recomp ARTEMIS Bundesministerium für Bildung und Forschung

VALIDAS

MoTeCh
Modellbasiertes Testen von Smartcards

iuk
Informations- und Kommunikationstechnik

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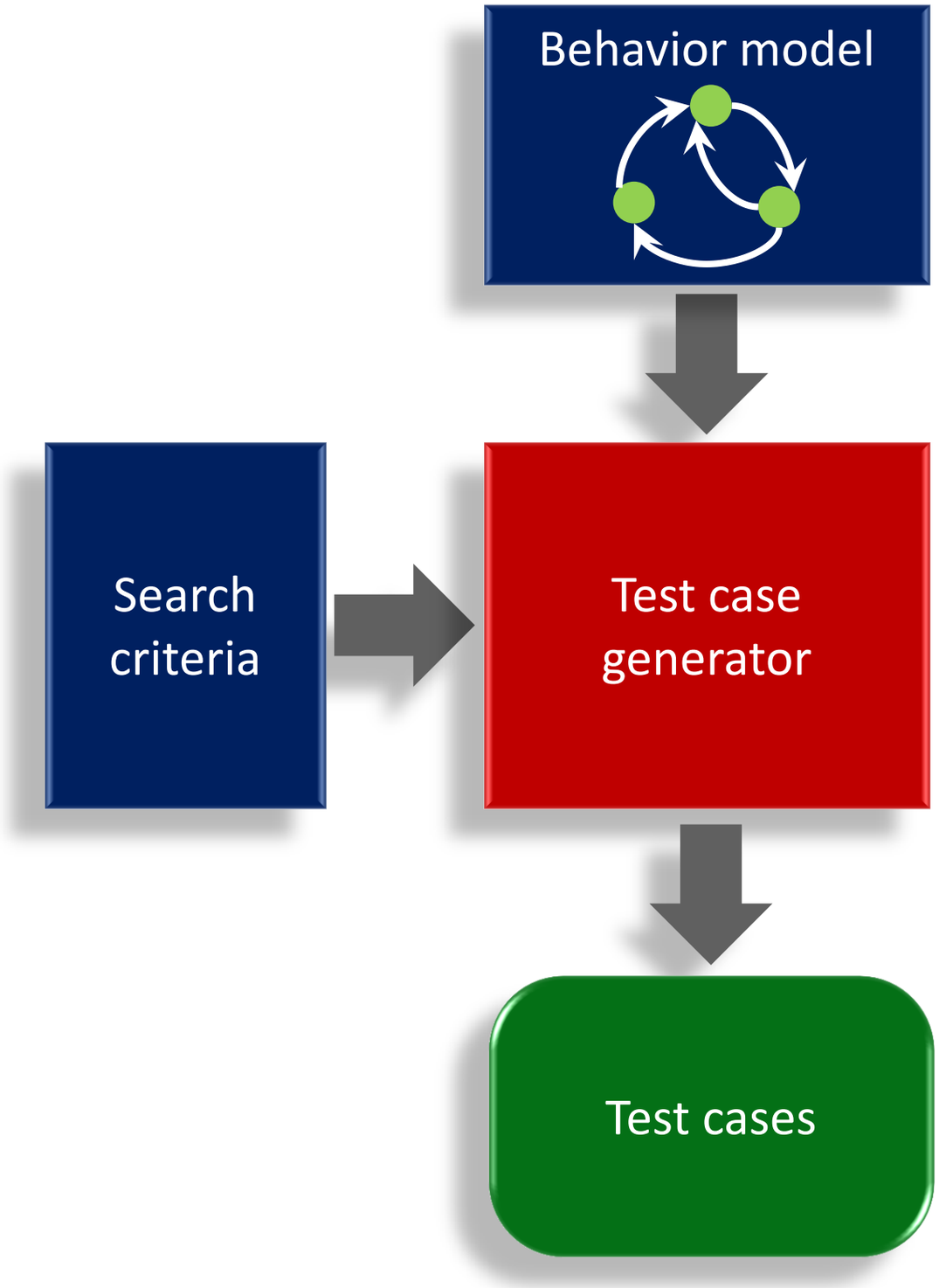
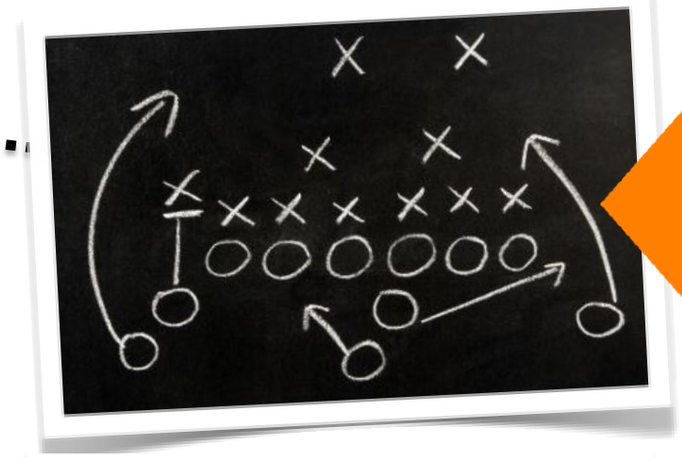
Tactic-Based Testing

MBTUC 2011 | Berlin, 18-20 October 2011

Model-Based Testing



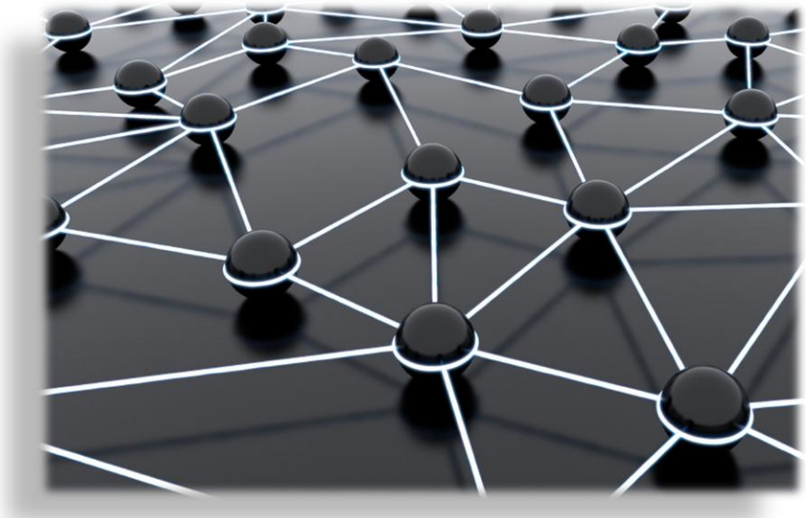


Model determines search paths

Model provides reference values

Model returns coverage data

Lessons Learned



Complex data spaces and algorithms

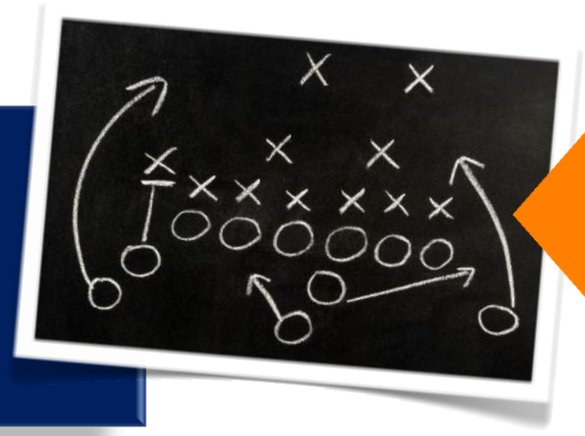
Inclusion of prior knowledge of developers

