

Key-note
AMOST& QuoMBaT

April 6th, 2010



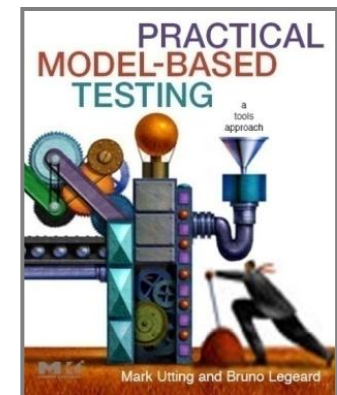
MBT for Large-Scale Enterprise Information Systems

Challenges and Quality Issue

Bruno Legeard

CTO

legeard@smartesting.com



Agenda



Introduction - Smartesting



Model-based testing to industrialize the functional testing process



Challenges and Quality Issues



MBT in practice – Lessons learned

Smartesting in a nutshell



- Independent Software Vendor, model-based testing solution provider, founded in 2003.
- Spin-off of a Computer Science Lab in France – University of Franche-Comté/LIFC
- 32 people - R&D Center and HQ in Besançon (France), Offices in Paris, NL and India (Bangalore)
- Focus on IT applications (Large-scale Enterprise Information Systems, Packaged applications – SAP, Oracle...) and Secured transaction Systems



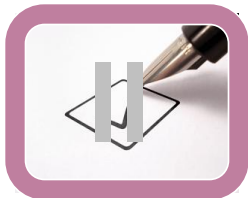
Agenda



Model-based testing to industrialize the functional testing process



Challenges and Quality Issues



MBT in practice – Lessons learned

Context of large-scale Enterprise Information Systems



➔ System of systems

- Several applications
- Mix of Bespoke and Packaged applications
- Mix of data-oriented and process-oriented applications

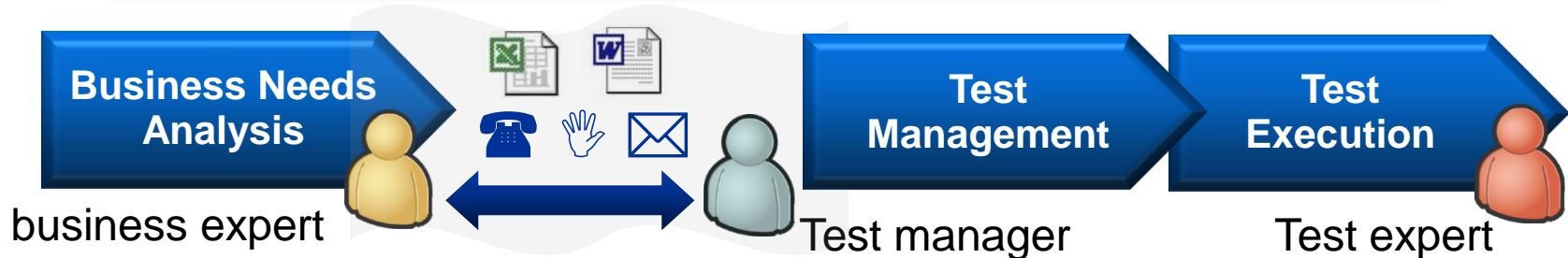
➔ Several levels of functional testing

- Application/system testing
- Multi-application/Acceptance/End-to-end testing

Functional testing of IT applications – Current situation

“Functional Testing is still 80% manual”

Source **OVUM**



- **How to ensure the quality of the test coverage?**
- **How to increase the percentage of automated testing?**
- **How to master costs and risks of functional testing?**

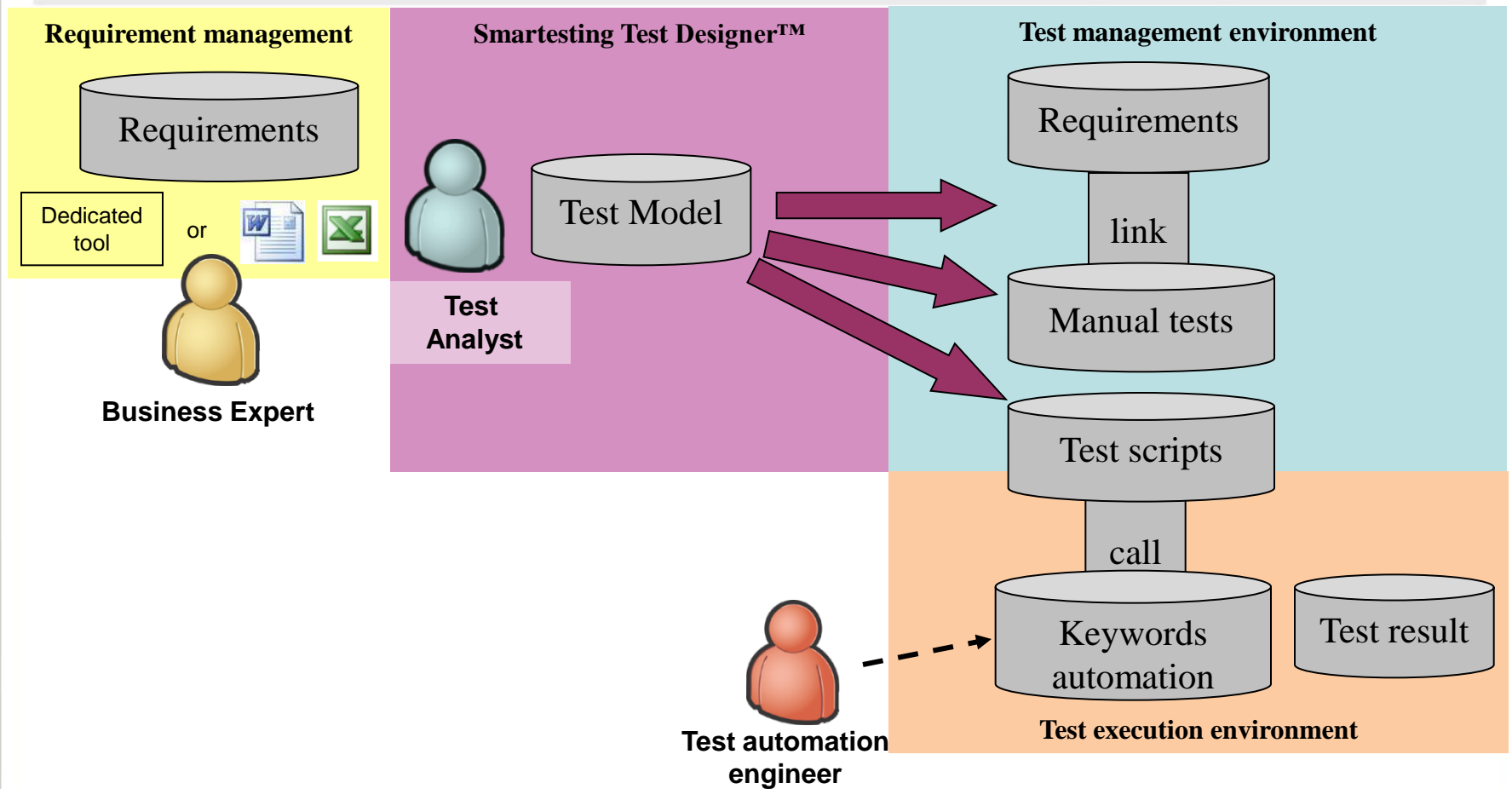
Software testing industrialization based on MBT

