TOPCASED Days

Using TOPCASED for Model-Based Testing

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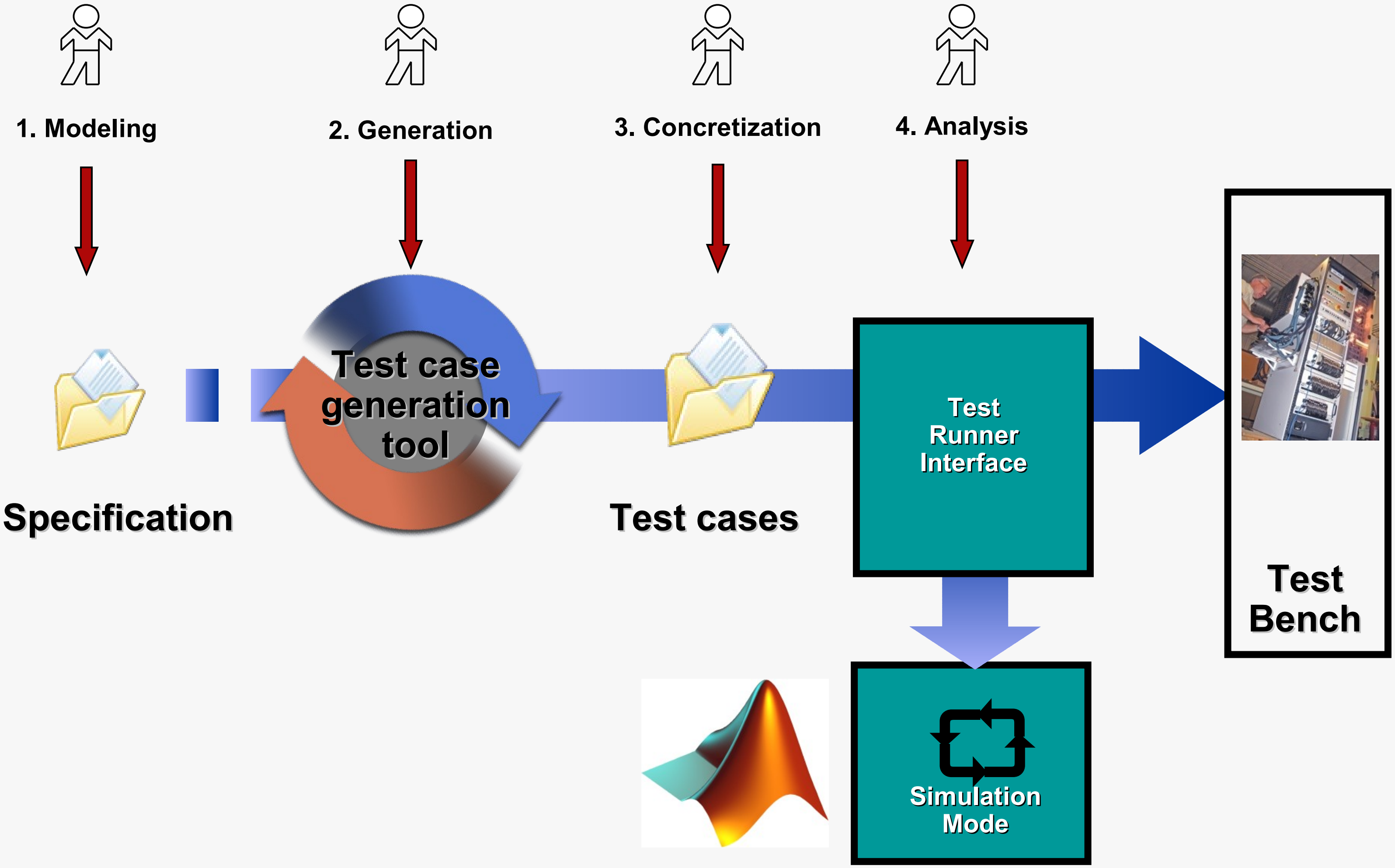
Outline

- Model-Based Testing
- VETESS project
- UML4MBT plug' in
- SysML4MBT plug' in
- Experimentations
- Demonstration

Model-Based Testing (MBT)



