AVS: A Test Suite for Automatically Generated Code

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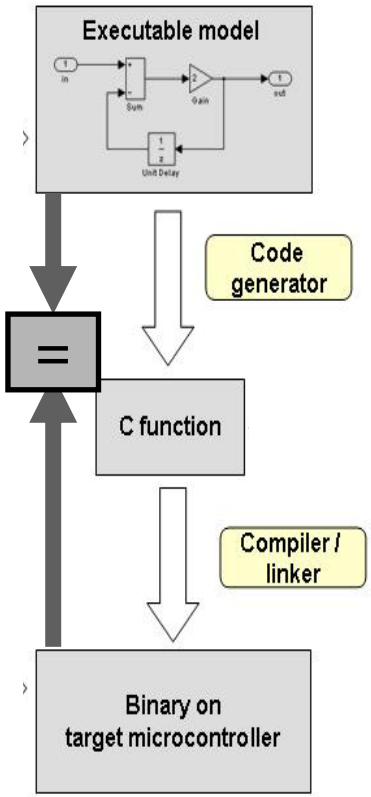
AVS: Automotive Code Validation Suite

Safeguarding the Code Generation Tool Chain

Objectives:

- **Demonstrate:** That C code corresponds to graphical model as generated from design in Simulink® and Stateflow®
- **Validate / Verify (V&V):** The quality and robustness through dynamic testing of the code generation down the tool chain (code generator / compiler / linker / target)
- **Generate:** Meaningful test cases for automatic execution in a constantly growing test suite
- **Support:** Maintaining quality levels through Regression testing



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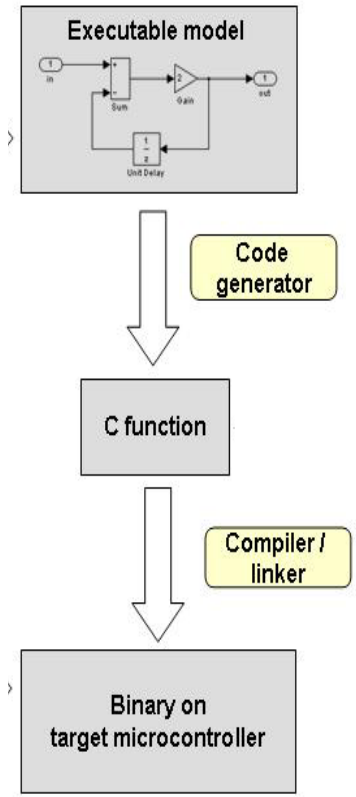
AVS: Automotive Code Validation Suite

Project History

- Joint project of Ford / ContiAutomotive / TUV Rheinland
- Originated from a Compiler Validation Project
- Work started in early 2002
- There have been three major versions since 2002
- Supports different code generator / compiler / linker tool chains, e.g., dSPACE TargetLink and The MathWorks Real-Time Workshop® Embedded Coder
- Meaning of the acronym AVS changed during the project