MBT process

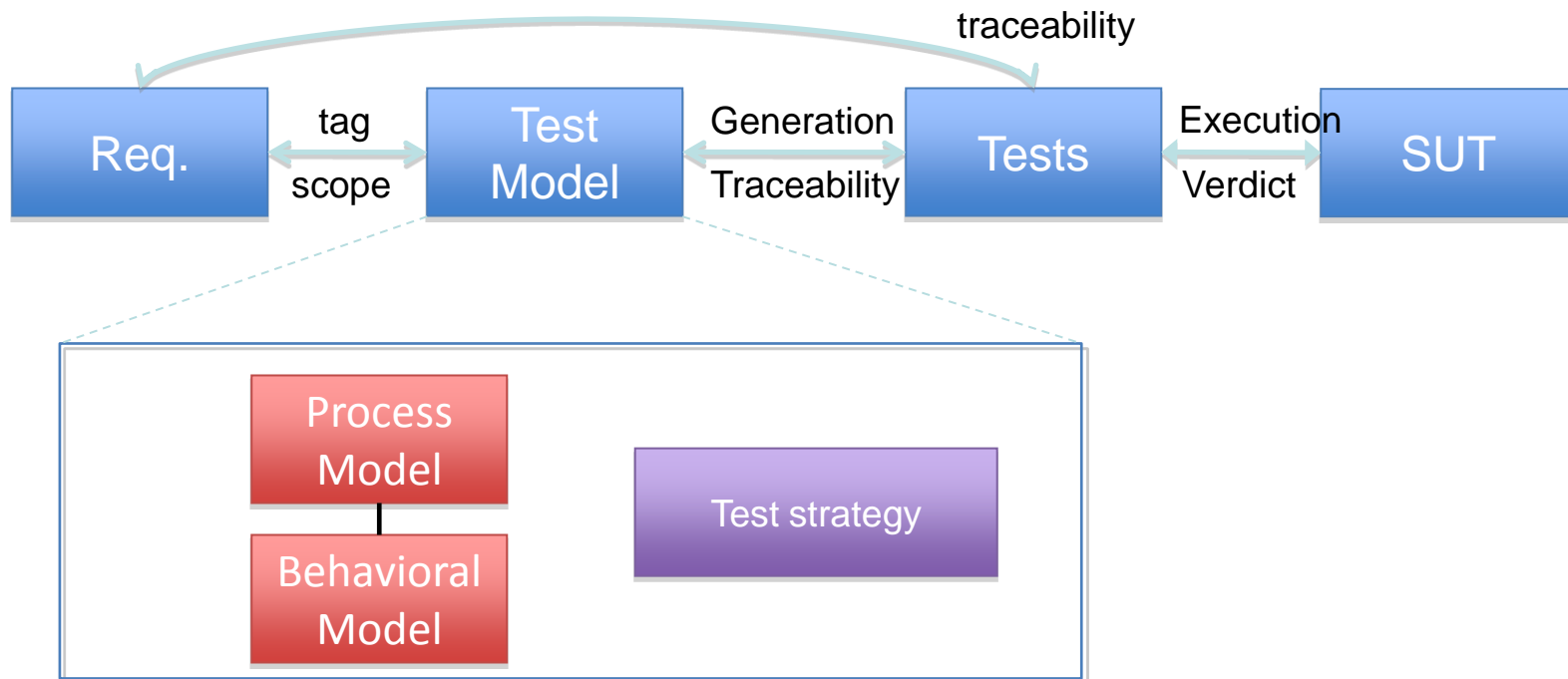


- **Continuous process from business requirements to the test execution**
- **Systematic coverage of expected behaviors**
- **Accelerate test design and test maintenance**
- **Compliant with Requirements & Risk-based testing approaches.**

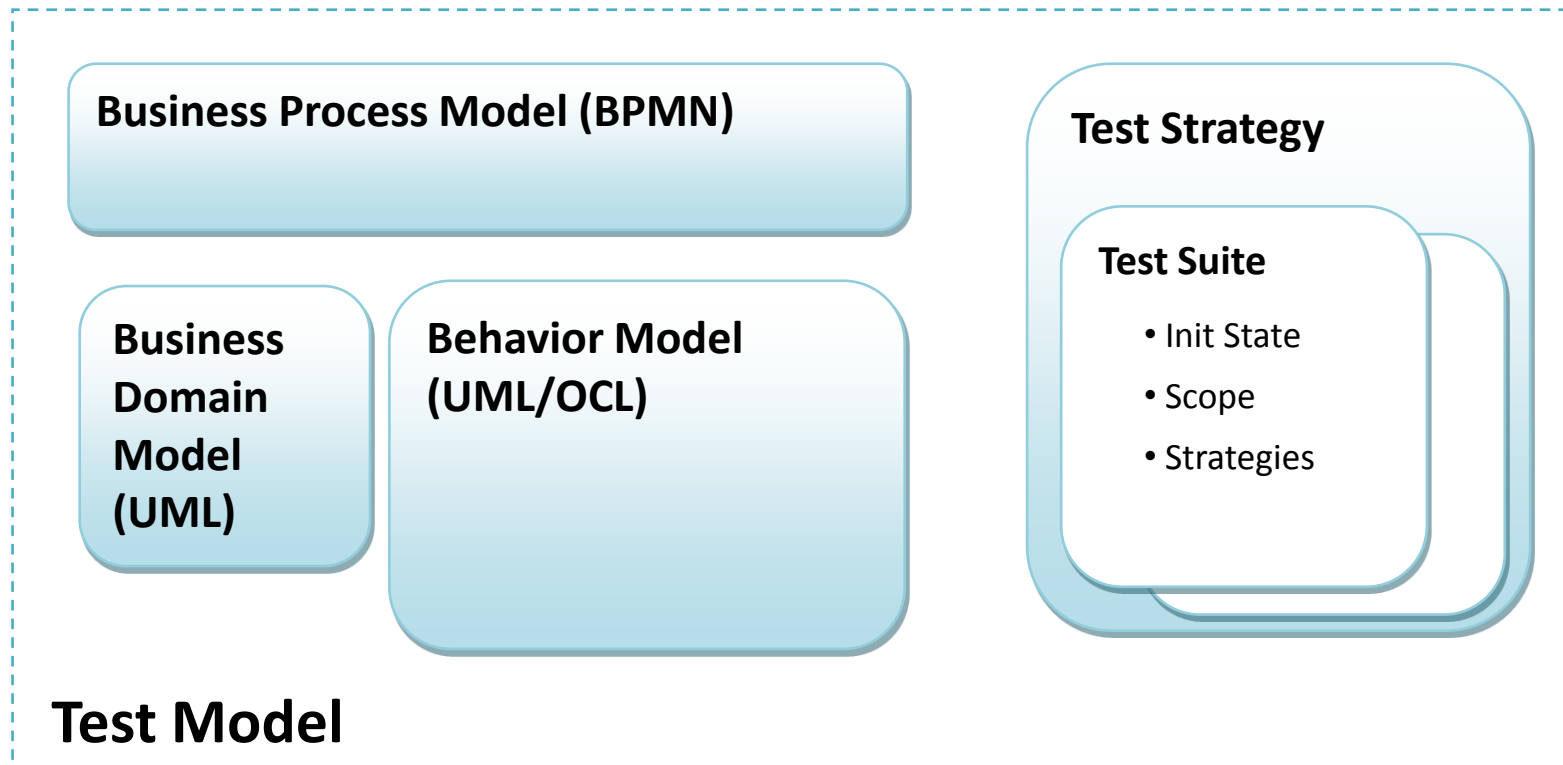
Smartesting MBT process



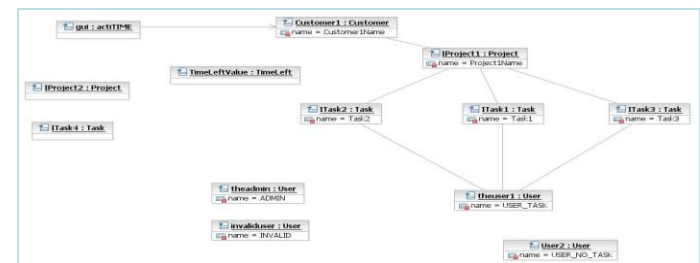
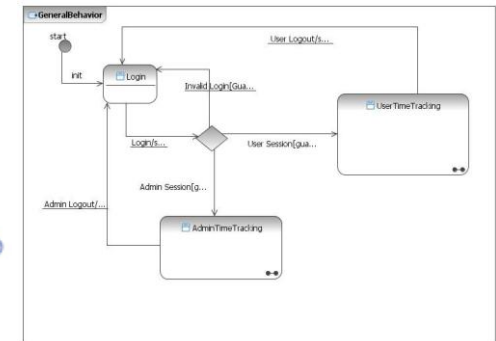
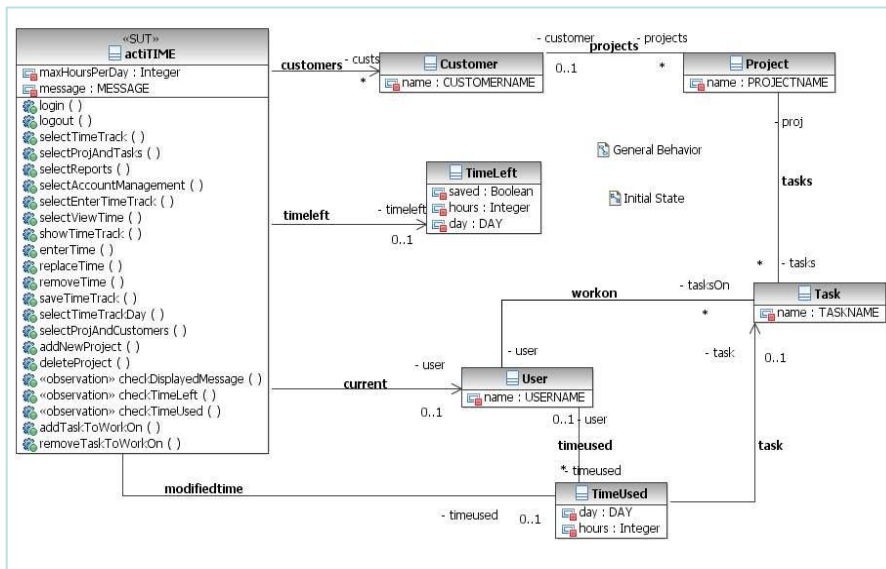
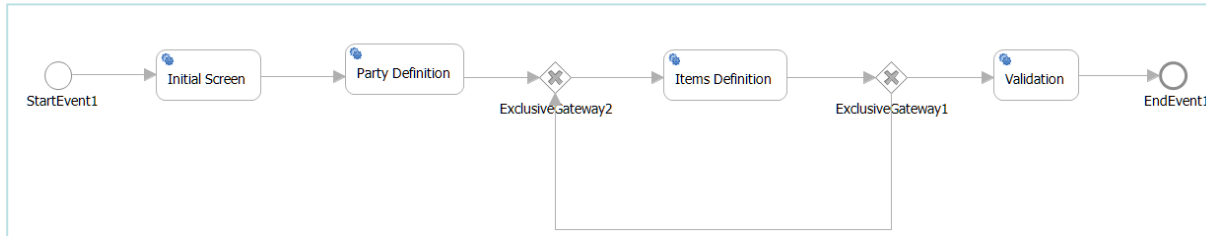
Test Model – 1/3



