

PRODUCT-LINE TESTING BASED ON EVOLVING REQUIREMENTS

Towards Requirements as Tests

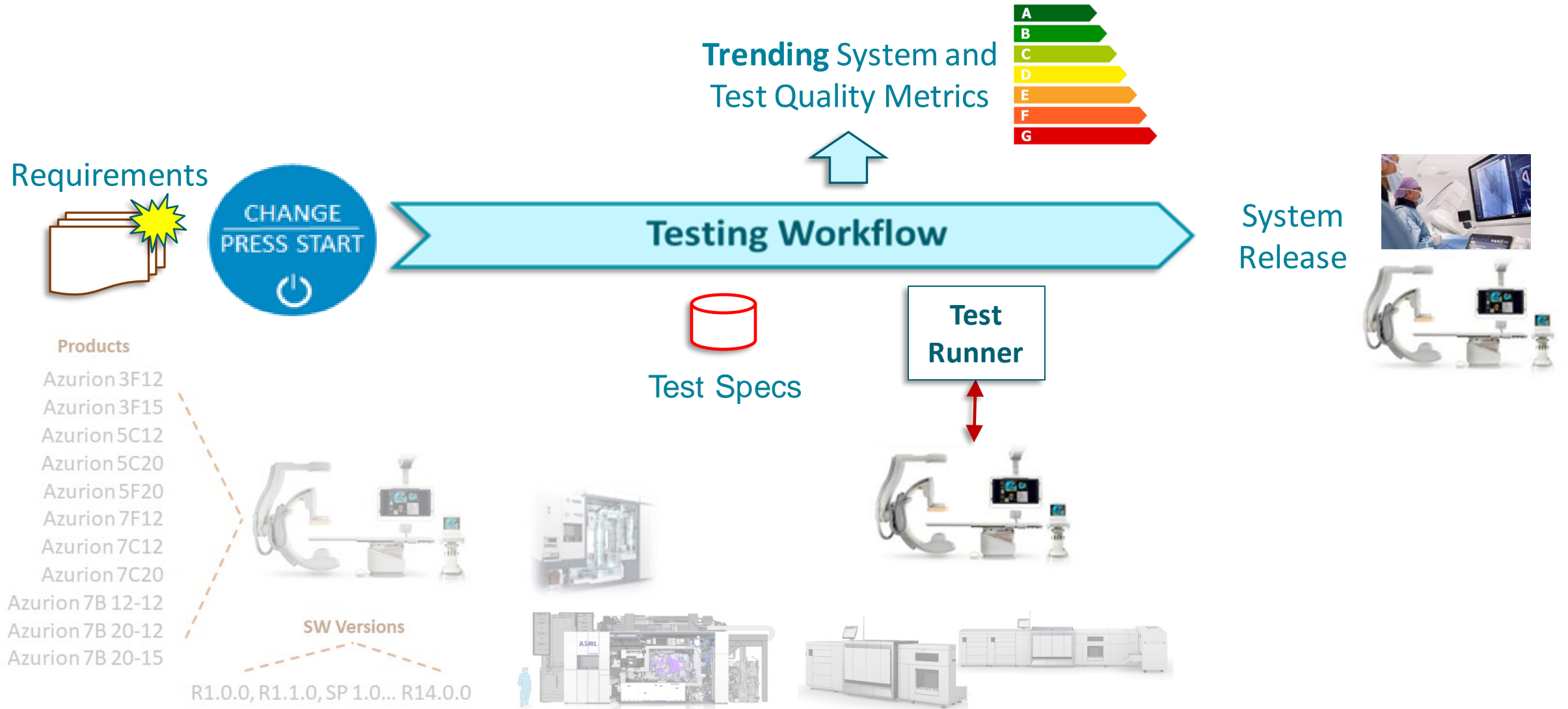
Debjyoti Bera

27.09.2022

Powered by industry, academia and TNO



THIS TALK

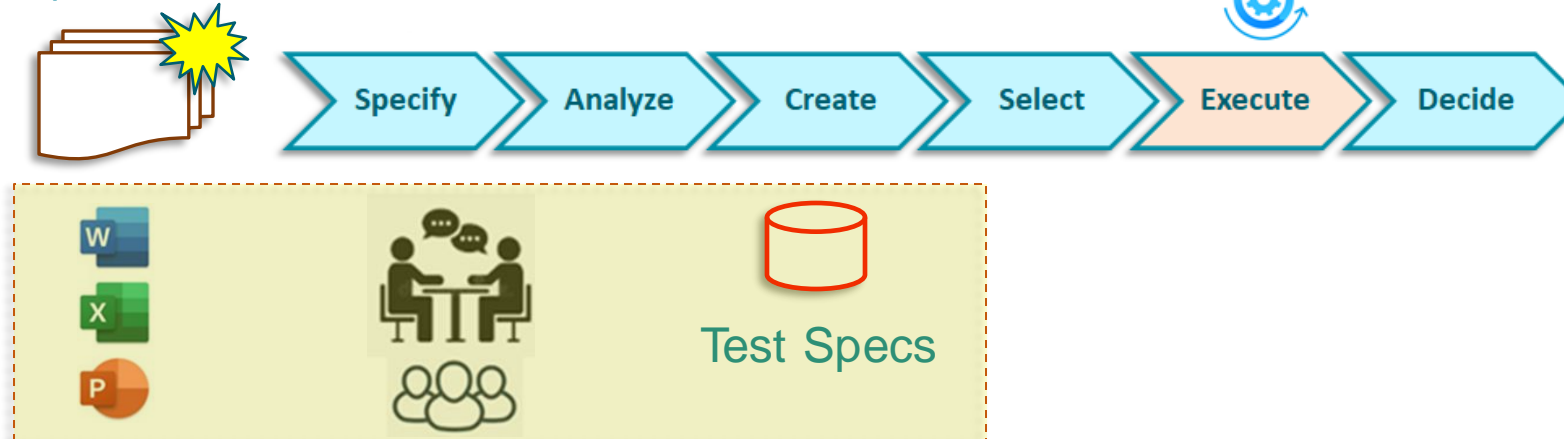


INNOVATIONS AROUND TESTING HARDLY KEEP UP...



