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QTronic
SIMULATION FOR ENGINEERING

Virtual ECUs for Developing Automotive Transmission Software

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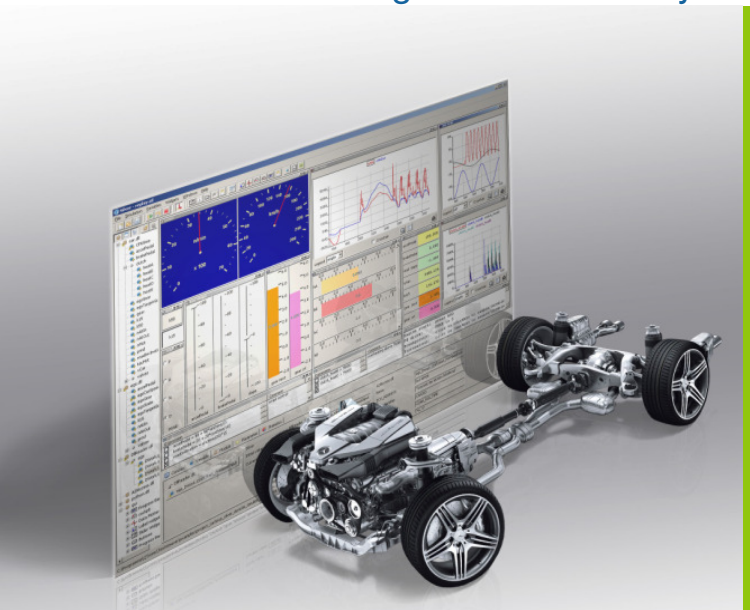

Virtual ECUs for Automotive Software
Agenda

- **Motivation**
- Software-in-the-Loop setup
- Debugging
- Experience
- Conclusion

Virtual ECUs for Automotive Software
Motivation and objective

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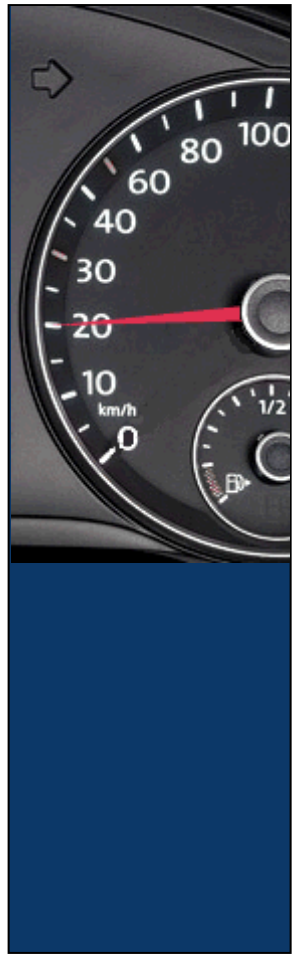
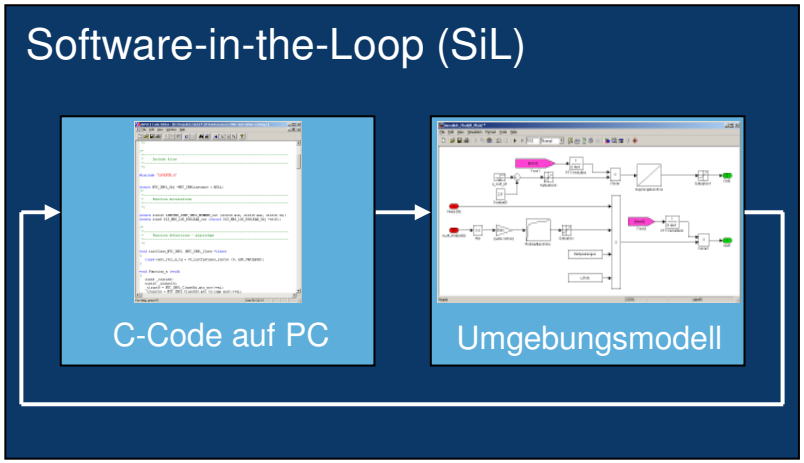
- **Motivation**
  - Series Transmission Software development
    - Different software variants
  - Functional behaviour testing
    - dSpace Hardware-in-the-Loop (HiL) systems and test vehicles
    - Limited possibilities for troubleshooting and analysis of software
    - Fully utilized HiL systems

