Real Time Developer Studio

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PragmaDev

Dedicated to the development of a
modelling tool
for the development of
Event driven software.

Network of partners:

- Trainings,
- Services,
- Testing,
- Products.

Distributors:

- Europe,
- Asia,
- US.

LAUREAT
CRÉATION D'ENTREPRISES DE TECHNOLOGIES INNOVANTES
MINISTERE DE LA RECHERCHE
2001

ANVAR

Partners

Atos Origin

Accelerated Technology
Embedded Systems Division of
Mentor Graphics

TASKING

OSS Nokalva

express logic

WIND RIVER
PARTNER

CS
COMMUNICATION
& SYSTEMES

OSE

Green Hills
•SOFTWARE, INC.•

CMX
SYSTEMS

References

AIRBUS

Alcatel·Lucent

RENAULT

MINISTÈRE DE LA DÉFENSE

THOMSON images & beyond

NORTEL NETWORKS

esa

WIPRO Applying Thought

NewLogic

LG Electronics

TOSHIBA

ERCOM

MITSUMI

- Universities : ENST, Polytechnica Bucarest, Telecom Beijing…

Philosophy

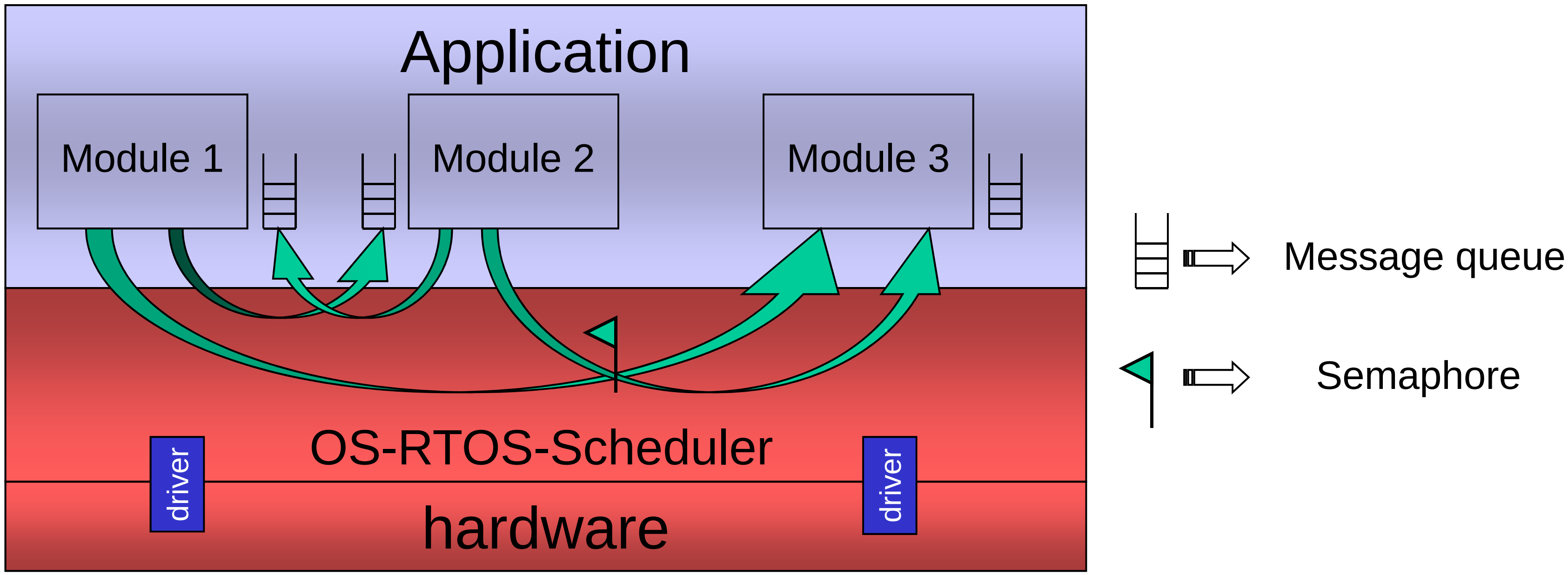
Develop a **modelling tool** based on the users' **needs**.

Target segment

Event driven systems

Embedded & Real time

- Decomposed in tasks running concurrently
- Communicating
- Synchronizing

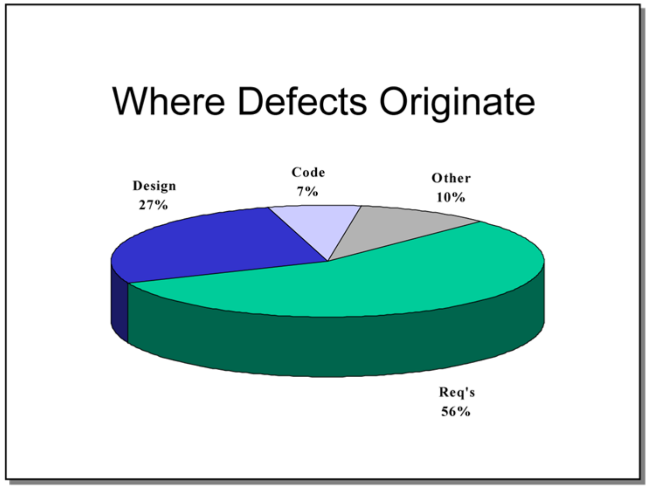


Issues

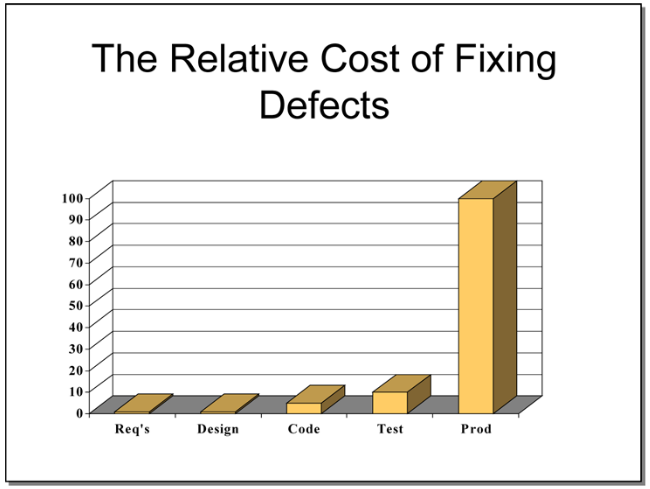
"The software content is doubling about every two years. The sheer volume is making it increasingly difficult for QA and test teams to keep up with traditional tools and processes."

Wind River Market Survey of Device Software Testing Trends and Quality Concerns in the Embedded Industry

June 2010



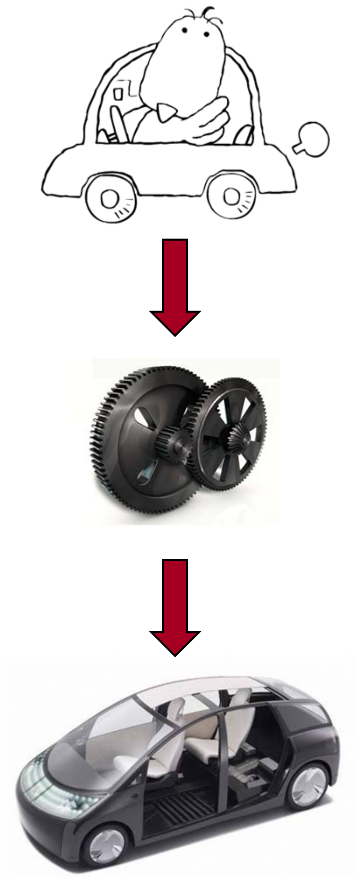
Never forget the 1:10:100 rule



Source: James Martin study

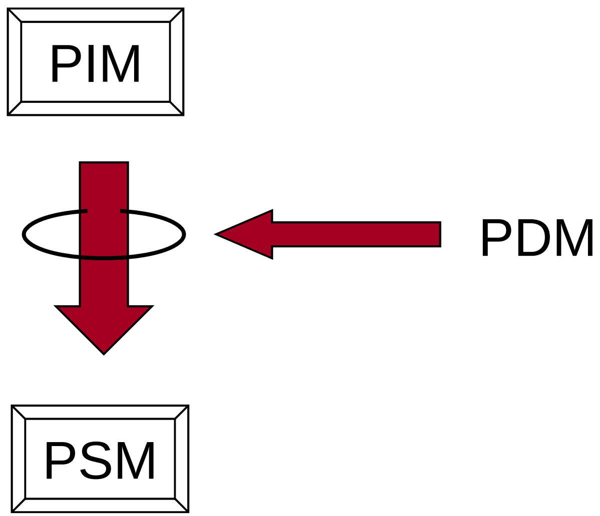
What modelling can solve

- Focus first on the What (Req) instead of focusing on the How (code),
- Modelling is about Communication and Documentation,
- Legibility of large systems gets critical. Would you build a house without drawing detailed plans ?
- Get control over productivity,
- Improve quality.



Model driven development

- Vocabulary
  - PIM: Platform Independant Model
  - PDM: Platform Definition Model
  - PSM: Platform Specific Model



The goal is to transform the abstract model (PIM) to a concrete model (PSM) using the platform definition model (PDM).

Requirements for a good PIM

- The abstract model must be platform independant, as its name states.
- The abstract model must be translatable to an implementation platform.
- For that purpose, the abstract model is based on a virtual machine offering:
  - Some basic services
  - A strong enough semantic.

Existing modelling languages

SDL	Specification and Description Language is an ITU-T standard. • Event oriented, • Used by ETSI to standardize telecommunication protocols, • Formal (complete and non-ambiguous).
UML	Unified Modeling Language is an OMG standard. • Can be used to represent any type of systems, • Informal.
SysML	System Modelling Language
AADL	Architecture Analysis Description Language
MARTE profile	Modeling and Analysis of Real-Time and Embedded systems
Z.109	UML profile based on SDL
Lustre / Esterel	Synchronous programming languages for the development of complex reactive systems
MATLAB	MAtrix LABoratory
Autosar	AUTomotive Open System Architecture
SART	Structured Analysis for Real Time (obsolete)

