

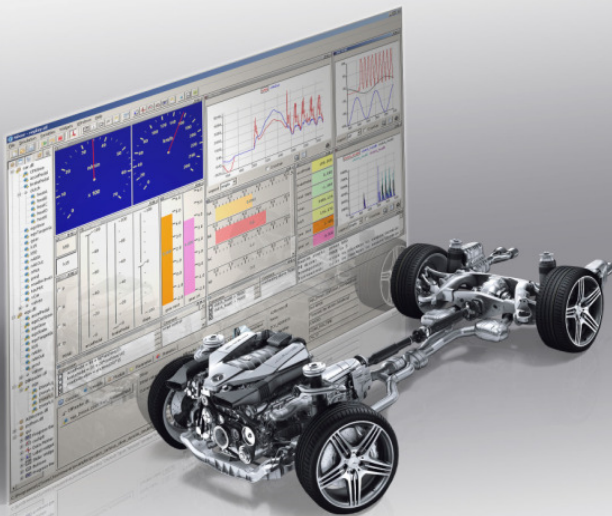
# Virtual ECUs for Developing Automotive Transmission Software

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Dr. Thomas Liebezeit, Jakob Bräuer, Roland Serway (IAV)

Dr. Andreas Junghanns (QTronic)

Innovative Fahrzeug-Getriebe und Hybrid & Elektro-Antriebe, Dezember 2011



# Virtual ECUs for Automotive Software

## Agenda

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- **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**

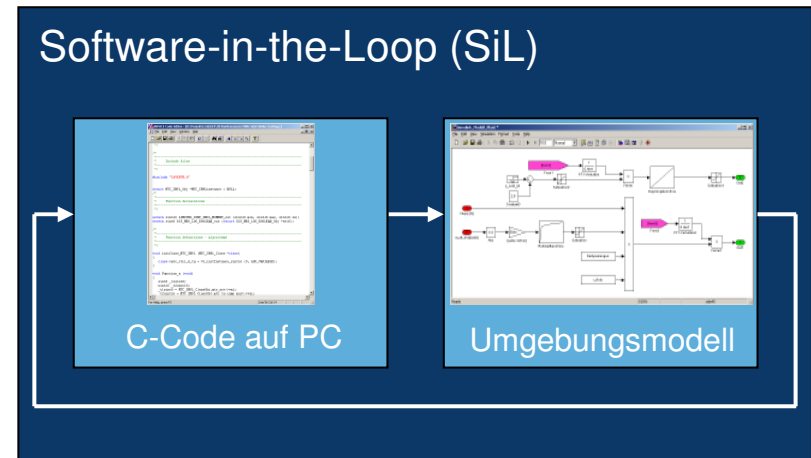
- Debugging of series transmission function software