Test Model – 2/3



Test Model – 3/3



With OCL to formalize the expected behavior

Example - SAP integration testing

REGRESSION TEST SD – Sales order - invoice

	Business process steps	Transaction -input	Expected results
1	<p>Creation of a sales order in reference to a contract</p> <p>Order type Sales organization Distribution channel Division Sales office Sales group Click on "create with reference", go to the "contract" tab, enter contract Click on "copy"</p> <p>Press enter: F - item line Material Order quantity Amount Select the line and click on the "display item details" + go to "account assignment" tab WBS element Save</p>	<p>VA01</p> <p>ZCS4 0056 00 00 F005 520</p> <p>3000010894 Warning: Profit center 056HD is locked in controlling area PA01</p> <p>1100 10 100</p> <p>F/AVTI-04-HD-FT</p>	<p>Message V1311: Std ord info&grance 4000454291 has been saved</p>
2	<p>Creation of a sales order (Sales ordertype doesn't exist)</p> <p>Order type Press enter</p>	<p>VA01</p> <p>ZCCC</p>	<p>Error 00058: Entry ZCCC does not exist in TVAK - check your entry</p>

09-11-2009

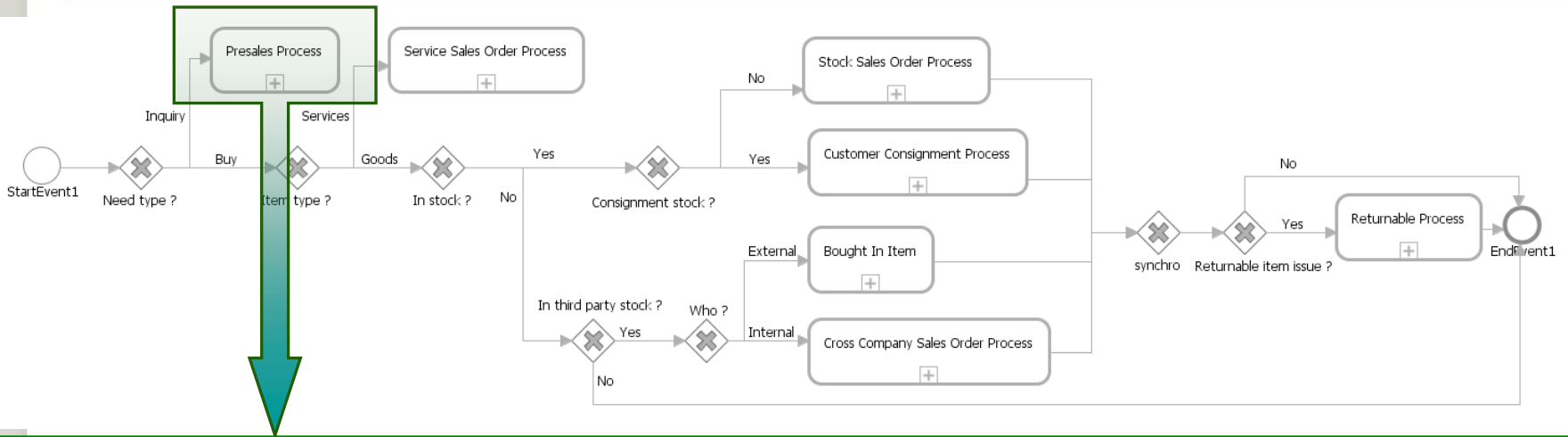
Page: 1

3	<p>Creation of a sales order (Sales ordertype not linked to sales area)</p> <p>Order type Sales organization Distribution channel Division Press enter</p>	<p>VA01</p> <p>ZCS1 0056 00 00</p>	<p>Error V1502: Order type 'ZCS1' has not been defined in Sales area <'0056','00,00'></p>
4	<p>Creation of a sales order in reference to a contract (Mandatory data not filled)</p> <p>Click on "create with reference"</p>	<p>VA01</p>	<p>Error 00055: Make an entry in all required fields</p>

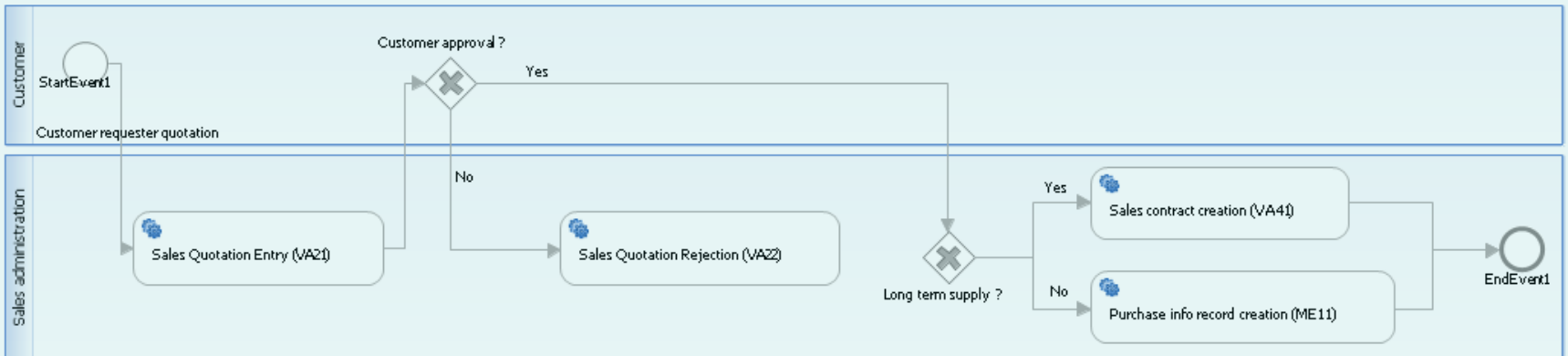
Specifications
documentation

Sales and Delivery SAP Module

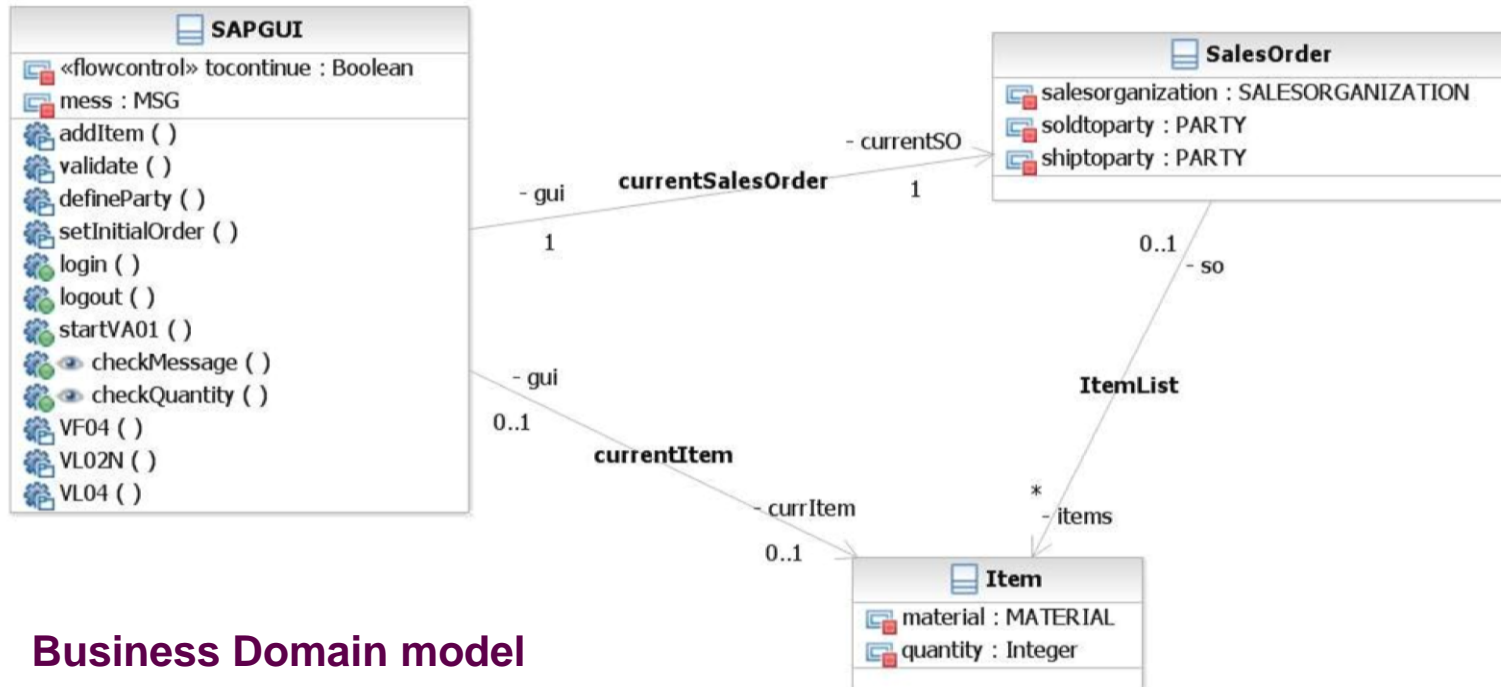
Business flows Modeling for the SD SAP module (with BPMN)