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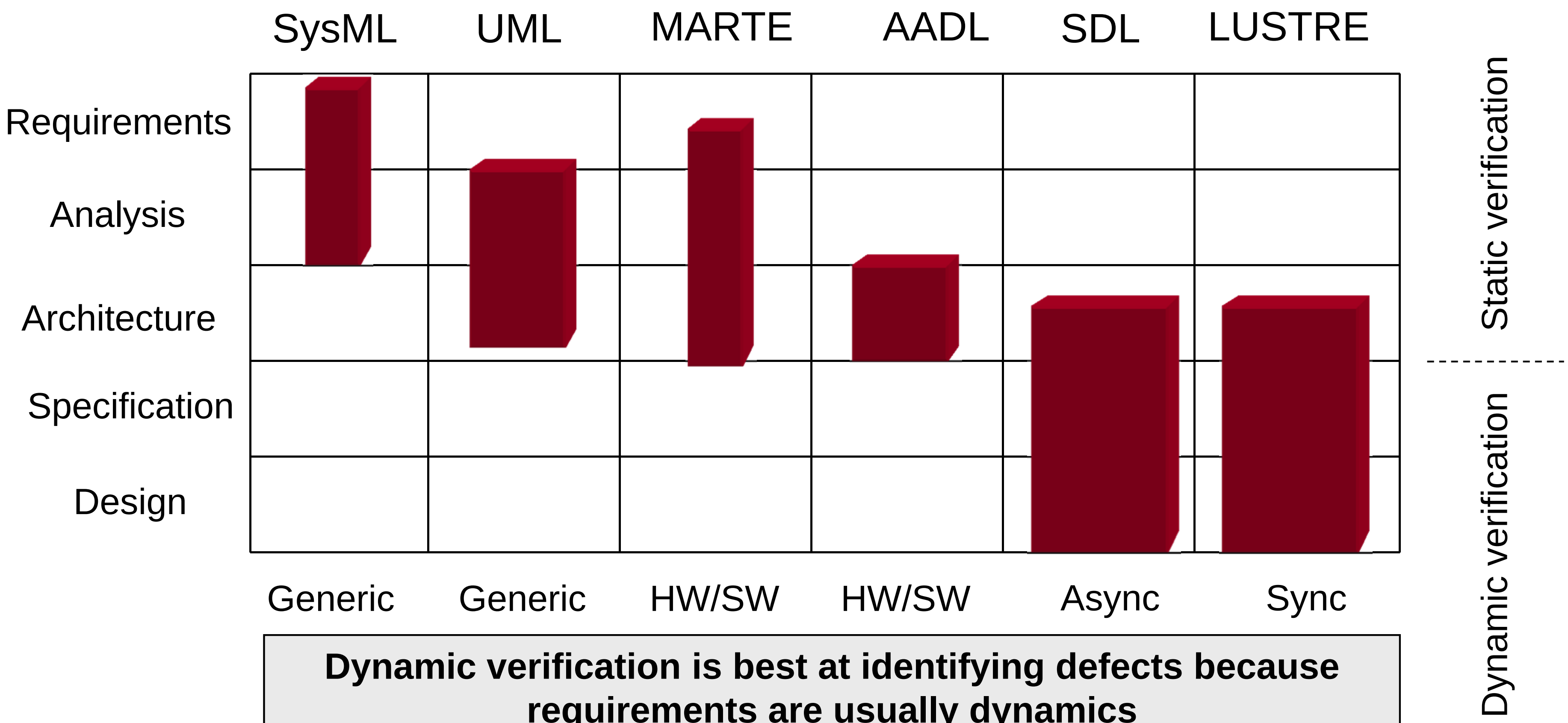
Modelling languages positioning



Dynamic verification is best at identifying defects because requirements are usually dynamics

No real time specificity in UML

- UML 1.x was too generic to describe a good PIM,
- UML 2.x introduced domain specific profiles,
    - Lots of tools defined proprietary profiles,
    - Z.109 is a standardized profile based on SDL.

SDL: the perfect picture

- SDL graphical abstraction (architecture, communication, behavior) brings a lot to development teams.
- SDL being formal, it is possible to simulate the system behavior on host with graphical debugging facilities.
- SDL being formal, full code generation is possible.
- SDL being object oriented, software components are reusable (ETSI telecommunication protocol standards fully use object orientation).
- SDL has the characteristics to describe a good PIM.

SDL: the figures

Years of experience allows to quantify gains of SDL usage.

- C code: 35 to 50 mistakes per 1000 lines
- SDL code: 8 mistakes per 1000 lines

- Development time is globally reduced by 35%
    - Reduced up to 50% in the left branch of the V cycle
    - Less gain on the right side of the V because of the gap with technical reality

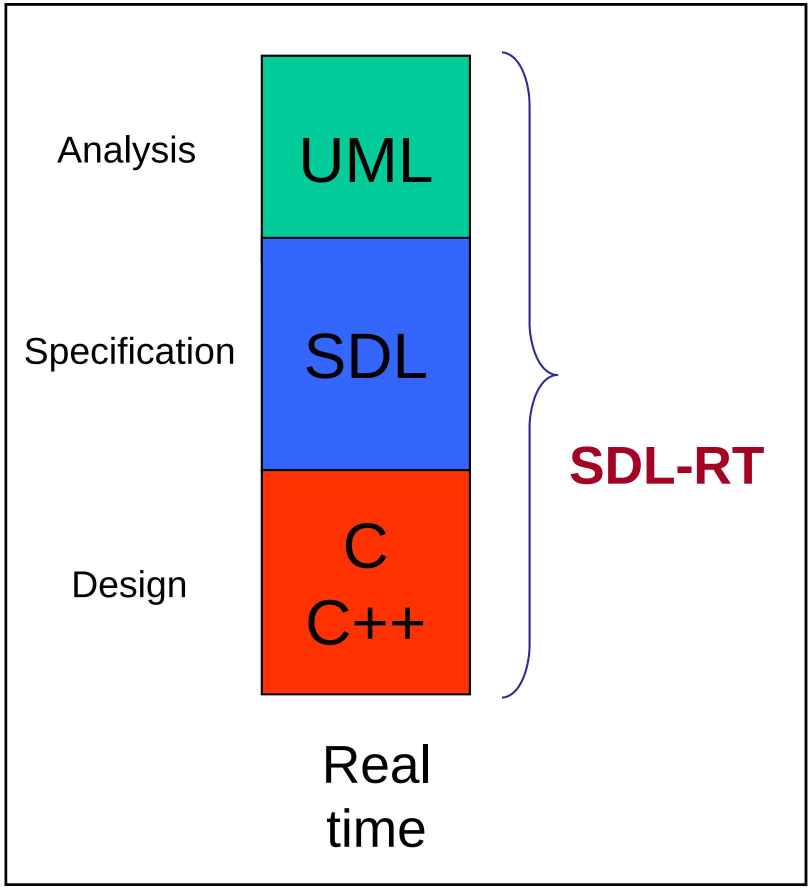
SDL: design problems

- All existing software modules (RTOS, drivers, legacy code) provide C APIs, not SDL,
- Some classical real time concepts are not present in SDL such as pointers and semaphores,
- SDL syntax is not suited for design.

- **Integration with legacy code is difficult,**
- **Integration with COTS components is tricky (driver or RTOS),**
- **Developers are frustrated,**
- **Generated code is not legible,**

An intermediate solution: SDL-RT

- Keep UML diagrams at high level during analysis and requirements
- Keep the SDL graphical abstraction (architecture, communication, behavior).
- Introduce C data types and syntax instead of SDL's.
- Remove SDL concepts having no practical implementation.
- Extend SDL to deal with uncovered real time concepts (interrupts, semaphores).



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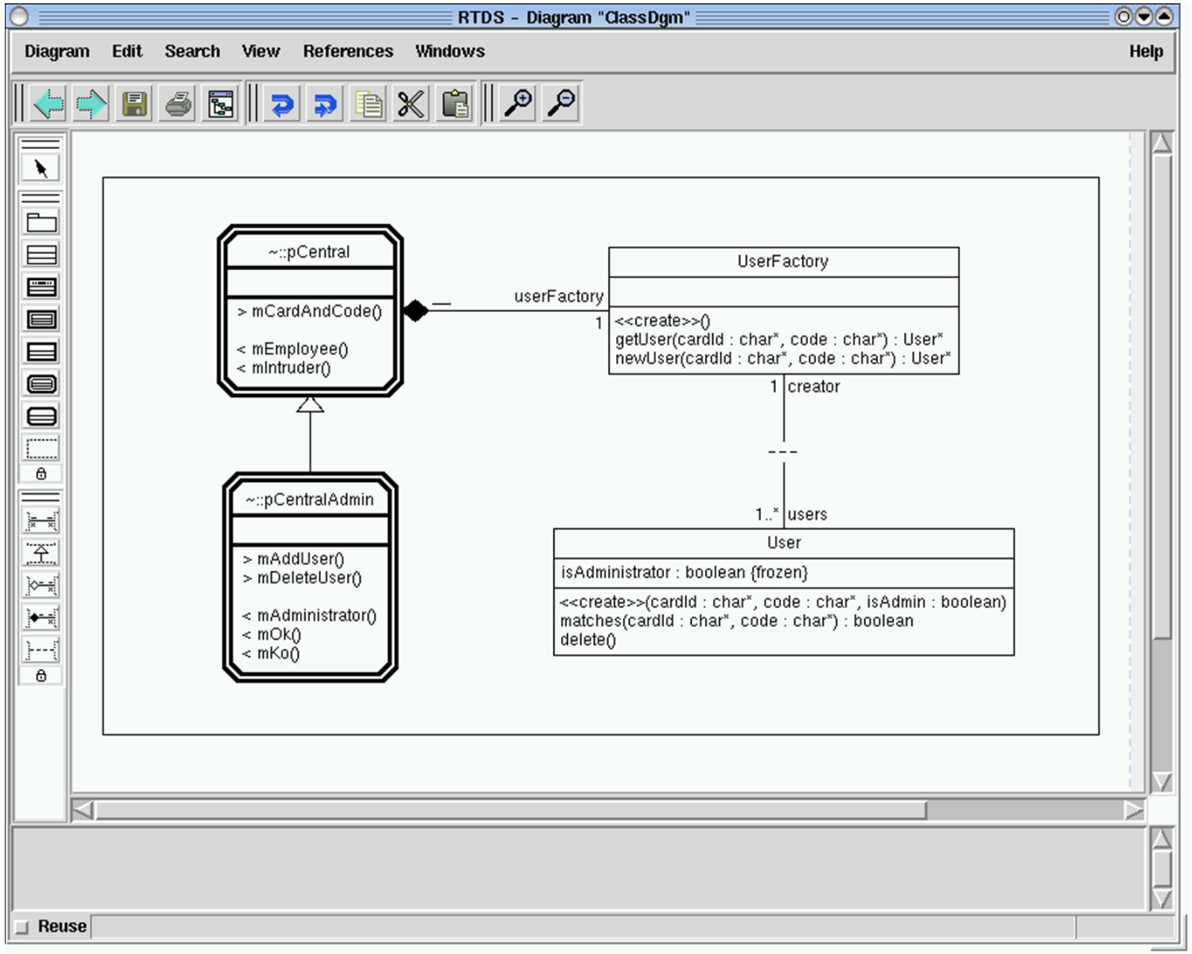
SDL-RT
specification & description language - real time

SDL-RT is:

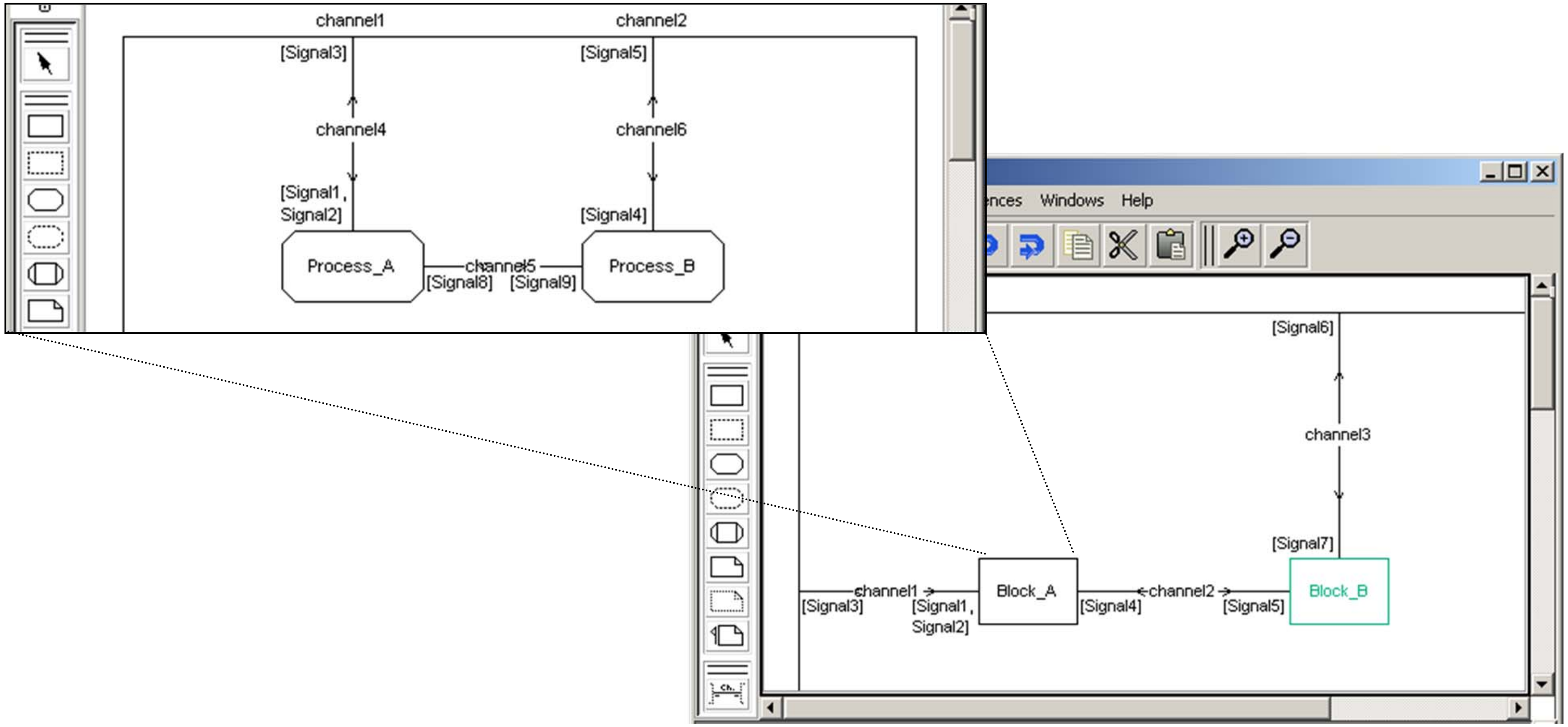
- Available from http://www.sdl-rt.org for free,
- Legible,
- Based on a standardized textual format (XML),
- Submited to ITU to be part of standard SDL,
- A UML real time profile.

Views: Class diagram

Relations between static classes (C++) and dynamic classes (SDL)



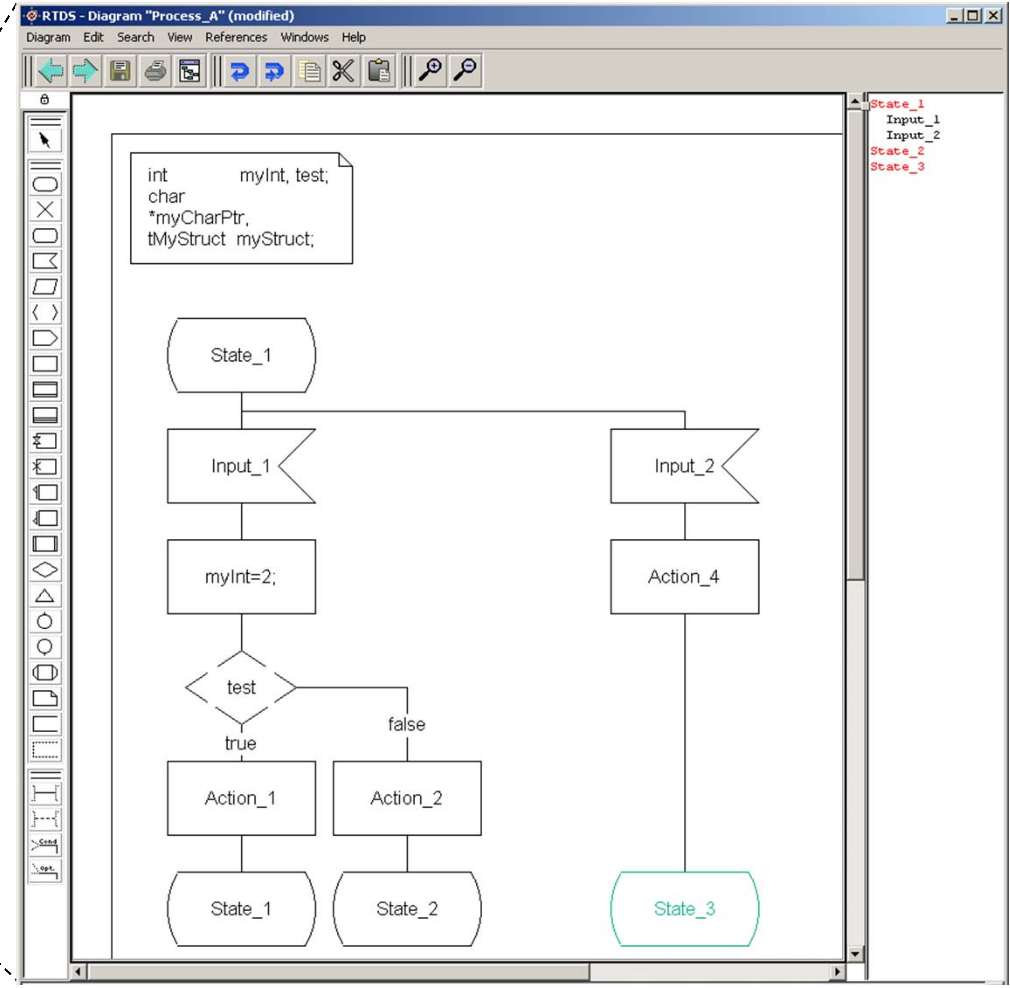
Views: Architecture and communication



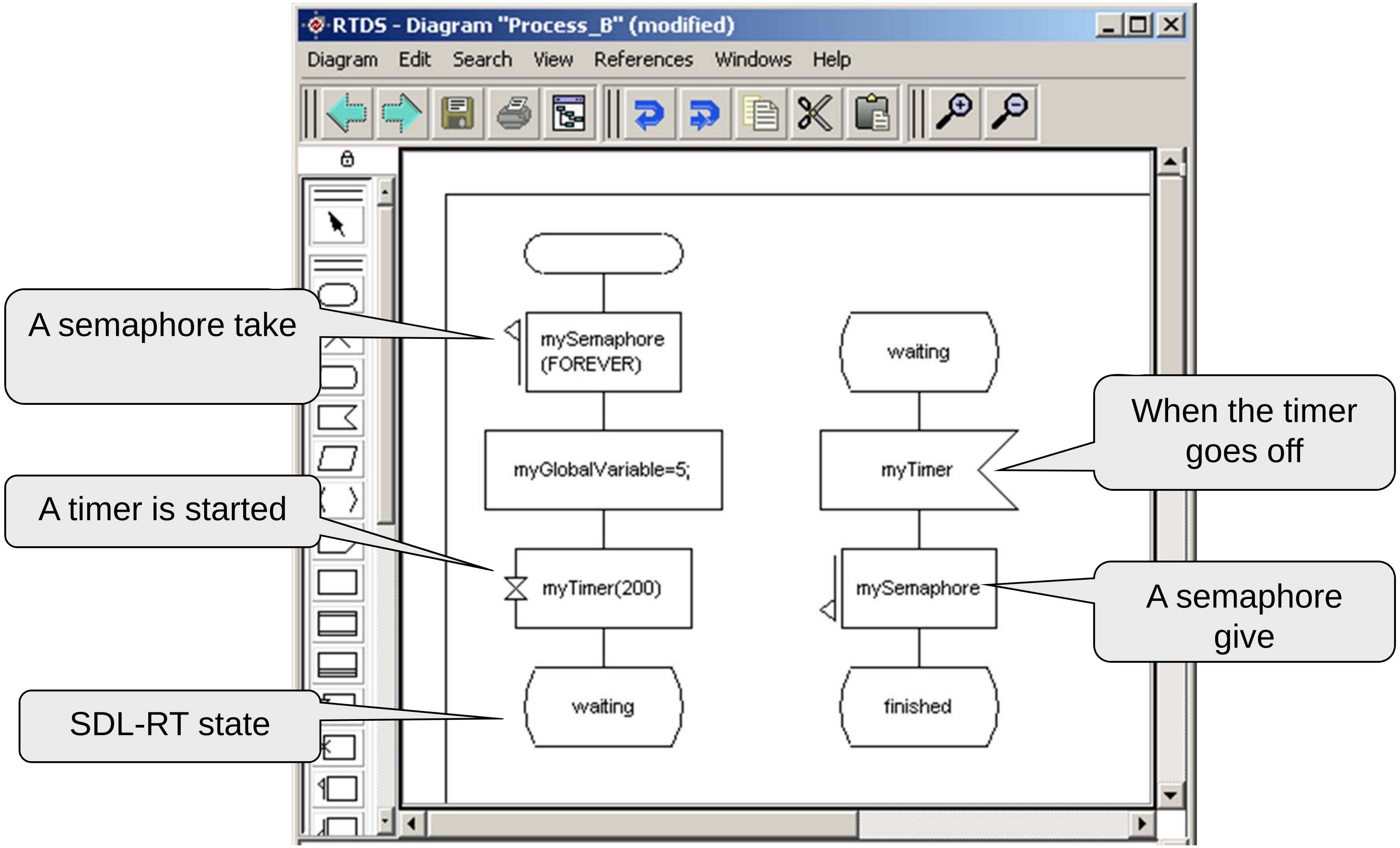
Views: Behavior and Data

SDL abstract data types or SDL-RT C/C++ data types.