- **Objective**
  - Debugging of series transmission function software



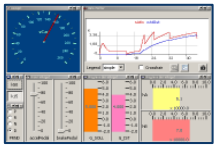
Virtual ECUs for Automotive Software
IAV‘s boundary conditions

- Usage of Software-in-the-Loop
  - Runs completely on Developer PC
  - Enables convenient debugging
- Full-featured debugging
  - Break points (fix, conditional)
  - Reading and changing of run-time variables
- No code changes allowed
- Full process control by IAV
- All-time deployable by developer
- Reuse standard data sources (A2L, PAR, DBC)
- Consistency over X-in-the-Loop (SiL, HiL)



Virtual ECUs for Automotive Software
Silver

- Silver from QTronic GmbH
  - Software-in-the-Loop (SiL) simulation environment
  - All relevant automotive standard formats supported
  - Allows debugging via Microsoft Visual Studio
  - IAV has already experience with Silver



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- **SiL setup**
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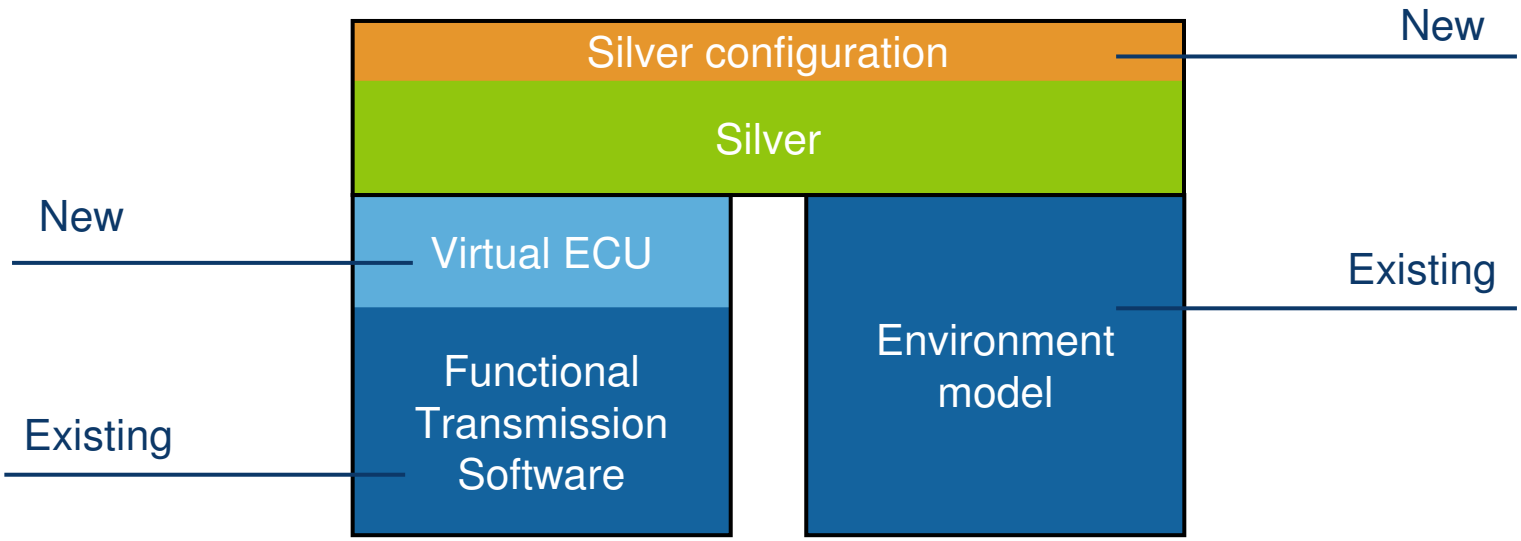
Virtual ECUs for Automotive Software
SiL Setup



