CAMEO 5

How to Verify and Validate Software Functions
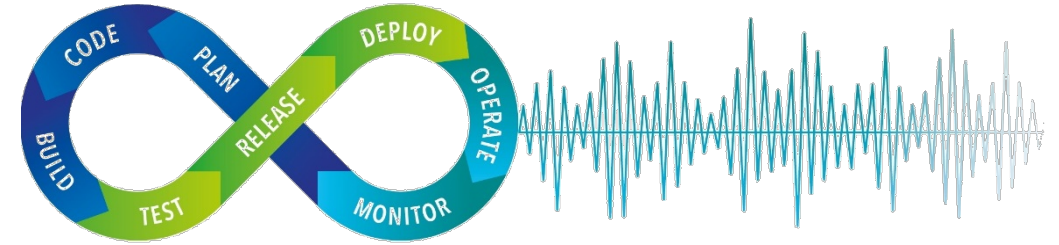
Public

Why Functional Testing?

Transformation of Vehicle Development

Hardware-centric development process → **Software-centric development process (DevOps)**

Calibration & opt	Functional testing

Simulation	HiL	Test Bed	Road

Dedicated tests for dedica	Any test on any environment

Defined testing dates	Continuous, automatic test

Verification
(aka *"**Functional Testing**" or* *"**Requirements-based testing**")*

Verification is the process of checking that the specifications are met

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Real practical test case **example**

Example

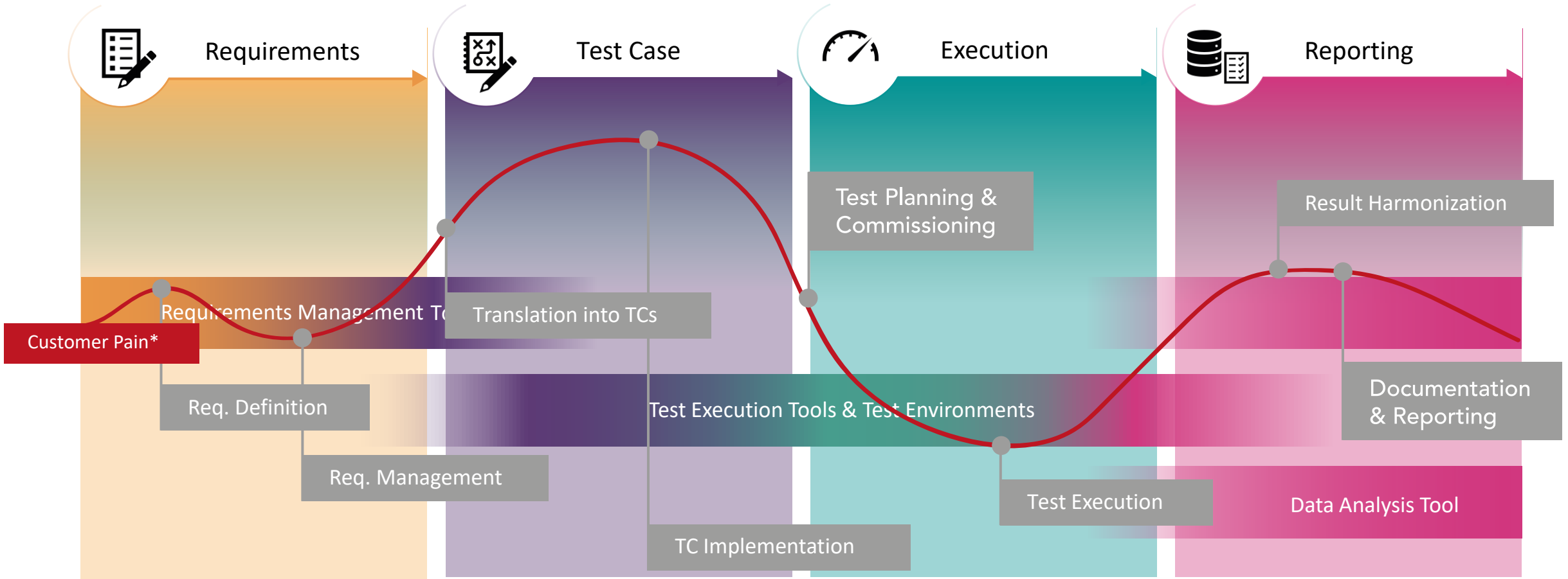|	
Pre-condition	Perform pre-condition steps e.g. initializing measurement tools,…
Check DTCs	Check/Clear DTCs Generate vehicle scan report with dedicated tools
Understand Test Case	Read and understand the test case procedure
Start Measurement	Start measurement
Request <vehicle speed>	Tester must inject the corresponding fault
Inject Fault	Inject fault (HW/CAN signal manipulation, calibration change,…)
Request <Key Cycle>	Command driver to operate vehicle: e.g. provoke healing, vehicle restart,…
Stop Measurement	Stop measurement
Check DTCs and Perform Analysis	Generate vehicle scan report Perform required analyses for test checklist.
Request Driver Comments	Request driver comments on test case.
Post-condition	Check if test was done correcT Setup test report Prepare for next test