Zoom on PreSales Process

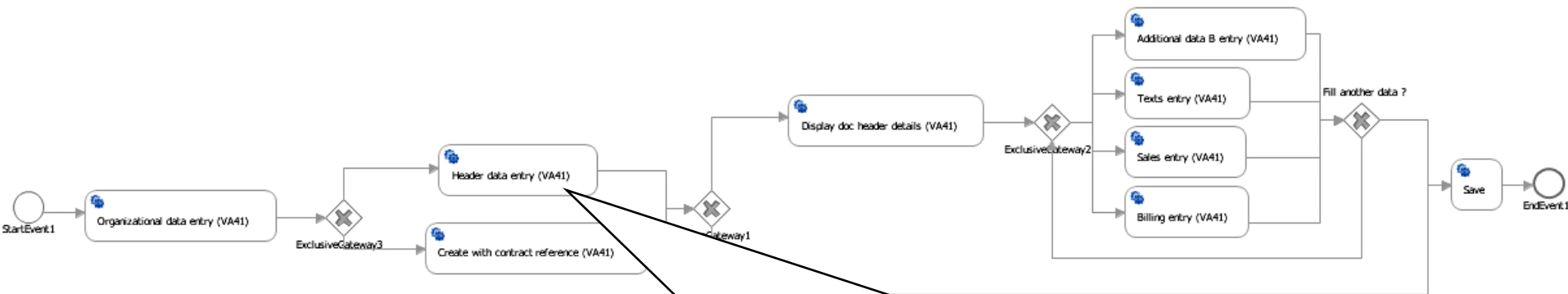


Business entities as a class diagram



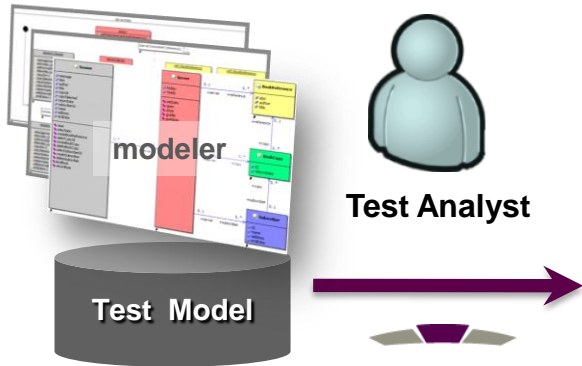
Business Domain model

Business rules as a behavior model (in OCL)

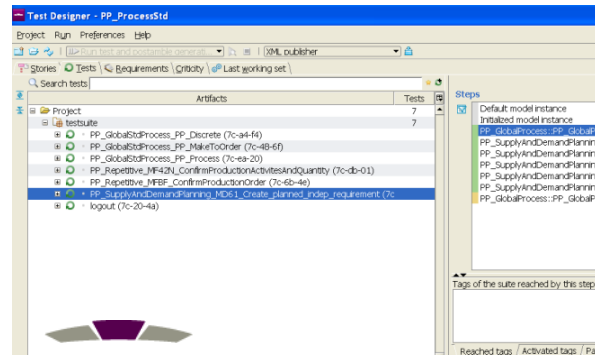


```
...  
---@REQ: VA41 - Create a contract  
---@AIM: For the creation of a standard contract you should not use an inter-company customer otherwise, error: ZNS086 :  
The donneur d'ordre / client livré is a company client. Cross-company flow out of impossible  
---@NAME: Standard contract could not have an inter-company customer  
self.message = MESSAGE::ERR_STANDARD_CONTRACT_COULD_NOT_HAVE_AN_INTER_COMP_CUSTOMER and  
self.tobecontinued = false  
...
```

Automated test generation

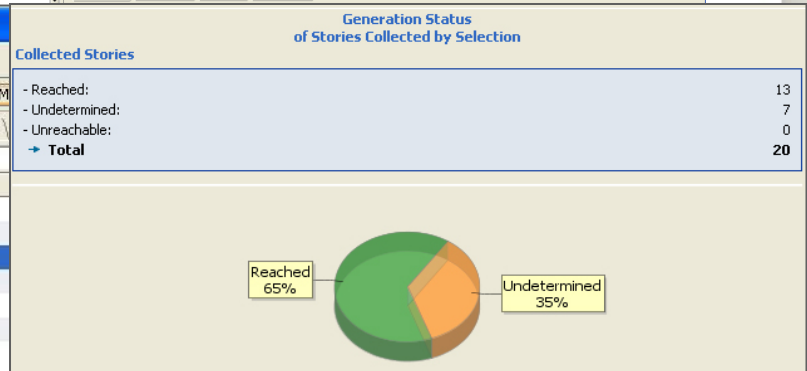
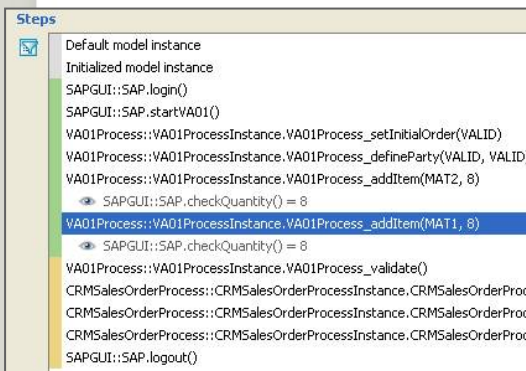


- Requirements traceability
- Smart coverage
- Risk based testing
- Automated impact analysis

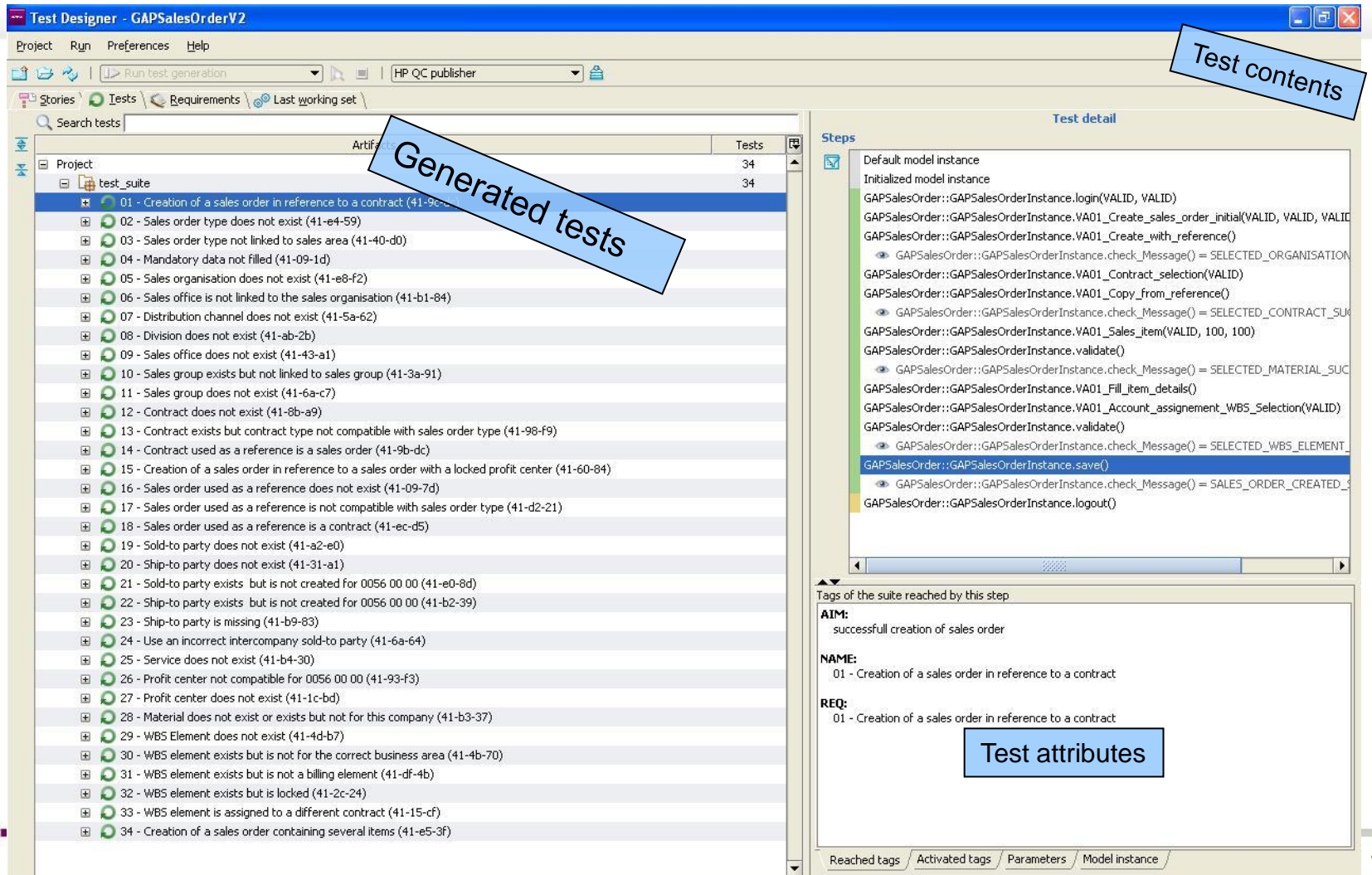


Requirements statistics
Show used, missing, unknown requirements

Requirement	In repository	In model	In test objective
ADMIN/ADD_PROJECT	✓	✓	✓
ADMIN/ADD_TASK	✓	✓	✓
ADMIN/DELETE_PROJECT	✓	✓	✓
ADMIN/DELETE_TASK	✓	✓	✓
COMMON/LOGIN	✓	✓	✓
USER/ENTER_TIME	✓	✓	✓
USER/REMOVE_TIME	✓	✓	✓
USER/SAVE_TIME	✓	✓	✓
USER/SHOW_TIME_TRA...	✓	✓	✓
USER/VIEW TIME-TRACK	✓	✓	✓
USER/WORKING_TASK	✓	✓	✓