“Relax, our engineers found 90 percent of the flaws.”

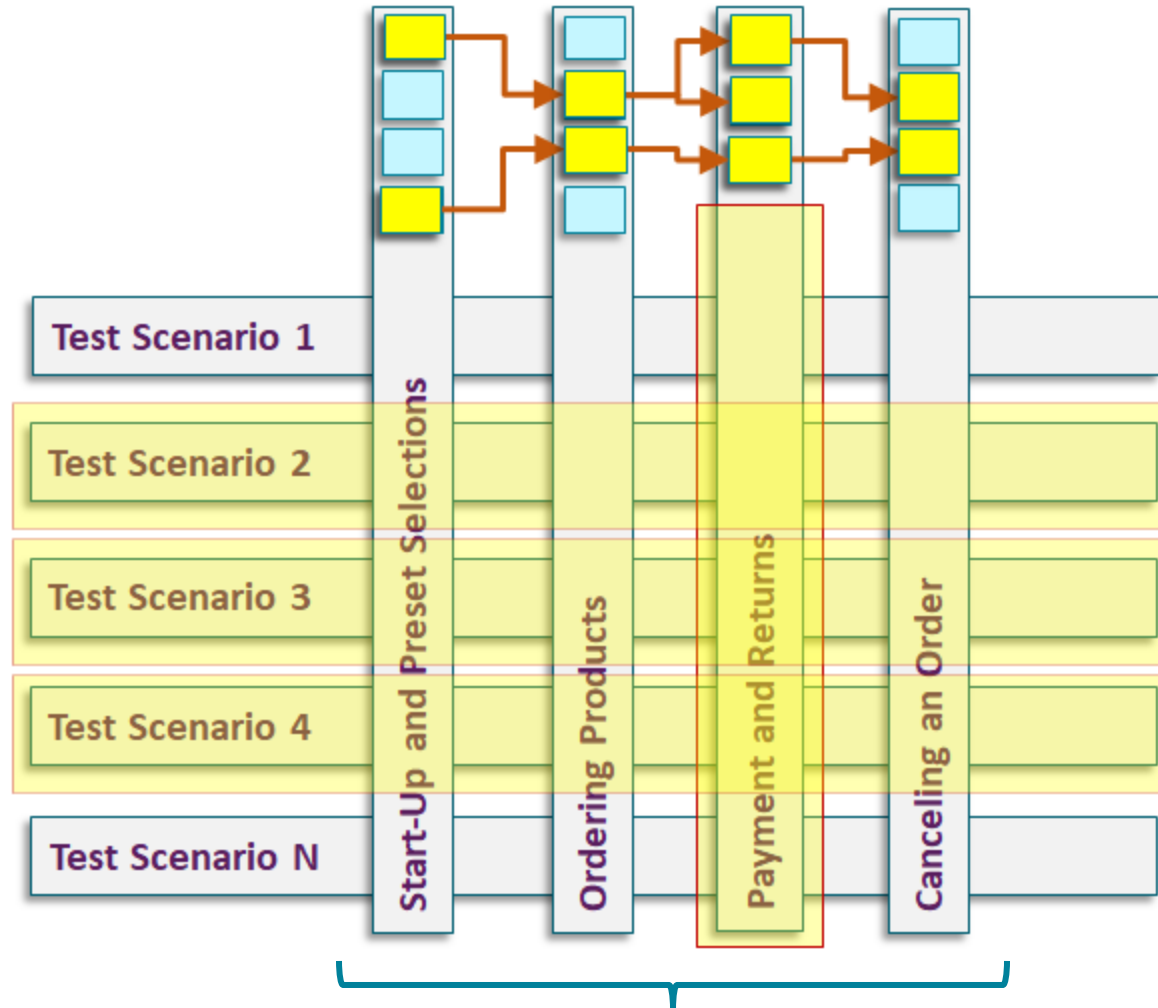
Requirements



System
Release



GAP BETWEEN REQUIREMENTS AND TESTS



Requirements

Requirements

Functionality <X>

Goal
Pre-conditions
Default Settings



Description

- The *system* shall periodically
- When the *user* does ... Then
- After initialization the *user* may ...
- During normal operation, the *system* will
- If the *user* selects, then ...
- ...
- The *user* may only be allowed ... if...

Test Scenarios

Scenario: coffeeMachine1 -

Scenario: coffeeMachine9 -

Scenario: coffeeMachine21 -

When the user
Then the coff
And the coffe
And the coffe
And the coffe



chine
ing screen
vertisement



election menu

When the user
Then the coff



ing screen



strength

When the user
And the user
And the user
Then the coff
And the coffe
And the coffee machine is ready
And the coffee machine shows the selection menu



strength
strength
capuccino
you screen

4 PAINS OF TESTING

Translation of informal requirements to test scenarios

Do the test scenarios satisfy the requirements?



What are the implications of adding a new requirement or updating existing ones?



