CASSANDRA/xUML

Executable UML Specifications

UML today

The Unified Modeling Language (UML®) not only allows us to model a specific implementation of a software system, but also to specify its functionality in an implementation-independent way. However, in practice such analysis models become all-to-often heavily "polluted" by design and implementation elements, since the software finally must be implemented in a specific programming language and on a specific operating system.

UML tomorrow

By turning UML models into precise **xUML** models (**Executable UML**), it becomes possible to define an environment in which such implementation-independent analysis models can be executed without considering technical details of the target platform. This results in the following advantages:

- The functionality of the system can be **tested, before the first line of code has been written**.
- **Searching and fixing errors** in the application logic can be carried-out **on the abstraction level of UML models** instead of the level of program code.
- The **semantics of UML models** can be "felt" and thus becomes much better understandable and **learnable**.

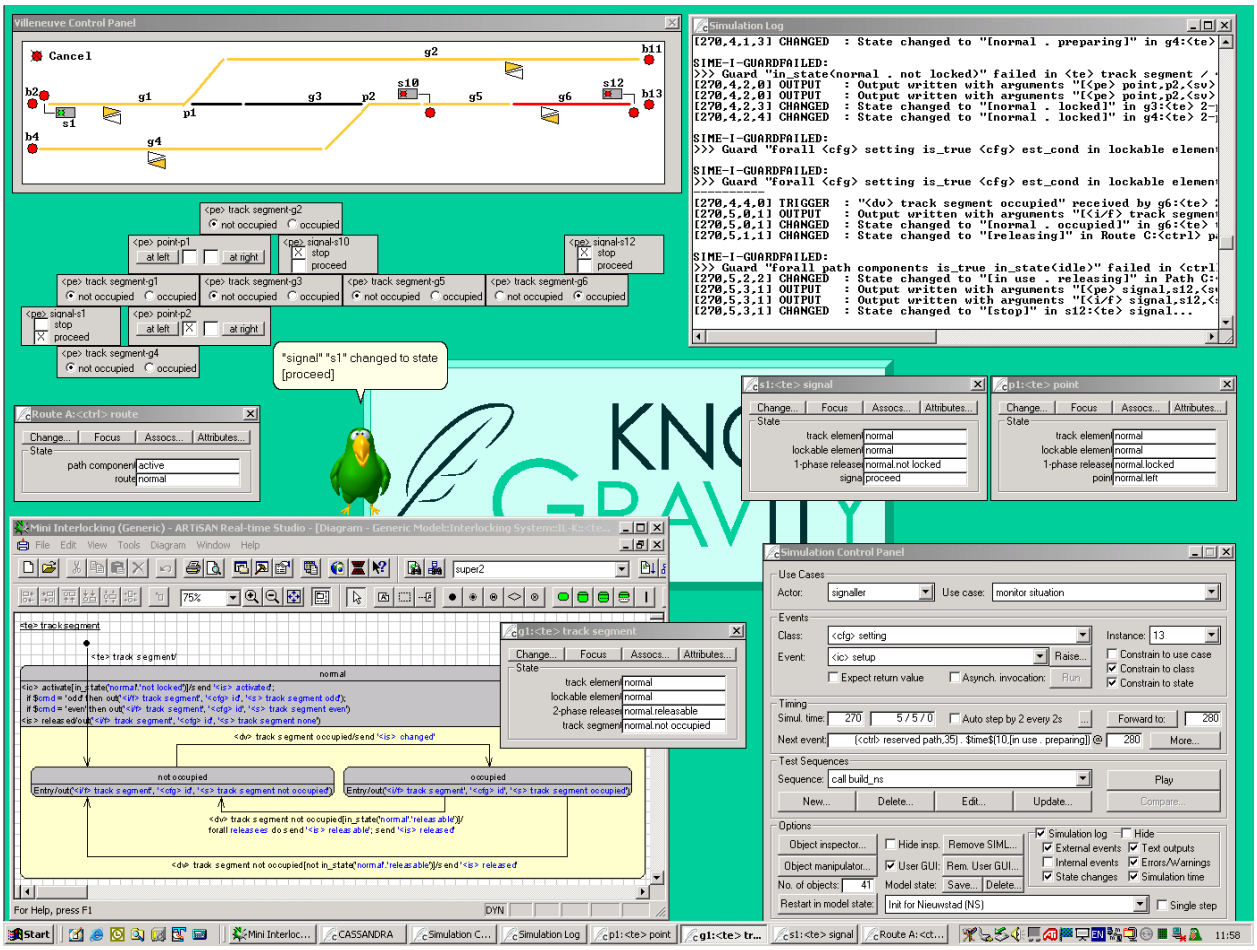
CASSANDRA/ xUML

Based on our software engineering platform CASSANDRA we developed a runtime environment that allows convenient execution of xUML models. This environment offers the following features:

- **A UML-VM (Virtual Machine)** that directly executes
  - the static system structure represented by class models with attributes, associations and multiple inheritance
  - the system behavior by means of state diagrams, including super states and concurrent states as well as time-based event handling
  - declarative **rules and rule sets** with **forward and backward inference** as well as "why"-explanations
  - nested transactions along object interactions for integrity constraints.
- A powerful **UML 2.0 based Action Language** for state transitions supports
  - creation and destruction of instances
  - establishing and loosing association-links between instances
  - navigation along associations (and association classes)
  - boolean, arithmetic and set-expressions with all and existence quantifiers
  - synchronous and asynchronous communication via events and broadcasts.
- The following tools are provided for **Model-Level Debugging**:
  - model-level debugger for interactive evaluation as well as break- and watch-points
  - object inspectors for in-situ observation of instances
  - an object manipulator to manipulate instances and their association links
  - a logger to record important events during a simulation run
  - a **regression tester** to record test scenarios and replay them automatically including automated verification of the system behavior.
- Complete **pattern-driven generation of user interfaces** from use case models and sequence diagrams
- Possible integration of a **dedicated user interfaces**.

UNIFIED MODELING LANGUAGE

The screen shot below shows a session with CASSANDRA/xUML to simulate a **railway interlocking system** (with kind permission of the EURO-Interlocking Project of the International Union of Railways, UIC).



What's next?

As soon as a precise and executable functional specification of a system is available, a whole set of new opportunities emerge:

- The specification may be considered as a PIM (Platform Independent Model) in the sense of OMG's **Model Driven Architecture (MDA®)** and thus be translated into a PSM (Platform Specific Model), i.e. into a final implementation.
- Based on the explicit information contained in such a specification, some less explicit information about the model can be derived that in turn can be used to **validate the specification**.
- A precise specification may be used as a base to apply **formal verification techniques** to prove certain safety-critical properties of the system.

Currently these types of CASSANDRA applications are subject to our research.

Requirements

To run CASSANDRA/xUML the following technical requirements must be fulfilled:

- CASSANDRA, V1.4.2/SP4
- CASE Tool ARTiSAN RtS, V4.1 or higher

Support for other CASE Tools on request.

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