An Approach for Execution of MARTE-based Application Models

Workshop on Distributed Object Computing for Real-time and Embedded Systems

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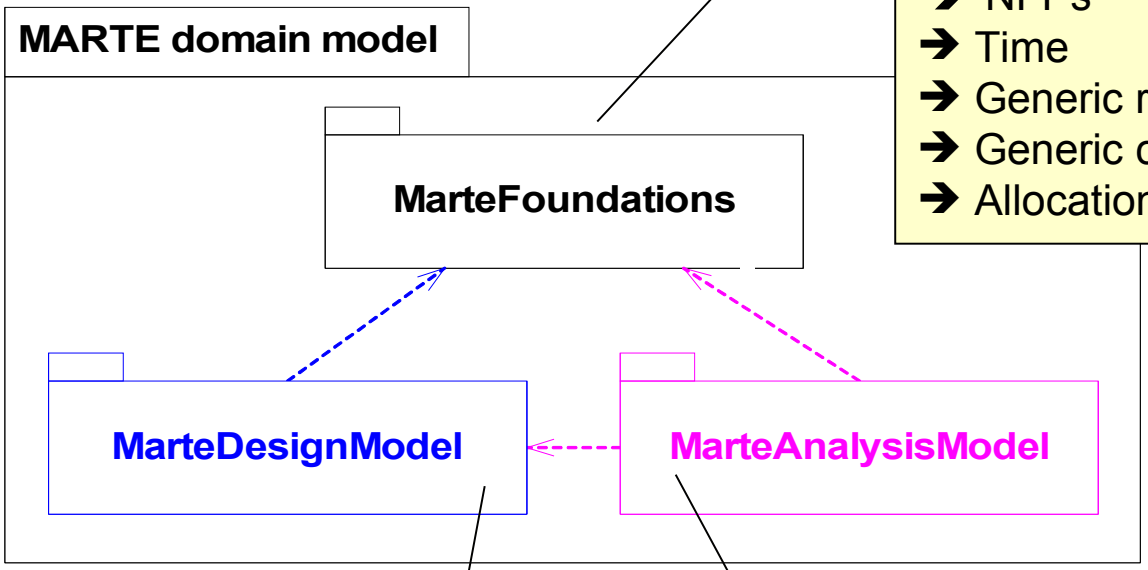
MDE for real-time applications

- A modeling language
  - Capturing real-time specificities in models
    - UML
    - Specialization for real-time domain : MARTE
- A modeling methodology
  - Modeling rules
  - Well formed models
- A tool support
  - Modeling real-time applications
    - Modeling language editors
    - Methodology rules tooling
  - Executing real-time models
    - Execution framework

Agenda

- UML profile for MARTE
  - A Real-time MoCC
- Accord approach
  - A modeling methodology
  - An execution framework for DRES
- MARTE models execution
  - Mapping of MARTE models to an execution platform
- Conclusions

UML profile for MARTE Overview



Foundations for RT/E systems modeling and analysis:
- ➔ CoreElements
- ➔ NFPs
- ➔ Time
- ➔ Generic resource modeling
- ➔ Generic component modeling
- ➔ Allocation

Specialization of MARTE foundations for modeling purpose (specification, design, …):
- ➔ RTE model of computation and communication
- ➔ Software resource modeling
- ➔ Hardware resource modeling

Specialization of foundations for annotating model for analysis purpose:
- ➔ Generic quantitative analysis
- ➔ Schedulability analysis
- ➔ Performance analysis

MARTE model of computation

- High-level modeling concepts for RT/E design
  - Qualitative aspects
    - E.g. concurrency and behavior
  - Quantitative aspects as real-time feature
    - E.g. deadline or period
- Allows expressing real-time constraints on component interfaces and connectors
  - Applicable whether component are active or passive
- For active components, introduces specific models of computation
  - Currently, active objects (e.g. Rhapsody, Rose RT, Accord)
  - Alternative MoCC can be defined using the MARTE foundations

MARTE model of computation (cont.)

