An Educational Platform for Automotive Software Development and Test

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Current Situation

- Development of functionality independent from target platform
- Heterogeneous tool environment for ECU development
- Tests cannot ensure functionality without errors
- Costly search of problems in data of test drives
- Support of regular teaching, like active learning units, lecture, online units, etc. with specific tools for software development and test

**Goals:**

- Easy to use for students
- Supporting ECU development and test
- Industry near approach
Development Process – Roles of Learners

- Topics Embedded engineering, test and test drive
- Learners can have three roles
  - Developer
  - Test Engineer
  - Data Analyst
- Each role has its own set of tools
- Learner can follow the complete development flow of an automotive software feature
ASTAS – Application specific Test of AUTOSAR Systems

- Prototype for static analysis and dynamic test of AUTOSAR ECUs/projects
- AUTOSAR compliant and usable for different toolchains and AUTOSAR versions
- Architectural knowledge is stored in separated knowledge base
- AUTOSAR tool chain connected to ASTAS for realization of dynamic test
- Static test can support correction suggestion, like connecting open ports, wrong task mapping and incorrect use of data types

Specific Features:
- Application specific test on target platform in successive manner
- Performance analysis, comparison of different configurations
- AUTOSAR specific test report
ASTAS – Screenshot

- Test sequence defines a set of modules.
- Each module can realize one task of static or dynamic test.
- Common test report.

Necessary:
- AUTOSAR project.
- Tool chain and ECU.
- Knowledge Base with data for version and product.
TUC DriveCloud – Recording Test Drives

- Database platform for test drive data
- Test drive defined by start and end time and set of sensor data streams
- Hardware device records data during test drive and upload data to TUC DriveCloud (live or deferred)
- Recording device can access different kinds of data, for example OBD2, specific data from bus (development access), data from other devices like camera and heart beat of driver
- Virtual test drives can be stored (CARLA drive simulator)
- Web interface for visualization and analysis of data
TUC DriveCloud – Web Interface

- Test drives are shown on map (based on GPS)
- Video streams are shown (mapping time)
- All sensor data can be shown in diagrams
- Export of test drive to other formats are possible
- Base for Machine Learning
Mapping

ASTAS Test report
• r messages about static analysis
• s results about dynamic test (basic software and RTE)
• Each entry refers to test object reference in knowledge base

TUC Test Drive Data
• Start and end time
• Pre defined car and driver
• Set of sensors
• each sensor has a number of log entries

→ Mapping
• changes in functionality/architecture can be mapped to sensor values
• Analysis and Test can highlight suspect elements
• Test drive can be prepared, focus on highlighted elements
Educational Use Case

- Automotive Demonstrator Yellow Car
- Set of ECUs, connected by CAN Bus
- Functionality: Remote Control, Light Control,
- Task for student:
  - Extend the current application of Light Control by checking an existing Alive Counter

- Problem:
  - Port in AUTOSAR application is not or wrongly connected
  - Basic Software is correctly configured
  → No change of signal value on CAN Bus

- Result:
  - ASTAS marks the signal of the open port (static test)
  - ASTAS BSW test shows correct behavior
  - Highlighted signal values when evaluating test drive
  → ASTAS test report with correction suggestion
Integrated Tools and Data Sets

- AUTOSAR Toolchain (2.1, 3.2, 4.0)
  - Elektrobit tresos Studio / Auto Core
  - dSpace System Desk, VEOS
  - Freescale S12X and STM SPC560
  - TraceTronic ECU-TEST

- Content ASTAS Knowledge Base
  - AUTOSAR 2.1, 3.2, 4.0
  - Basic Software Modules and RTE
  - 3000 functions of Basic Software
  - 48 BSW Modules with 1096 functions (3.2)

- Content TUC DriveCloud
  - 9 configured cars with 62 sensors
  - 33 drive setups
  - 145 recorded test drives
ASTAS – E-Learning Support

- Learning Management System for visualization automotive specific architecture (here AUTOSAR, Classic Platform)
- ASTAS Knowledge Base as data source
- Different views for learner
  - Abstract view (general overview)
  - Programmers view (functions, etc.)
- Experience data like example projects and best practices
- Scenarios can be used like videos, showing complex processes (stepwise)
- Adaptive Learning → Publication SoftCom 2019
ASTAS – Adaptive Learning

- **Main Idea:** Stepwise Learning based on Skill Level of Learner, Top-Down-Approach
- Five levels for classification of learner
- Each Skill Level activates different information for the learner
- Knowledge of lower levels is always accessible
- Activated information in each level is part of assessment for next level
- Access is realized by item structure in Knowledge Base

<table>
<thead>
<tr>
<th>Level Name</th>
<th>Accessible Data</th>
<th>Necessary Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undefined</td>
<td>No Data is Presented (No access to the platform)</td>
<td>0</td>
</tr>
<tr>
<td>Beginner</td>
<td>Overview and introduction of the OS layers</td>
<td>1 to 30</td>
</tr>
<tr>
<td>Medium</td>
<td>Overview of the different areas of the layers</td>
<td>31 to 60</td>
</tr>
<tr>
<td>Professional</td>
<td>All software modules and its functionality, functions of software modules</td>
<td>61 to 84</td>
</tr>
<tr>
<td>Expert</td>
<td>Animations of OS internal process, dependency between software modules</td>
<td>85 to 100</td>
</tr>
</tbody>
</table>
Summary

• Base for supporting AUTOSAR development and test in combination with test drives

• Supporting information flow between AUTOSAR testing and data of test drives

• Approach contains commercial tool chains for teaching students in standard tools

• Usable for demonstrators, virtual cars, and real cars

• E-Learning tool especially for teaching AUTOSAR
Thank you for your attention.

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