Tutorial
MBT for Beginners

Eddie Jaffuel
Consultant
Agenda

• Introduction (15 min)
• MBT as a black box (35 min)
• Open the box (20 min)
• The value of MBT (10 min)
• Questions (10 min)
Agenda

• **Introduction**
  - The speaker
  - What is MBT?
  - Goal of the tutorial
  - Focus of the tutorial
  - MBT Process overview

• MBT as a black box

• Open the box

• The value of MBT

• Questions
Who is Eddie JAFFUEL?

- Independent consultant
- Expert in Modeling and **Model Based Testing** for 10 years
  - Proof Of Concepts
  - Deployment Pilot Projects
  - Training, Coaching and Knowledge Transfer
  - Model Production
  - Technical Lead and Project Manager for the MBT technics:
    - Information Technologies
    - Automotive industries
    - Embedded Systems (Smartcard & Device industries)
      -> MBT applied to **GLOBALPLATFORM™** Compliance Testing (KeyNote)
- More information... [LinkedIn](https://www.linkedin.com)
What is MBT?

• The context:
What is MBT?

- MBT = Model Based Testing
- Focused on Test Design
- Combines a method: Model-Based
- And a Technology: automatic test generation from a model

![Diagram showing the process flow of MBT solution with roles and technologies involved.]

**Computer-aided Design**
Goal of the tutorial

- Understand the principles of MBT
  - How a MBT Tool may deduce tests from a Model?

- Explanation based on One MBT Methodology
  - from the Requirements...
  - through the Test Objective Charter...
  - through the Behavioral Model
  - to the generated Tests for manual execution

- Benefits of MBT approach
  - Different levels of factorization,
  - Ability to manage changes more efficiently through MBT
## Focus of the Tutorial

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Focus of the tutorial</th>
<th>Not covered by tutorial but MBT is also applicable for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kind of System Under Test</td>
<td>Web based application</td>
<td>Application Java / ERP / CRM Multi-Applications System / ...</td>
</tr>
<tr>
<td>Interface to access to SUT</td>
<td>Graphical User Interface</td>
<td>API / Services / SOA Flow / ...</td>
</tr>
<tr>
<td>Level of test</td>
<td>Application Testing Functional Testing</td>
<td>System Testing Integration Testing Compliance Testing ...</td>
</tr>
<tr>
<td>Nature of test execution</td>
<td>Manual Execution</td>
<td>Automated Execution</td>
</tr>
<tr>
<td>Test format</td>
<td>HTML</td>
<td>TTCN, XML, script languages, VB, C, Java ...</td>
</tr>
<tr>
<td>Model</td>
<td>UML (Unified Modeling Language)</td>
<td>BPMN, ...</td>
</tr>
<tr>
<td>MBT Solution/Product</td>
<td>Smartesting CertifyIt</td>
<td>Conformiq, Matelo, SpecExplorer, ...</td>
</tr>
</tbody>
</table>
What kind of tests?

End-to-end test, ERP, CRM...

Acceptance test multi-applications / services

Functional test single application

Focus of the tutorial
Agenda

• Introduction
• **MBT as a black box**
  - *Introduction of the System Under Test*
  - Test Objective Charter
  - Behavioral Model
  - Test Plan Publication
• Open the box
• The value of MBT
• Questions
Introduction of the System Under Test (1/4)

- It is a simple Web Application: Sims
- Features
  - Manage the inhabitants (Add / Delete / Edit)
  - Marry the inhabitants
  - Divorce the inhabitants
- Navigation
  - Start at HOME
  - Go to CHURCH to perform a Marriage, once done go back HOME
  - Go to COURT to perform a Divorce, once done: go back HOME
Introduction of the System Under Test (2/4)
Introduction of the System Under Test (3/4)
Introduction of the System Under Test (4/4)

Smart-Sims in Court

<table>
<thead>
<tr>
<th>First name</th>
<th>Last name</th>
<th>Gender</th>
<th>Age</th>
<th>Married with</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isabel</td>
<td>H</td>
<td>Female</td>
<td>34</td>
<td>Eddie Jaffuel</td>
</tr>
<tr>
<td>Eddie</td>
<td>Jaffuel</td>
<td>Male</td>
<td>39</td>
<td>Isabel H</td>
</tr>
<tr>
<td>Dooley</td>
<td>NSEWOLO</td>
<td>Male</td>
<td>35</td>
<td>Christelle NSEWOLO</td>
</tr>
<tr>
<td>Christelle</td>
<td>NSEWOLO</td>
<td>Female</td>
<td>30</td>
<td>Dooley NSEWOLO</td>
</tr>
</tbody>
</table>

