Model-based Development for RTSJ Platforms

Java Technologies for Real-time and Embedded Systems

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Topics

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- RTSJ code generation approaches
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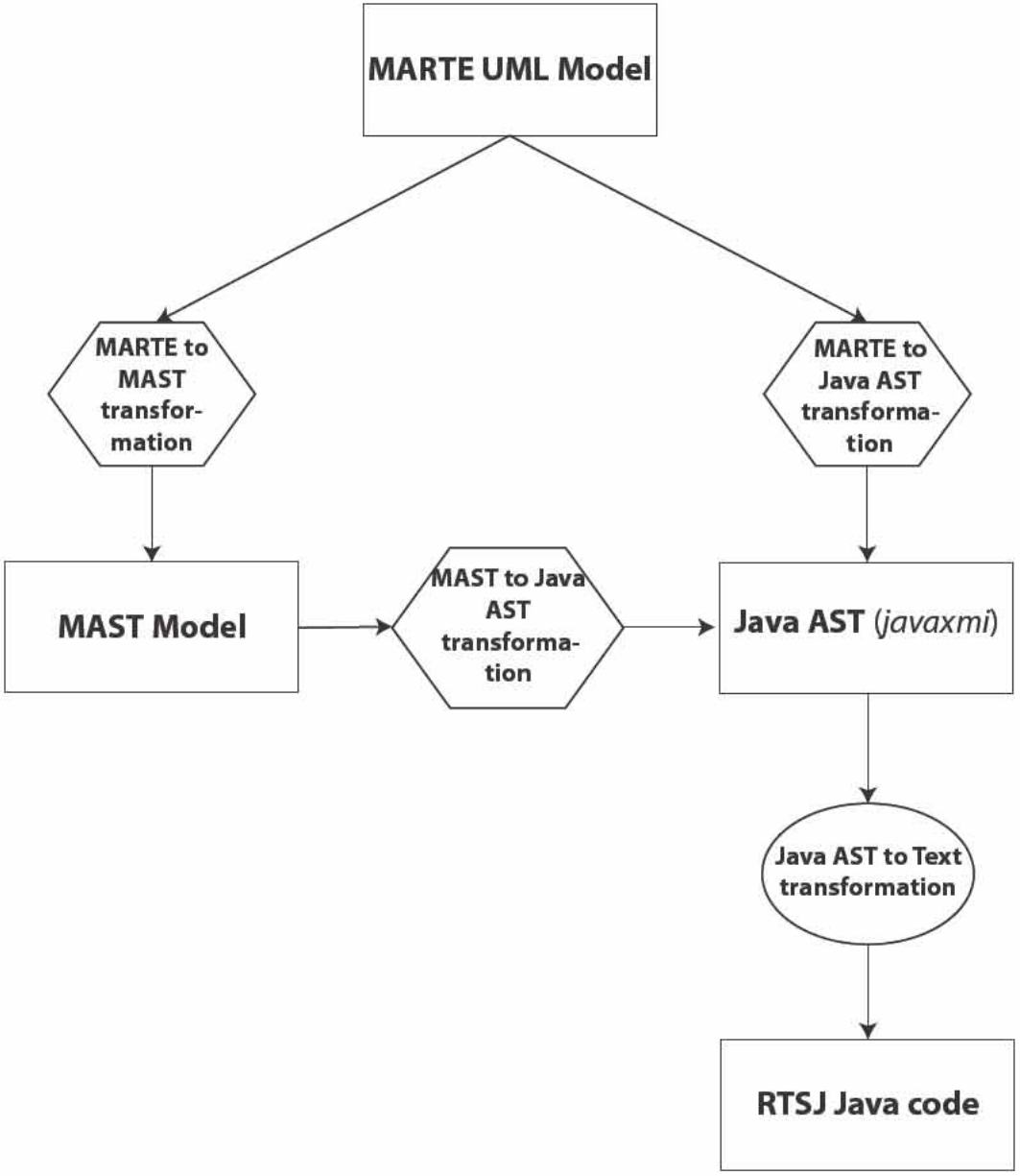
  - » MARTE
- Integration MARTE-MAST-RTSJ
- RTSJ generation code
  - » Handled RTSJ Classes
  - » NOT handled RTSJ Classes
- Transformation Patterns
- Application example
- Tools availability

