7th UCAAT User Conference on Advanced Automated Testing

ETSI

APPLYING KEYWORD DRIVEN TESTING TO VALIDATE VEHICLE SOFTWARE

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MICRONOVA Software and Systems

TKI Automotive

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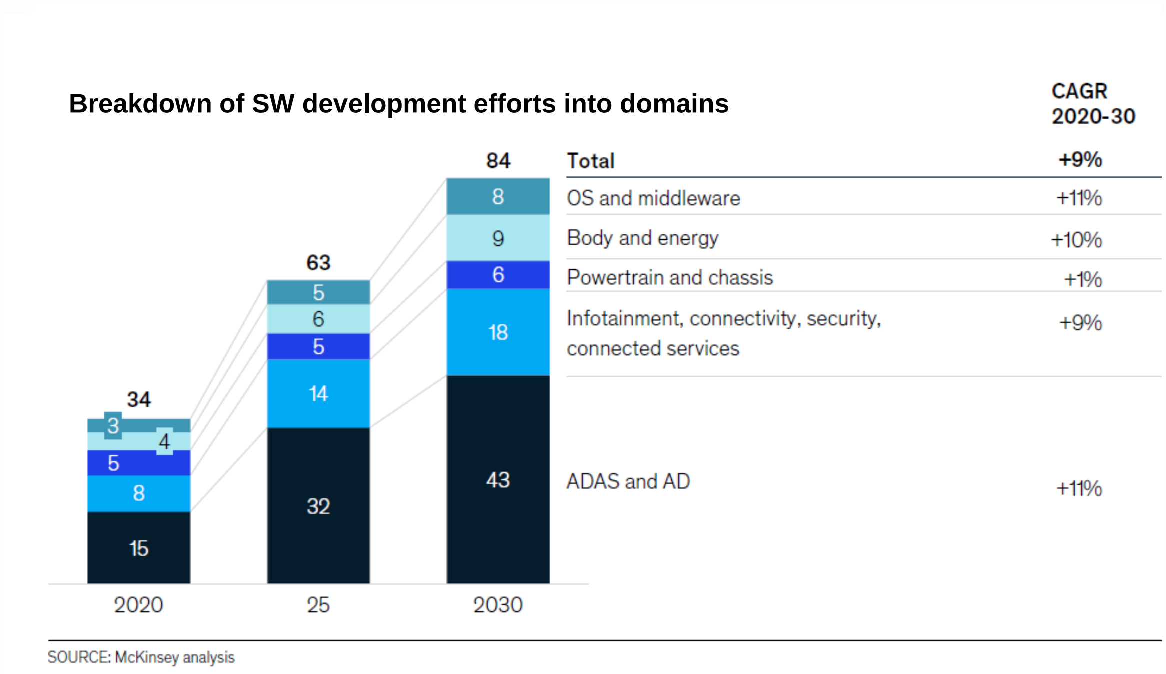
AUTOMOTIVE INDUSTRY CHALLENGE

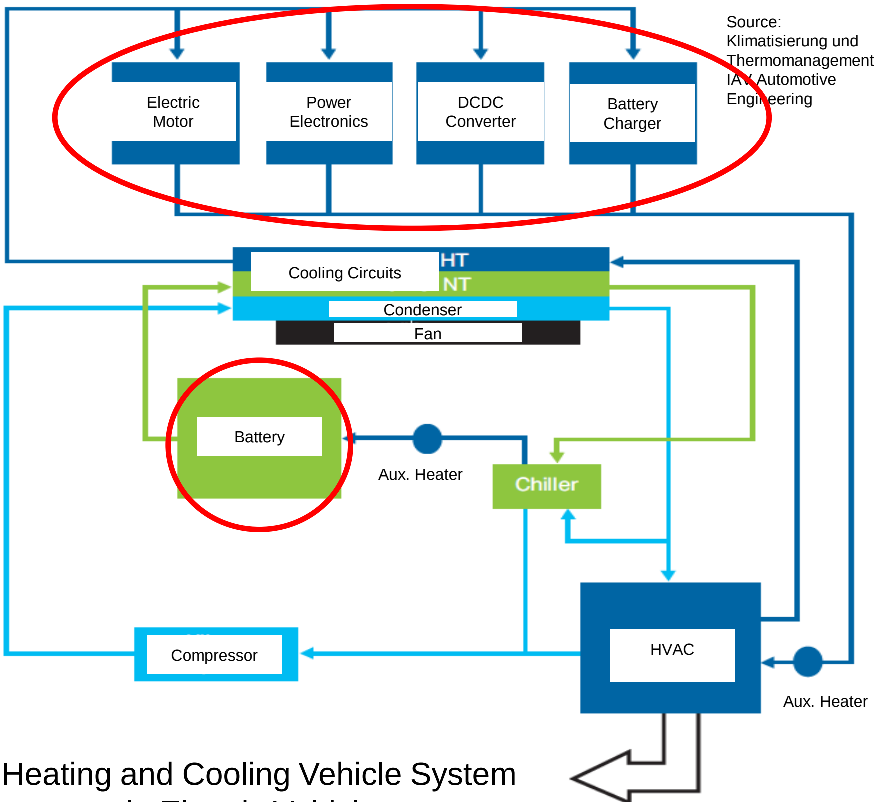
The Changing Automotive Landscape

"In the next decade, the automotive industry will face a magnitude of change that has not been seen in a century. This change will be driven primarily by four mutually reinforcing trends, i.e., autonomous, connected, electric, and shared (ACES) vehicles…" Source: Automotive software and electronics 2030, McKinsey & Company