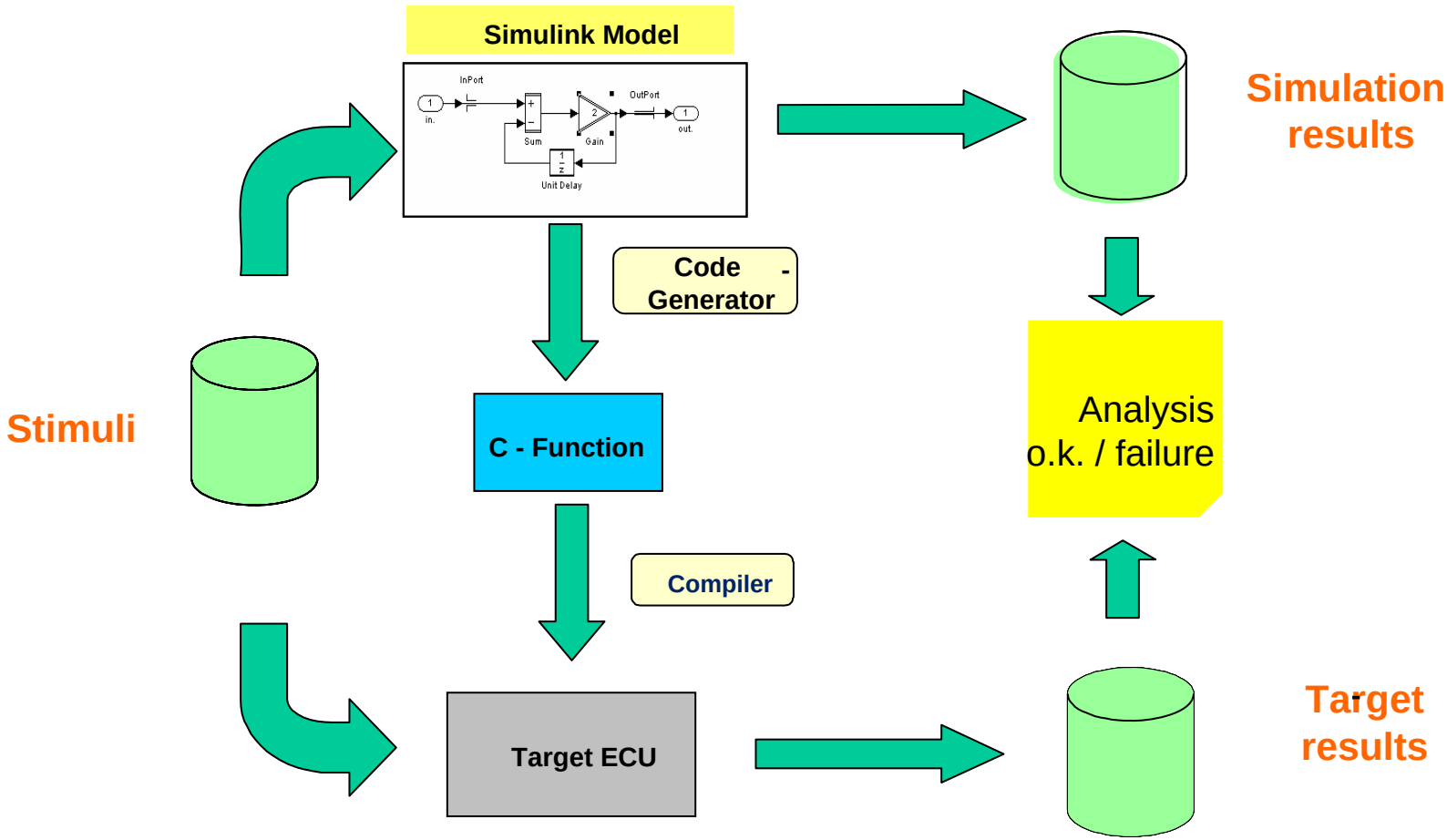
Automatic Code Generation Tool Chain



Motivation for the AVS Project

- The advance of high level software design tools into the world of safety critical applications
- The prevailing use of graphical modeling and simulation, as in MATLAB® and Simulink®, among control engineers
- The facilitating of shorter production cycles through reduced complexity and approved reuse on validated design tools
- The maintenance and continuous improvement of product quality and robustness
- The tremendous risks involved in cases of faulty software in a mass produced vehicle
- The existing quality means (like e.g., FMEA) are not always applicable for software and its certification

AVS (Automotive Code Validation Suite) Concept



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Key Properties of AVS

- Validation by means of an **automated** test-suite
- Test cases are **generic** and **derived** from the actual control algorithms
- Suite contains different test cases
  - **positive :** result o.k. expected
  - **negative :** expected to provoke error message
  - "**fault**" **:** documents a faulty behaviour
- Easy changeability to fit different scenarios (different code generators, compilers and optimization settings).
- Provides easy way to use private test cases to protect intellectual property (IP)
- Communication to tool vendors and automotive industry to avoid double work

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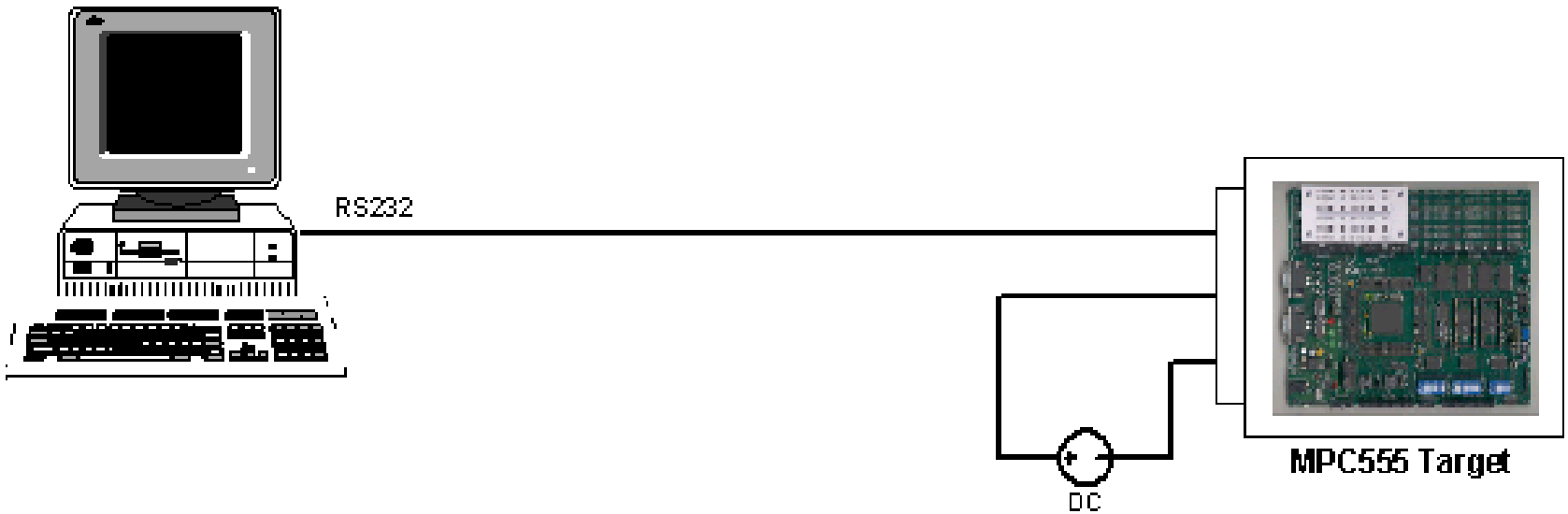
Processor in the Loop (**PIL**) with Evaluation Board