Modeling language and tool issues

Tactic-Based Testing

Main idea: Seamless combination of model- and script-based testing

Tactics



Tactic determines search paths

Data model

Tactic Interpreter & Coverage measurement

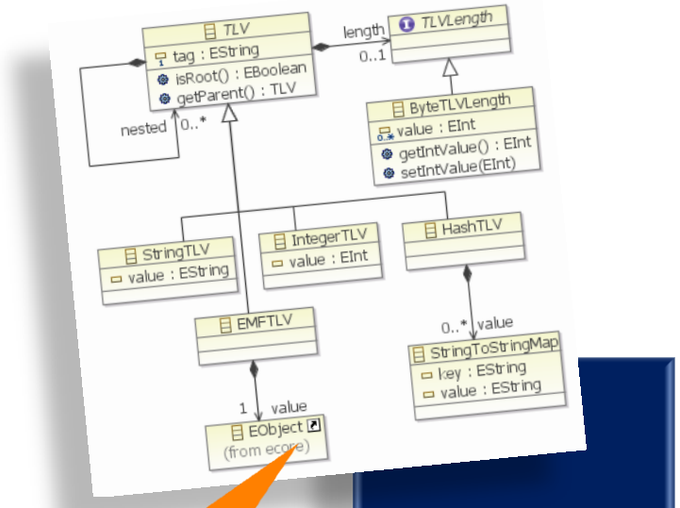
Test cases

Coverage over tactic, data and oracle models

Oracle model provides reference values

Oracle model

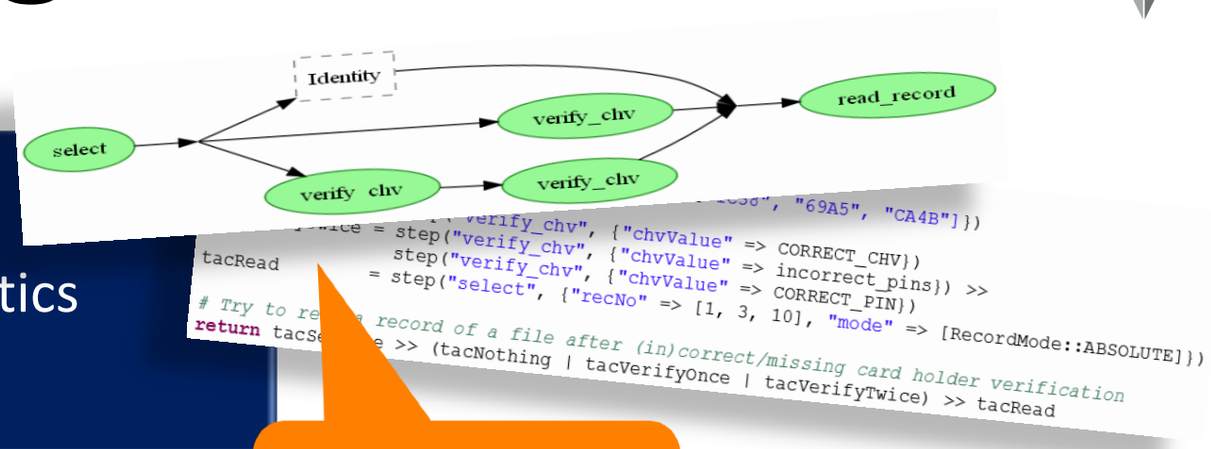
Tactic-Based Testing - Framework



Data models based on EMF, Java, …

Data model

Tactics



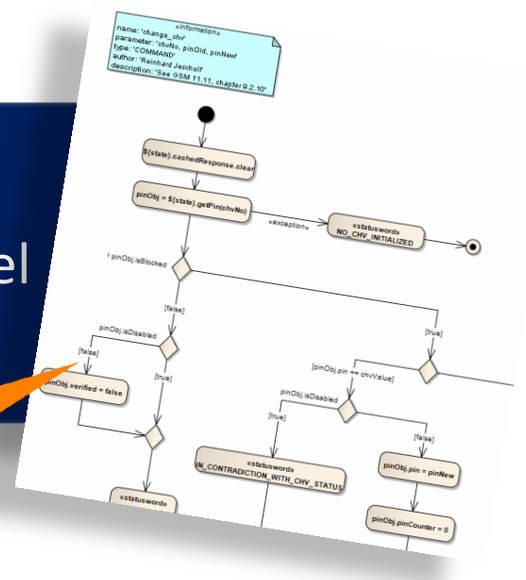
JRuby as tactic language

Tactic Interpreter & Coverage measurement

Test cases

Test case and coverage data output as XML

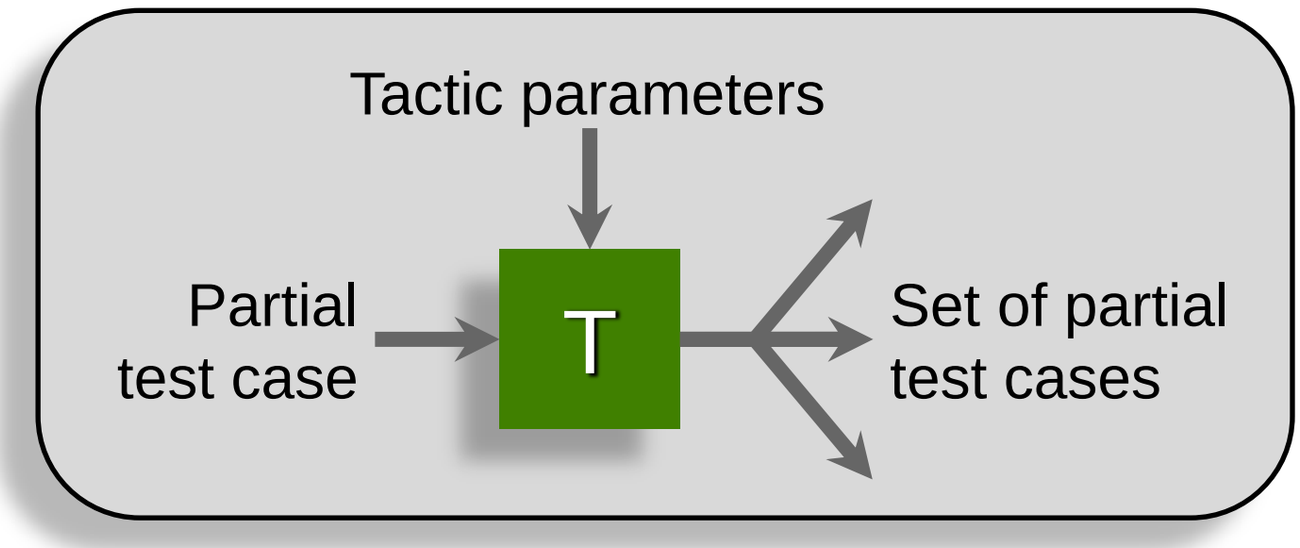
Oracle model

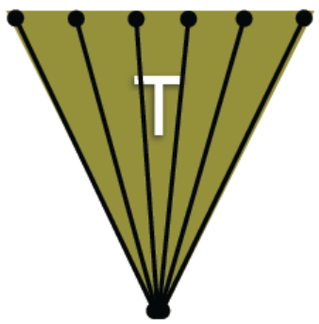


Oracle models in UML, Java or JRuby. Generic interface for other languages

Tactic-Based Testing – Tactics

- Use of *tactics* to build up arbitrary search strategies
- The structure of the tactics defines the structure of the test cases