Drawbacks:

- Typical 2 persons are requested to perform such kind of tests in vehicle
- A high qualified tester is required
- No feedback during testing (i.e. did I perform the test correct?)
- Always a painful post processing is mandatory
- …

Marijn Hollander | AVL

Functional safety (safety functions)

Test type	Driving speed	Short description	Additional info	Description	Remarks
CAN Corruption C1	Low speed (creep)	TRANSM1 (0x104) Trans_ Limphome_ Faults	Fault value: 1	_ PRNDL = P, key ON to RUN _ Start Data Collection _ Apply brake, key ON to START, PRNDL = D_ Accel to creep speed_ Action: Inject fault on CAN message and note reactions_ record data for 10 sec after action _ Decel to 0 mph in ~6 sec _ PRNDL = P_ key OFF _ key ON to START _ Did the vehicle restart? _ PRNDL = D_ Drive vehicle and note gear shifting _ Decel to 0 mph _ PRNDL = P_ End Data Collection _ Clear codes, key OFF	A simple CAN corruption test case where the specified signal's value is modified to the desired value. The fault is inserted in the CAN network in a way that only one ECU gets the corrupted value.

# ~ 1800 tests

Functional Testing Workflow

Requirements | Test Case | Execution | Reporting

Customer Pain*

Requirements Management Tool

Req. Definition

Req. Management

Translation into TCs

TC Implementation

Test Planning & Commissioning

Test Execution Tools & Test Environments

Test Execution

Result Harmonization

Documentation & Reporting

Data Analysis Tool

OEM:
60% of whole process
only for test case implementation

*Result of several activities over 18 months
(customer interviews, quantitative surves (internal), company wide workshops)

