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
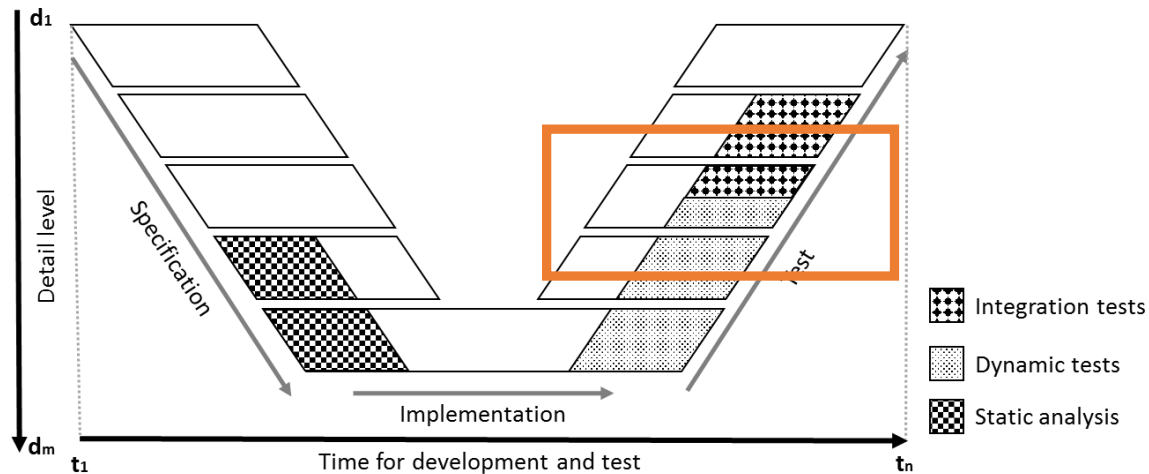
Development Process – Roles of Learners

- 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
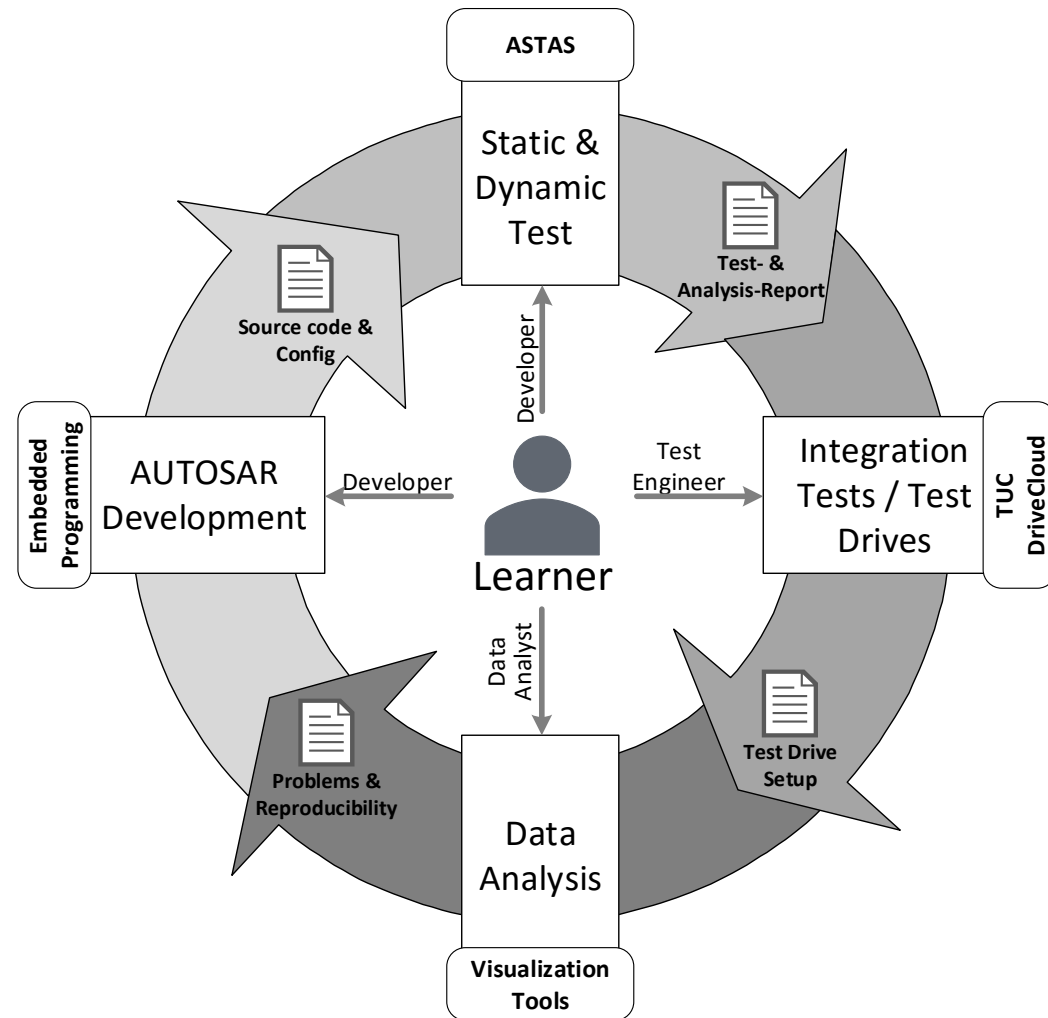
ASTAS – Application specific Test of AUTOSAR Systems

