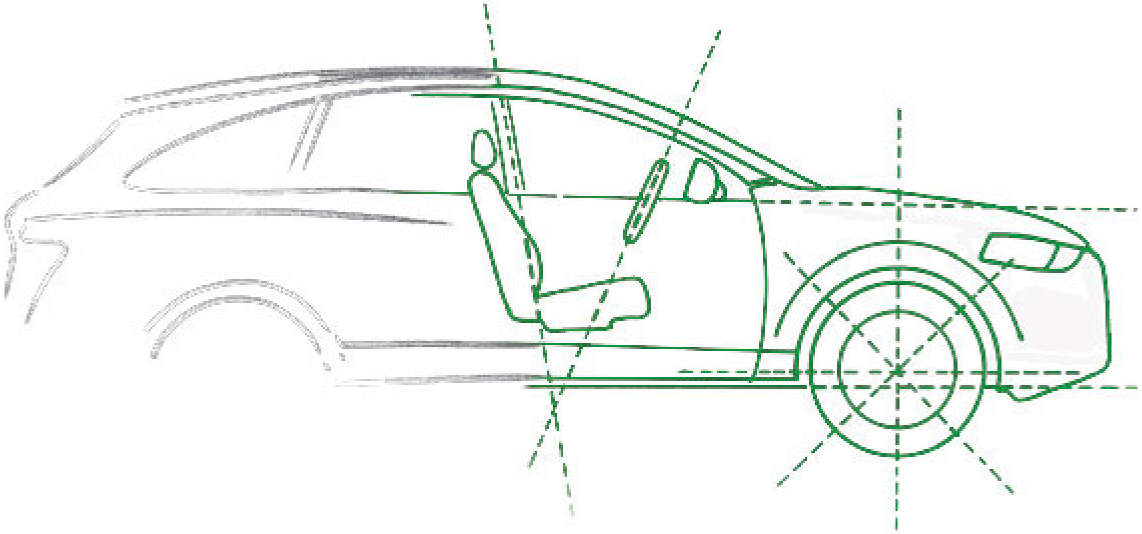
Reuse of Hardware Independent Test Sequences across MiL-, SiL- and HiL-Test Scenarios

Testing Expo 2008
Stuttgart



Berner & Mattner Systemtechnik GmbH

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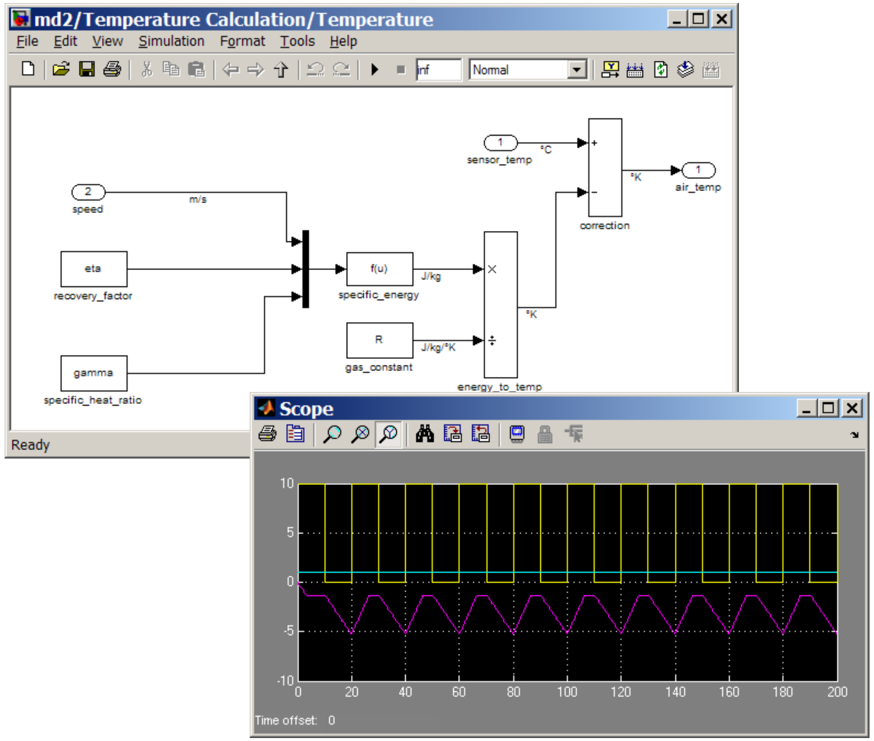
Test methods in the automotive industry (1)