- Software Standardization (e.g. Autosar) enables the separation from Hardware and Software. As result, Hardware is becoming a commodity i.e. **Software is the most important added value to the final product**
- Surge in Complexity of Software Functions (i.e. Energy Domain)
- Increasing Safety Criticality of Software Functions
- Higher demand for faster and cost effective Verification & Validation Processes

Thermal Management System Overview: Hybrid (PHEV), Electric (BEV) Vehicles



Source: Klimatisierung und Thermomanagement IAV Automotive Engineering

Heating and Cooling Vehicle System in Electric Vehicles

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AUTOMATED VIRTUAL DRIVING CYCLES: PROJECT GOAL AND OBJECTIVES

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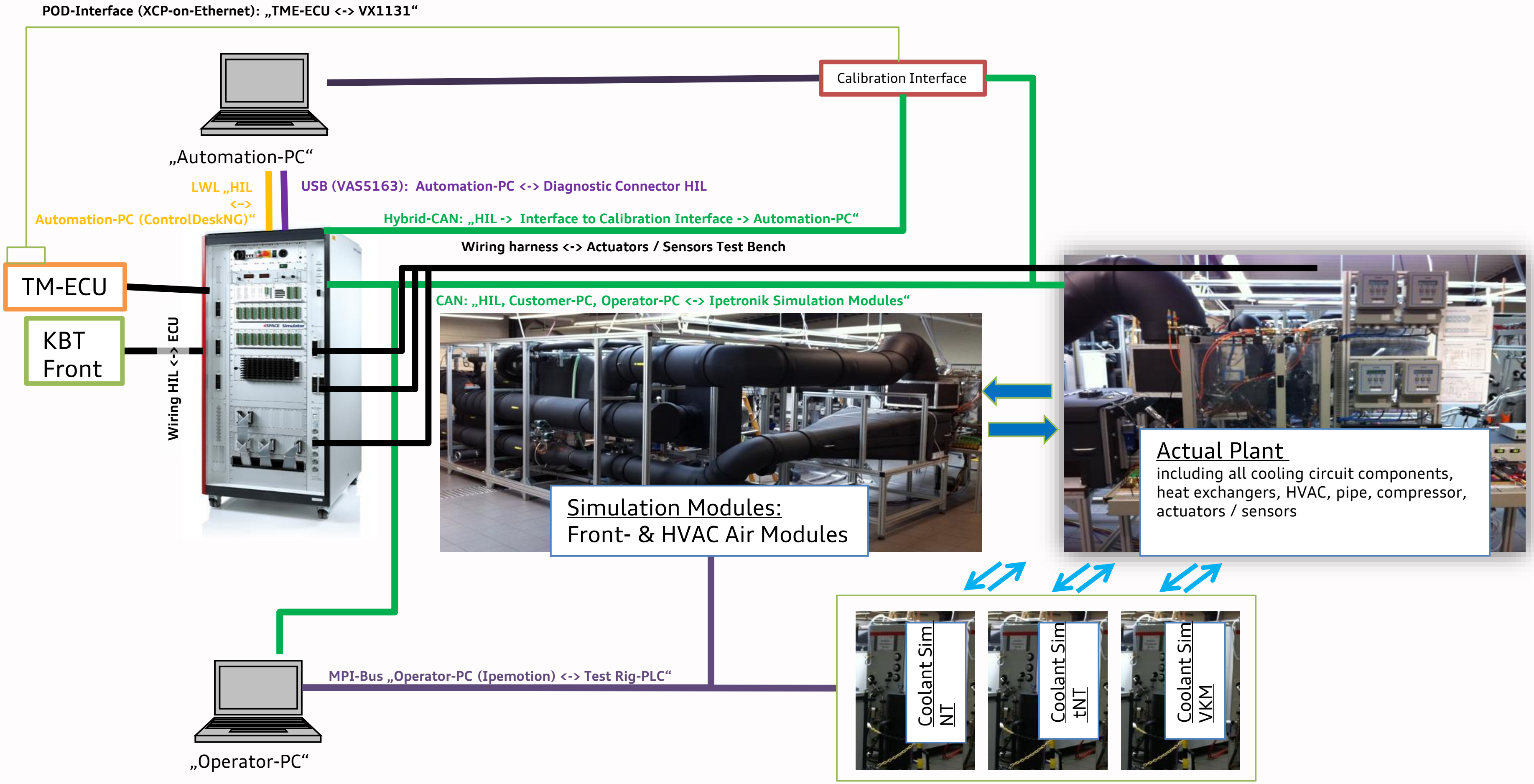
Project Goal and Objectives

- Shift In-Vehicle Tests to a Test Rig (reduction of the number of vehicle prototypes)
- Raise Productivity in terms of Test Cases
- Customer Focus on Specifying and not on Implementing Tests
- Provide an efficient Software Validation Process based on Customer Skill Set (good Knowledge on In-Vehicle Software Validation)
- Improve Communication within the Test Team
- Drive cross functional cooperation within the Organization

