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Experimentation of MARTE in the Industry

An early adopter case study

Sébastien Demathieu
Thales Research & Technology
[sebastien.demathieu@thalesgroup.com]

MARTE fosters model-based design of real-time and embedded systems in Thales

- Why we need a UML profile for Real-Time and Embedded
- Involvement of Thales in the definition of MARTE
- Case study: a generic Flight Management System
- Applying MARTE to design a generic FMS

UML MARTE

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Why we need a UML profile for RTE

UML is emerging as a possible solution to address the Real-Time and Embedded domain

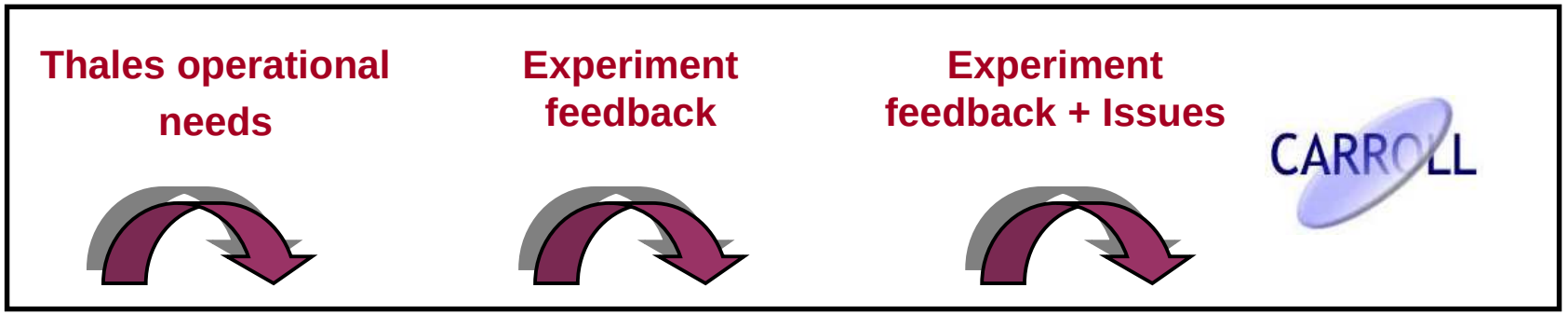
- A large audience in the Software Engineering community
- Extension capabilities through UML profiles (e.g. SysML)
- But lacks key notions to fully address RTE specifics (time, resource, scheduling)

Previous attempts to adapt UML to the RTE domain

- Academic initiatives
- Commercial tools: ARTiSAN, Rational Rose RT, Rhapsody (Real-Time UML)
- UML profile for Scheduling, Performance and Time (SPT)
  - The first OMG adopted specification in this domain
  - Defines annotation mechanisms to perform quantitative analysis
  - Required major improvements over time

Extensions to UML 2 are required to deal with modeling and analysis of Real-Time and Embedded systems

Involvement of Thales in MARTE



Request For Proposal definition — 02 / 2005

Initial Submission — 10 / 2005

Revised submission adopted by TC — 06 / 2007

Finalization Task Force — Today

First experiments on software design

SYSTEM@TIC PARIS-REGION Pôle de compétitivité

Experiments on platform modeling + Scheduling analysis

Next steps:

Deployment of MARTE

Application to Systems Engineering

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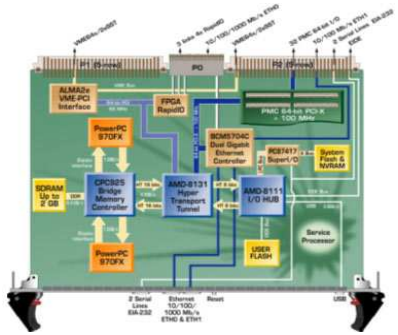
The case study: a generic FMS (1)

A software-intensive avionics system

- Automated navigation (guidance for related devices: AP / FD / ATH)
- Lateral and vertical trajectory optimizations
- Fuel consumption and forecast
- Flight data display

A safety-critical, hard-real time, embedded system

- Strict latency on processings and communications
- Strict jitter constraints
- Dimensioning of buses, FIFOs and CPU power



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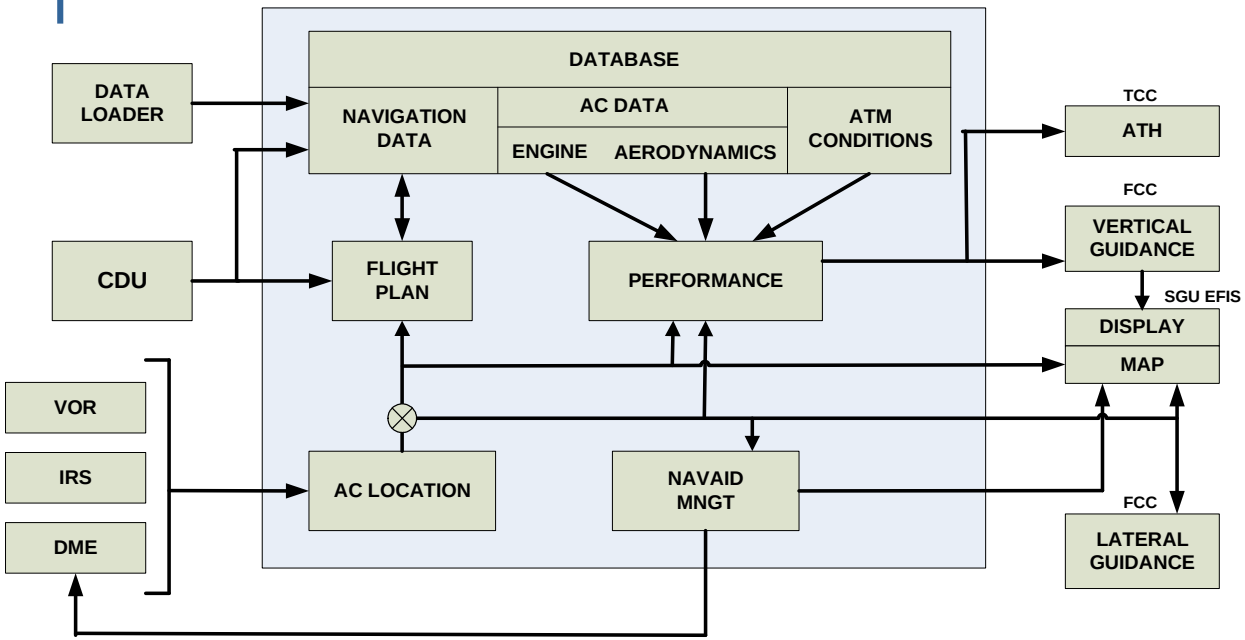
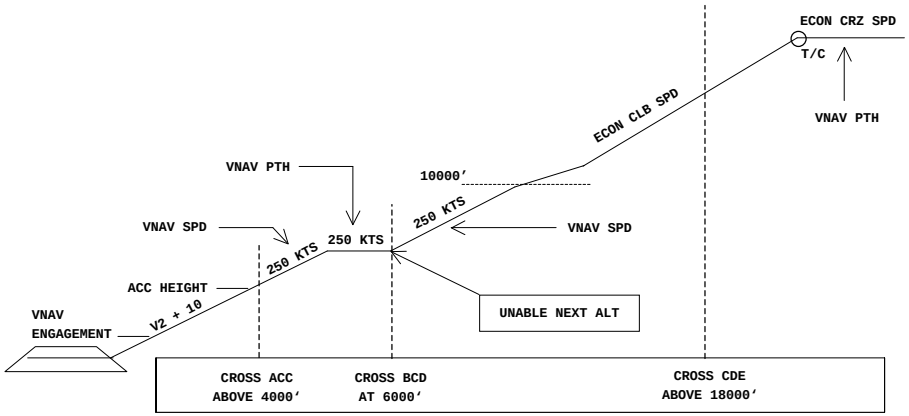
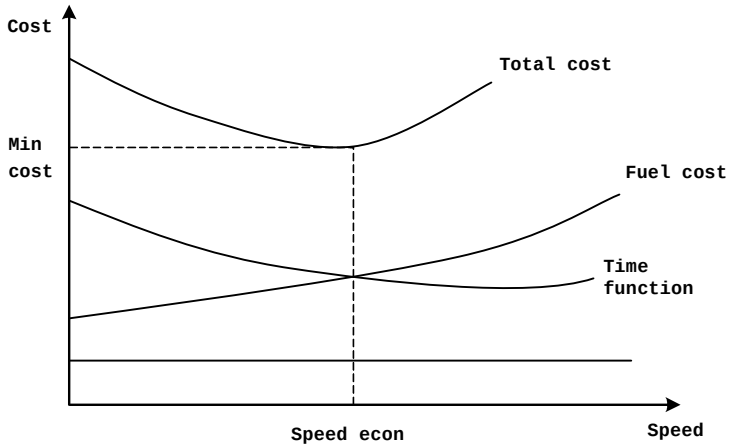
The case study: a generic FMS (2)