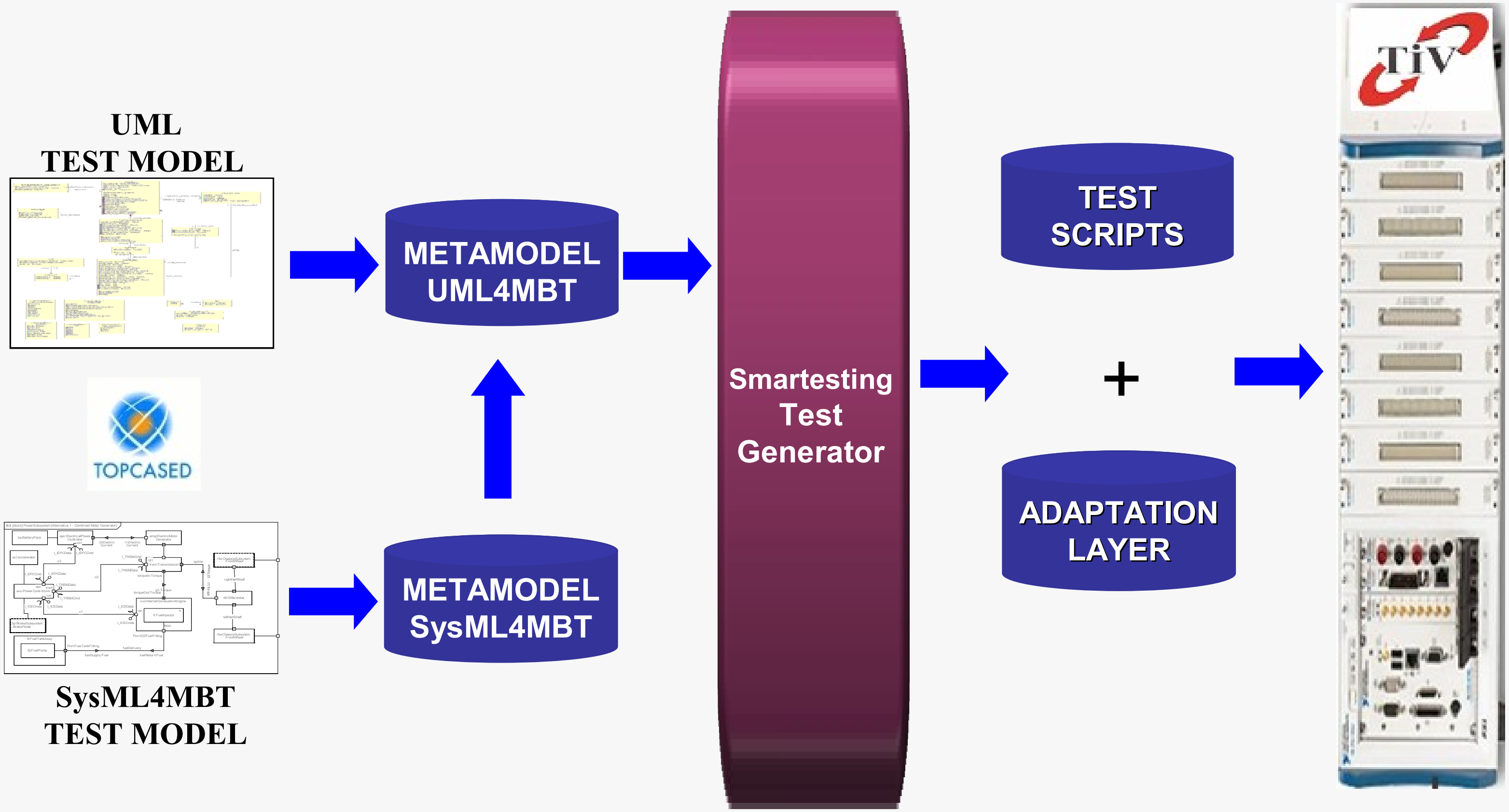
VETESS project

- VETESS: verification of vehicle embedded system by automatic test generation from specifications.

- Project labeled by the French competitiveness cluster “automotive of future” (2008/2010).

- Project members:
  - Smartesting: editor of tooled MBT solution (Test Designer).
  - Clemessy: testing bench provider (Test In View).
  - PSA Peugeot Citroën: car manufacturer.
  - LIFC: Model-Based Testing expertise (MBT).
  - MIPS: Model Driven Engineering expertise (MDE).