Requirements

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And the user
And the user
Then the coff
And the coffe
And the coffee machine is ready
And the coffee machine shows the selection menu
```

A collection of logos for BDD (Behavior Driven Development) tools. The logos are arranged in a grid. The first row contains 'BDD', 'pytest', and 'specflow'. The second row contains 'cucumber', 'behat', and 'jbehave'. To the right of the logos, there is a list of terms: 'chine', 'ing screen', 'vertisement', 'election menu', 'ing screen', 'strength', 'trength', 'strength', 'capuccino', and 'you screen'.

4 PAINS OF TESTING

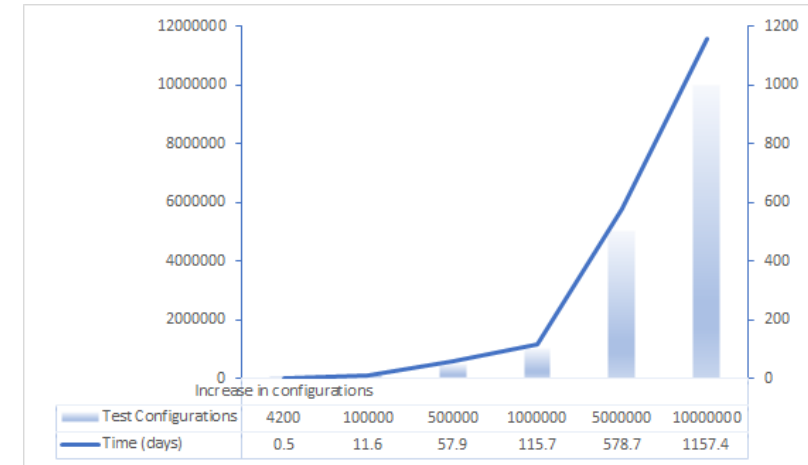
Translation of informal requirements to test scenarios

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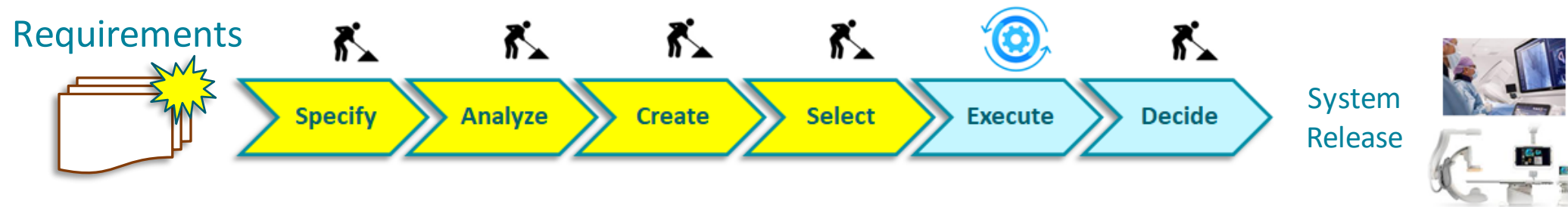
Which tests and configurations must be **selected** for execution to **cover** for a change to requirements?



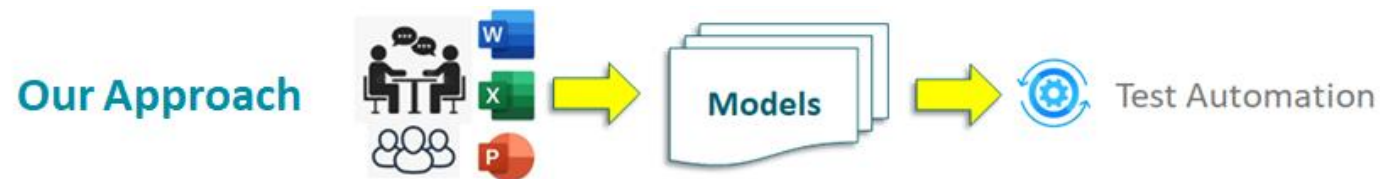
What are the **implications** of adding a new requirement or updating existing ones?



OUR MISSION

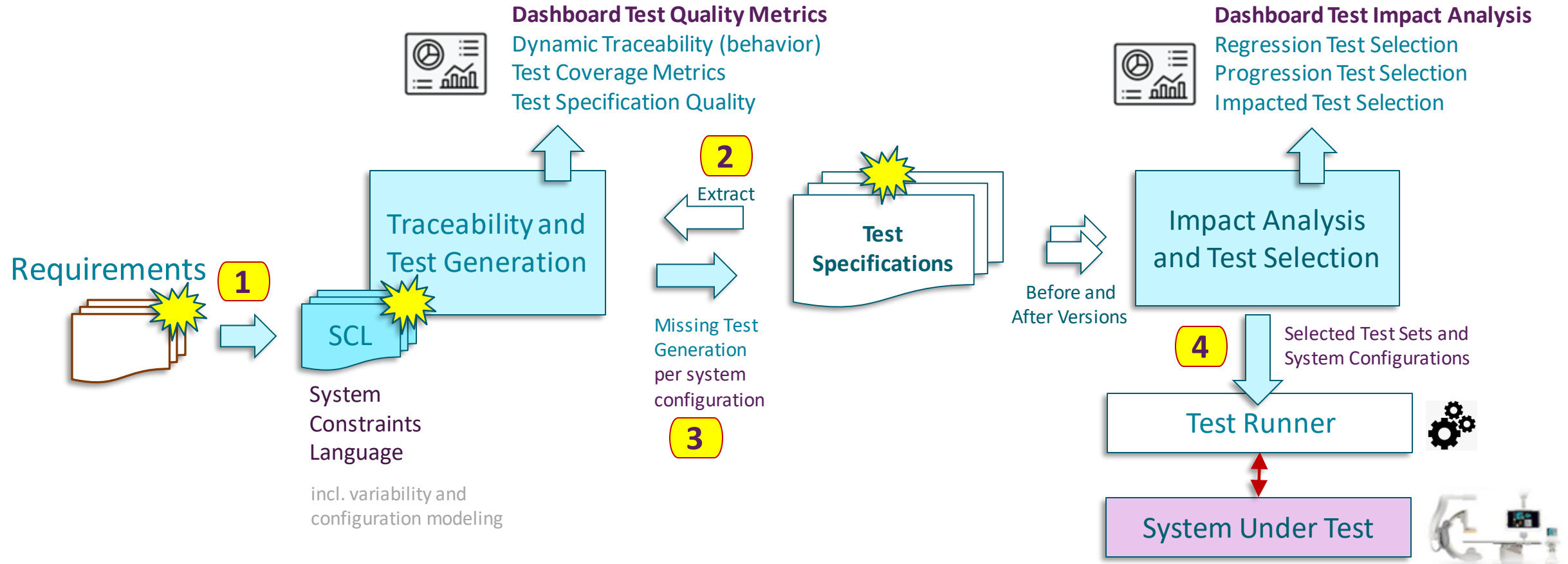


Improve efficiency and effectiveness of testing after a specification change



