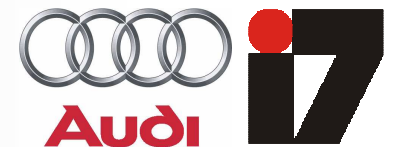


INI.FAU

**Model Driven Test Industrialization with MaTeLo and EXAM
at AUDI AG
Model Driven Hardware-in-the-loop testing**

Sebastian Siegl (INI.FAU): extern.sebastian.siegl@audi.de



Motivation

„In the past vehicle safety has been constructed; In the future it is going to be implemented in software.“

Dr. U Widmann, AUDI AG, Head of Vehicle Safety

- Automobiles turn into Systems of Systems
 - Testing Method has to cope with Complexity and Variance
 - Testing Time on HIL is scarce
- Efficiency
 - Systematic Testing
 - Significant Testing



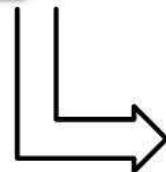
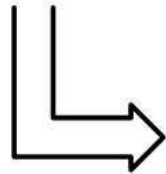
- Motivation
- **Test process at AUDI**
 - **EXAM**
 - **Test Model**
 - **Model Driven Testing**
- Tool Chain
 - MaTeLo and EXAM
- Testmodels
 - Start Stop
 - Comfort
 - Energy management
- Outlook

Extended Automation Method

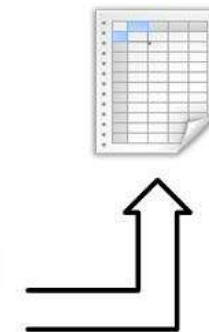
company standardised test automation

EXAM defines a process, the assignment of tasks, and the tools used to

- manually model test cases graphically in the UML.
- generate test scripts automatically from the graphical descriptions.
- separate the test description and its implementation.
- develop tests enterprise-wide in teams.
- accumulate and structure test know-how.
- to use shareable test automation functionalities.



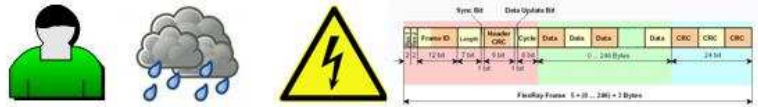
- Manual Creation of test cases
 - awkward
 - error-prone
 - requirements hard to analyze
 - test coverage hard to assess



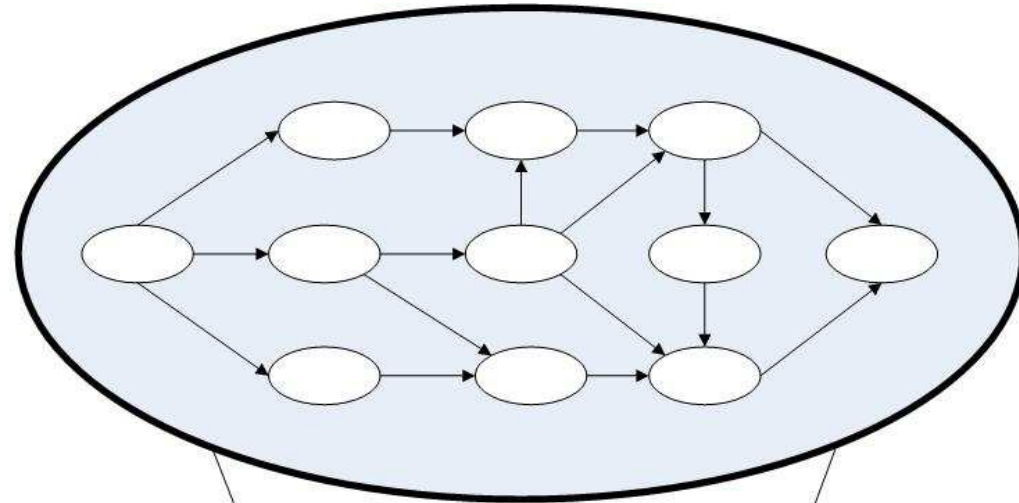
Hardware-in-the-loop simulator (HIL)