VETESS project



UML
TEST MODEL

METAMODEL
UML4MBT

SysML4MBT
TEST MODEL

METAMODEL
SysML4MBT

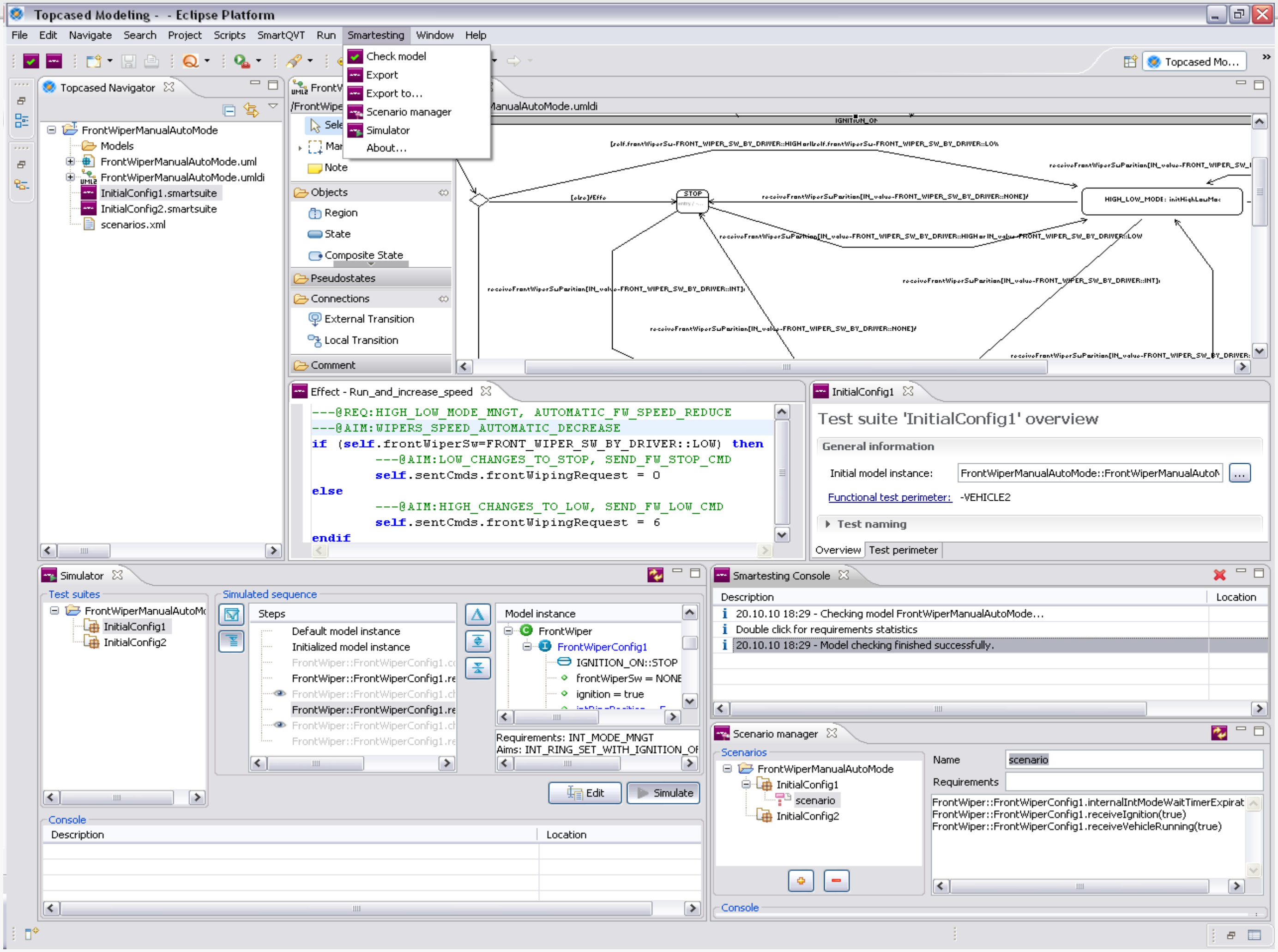
Smartesting
Test
Generator

TEST
SCRIPTS

+

ADAPTATION
LAYER

UML4MBT plug’ in



Effect - Run_and_increase_speed

```
---@REQ:HIGH_LOW_MODE_MNGT, AUTOMATIC_FW_SPEED_REDUCE
---@AIM:WIPERS_SPEED_AUTOMATIC_DECREASE
if (self.frontWiperSw=FRONT_WIPER_SW_BY_DRIVER::LOW) then
        ---@AIM:LOW_CHANGES_TO_STOP, SEND_FW_STOP_CMD
        self.sentCmds.frontWipingRequest = 0
else
        ---@AIM:HIGH_CHANGES_TO_LOW, SEND_FW_LOW_CMD
        self.sentCmds.frontWipingRequest = 6
endif
```