RTSJ Java code generation process

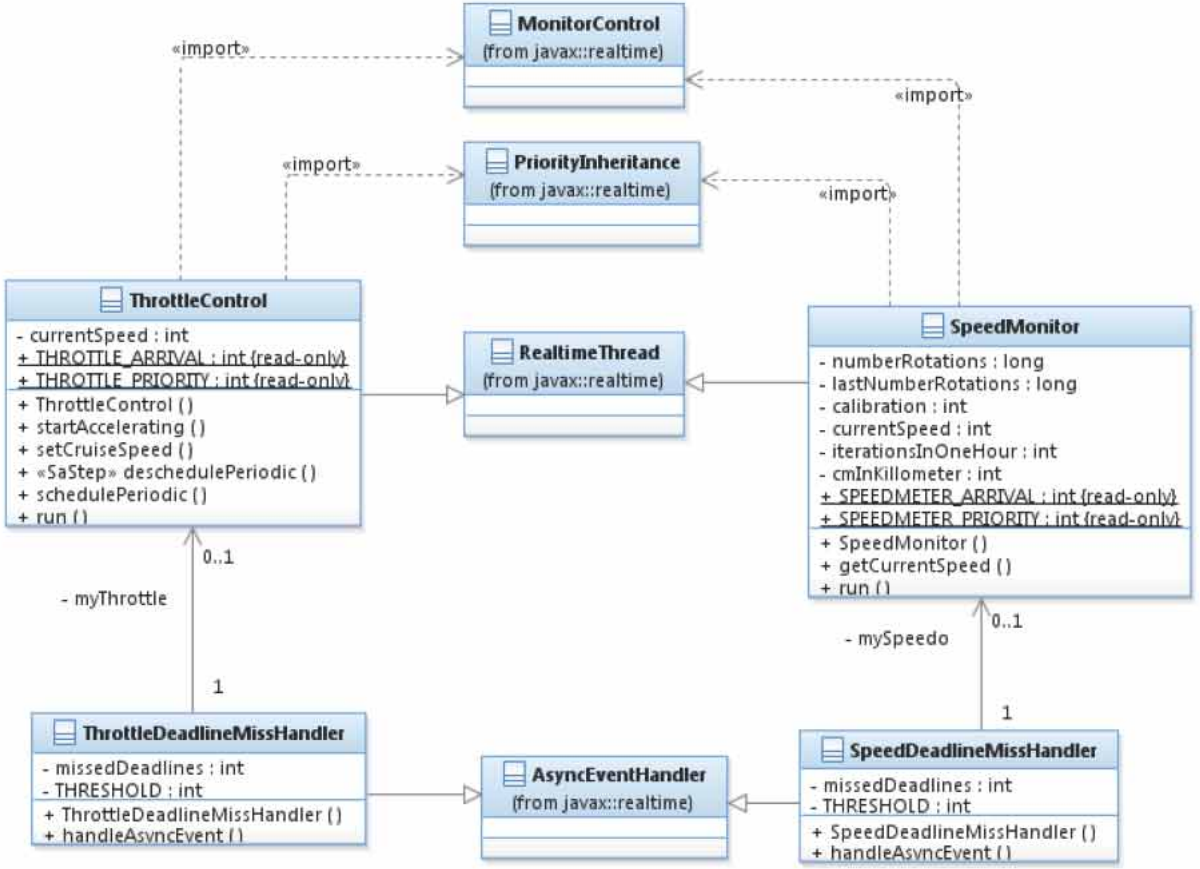


RTSJ code generation approaches

- Models that reuse the RTSJ UML model library
  - » Load of RTSJ in UML models
  - » Reuse of RTSJ Types and Methods
  - » Software models and Scheduling Analysis models are independent
- Models annotated with MARTE (GRM, SwConcurrency, GQAM and SAM)
  - » Application of profiles
  - » Stereotype applications
  - » Scheduling analysis models and Java RTSJ code consistent