Model Driven Testing

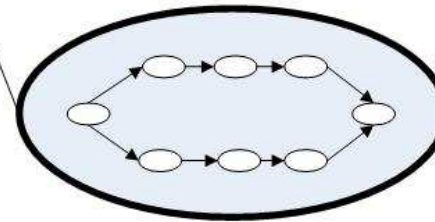
Markov Chain Usage Model



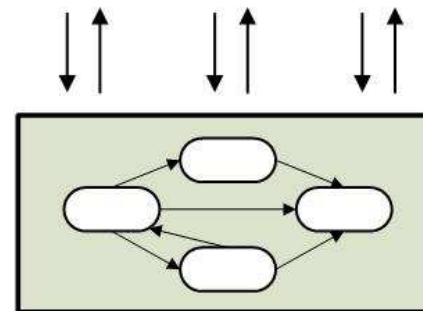
Usage Population
Possible Sequences of Input S^*

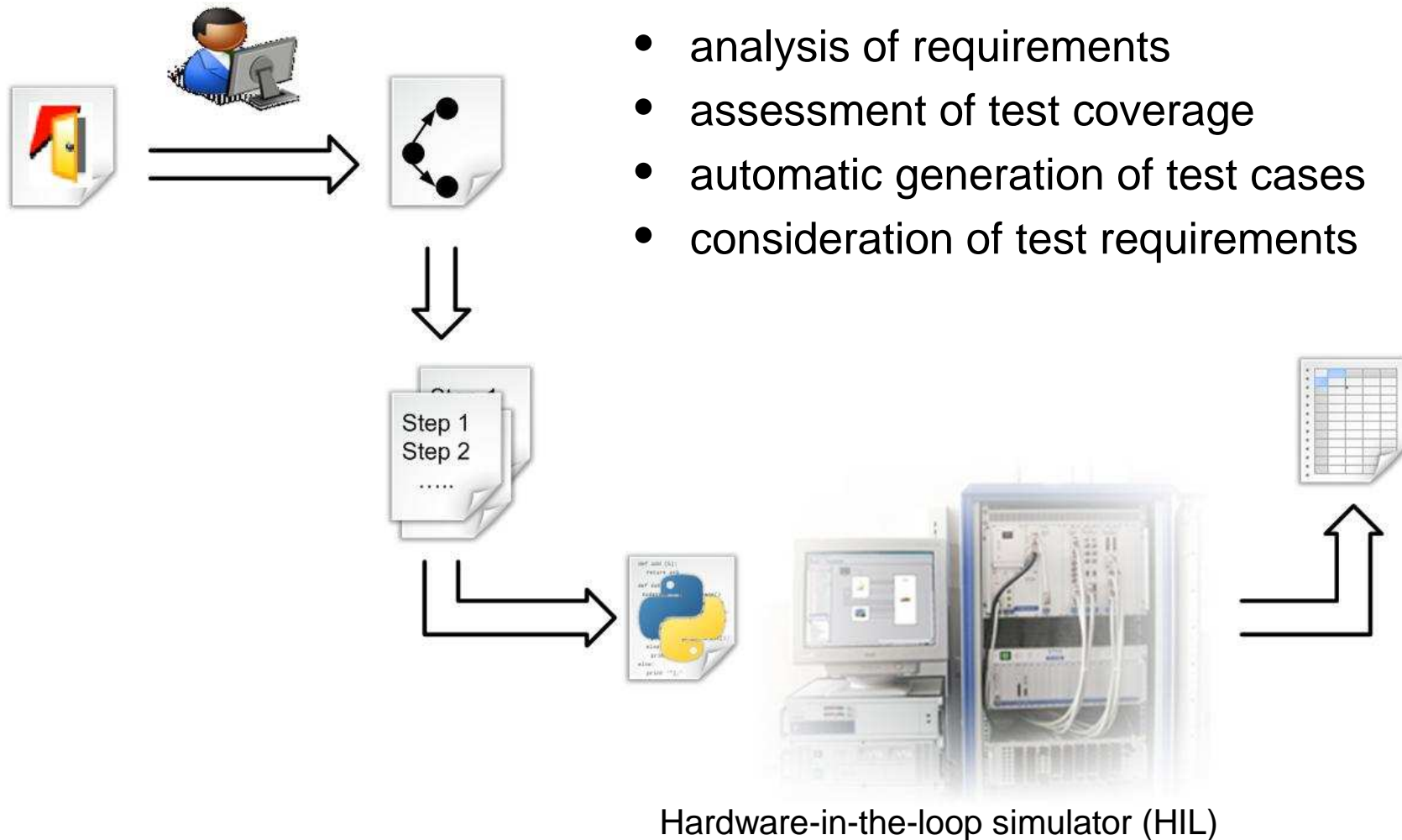


Sample
Stimuli sequences U to be executed



System-under-Test
Responses R





Start Stop

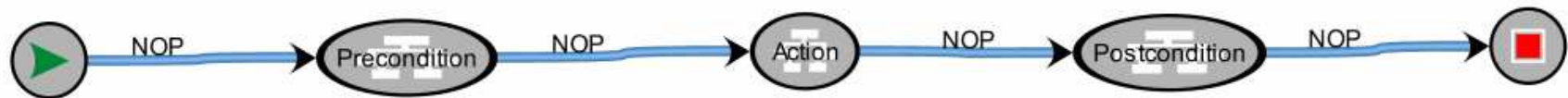
- Automatic shutdown of engine during standing phases
- Technique to reduce the CO2 emissions and fuel consumption
- Highly distributed functionality, almost all ECUs participate

Test model Start Stop

- Requirement Specification
- Input Domain comprised