InitialConfig1

Test suite 'InitialConfig1' overview

General information

Initial model instance: FrontWiperManualAutoMode::FrontWiperManualAutoM

Functional test perimeter: -VEHICLE2

Test naming

Overview | Test perimeter

Simulated sequence steps:

- Default model instance
- Initialized model instance
- FrontWiper::FrontWiperConfig1.c
- FrontWiper::FrontWiperConfig1.re
- FrontWiper::FrontWiperConfig1.cl
- FrontWiper::FrontWiperConfig1.re
- FrontWiper::FrontWiperConfig1.cl
- FrontWiper::FrontWiperConfig1.re

Model instance:

- IGNITION_ON::STOP
- frontWiperSw = NONE
- ignition = true

Requirements: INT_MODE_MNGT
Aims: INT_RING_SET_WITH_IGNITION_OI

Smartesting Console

Description	Location
20.10.10 18:29 - Checking model FrontWiperManualAutoMode…	
Double click for requirements statistics	
20.10.10 18:29 - Model checking finished successfully.	

Name: scenario

Requirements:

```
FrontWiper::FrontWiperConfig1.internalIntModeWaitTimerExpirat
FrontWiper::FrontWiperConfig1.receiveIgnition(true)
FrontWiper::FrontWiperConfig1.receiveVehicleRunning(true)
```

UML4MBT plug’ in: UML4MBT

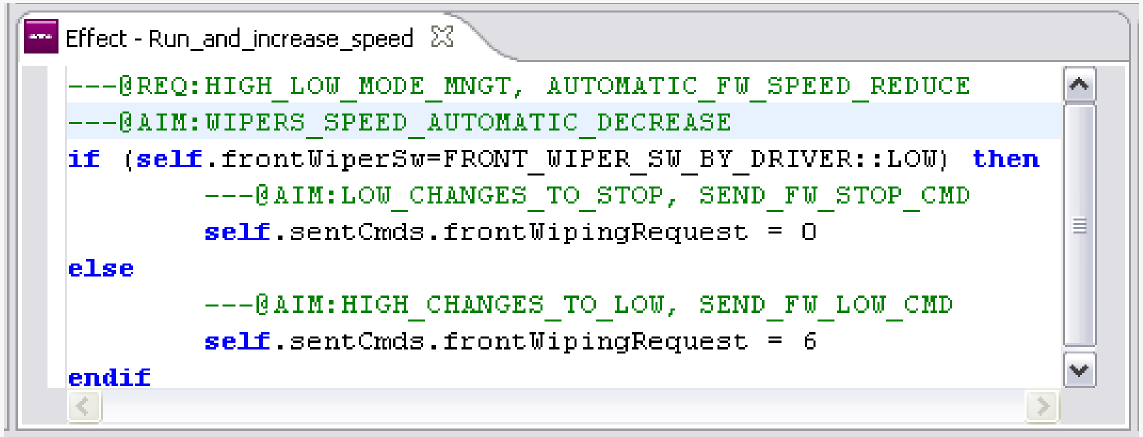
- Class Diagram:
  - Static view of the system.
  - Classes, associations, enumerations, class attributes and operations.
- Object Diagram:
  - Concrete objects used to compute test cases.
  - Define the initial state of the system.
  - Must be an instantiation of the class Diagram.

UML4MBT plug’ in: UML4MBT

- Dynamic view:
  - One Statemachine Diagram (annotated with OCL constraint).
    - 🚫 parallel states
    - historic states
    - fork and join states
  - OCL expressions to precise behaviors of operations and transitions.
- Several restrictions on OCL.

