Model-Based Black Box Testing and its Standardization Layers

THE SOLUTION TO BOOST YOUR TEST EFFICIENCY
Since 1998
French: 45 experts
Turnover 2010: 4 M€

Expertise offer:

- PROCESS IMPROVEMENT
- SAFETY ENGINEERING
- SYSTEM ENGINEERING
- OPTIMIZED TESTING
- SOFTWARE RELIABILITY

EMBEDDED SYSTEMS
AGENDA

- THE TEST PROBLEM
- THE EXPECTED SOLUTION
- THE MODEL-BASED TESTING SOLUTION
- A PRAGMATIC INDUSTRIAL USE-CASE
- A MORE STANDARDIZED TOOLS INTEGRATION
THE TESTING PROBLEM

- **Test Resources Lack**
  - Testing Effort
  - System Complexity
  - Test Needs
  - Test Availability
  - Time

- **Test Focus Deviation**
  - Reliability
  - Market Expectation
  - Usage Intensity
  - Reality
  - Product Life

- **Development Phase**
- **Customer Validation**
- **Normal Usage**
HOW TO SOLVE THIS ISSUE?

1. Test the SUT usage before product release
2. Use best in class engineering process
3. Widely use automatic generation
4. Use dedicated tools that decouple engineering productivity
5. Use formalization and traceability
MODEL-DRIVEN ENGINEERING

**DESIGN**
- Design Model
  - Generate
  - Compile
  - Code
    - EXE

**TEST**
- Usage Model
  - Generate
  - Derive
  - Test Cases
    - Test Scripts

**Functional Requirements**
- Implement
- Scenarize

**MaTeLo**
- Model Based Testing
WHAT IS MaTeLo?

Formal Test Specification

Product Usage Point of View

More Productive Coverage

MaTeLo

Markov Test Logic

Test Execution Compatibility

Fully Measured Process

Bidirectional Requirements Traceability

Systematic Engineering Productivity
INTEGRATED TEST WORKFLOW

MaTeLo Usage Model Editor
Test Design into Usage Models

MaTeLo Testor
Automatic Test Cases Generation

MaTeLo Test Campaign Analysis
Confidence And Coverage Reporting

EXAM
Test Automation

PLAN
ACT
DO
CHECK
MaTeLo EDITOR Usage Model Design
MATELO USAGE MODELS

→ Probability on every Alternatives
→ Association of Requirements
→ Configuration of Test Operations
→ Setup Transition as Test Step
MODEL TRANSITION = TEST STEP

Requirements
- Select_Gear(5)
- Accelerate(100%)
- Check_Speed(185)

Test Oracle
- Outputs = f(Inputs)

Stimulations
- Inputs Stimulation
- Equivalence Classes
- Timing

Verifications
- Expected Outputs
- Timing
Profiles can be embedded to qualify the usage model

- Operational profiles
- Test profiles

Data distribution

Usage path probability
MaTeLo EDITOR
Requirements Management
REQUIREMENTS MANAGEMENT

IBM Rational Doors

MaTeLo Requirements Library

MaTeLo Usage Model

Import

Association

(N,M)

Requirement Update
New Baseline

Update

Quick Model Update

Available for other ReqMgt tools with import of XML or CSV files
MaTeLo TESTOR
Test Cases Generation
MaTeLo TEST STRATEGY

DEFINE THE TEST STRATEGY, BY CHOOSING

- Test Algorithm
- Test Profile
- Part of model to test

FREQUENCY
FOCUS

CRITICALITY, COMPLEXITY
UPDATE FOCUS

REQUIREMENTS
COVERAGE

OPERATIONAL
COVERAGE
## MaTeLo TESTOR: HTML TEST PLAN

### Test Function

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Test Function</th>
<th>Input</th>
<th>Expected Result</th>
<th>Verdict</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wind will blow equal or over 30 km/h</td>
<td>Weather</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Set Wind Force</td>
<td>Parameter</td>
<td>Input</td>
<td>Weather:Wind Force</td>
</tr>
<tr>
<td></td>
<td>Set Sunshine Intensity</td>
<td>Parameter</td>
<td>Input</td>
<td>Weather:Sunshine Intensity</td>
</tr>
</tbody>
</table>

### Test Stand Associations

<table>
<thead>
<tr>
<th>Name</th>
<th>Param Name</th>
<th>Type</th>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example: MaTeLo FOR EXAM

**Test Repository**
- SUT Interface
- Test Operations
- Stimulation
- Measurement
- Administration
- Sub Test Sequences

**Requirements**
- Name
- UUID
- Description

**Automatic Test Cases**
- Automatic call of Test Operation
- Automatic parameterisation
- Requirements association
- Test Case description generation
- Usage model respect
MaTeLo TCA Test Campaign Analysis
TEST CAMPAIGN PROCESS

Target Quality Criteria
1. Coverage
2. Reliability

Confidence Indicators

- New Package
- New Test Cases Generation

Metrics Quality/Version

- Operational Confidence
- Needs Coverage
- Functional Coverage

New version
From Pragmatic Tools Integration To Its Standard Adoption
THEORETICAL MBT WORKFLOW

