NASA IV&V Perspective on Recent Trends in Executable Models

This poster focuses on the recent trend in UML simulation toolkits where tools interpret models instead of relying on generated code. This is an important development since it requires minimal configuration, can be used earlier in the lifecycle and can evolve as the design matures.

Model-Driven Validation and Verification

model validation starts during design phase, continues throughout
design constraints included as part of model, assessed via automation
automated design analysis (i.e., measuring coupling and cohesion, dependency analysis)
runtime model checking: values, constraints, parametric
conditional breakpoints (achieve desired state and assess)
post-simulation analysis

OMG's fUML

http://www.omg.org/spec/FUML/

Semantics Of A Foundational Subset For Executable UML Models (Fuml)

A virtual machine for executing UML Activities for verification. It supports structural and behavioral semantics of systems through a subset of the UML metamodel.

W3 SCXML

http://www.w3.org/TR/scxml/

State Chart XML (SCXML): State Machine Notation for Control Abstraction

A generic execution environment based on Harel state charts. Useful for event-driven systems, control systems, view navigation, and system interactions. SCXML can be used for code generation.

Parametrics

http://www.omgsysml.org/

part of the OMG Systems Modeling Language

SysML Constraint blocks specify physical properties of a system or system performance expectations. Model simulations can evaluate and track critical parameters such as size, weight, speed, power, temperature and others throughout the system life cycle. Some tools integrate with external math solvers.

AADL

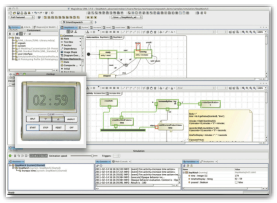
http://www.aadl.info/

Architecture Analysis & Design Language

Is designed for the specification, analysis, and automated integration of real-time performance-critical (timing, safety, schedulability, fault tolerant, security, etc.) distributed computer systems. It facilitates the analysis of system designs (and system of systems) prior to development and supports a model-based, model-driven development approach throughout the system life cycle.

Tool Feature Comparison

Product	Metamodel(s)	Execute Activity	Action Language(s)	Execute State Machine	Model Audits	Visual Debugger	OMG fUML	SCXML	AADL	SysML Parametrics	Execute External Classes	Requirements Integration
MagicDraw Cameo Simulation Toolkit	UML2, SysML	Y	JSR223*	Y	Y	Y	Y	Y	N	Y	N	Y
IBM Rational Software Architect	UML2, SysML	Y	UAL, Java , C++	Y	Y	Y	N	N	N	Y	N	Y
IBM Rational Rhapsody	UML2, SysML	Y	C++	Y	Y	Y	N	N	N	Y	N	Y
TopCased 5.0	UML2, SysML	N		Y	Y	Y	N	N	Y	N	N	Y
NASA IV&V Model Animator	UML2	Y	N/A	Y	Y	Y	N	N	N	N	Y	Y

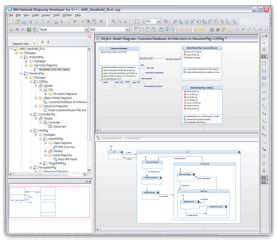


MagicDraw Cameo

Commercial

Key executable model features:

- Activity execution (OMG™ fUML standard)
- State machine execution (W3C SCXML standard)
- SysML parametric execution (OMG SysML standard)
- Multiple action languages support (JSR223 standard)
- Exporting UML state machine to SCXML file format
- Full featured model debugger
- Execution animation
- Quick UI prototyping
- Pluggable engines and evaluators
- Model-driven test cases and scenarios

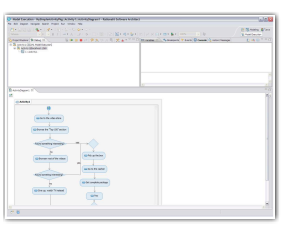


IBM Rhapsody

Commercial

Key executable model features:

- Application generation for C, C++, Java and Ada
- Animation and model execution
- Automate testing of code and visualize test cases
- Simplified execution framework with ARINC 653 adapter
- Domain-specific language support for graphical C, MARTE or custom
- MISRA-C and MISRA-C++ code for embedded systems
- Dynamically analyze and execute SysML parametric diagrams
- Requirements analysis and traceability

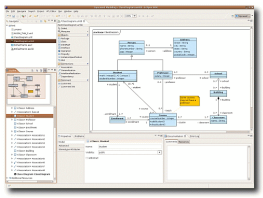


Rational Software Architect

Commercial

Key executable model features:

- Execute UML behavior models to simulate the behavior
- Animate behavior diagrams during execution
- Control the execution using breakpoints and other commands
- Animating composite structure and topologies
- Animating topologies
- Historic messages in topology animations
- Simulating event-driven models
- Run-time prompting
- Simulating business process models

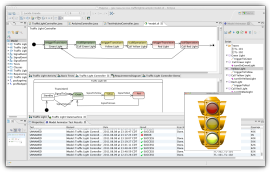


TopCased

Open Source

Key executable model features:

- Activity execution
- State machine execution
- SysML execution
- Extensible Code generation
- Model debugger
- Execution animation
- Lots of features, poorly organized UI
- Lack of documentation



Model Animator

Developed by NASA IV&V

Key executable model features:

- Activity model execution (requires no markup)
- UML profile links Activities, StateMachines and Operations
- Trigger multiple state machines
- Call Class Operations
  - Optionally invoke external, implementation
- Model debugger
- Execution animation
- Save and load animation scenarios
- Requirements integration
- Developed here at NASA IV&V!

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