UML4MBT plug' in: OCL editor

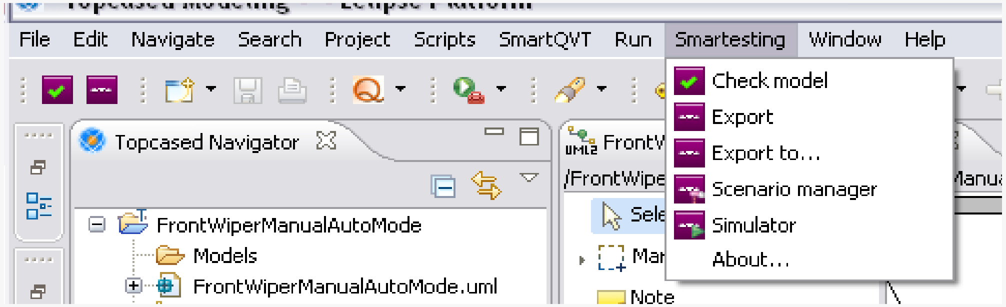
- OCL editor:
  - Syntactic coloring.
  - Auto-completion:
    - Transitions guards and effects.
    - Operations preconditions and postconditions.
    - States onEntry and onExit.



```
---@REQ:HIGH_LOW_MODE_MNGT, AUTOMATIC_FW_SPEED_REDUCE
---@AIM:WIPERS_SPEED_AUTOMATIC_DECREASE
if (self.frontWiperSw=FRONT_WIPER_SW_BY_DRIVER::LOW) then
        ---@AIM:LOW_CHANGES_TO_STOP, SEND_FW_STOP_CMD
        self.sentCmds.frontWipingRequest = 0
else
        ---@AIM:HIGH_CHANGES_TO_LOW, SEND_FW_LOW_CMD
        self.sentCmds.frontWipingRequest = 6
endif
```

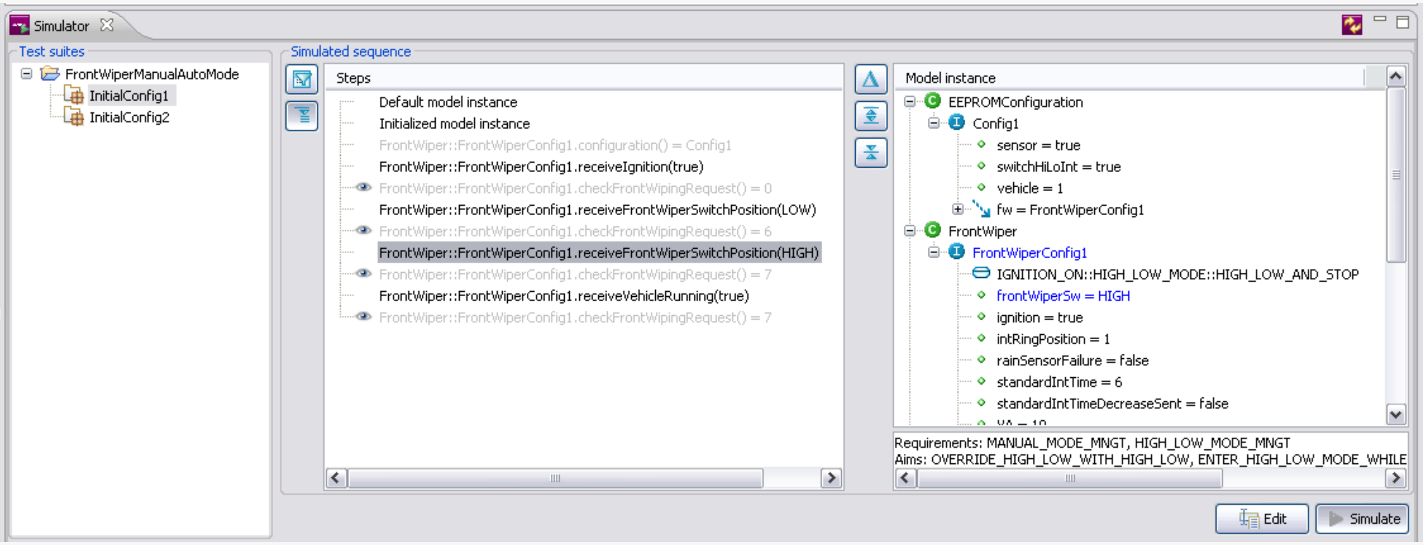
UML4MBT plug' in: verification part 1

- Syntactic verification:
  - UML model satisfies UML4MBT restrictions.
  - Checking syntactic errors:
    - Same name for an association and a class.
    - Multiplicities violations (object diagram).
    - OCL errors…



UML4MBT plug’ in: verification part 2

- Functional validation:
  - Simulation of the model.
  - Checking the correctness of modeled behaviors.