Constraint: Link as close as possible to technologies and WoW in Industry

METHOD: AUTOMATED REQUIREMENTS-DRIVEN TESTING



THE SYSTEM CONSTRAINTS LANGUAGE

Capture System Requirements as Constraints over System Actions

Five classes of Functional Constraints (> 25 templates and Extensions)

- Future Something in the present causes another thing in the future
- Past Something is possible now due to something done in the past
- Past-Future Somethings in the past and future are coupled
- Existential Something always happens
- Choice Something thing or another eventually happens

Actor: Engineer



Requirements

Functionality <X>

Goal

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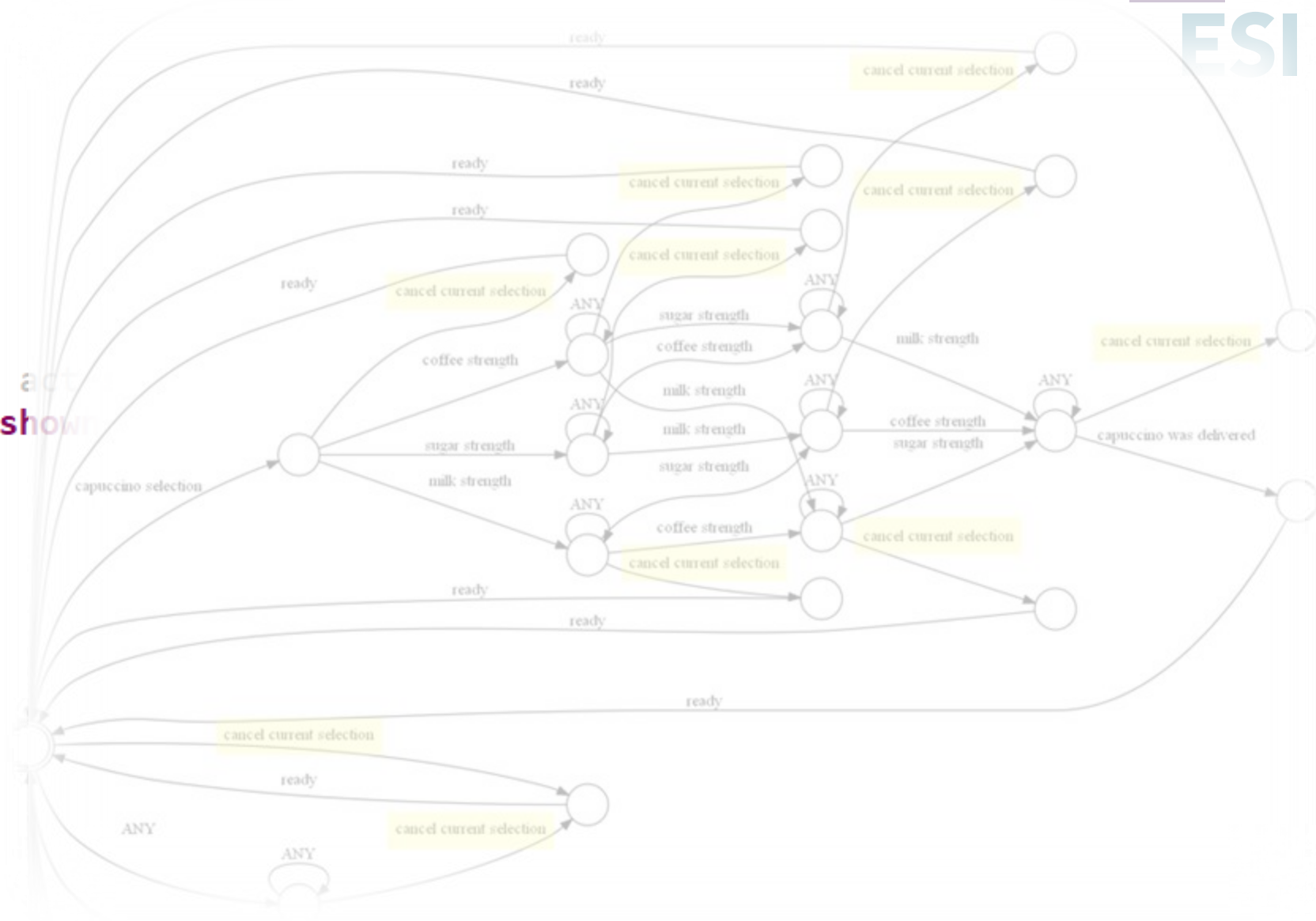
SPECIFY AS YOU THINK

R6. Order Cancellation

if the customer performs act
act-seq ready should be shown

Many Extensions

- Data associated with Actions
- Sequences of Actions
- Hierarchy and Compositionality
- Timing Constraints



CAPTURING SYSTEM VARIABILITY

SCL Constraints

R1. Turning On

R2. Order Selection

R3. Water Delivery

R4. Espresso Delivery

R5. Capuccino Delivery

R6. Order Cancellation

Basic2021