New divorce

First person
Isabel H

Second person
Eddie Jaffuel

Divorce
Agenda

• Introduction

• **MBT as a black box**
  - Introduction of the System Under Test
  - **Test Objective Charter**
  - Behavioral Model
  - Test Plan Publication

• Open the box

• The value of MBT

• Questions
Test Objective Charter (1/3)

- a « Test Objective Charter » (TOC) helps to
  - List and Identify the REQUIREments or Business Rules to cover
  - Describe the Expected Coverage (Test AIMS)

⇒ WHAT to cover
<table>
<thead>
<tr>
<th>Requirement description</th>
<th>#AIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The conditions which allow to add one inhabitant are: - all its informations are provided (identifier, gender, age) - its age have to be greateed than 1 - the inhabitant not already exist</td>
<td>Success</td>
</tr>
<tr>
<td>In case of success, the inhabitant is added to the list of inhabitants, and its information are displayed. A new inhabitant is single by default. If an error occurs, an error message indicates which condition is not fulfilled.</td>
<td>Already exists</td>
</tr>
<tr>
<td>You can only suppress one inhabitant if it exists</td>
<td>Success</td>
</tr>
<tr>
<td></td>
<td>Empty identifier</td>
</tr>
<tr>
<td></td>
<td>Age not strictly positive</td>
</tr>
<tr>
<td>@REQ</td>
<td>Requirement description</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------</td>
</tr>
</tbody>
</table>
| MARRIAGE | The conditions which allow a marriage are:  
- age over 18  
- none of them are married  
- one male and one female | Success |
| | Once the marriage is accepted, the status of the 2 inhabitants is modified accordingly their fields "Married with ..." is filled | Error same person |
| | If an error occurs, an error message indicates which condition is not fullfilled. | Error same gender |
| | | Error one is not adult |
| | | Error one is already married |
Agenda

• Introduction
• **MBT as a black box**
  - Introduction of the System Under Test
  - Test Objective Charter
  - Behavioral Model
  - Test Plan Publication
• Open the box
• The value of MBT
• Questions
Behavioral Model

• The different components of the Behavioral Model:
  - Static part
    • Points of Control and Observation ➔ Operations
    • Data Representation ➔ Classes
  - Dynamic part
    • Initial Data of the System Under Test (SUT) ➔ Objects
    • Flows ➔ State Machine
    • Business Rules ➔ OCL: Object Constraint Language
Behavioral Model: Points of Control ➔ Operations

Point Control Obs

Smart-Sims at Home

<table>
<thead>
<tr>
<th>First name</th>
<th>Last name</th>
<th>Gender</th>
<th>Age</th>
<th>Married with</th>
<th>Edit</th>
<th>Delete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isabel</td>
<td>H</td>
<td>Female</td>
<td>34</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Jaffuel</td>
<td>Male</td>
<td>39</td>
<td>--</td>
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<td>Dooley NSEWOLO</td>
<td></td>
<td></td>
</tr>
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</table>

New Inhabitant ➔ Go to church ➔ Go to Court
Behavioral Model: Points of Control ➔ Operations + Parameters
Behavioral Model: Points of Control ➔ Operations + Parameters

Point Control Obs

New marriage

First person
- Isabel H

Second person
- Eddie Jaffuel

Get Married
Behavioral Model: Points of Observation ➔ Operations

Point Control Obs

New marriage

1 error prohibited this wedding from being saved:

- Second spouse already married

First person
- Isabel H

Second person
- Dooley NSEWOLO

Get Married
Behavioral Model

• The different components of the Behavioral Model:
  - Static part
    • Points of Control and Observation ➔ Operations
    • Data Representation ➔ Classes

- Dynamic part
  • Initial Data of the System Under Test (SUT) ➔ Objects
  • Flows ➔ State Machine
  • Business Rules ➔ OCL: Object Contraint Language
Behavioral Model : Data Representation

- **The Class diagrams** helps to model the **Data representation**
  - **Classes** helps to represent the Business Entities
  - **Attributes** are the characteristics of the Business Entities
  - **Association** are the relations between Business Entities

![Data Representation Diagram]
Behavioral Model

• The different components of the Behavioral Model:
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    • Flows ➔ State Machine
    • Business Rules ➔ OCL: Object Constraint Language
Behavioral Model: Initial Data of the SUT

- The **Object diagram** used to model the **Initial Data of the SUT**
  - Objects are instance of Business Entities