- Provides high-level concepts for modeling qualitative real-time features on classes / structured classes / components
  - Real-Time Unit (RTUnit)
    - Specialization of the Active Objects of the UML 2
    - Owns at least one schedulable resource
    - Resources are managed either statically (pool) or dynamically
    - May have operational mode description (similar to AADL modes)
  - Protected Passive Unit (PPUnit)
    - Specialization of the Passive Objects of the UML2
    - Requires schedulable resources to be executed
    - Supports different concurrency policies (e.g. sequential, guarded)
    - Policies are specified either locally or globally
    - Execution is either immediateRemote or deferred

MARTE model of computation (cont.)

- Provides high-level concepts for modeling quantitative real-time features on classes / structured classes / components
  - Real-Time Behavior (RtBehavior)
    - Message Queue size and policy bound to a provided behavior
  - Real-Time Feature (RTF)
    - Extends UML Action, Message, Signal, BehavioralFeature
    - Relative/absolute/bound deadlines, ready time and miss ratio
  - Real-Time Connector (RteConnector)
    - Extends UML Connector
    - Throughput, transmission mode and max blocking/packet Tx time

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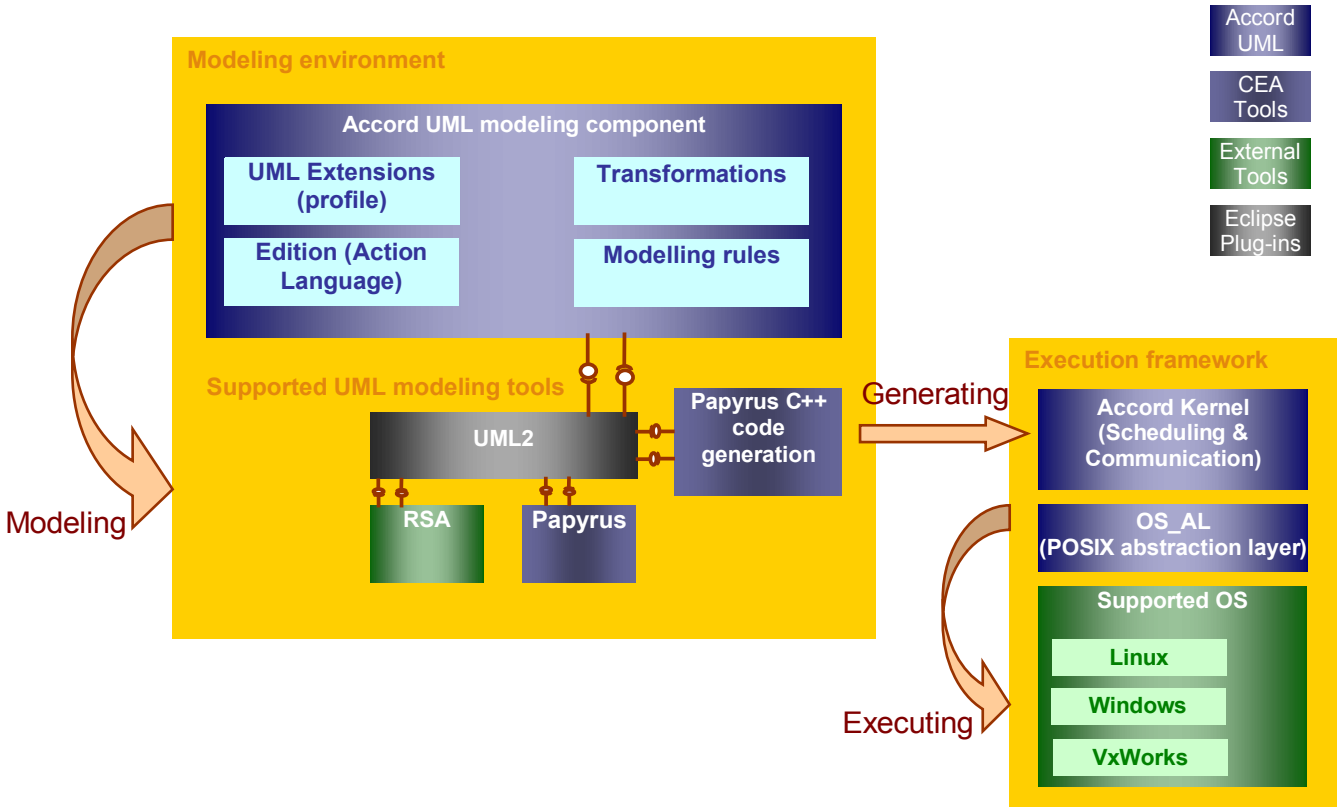
Accord framework architecture