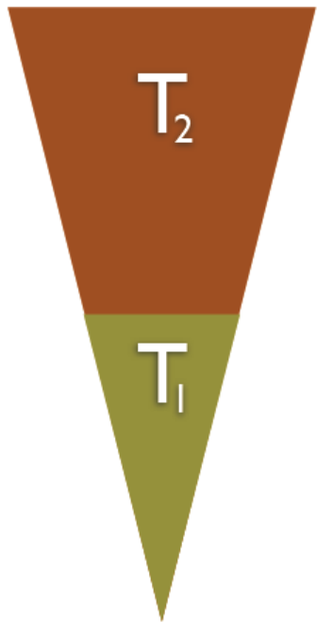




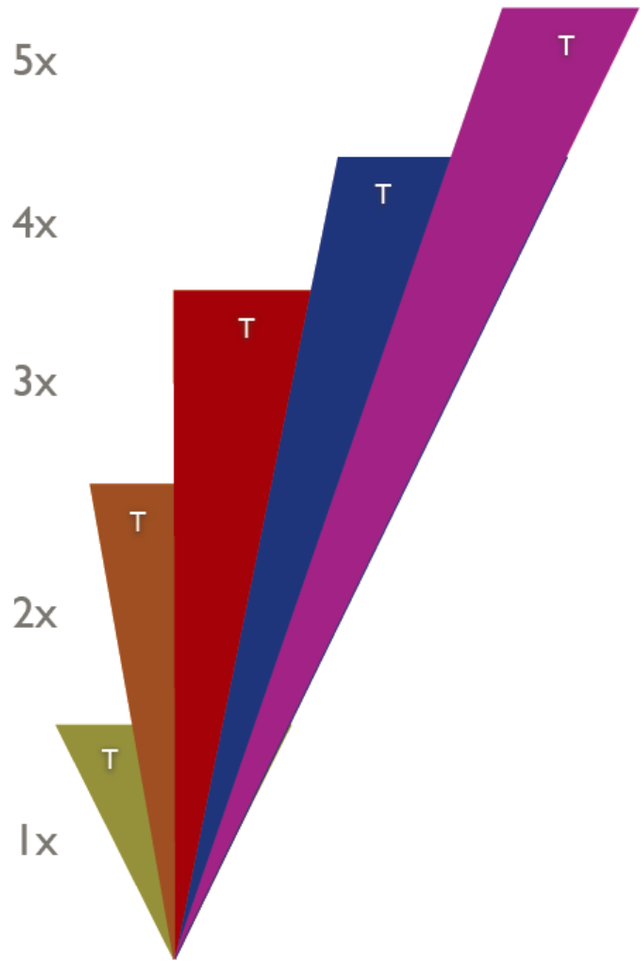
StepTactic

StoreTactic

OrElseTactic



AndAlsoTactic



IterativeDeepeningTactic

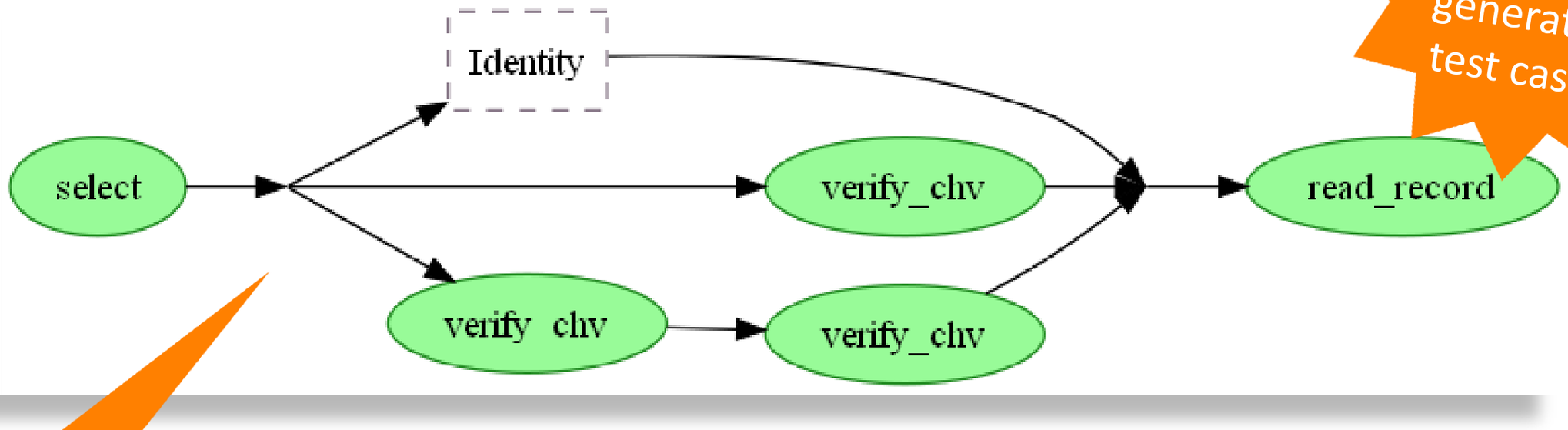
Tactic Based Testing – Sample

Tactic written in JRuby

```
incorrect_pins = [...] # List of 5 incorrect PINs
tacSelFile     = step("select", {"file" => ["1C38", "69A5", "CA4B"]})
tacNothing     = identity();
tacVerifyOnce  = step("verify_chv", {"chvValue" => CORRECT_CHV})
tacVerifyTwice = step("verify_chv", {"chvValue" => incorrect_pins}) >>
                 step("verify_chv", {"chvValue" => CORRECT_PIN})
tacRead        = step("select", {"recNo" => [1, 3, 10], "mode" => [RecordMode::ABSOLUTE]})

# Try to read a record of a file after (in)correct/missing card holder verification
return tacSelFile >> (tacNothing | tacVerifyOnce | tacVerifyTwice) >> tacRead
```