 - Passenger Operations
 - Environmental Effects
 - ECUs
- Structure followed EXAM Modeling Guidelines
(Tool employed for modeling: MaTeLo from All4tec)

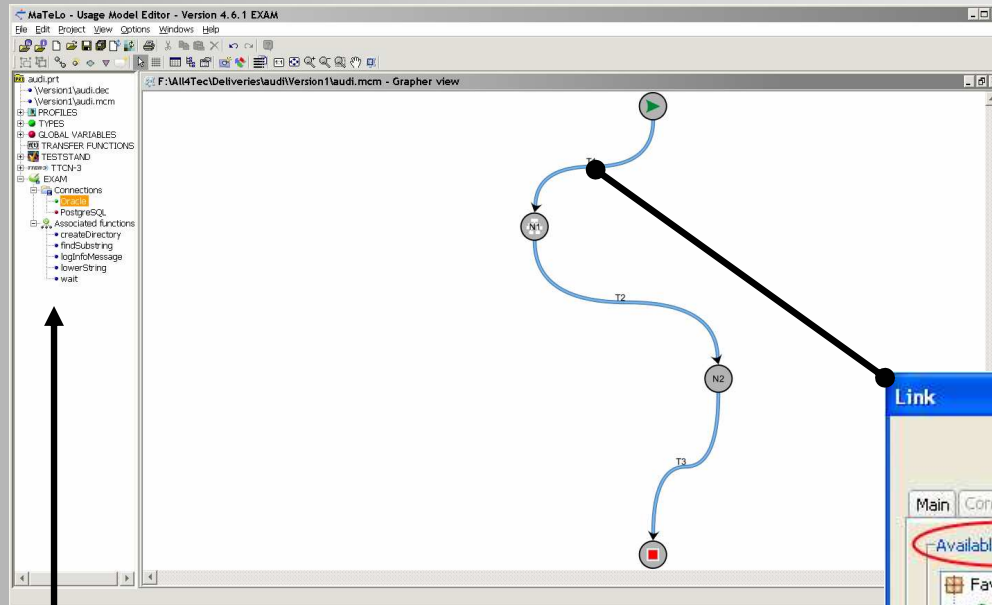
During Creation of the Model it was possible to identify

- one clearly erroneous specification
- three contradictions within the requirements specification
- ambiguities in the specification



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MaTeLo Editor and



EXAM Library in MaTeLo editor

Link

Name : T1 Comment : My transition comment

Main Condition Context - 0 TestStand Functions - 0 Exam Functions - 3 Requirements - 0