Accord is a platform of MDE for DRES

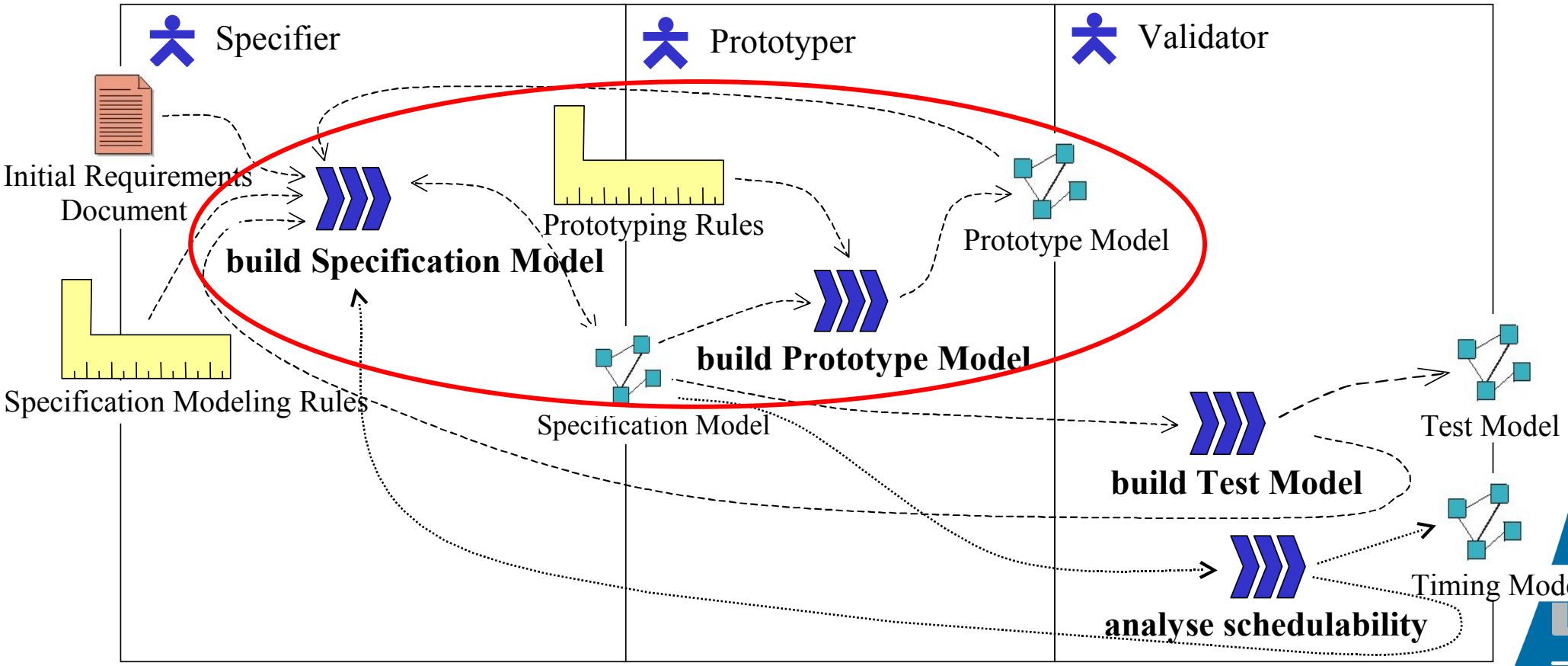
➔Offers high level of abstraction approach