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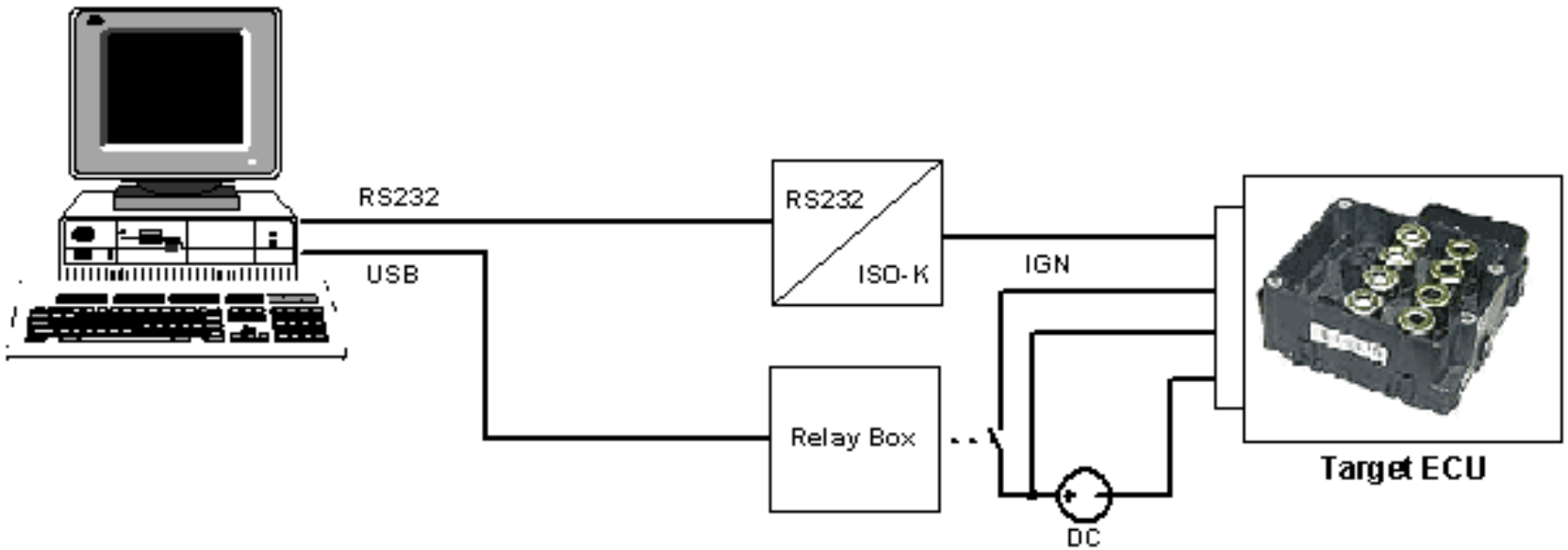
Target in the Loop (TIL) Setup with Production ECU



AVS Target in the Loop (TIL) Setup

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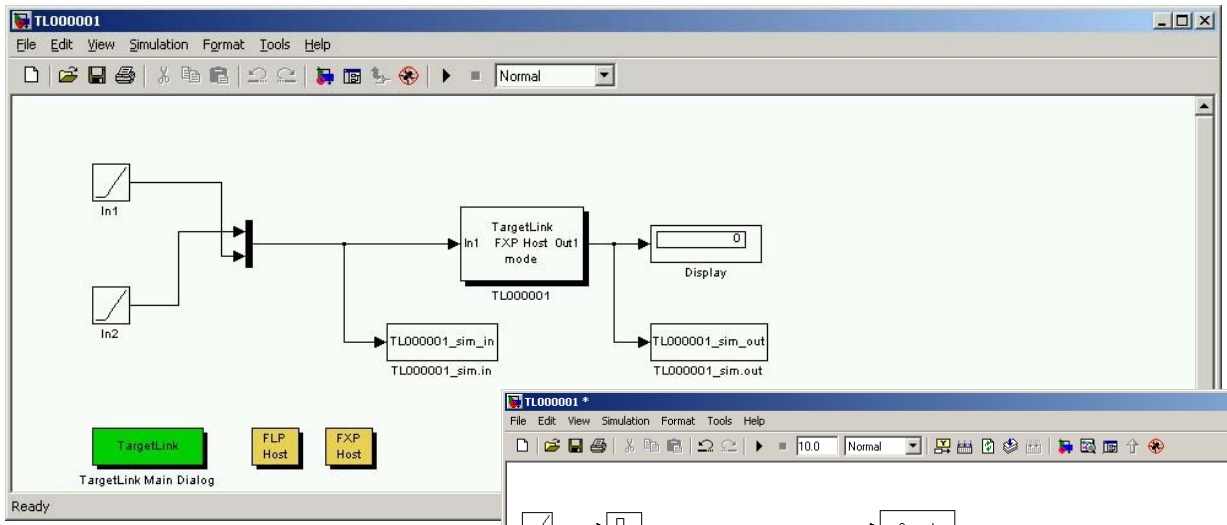
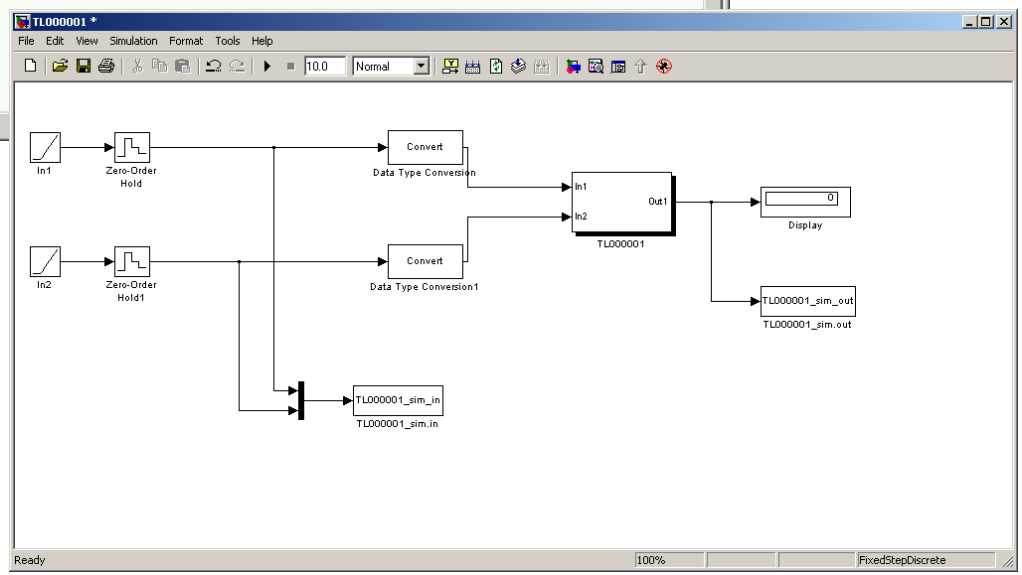
Architecture of AVS compatible Test Cases