Test Generation in Smartesting Test Designer



The screenshot displays the Smartesting Test Designer interface for a project named "GAPSalesOrderV2". The interface is divided into several sections:

- Test contents:** A top-right callout box pointing to the "Test detail" pane.
- Generated tests:** A large list of 34 test cases on the left side, each with a green status icon and a description. A blue callout box labeled "Generated tests" points to this list.
- Test detail:** A right-hand pane showing the execution steps for a selected test case. It includes a "Steps" section with a list of method calls and a "Tags of the suite reached by this step" section with "AIM", "NAME", and "REQ" fields. A blue callout box labeled "Test attributes" points to the "REQ" field.

Generated tests list:

Test ID	Description
01	Creation of a sales order in reference to a contract (41-9c-8d)
02	Sales order type does not exist (41-e4-59)
03	Sales order type not linked to sales area (41-40-d0)
04	Mandatory data not filled (41-09-1d)
05	Sales organisation does not exist (41-e8-f2)
06	Sales office is not linked to the sales organisation (41-b1-84)
07	Distribution channel does not exist (41-5a-62)
08	Division does not exist (41-ab-2b)
09	Sales office does not exist (41-43-a1)
10	Sales group exists but not linked to sales group (41-3a-91)
11	Sales group does not exist (41-6a-c7)
12	Contract does not exist (41-8b-a9)
13	Contract exists but contract type not compatible with sales order type (41-98-f9)
14	Contract used as a reference is a sales order (41-9b-dc)
15	Creation of a sales order in reference to a sales order with a locked profit center (41-60-84)
16	Sales order used as a reference does not exist (41-09-7d)
17	Sales order used as a reference is not compatible with sales order type (41-d2-21)
18	Sales order used as a reference is a contract (41-ec-d5)
19	Sold-to party does not exist (41-a2-e0)
20	Ship-to party does not exist (41-31-a1)
21	Sold-to party exists but is not created for 0056 00 00 (41-e0-8d)
22	Ship-to party exists but is not created for 0056 00 00 (41-b2-39)
23	Ship-to party is missing (41-b9-83)
24	Use an incorrect intercompany sold-to party (41-6a-64)
25	Service does not exist (41-b4-30)
26	Profit center not compatible for 0056 00 00 (41-93-f3)
27	Profit center does not exist (41-1c-bd)
28	Material does not exist or exists but not for this company (41-b3-37)
29	WBS Element does not exist (41-4d-b7)
30	WBS element exists but is not for the correct business area (41-4b-70)
31	WBS element exists but is not a billing element (41-df-4b)
32	WBS element exists but is locked (41-2c-24)
33	WBS element is assigned to a different contract (41-15-cf)
34	Creation of a sales order containing several items (41-e5-3f)

Test detail (Steps):

```
Default model instance
Initialized model instance
GAPSalesOrder::GAPSalesOrderInstance.login(VVALID, VVALID)
GAPSalesOrder::GAPSalesOrderInstance.VA01_Create_sales_order_initial(VVALID, VVALID, VVALID)
GAPSalesOrder::GAPSalesOrderInstance.VA01_Create_with_reference()
  GAPSalesOrder::GAPSalesOrderInstance.check_Message() = SELECTED_ORGANISATION
GAPSalesOrder::GAPSalesOrderInstance.VA01_Contract_selection(VVALID)
GAPSalesOrder::GAPSalesOrderInstance.VA01_Copy_from_reference()
  GAPSalesOrder::GAPSalesOrderInstance.check_Message() = SELECTED_CONTRACT_SU
GAPSalesOrder::GAPSalesOrderInstance.VA01_Sales_item(VVALID, 100, 100)
GAPSalesOrder::GAPSalesOrderInstance.validate()
  GAPSalesOrder::GAPSalesOrderInstance.check_Message() = SELECTED_MATERIAL_SUC
GAPSalesOrder::GAPSalesOrderInstance.VA01_Fill_item_details()
GAPSalesOrder::GAPSalesOrderInstance.VA01_Account_assignment_WBS_Selection(VVALID)
GAPSalesOrder::GAPSalesOrderInstance.validate()
  GAPSalesOrder::GAPSalesOrderInstance.check_Message() = SELECTED_WBS_ELEMENT_
GAPSalesOrder::GAPSalesOrderInstance.save()
  GAPSalesOrder::GAPSalesOrderInstance.check_Message() = SALES_ORDER_CREATED_S
GAPSalesOrder::GAPSalesOrderInstance.logout()
```

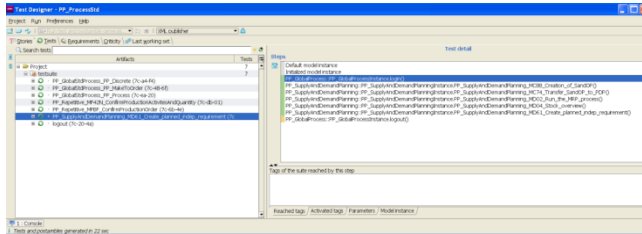
Test attributes (Tags of the suite reached by this step):

AIM: successfull creation of sales order

NAME: 01 - Creation of a sales order in reference to a contract

REQ: 01 - Creation of a sales order in reference to a contract

Test publication: manual and automated tests

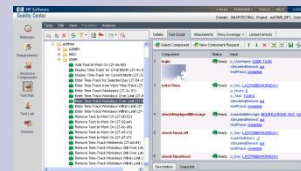


Test Analyst

Publication

Test Repository

Manual testing + Automated testing



Automation engineer

Publication - HP Quality Center



HP Software Quality Center

Domain: F_BOR_AO_ES_SAP, Project: POC2_NESSIE, User: A125264

Tests Edit View Favorites Analysis

Releases Requirements Business Components Test Plan Test Lab Defects

Quality Center

01 - Creation of a sales order in reference to a contract (41-9c-dc)
02 - Sales order type does not exist (41-e4-59)
03 - Sales order type not linked to sales area (41-40-d0)
04 - Mandatory data not filled (41-09-1d)
05 - Sales organisation does not exist (41-e8-f2)
06 - Sales office is not linked to the sales organisation (41-b1-84)
07 - Distribution channel does not exist (41-5a-52)
08 - Division does not exist (41-ab-2b)
09 - Sales office does not exist (41-43-a1)
10 - Sales group exists but not linked to sales group (41-3a-91)
11 - Sales group does not exist (41-6a-c7)
12 - Contract does not exist (41-8b-a9)
13 - Contract exists but contract type not compatible with sales order type (41-98-f9)
14 - Contract used as a reference is a sales order (41-9b-dc)
15 - Creation of a sales order in reference to a sales order with a locked profit center (41-60-...)
16 - Sales order used as a reference does not exist (41-09-7d)
17 - Sales order used as a reference is not compatible with sales order type (41-d2-21)
18 - Sales order used as a reference is a contract (41-ec-d5)
19 - Sold-to party does not exist (41-a2-e0)
20 - Ship-to party does not exist (41-31-a1)
21 - Sold-to party exists but is not created for 0056 00 00 (41-e0-8d)
22 - Ship-to party exists but is not created for 0056 00 00 (41-b2-39)
23 - Ship-to party is missing (41-b9-83)
24 - Use an incorrect intercompany sold-to party (41-6a-64)
25 - Service does not exist (41-b4-30)
26 - Profit center not compatible for 0056 00 00 (41-93-f3)
27 - Profit center does not exist (41-1c-bd)
28 - Material does not exist or exists but not for this company (41-b3-37)
29 - WBS Element does not exist (41-4d-b7)
30 - WBS element exists but is not for the correct business area (41-4b-70)
31 - WBS element exists but is not a billing element (41-df-4b)
32 - WBS element exists but is locked (41-2c-24)
33 - WBS element is assigned to a different contract (41-15-cf)
34 - Creation of a sales order containing several items (41-e5-3f)
35 - Creation of a sales order without any reference to a document (41-b0-e4)