Seamless Testing over Test Environments

Test Management
*not complete

DevOps Integration

CAMEO 5
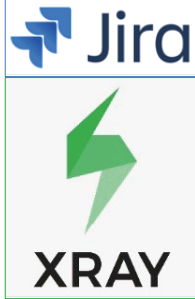
Test Control/ Test Sequencing/ Intelligent Testing	CAMEO 5						
Application/ Operating System/ Test Automation *not complete	IPG AUTOMOTIVE CM C B FM JMAG	XCP SYNOPSYS	dSPACE Control desk ni	dSPACE Control desk ni	dSPACE Control desk		TORNADO FEV KS MORPHEE	INCA CANape/CANoe ATI Vision DiagRA XCP Etc.
Environments *not complete								
	Simulation	SiL / MiL	HiL	VTB	PHiL	PHiL	Testbeds	Vehicle
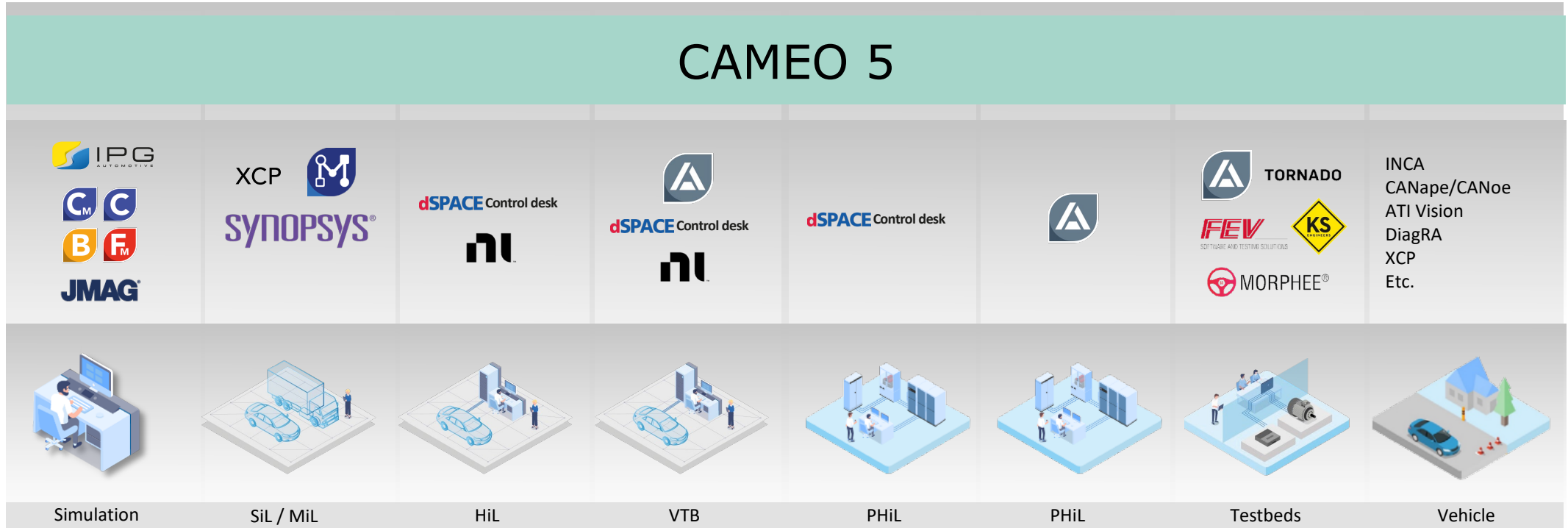
Seamless Testing
Over Testing Types

Calibration & Optimization

Trade-offs, Optimize, Improvement, Tuning

- Optimize Efficiency
- Extend Range
- Increase Power
- Optimize Hardware

- **Example:** E-Motor & Inverter combined Efficiency vs. NVH vs. De-Rating
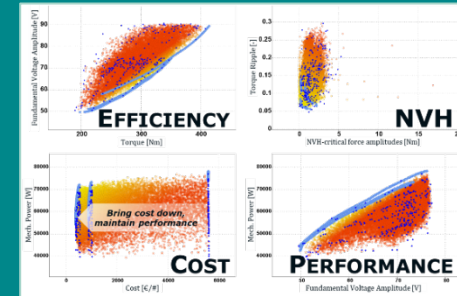
Validation

Validation is the process of checking whether the specification captures the end-customer's requirements

- Targets Reached?
- Still Improvable?
- Satisfying?

- **Example:** Cooling system and calibration sufficient; E-Drive Torque & Power
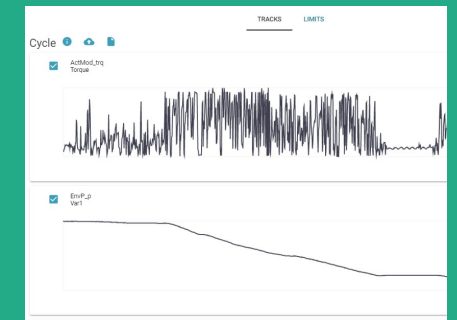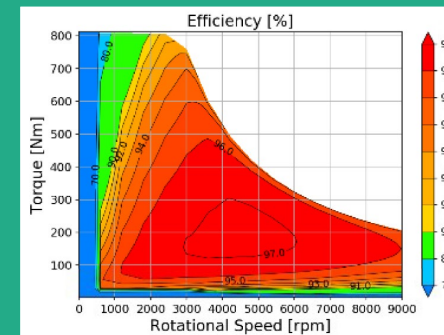
Verification
(aka "Functional Testing" or "Requirements-based" testing)