MiL (Model in the Loop)

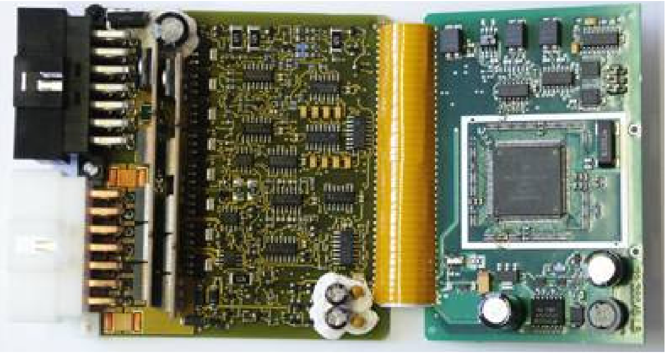
- Test object: model
- Input signals are simulated
- Output signal values will be saved / logged and can be compared to the expected values
- Automatic test execution through:
  - The development environment used for modeling
  - External tools using the appropriate interface of the modeling environment (e.g.: automation interface of MATLAB/Simulink)



Test methods in the automotive industry (2)

SiL (Software in the Loop)

- Test object: generated code
- Environment is simulated
- The inputs and outputs of the test object are connected to the test system
- The generated code is executed on a PC or on an evaluation board
- Automatic test execution through:
  - The used development environment (e.g.: MATLAB/Simulink with Realtime Workshop)
  - Interfaces to external tools