THERMAL MANAGEMENT TEST RIG: OVERVIEW

Test Rig: System HiL



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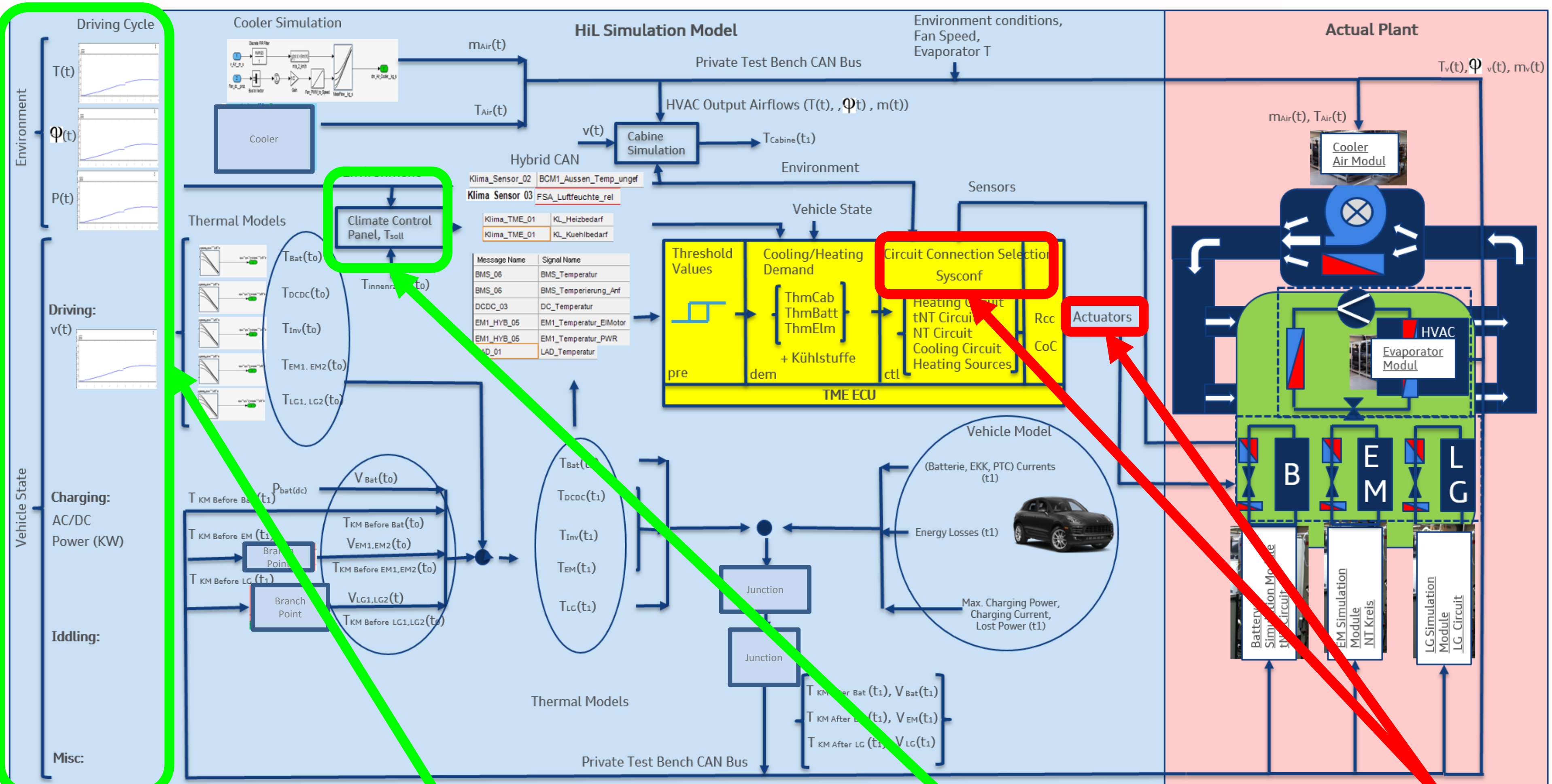
TEST REQUIREMENTS: VEHICLE DRIVING CYCLES AND EXPECTED SYSTEM RESPONSE

Test Specification



ID: Test-Case	SW-Function	#	Vehicle Driving Cycle	Time [t] or Event [/]	Environment Temperatur [°C] ... (Air)	Vehicle Variant	Measurement Preconditions	Climate Control Panel Settings: Temper...	Settings	Action	Manipulation in-vehicle system	Valid Measurement Conditions (Batt info,EKK > Vmin ...)	TC-Goal --> Expected Result
TC_004.3_VDA-Pulldown	SYS_Diagnosefunktionen/Überwachung Kältekreis/System/Heißgas SYS_Diagnosefunktionen/Übe	1.	M_003.2_Konditionierung_Sonne	1h	40°C with 1000W/m² Sun Radiation	PHEV	Measurement Sequence according to Driving Cycle Page 27 see Column O	LOW (AC-max or pressing Air recirculation)	AUTO AC	/	/	/	Test Criteria based on Table XXX Column O Page 28 SYS_Diagnostic/Monitoring Cooling Circuit/System/Hot-gas: TmeRcc_stCtlCmpr_VW == Heißgasbregelung && Eng_v_VW

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KEYWORD-DRIVEN TEST TOOL: TEST CASE GENERATOR

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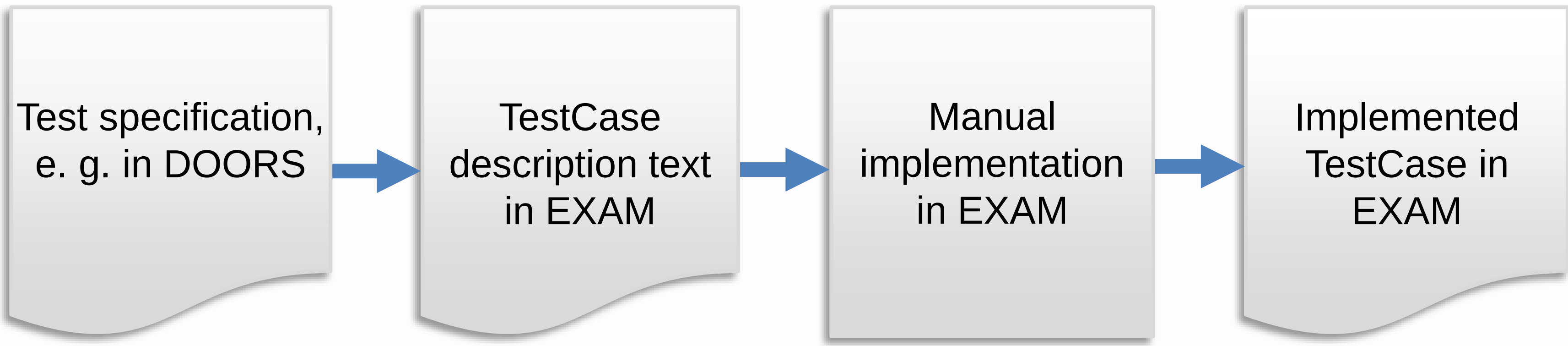
Workflow without Test Case Generator