Details Test Script Attachments Req Coverage Linked Defects

Component	Status	Input
1 login	Ready	p_UserName: VALID p_Pwd: VALID stimulatedElement: GAPSalesOrderInstance testPhase: body
2 VA01_Create_sales_order_initial	Ready	p_Channel: VALID p_Division: VALID p_OrderType: VALID p_SalesOffice: VALID p_SalesGroup: VALID p_SalesOrga: VALID stimulatedElement: GAPSalesOrderInstance testPhase: body
3 VA01_Create_with_reference	Ready	stimulatedElement: GAPSalesOrderInstance testPhase: body
4 check_Message	Ready	retmess: SELECTED_ORGANISATION_SUCCES stimulatedElement: GAPSalesOrderInstance testPhase: body
5 VA01_Contract_selection	Ready	p_ContractNum: VALID stimulatedElement: GAPSalesOrderInstance testPhase: body
6 VA01_Copy_from_reference	Ready	stimulatedElement: GAPSalesOrderInstance testPhase: body
7 check_Message	Ready	retmess: SELECTED_CONTRACT_SUCCESSUL stimulatedElement: GAPSalesOrderInstance testPhase: body
8 VA01_Sales_item	Ready	p_MaterialName: VALID p_OrderQuantity: 100 p_OrderAmount: 100 stimulatedElement: GAPSalesOrderInstance testPhase: body
9 validate	Ready	stimulatedElement: GAPSalesOrderInstance

DESCRIPTION Snapshot

Smartesting Test Designer key points



- Based on standard UML 2.x and BPMN 1.x or 2.0
 - Integrated with modeling tools under Eclipse/UML (IBM RSM, open-source, Borland/MicroFocus Together)
- Integration into existing test environments
 - Test management & test execution tools (HP QC/QTP, IBM RQM/RFT, TestLink/Selenium)
- Test generation strategies
 - Structural model coverage criteria
 - Scenario & Schema-based testing

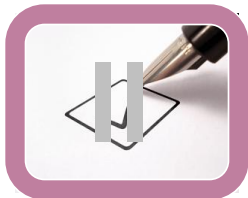
Agenda



Model-based testing to industrialize the functional testing process



Challenges and Quality Issues



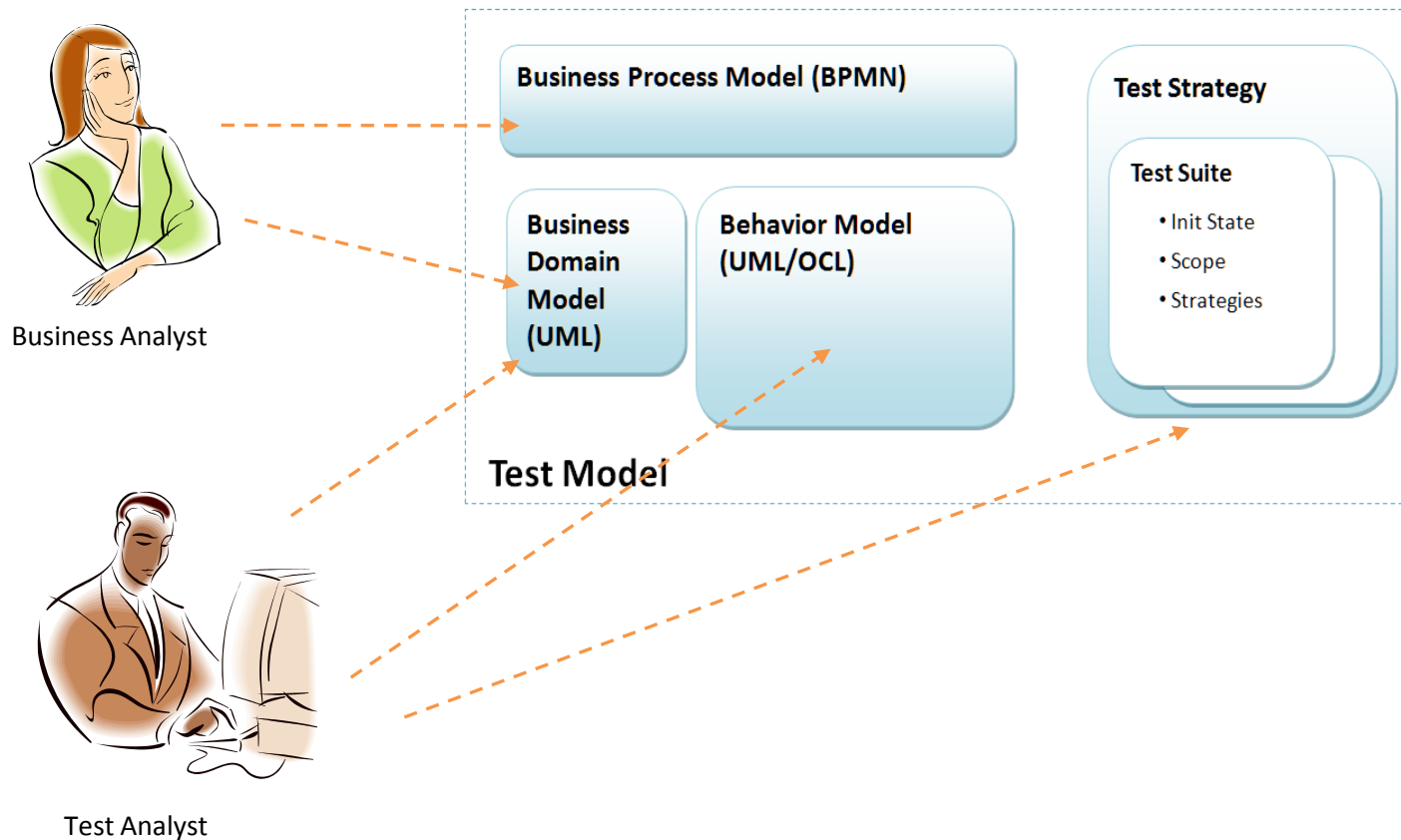
MBT in practice – Lessons learned

Challenges & Quality Issues #1

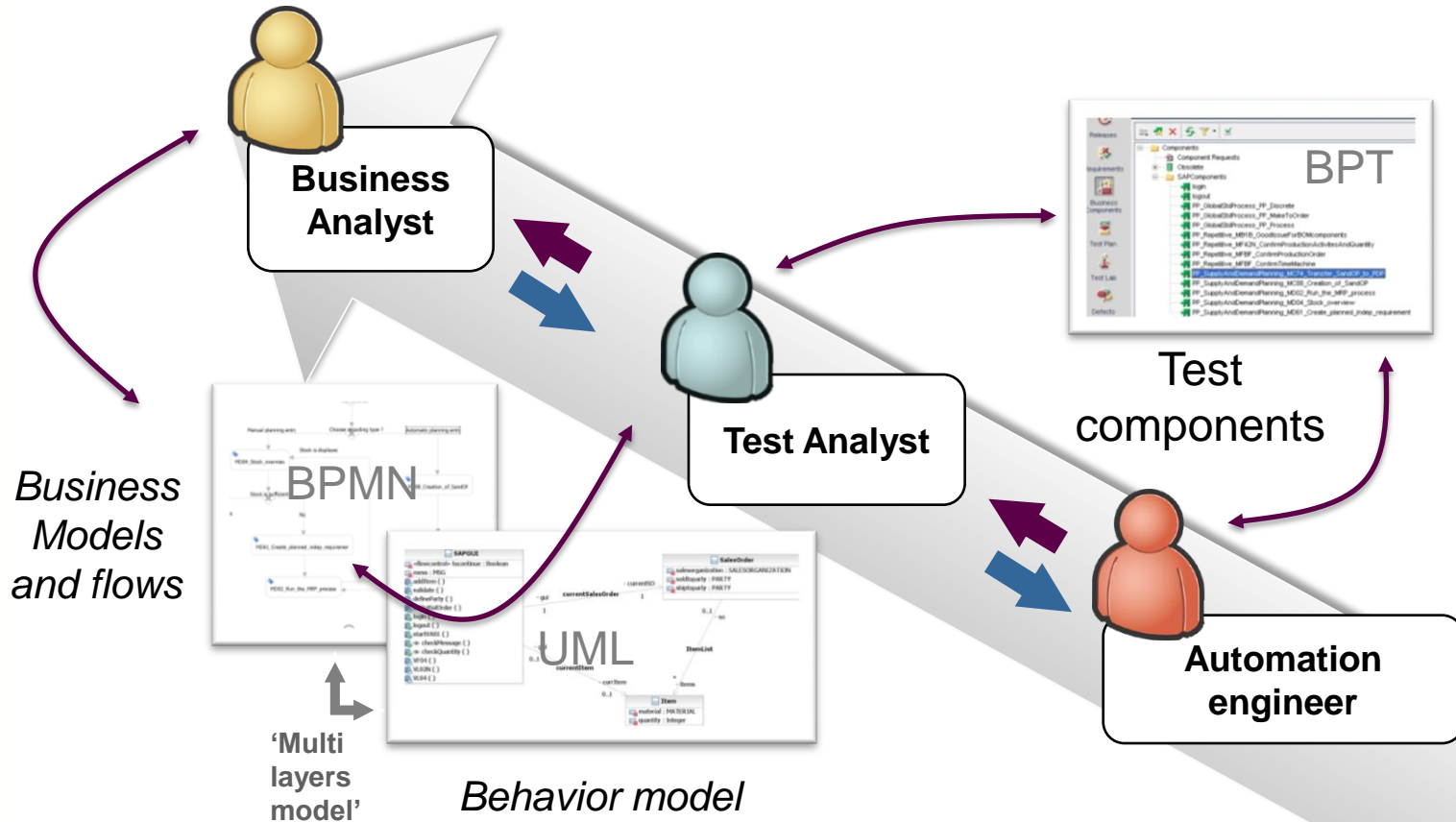


- ➔ Alignment of the test repository with the business requirements
 - How to facilitate the communication between business analysts and testers?
 - How to prioritize the test design with the critical business processes (particularly for end-to-end testing) in a risk-based approach?