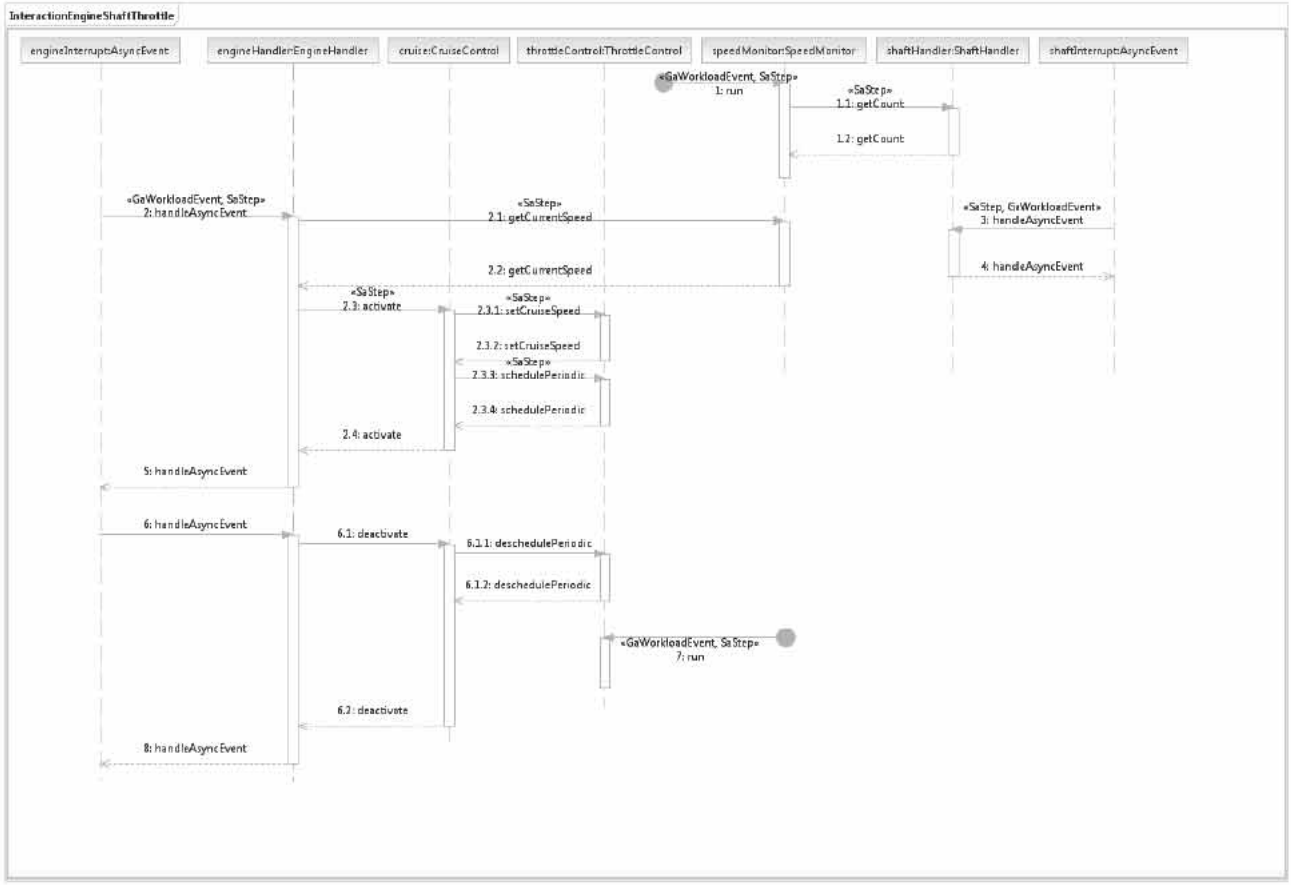
RTSJ Models and RTSJ Generation

- Import of RTSJ Model library
- Reuse, in user model, of RTSJ classes and methods (*Realtime-Thread*, *AsynEvent*, ...)
- Generate RTSJ Java code
  - » Generate Java AST (this the L0 of Java applications)
  - » Generate Java code