Results in 63 generated test cases



Visualization of a tactic structure

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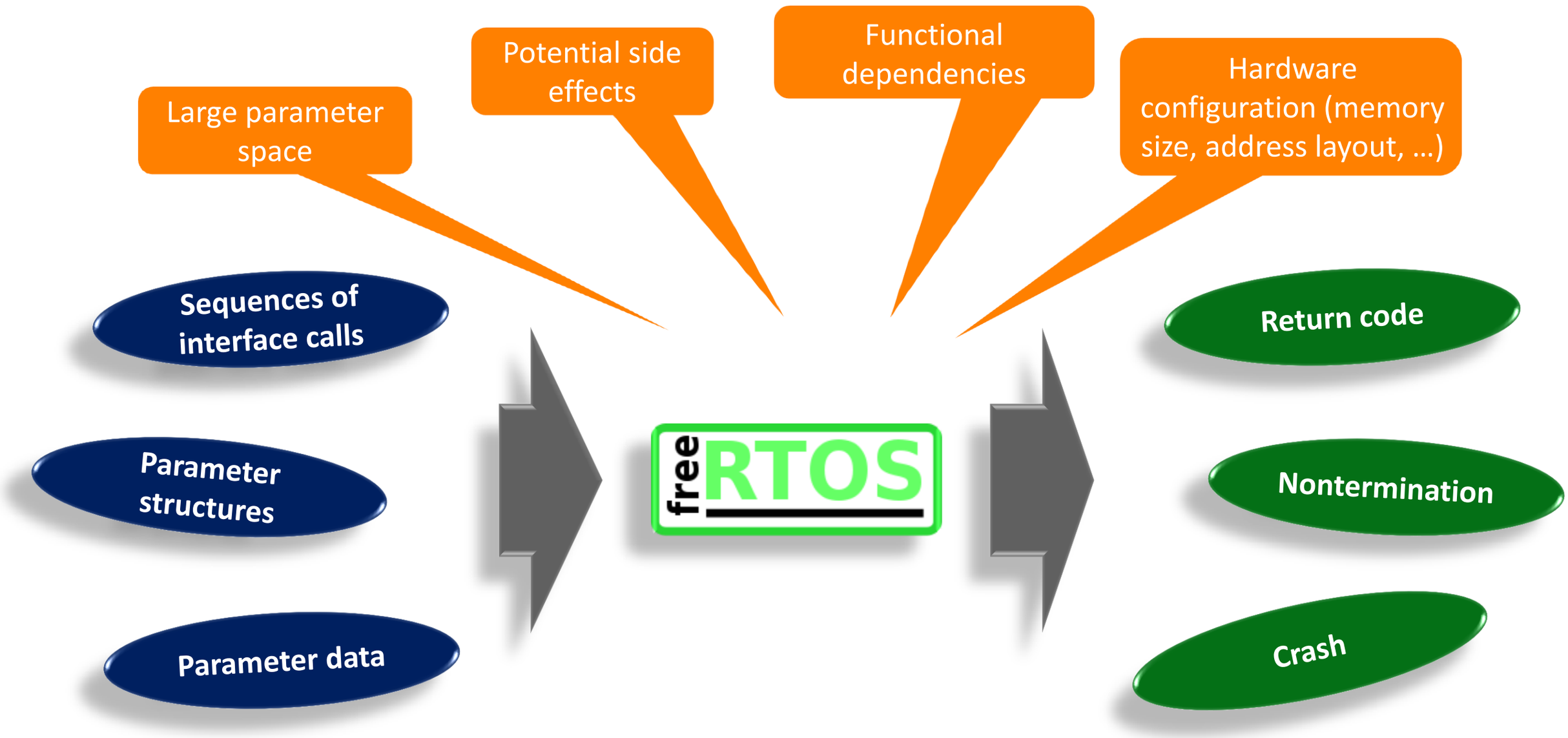
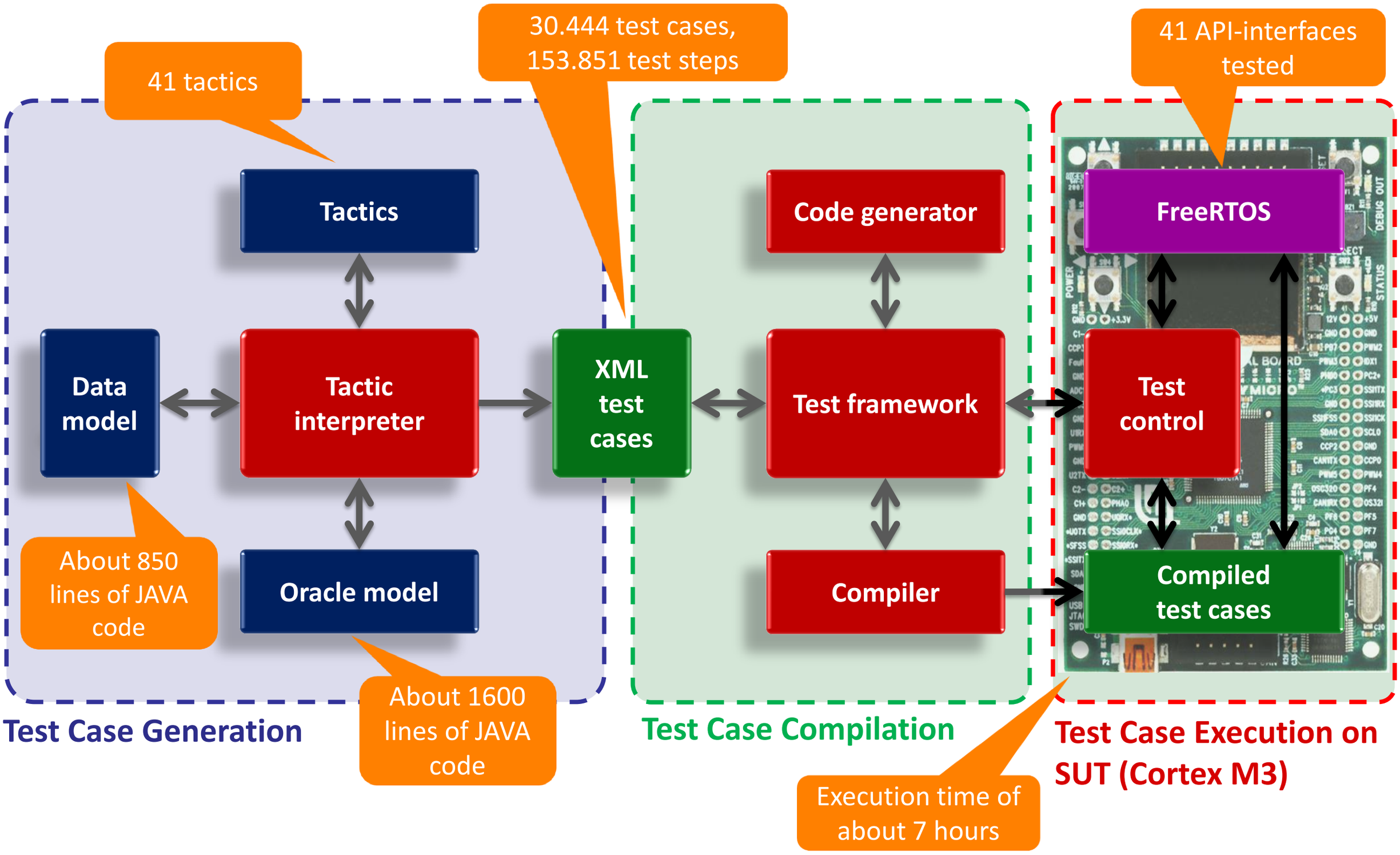
- **Founded 2000**
- **17 employees**
- **Competences**
  - Model-based development
  - (Test-) Specification
  - Test automation
  - Tool qualification
  - AUTOSAR
- **Customers & Partners**
  - BMW
  - EADS
  - ESG
  - Giesecke & Devrient
  - Infineon
  - Audi/AEV