➔Based on UML/MARTE

Powered with Papyrus:

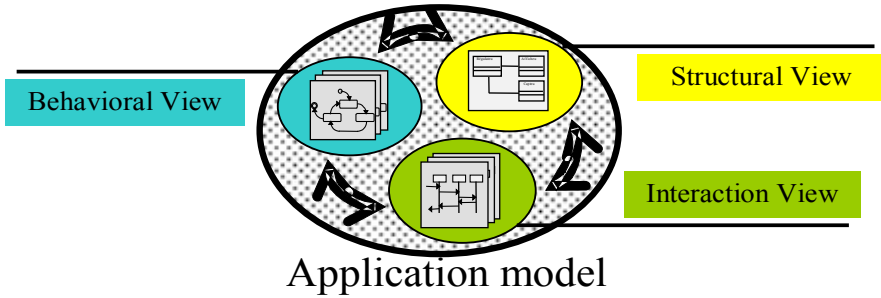
http://www.papyrusuml.org

Outlines of the Accord modeling methodology

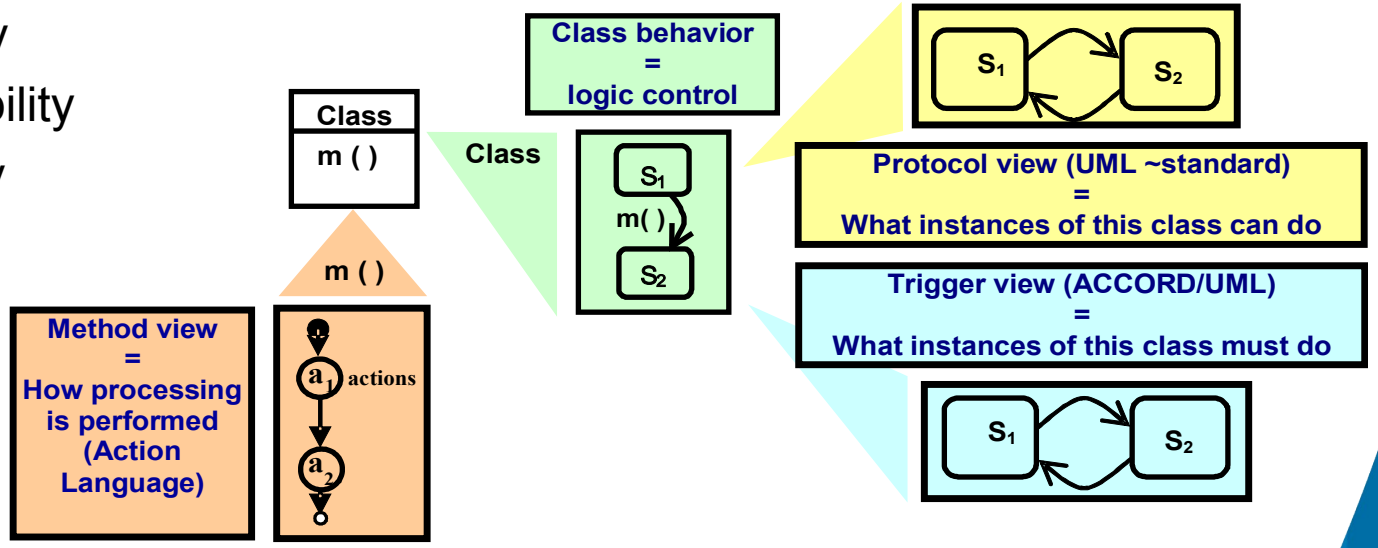


Accord model structure

- Consistency & complementarities
  - Separation of concerns
  - Verify consistency between views