Test cases are implemented manually, according to Test Specifications



Problems:

- Data Maintenance necessary in Several Places
- Slow, error-prone manual Implementation
- High Variance in Implementation

Automatic Generation of Test Cases

Test Specification

Precondition:
10. Ignition on

Action:
20. Stop Sending 'FRA::ESP_21'
30. Wait for DTC '40004' active 20s

Postcondition:
40. Ignition off

Expected Result:
30. Check DTC '40004' active

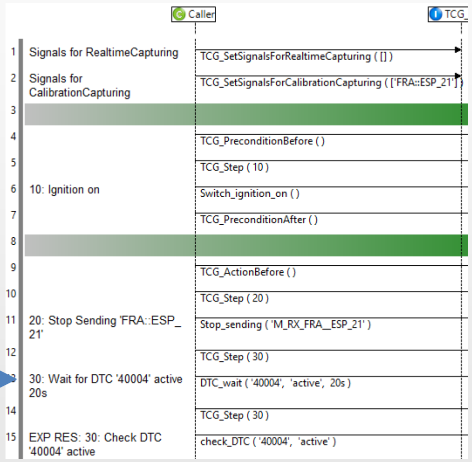
Operation Mapping

String from Testspec → EXAM Operation

„Ignition on“ → Switch_ignition_on
„Klemme 15 an“ → Switch_ignition_on
„Stop Sending %1 → Stop_sending
„Wait for DTC %1 %2 %3“ → DTC_wait
…

Sequence Diagram

Generated, executable TestCase



USE CASE: PULL-DOWN

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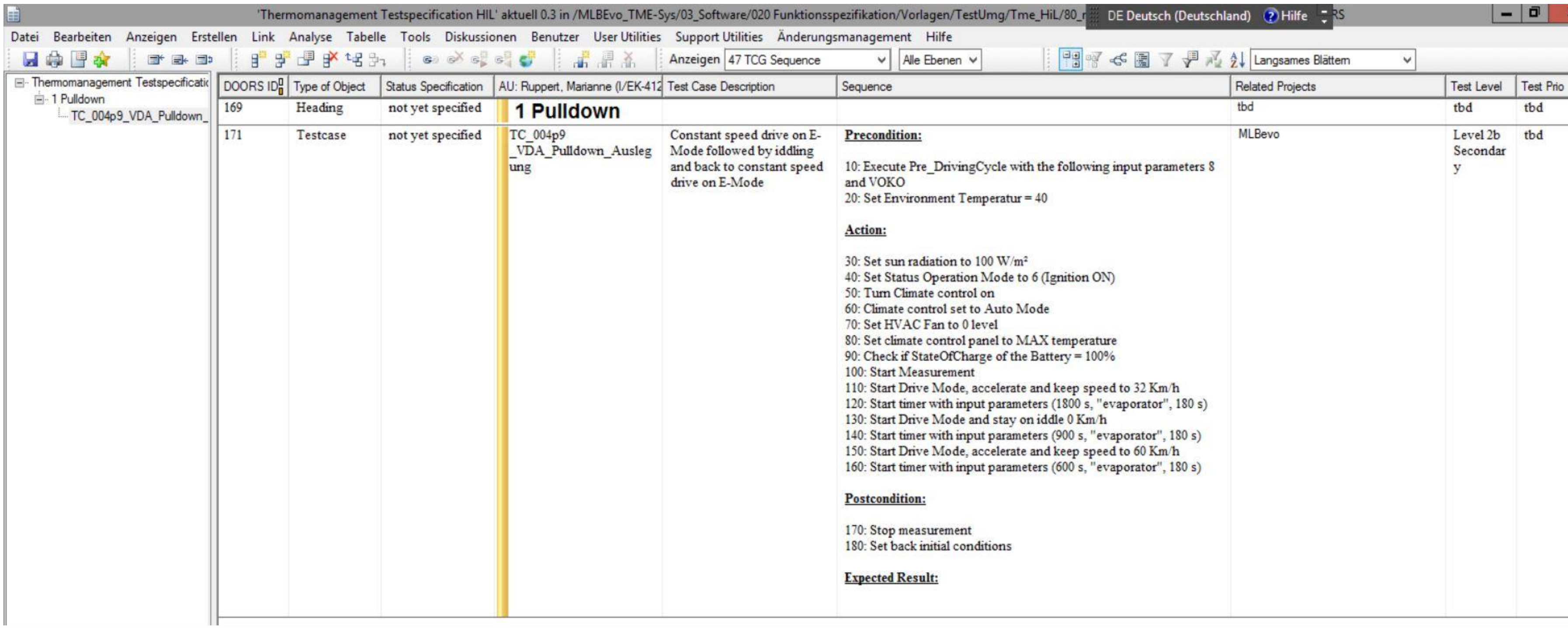
ETSI The Standards People