FreeRTOS – Interface Testing

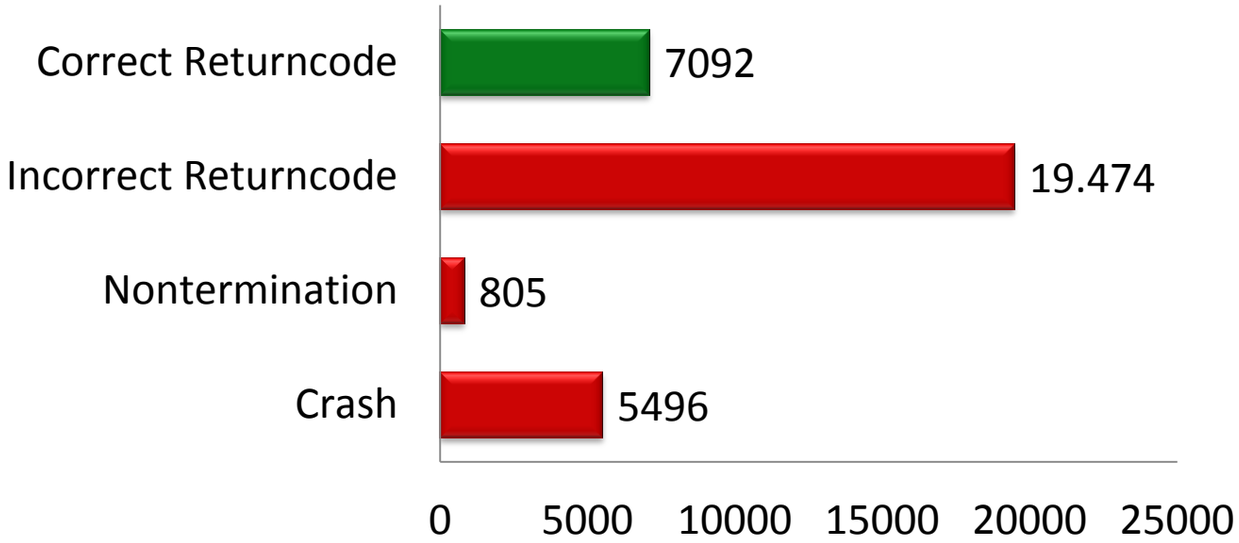
Interface and robustness testing of off-the-self components