Process A

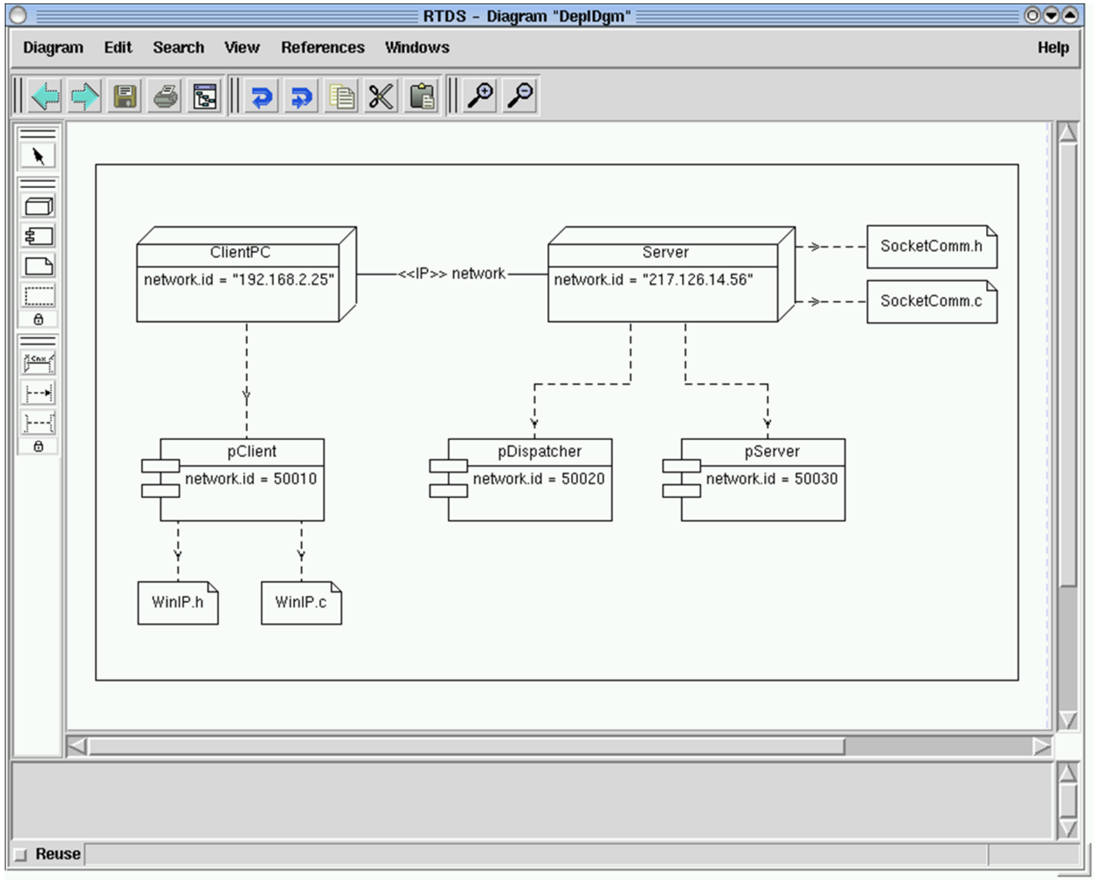


Views: Operating system services



Views: Distributed systems

Physical deployment



Model views

- Library of components
- System architecture
- Interface definitions
- Application deployment
- Real time concepts
- Key points in the design

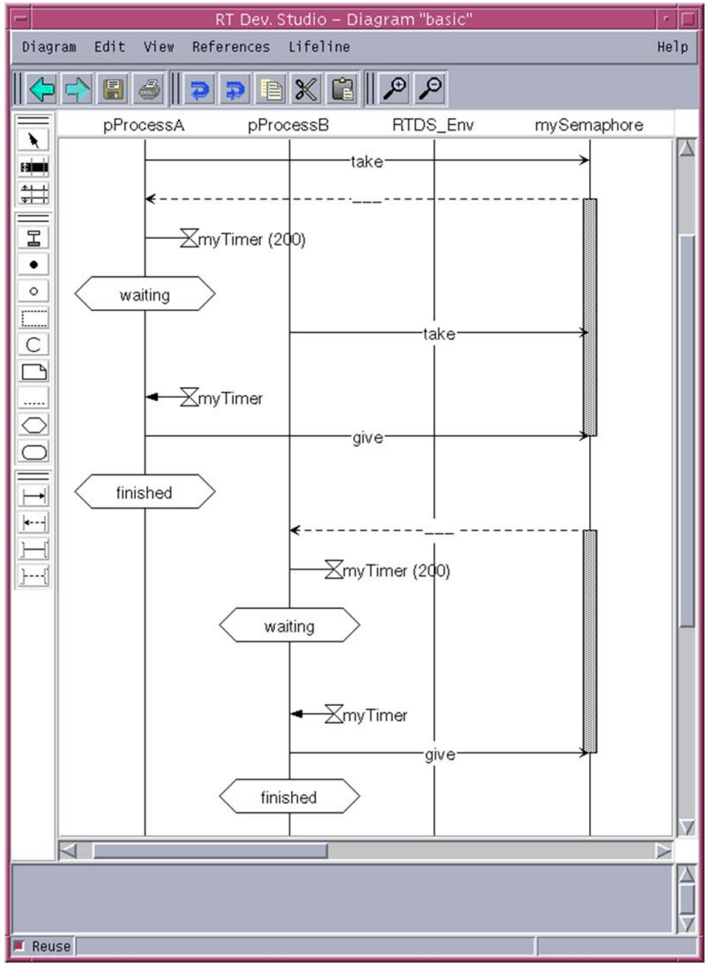
MSC: dynamic view

Message Sequence Chart

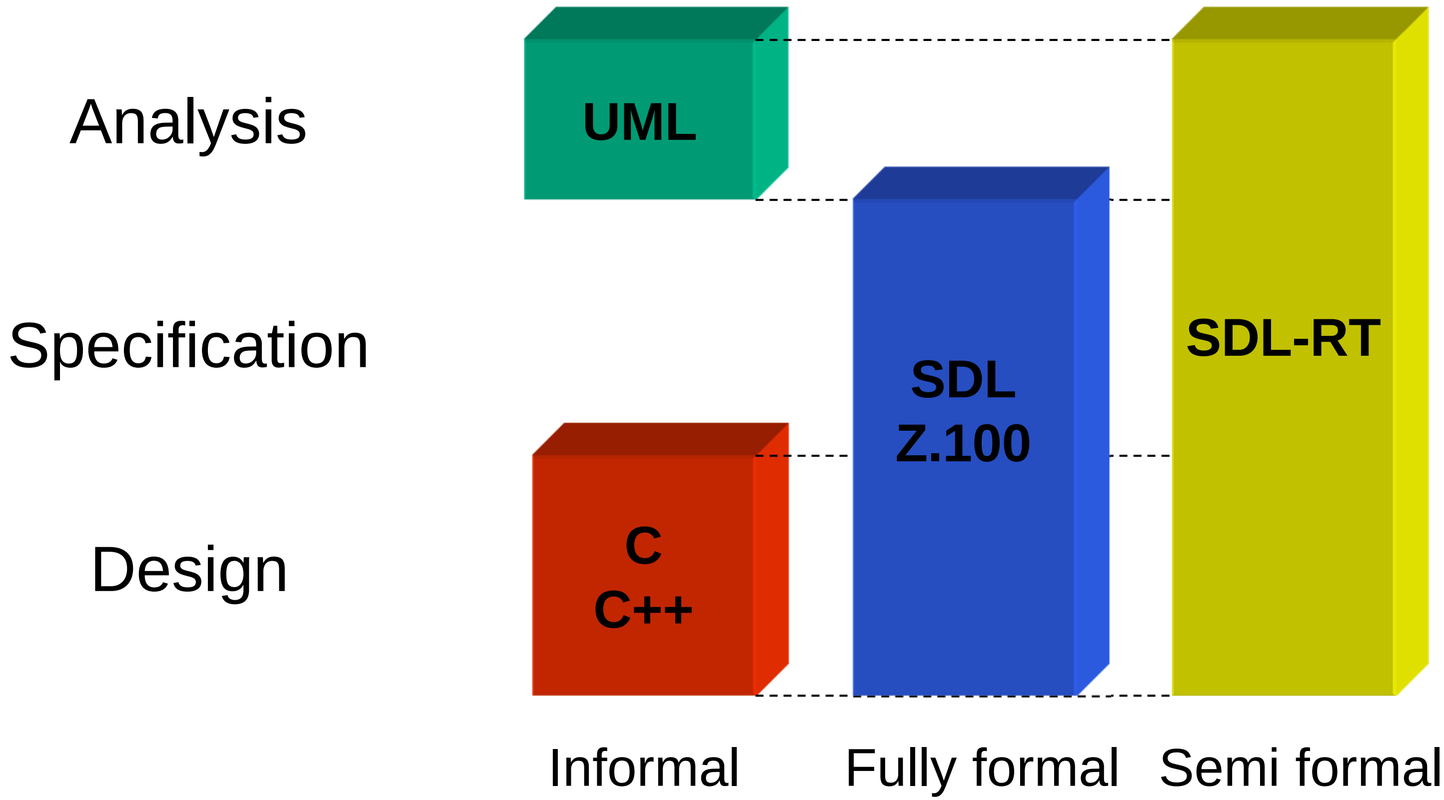
- Vertical lines represent a task, the environment or a semaphore,
- Arrows represent message exchanges, semaphore manipulations or timers.

Can be used:

- As specification
- Execution traces



RTDS: supported languages



RTDS: supported languages

Informal modelling for requirements: UML

- Edition
- C++ stubs generation

Semi-formal modelling for design: SDL-RT

- Edition
- Syntaxic et semantics checking
- Code generation
- Graphical debugging

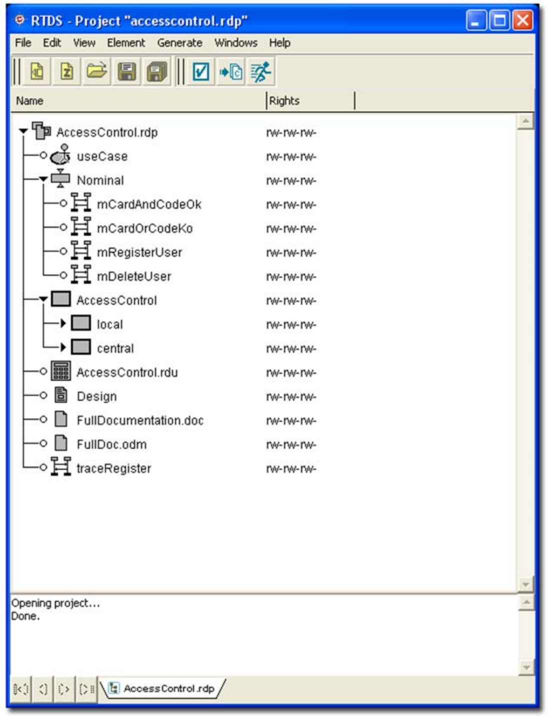
Fully formal modelling for specification: SDL Z.100

- Edition
- Syntaxic et semantics checking
- Simulation
- Verification
- Code generation
- Graphical debugging
- Test

Tools: the Project manager

It is the « hub » of the toolset:

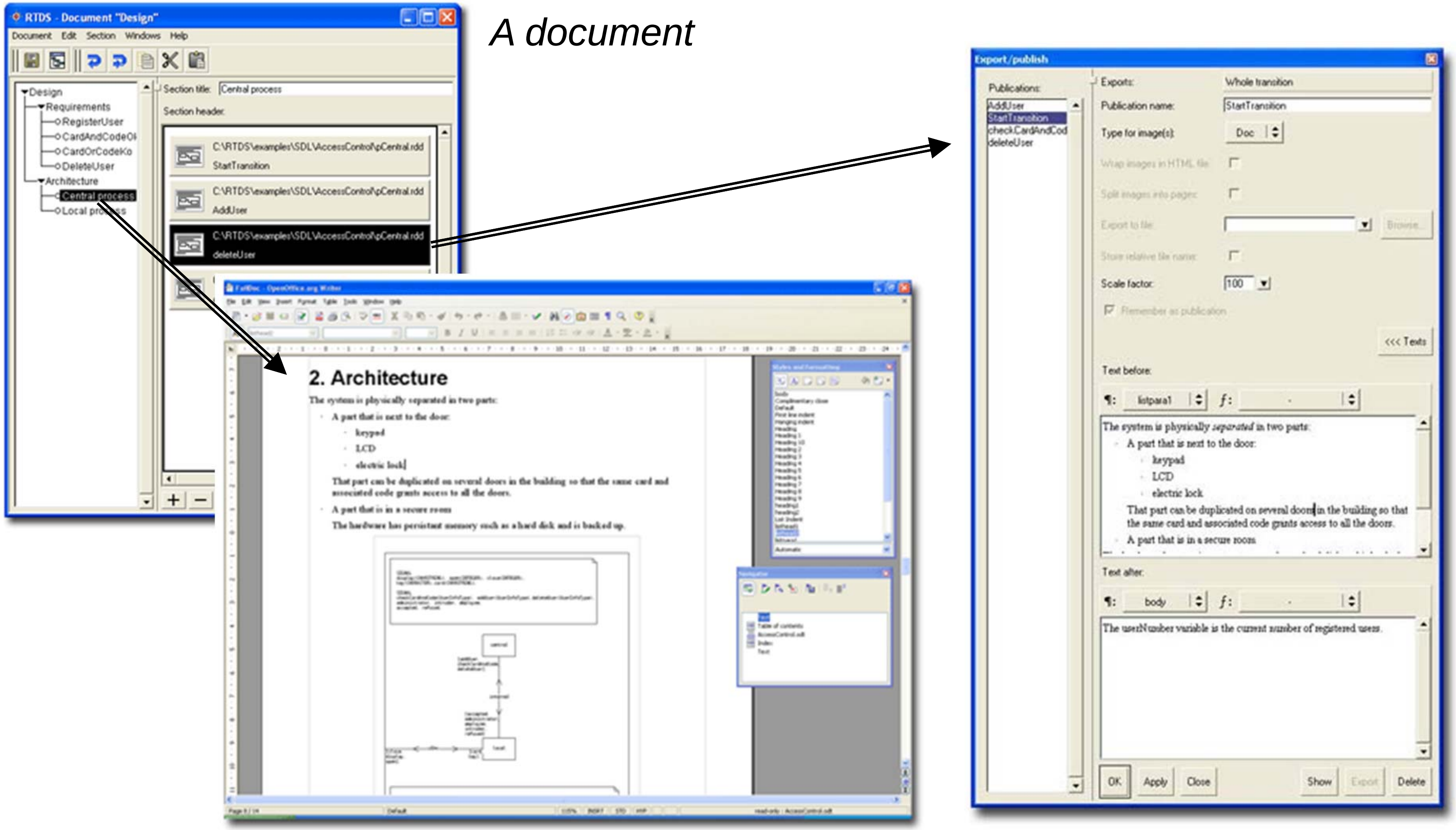
- File organization (UML, SDL, SDL-RT, C, C++, H, traces and others) with packages,
- Calls the editors, the debugger, and the code generator,
- Handles code generation profiles.



Documentation generation

- Logical publications (state, transition, partition, diagram)
- Comments preceeding or following the publication
    - Styles for paragraphs
    - Styles for characters
- Export format
    - RTF
    - OpenDocument
    - HTML
    - SGML
- Exported elements
    - Texts with publications
    - Index entries
    - Table of contents entries

Documentation generation



A document

The generated documentation

A publication

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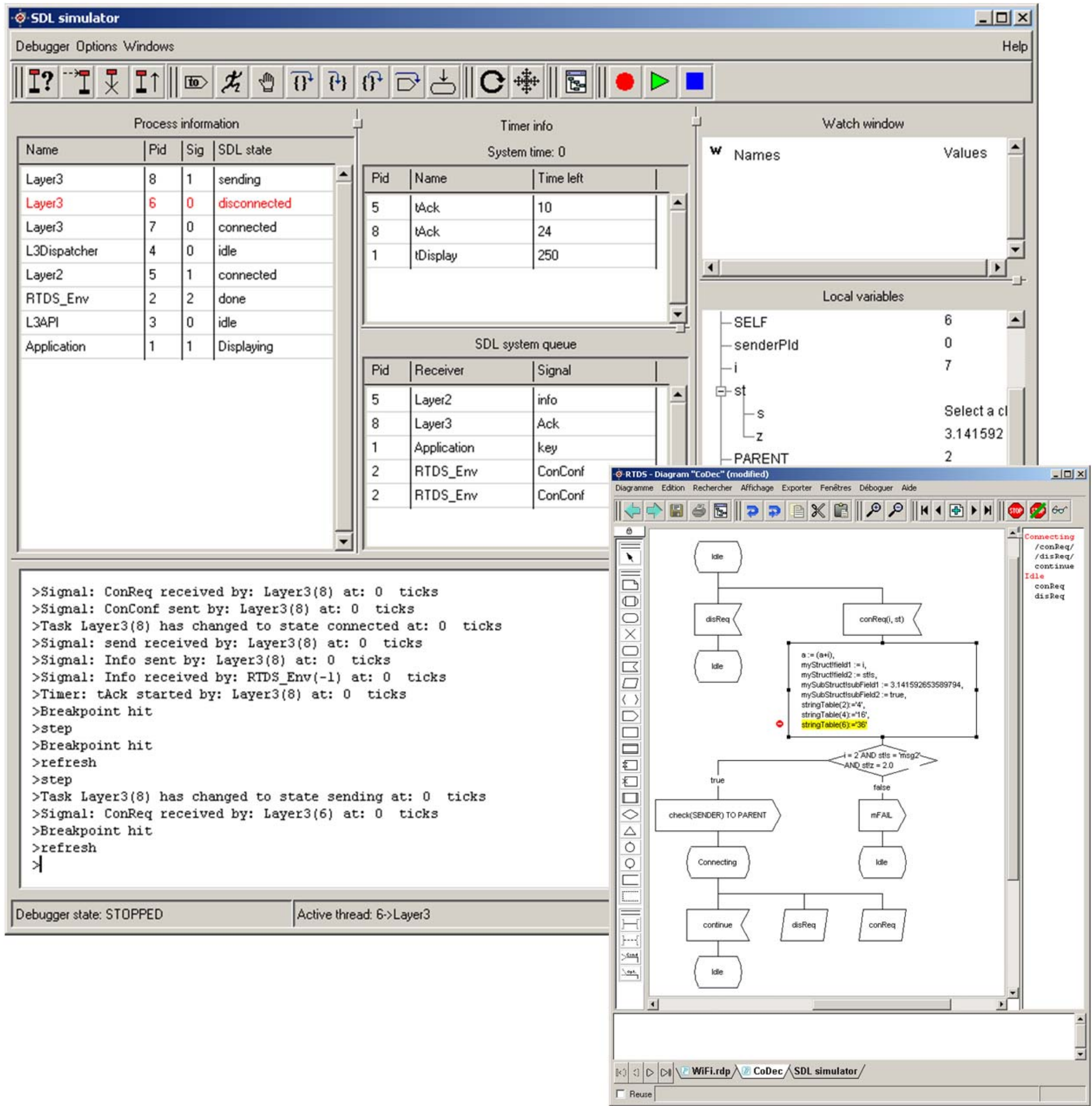

Model simulator

A graphical *debugger* for fully formal models based on the model semantic

- Set breakpoints and step in the diagrams,
- Externally defined or interactive operator calls,
- Dynamic traces,
- Connecting an external tool is possible through a socket.

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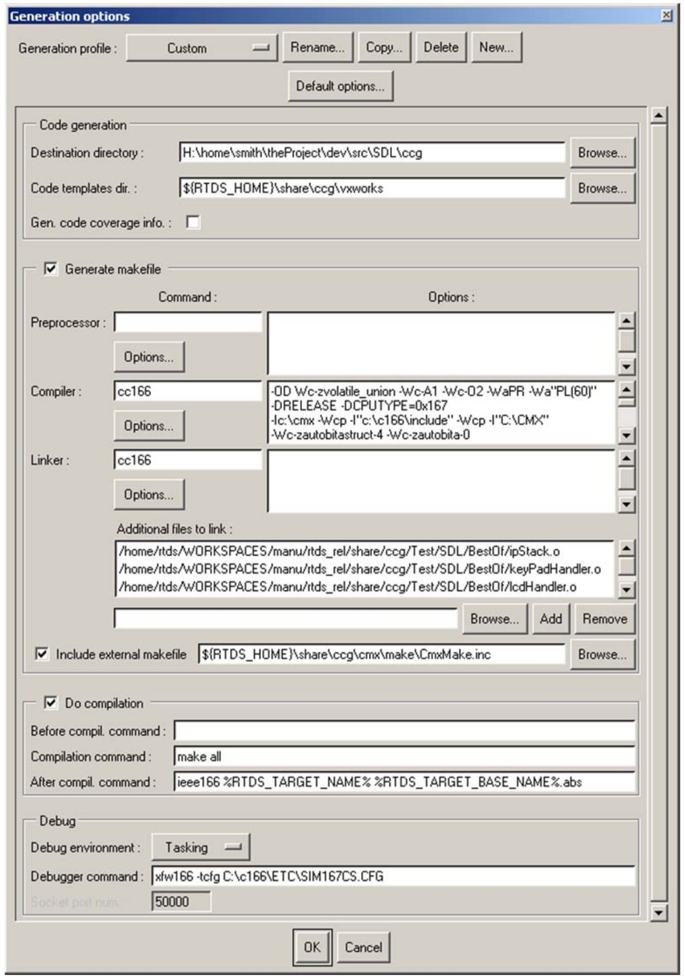
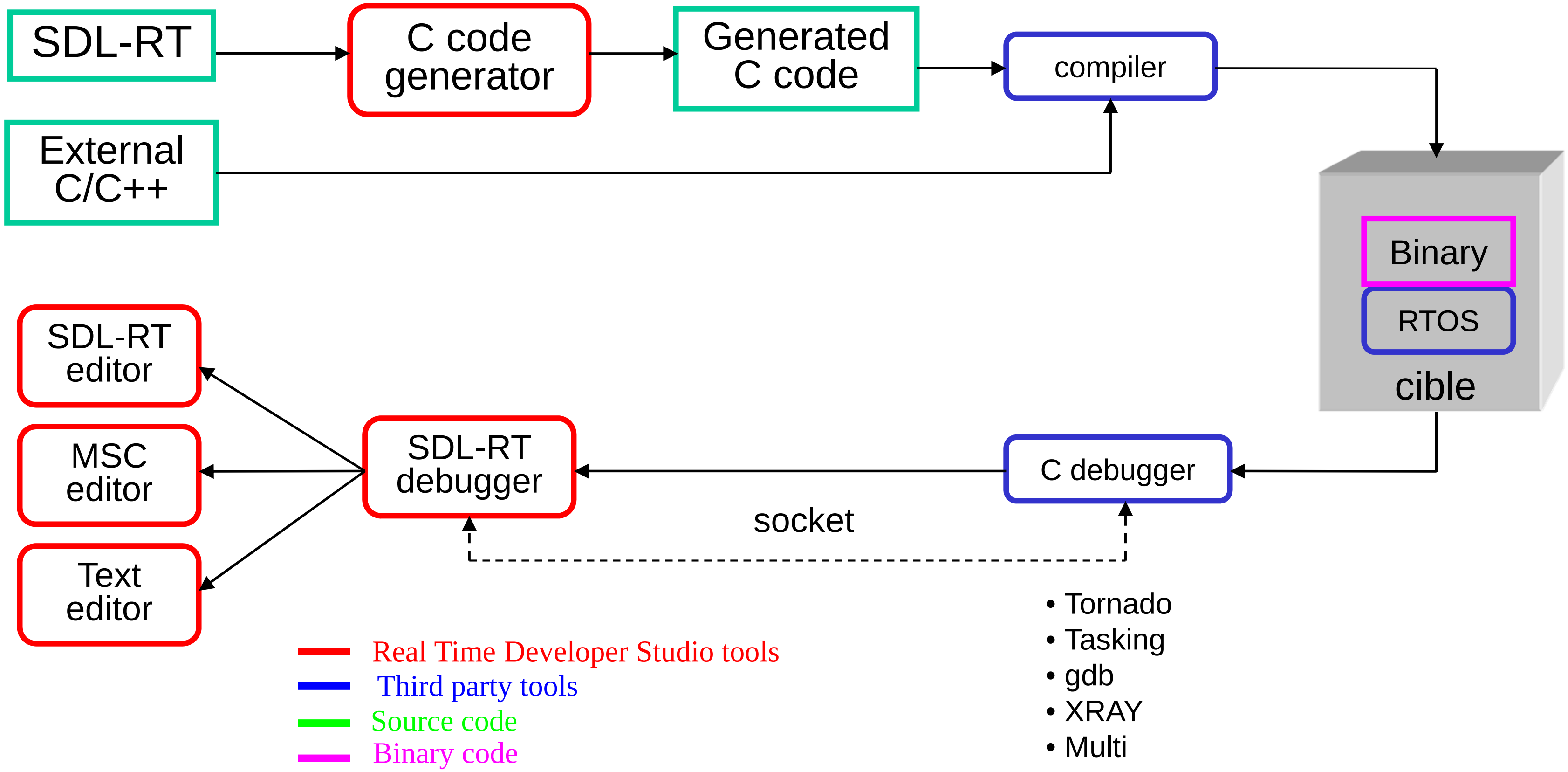
Code generation



- C++ skeleton for static classes
- C or C++ for dynamic classes
- Generated code is legible
- Generation profile wizard
- The code is:
  - Integrated with: VxWorks, OSE, OSE Epsilon, CMX RTX, Nucleus, uiTRON, Posix, ThreadX, and Win32,
  - Provided with an scheduler,
  - Royalty free,
  - Documented for customization.