Atomic Test Action

Usage Model

Test Cases

Test Scheduler

Test Scripts

Simulator

System Under Test

Test Execution Log

Confidence & Coverage Reports

Test Cases Verdicts

Functional Requirements

Test Cases

Test Execution Log
A 1st INDUSTRIAL TOOLS INTEGRATION

- Automation Test Framework
  - Usage Model
    - MaTeLo
  - Test Scheduler
    - UML
    - Python
  - Test Scripts
  - Simulator
    - dSpace
    - MicroNova
    - Carts
    - Vision
    - CAN
    - IOs
- Doors
- Test Cases
- Test Execution Log
- Confidence & Coverage Reports
- Test Cases Verdicts
- Functional Requirements

- Atomic Test Action
- System Under Test
A 2nd INDUSTRIAL TOOLS INTEGRATION

- **Automation Test Framework**
  - Test Scheduler
  - Test Cases
  - Test Execution Log
  - Test Cases Verdicts
  - Confidence & Coverage Reports

- **Test Cases**
  - Proprietary
  - UML
  - Python

- **Simulator**
  - dSpace
  - NI
  - MicroNova
  - Carts

- **System Under Test**
  - CAN
  - Diagnostic
  - Calibration
  - IOs
  - Radio

- **Functional Requirements**
  - Doors
  - Reqtify
  - MaTeLo
  - MS Excel

- **Usage Model**
  - Atomic Test Action

- **Additional Tools**
  - TestStand
  - EXAM
  - Reqtify
  - MS Excel
  - MaTeLo
VARIOUS TOOLS INTEGRATION

Atomic Test Action

Usage Model MaTeLo

Test Cases

Automation Test Framework
  CANoe
  TestStand
  EXACT

Test Scheduler
  UML
  TTCN-3

Test Scripts
  Python
  CSV
  dSpace
  NI
  Opal-RT
  Clemessy
  MicroNova
  Carts

Simulator
  Simulink
  CANoe
  Vision
  CAN
  Diagnostic
  CAN
  Flexray
  CAN
  Radio
  CAN
  Temperature

Confidence & Coverage Reports

Test Cases Verdicts

Test Execution Log

Functional Requirements
  Doors
  Reqtify

HP QC
  MS Excel
  CSV
  XML

ExAM
  TestStand
  EXACT

Proprietary
  Java
  C, C#

Test Execution Log

MaTeLo
<table>
<thead>
<tr>
<th>Items</th>
<th>Tools</th>
<th>Standard</th>
<th>Application Feeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>Doors</td>
<td>RIF, ReqIF</td>
<td>3/5</td>
</tr>
<tr>
<td>Test Specification Model</td>
<td>MaTeLo, Word</td>
<td>- (DSL)</td>
<td>-</td>
</tr>
<tr>
<td>Test Cases Specification</td>
<td>Doors, Word, EXAM</td>
<td>ATX, OTX</td>
<td>0/5, 2/5</td>
</tr>
<tr>
<td>Test Campaign, Management</td>
<td>MaTeLo, Quality Center</td>
<td>ATX</td>
<td>0/5</td>
</tr>
<tr>
<td>Test Case Implementation</td>
<td>EXAM, ECU TEST, TestStand, vb, python...</td>
<td>HIL API, TTCN3</td>
<td>1/5, 2/5</td>
</tr>
<tr>
<td>Test Execution</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>• Physical Signal</td>
<td>NI, dSPACE, Vector...</td>
<td>HIL API</td>
<td>1/5</td>
</tr>
<tr>
<td>• Network Signal</td>
<td>CAN, LIN, FlexRay...</td>
<td>FIBEX</td>
<td>3/5</td>
</tr>
<tr>
<td>• ECU parameter</td>
<td>CANape, INCA</td>
<td>XCP</td>
<td>5/5</td>
</tr>
<tr>
<td>• Diagnostic</td>
<td>CANdela,</td>
<td>ODX, UDS</td>
<td>5/5</td>
</tr>
<tr>
<td>• Simulator Signal</td>
<td>Simulink, AMEsim...</td>
<td>HIL API</td>
<td>1/5</td>
</tr>
<tr>
<td>• Test Device Signal</td>
<td>Agilent, LeCroy...</td>
<td>GDI</td>
<td>3/5</td>
</tr>
<tr>
<td>Test Case Execution Log, Trace</td>
<td>NI, EXAM, dSPACE, ETAS...</td>
<td>ODS, ATML</td>
<td>2/5, 2/5</td>
</tr>
<tr>
<td>Test Case Verdict</td>
<td>Quality Center, MaTeLo</td>
<td>ATX</td>
<td>0/5</td>
</tr>
<tr>
<td>Issue</td>
<td>BugZilla, Jira, Quality Center</td>
<td>ISSUE</td>
<td>?</td>
</tr>
<tr>
<td>Requirement Coverage</td>
<td>Doors, Quality Center, MaTeLo</td>
<td>ATX, ReqIF</td>
<td>0/5, 2/5</td>
</tr>
<tr>
<td>Confidence Indicator</td>
<td>Quality Center, MaTeLo</td>
<td>ATX</td>
<td>0/5</td>
</tr>
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QUESTION?

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Wiki & Forum & Documentation
www.all4tec.net
ABSTRACTION LAYERS

MaTeLo

<< derive >>

Test Case Specification

HIL API

<< generate >>

Test Flow Control Device Driver

ATX

<< control >>

System Under Test

ODX, FIBEX, XCP...

Hardware In the Loop Test Bench

Python Precompiled Application

UML Sequence Diagram

Markov-Chain Usage Model

Usage Scenario Description

Hardware In the Loop Test Bench

Third Party Equipment

EXAM

MaTeLo