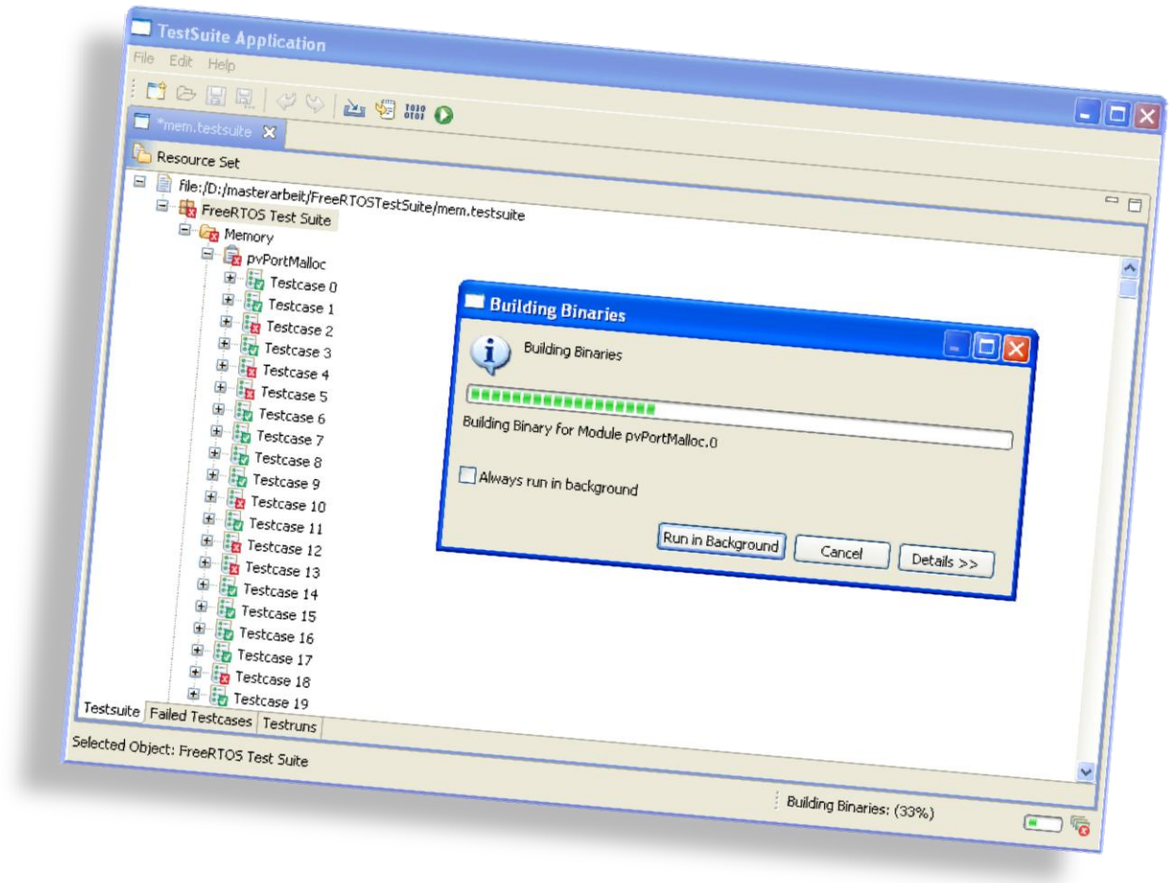


FreeRTOS – Test Setup



FreeRTOS – Test Results





Example: **pvPortMalloc (2^{32}-5)**

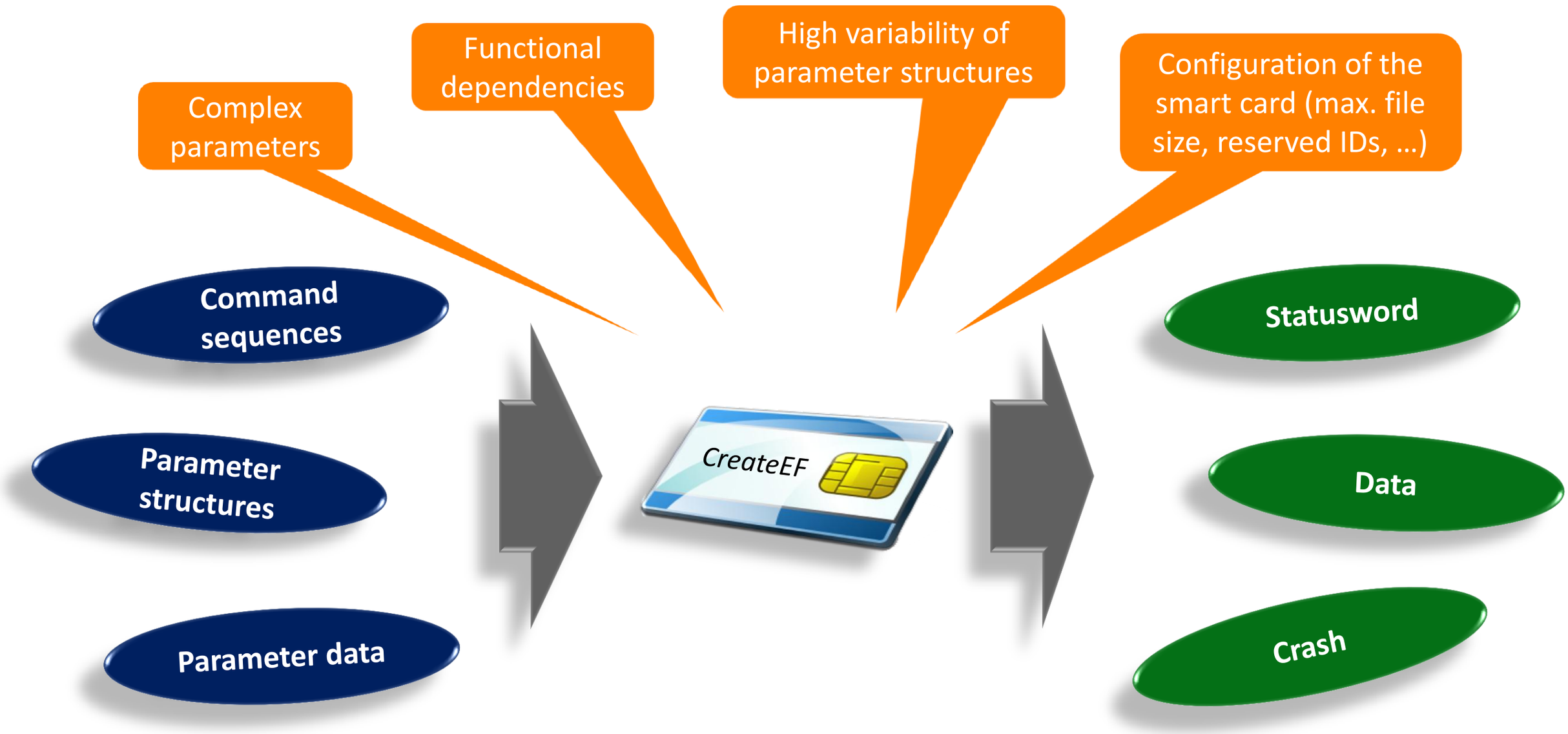
- Expected result: NULL-Pointer
- Observed result: Valid memory address
- Reason: **Integer overflow**

$$(2^{32} - 5) + 16 = 2^{32} + 11 \Rightarrow 11$$

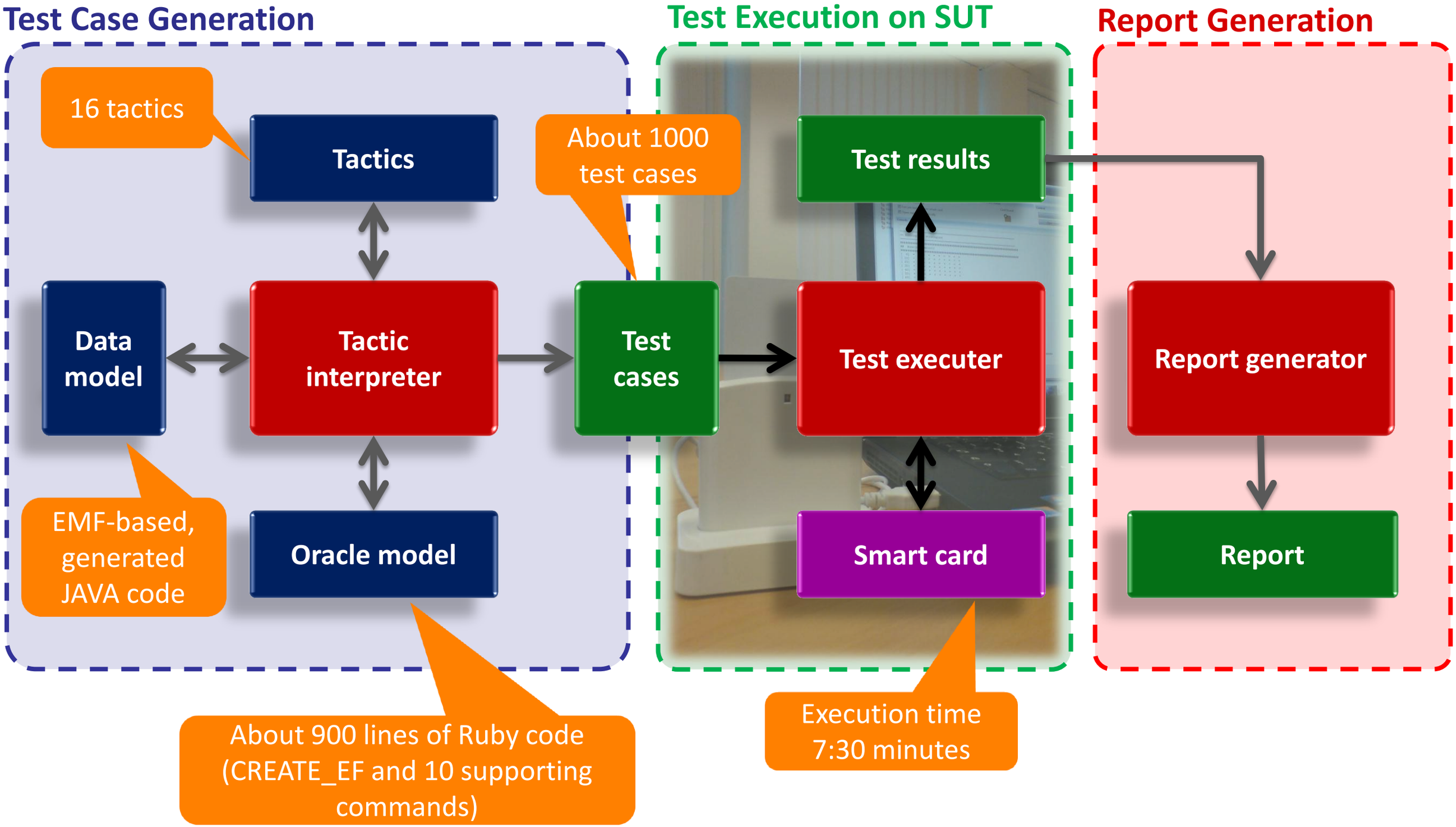
Header of linked list block for heap management