Pull-Down: SPEC


'Thermomanagement Testspecification HIL' aktuell 0.3 in /MLBEvo_TME-Sys/03_Software/020 Funktionsspezifikation/Vorlagen/TestUmg/Tme_HiL/80_r

Datei Bearbeiten Anzeigen Erstellen Link Analyse Tabelle Tools Diskussionen Benutzer User Utilities Support Utilities Änderungsmanagement Hilfe

Anzeigen 47 TCG Sequence | Alle Ebenen | Langsames Blättern

Thermomanagement Testspecificatic
1 Pulldown
TC_004p9_VDA_Pulldown_

DOORS ID	Type of Object	Status Specification	AU: Ruppert, Marianne (I/EK-412	Test Case Description	Sequence	Related Projects	Test Level	Test Prio
169	Heading	not yet specified	**1 Pulldown**			tbd	tbd	tbd
171	Testcase	not yet specified	TC_004p9 _VDA_Pulldown_Auslegung	Constant speed drive on E-Mode followed by iddling and back to constant speed drive on E-Mode	**Precondition:** 10: Execute Pre_DrivingCycle with the following input parameters 8 and VOKO 20: Set Environment Temperatur = 40 **Action:** 30: Set sun radiation to 100 W/m² 40: Set Status Operation Mode to 6 (Ignition ON) 50: Turn Climate control on 60: Climate control set to Auto Mode 70: Set HVAC Fan to 0 level 80: Set climate control panel to MAX temperature 90: Check if StateOfCharge of the Battery = 100% 100: Start Measurement 110: Start Drive Mode, accelerate and keep speed to 32 Km/h 120: Start timer with input parameters (1800 s, "evaporator", 180 s) 130: Start Drive Mode and stay on iddle 0 Km/h 140: Start timer with input parameters (900 s, "evaporator", 180 s) 150: Start Drive Mode, accelerate and keep speed to 60 Km/h 160: Start timer with input parameters (600 s, "evaporator", 180 s) **Postcondition:** 170: Stop measurement 180: Set back initial conditions **Expected Result:**	MLBevo	Level 2b Secondary	tbd

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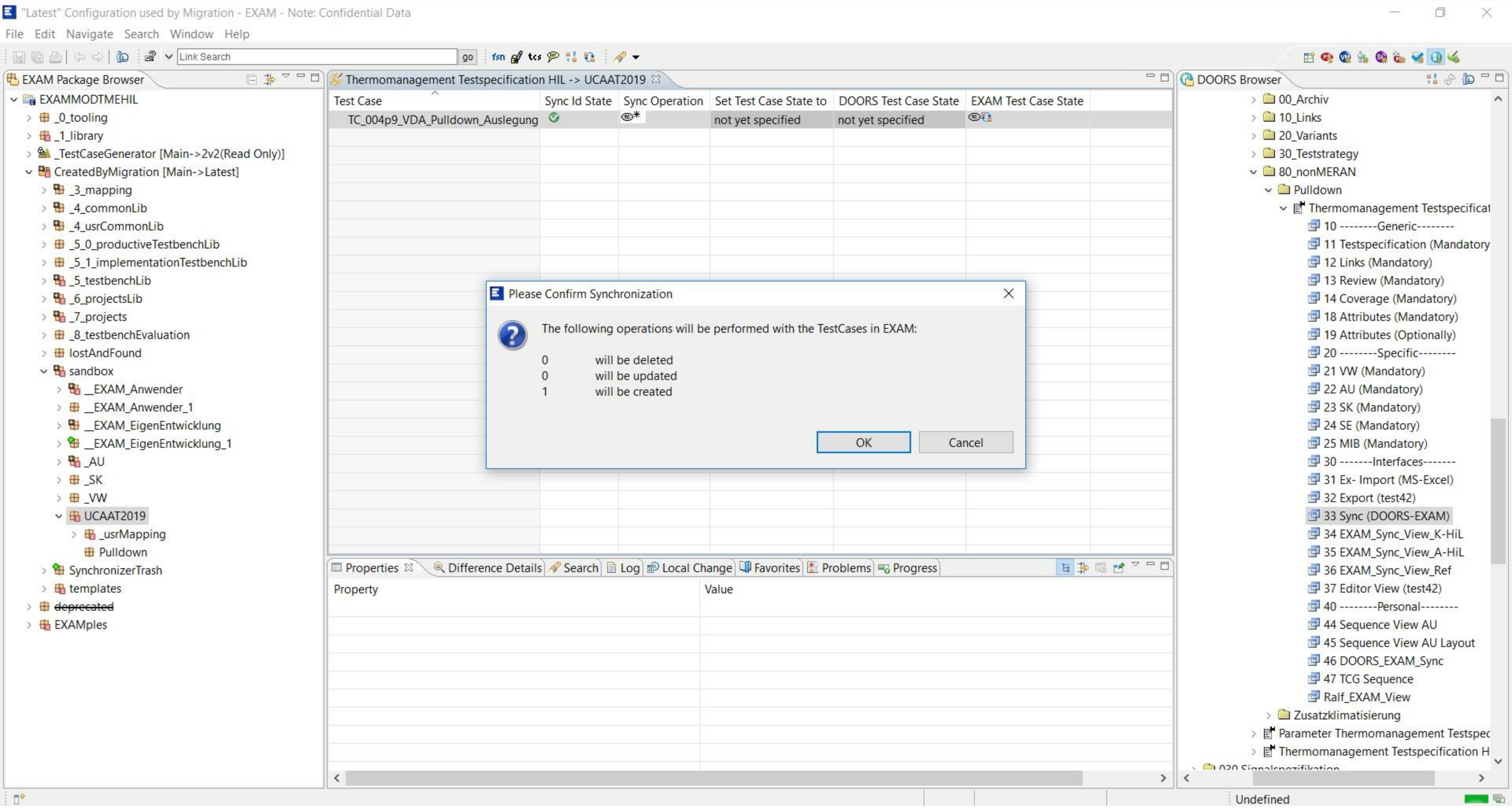
Pull-Down: DOORS Synchronizer