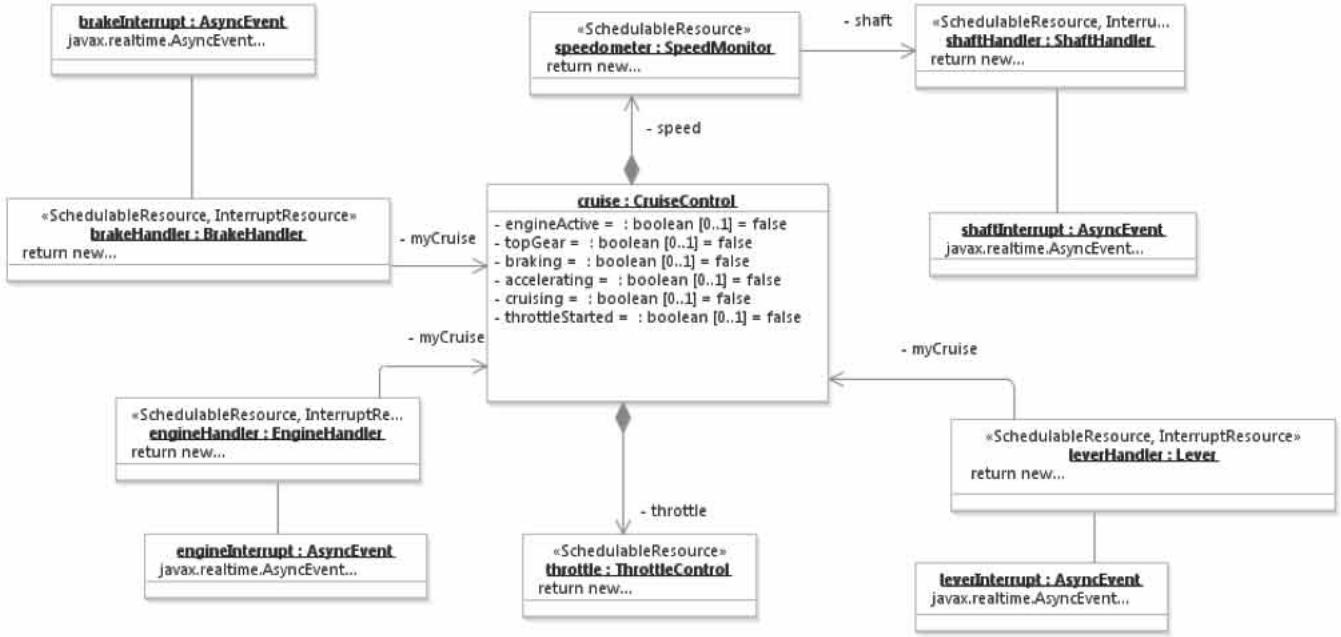
Scheduling Analysis Annotations MARTE-MAST

- MARTE-Scheduling analysis and software model are supported in the same UML model.
  - » *MARTE-Scheduling analysis* introduces information to make scheduling analysis
- Both can contain inconsistencies