- 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
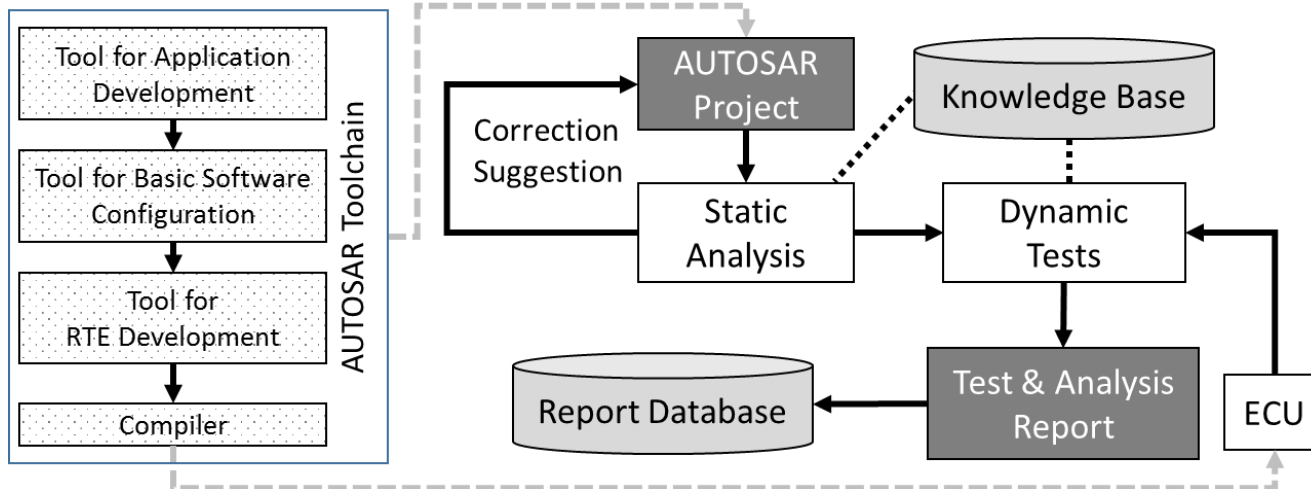
Specific Features:

- Application specific test on target platform in successive manner

- Performance analysis, comparison of different configurations

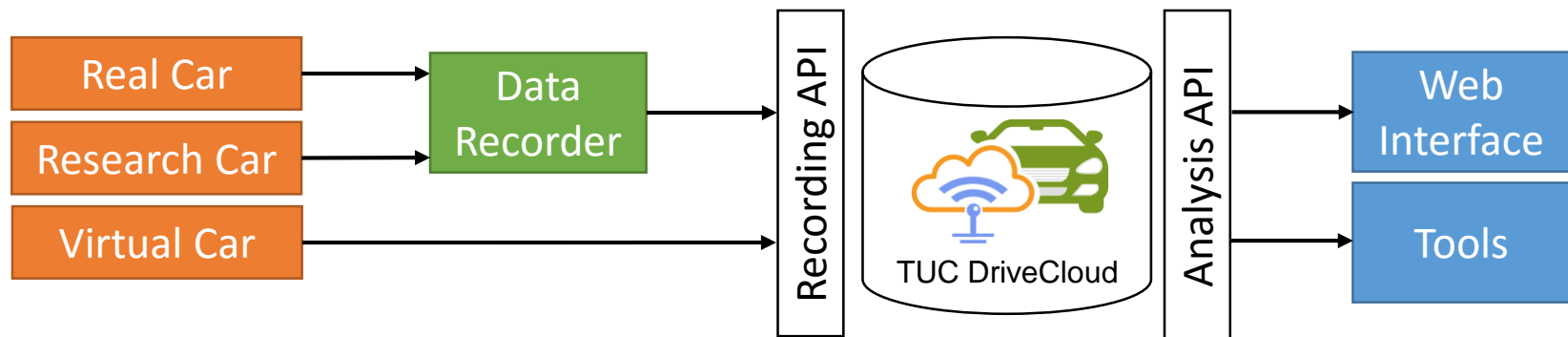- AUTOSAR specific test report

ASTAS – Screenshot

- Test sequence defines a set of module

- 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
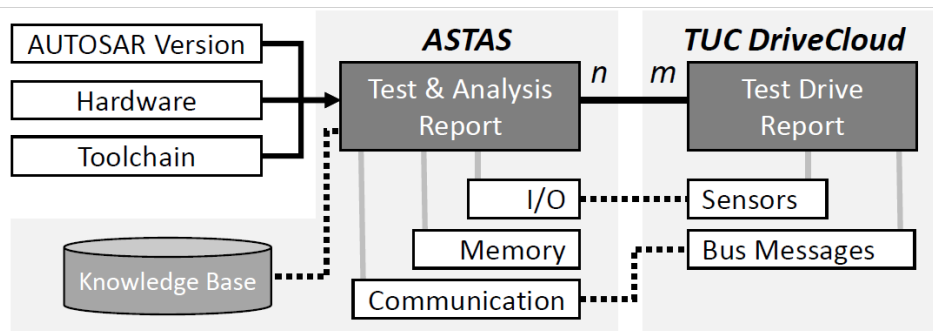
Educational Use Case

- 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
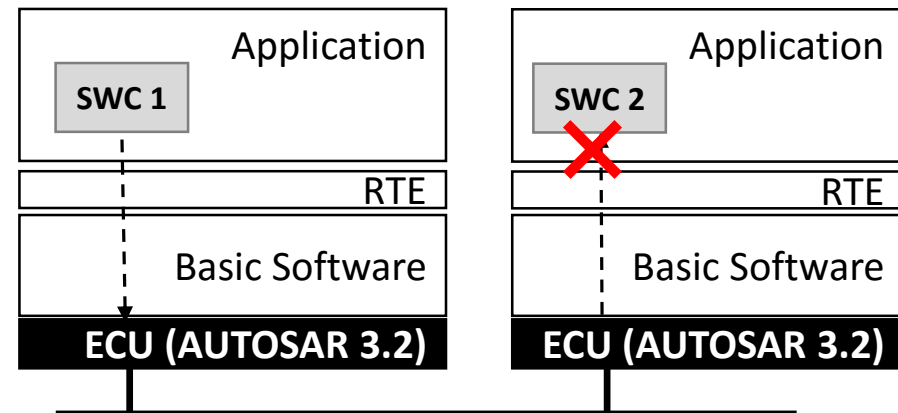
Integrated Tools and Data Sets