Debugging architecture

The Model debugger relies on a traditional C debugger or cross debugger to provide graphical debugging.

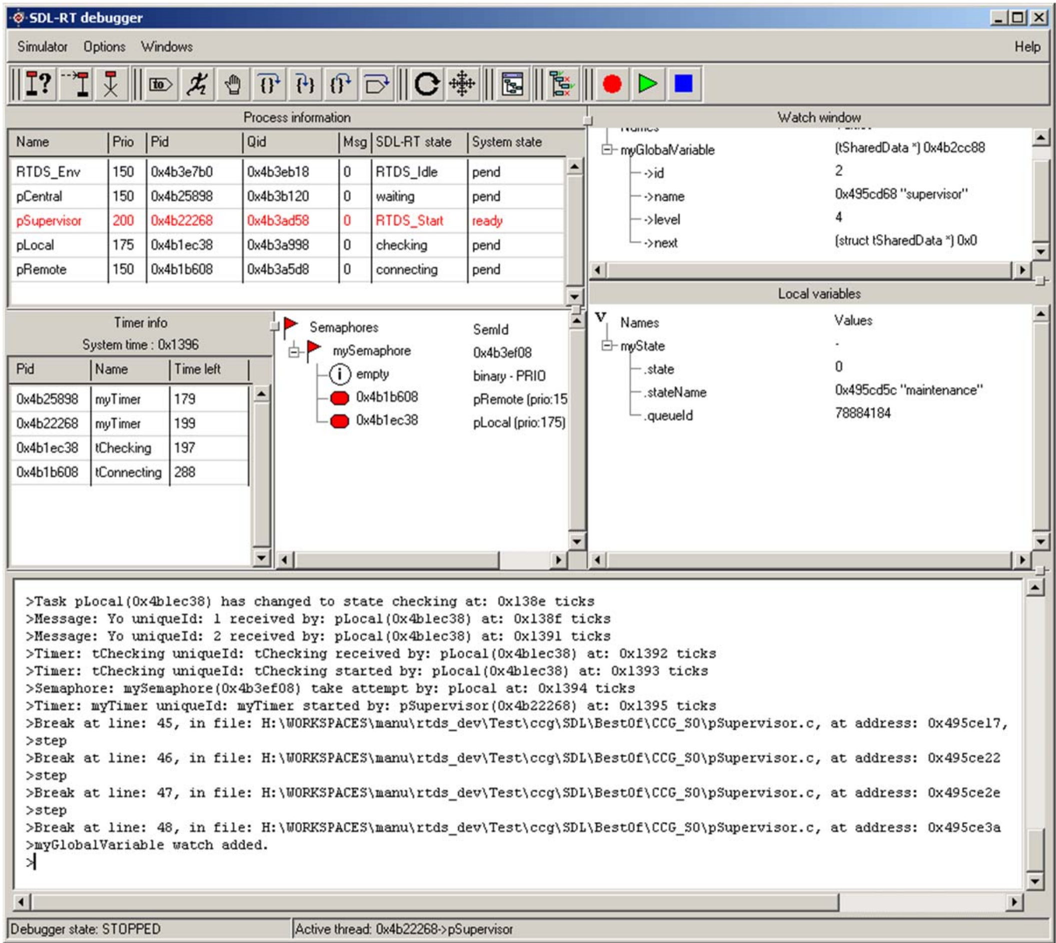


Model debugger

Relies on the target semantic: processor and RTOS.

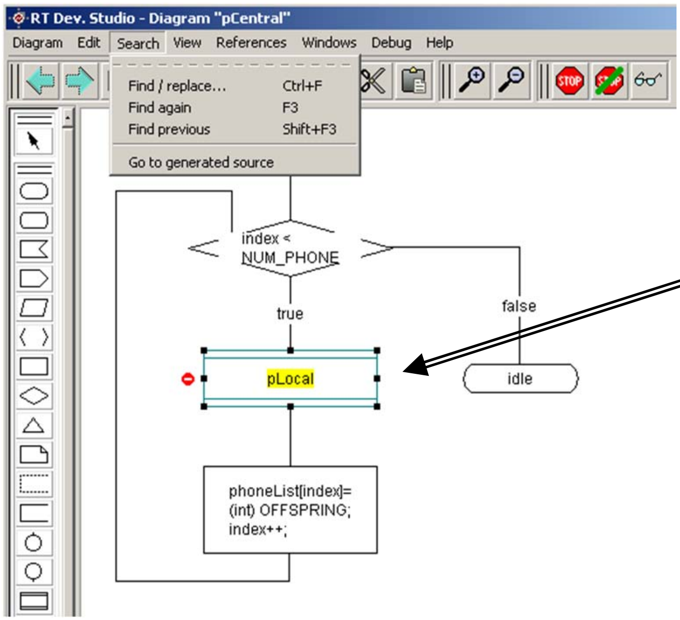
Debug in the model:

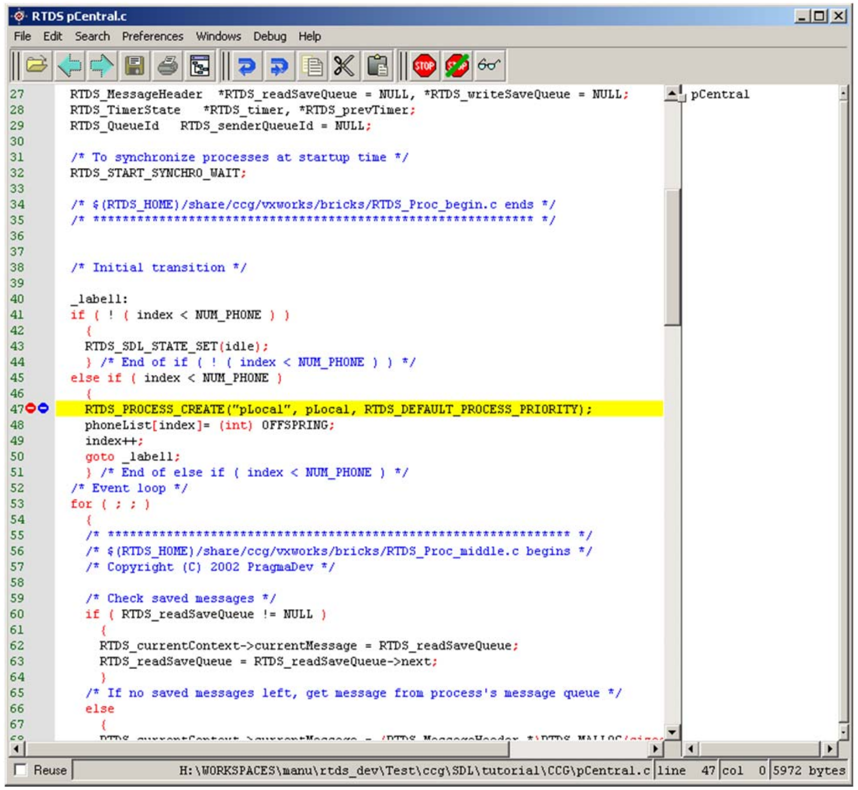
- Breakpoints, stepping, in the SDL/RT diagrams or in the generated C files,
- Dynamic MSC traces,
- Connecting an external tool is possible through a socket.



Debug features

- Switch between
  - Model
  - Generated C/C++ code





Graphical traces

Execution traces:

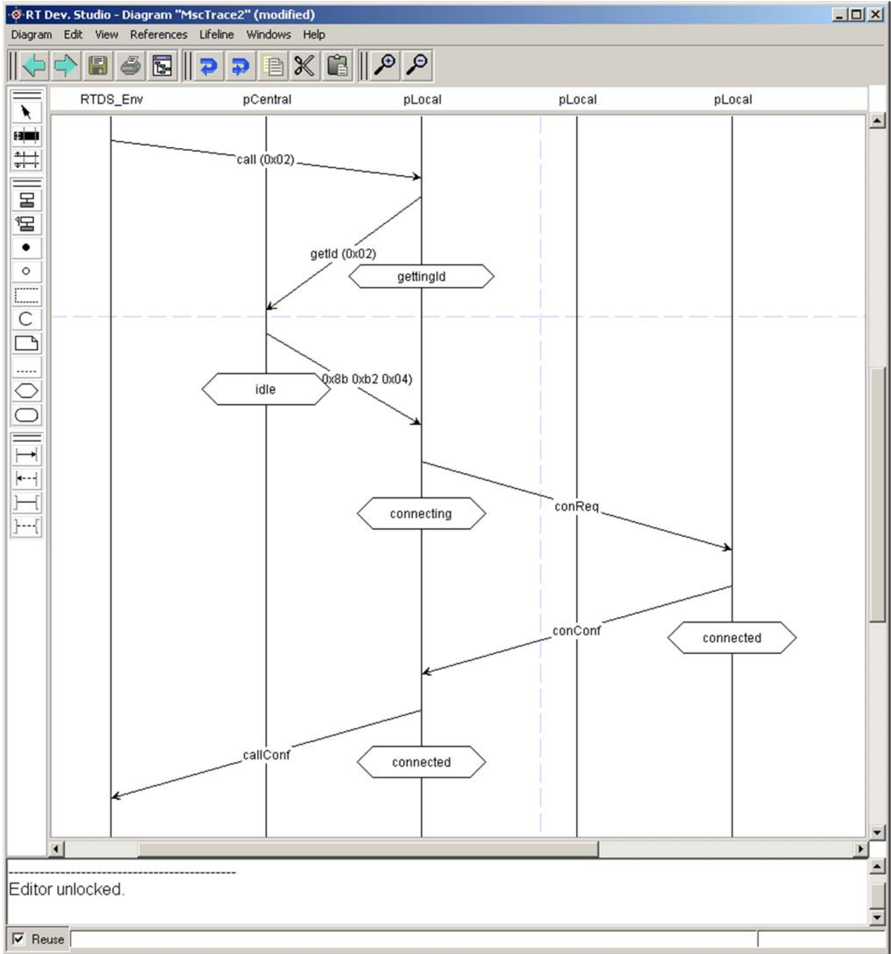
- States,
- Events,
- Semaphores,
- Timers.