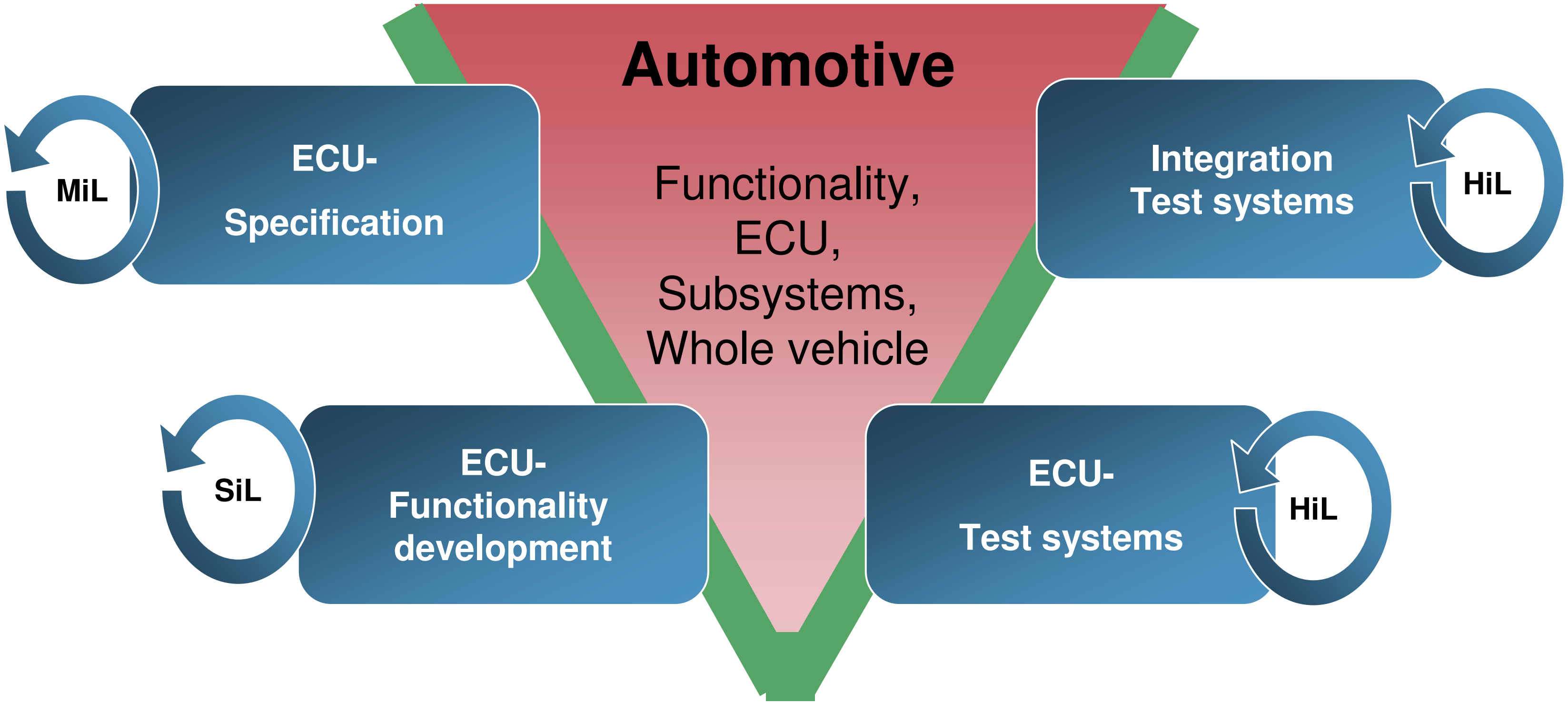


Test methods in the automotive industry (3)

HiL (Hardware in the Loop)

- Test object: real ECU
- Environment simulation through environment models (e.g.: MATLAB/Simulink)
- Inputs and Outputs are connected to the HiL-Simulator
- Stimuli is generated by the HiL-Simulator
- Comparison of the ECU output values to the expected values
- Automatic test execution through the control software of the HiL-Simulator

Test methods in the automotive industry - Summary



Automotive

Functionality,
ECU,
Subsystems,
Whole vehicle

ECU-
Specification

ECU-
Functionality
development

Integration
Test systems

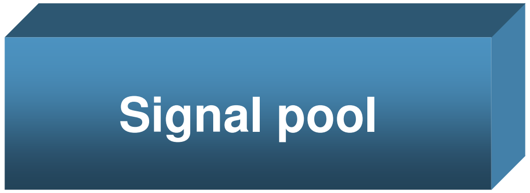
ECU-
Test systems

Challenges / Problems

- Test cases of the early development phases can not be used in later development phases (MiL test cases can not be used for SiL- or HiL-Tests)
- Test cases for the ECU can be created only when the ECU is available
- High occupancy of the HiL-Simulators for the creation of the tests
- Test cases have to be adapted or recreated if the HW is replaced or modified
- Reuse of models in the later development phases
- Verification of the ECU against the specification model

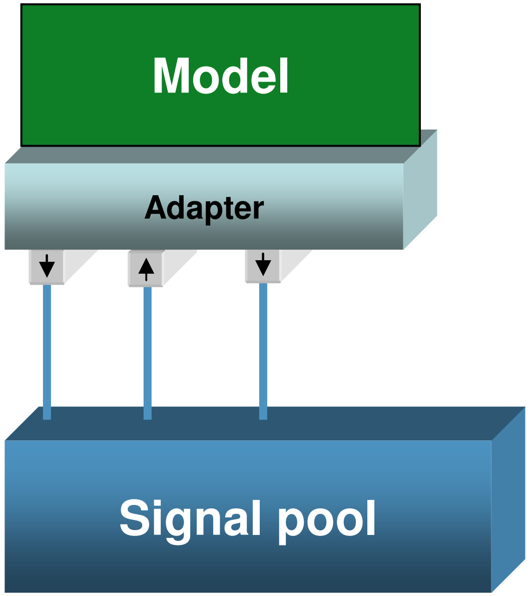
Solution: Signal abstraction

- The signal pool contains all signals of the system
- Every signal has
  - a name
  - a type
  - a length
  - a signal-ID
- Signals are generated on the basis of a configuration
- All components of the system communicate via the signal pool