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<td>Christelle</td>
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</table>
Behavioral Model

- The different components of the Behavioral Model:
  - Static part
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    - Data Representation ➔ Classes
  - Dynamic part
    - Initial Data of the System Under Test (SUT) ➔ Objects
    - Flows ➔ State Machine
    - Business Rules ➔ OCL: Object Constraint Language
Behavioral Model: Dynamic Flows

- The **State Machine** used to model the Dynamic Flows
  - With States and Transitions

![State Machine Diagram]
Behavioral Model

• The different components of the Behavioral Model:
  - Static part
    • Points of Control and Observation ➔ Operations
    • Data Representation ➔ Classes
  - Dynamic part
    • Initial Data of the System Under Test (SUT) ➔ Objects
    • Flows ➔ State Machine
    • Business Rules ➔ OCL: Object Constraint Language
### Behavioral Model: Business Rules

#### Test Objective Charter

<table>
<thead>
<tr>
<th>Requirement description</th>
<th>Requirement</th>
<th>MARRIAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>@REQ</td>
<td>MARRIAGE</td>
</tr>
<tr>
<td>The conditions which allow a marriage are:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- age over 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- none of them are married</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- one male and one female</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once the marriage is accepted, the status of the 2 inhabitants is modified accordingly their fields &quot;Married with ...&quot; is filled</td>
<td>#AIM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error same person</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error same gender</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error one is not adult</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error one is already married</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Success</td>
</tr>
</tbody>
</table>

#### Business Rules

```plaintext
---@REQ: MARRIAGE
if person1 = person2 then
    ---@AIM: Error same person
    self.message = MESSAGES::ERROR_MARRIAGESAME_PERSON
else if person1.gender = person2.gender then
    ---@AIM: Error same gender
    self.message = MESSAGES::ERROR_MARRIAGESAME_GENDER
else if (person1.age < 18) or (person2.age < 18) then
    ---@AIM: Error one is not adult
    self.message = MESSAGES::ERROR_MARRIAGE_NOT_AN_ADULT
else if person1.is_married() or person2.is_married() then
    ---@AIM: Error one is already married
    self.message = MESSAGES::ERROR_MARRIAGE NOT_SINGLE
else
    ---@AIM: Success
    self.message = MESSAGES::NO_MESSAGE
    and
    if person1.gender = GENDER::MALE then
        ---@AIM: person1 is a man
        person1.wife = person2
    else
        ---@AIM: person1 is a woman
        person1.husband = person2
    endif
```
### Test Objective Charter

<table>
<thead>
<tr>
<th>@REQ</th>
<th>MARRIAGE</th>
</tr>
</thead>
</table>
| **Requirement description** | The conditions which all must be met to get a valid marriage are:  
- age over 18  
- none of them are married  
- one male and one female |

Once the marriage is accepted, their status of the 2 inhabitants accordingly their fields "spouse name" is filled.

If an error occurs, an error message indicates which condition was not fulfilled.

<table>
<thead>
<tr>
<th>#AIM</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Error same person</td>
<td></td>
</tr>
<tr>
<td>Error same gender</td>
<td></td>
</tr>
<tr>
<td>Error one is not adult</td>
<td></td>
</tr>
<tr>
<td>Error one is already married</td>
<td></td>
</tr>
<tr>
<td>Success</td>
<td></td>
</tr>
</tbody>
</table>

### Business Rules

```c
---@REQ: MARRIAGE
if person1 = person2 then
    ---@AIM: Error same person
    self.message = MESSAGES::ERROR_MARRIAGESAME_PERSON
else if person1.gender = person2.gender then
    ---@AIM: Error same gender
    self.message = MESSAGES::ERROR_MARRIAGESAME GENDER
else if (person1.age < 18) or (person2.age < 18) then
    ---@AIM: Error one is not adult
    self.message = MESSAGES::ERROR_MARRIAGE NOT AN ADULT
else if person1.is_married() or person2.is_married() then
    ---@AIM: Error one is already married
    self.message = MESSAGES::ERROR_MARRIAGE NOT SINGLE
else
    ---@AIM: Success
    self.message = MESSAGES::NO_MESSAGE
and
    if person1.gender = GENDER::MALE then
        ---@AIM: person1 is a man
        person1.wife = person2
    else
        ---@AIM: person1 is a woman
        person1.husband = person2
endif
```
Agenda

• Introduction
• **MBT as a black box**
  - Introduction of the System Under Test
  - Test Objective Charter
  - Behavioral Model
  - **Test Plan Publication**
• Open the box
• The value of MBT
• Questions
### Test Plan Publication (HTML)

#### Requirement

**MARRIAGE**

The conditions which allow a marriage are:
- age over 18
- none of them are married
- one male and one female

Once the marriage is accepted, the status of the 2 inhabitants is modified accordingly: their fields "Married with ..." is filled.