- **TargetLink Test Logik**
- **Real-Time Workshop® Embedded Coder Test Logik**

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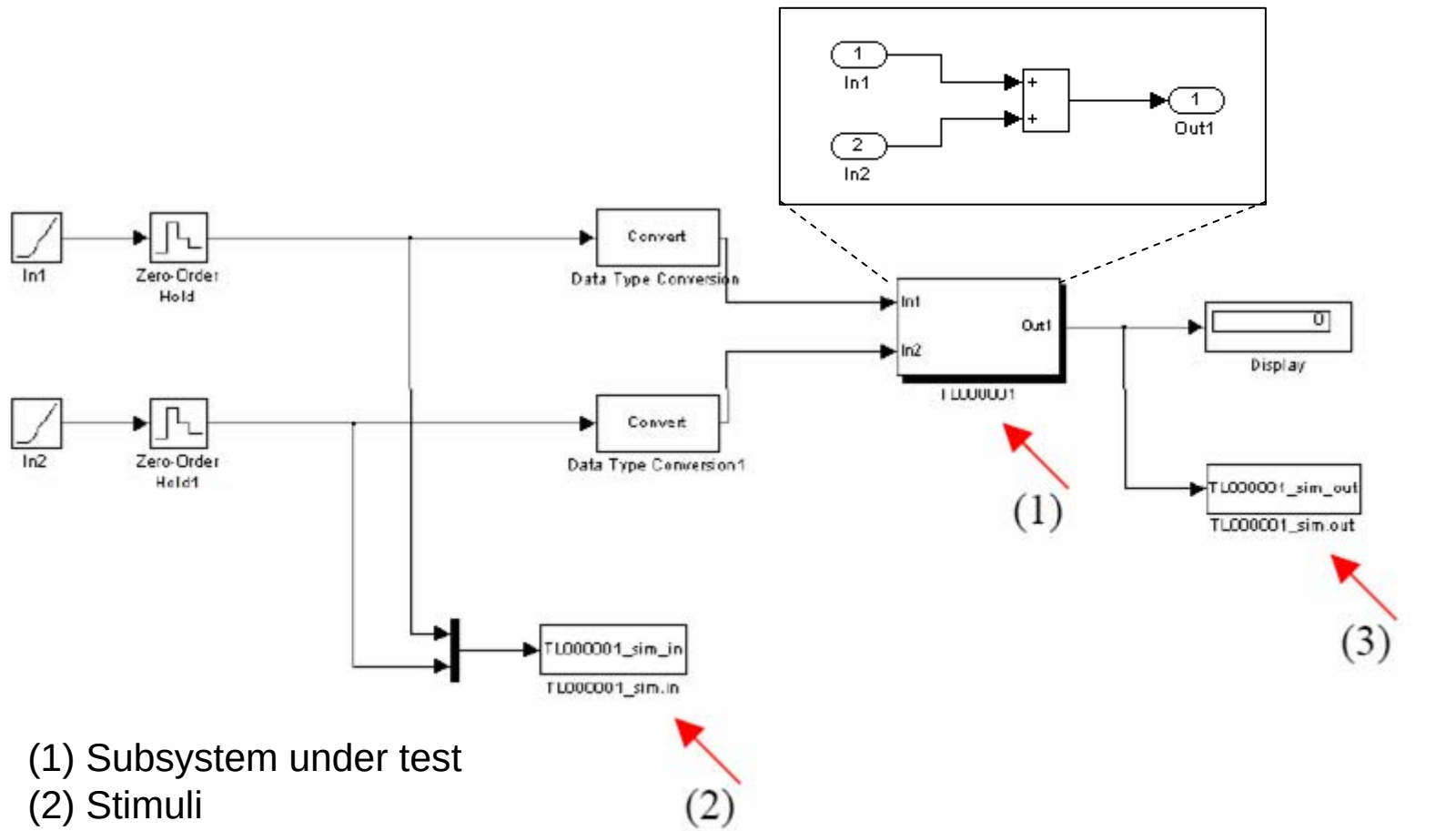
Embedded Coder Test Case