Roles and collaboration (1)



Roles and collaboration (2)

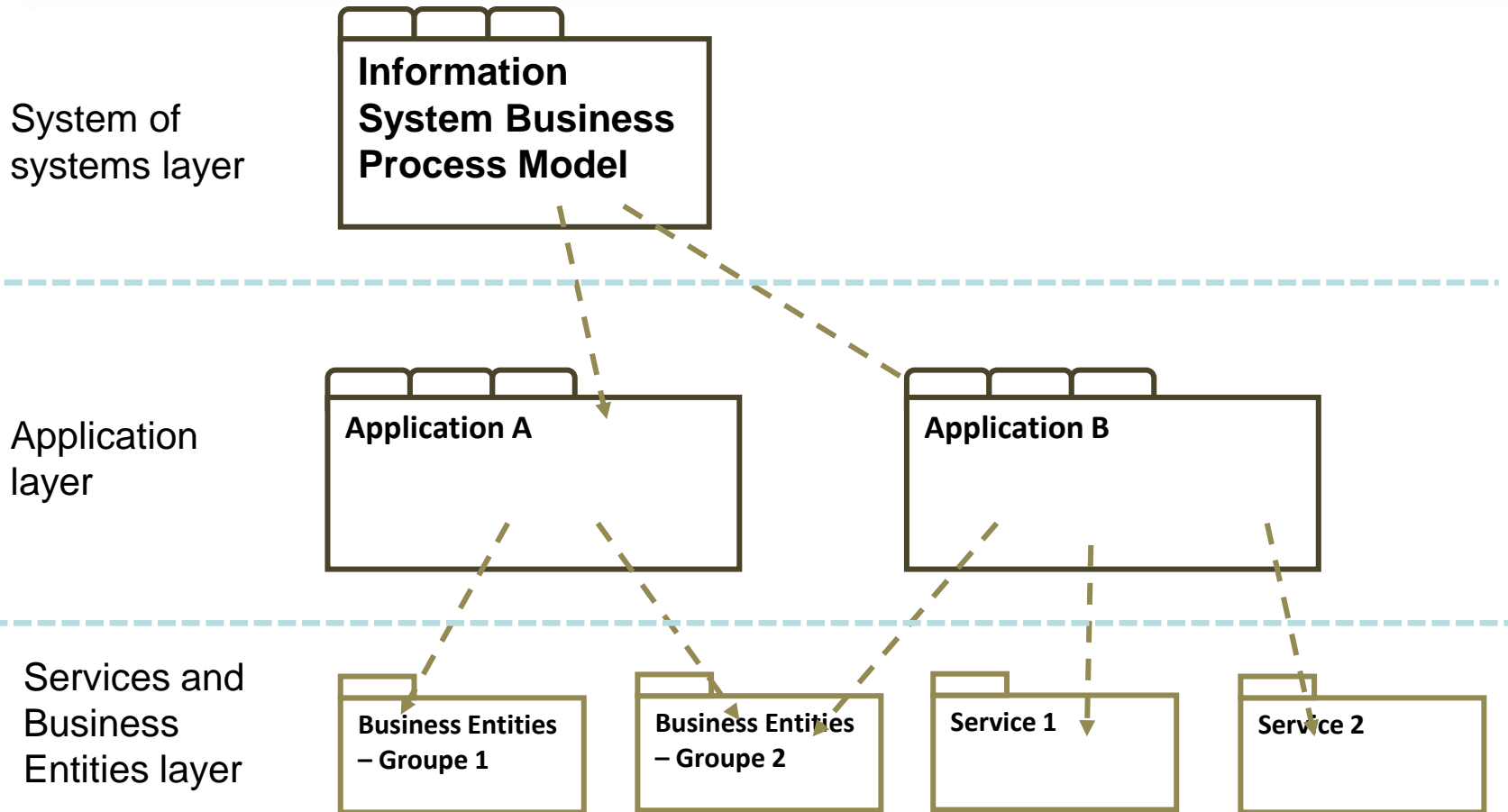


Challenges & Quality Issues #2



- ➔ How to manage the complexity and re-usability of the test model
 - Collaborative work (large testing team for large-scale enterprise IT)
 - Several levels of testing
 - Application testing
 - End-to-End testing

Test model - Layered structure



Challenges & Quality Issues #3



- ➔ MBT should manage both manual and automated testing
 - Testers in the IT field reserve test automation for regression testing
 - How to manage both manual and automated test execution in the MBT process?
- ➔ MBT enhances the Key-word testing approach

Fully documented test repository



From the description of operations in the Test model to the documentation of each steps in the test repository.

The screenshot displays the Rational Quality Manager interface. The main window shows a test script execution report for 'Display Time-Track for Current Month (27-43-3d) Execution'. The report includes a 'Test Environment' section with the test script name and a 'Script Steps' table. The table has columns for Step, Result, Description, and Expected Results. The steps are as follows:

Step	Result	Description	Expected Results
1		Setup: initTest Technical Init for automation	
2		Body: login Fill the Username and Password fields with the values Caroline (password: pass). Then click the "Login Now" button.	
3		Body: enterTime Identify the line matching the task Telesales. Then enter 5 in the box corresponding to the date Saturday last week.	The displayed message is equal to "MODIFICATIONS_NOT_SAVED". The remaining time for Saturday last week must be 5 hour(s) Time used on task Telesales for Saturday last week must be 5 hour(s)
4		Body: saveTimeTrack Click the "Save Time-Track" button.	The displayed message is equal to "MODIFICATIONS_SUCCESSFUL_SAVE".
5		Body: confirmation	
6		Body: selectViewTime Select the "View My-Time Track" tab.	
7		Body: showTimeTrack In the calendar, select the date (month or year) corresponding to CURRENT_MONTH.	The displayed message is equal to "DISPLAYED_UNTIL_TODAY".
8		Tear down: endTest	

Agenda



Model-based testing to industrialize the functional testing process



Challenges and Quality Issues



MBT in practice – Lessons learned

Lesson learned #1: Modeling paradigms

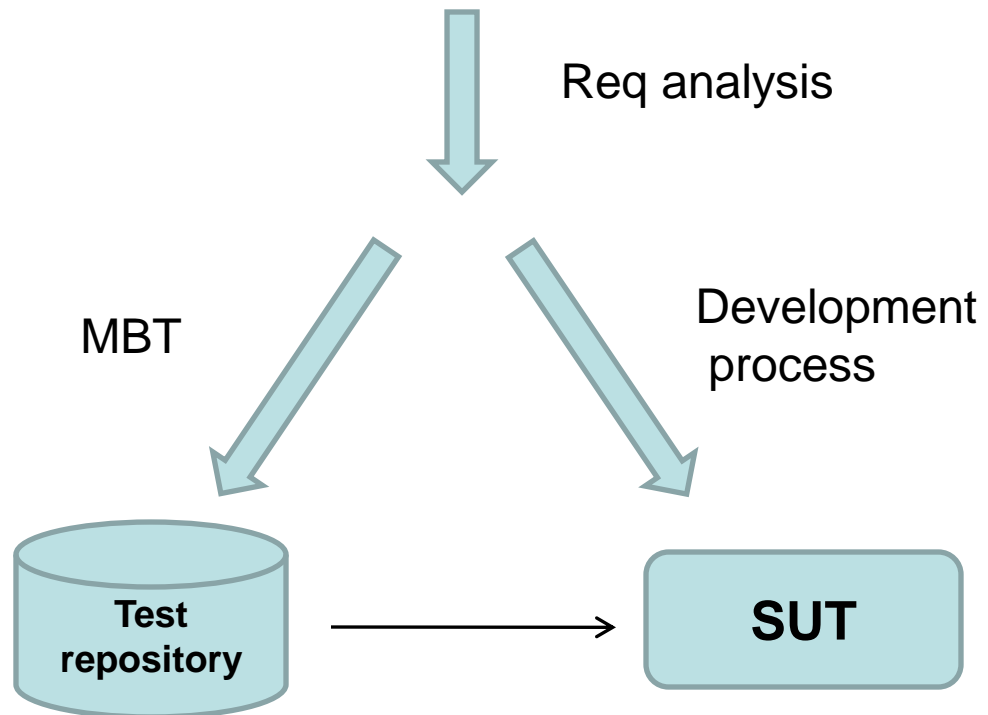
- ➔ **Multi-paradigm approach** (see W. Grieskamp – 2006 FATES invited paper)
 - Diagrammatic and Textual notations
 - Pre-post, State-based and Process-based modeling paradigms
- ➔ **Supporting model sharing and re-use**
 - Structuring models using packages
 - Model composition

Lesson learned #2: Dedicated test model

➔ Model-based testing: the inversed Y model

Reusability of business process models and business domain models from the Req analysis phase..