FMS block diagram



Lateral and vertical navigation



Fuel consumption / cost index

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Tool support

Early experiments of MARTE required to develop our own tooling

- MARTE profile implemented in various UML tools (Rhapsody, IBM RSA, MagicDraw)
- Value Specification Language (VSL) editor consolidated from Papyrus
- RapidRMA gateway developed for model-based scheduling analysis

Tools integrated through Eclipse / EMF / UML2

Implementation of MARTE for RSA available in open source (EPL)

- OMG MARTE web site: http://www.omgmarte.org

Experimentation highlights

System context definition

- Use case overview
- Time constraints on performance scenarios
- Types and units

System design

- Logical decomposition (structure, behavior)
- Physical decomposition (resources)
- Allocation

Scheduling analysis

- Building scheduling analysis model
- Validate system scheduling with RapidRMA

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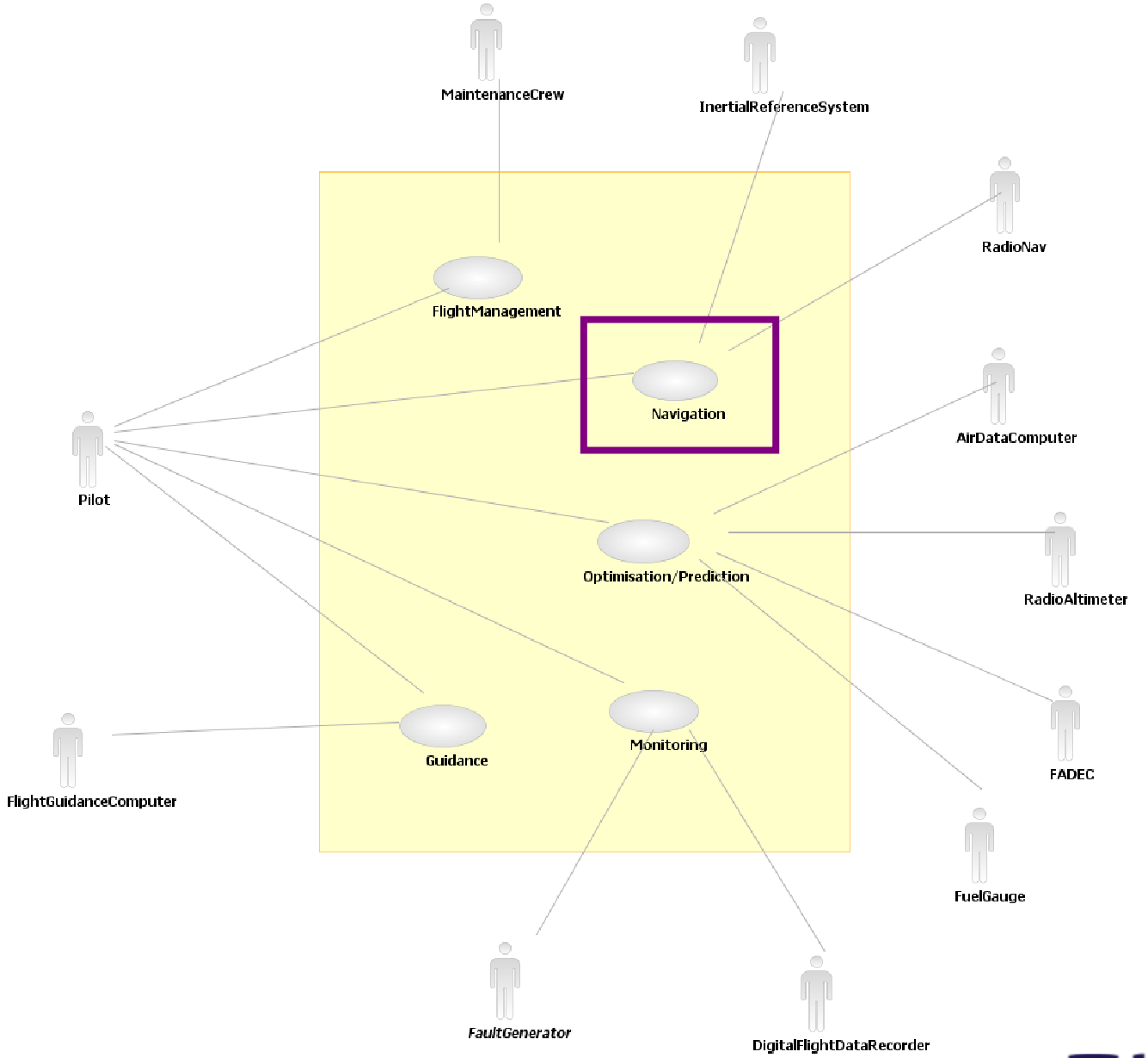
Context and use cases



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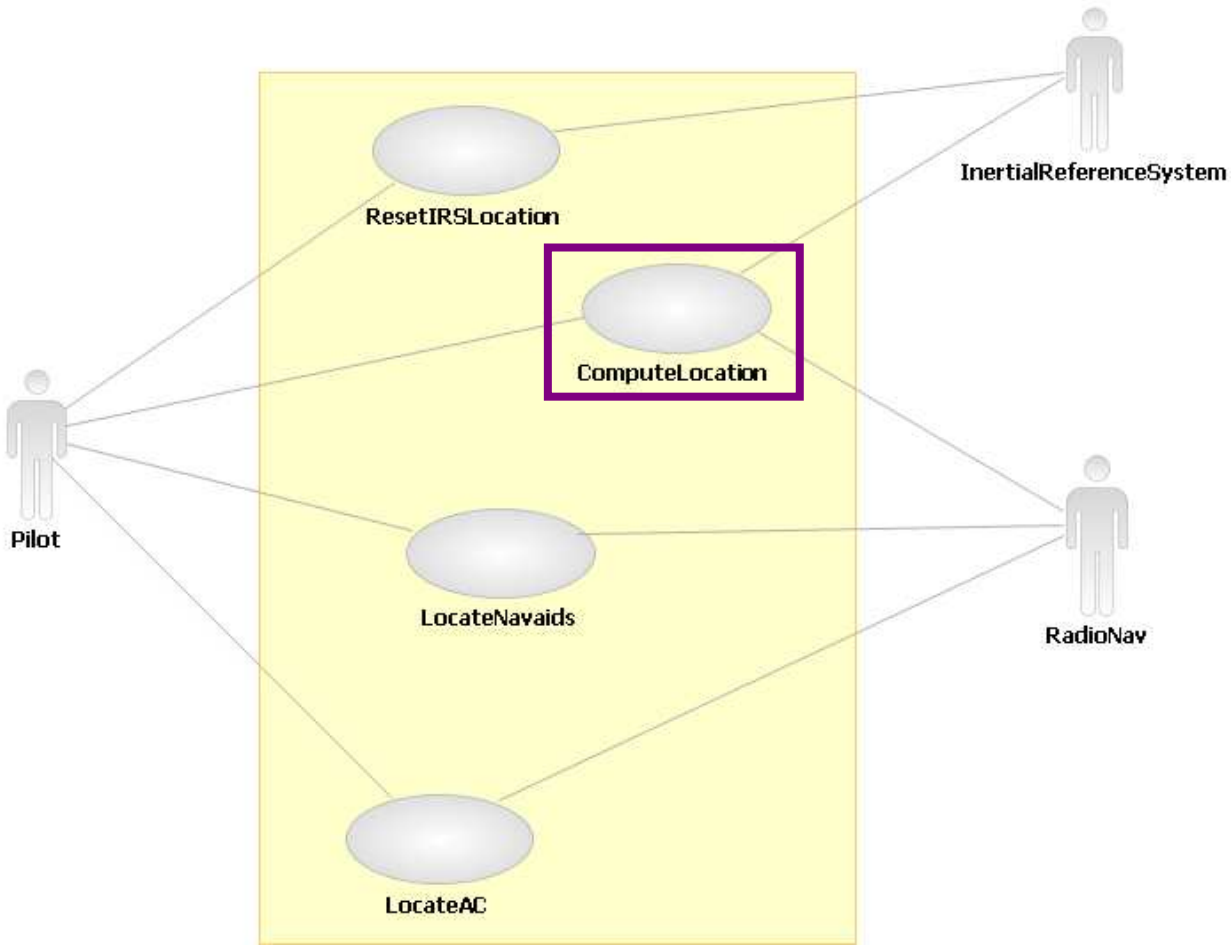