Description of Test Logic



(1) Subsystem under test
(2) Stimuli
(3) Results

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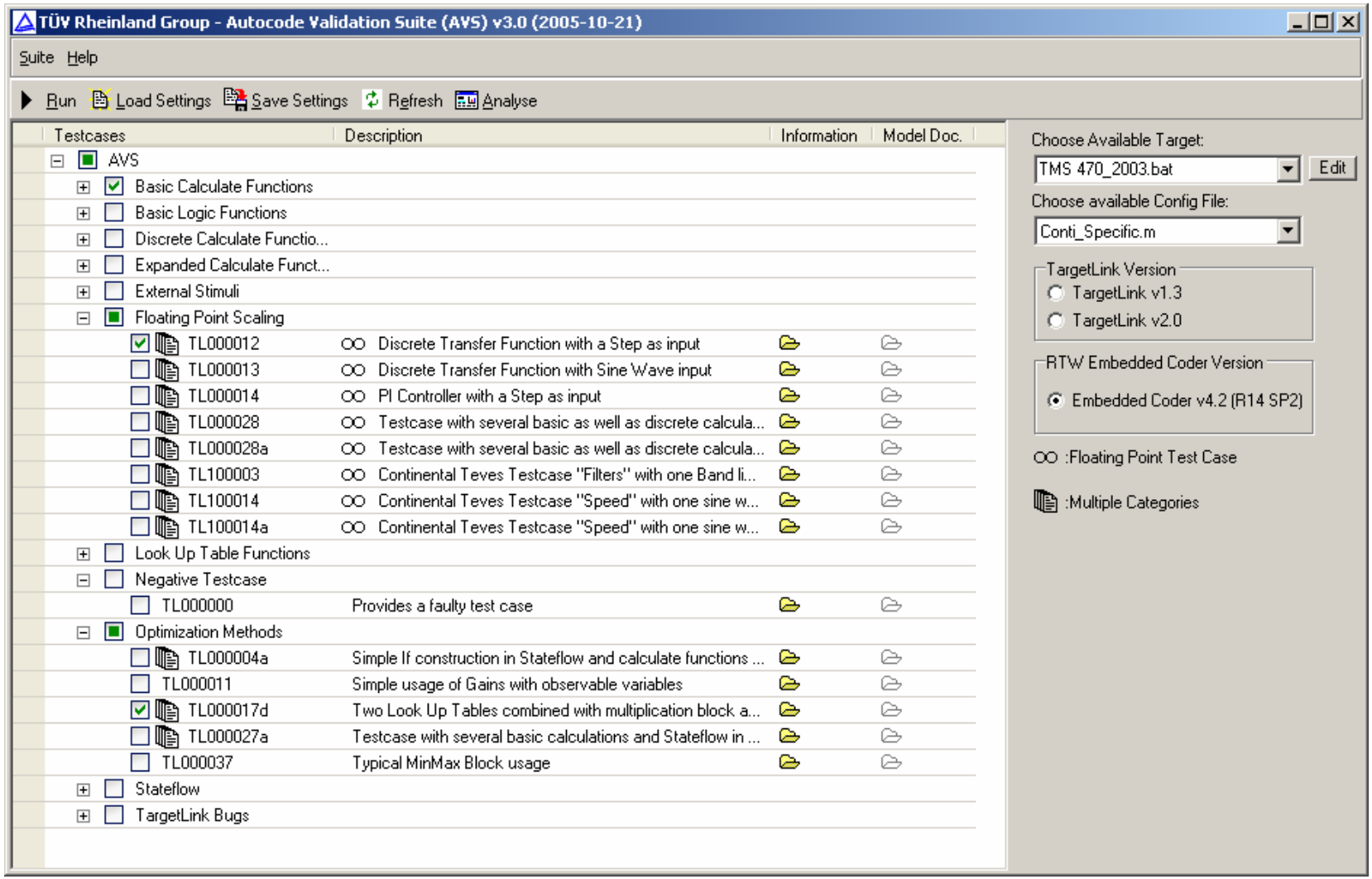
AVS User Interface