# Virtual ECUs for Automotive Software

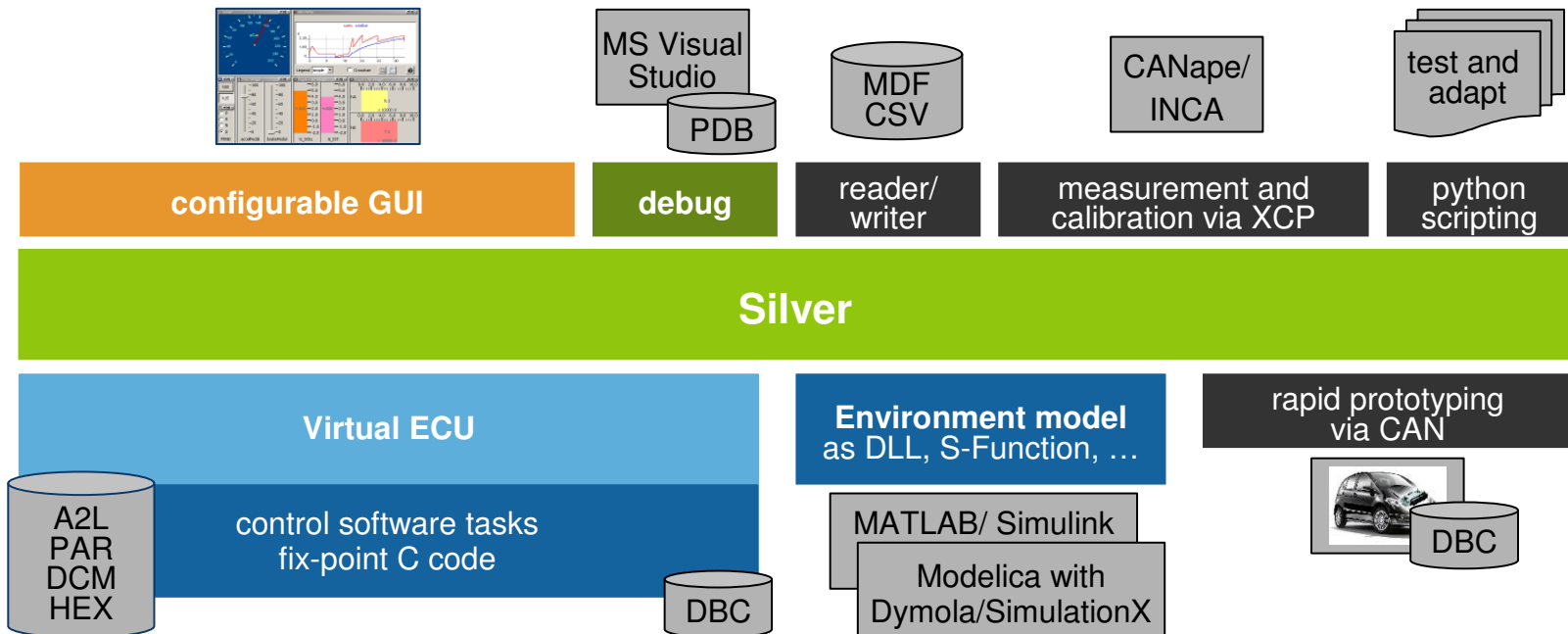
## IAV's boundary conditions

- 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



# Virtual ECUs for Automotive Software

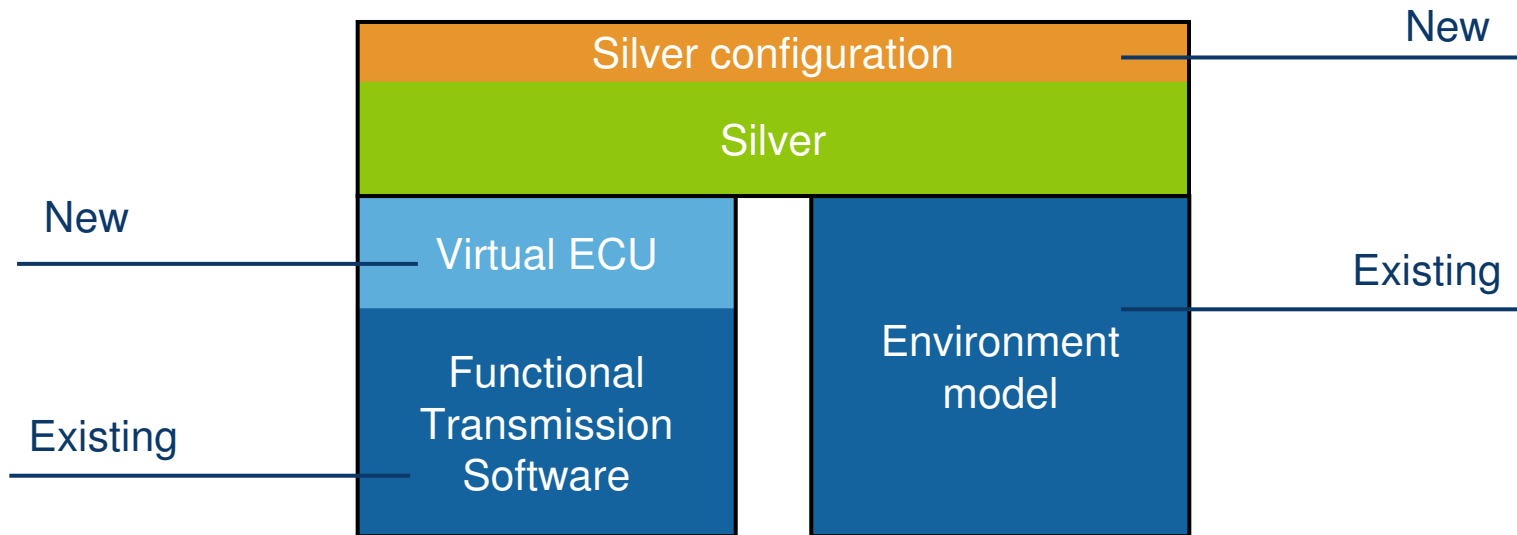
## Agenda

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

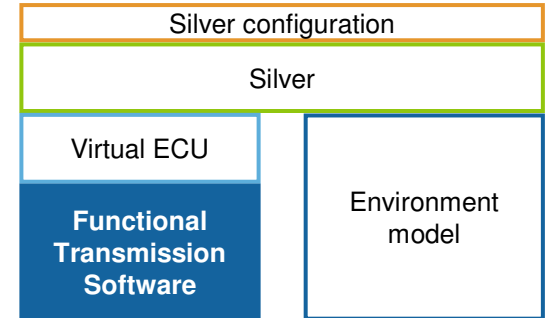


# Virtual ECUs for Automotive Software

## SiL Setup: Transmission Software

- **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

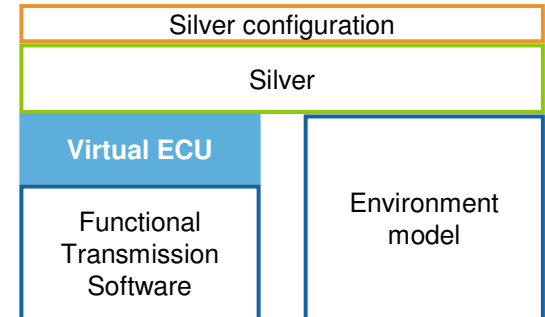
- Task slices

- BIOS functionality

- Non-volatile memory

- SiL task

- Write C-Code using Silver Basis Software (SBS)
    - New: Virtual CAN