Smart Card – Command Testing

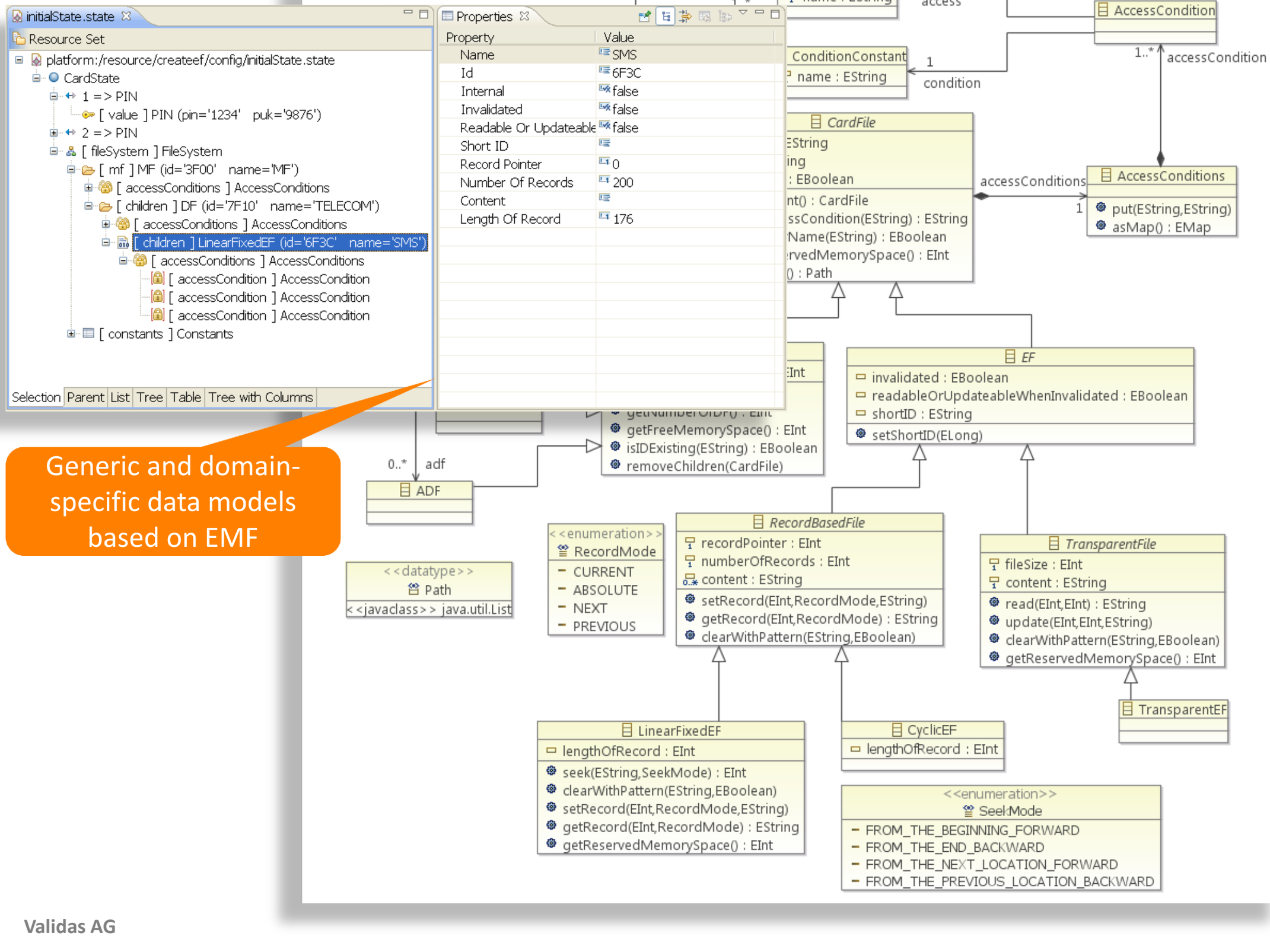
Exhaustive testing of CREATE_FILE and its parameters to create elementary files on a smart card



Create File – Test Setup



Create File – Data Model



Generic and domain-specific data models based on EMF

Create File – Test Execution

Tactics to achieve test goals

```
## Creates                    tic to test tag 83 (fileID)
## - Reserved id              ll be tested
## - Unreserved ids w         l be tested (XX00, 00XX, XXXX)
## - Already existing ids will be tested
set_initial_state loadInitialState

file_ids = [
  "3F00",
  "0000", "FFFF",              # Reserved
  "0100", "5600", "FF00",      # Unreserved
  "0001", "0056", "00FF",      # Unreserved - representative 1
  "0101", "ABCD", "FFFE",      # Unreserved - representative 1
  FILE_ID_EF,                  # Unreserved - representative 1
  "0815",                      # Unreserved
]                              # Already in use

# Create a new tacti
steps_sub
  tlvs =

  tac_crea
  tac_crea

  next crea
end

return namir
```

Report
CreateEF test cases

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Information | Summary | Overview

INFORMATION

User	jeschull
Start of Test	07:49:23
End of Test	07:51:07
Tool-Version	1.0.0

SUMMARY

Number of Scenarios	8
Executed Testcases	231 of 231
Executed Teststeps	2061 of 2081

Test reports & analysis support

Tactic based testing - Validas AG

Test case generation and execution for CreateEF

Options
- Execute strategies
- Execute test cases on smart card
- Open report automatically

Smartcard status: Card found

Control: Start | Open report | Open visualization

Console

```
============================================================
== Initializing the action language parser
============================================================
  done in 2339 ms

============================================================
== Running the strategies
============================================================
##############################################################
##  Running: strategy_scenario_duplicateFileID
##############################################################
[  0]  *  *  *  *  *  *  *  *  *  *
[ 10]  *  *  *  *  *  *  *  *  *  *
[ 20]  *  *  *  *  *  *  *
------------------------------------------------------------
Test cases generated by current strategy: 27
Total number of generated test cases    : 27
Time for strategy                       : 2857 ms

##############################################################
##  Running: strategy_scenario_recreateFile
```