Available Function 1

Chosen Functions 2

Function Params 3

Name	Type	Value
sString	Input	testinput
sResult	Value	sNewString

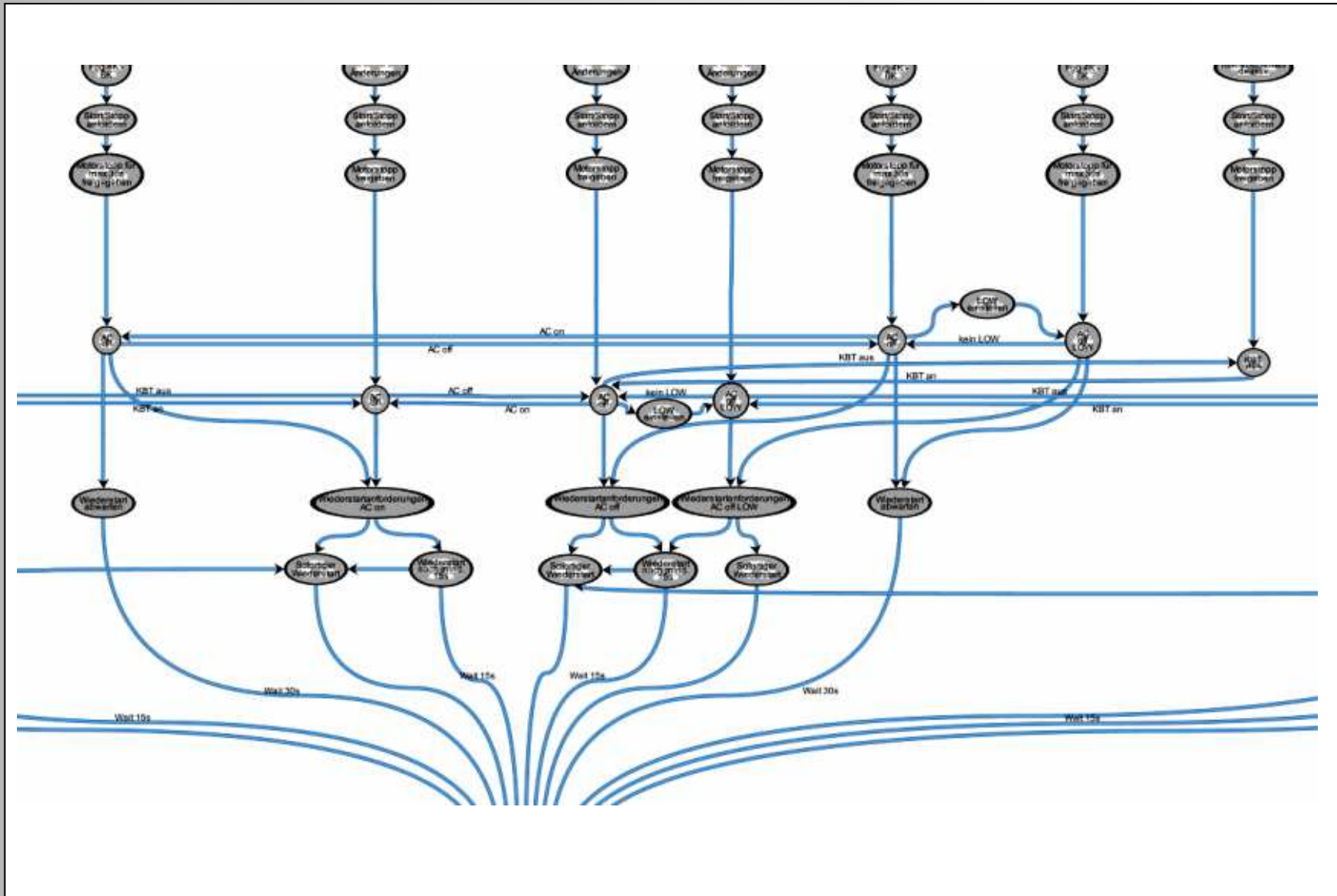
- Associated EXAM objects
- Change Monitoring of EXAM
- Usage Monitoring in MaTeLo Model
- Update in MaTeLo Model

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Testmodels

- Start Stop
 - Power Train
- Energy Management
 - Start Stop
- Comfort
 - Additional Heating
 - MMI Programming
 - Start Stop
 - Interior lighting
- Safety
 - Safety computer

Comfort Start Stop



Results

Clear separation between modelling and programming

Result of work of test engineers is available in models

Reusability and modifiability is given by the model structure

Quality of specification improved: earlier detection of errors

Quality of test specification improved by higher systematics

Efficient testing through more significant test cases

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- **Outlook**

- Analysis of Requirements
- Systematic Generation of test cases
 - Generation Strategies
- Next projects at Audi
 - Comfort
 - Dashboard
 - Energy Management
 - Power Train
 - Integral Safety

Thank you!