Trace level configuration

Display of system time

MSC Diff allows to check:

- Conformity,
- Non-regression.



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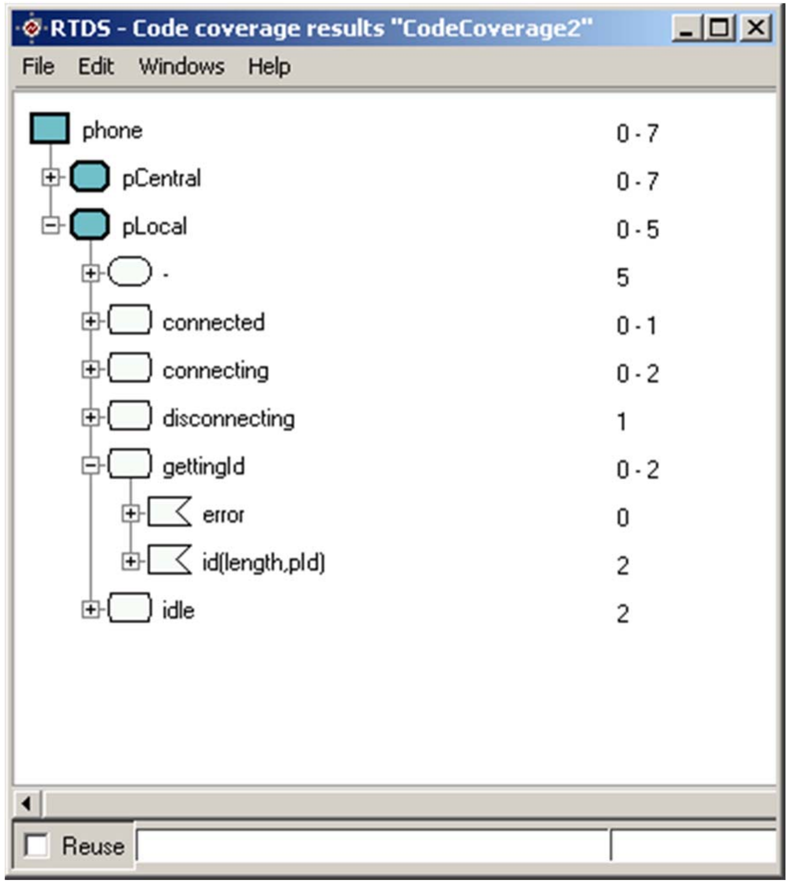
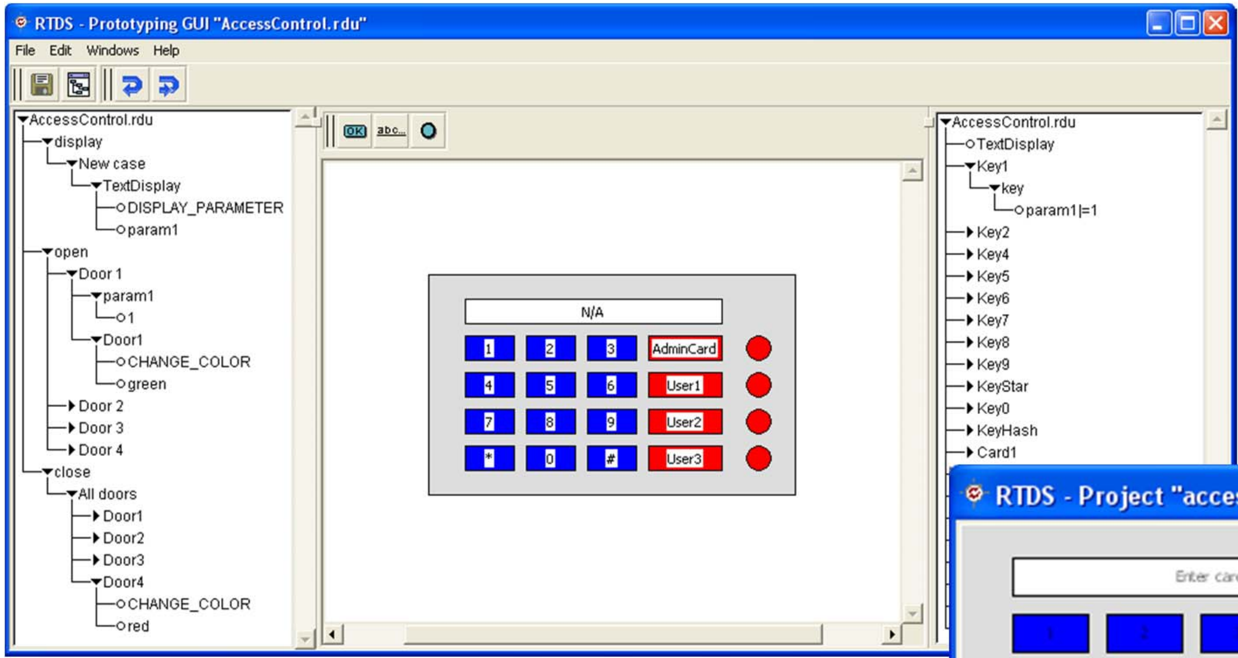
Model coverage

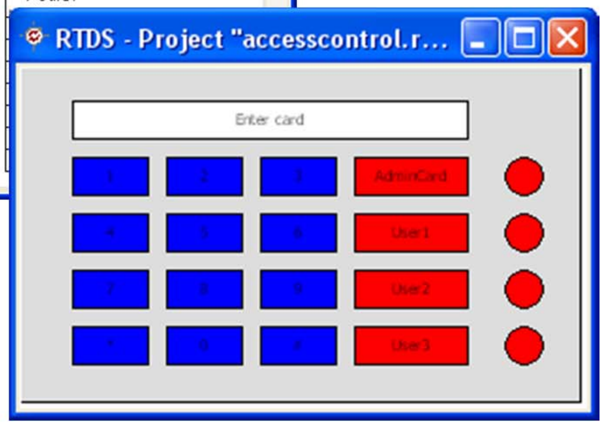
- Graphical model coverage analysis
- Merge feature



Prototyping interface

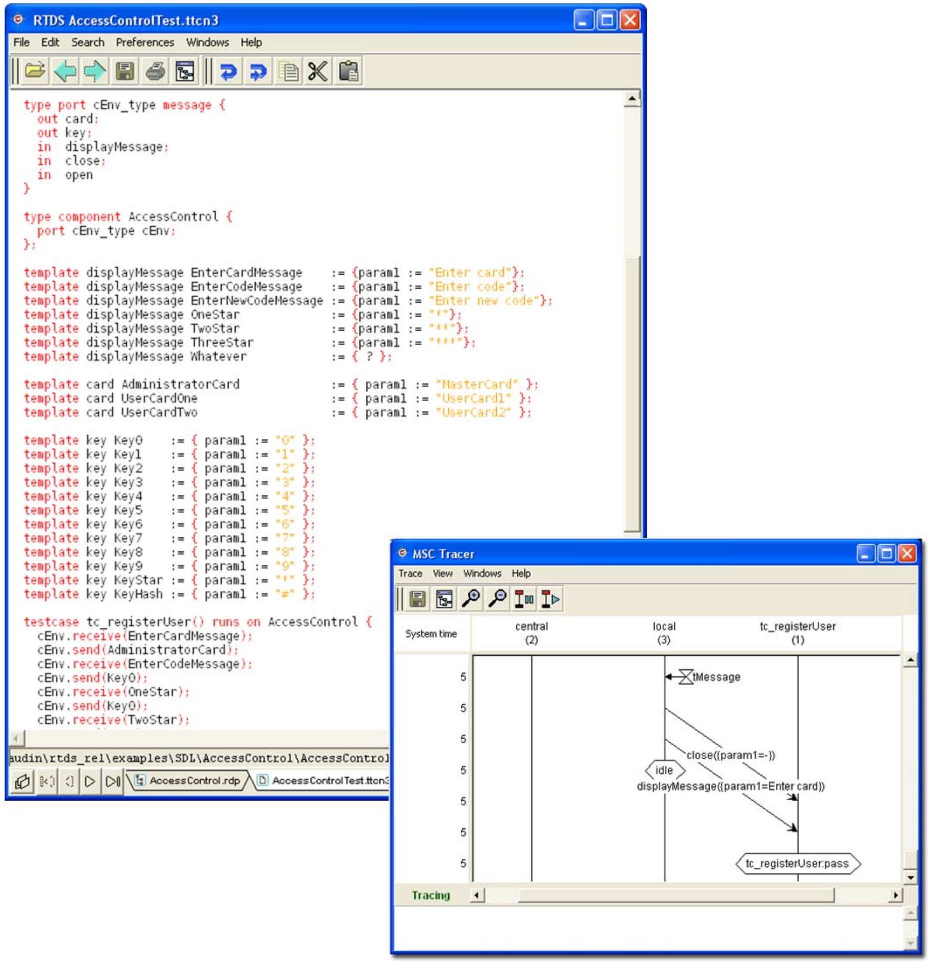


➢ Knows about the model inputs and outputs.



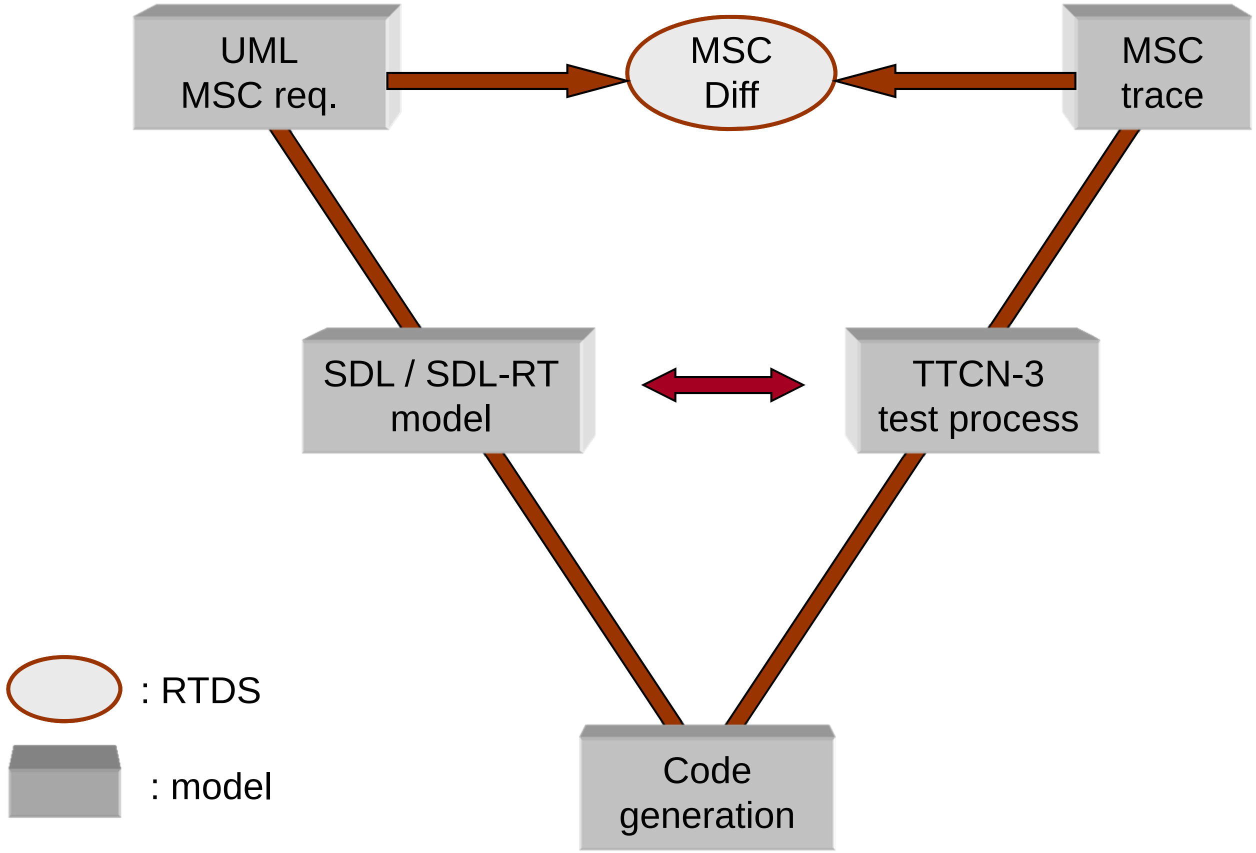
➢ Connects automatically to the simulator or the debugger.