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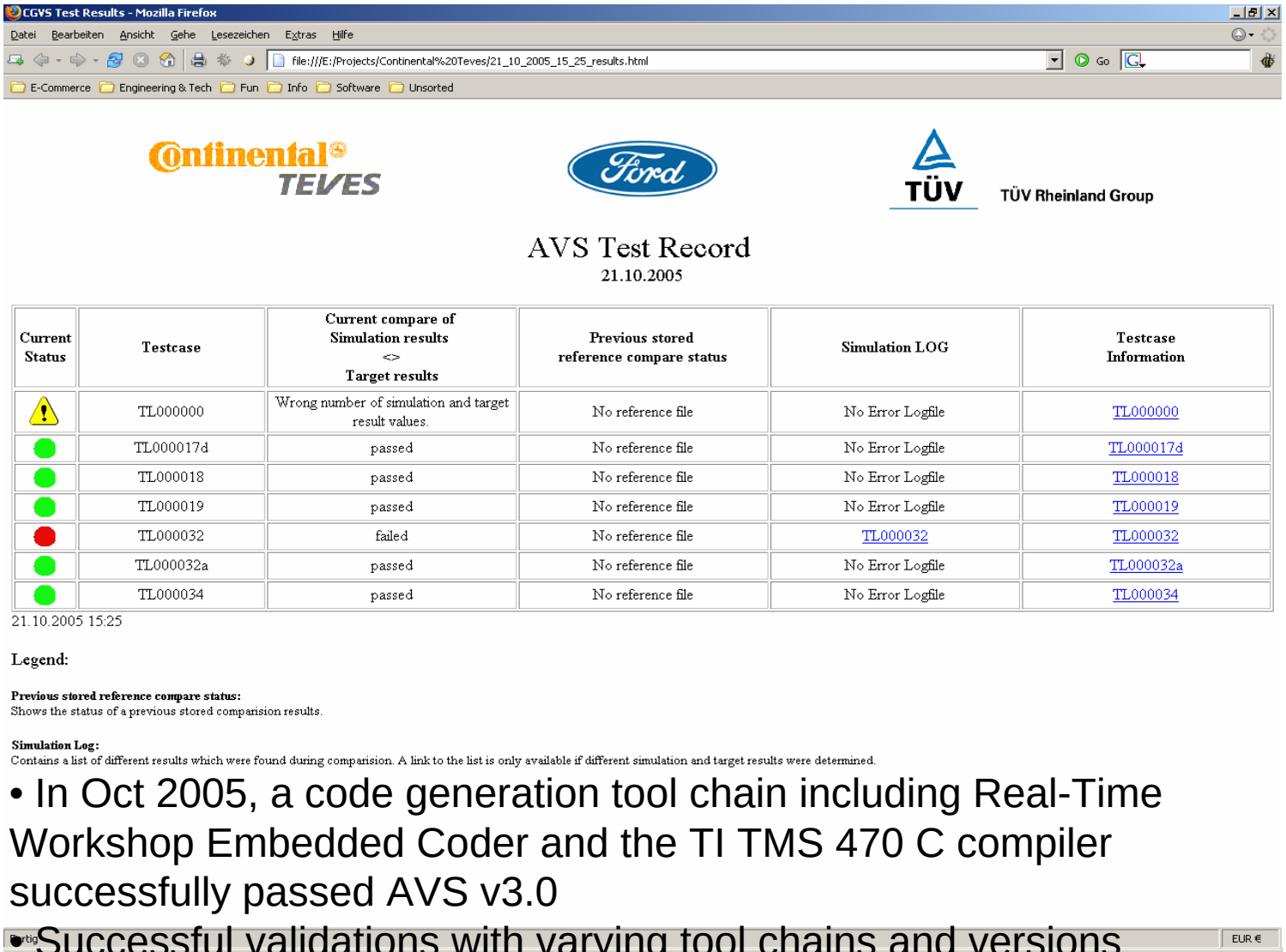
AVS Result Evaluation


CGVS Test Results - Mozilla Firefox

Datei Bearbeiten Ansicht Gehe Lesezeichen Extras Hilfe

file:///E:/Projects/Continental%20Teves/21_10_2005_15_25_results.html

E-Commerce Engineering & Tech Fun Info Software Unsorted

Continental TEVES Ford TÜV TÜV Rheinland Group

AVS Test Record

21.10.2005

Current Status	Testcase	Current compare of Simulation results <> Target results	Previous stored reference compare status	Simulation LOG	Testcase Information
⚠	TL000000	Wrong number of simulation and target result values.	No reference file	No Error Logfile	TL000000
●	TL000017d	passed	No reference file	No Error Logfile	TL000017d
●	TL000018	passed	No reference file	No Error Logfile	TL000018
●	TL000019	passed	No reference file	No Error Logfile	TL000019
●	TL000032	failed	No reference file	TL000032	TL000032
●	TL000032a	passed	No reference file	No Error Logfile	TL000032a
●	TL000034	passed	No reference file	No Error Logfile	TL000034

21.10.2005 15:25

Legend:

Previous stored reference compare status:
Shows the status of a previous stored comparision results.

Simulation Log:
Contains a list of different results which were found during comparision. A link to the list is only available if different simulation and target results were determined.

- In Oct 2005, a code generation tool chain including Real-Time Workshop Embedded Coder and the TI TMS 470 C compiler successfully passed AVS v3.0
- Successful validations with varying tool chains and versions

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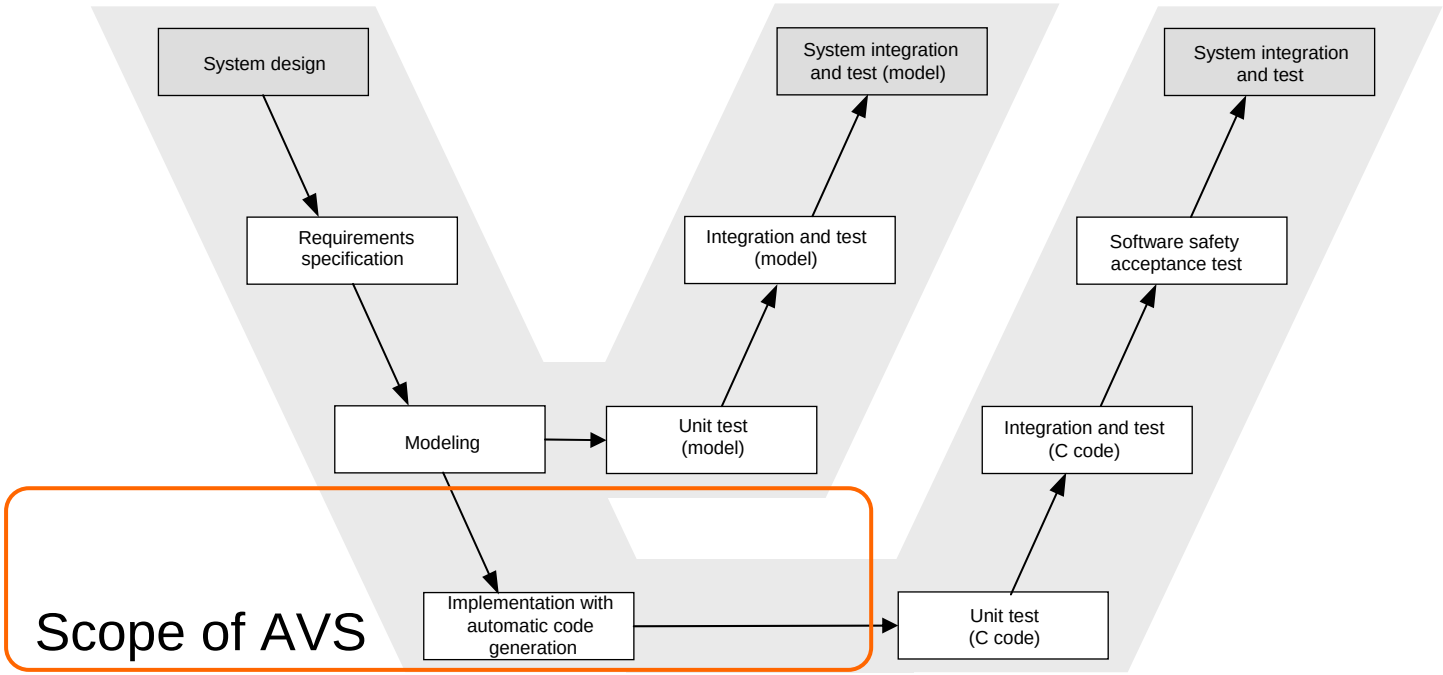
AVS for safety-related Applications, Software Safety