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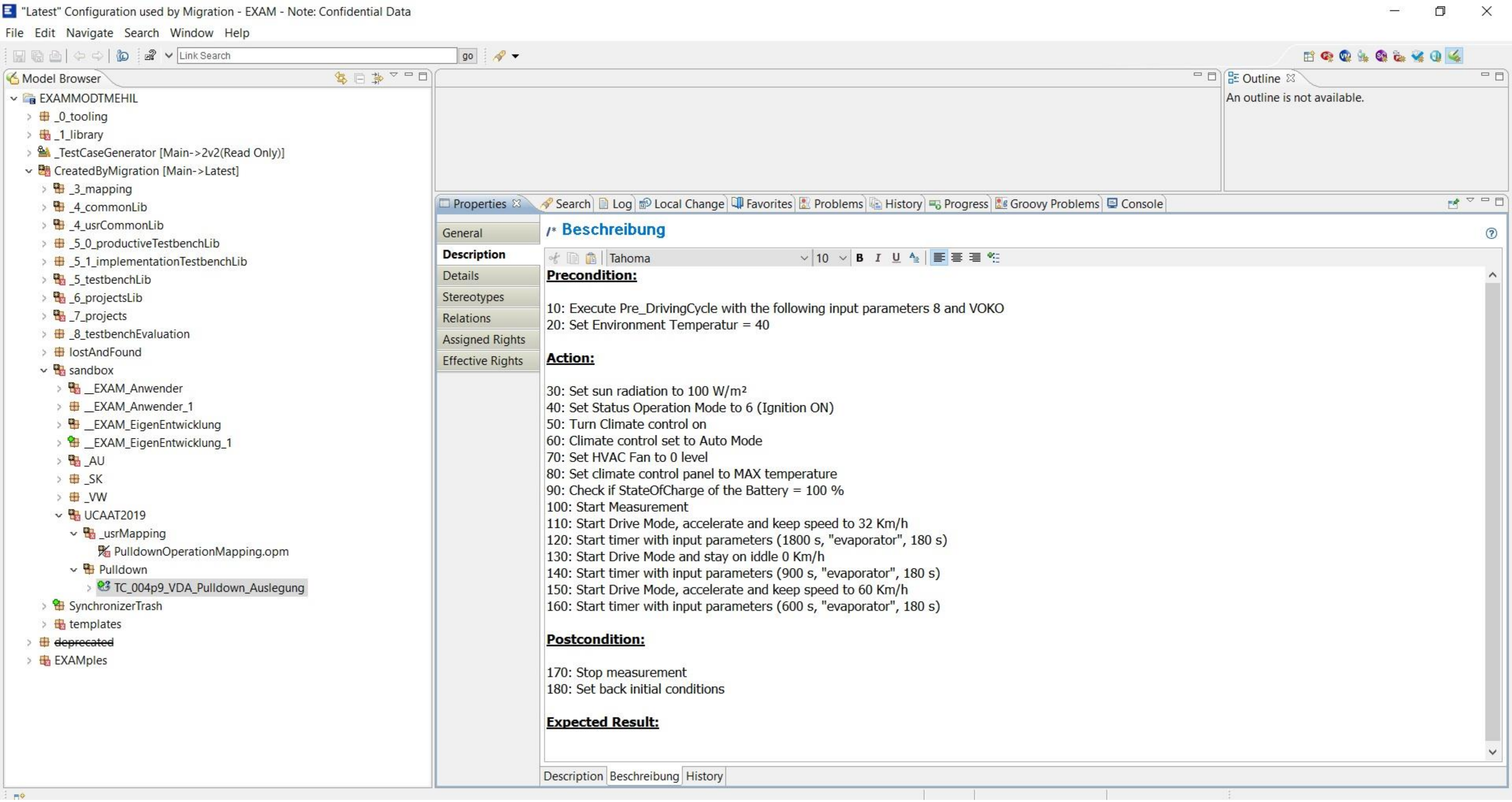