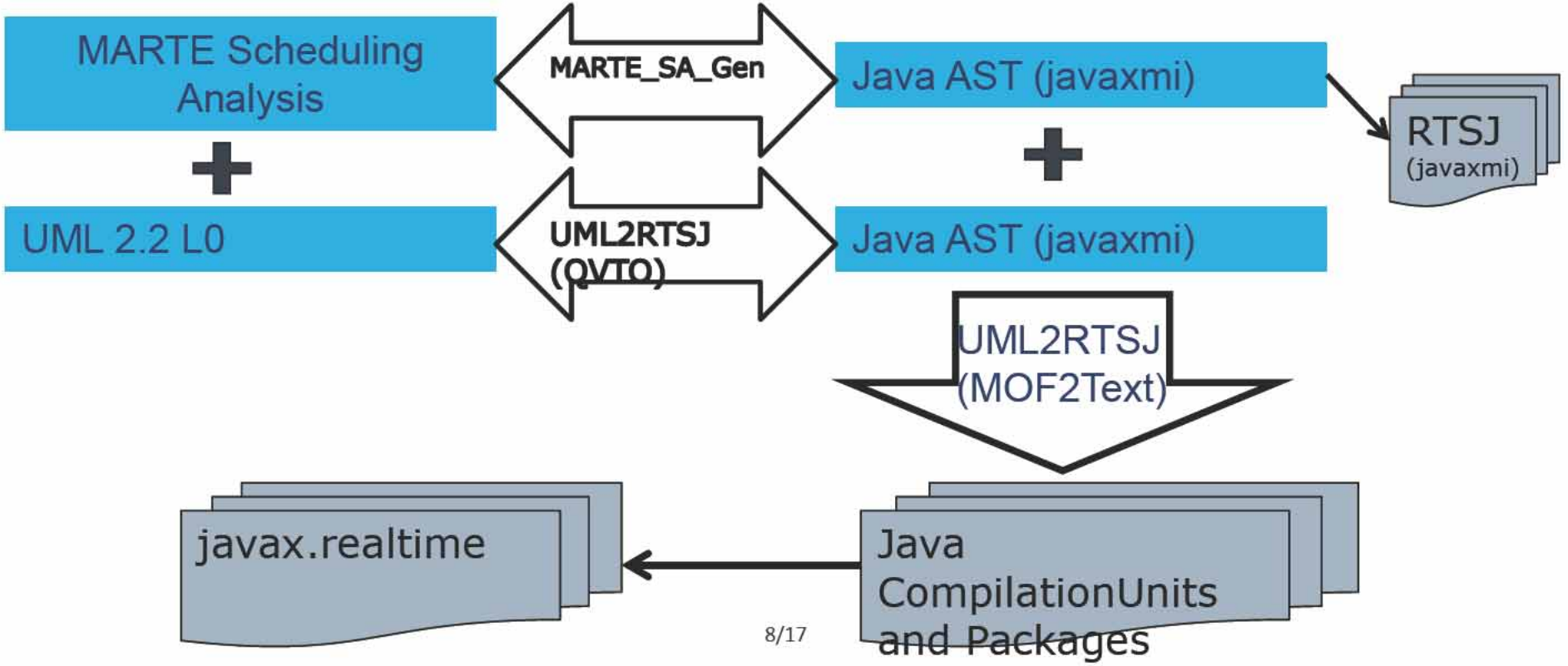
UML+MARTE to Java RTSJ and MAST

- Model with MARTE: timing information is represented with MARTE and not with UML-RTSJ libraries
- Integrated generation of MAST and RTSJ Java code
  - » Generate Java AST and MAST analysis model
  - » Generate Java code (the same for any *javaxmi*)



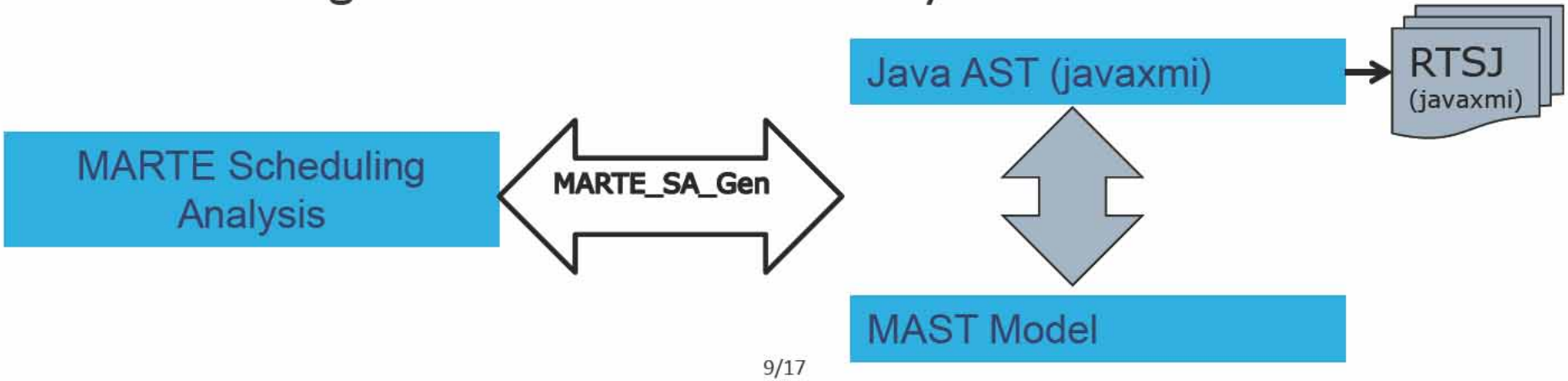
Integration of MARTE-MAST-RTSJ (1)