Navigation use cases

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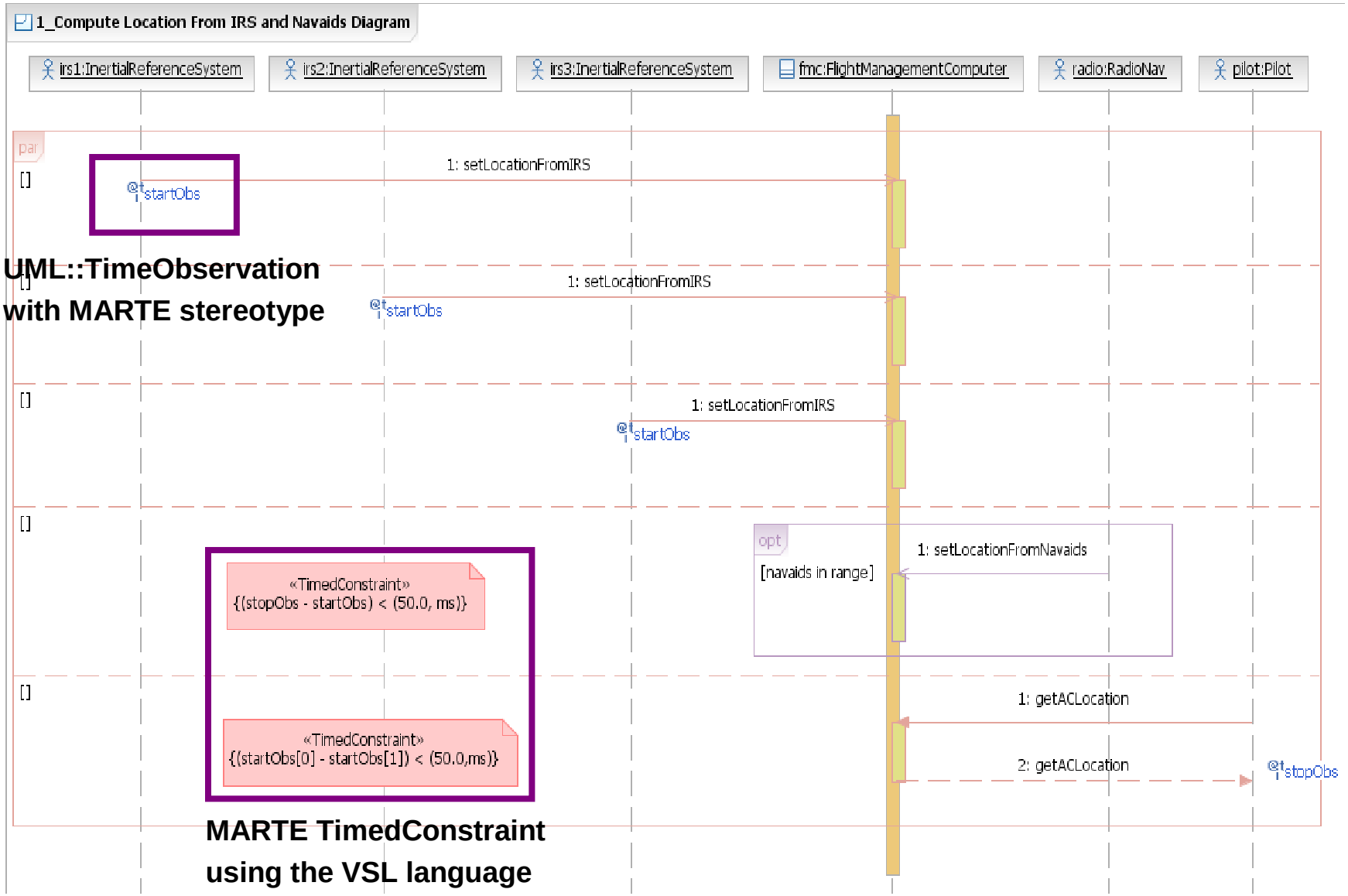
Time constraints on performance scenarios



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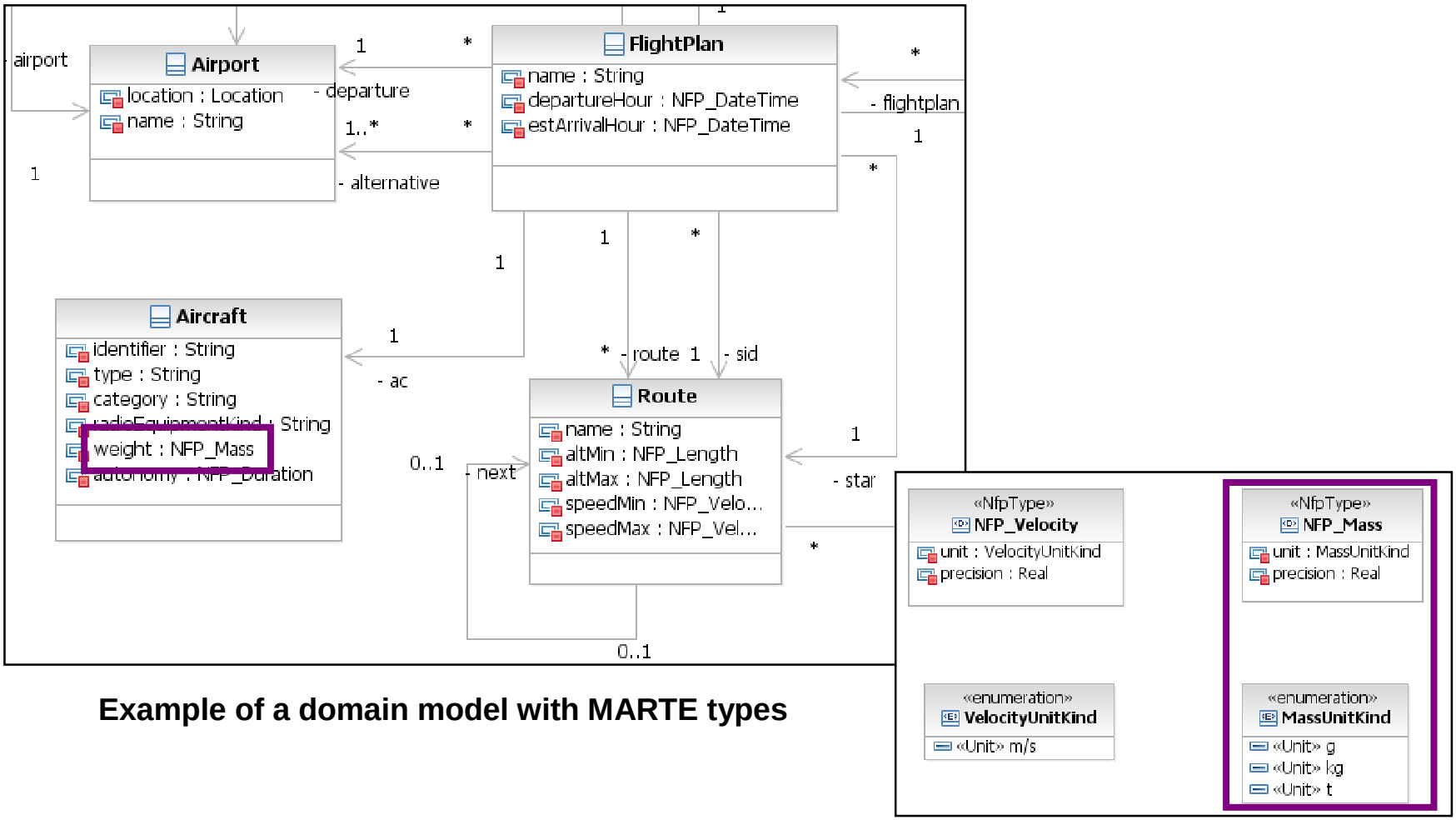
Types and units



Example of a domain model with MARTE types

User-defined types and units that extend the MARTE Library

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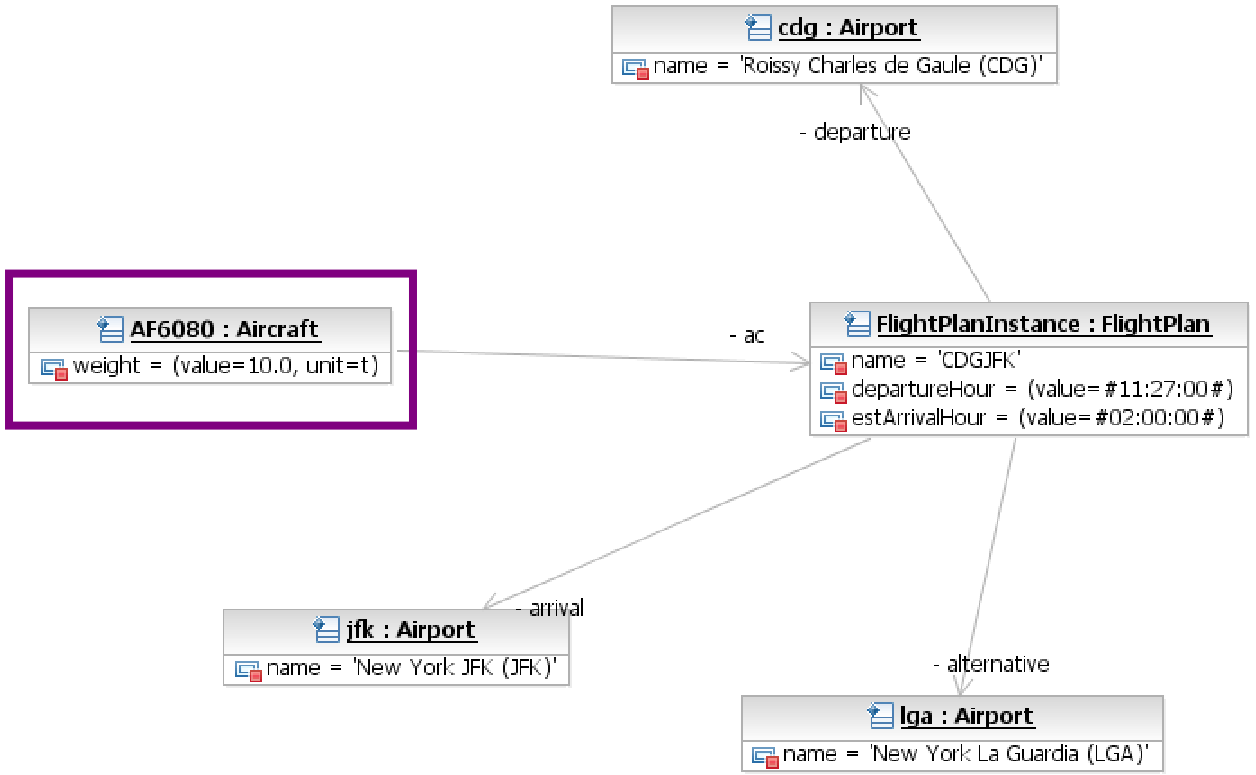
Using types and units in VSL expressions