- Validation by means of an AVS:
  additional quality assurance for organizations using production code generation for safety-related applications



- Supports requirements according to IEC 61508 and upcoming ISO 26262

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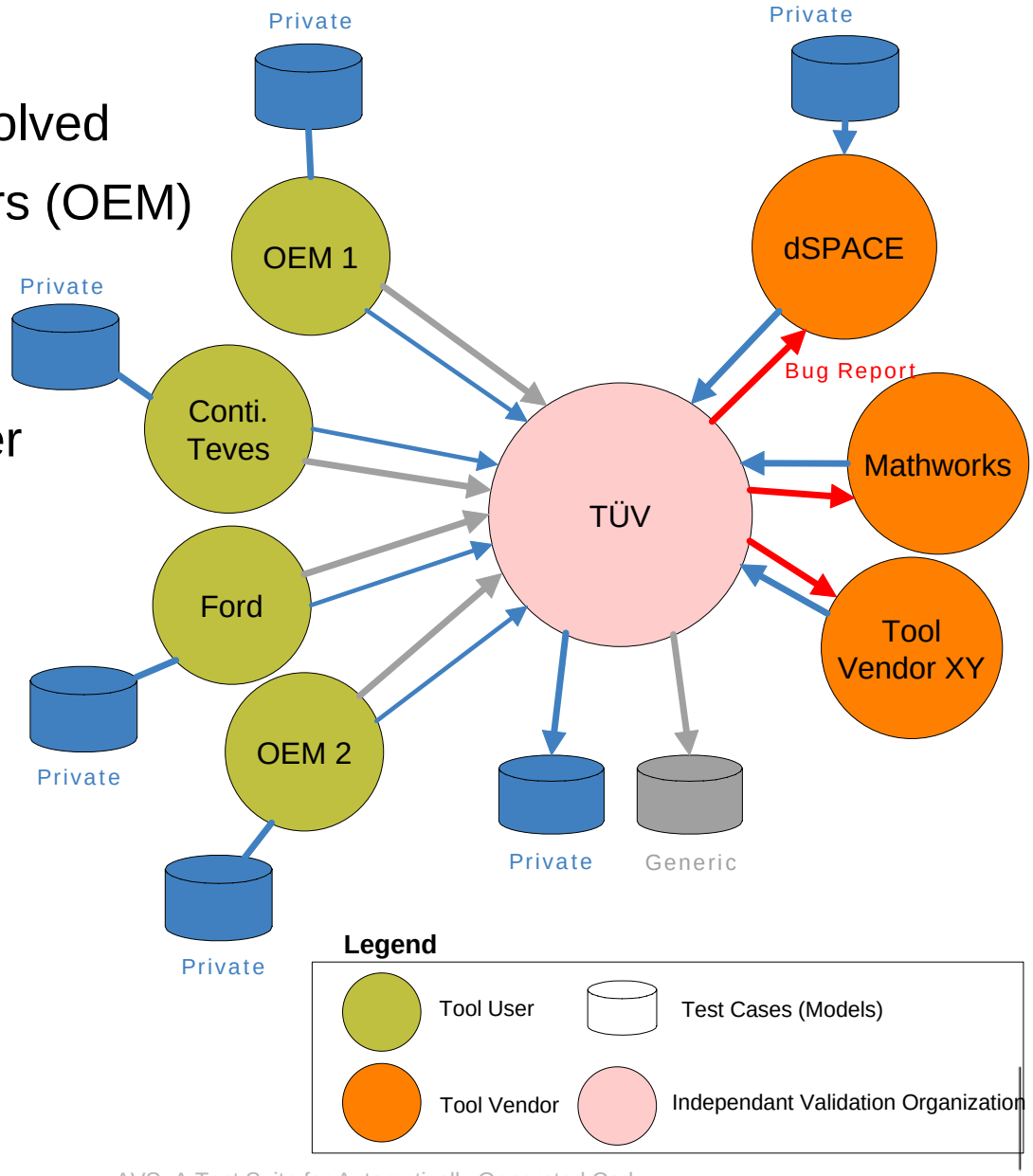
Optimization Level Verification (OLV)