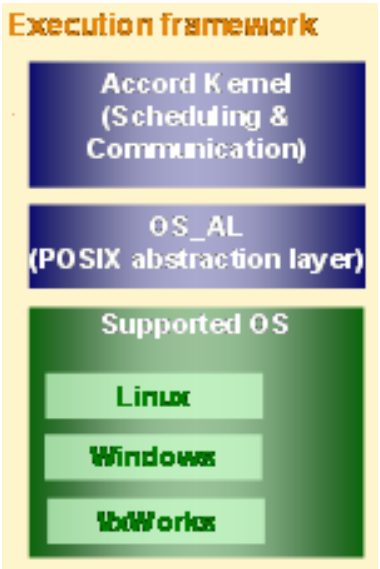


- Modeling system behavior
  - Separation of concerns improves:
    - Readability
    - Maintainability
    - Reusability



➔ Use MARTE (RTEMoCC) to capture RTE characteristics

Execution platform



- OS abstraction layer
  - POSIX compliant operating systems
    - Linux, Solaris, VxWorks…
  - Offers basic mechanisms (not dependent of the OS)
    - Thread, semaphore, mutex…
- Real-time kernel
  - Relies on the OS abstraction layer
  - Provides resources for MARTE RtUnits execution
    - Real-Time Objects
  - Provides a deadline controller that verifies RT constraints at runtime
    - Real-Time Features
  - Provides a scheduler
    - Service scheduling
  - Provides intra concurrency management policy of RtUnits
    - n reader / 1 writer protocol