Units and types used along with value specifications

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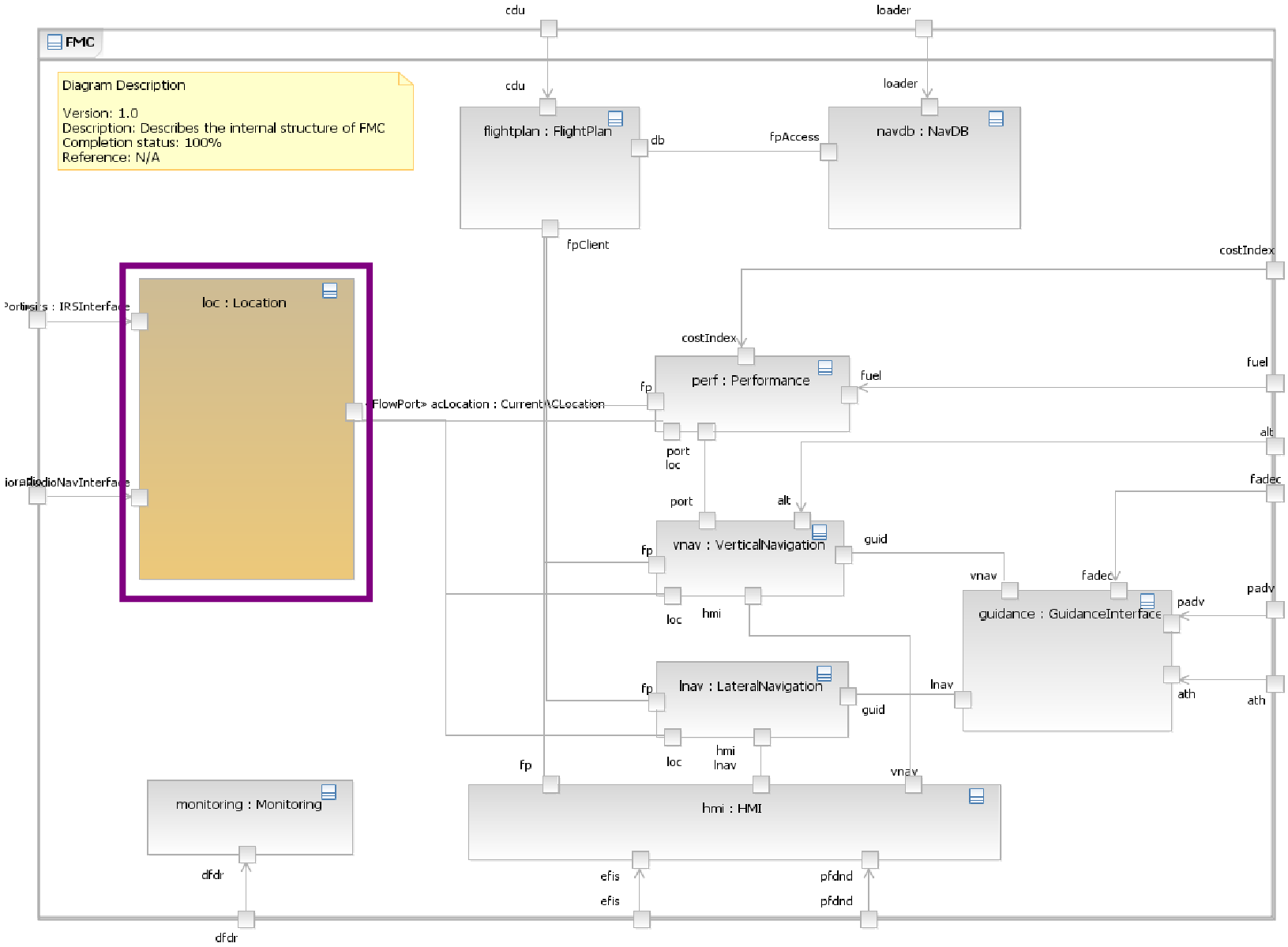
Logical decomposition (structure)



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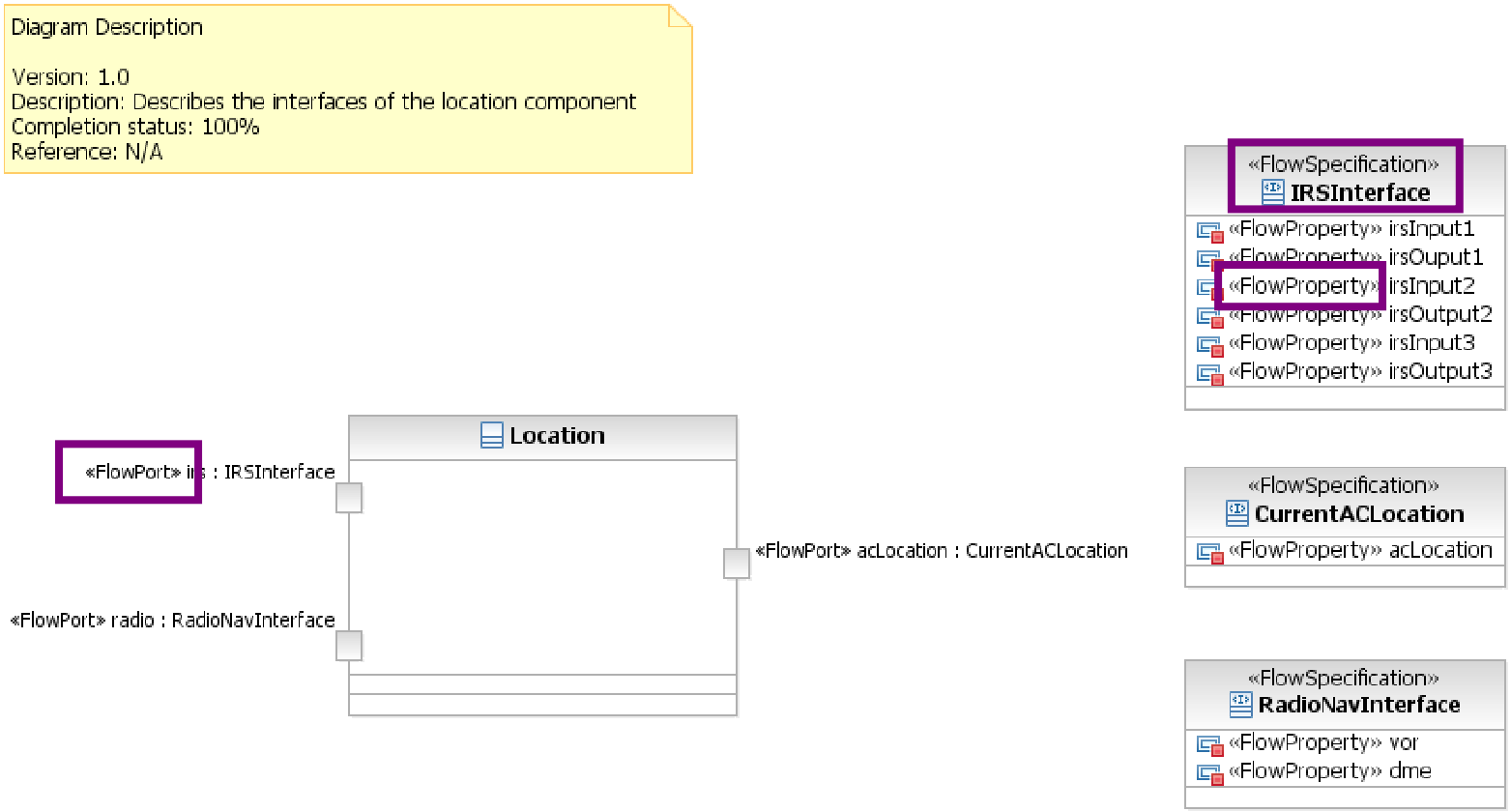