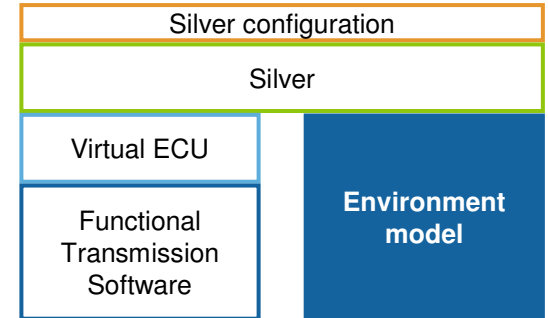


# Virtual ECUs for Automotive Software

## SiL Setup: Environment Model

- **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

## Agenda

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- Motivation
- SiL setup
- **Debugging**
- Experience
- Conclusion

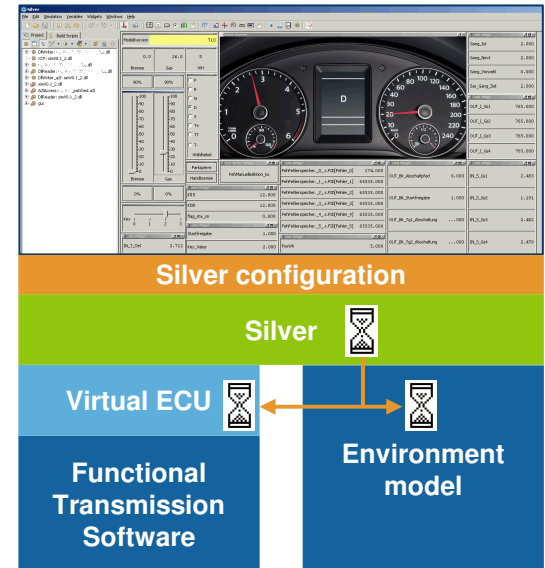
# Virtual ECUs for Automotive Software Debugging

## • Characteristics

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

## • Debugging focus

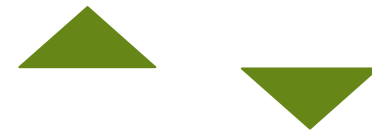
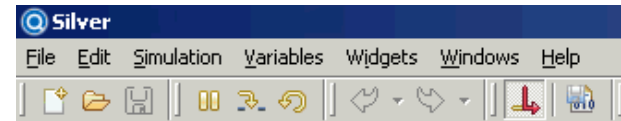
- Situations that are difficult to produce
- Timing errors
- Re-simulation of vehicle measurements
- Fault simulation
- „Living code“