Test suites:

```
FrontWiperManualAutoMode
    InitialConfig1
    InitialConfig2
```

Simulated sequence – Steps:

```
Default model instance
Initialized model instance
FrontWiper::FrontWiperConfig1.configuration() = Config1
FrontWiper::FrontWiperConfig1.receiveIgnition(true)
FrontWiper::FrontWiperConfig1.checkFrontWipingRequest() = 0
FrontWiper::FrontWiperConfig1.receiveFrontWiperSwitchPosition(LOW)
FrontWiper::FrontWiperConfig1.checkFrontWipingRequest() = 6
FrontWiper::FrontWiperConfig1.receiveFrontWiperSwitchPosition(HIGH)
FrontWiper::FrontWiperConfig1.checkFrontWipingRequest() = 7
FrontWiper::FrontWiperConfig1.receiveVehicleRunning(true)
FrontWiper::FrontWiperConfig1.checkFrontWipingRequest() = 7
```

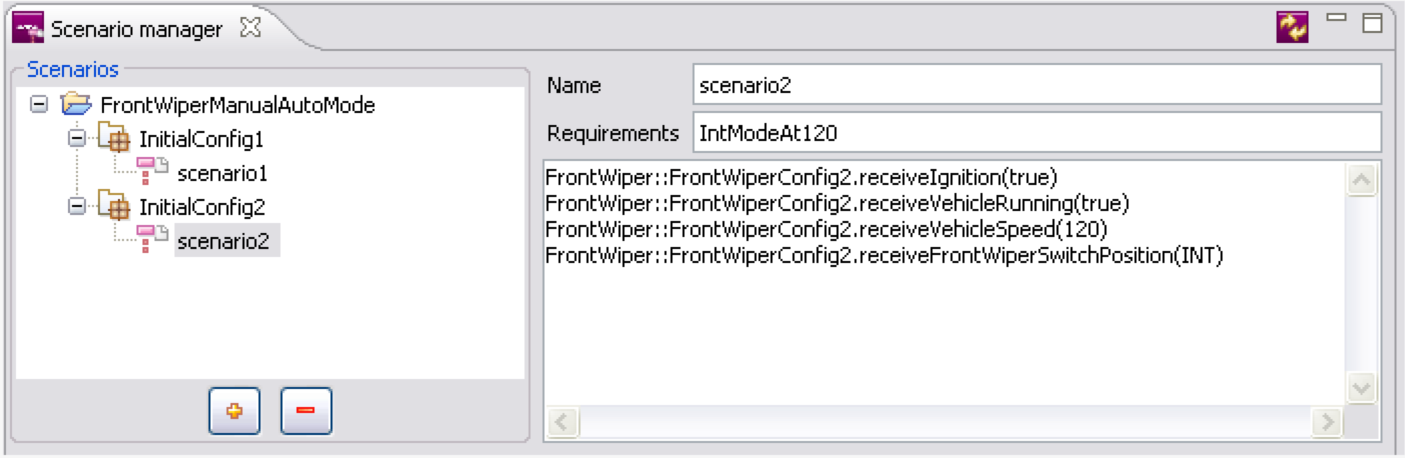
Model instance:

```
EEPROMConfiguration
    Config1
        sensor = true
        switchHiLoInt = true
        vehicle = 1
        fw = FrontWiperConfig1
FrontWiper
    FrontWiperConfig1
        IGNITION_ON::HIGH_LOW_MODE::HIGH_LOW_AND_STOP
        frontWiperSw = HIGH
        ignition = true
        intRingPosition = 1
        rainSensorFailure = false
        standardIntTime = 6
        standardIntTimeDecreaseSent = false
        VA = 10
```

Requirements: MANUAL_MODE_MNGT, HIGH_LOW_MODE_MNGT
Aims: OVERRIDE_HIGH_LOW_WITH_HIGH_LOW, ENTER_HIGH_LOW_MODE_WHILE

UML4MBT plug' in: scenario manager

- Scenario manager:
  - Creating and checking of scenarios.
  - Sequences of operation calls.
  - New test cases.