- UML2RTSJ supports the mapping from UML 2.2 L0 to *javaxmi*
- MARTE_SA_Gen extends this for the integration of *MARTE Scheduling analysis* into *javaxmi* models
- Java AST models based on RTSJ (*javaxmi*) are consistent with MAST models generated



Integration of MARTE-MAST-RTSJ (2)

- UML+RTSJ Model Library and UML+MARTE differences:
  - » UML+RTSJ includes explicit references to RTSJ library (types, method calls, generalizations, ...)
  - » UML+MARTE does not include any reference to RTSJ. Any reference to RTSJ in Java code is generated based on MARTE
  - » UML+RTSJ are based on Java primitive types (e.g. long, void, ...)
  - » UML+MARTE do not use Java types.
  - » The consistency of MAST model and RTSJ behaviour depends on modeller
  - » Generator guarantees the consistency of MAST and RTSJ behaviour



RTSJ Classes handled in mapping

- Threads
  - » *RealtimeThread*
- Scheduling
  - » *SchedulingParameters, PriorityParameters ReleaseParameters, PeriodicParameters AperiodicParameters, SporadicParameters, ProcessingGroupParameters*
- Synchronization
  - » *MonitorControl, PriorityCeilingEmulation, PriorityInheritance*
- Asynchrony
  - » *AsyncEvent, AsyncEventHandler, BoundAsyncEventHandler*

RTSJ Classes NOT handled in mapping

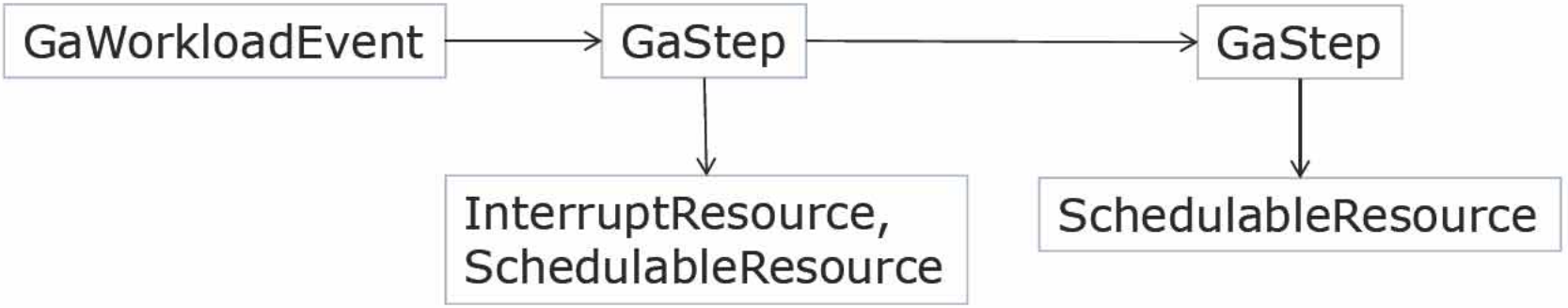
- MARTE handles memory as resource, but we cannot make classifications as: *Immortal*, *Heap*, *Scoped*
  - » Fundamental in RTSJ execution time predictability
- Threads
  - » *NoHeapRealtimeThread*
- Memory Management
  - » *Scoped Memory, Immortal Memory, Physical Memory Manager, Raw Memory Access*
- System and Options
  - » *POSIXSignalHandler*, *RealtimeSecurity*

Transformation Patterns (1)

- MARTE2RTSJ generates Java anonymous classes for handling *SchedulableResource* and handlers of *GaWorkloadEvent*. These classes
  - » Template for each RTSJ thread pattern
    - Periodic, Sporadic, Aperiodic
  - » Handling of exceptions
    - Deadlines, Execution times
- MARTE2RTSJ configures object monitor based on *SaSharedResource*
- MARTE2RTSJ supports combination of *AsyncEvent* and *AsyncEventHandler* based on *InterruptResource*/*SchedulableResource*, and *GaSteps* sequences