Flow-related concepts inspired from SysML

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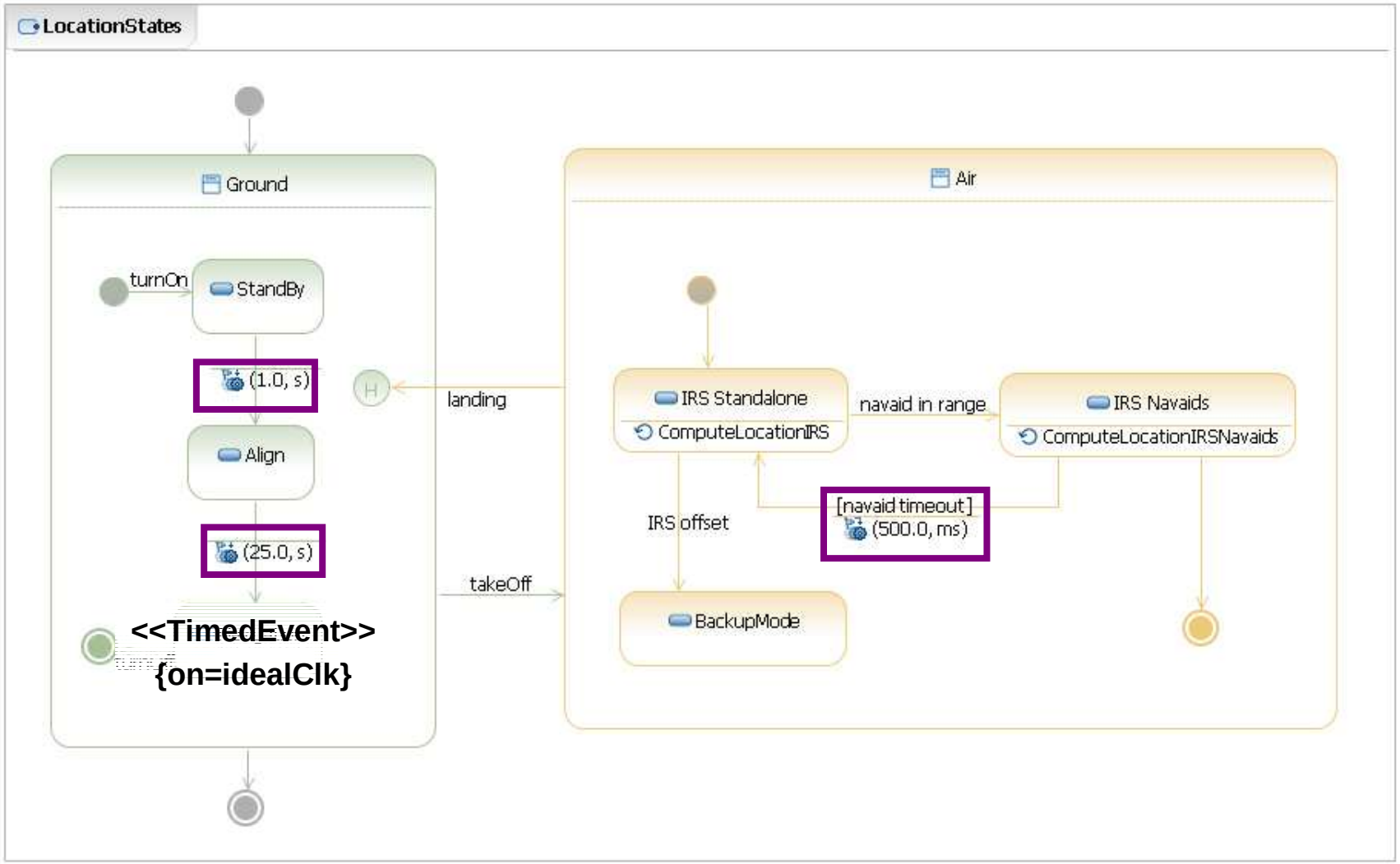
Logical decomposition (behavior)



Time-triggered transitions (relies on physical time in this example)

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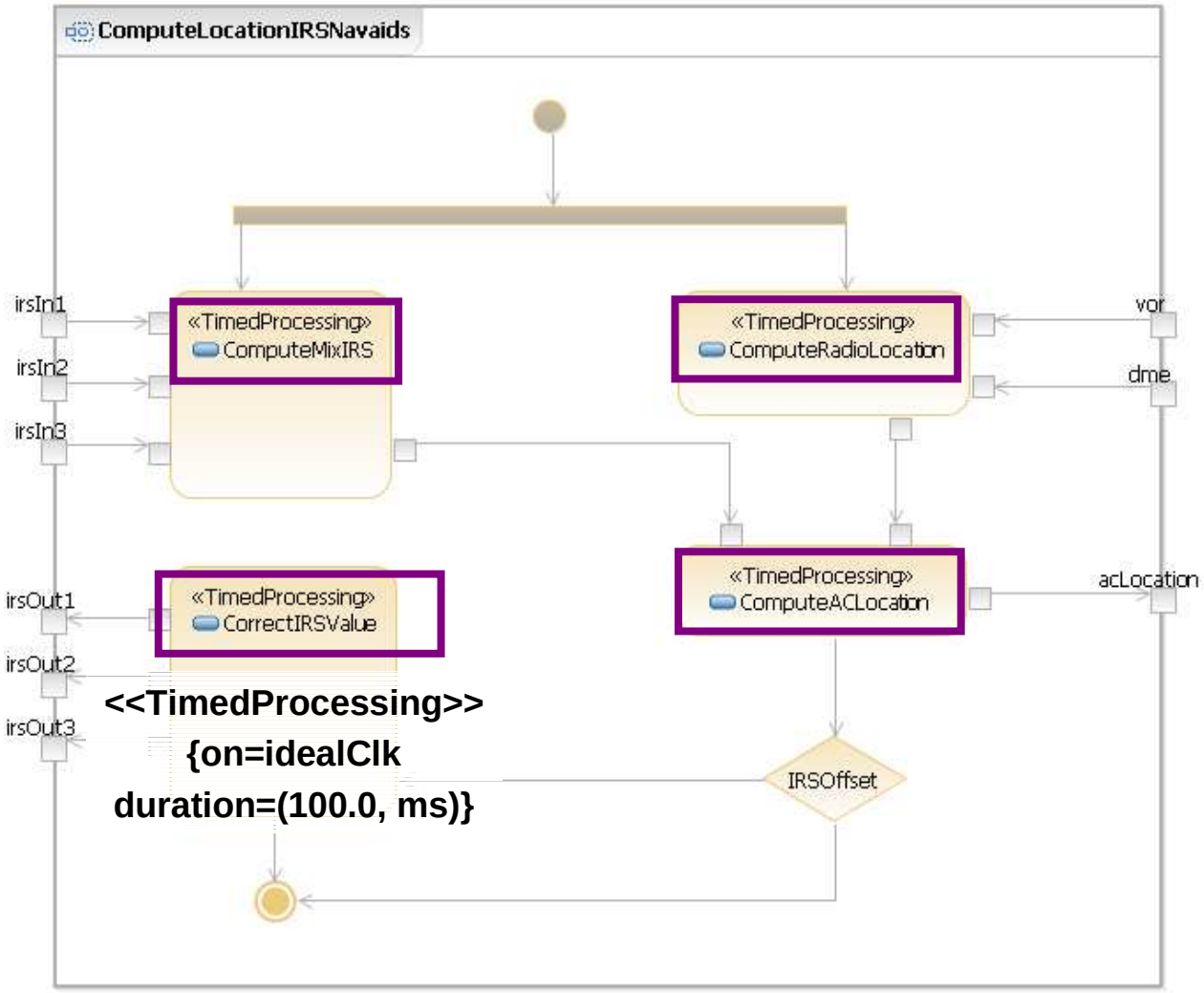
Logical decomposition (behavior)