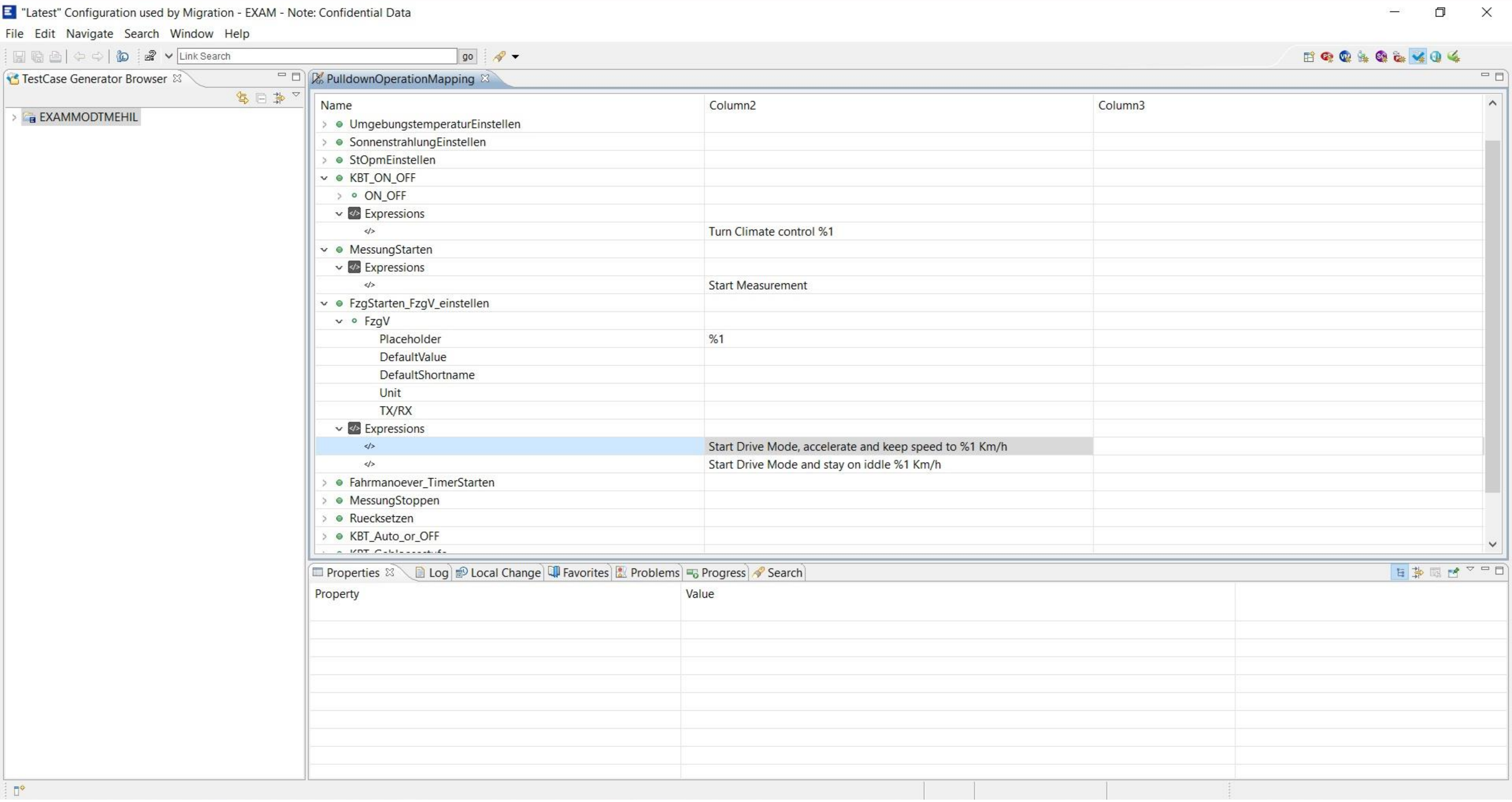
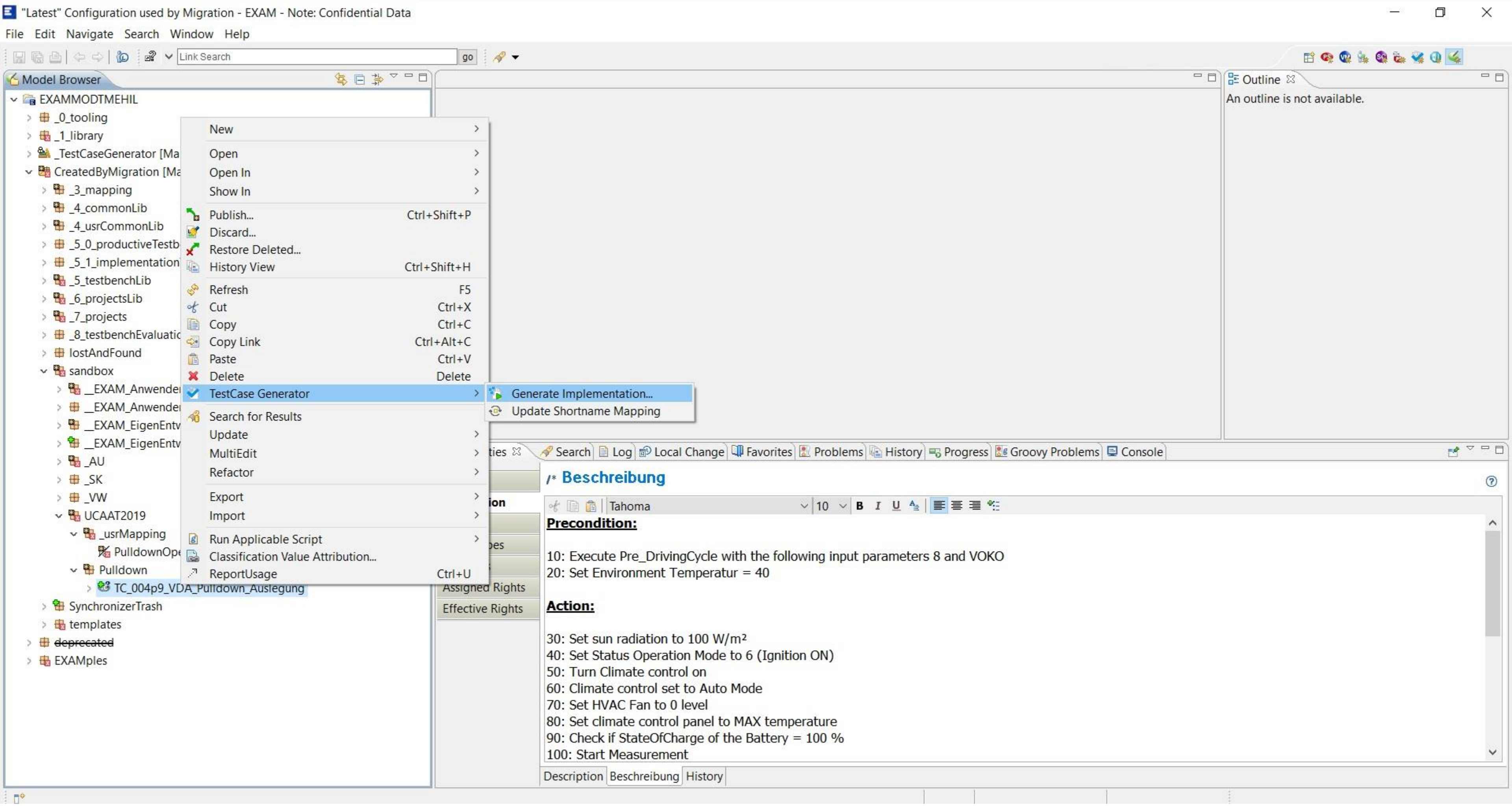
Pull-Down: Test Case Description