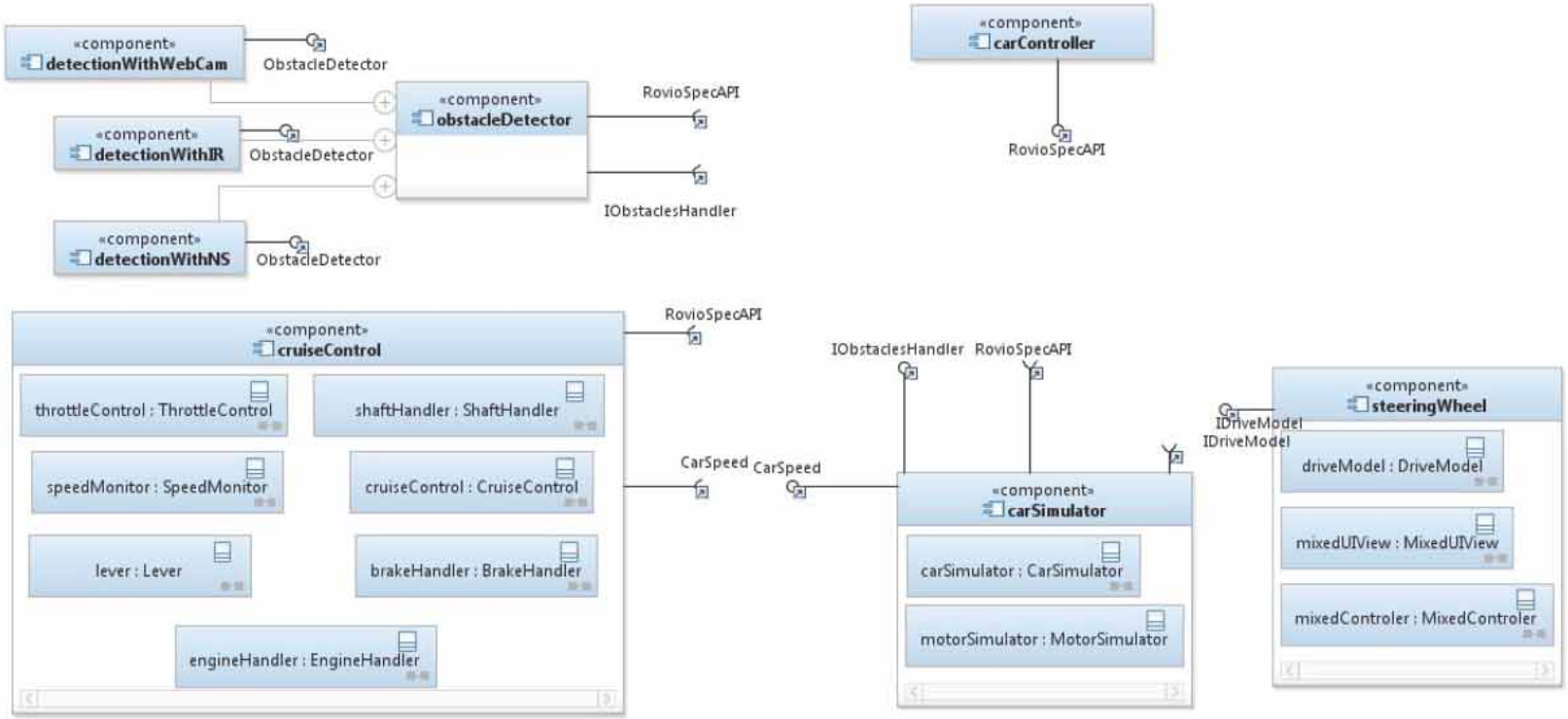
Transformation Patterns (2)

- MARTE2RTSJ *AperiodicThread* template for handling Bursty and Deferred MARTE aperiodic
  - » *release* method for notification of aperiodic event arrival
  - » *run* method: thread cycle
  - » array of timers for handling aperiodic events deadlines
- *AsyncEvent -> BundedAsyncEventHandler* sequence are represented with