Timed processings (with a duration) in an activity diagram

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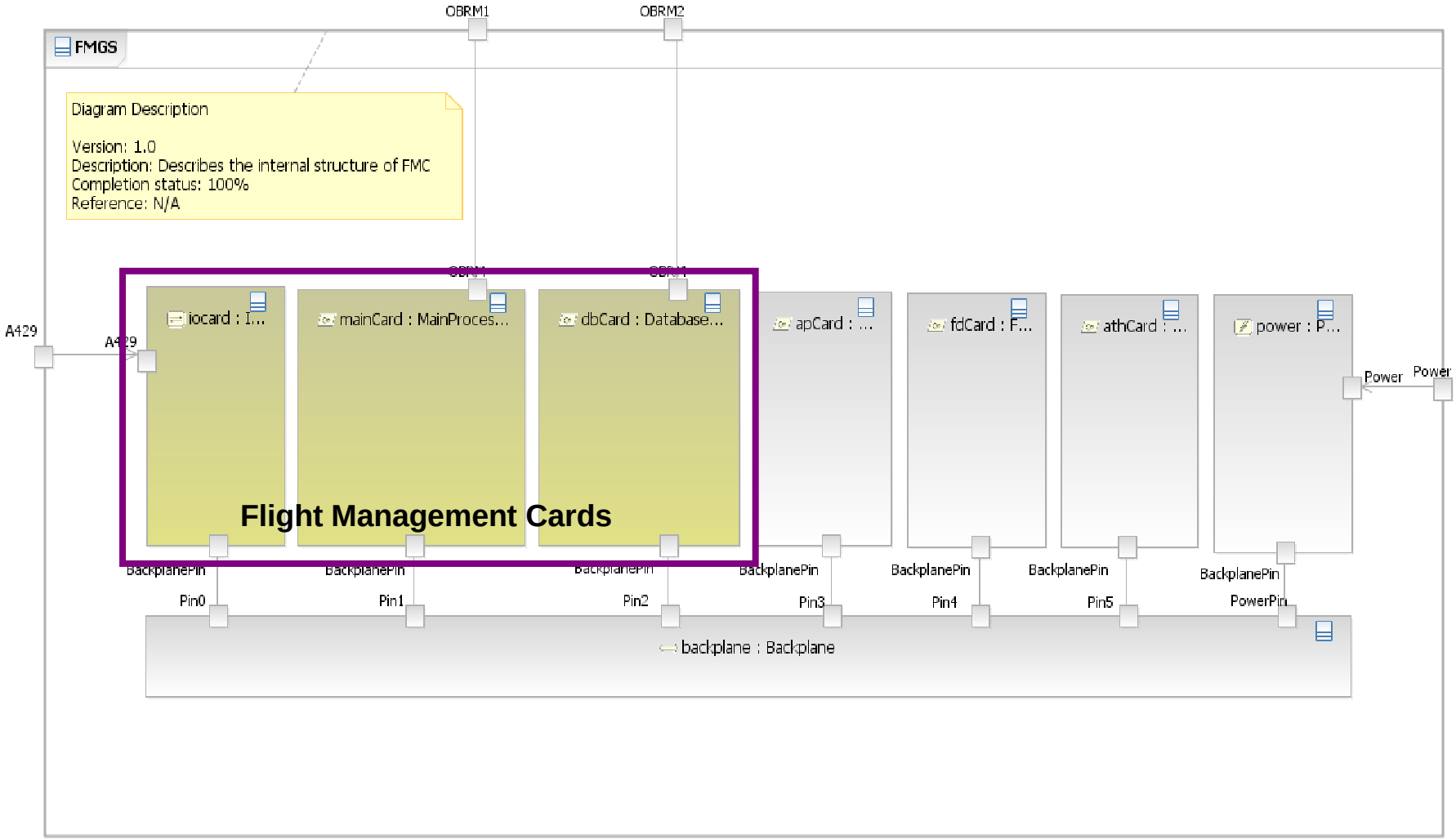
Physical decomposition (hardware)



Top-level decomposition of the Flight Management and Guidance Computer

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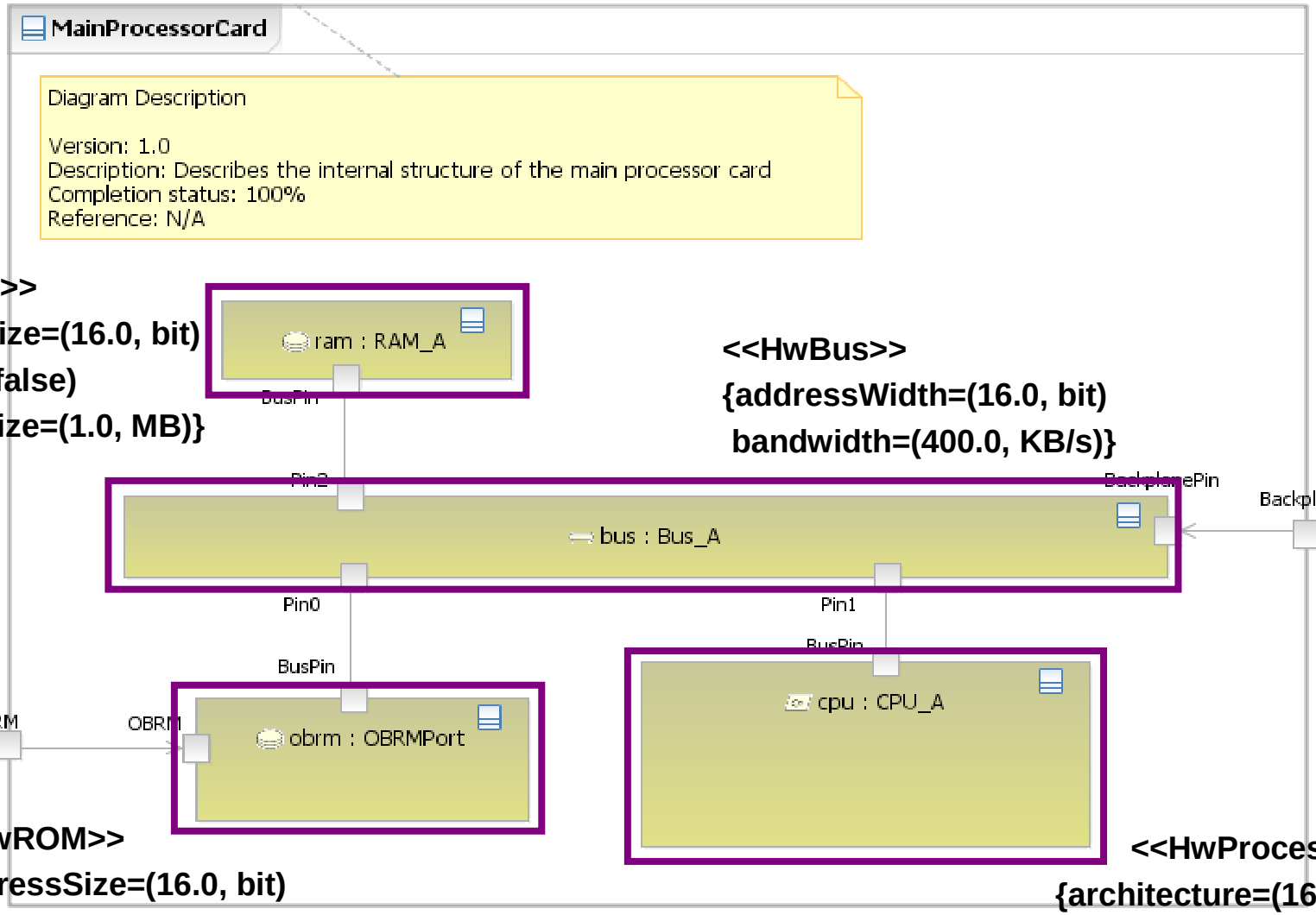
Physical decomposition (hardware)