➔ **Dedicated behavior test model for automated test generation**



Lesson learned #3: Test generation strategies



➔ Two complementary approaches:

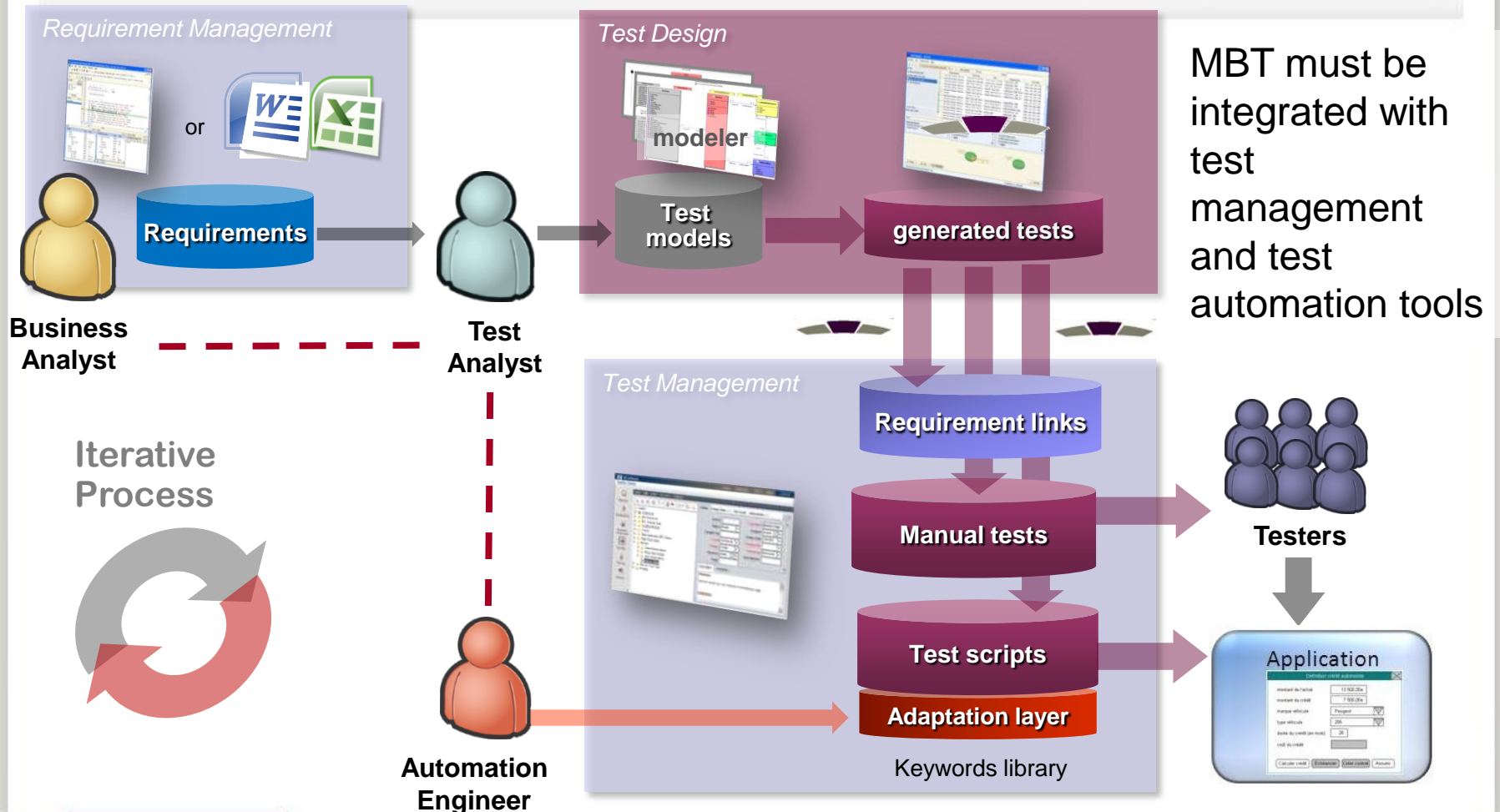
– Structural model coverage

- Using classical coverage criteria (Transition & decision coverage, path coverage, data coverage)
- Based on risk analysis

– Scenario-based test generation

- Generation based on high level scenario or use cases
- Symbolic animation of scenario on the model to compute the expected results and input parameters
- Generating tests from test schemas

Lesson learned #4: Integration issues



Agenda



Model-based testing to industrialize the functional testing process



Challenges and Quality Issues



MBT in practice – Lessons learned

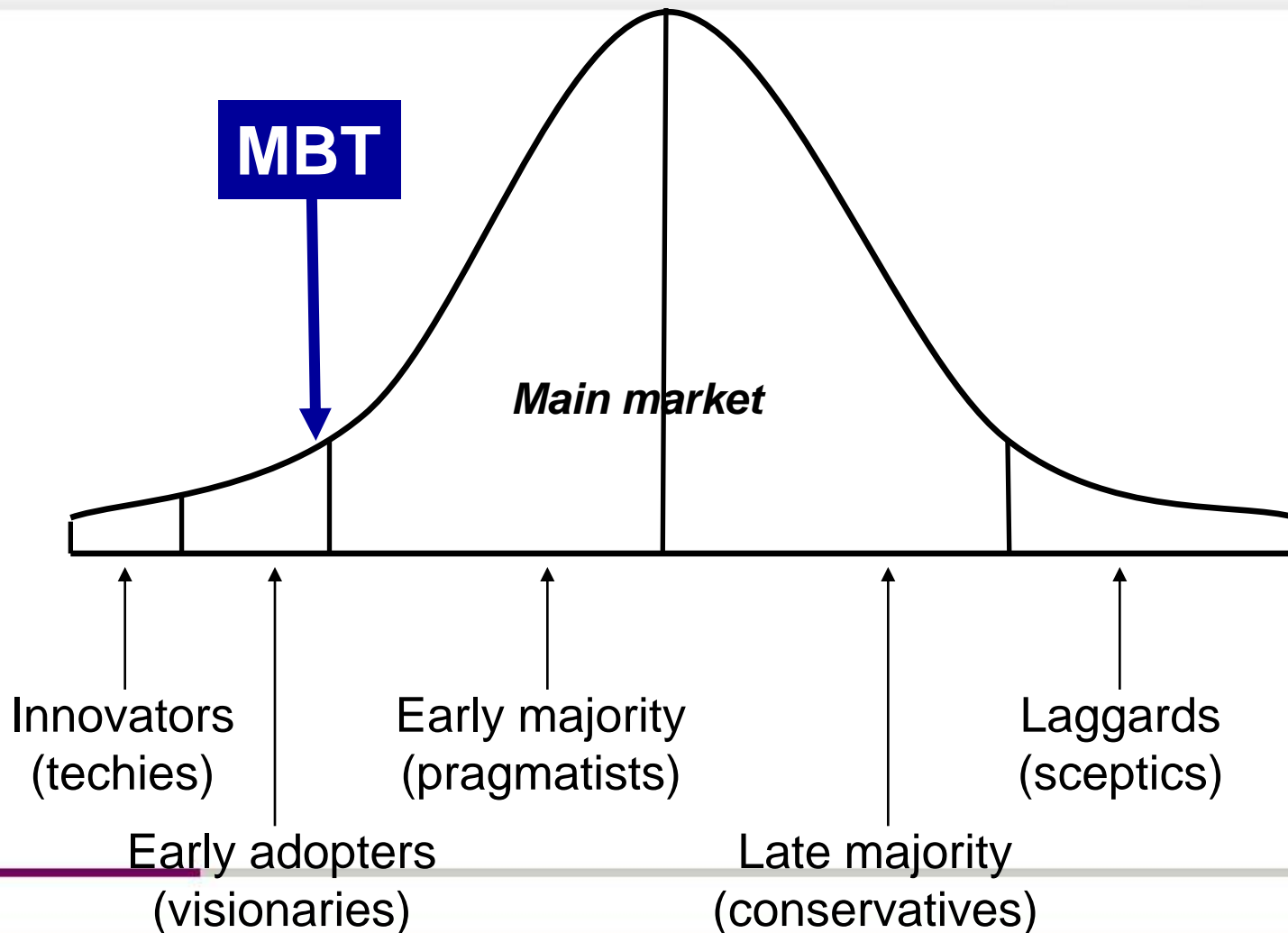


Conclusion – Where is MBT

Conclusion

- ➔ MBT is now emerging in industry for several reasons:
 - The complexity of software applications continues to increase, and the user's aversion to software defects is greater than ever ;
 - The cost and time of testing is already a major proportion of many projects ; MBT can decrease the overall cost of test by generating manual and automated tests ;
 - The MBT approach and the associated tools are now mature enough to be applied in many application areas.

Technology adoption life cycle



Some Research Challenges in MBT

- Fitting MBT into existing processes (including agility) and tool chains
- How to make MBT modeling easier (behavioral part)?
 - Link with requirements analysis activities?
 - Dedicated Domain Specific Modeling languages?
- Link between MBT approach and Code analysis
- Effectiveness of test generation strategies (Theoretical & Experimental works needed)
- MBT for non functional properties (security, usability, performance, availability...)