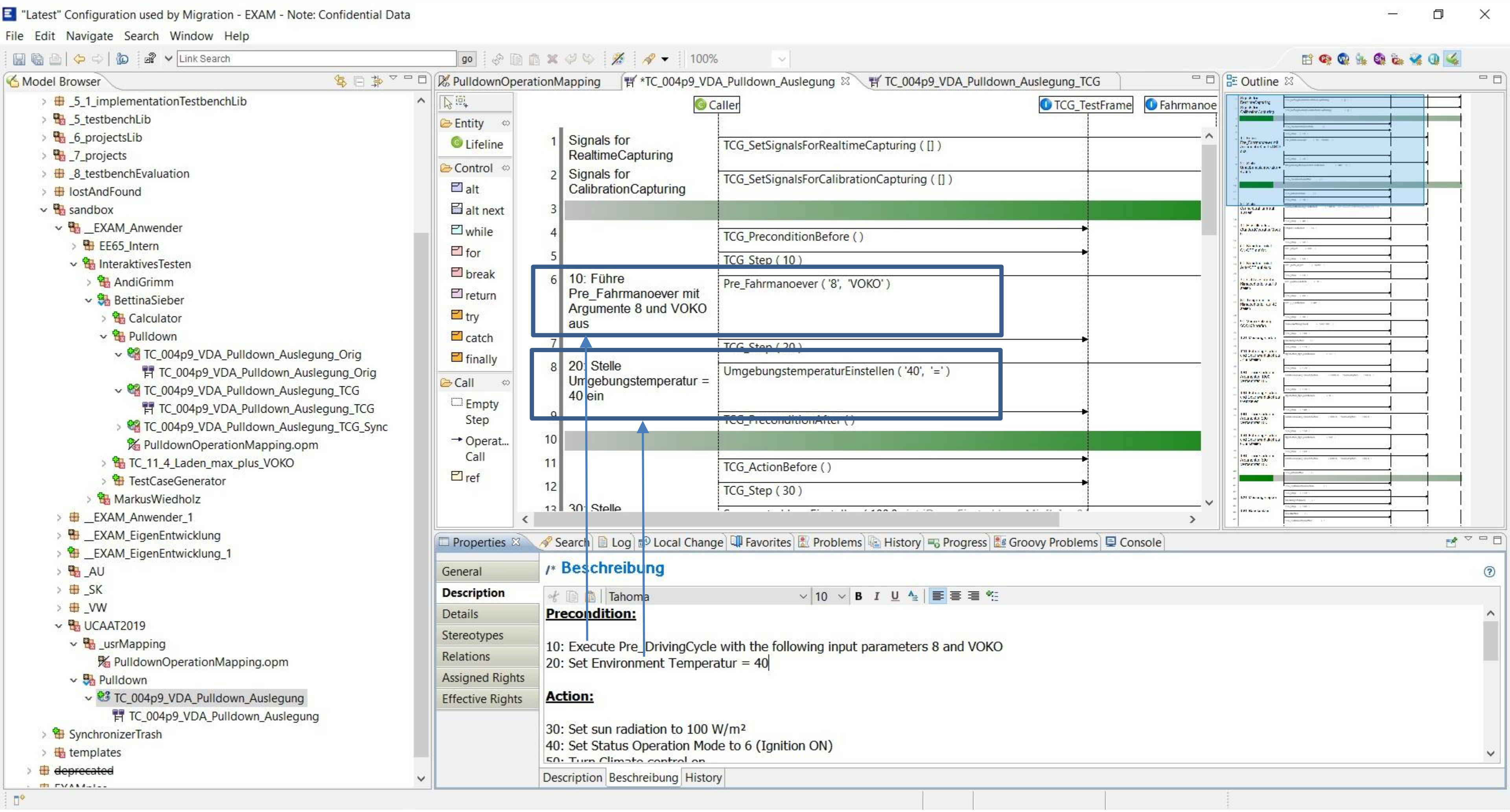
Pull-Down: Mapping



Pull-Down: Test Case Generation



Pull-Down: Test Case



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CONCLUSIONS: ADDED VALUES

Key Take Aways

- Increasing SW Complexity drives the adoption of new Test Methods such as Keyword Driven Testing
- Provides an excellent Common Ground for cross functional Cooperation within the Organization
- The Usage of Test Case Generation sets the first Milestone for a well defined and structured Software Validation Process
- Automatic Test Case Generation raises Productivity and Quality Standards while reducing Time to Market

Thank you for your attention!

Q&A Time!

Time for Questions and hopefully also for some Answers…

Special Thanks to our Colleagues from Audi (EK-4, EE-I3) and dSPACE!!!