<<HwRAM>>
{addressSize=(16.0, bit)
isStatic=(false)
memorySize=(1.0, MB)}

<<HwBus>>
{addressWidth=(16.0, bit)
bandwidth=(400.0, KB/s)}

<<HwROM>>
{addressSize=(16.0, bit)
memorySize=(512.0, KB)}

<<HwProcessor>>
{architecture=(16.0, bit)
frequency=(4.0, MHz)}

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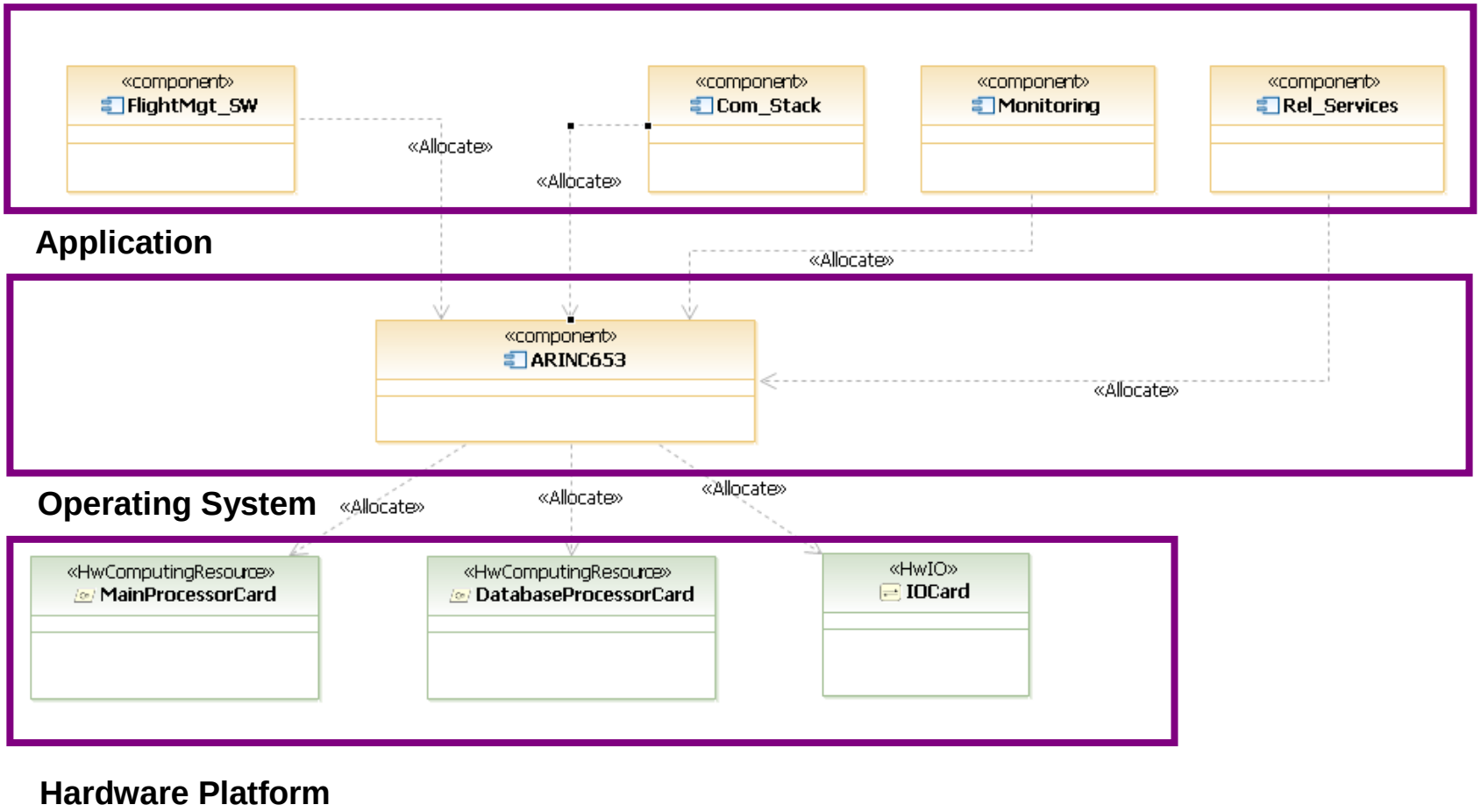
Physical decomposition (software artifacts)



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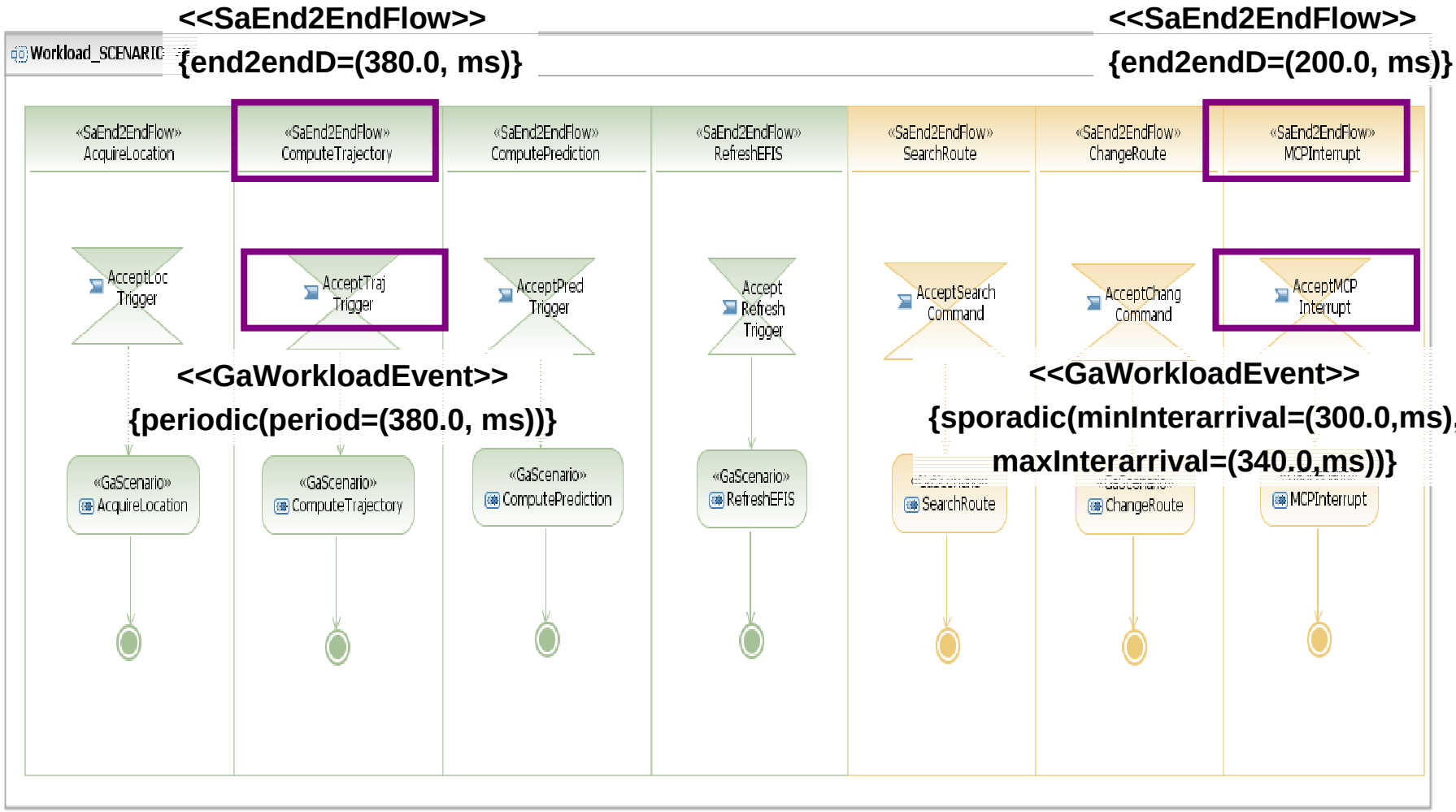
Scheduling analysis (workload)



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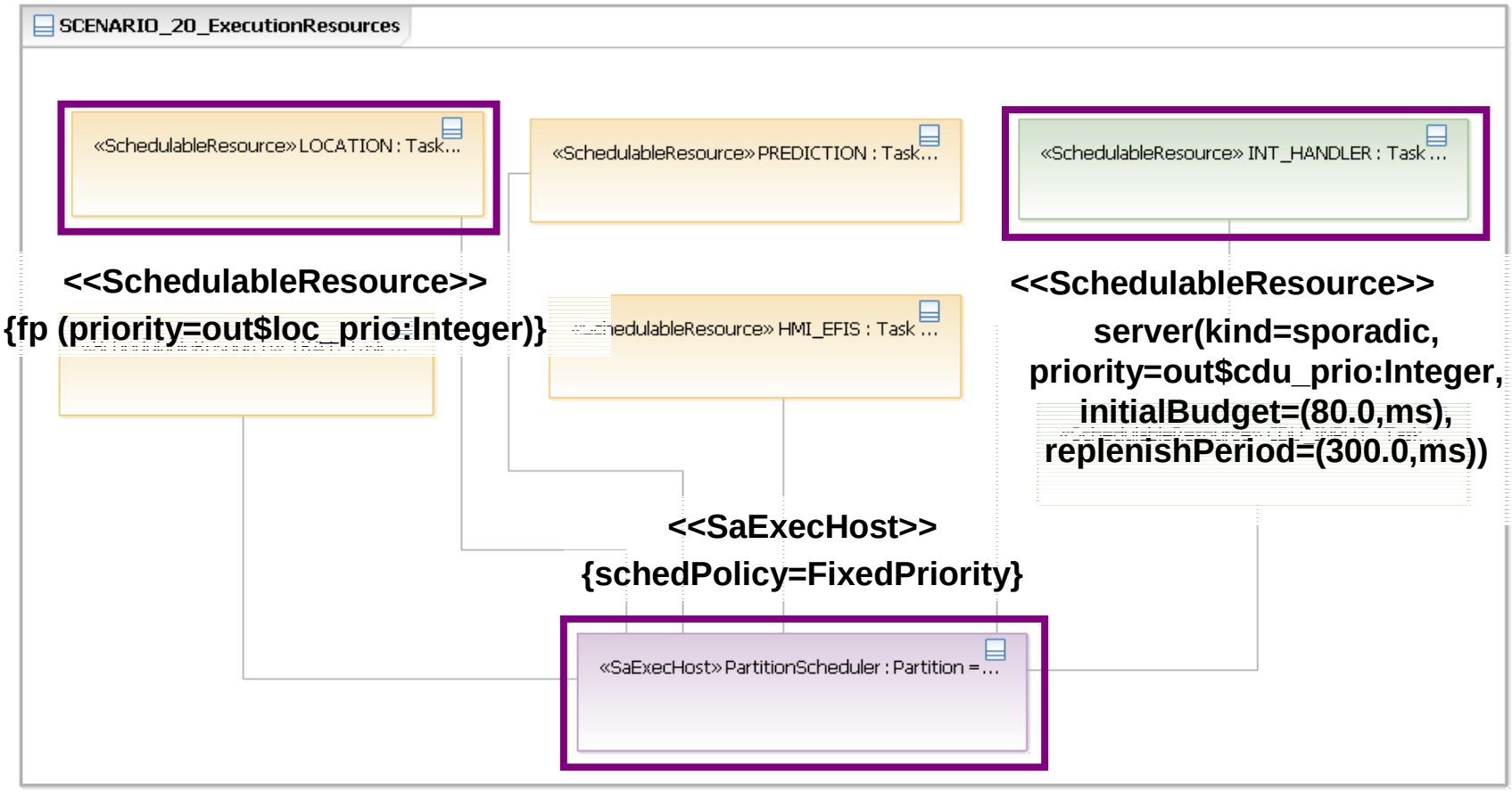
Scheduling analysis (resource)