Virtual ECUs for Automotive Software
SiL Setup: Transmission Software

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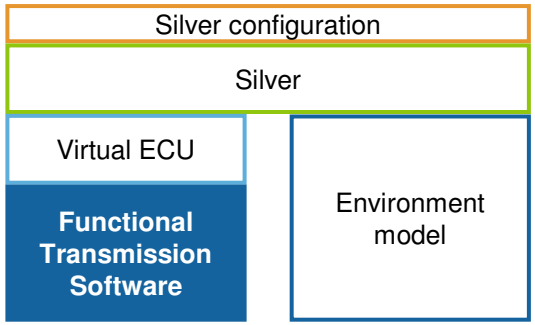
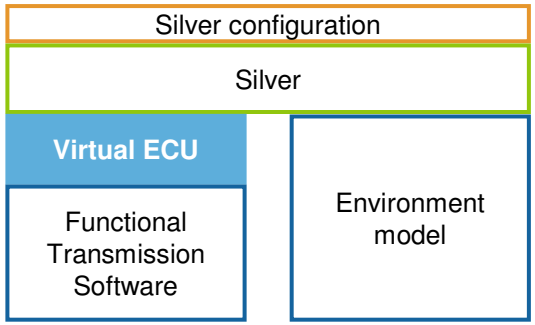
- **Transmission software**
  - C-Code (Hand coded, auto code from TargetLink)
  - Mostly accessible as code, some as LIB
  - Interface to Virtual ECU
    - ECU BIOS calls
    - get/set functions for sensor, actuator, CAN data
  - SiL task
    - Compile for PC processor (x86, Microsoft C Compiler)
    - Current developer code



Virtual ECUs for Automotive Software
SiL Setup: Virtual ECU

- **Virtual ECU**
  - Hardware and software
    - IO interface to Silver-API
      - Input and output signals
      - Virtual CAN
    - Timing
      - Task slices
    - BIOS functionality
    - Non-volatile memory
  - SiL task
    - Write C-Code using Silver Basis Software (SBS)
    - New: Virtual CAN