If an error occurs, an error message indicates which condition is not fulfilled.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Aims</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARRIAGE</td>
<td>Error one is already married</td>
<td>testSuite_Family</td>
</tr>
<tr>
<td></td>
<td>Marry_Error_one_is_already_married (02-23-c8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Error one is not adult</td>
<td>testSuite_Family</td>
</tr>
<tr>
<td></td>
<td>Error same gender</td>
<td>testSuite_Family</td>
</tr>
<tr>
<td></td>
<td>Marry_Error_same_gender (02-9a-ed)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Error same person</td>
<td>testSuite_Family</td>
</tr>
<tr>
<td></td>
<td>Marry_Error_same_person (02-2a-e4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Success</td>
<td>testSuite_Family</td>
</tr>
<tr>
<td></td>
<td>Marry_Success (02-ae-f1)</td>
<td></td>
</tr>
</tbody>
</table>

#### DIVORCE

The conditions which allow a divorce are:
- 2 person being married together

Once the divorce is accepted, the status of the 2 inhabitants is modified accordingly: their fields "Married with ..." is empty.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Aims</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIVORCE</td>
<td>Error married but not together</td>
<td>testSuite_Family</td>
</tr>
<tr>
<td></td>
<td>Divorce_Error_married_but_not_together (02-24-87)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Error one is not married</td>
<td>testSuite_Family</td>
</tr>
<tr>
<td></td>
<td>Divorce_Error_one_is_not_married (02-91-7c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Success</td>
<td>testSuite_Family</td>
</tr>
<tr>
<td></td>
<td>Divorce_Success (02-57-2b)</td>
<td></td>
</tr>
</tbody>
</table>
## Test: Marry_Error_same_person (02-2a-e4)

<table>
<thead>
<tr>
<th>Steps</th>
<th>Actions</th>
<th>Requirements, aims</th>
</tr>
</thead>
</table>
| **Step 1** (sut) | Go to church  
Click on the button "Go to church" |
| **Step 2** (sut) | Marry  
Click on "Get Married"  
Select the first person identified with EDDIE  
Select the second person identified with EDDIE  
Click on the button "OK" |

2.1 Check that the message ERROR_MARRIAGESAME_PERSON is displayed
<table>
<thead>
<tr>
<th>Steps</th>
<th>Actions</th>
<th>Requirements, aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><em>Go to church</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Click on the button &quot;Go to church&quot;</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td><em>Marry</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Click on &quot;Get Married&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select the first person identified with DOOLEY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select the second person identified with CHRISTELLE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Click on the button &quot;OK&quot;</td>
<td></td>
</tr>
</tbody>
</table>

2.1 Check that the message *ERROR_MARRIAGE_NOT_SINGLE* is displayed
### Test: Marry_Error_same_person (02-2a-e4)

<table>
<thead>
<tr>
<th>Steps (sut)</th>
<th>Actions</th>
<th>Requirements, aims</th>
</tr>
</thead>
</table>
| Step 1 (sut) | Go to church  
Click on the button "Go to church" |  |
| Step 2 (sut) | Marry  
Click on "Get Married"  
Select the first person identified with EDDIE  
Select the second person identified with EDDIE  
Click on the button "OK" | REQ MARRIAGE  
AIM Error same person |

#### Point Control Obs

**Marry**

- Click on "Get Married"
- Select the first person identified with $IN_id1$
- Select the second person identified with $IN_id2$
- Click on the button "OK"

### Test: Marry_is_already_married (02-23-c8)

<table>
<thead>
<tr>
<th>Steps (sut)</th>
<th>Actions</th>
<th>Requirements, aims</th>
</tr>
</thead>
</table>
| Step 2 (sut) | Marry  
Click on "Get Married"  
Select the first person identified with DOOLEY  
Select the second person identified with CHRISTELLE  
Click on the button "OK" | REQ MARRIAGE  
AIM Error one is already married |

#### 2.1 Check that the message ERROR_MARRIAGE_NOT_SINGLE is displayed
MBT Process Overview

Specifications → Test Analyst

Test Objective Charter (XLS) → Test Analyst

Test Objective Charter (XLS) → Client

Test Analyst → Behavioral Model

Behavioral Model → MBT Tool

MBT Tool → Generated Test Sequences

Generated Test Sequences → Test Plan (HTML)