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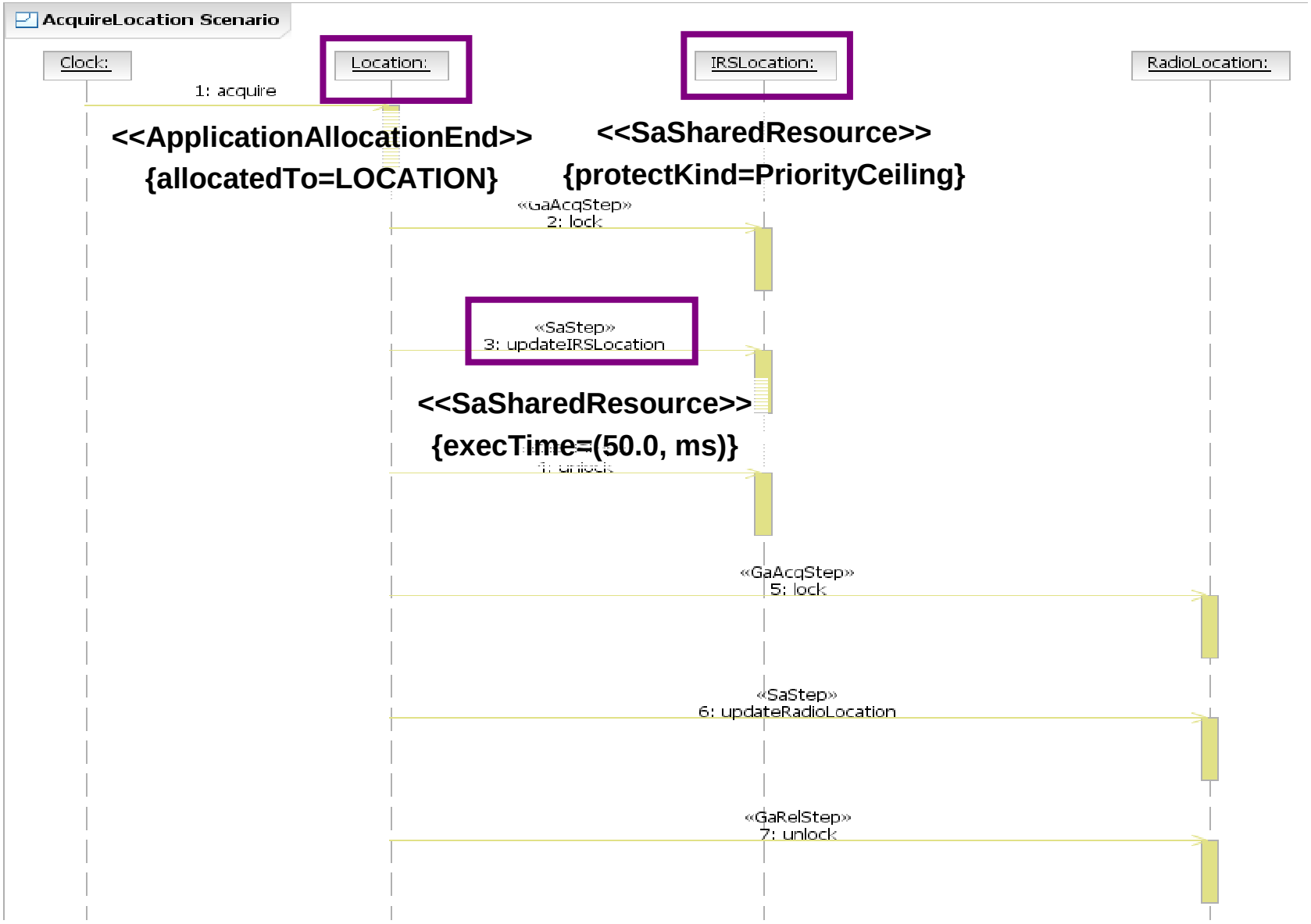
Scheduling analysis (scenario)



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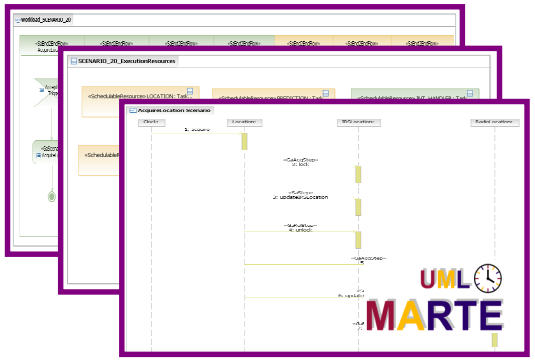
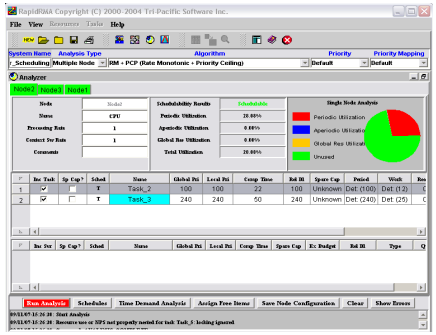
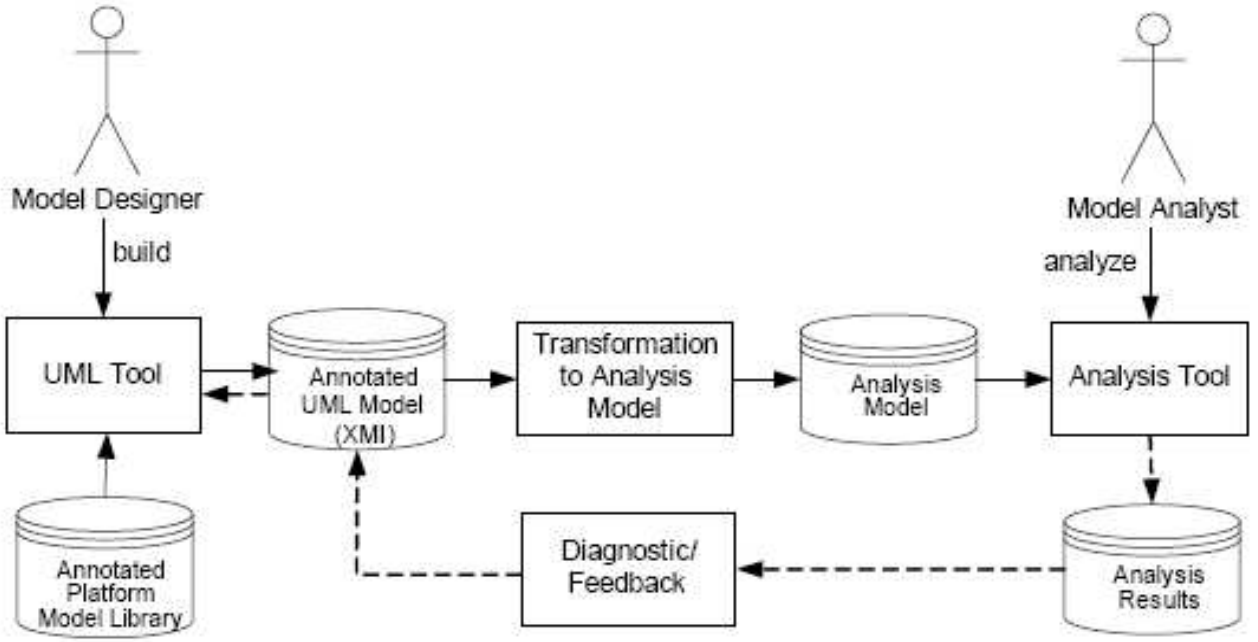
MARTE to TriPacific RapidRMA





Compute a schedule for tasks in a partition

Help dimensioning the sporadic servers



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Conclusion

MARTE has provided the necessary support for modeling and analyzing our system

- Modeling Time and NFPs
- SW / HW platform design
- RMA scheduling analysis

UML and MARTE are key enablers for model-based analysis and early validation

We are eager to see tool vendor implementations of MARTE