Virtual ECUs for Automotive Software
SiL Setup: Environment Model

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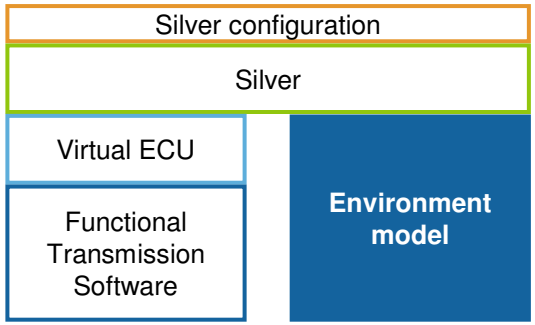
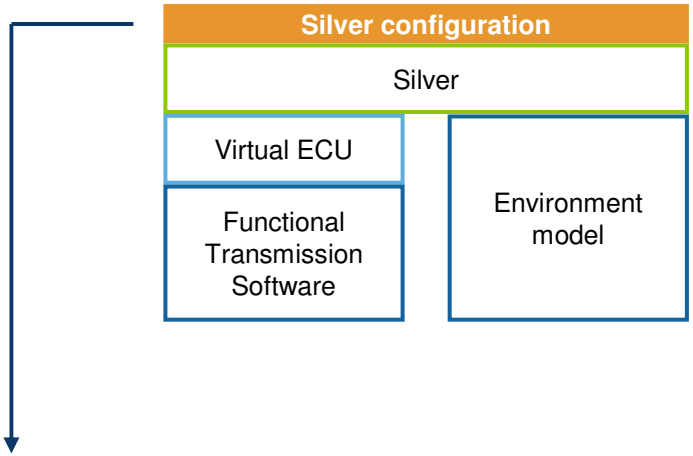
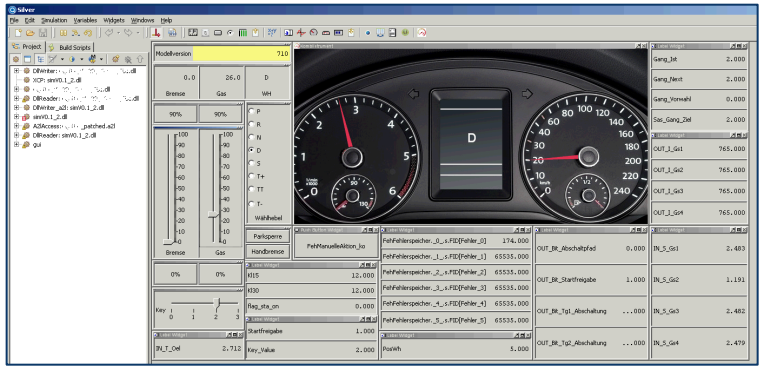
- **Environment model**
  - Longitudinal vehicle dynamics and CAN rest bus
  - SiL task
    - Reuse existing HiL model
      - Implemented in Simulink
      - Adjust Timing
      - Switch block set to Silver block library (IO, CAN)
    - Compile for PC processor (x86)
      - Silver simbuild tool
      - Real Time Workshop
      - Microsoft C Compiler
  - Rollout via version control system



Virtual ECUs for Automotive Software
SiL Setup: Silver Configuration

- **Silver configuration**
  - Graphical user interface
    - Start/ stop simulation
    - Interact with simulation (gear lever, accelerator and brake pedal)
    - Display and change elementary information
      - Software: A2L measurement signals and parameters
      - Model: Status information
  - PAR file flashing
  - Access A2L
  - SiL task
    - Setup new experiment





Virtual ECUs for Automotive Software
Agenda

- Motivation
- SiL setup
- **Debugging**
- Experience
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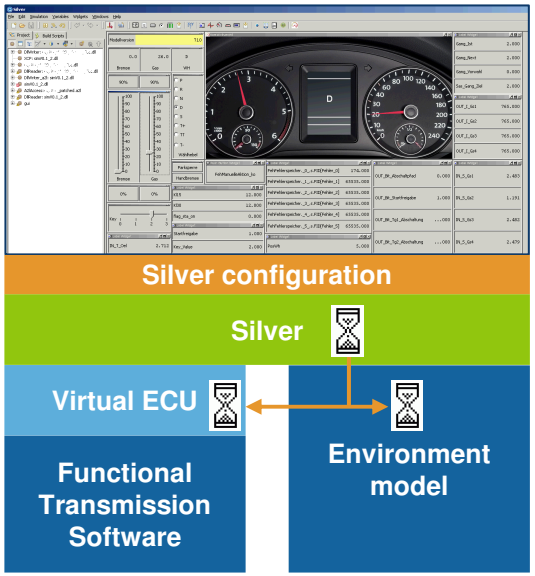
Virtual ECUs for Automotive Software
Debugging

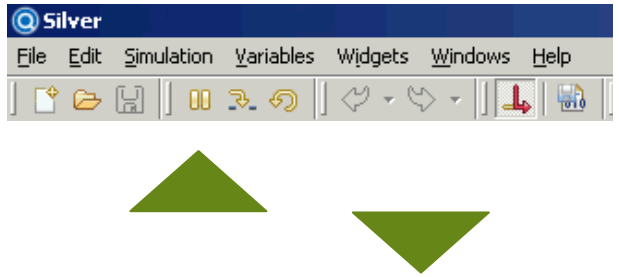
- **Characteristics**
  - SiL setup (as described before) with current developer software
  - Stops whole simulation (incl. environment model)
  - Configuration is easily adaptable