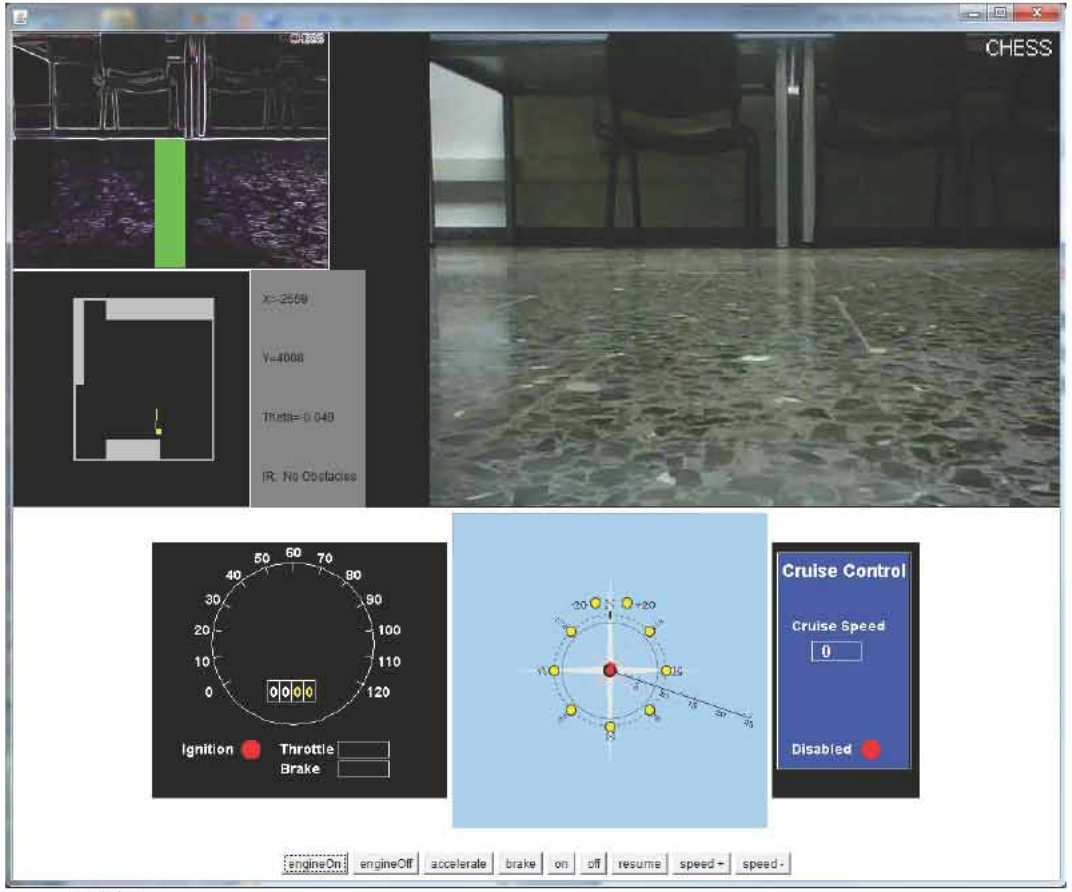
Application Example: tele-presence car

- Tele-drive for a tele-presence car. Main components:
  - » Steering wheel and throttle pedal handlers
  - » Cruise control system: handlers of brake, throttle, lever, speed and engine, and control
  - » Combined obstacles detector: indoor localization sensor, webcam images filter, IR detector



Application Example: tele-presence car

- Transformations and generators provides:
  - » MAST scheduling analysis for schedulable resources
  - » RTSJ Java code-> RTSJ code generated + logical code in Opaque Behaviors



http://www.erma-assets.org

- Eclipse Indigo with ERMA 64K and 32K
- Eclipse Indigo 64K with ERMA and Papyrus
- ERMA plug-ins site
- ERMA plug-ins for RSA 8.0.3
- ERMA Safety-Analysis Assets
  - » S&D Profiles and Model Libraries
  - » FTA & FMECA Eclipse Languages
  - » UML to FTA & FMECA transformations
  - » Item Toolkit Bridges
- ERMA Real-Time Assets
  - » MARTE 1.1 Conform Standard and Stereotypes Editor
  - » RTSJ and Ada-Ravenscar Modelling tools
  - » MAST Eclipse Languages
  - » MARTE to MAST and RTSJ

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Thank you for your attention!

STRAST dit UPM

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