# Virtual ECUs for Automotive Software Debugging

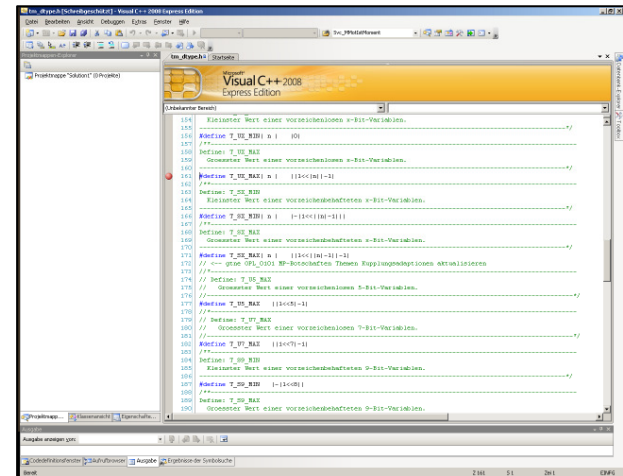
- **Silver Signal debugging**

- 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

## Agenda

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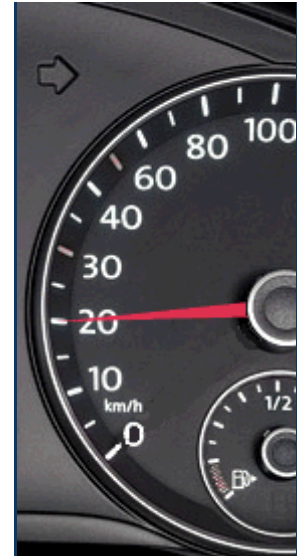
- Motivation
- SiL setup
- Debugging
- **Experience**
- Conclusion

# Virtual ECUs for Automotive Software

## Experience: Build up and maintenance

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- 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. 1/2 developer

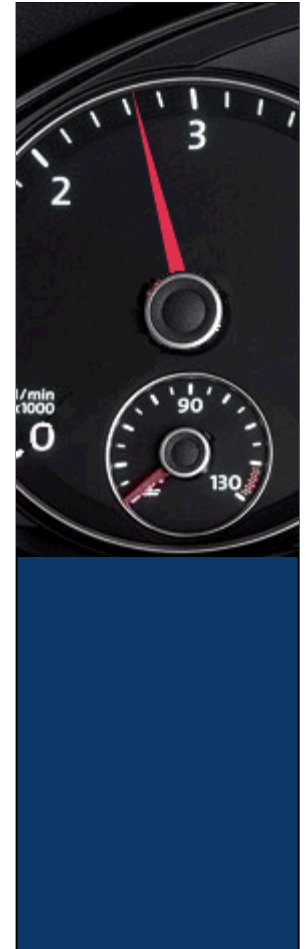




# Virtual ECUs for Automotive Software Experience

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- 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



# Virtual ECUs for Automotive Software

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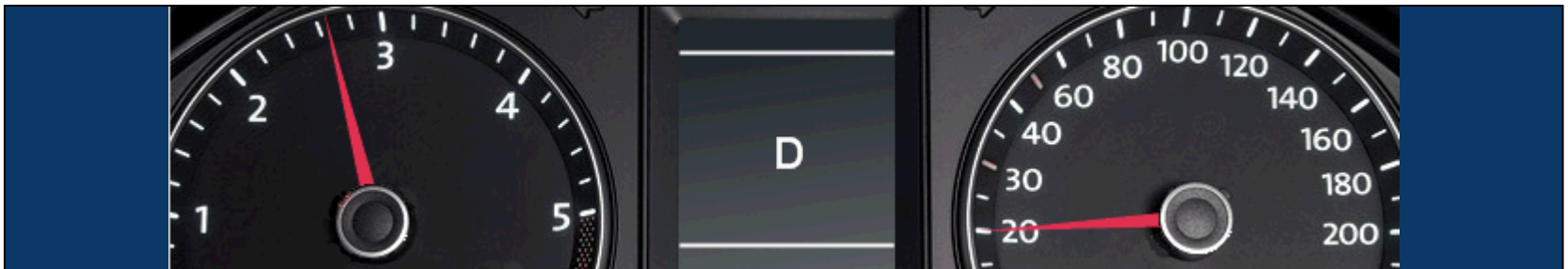
- Motivation
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- **Conclusion**

# 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



# Thank you!

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**Dr. Thomas Liebezeit**

IAV GmbH  
Ingenieurgesellschaft Auto und Verkehr

Carnotstraße 1, 10587 Berlin  
Telefon: +49 30 39978-9021

[thomas.liebezeit@iav.de](mailto:thomas.liebezeit@iav.de)