Verification is the process of checking that the specifications are met

- Fixed Steps
- Fixed Values
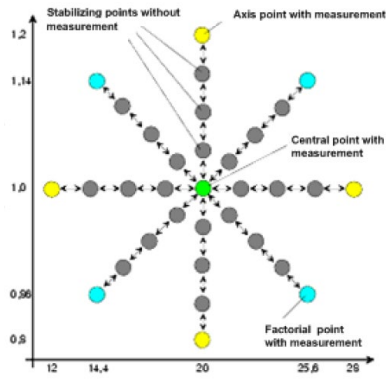- Yes / No
- Failed / Passed
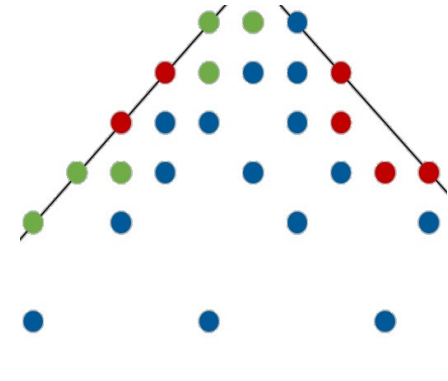
- Example: SOTIF, ISO 26262
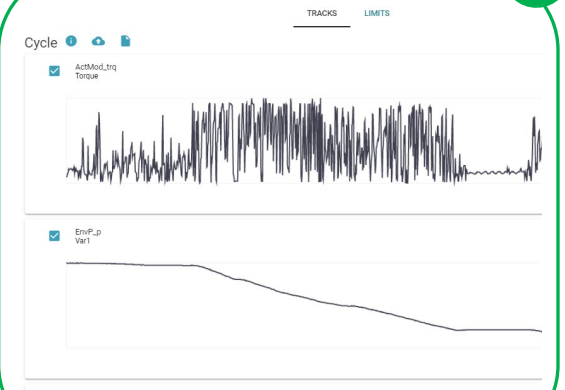
Advanced Testing
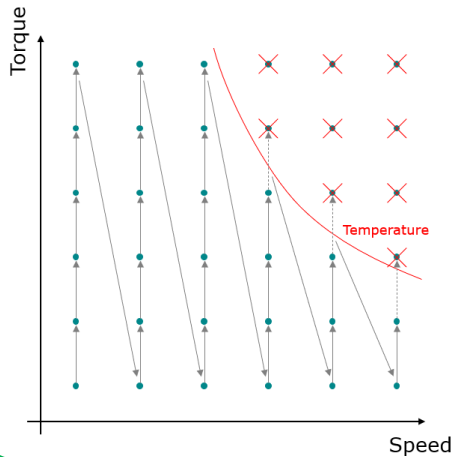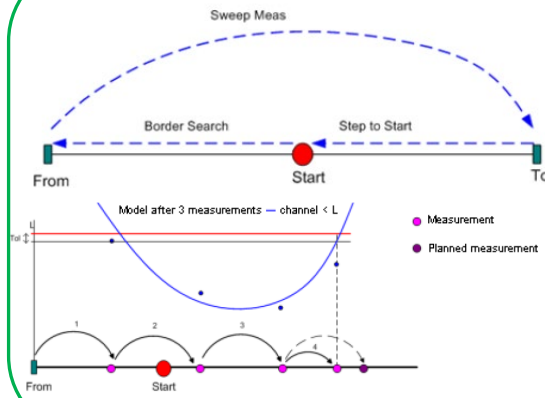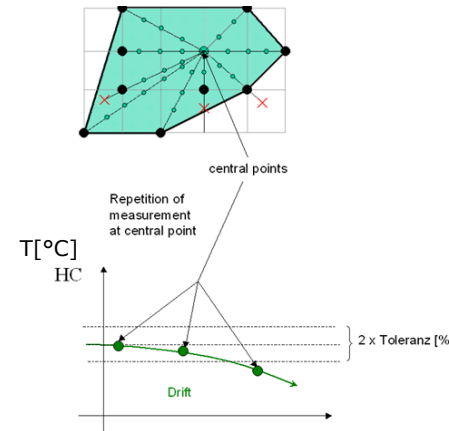## NEW Intelligent Testing Types