- Almost all tools (code generators, intermediate tools, compiler, assemblers, linkers) allow optimization settings
- Typical range for optimization levels is between 0 (no optimization) up some n (e.g., 6, full optimization)
- Every optimization step means additional operations between source model and final binary code
- Every optimization can possibly change the behavior of the final ECU with regard to overall performance and timing constraints
- OLV property of AVS either proofs “optimization works”, or gives the maximum level, where optimization has no negative impact on the final ECU

Possible Interaction of AVS Partners

Different parties involved

- Car manufacturers (OEM)
- Tier 1 supplier
- TUV
- Tool manufacturer
- Service provider



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Affected Areas : Where AVS can be used

- CASE tools & methods
- Safety critical devices
- Controls
- Functional architecture
- Electric/Electronic (EE) architecture
- Vehicle integration
- Testing and regression testing

Automotive Code Validation Suite

Summary

- AVS validates the entire tool chain, including the microcontroller and target ECU
- Processor in the Loop (**PIL**) Setup, Target in the Loop (**TIL**) Setup
- Joint venture Ford / ContiAutomotive / TUV Rheinland
- Active participation in German **AVS working group** (Audi, Ford, Daimler AG, BMW, Volkswagen, ContiAutomotive, Bosch, Wabco, Siemens-VDO, Getrag-Ford, ZF Friedrichshafen), comparable to AUTOSAR aim :
  "Cooperate on standards, compete on implementation“
- Open for **new partners**
- 3 major revisions showed **high quality** of investigated tool chains
- Optimization Level Validation (**OLV**) saves target memory and execution time
- New features and areas of improvement for AVS are defined

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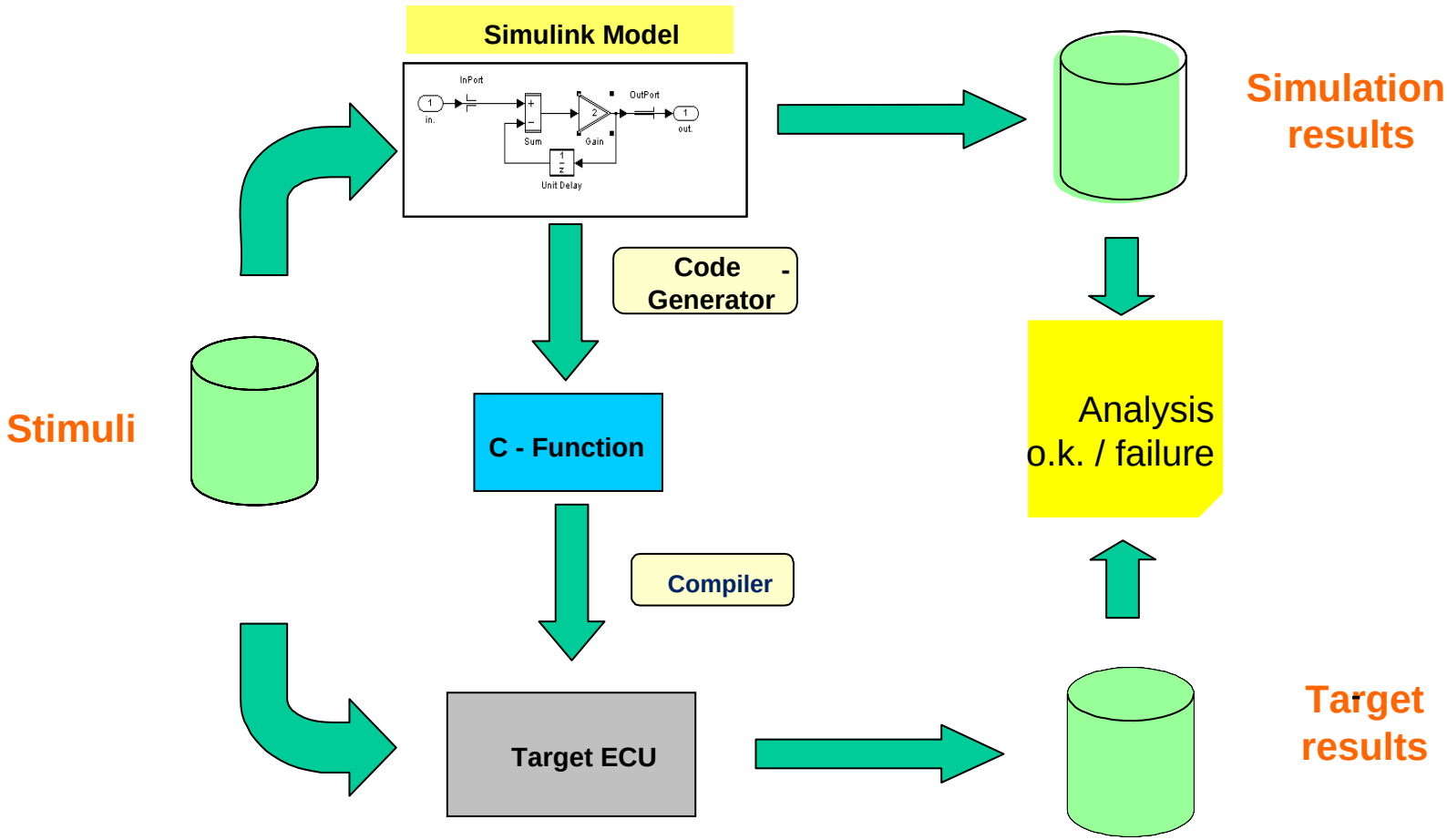
AVS (Automotive Code Validation Suite) Concept



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- AUTOSAR (AUTomotive Open System ARchitecture) http://www.autosar.org/

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