Model based testing



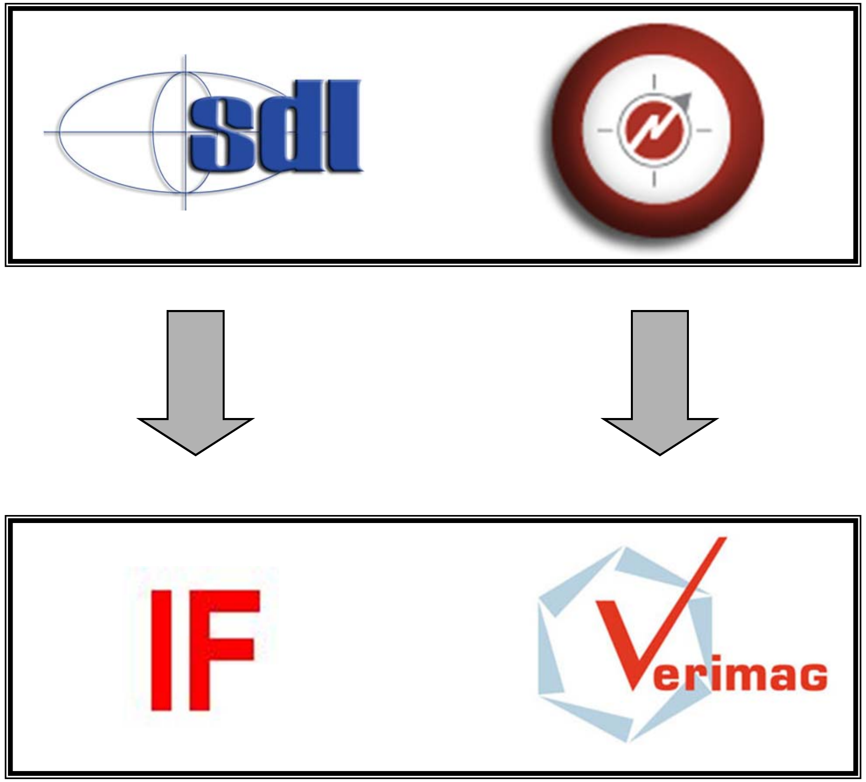
- Based on TTCN-3 international standard:
  - Data types definitions,
  - Templates definitions,
  - Test cases,
  - Execution control.
- Connects automatically to the Simulator:
  - Breakpoints in the model or in the test suite,
  - Verdict displayed in the trace.

Methodology

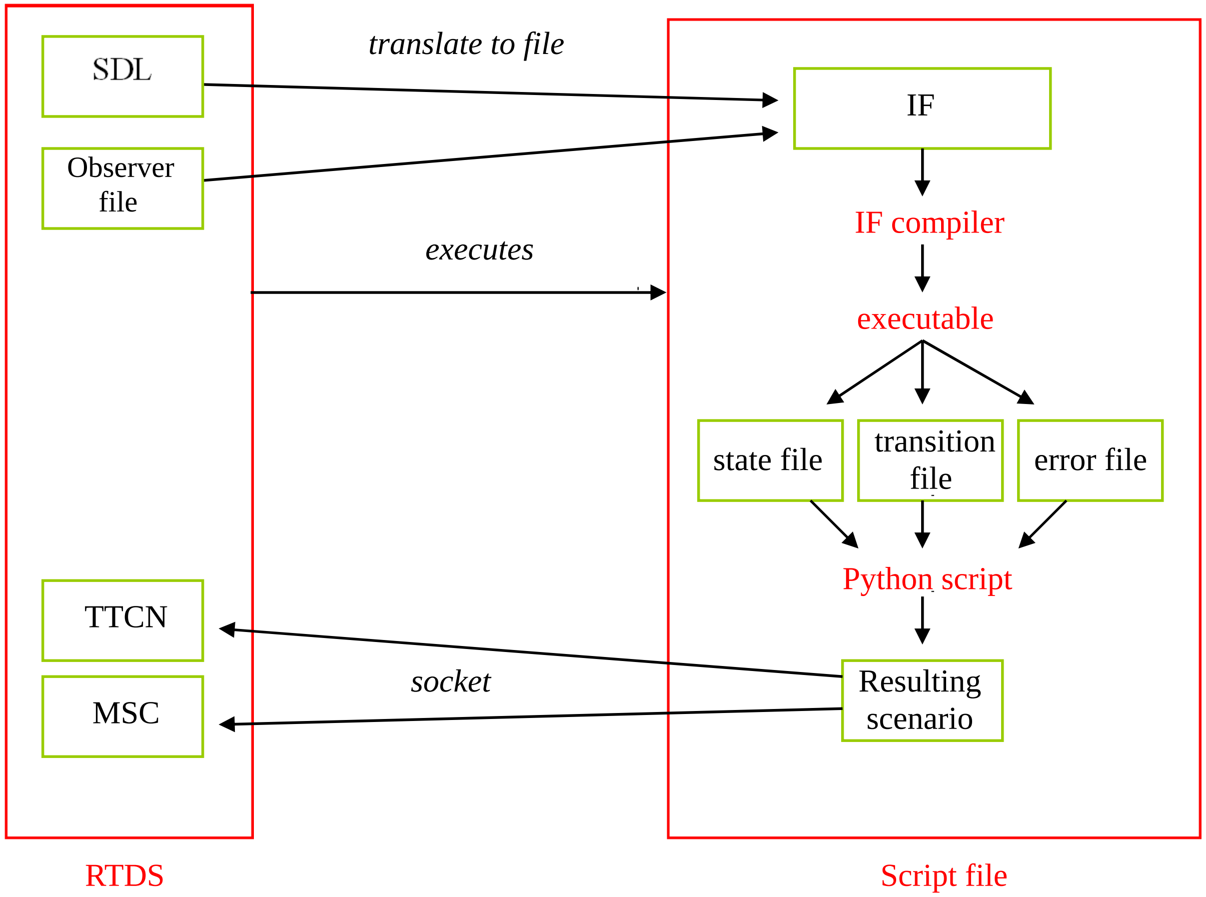


Model checking

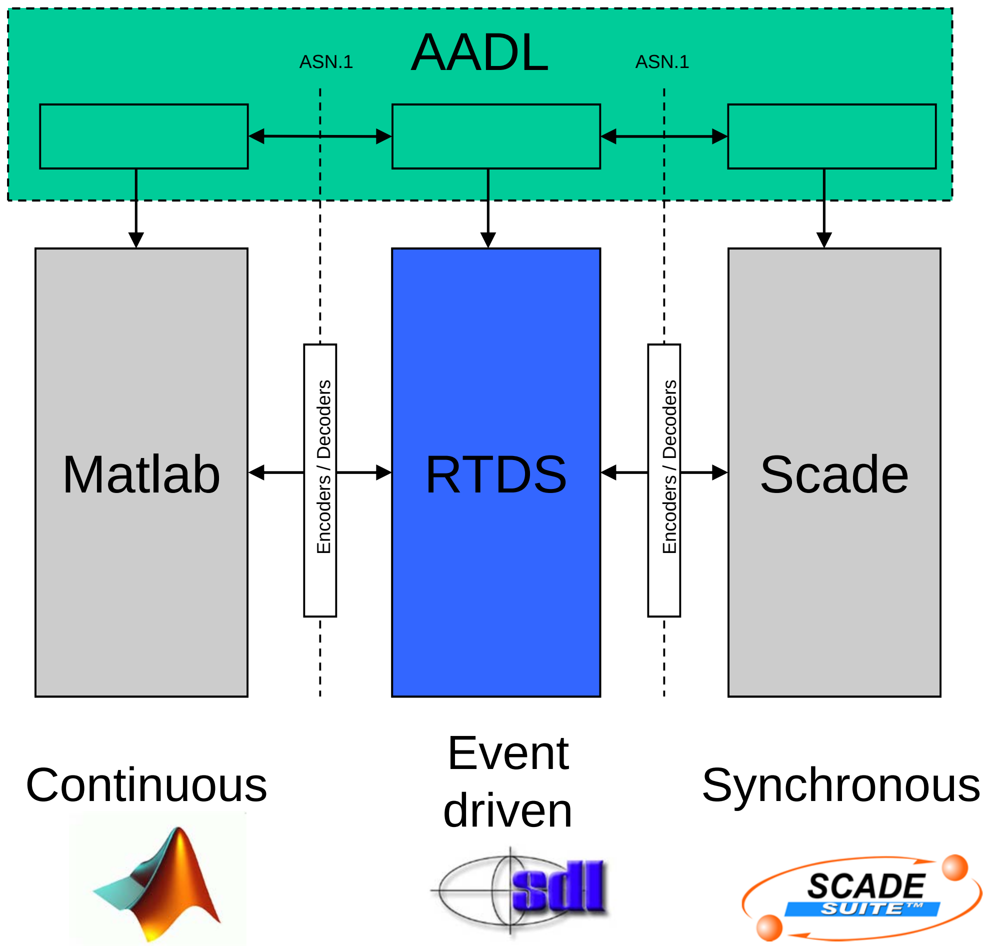
- Partnership with Verimag on IF technology.
  - Exhaustive simulation,
  - Observers,
  - Test generation.
- RTDS feature
  - Export to IF,
  - Execute a script
  - Generate an MSC feedback.



Implementation



ESA Taste framework integration



Project management

- Textual storage format, graphical diff tool, and an automatic merge tool provide a consistent integration with configuration management tools.
- Single diagrams can be exported as PNG, JPEG, PS, and HTML.
- Full documentation of the model can be generated.
- Traceability information and Reqtify integration.
- System requirements:
    - Solaris,
    - Windows,
    - Linux.
- Floating licenses.

Conclusion

- Three levels of modelling:
    - Informal,
    - Semi-formal,
    - Formal.
- Tools to:
    - Document,
    - Simulate,
    - Validate,
    - Test.
- Based on international standards.
- Integrated in Taste framework.

Stand alone MSC Tracer

- Trace on-line or off-line your target behavior with a standard graphical representation.
  - Self-document your test campaigns,
  - Check non-regression,
  - Easy connexion,
  - Free version available.