DoE List
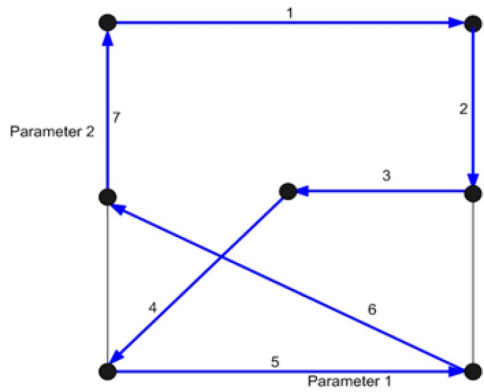
Screening

Active DoE
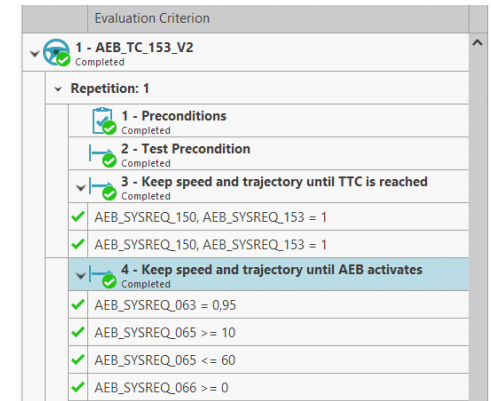
Cycle Testing — NEW

Full Factorial

Flex Sweep

Tolerance Check

Functional Testing — NEW
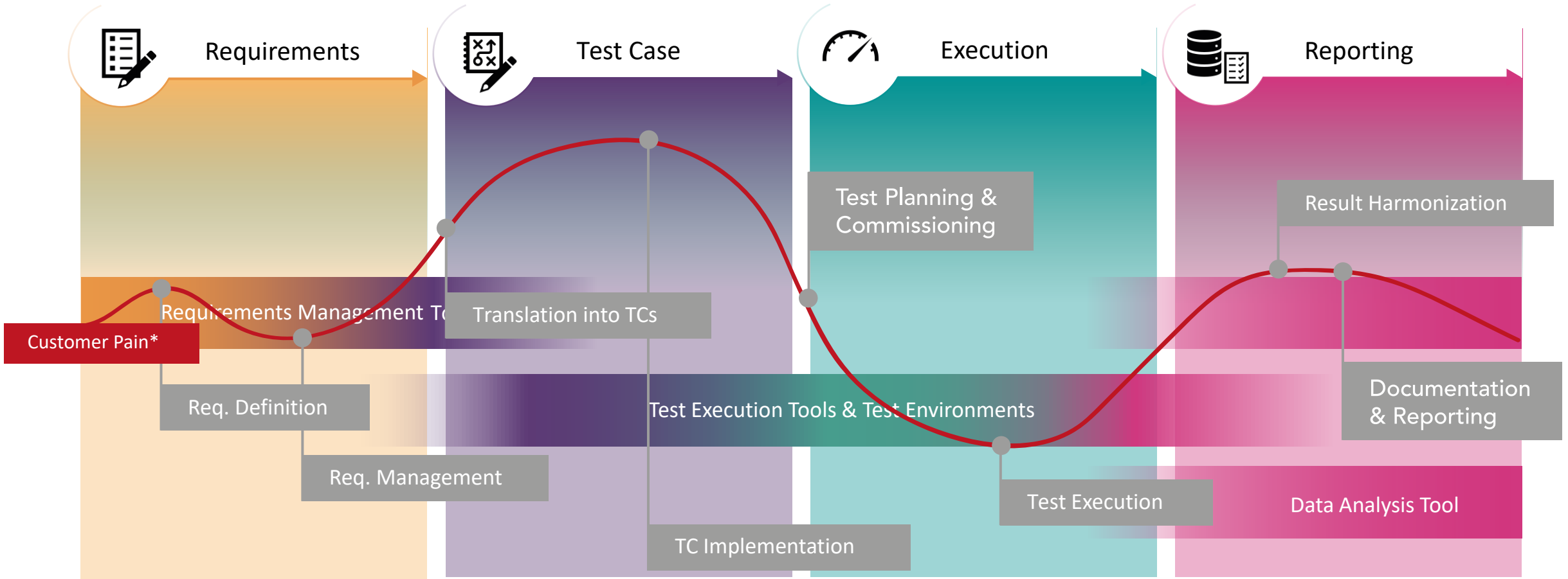
Functional Testing in CAMEO

