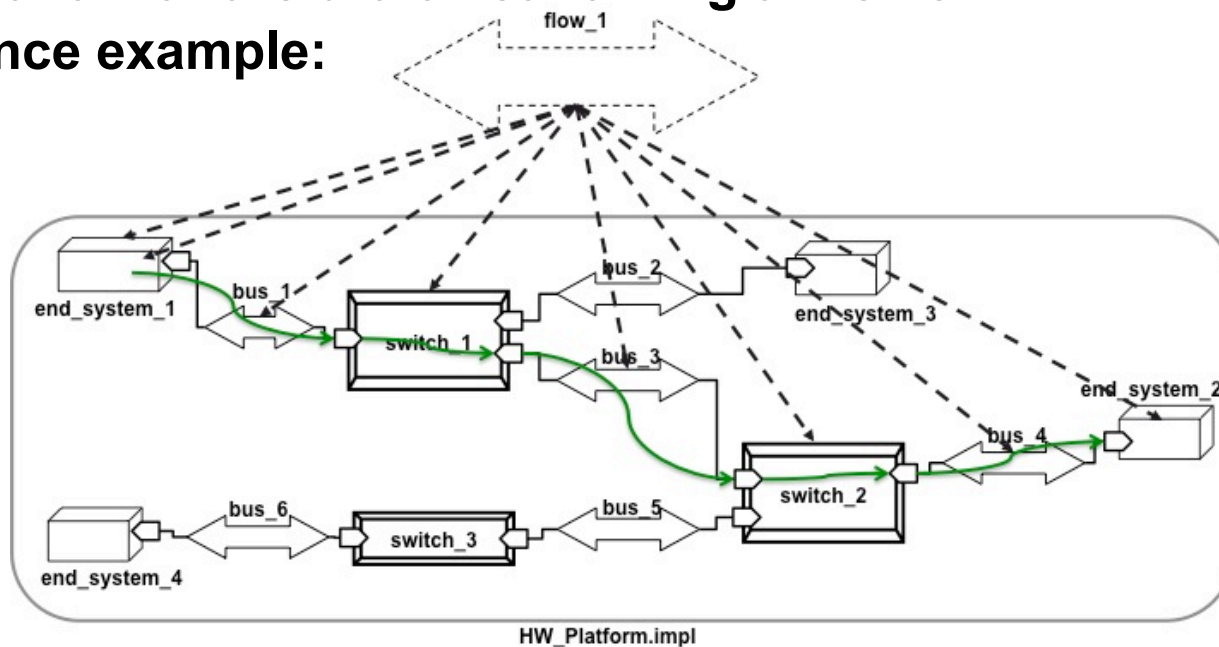


4. Code generation

Switched Ethernet Flows Analysis (SEFA)



- Implementation of the trajectory approach to compute the worst-case communication latency on AFDX networks
- Compliant with the draft Networking annex of AADL
- Reference example:



- Used by ALSTOM and SAFRAN in R&D activities

<https://mem4csd.telecom-paristech.fr/blog/index.php/switched-ethernet-flows-analysis/>

MEM4CSD: Model-based Engineering Methods for Complex Systems Design

■ Tools webpage:

<https://mem4csd.telecom-paristech.fr/>

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Welcome to my booth for a demo/discussion!

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