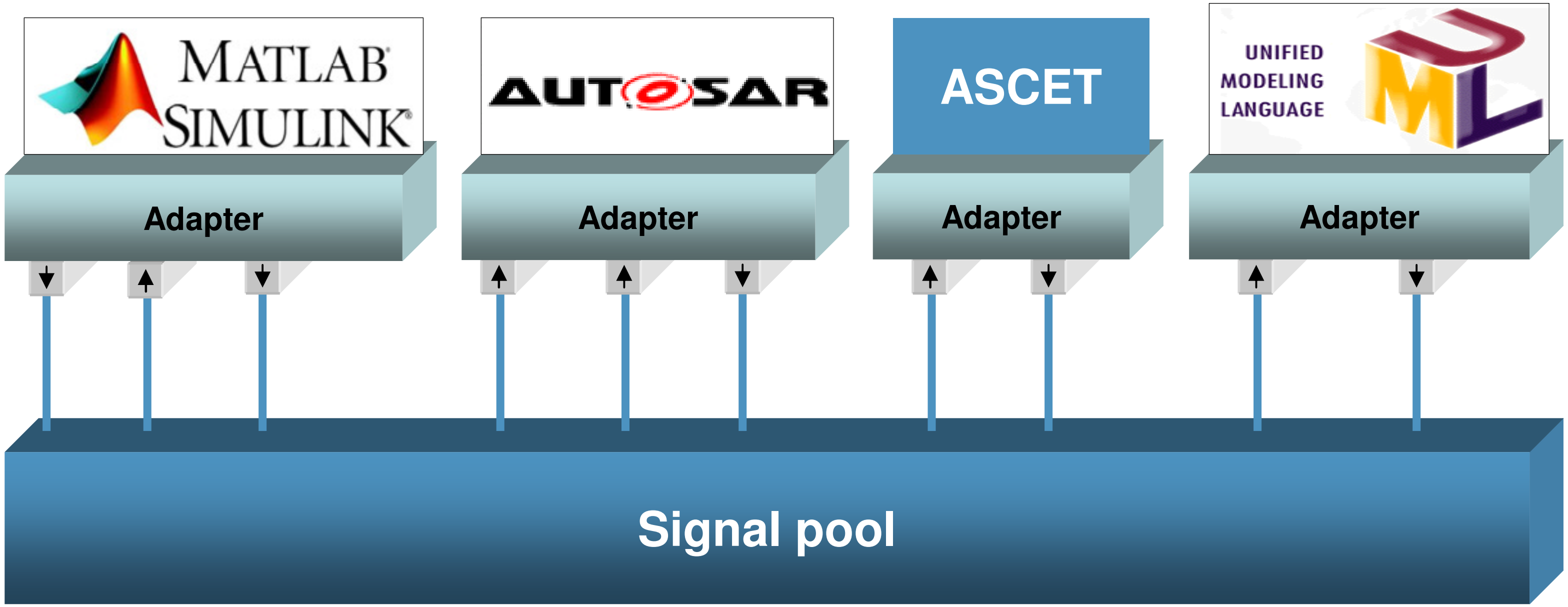


Model Integration

- Models can access the signal pool via ports
- The mapping, port to signal can be configured
- Adapters can register themselves for changes on the signal pool
- Adapters notify the model about the changes on the signal pool
- Models have no information about:
  - The used HW
  - Other communication partners
  - The test platform