LIVE DEMO

Test case generation

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Example: Test Creation from Prose Functional Test Requirements Exported from CODEBEAMER

CODEBEAMER exported .XLS: Prose Text Test Definitions

Test with identified Steps, Parameters and Validations

Import, Interpretation & Auto Test Creation

Example: Test Creation from Prose Functional Test Requirements Exported from CODEBEAMER

Create Library Modules and Replace unidentifiable Instructions

Use Library Module Names directly in Future Requirements

LIVE DEMO

Integration of CAMEO into CI/CD Toolchain

Functional Testing
CI/CD DevOps Toolchain Layer Overview

Software Lifecycle & DevOps Tools

Jira ⚡ XRAY IBM Rational. DOORS

Software Test Automation

Jenkins Azure DevOps
Azure Pipelines
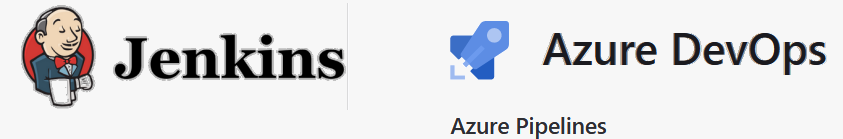
Automotive Unified Test Execution

AVL CAMEO 5™
Create a new Continuum

Automotive Automation & CoSim Systems

FEV SOFTWARE AND TESTING SOLUTIONS KS ENGINEERS SYNOPSYS® MORPHEE®

Automotive Test Environments
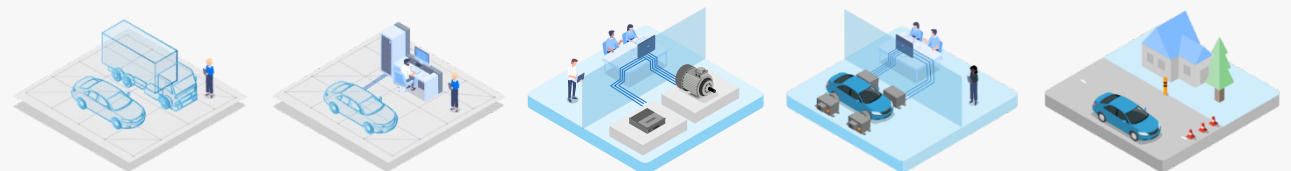
Functional Testing
CI/CD Toolchain Integration

PLM/RLM

Jira
XRAY

- Select Scenario Outline
- Select Variables
- Schedule Multiple Tests

Test Details
Type: **Cucumber**

Scenario Outline
Given the UUT temperature is at <UUT temperature>
And the brake fluid level is <Brake fluid level>
And the road gradient is <Road gradient>
When brake fluid level has been measured
Then the displayed message should be <Display message>

Examples:
UUT temperature	Brake fluid level	Road gradient	Display message
30	Low	Flat	Low
55	OK	Flat	OK
80	Low	Inclined	OK
100	OK	Inclined	OK

- Result Creation
- Report Attachment

PASS
PASS
FAIL
PASS

Test Automation
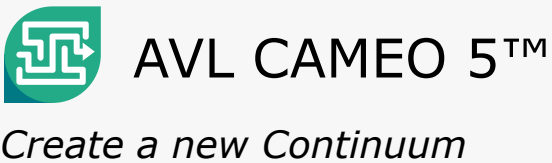
Jenkins

Azure DevOps

Azure Pipelines

- Select Agent (CAMEO PC)
- Value Transfer
- Call Sequence Setup & Execution
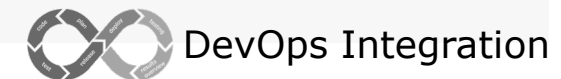
Get test settings from XRAY test instances

Return test success/fail status

Test Execution

AVL CAMEO 5™

Create a new Continuum

#n Machines

- Test Sequence Generation with Selected Tests & Parameters
- Test Sequence Execution

DevOps Integration

LIVE DEMO

Thank you!

Marijn Hollander
Senior Group Product Manager | Advanced
Optimization & Testing

Thank you

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