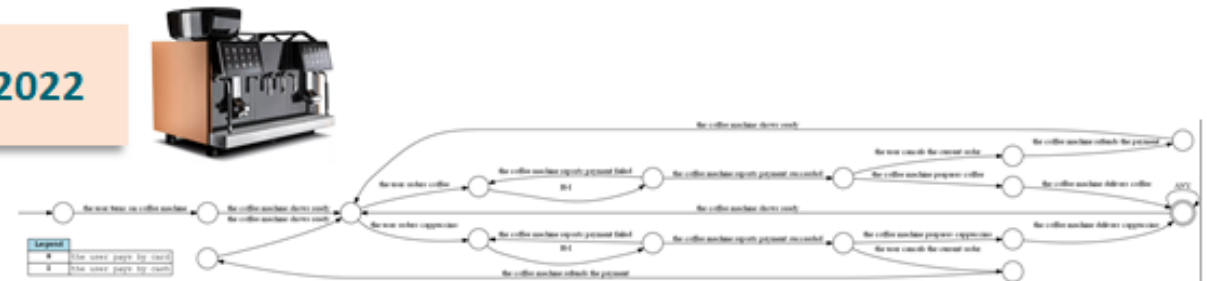
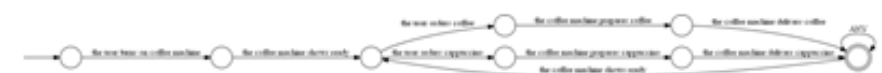
Economy2021



Premium2022



Generated Specification Models (per System Configuration)



Legend
B1 the user pays by card
B2 the user pays by cash

Specify

Analyze

Create

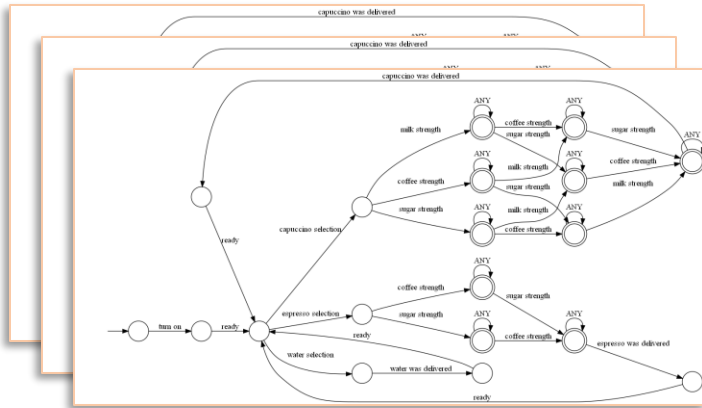
Select

Execute

Decide

GENERATING MISSING TEST SCENARIOS

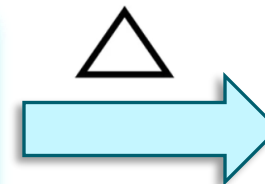
SCL Specifications



Delta Test
Generation



Existing Tests



Coverage and
Statistics

Missing Test Scenarios (per system configuration)



Scenario: coffeeMachine1 -

Scenario: coffeeMachine9 -

Scenario: coffeeMachine21 -

When the user starts the coffee machine
Then the coffee machine shows loading screen
And the coffee machine displays advertisement
And the coffee machine is ready
And the coffee machine shows the selection menu

When the user selects capuccino
Then the coffee machine shows loading screen

When the user selects medium sugar strength
And the user selects medium milk strength
And the user selects medium coffee strength
Then the coffee machine delivered capuccino
And the coffee machine shows thank you screen
And the coffee machine is ready