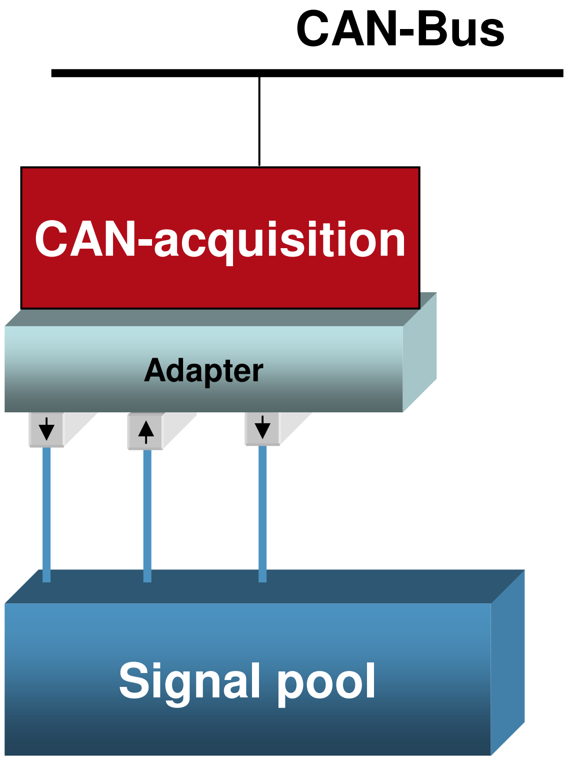


Linking of different model types



HW Integration (e.g.: CAN)

- CAN signals are mapped to ports
- The connection, port to signal pool signal can be configured
- Adapter registers himself for changes on the signal pool
- Adapter sends the appropriate CAN message automatically on changes
- Adapter “disassembles” the incoming CAN messages and sets the signal values on the signal pool accordingly



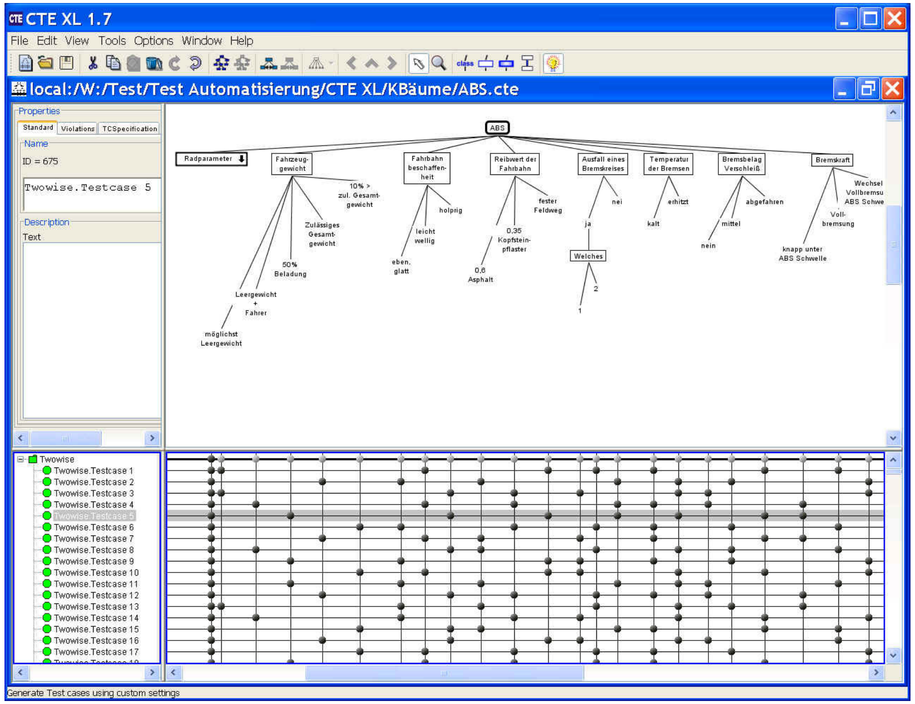
Test integration

- Test cases communicate via the signal pool
- Signals
  - WiperPoti
  - WiperLever
  - WiperStatus
- Test case can be reused through parametrization
- Parameters
  - INTERVAL
  - TIME

```
interval_wiping() {
   // set wiping interval
   WiperPoti.sendValue(INTERVAL);
   // set wiperlevel
   WiperLever.sendValue(1);
   // wait for wiper to start
   ASSERT(WiperStatus.wait(true, 1000));
   // wait for wiper to stop
   ASSERT(WiperStatus.wait(false, 2000));
   // wait for 2nd interval
   ASSERT(WiperStatus.wait(true, TIME));
   // wait for wiper to stop
   ASSERT(WiperStatus.wait(false, 2000));
   // switch off wiper
   WiperLever.sendValue(0);
}
```