- **Debugging focus**
  - Situations that are difficult to produce
  - Timing errors
  - Re-simulation of vehicle measurements
  - Fault simulation
  - „Living code“

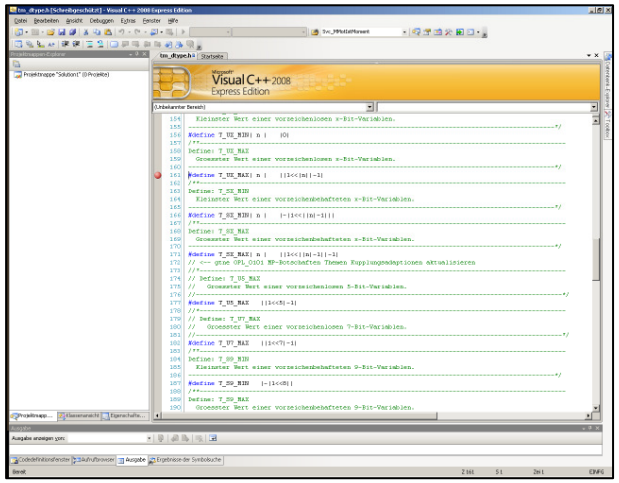


Virtual ECUs for Automotive Software
Debugging

- **Silver Signal debugging**
  - Stop Silver simulation at arbitrary time
  - Analyse signals (with history even new added)



- **Code debugging**
  - Open QTronic Silver with correct experiment
  - Open Microsoft Visual Studio
    - Open C file
    - Set break point(-s)
    - Attach to Silver process
  - Start Simulation
  - Debug



Virtual ECUs for Automotive Software
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- **Experience**
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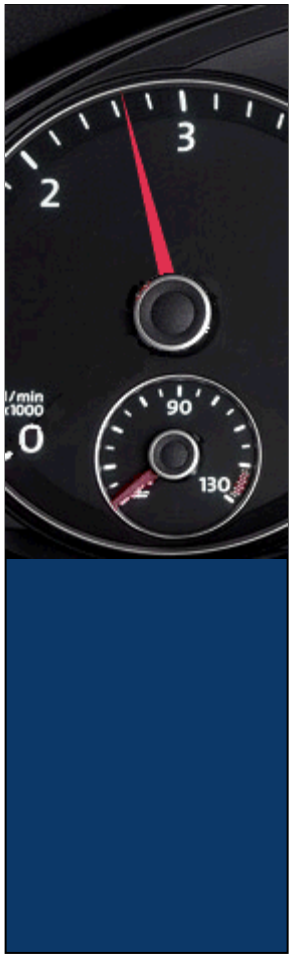
Virtual ECUs for Automotive Software
Experience: Build up and maintenance

- IAV had already experience with Silver usage
- First build up of SiL Setup
  - Work of IAV (with help from QTronic)
  - Effort: 6 MM
- Maintaining/ updating effort
  - Keep running since 1 year
  - Tasks
    - Adapting to function software changes (frequently)
    - Model updating (less frequently)
    - Change to new Silver API 2.4:
      - Better access to model data
      - Use build in CAN
    - Process improvements
  - Effort: ca. ½ developer

Virtual ECUs for Automotive Software
Experience

- Added value from debugging
  - New quality of debugging
    - Step through code
    - Full access to all variables
    - Full history of signals in Silver
  - Analysis times reduced
  - Faster change-analysis-change cycles
- User acceptance
  - Growing acceptance
  - Advantages are fully accepted
  - High availability requested



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Virtual ECUs for Automotive Software
Conclusion

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- Silver enables build up of automotive SiL simulations easily
- Debugging at SiL level is successful
- SiL will be established soon
- Additional use cases planed for SiL simulation

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Thank you!

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