Passed	Failed	Error	Not Executed
207	24	0	0

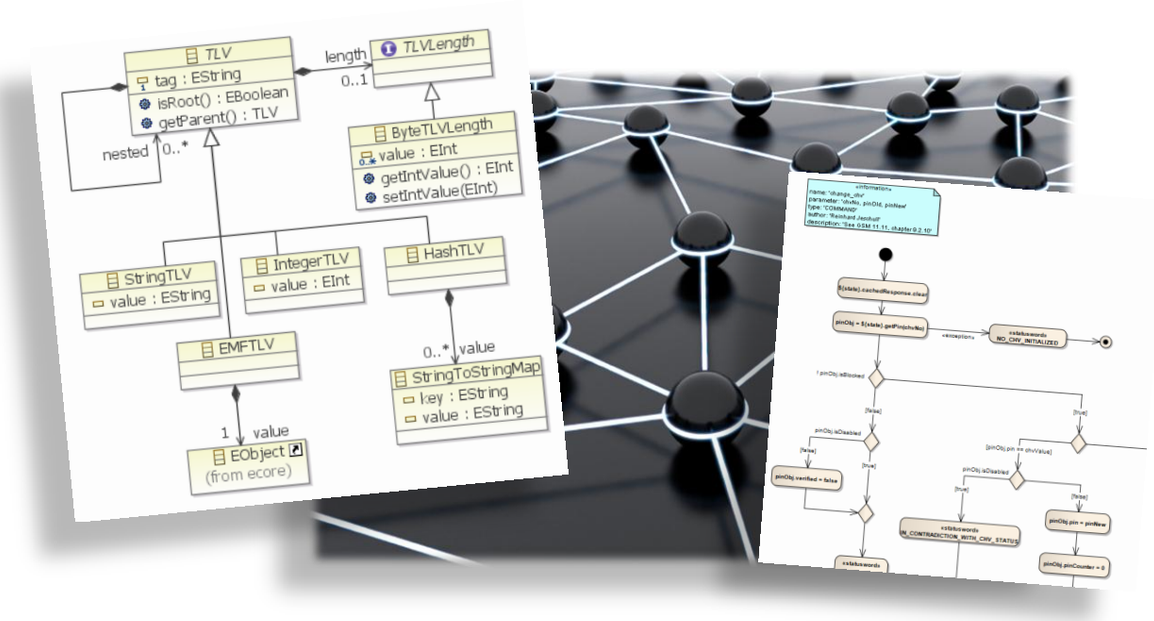
Statistic

Passed	Failed	Error	Not Executed
28	0	0	0

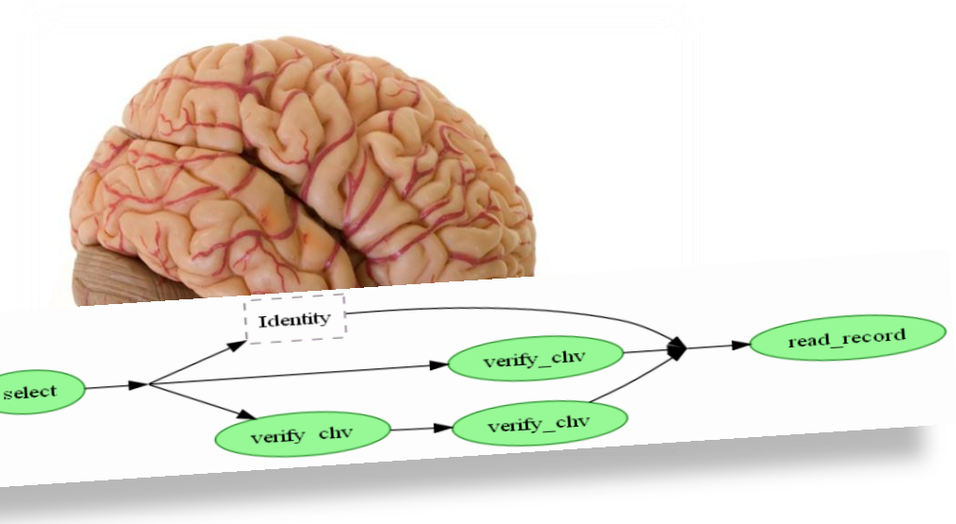
Passed	Failed	Error	Not Executed
32	8	0	0

Test execution environment

Lessons Learned



Complex data spaces and algorithms



Inclusion of prior knowledge of developers

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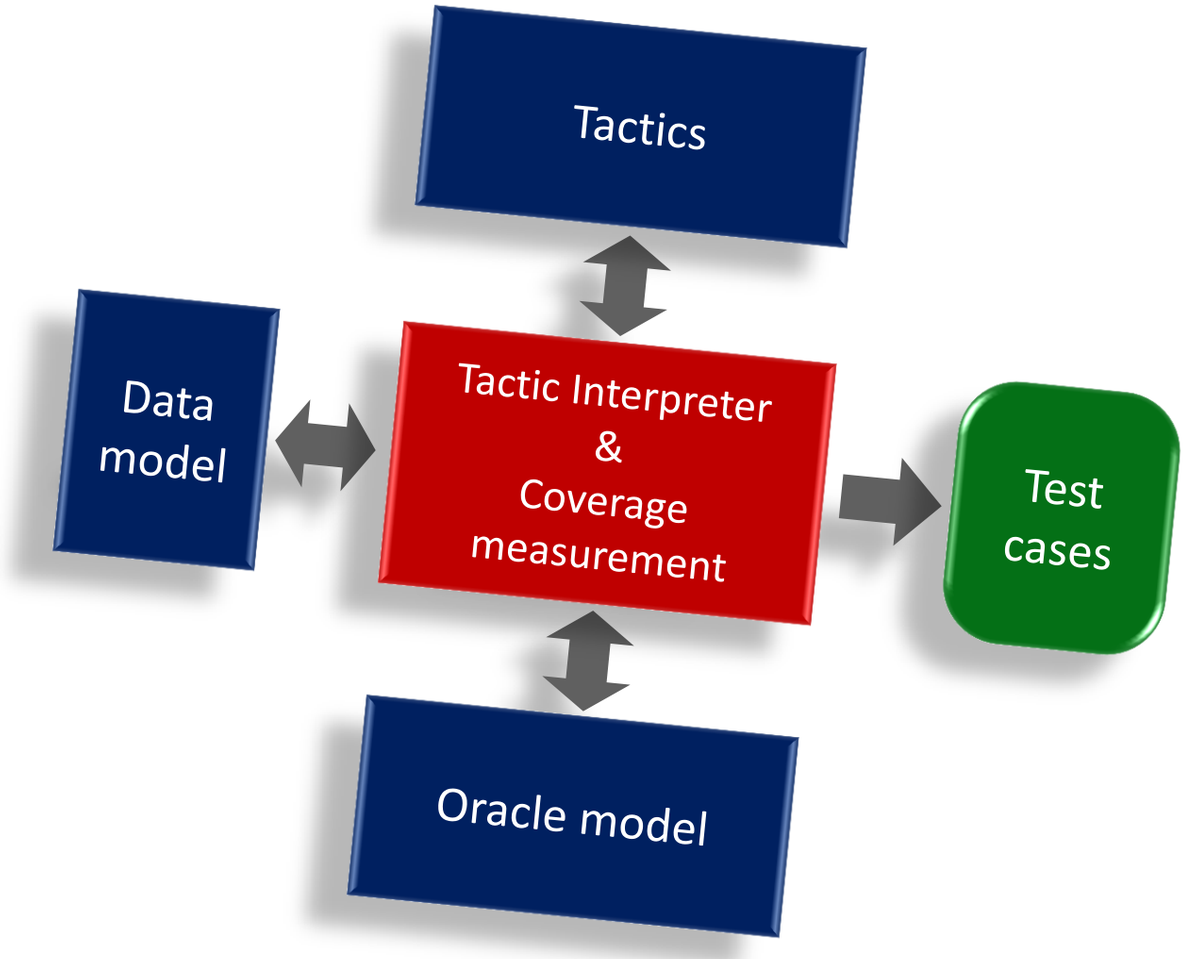
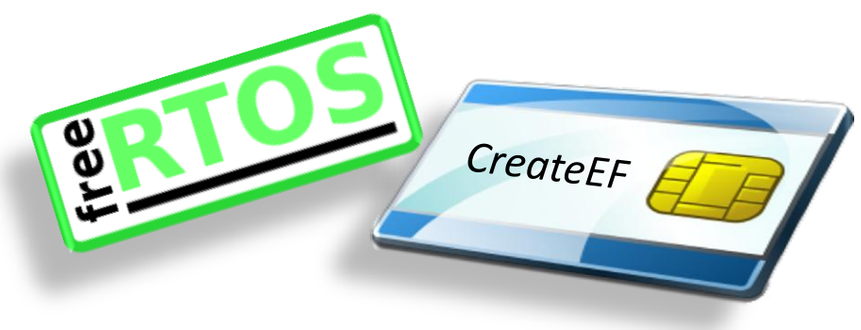
Modeling language and tool issues

Summary

- Tactic-based testing for flexible control of test case generation
- Precise specification of test cases with varying parameters and structures
- Applicable to wide range of test objects





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