A Highly Automated Test and Validation Tool Chain for Advanced Driver Assistance Systems – Using CarMaker with ECU-TEST

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TraceTronic – What do we do?

Overall solution at TraceTronic

Function development & calibration

Test & validation

Software development

ECU-TEST

TEST-GUIDE

TRACE-CHECK

Test-systems

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Outline

- Automated Driving – Brief overview with a focus on testing
- Test automation with IPG products
- Example tool chain
- Parameter variation
- Results visualization
- Big Picture
- Screencast
Five Levels of Vehicle Autonomy

**Level 0**
No automation: the driver is in complete control of the vehicle at all times.

**Level 1**
Driver assistance: the vehicle can assist the driver or take control of either the vehicle's speed, through cruise control, or its lane position, through lane guidance.

**Level 2**
Occasional self-driving: the vehicle can take control of both the vehicle's speed and lane position in some situations, for example on limited-access freeways.

**Level 3**
Limited self-driving: the vehicle is in full control in some situations, monitors the road and traffic, and will inform the driver when he or she must take control.

**Level 4**
Full self-driving under certain conditions: the vehicle is in full control for the entire trip in these conditions, such as urban ride-sharing.

**Level 5**
Full self-driving under all conditions: the vehicle can operate without a human driver or occupants.

*Source: SAE & NHTSA*
Challenge Big Testing

- Test-space coverage
  - Large, high-dimensional parameter spaces
  - Goals: finding all critical spots, minimal test effort

- Test execution and evaluation
  - Test automation
  - Parallelized test execution
  - Optimization

- Test management
  - State-of-the-art visualization
  - Statistical methods, e.g. sensitivity analysis

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Overview of supported tools

**Simulation platform**
- **HiL real-time**
  - dSPACE ControlDesk
  - ETAS LABCAR
  - NI VeriStand
  - MicroNova NovaSim
  - AVL PUMA
  - OPAL-RT
  - D2T Morpheee
  - KS TORNADO
- **MiL/SiL**
  - Mathworks MATLAB/Simulink
  - IPG CarMaker
  - IPG TruckMaker
  - IPG MotorcycleMaker
  - ADTF 2

**ECU**
- **ETAS INCA**
- **ATI Vision**
- **Vector CANape**
- **Softing DTS**
- **Softing EDIABAS**
- **RA Consulting DiagRA**
- **Raw diagnostics**

**BUS**
- **ETAS INCA**
- **Vector CANoe/CANalyzer**
- **BUS-HW: Vector, PEAK, IXXAT, ETAS, X2E, SOFTING, GOEPEL**
- **IXXAT-RBS**

**Misc.**
- **ASAM XIL-API**
- **VISA**
- **Ethernet SOME/IP**
- **NI LabView**
- **Lauterbach TRACE32**
- **PLS UDE**
- **dSPACE FIU FSS**
- **hard&soft FIU**
- **Quancom relais**
- **Beckhoff TwinCAT**

The tools are categorized into four main sections: Plant model/implementation model, Diagnostics/measurement and calibration, Bus communication, and Electrical error sim., relays, etc. Each section contains tools that are relevant to the specific category. The diagram illustrates the integration of these tools with the simulation platform, ECU, and BUS components.
Overview TEST-GUIDE

Test results:
- Reports
- Logs
- Recordings
- Hex-Files
...

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Test automation with IPG products

- Support for MiL, SiL and HiL workflows
- Simulation control
- Configuration and parameterization
- Model access (varying features)
- Recording and analysis of traces

[Source: IPG, Mathworks]
Example Toolchain

- **Parameter sets**: e.g. distances, times, speeds
- **Simulation**: e.g. CarMaker, TruckMaker, MotorcycleMaker
- **Evaluation**: e.g. TTC, THW, max. acceleration

Return of results, optimization and search

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Parameter variation

Extensive options of parameter variations

- Preview of the number of generated parameter sets
- Support of n-wise method
- Selecting a random subset of generated parameter sets
Example: Particle Swarm Optimization

- Metaheuristic moving candidate solutions in the search-space (particles)
- In each iteration speed and direction of every particle is calculated
- Speed and direction depends on own and global best position

[Source: Wikipedia]
Results visualization

2D heatmap showing criticality of concrete scenarios with respect to multiple parameters

Signal plots showing the metrics time-to-collision and time-headway for a concrete scenario.

Parallel coordinates shows graphically the dependencies of the parameters in the entire parameter space.

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Big Picture

Test-case implementation → Test control & Parameter variation → Test execution (MiL/SiL/HiL) → Test-result evaluation → Validation vehicle → Analysis

Visualization → Test results & Measured data

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IPG AUTOMOTIVE

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Let’s have a look at the tooling

Screencast and explanations