Variant diversity using the classification tree method

- Definition of the parameters (eventually derived from the test cases)
- Definition of the possible parameter values
- Configuration of the variants
- Generation of the variants
- Definition of the expected results
- Used for parameterization of the test cases



CTE XL 1.7

local:/W:/Test/Test Automatisierung/CTE XL/KBäume/ABS.cte

Name
ID = 675
Twowise.Testcase 5

Description
Text

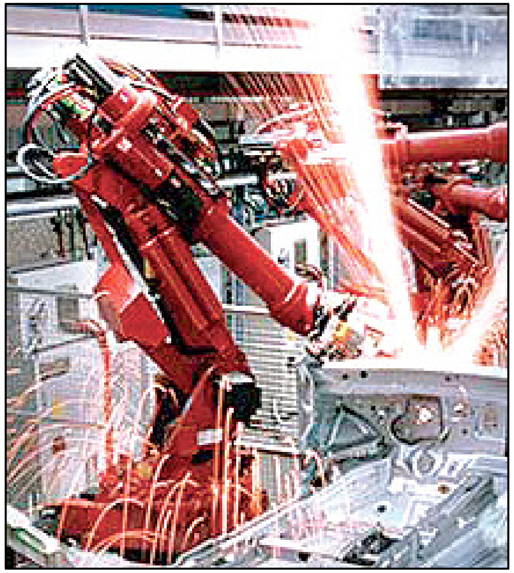
Twowise
Twowise.Testcase 1
Twowise.Testcase 2
Twowise.Testcase 3
Twowise.Testcase 4
Twowise.Testcase 5
Twowise.Testcase 6
Twowise.Testcase 7
Twowise.Testcase 8
Twowise.Testcase 9
Twowise.Testcase 10
Twowise.Testcase 11
Twowise.Testcase 12
Twowise.Testcase 13
Twowise.Testcase 14
Twowise.Testcase 15
Twowise.Testcase 16
Twowise.Testcase 17

Generate Test cases using custom settings

Integration into the model based development (1)

Car manufacturer…

- creates specification models
- develops test cases
- tests models “stand-alone” or in combination with
  - other models
  - generated code
  - ECUs
- provides models and test cases for its suppliers



Integration into the model based development (2)

Supplier…

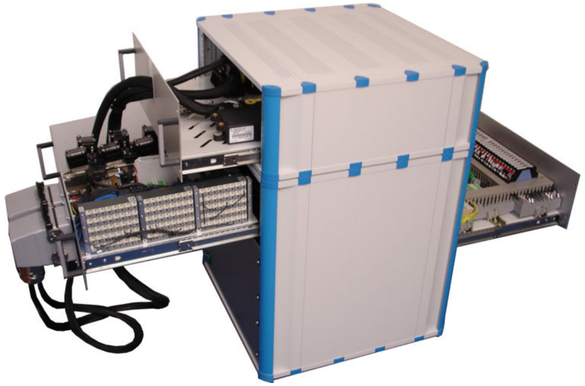
- makes models more detailed
- generates code
- develops test cases
- tests code "stand-alone" or in combination with
  - models
  - other generated code
  - ECUs
- builds the ECU
- tests the ECU "stand-alone" or in combination with
  - models
  - generated code
  - other ECUs
- delivers the ECU and test cases to the car manufacturer

Integration into the model based development (3)

Car manufacturer…

- tests the ECU alone or in combination with
  - generated code
  - specification models
  - other ECUs

Summary



- Test cases are independent of
  - the used environment
  - the used HW
- Test cases can be parameterized
- Test cases can be created already in the early development phases and reused in later development phases
- Derivation of the test cases from the models used
- Models can be used for the verification of the ECUs

?