- 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

TUC
DriveCloud

AUTOSAR
Toolchain

ASTAS
Knowledge
Base
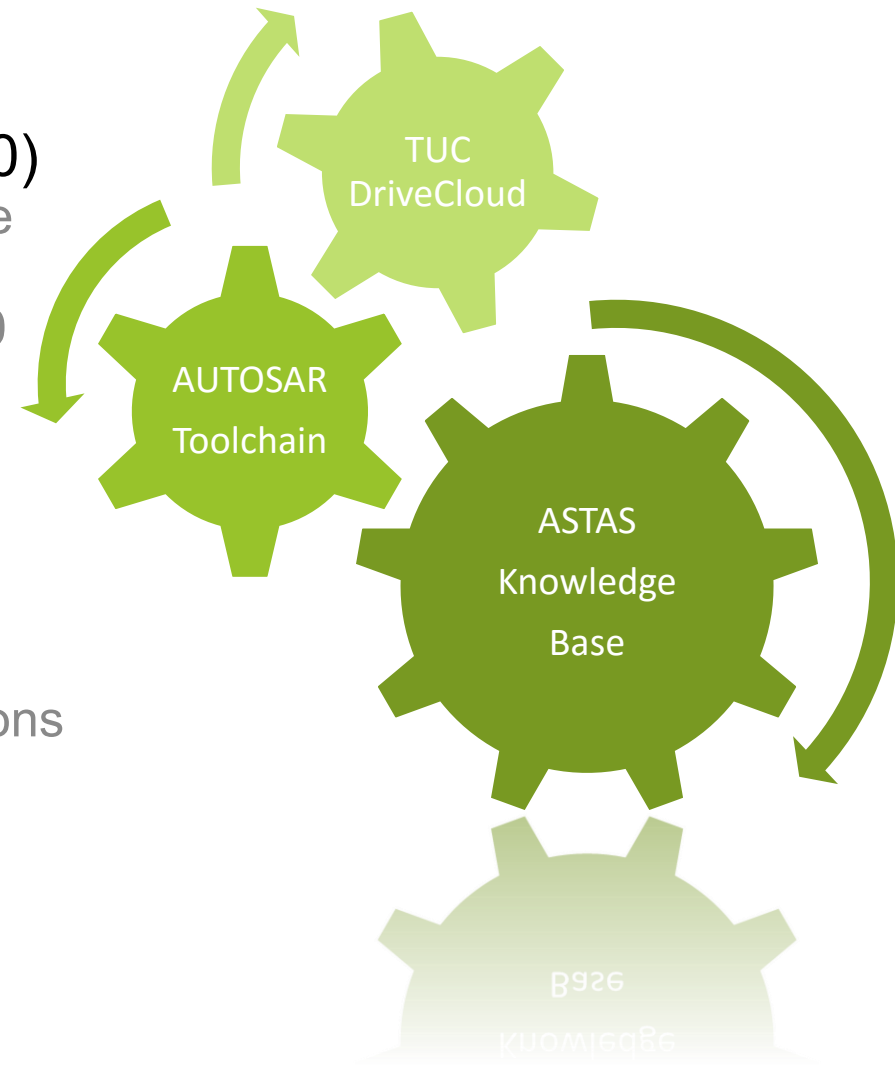
ASTAS – E-Learning Support

- 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
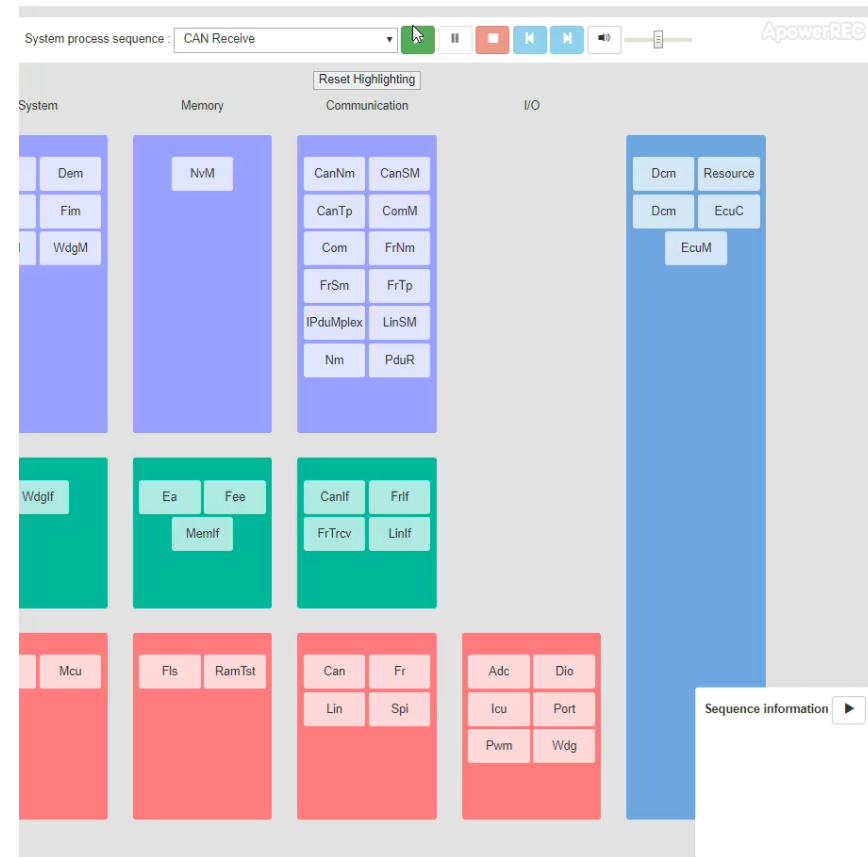
ASTAS – Adaptive Learning

- **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

Level Name	Accessible Data	Necessary Percent
Undefined	No Data is Presented (No access to the platform)	0
Beginner	Overview and introduction of the OS layers	1 to 30
Medium	Overview of the different areas of the layers	31 to 60
Professional	All software modules and its functionality, functions of software modules	61 to 84
Expert	Animations of OS internal process, dependency between software modules	85 to100

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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