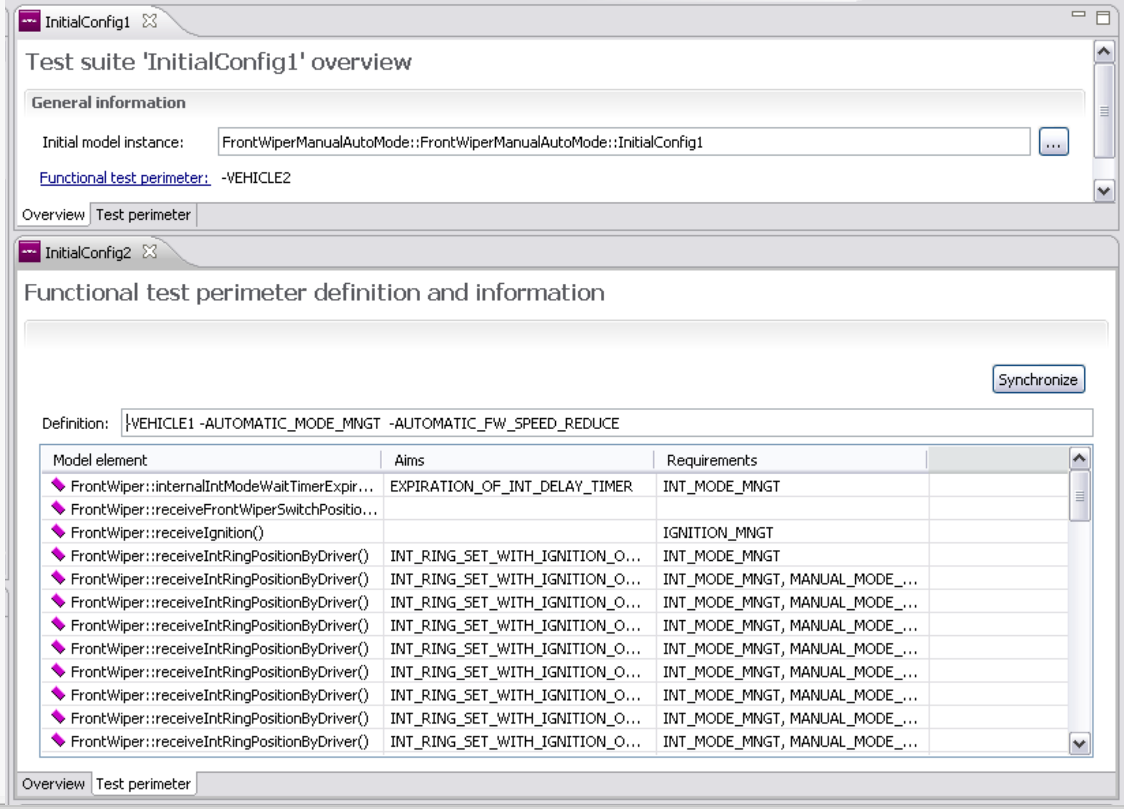
Name: scenario2

Requirements: IntModeAt120

```
FrontWiper::FrontWiperConfig2.receiveIgnition(true)
FrontWiper::FrontWiperConfig2.receiveVehicleRunning(true)
FrontWiper::FrontWiperConfig2.receiveVehicleSpeed(120)
FrontWiper::FrontWiperConfig2.receiveFrontWiperSwitchPosition(INT)
```

UML4MBT plug' in: test suites

- Test suites:
  - Splitting test targets.



InitialConfig1

Test suite 'InitialConfig1' overview

General information

Initial model instance: FrontWiperManualAutoMode::FrontWiperManualAutoMode::InitialConfig1

Functional test perimeter: -VEHICLE2

InitialConfig2

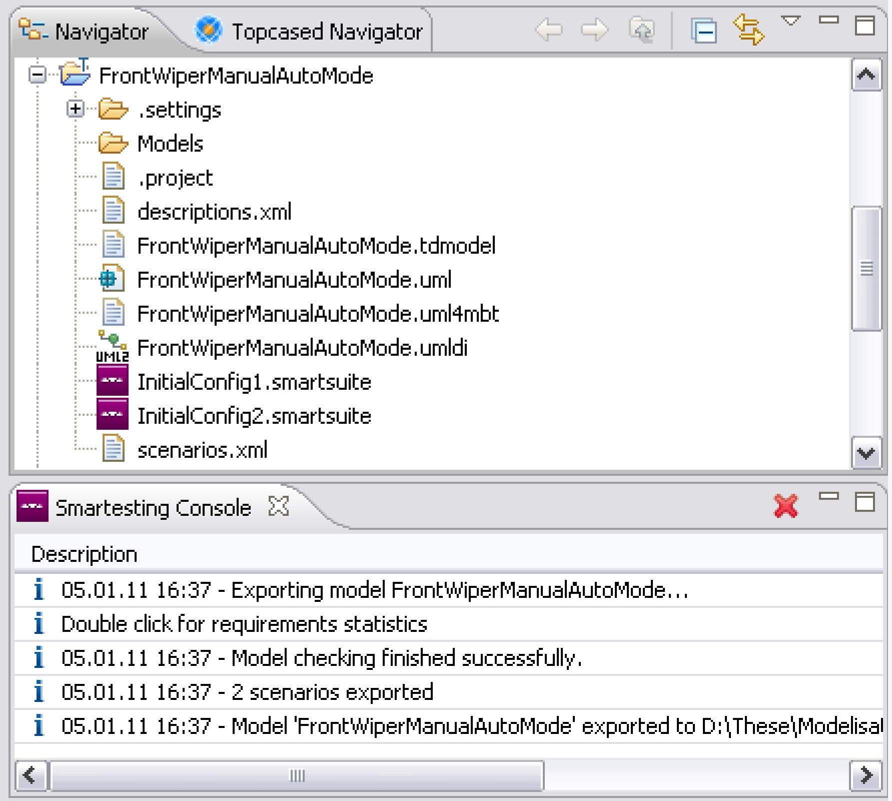
Functional test perimeter definition and information