Test Plan (HTML) → Test Objective Charter (XLS)

Test Objective Charter (XLS) → Manual Tester

Manual Tester → Test Analyst

Any kind of Magic? ➔ Let’s open the box!
Agenda

• Introduction
• MBT as a black box
• Open the box
• The value of MBT
• Questions
Test Generation Details

1. MBT Tool

2. MBT Tool

Behavioral Model

MBT Tool

Generated Test Sequences

Coverage Criteria

Generated Test Sequences

Generated Test Targets

MBT Tool

Generated Test Sequences

Initial Data of SUT

MBT Tool

Business Rules

MBT Tool

Business Rules

Flows

Flows

Flows

Behavioral Model
Test Target Generation from Model Flows

Coverage Criteria
- Cover all transitions
- Cover all states
- ...

Test Targets
- Cover Transition « Marry »
- Cover Transition « Divorce »
- ...

Generated Test Targets

MBT Tool

Flows
Test Target Generation from Business Rules

Coverage Criteria
- Cover all branches of the Rules
- Cover all conditions in a decision

MBT Tool

Business Rules

Test Targets for « Marry »
- Cover Behavior « Error same person »
- Cover Behavior « Error same gender »
- Cover Behavior « Error one is not adult »
  - Only person1 is adult
  - Only person2 is adult
  - The 2 persons are not adult
- ...
2) Test Sequence Generation from Model Flows

Test Target:
- Cover the Transition « Marry »

Generated Test Targets

MBT Tool

Generated Test Sequences

Test Sequence to cover that Test Target
1) Go to church
2) Marry
Test Sequence Generation From Business Rules

Business Rules

Initial Data of SUT

Test Target:
- Transition « Marry »
- Behavior « Error same person »

Generated Test Targets

MBT Tool

Generated Test Sequences

Test Sequence to cover that Test Target
1) Go to church
2) Marry (person1 = EDDIE, person2 = EDDIE)

Expected Result:
Message ERROR_MARRIAGESAME_PERSON
Test Sequence Generation From Business Rules

Test Target:
- Transition « Marry »
- Behavior « Error one is already married »

Generated Test Targets

Business Rules

Initial Data of SUT

Generated Test Sequences

Test Sequence to cover that Test Target
1) Go to church
2) Marry (person1 = DOOLEY, person2 = CHRISTELLE)

Expected Result:
Message ERROR_MARIAGE_NOT_SINGLE
MBT is dedicated to manage complexity and to reduce it. Main key points are: Factorization and Reusability. Let’s see the impact of functional changes in the Model.
Agenda

• Introduction
• MBT as a black box
• Open the box
• The value of MBT
• Questions
Change in Model Flows

Test Sequence
1) Go to town hall
2) Go to church
3) Marry (person1 = EDDIE, person2 = EDDIE)
Expected Result: Message ERROR_MARRIAGESAME_PERSON

Test Sequence
1) Go to town hall
2) Go to church
3) Marry (person1 = DOOLEY, person2 = CHRISTELLE)
Expected Result: Message ERROR_MARRIAGENOT_SINGLE
Change in Business Rules

« Marriage between same gender now Allowed »

Impact in Business Rules only at 1 place

Business Rules

Initial Data of SUT

Flows

MBT Tool

Deleted Test Sequence for the « Error Same Gender »

New Test Sequences for the cases with Same Gender
- Male-Male
- Female-Female
Change in Initial Data of SUT

Do not want to define any pre-requisites for Initial Data

Impact in « Initial Data of SUT » only which is now empty

Updated Test Sequence to cover that Test Target
1) Add_Inhabitant (id = ID1, gender = MALE, age = 20)
2) Add_Inhabitant (id = ID2, gender = FEMALE, age = 21)
3) Go to church
4) Marry (person1 = ID1, person2 = ID2)
   Expected Result: Message SUCCESS
5) Go to church
6) Marry (person1 = ID1, person2 = ID2)
   Expected Result: Message ERROR_MARRIAGE_NOT_SINGLE
7) Delete_Inhabitant (ID1)
8) Delete_Inhabitant (ID2)
As Take Away

• The metaphor for MBT

• Factorization
• Reusability
• Capitalization
• Productivity
• Change Management

• Other benefits of MBT
  - Regarding specifications, Model is closer than Tests
  - Early raise issues in specifications
  - Booster for test automation of the tests
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Thank your for attention!
Any question?

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