And the coffee machine shows the selection menu



Specify

Analyze

Create

Select

Execute

Decide

Requirements



Test Scenarios

which tests satisfy
which requirements
and vice-versa?

ENABLING DYNAMIC TRACEABILITY (BEHAVIOR)

Conformance Checking Report

% Model
Coverage

% Test
Coverage

Requirements as
SCL Constraints

Number of Conforming
Test Scenarios

State
Coverage

Transition
Coverage

Test Coverage

OrderCappuccinoByCard
SVG

4

83.3333

41.6667

25

CoffeePaymentFailureAndCancellation
SVG

2

100

62.5000

12.5000

Constraint: cappuccino is
delivered after *a card payment*

Constraint Name

Scenario Name

Description

OrderCappuccinoByCard
SVG

Scenario: coffeeMachine0 -

Conforming
Test Scenario

the user turns on coffee machine
the coffee machine shows ready
the user orders cappuccino
the user pays by card
the coffee machine reports payment succeeded
the coffee machine prepares cappuccino
the coffee machine delivers cappuccino

Specify

Analyze

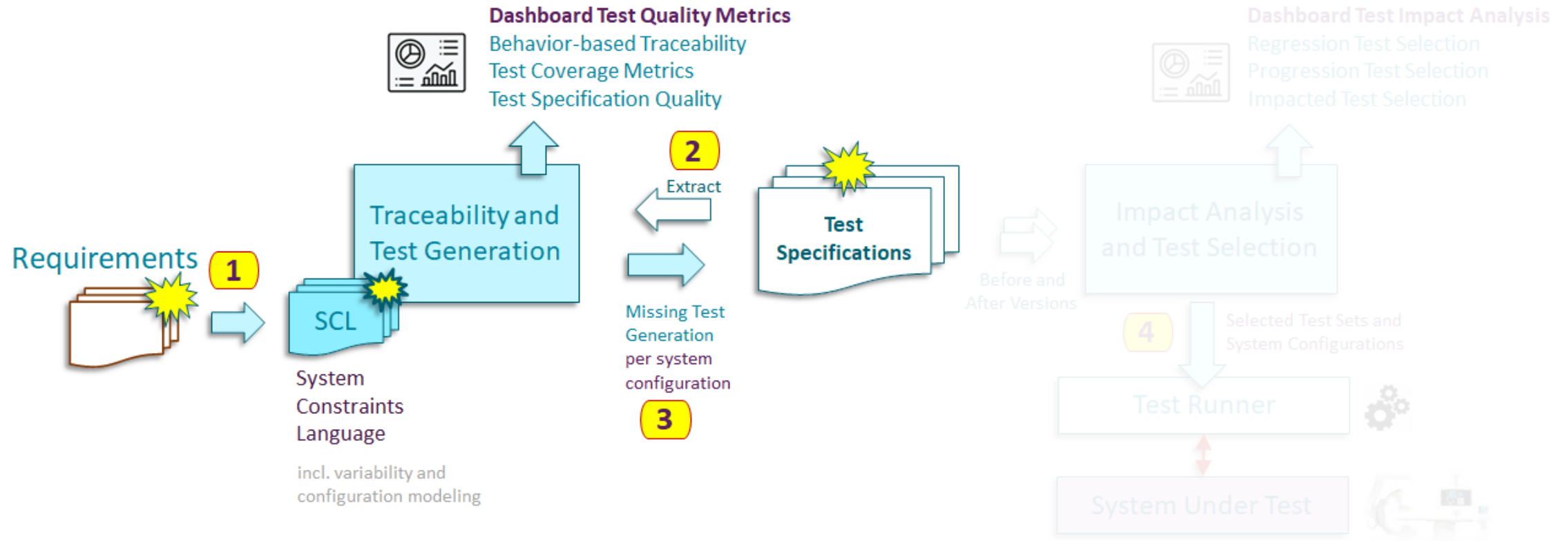
Create

Select

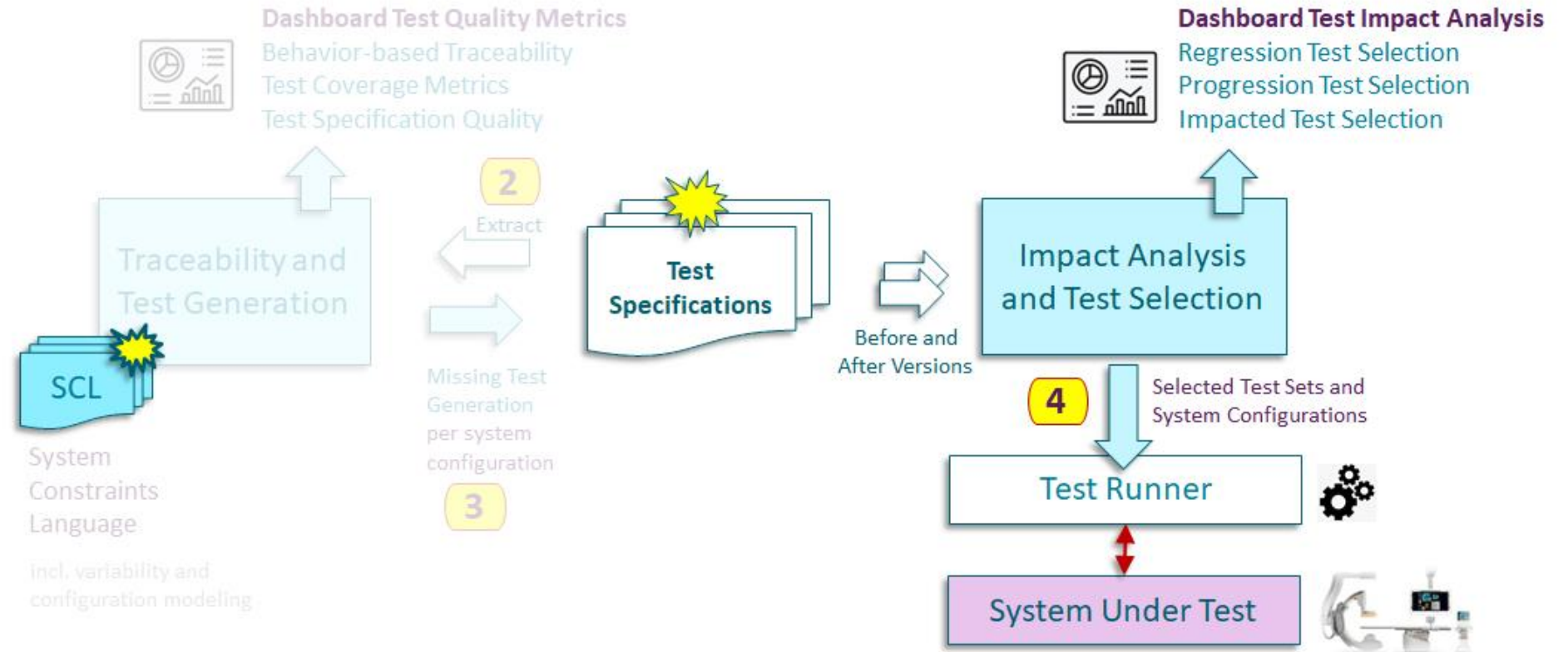
Execute

Decide

SO FAR, WE HAVE SEEN



DEALING WITH IMPACT OF A SPECIFICATION CHANGE



IMPACT OF A SPECIFICATION CHANGE