➔ Transformation: from MARTE-based models to execution platform specific models

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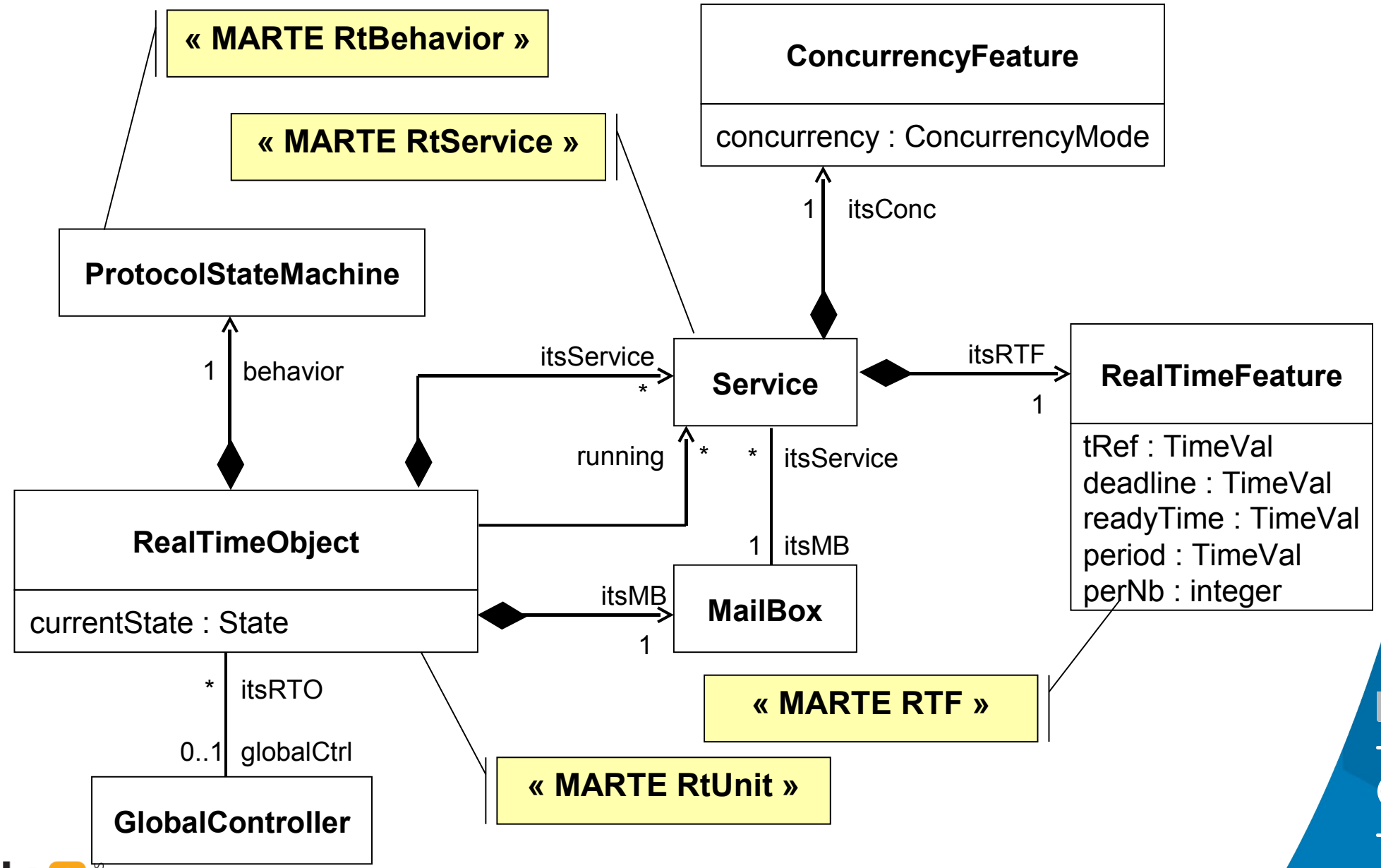
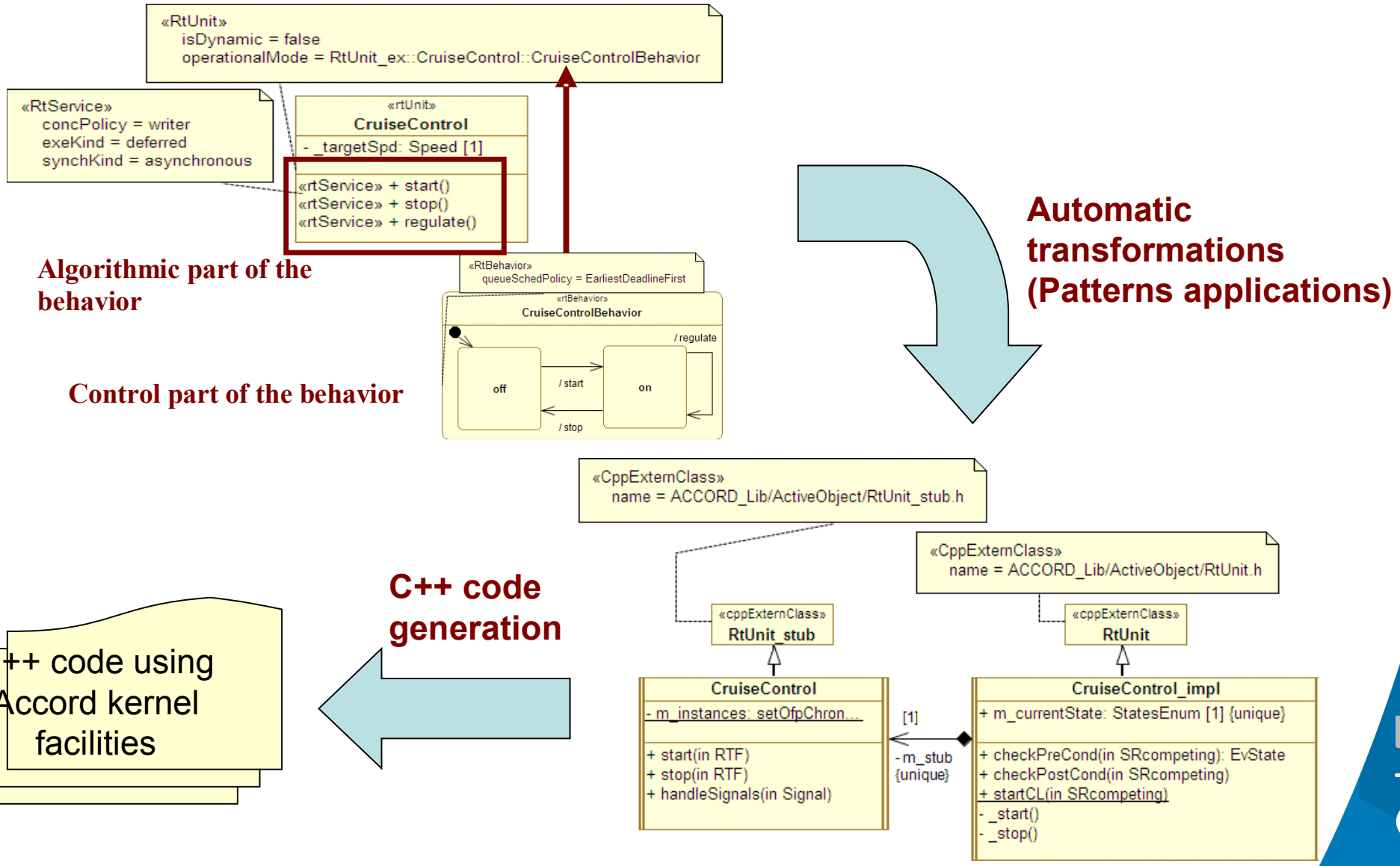
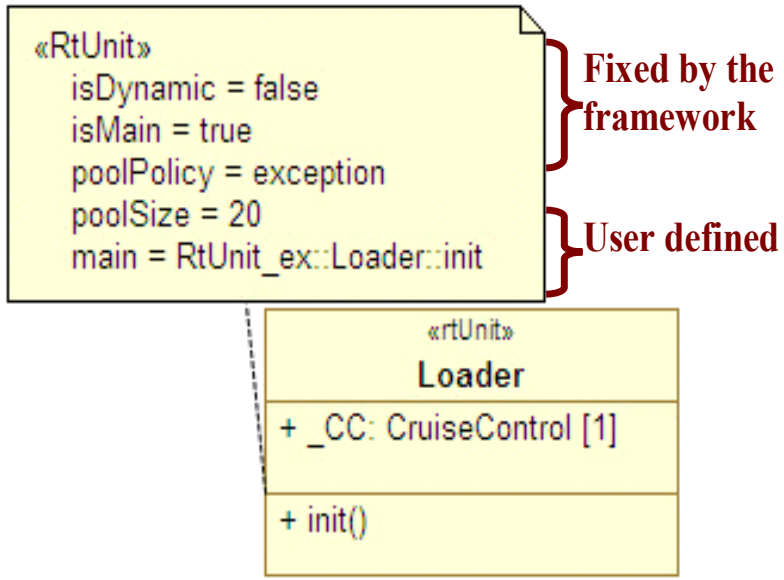
Mapping MARTE concepts on the execution platform



From MARTE-based model to RT executable code



Current limitations and next steps



- Current limitations
  - Partial support of MARTE MoCC family
  - C++ as the action language
  - Component-based models are not executable
- Next steps and ongoing work
  - Larger support of MARTE MoCC by Accord Kernel (parameterization)
  - C++ code generator for an action language
  - Provide transformations to the execution platform for component-based models

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Conclusions

- MARTE-based modeling methodology
  - Provides executable MARTE-based models
- Execution platform
  - Provides execution resources for MARTE concepts
- Tool support
  - Modeling
    - Papyrus UML (http://www.papyrus-uml.org)
      - Advanced modeling for UML / MARTE / SysML
  - Automated transformations
    - MARTE-based models to execution platform mapping (patterns)
    - Automatic C++ code generation
- Ongoing work for a larger support of MARTE MoCC and modeling processes

Thank you for your attention!