Definition: -VEHICLE1 -AUTOMATIC_MODE_MNGT -AUTOMATIC_FW_SPEED_REDUCE

Model element	Aims	Requirements
FrontWiper::internalIntModeWaitTimerExpir...	EXPIRATION_OF_INT_DELAY_TIMER	INT_MODE_MNGT
FrontWiper::receiveFrontWiperSwitchPositio...		
FrontWiper::receiveIgnition()		IGNITION_MNGT
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT, MANUAL_MODE_...
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT, MANUAL_MODE_...
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT, MANUAL_MODE_...
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT, MANUAL_MODE_...
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT, MANUAL_MODE_...
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT, MANUAL_MODE_...
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT, MANUAL_MODE_...
FrontWiper::receiveIntRingPositionByDriver()	INT_RING_SET_WITH_IGNITION_O...	INT_MODE_MNGT, MANUAL_MODE_...

UML4MBT plug' in: export

- Export:
  - Exporting model to a metamodel based file. (.uml4mbt)


Navigator
Topcased Navigator
FrontWiperManualAutoMode
.settings
Models
.project
descriptions.xml
FrontWiperManualAutoMode.tdmodel
FrontWiperManualAutoMode.uml
FrontWiperManualAutoMode.uml4mbt
FrontWiperManualAutoMode.umldi
InitialConfig1.smartsuite
InitialConfig2.smartsuite
scenarios.xml
Smartesting Console
Description

```
05.01.11 16:37 - Exporting model FrontWiperManualAutoMode...
Double click for requirements statistics
05.01.11 16:37 - Model checking finished successfully.
05.01.11 16:37 - 2 scenarios exported
05.01.11 16:37 - Model 'FrontWiperManualAutoMode' exported to D:\These\Modelisat
```

SysML4MBT plug’ in: SysML4MBT

- Block Definition Diagram (BDD):
  - Static view of the system and its environment.
  - Blocks, associations, compositions, enumerations, blocks attributes and operations, ports and signals.

- Internal Block Diagram (IBD):
  - Interconnection between blocks.
  - Represents electrical or mechanical communications.

SysML4MBT plug' in: SysML4MBT

- Dynamic view:
  - One or more Statemachine Diagrams (annotated with OCL constraints).
    - parallel states
    - historic states
    - fork and join states
  - OCL expressions to precise behaviors of operations and transitions.
  - Triggers: signal reception.

SysML4MBT plug' in: SysML4MBT

- OCL:
  - Same restrictions than in UML4MBT.
  - Addition of OCL ^ operator (signal sending).
- Requirements Diagram:
  - Represents system requirements.
  - Links requirements with model elements that satisfy them.

SysML4MBT plug' in

- Adapted from UML4MBT plug' in:
  - OCL editor.
  - Syntactic verification.
  - Definition of test suites.
- New dedicated export:
  - Exporting the model to a SysML4MBT file.
  - Transforming the SysML4MBT file to a UML4MBT file. [LBL+10]

[LBL+10] J. Lasalle, F. Bouquet, B. Legeard and F. Peureux. SysML to UML model transformation for test generation purpose. In Proceedings of the 3rd ICFEM International workshop on UML and Formal Methods (UML&FM'10), Shanghai, China, November 2010, ACM Press.

Experimentations

- Wiper:
  - Specification of the front wiper system of a car.
  - The modeled functionalities are slow speed drying up, high speed drying up, intermittently speed drying up and cleaning with drying up.
  - 133 behaviors covered with 115 tests.
  - Tests executed with simulation mode.
- Steering:
  - Representation of the steering column of a car.
  - Reaction of the steering column in regard of road.
  - 154 behaviors covered with 154 tests.
  - Tests executed on physical test bench.

Demonstration

- Video:
  - English version: http://lifc.univ-fcomte.fr/vetess/video_en/
  - French version: http://lifc.univ-fcomte.fr/vetess/video_fr/

The End

Any questions?

http://lifc.univ-fcomte.fr/vetess/