Graph options

View

Edge type

Spacing 10

Min. testset

Legend

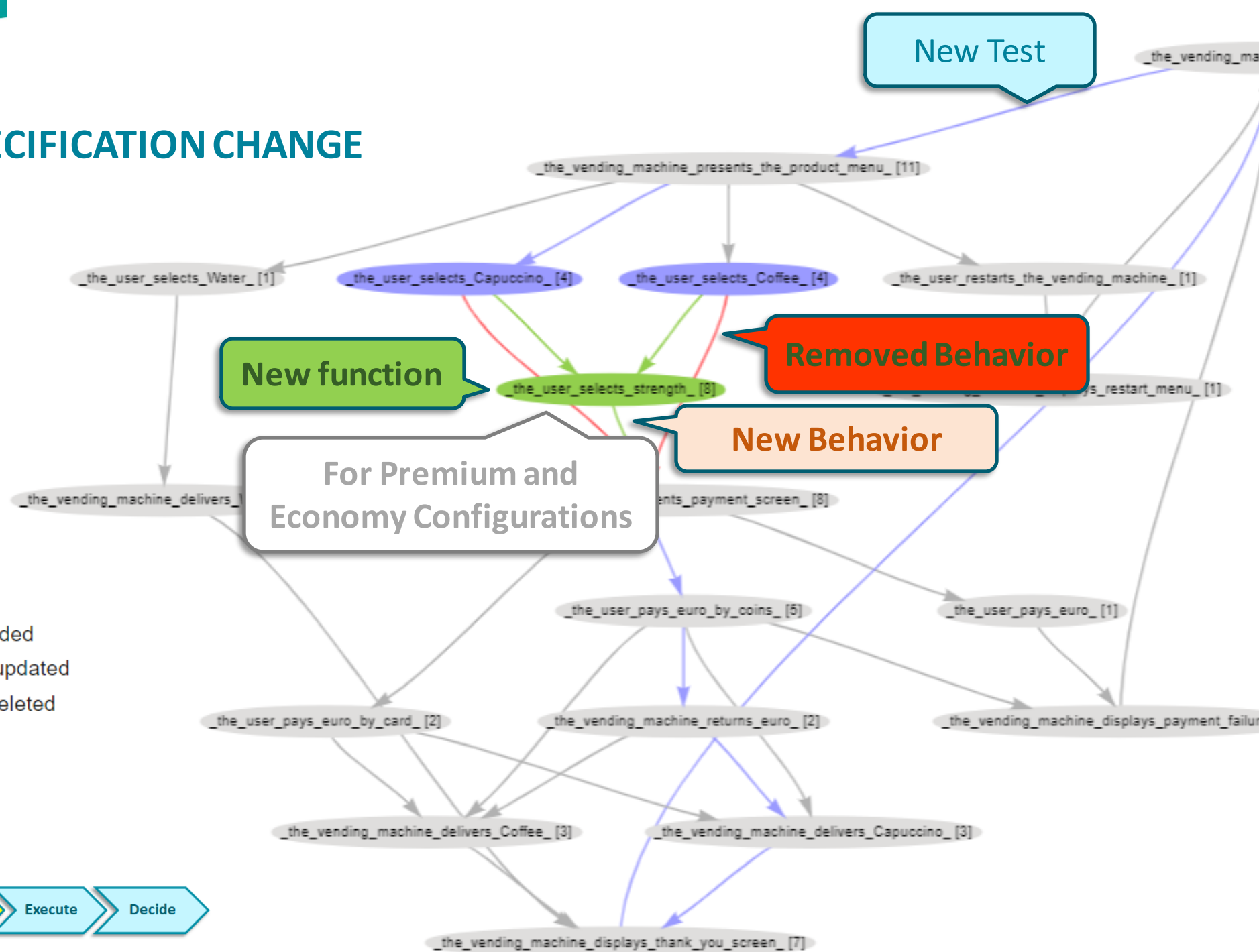
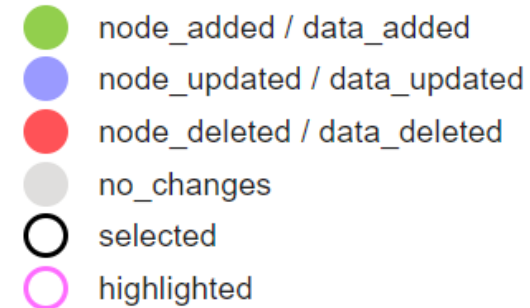
- node_added / data_added
- node_updated / data_updated
- node_deleted / data_deleted
- no_changes
- selected
- highlighted

Impact of
specification
changes

Behavior
Impact






IMPACT OF A SPECIFICATION CHANGE



REGRESSION TEST-CONFIGURATION SELECTION

Select tests and configurations based on impact

Configuration	Selected Tests	Category
<input type="checkbox"/> BASIC_Y202 	<input type="checkbox"/> Scenario Outline: The user orders Coffee and Pays for it unsuccessfully <input type="checkbox"/> Scenario Outline: The user orders Coffee and Pays more than needed <input type="checkbox"/> Scenario Outline: The user orders Coffee and Pays by Coins for it successfully the Coffee is delivered	PROGRESSION
<input type="checkbox"/> PREMIUM_Y2022 	<input type="checkbox"/> Scenario Outline: The user orders Capuccino and Pays for it unsuccessfully <input type="checkbox"/> Scenario Outline: The user orders Capuccino and Pays for it successfully by card and the Capuccino is delivered <input type="checkbox"/> Scenario Outline: The user orders Coffee and Pays by card for it successfully the Coffee is delivered <input type="checkbox"/> Scenario Outline: The user orders Water and it is delivered without payment <input type="checkbox"/> Scenario Outline: The user orders Capuccino and pays more than needed the money is returned and the Capuccino is delivered	REGRESSION AND PROGRESSION
<input type="checkbox"/> BASIC_Y2022 	<input type="checkbox"/> Scenario Outline: The user orders Coffee and Pays by card for it successfully the Coffee is delivered <input type="checkbox"/> Scenario Outline: The user orders Water and it is delivered without payment	REGRESSION AND PROGRESSION

Specify

Analyze

Create

Select

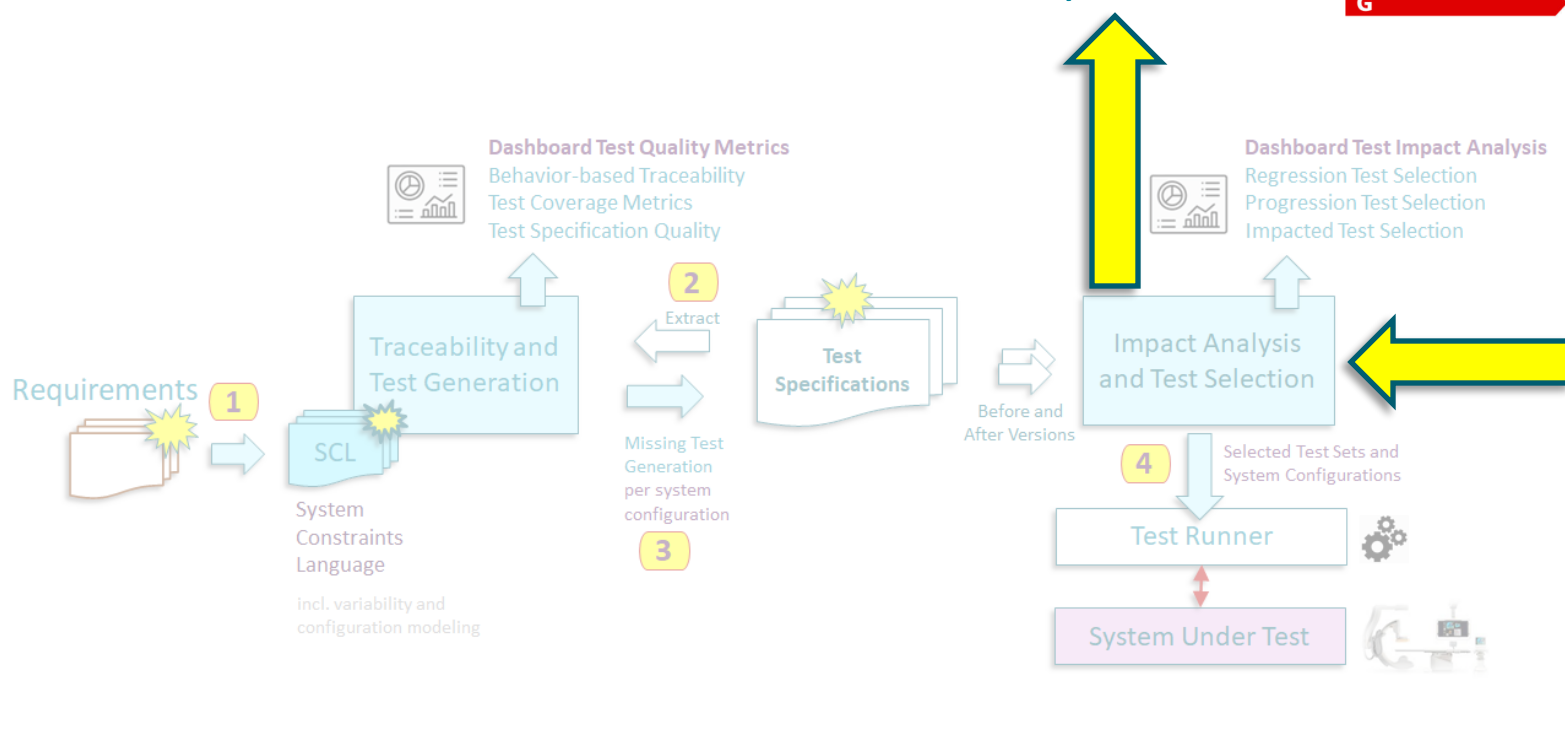
Execute

Decide

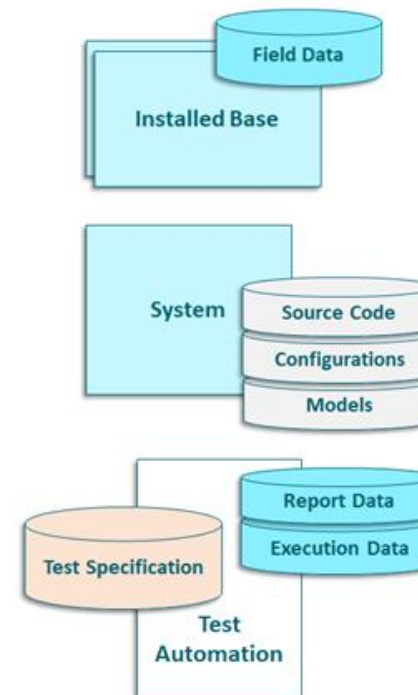
LOOKING AHEAD

When do I stop testing?

Trending System and
Test Quality Metrics



Additional Sources of Data



How do
customers use
the system?

What has changed
in the system
software?

How has the system
performed during
testing?

TAKE AWAY

When do I stop testing?

Trending System and
Test Quality Metrics



Requirements



Testing Workflow



Test Specs

Test
Runner



System
Release

