

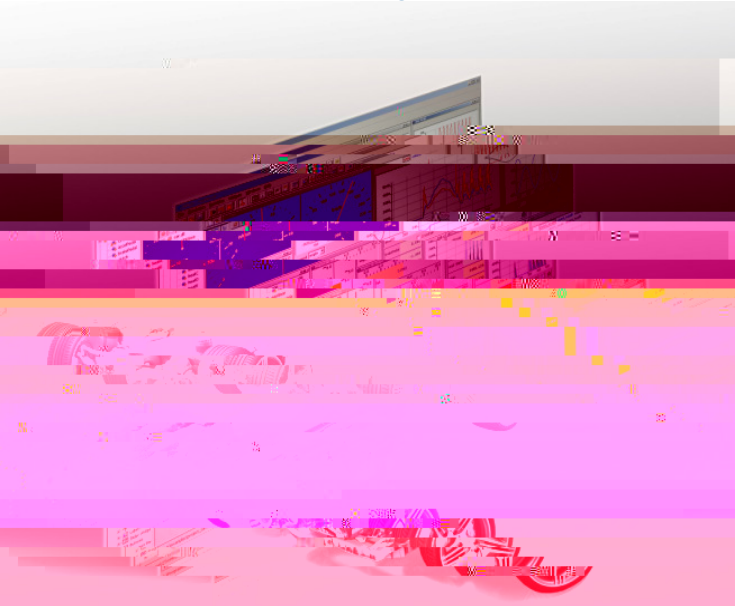
# Virtual ECUs for Developing

---

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

## 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

# Virtual ECUs for Automotive Software

## Silver



- Silver from QTronic GmbH
  - Software-in-the-Loop (SiL) simulation environment
  - Relevant automotive standard formats supported
  - Debugging via Microsoft Visual Studio
  - Already experience with Silver



# Virtual ECUs for Automotive Software

## Agenda

---



- Motivation
- **SiL setup**
- Debugging
- EwJ J(g)-0.4241092(a)-1. • g



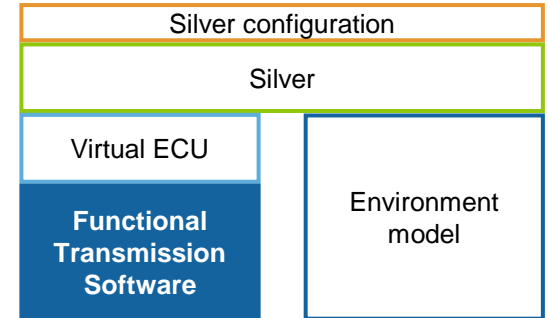
# Virtual ECUs for Automotive Software

## 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

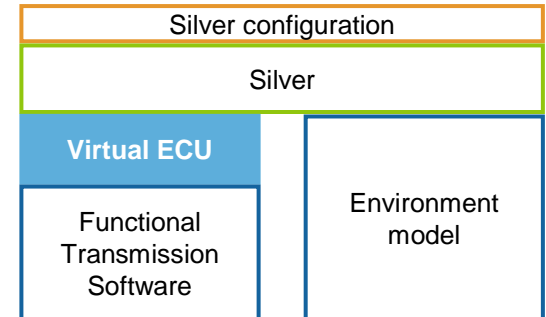
- BIOS functionality

- Non-volatile memory

- SiL task

- Write C-Code using Silver Basis Software (SBS)

- New: Virtual CAN



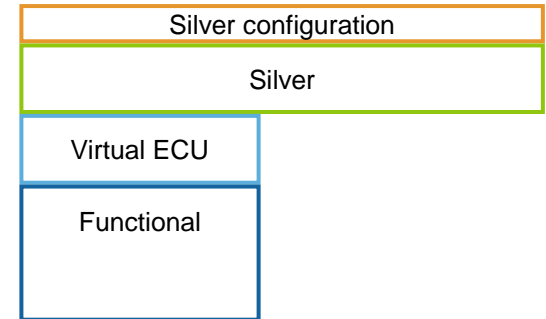
# Virtual ECUs for Automotive Software

## 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



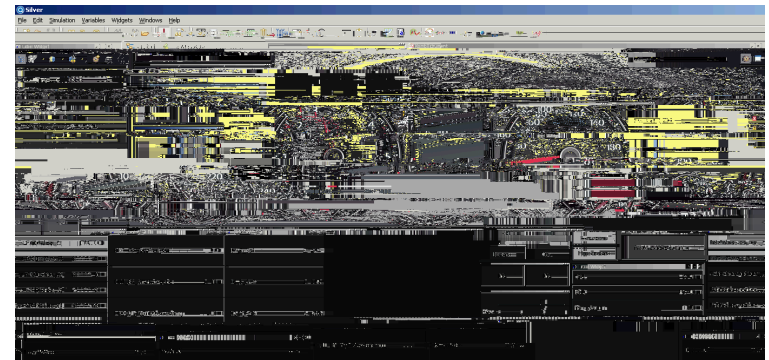
# Virtual ECUs for Automotive Software

## 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
- Conclusion

# Virtual ECUs for Automotive Software Debugging

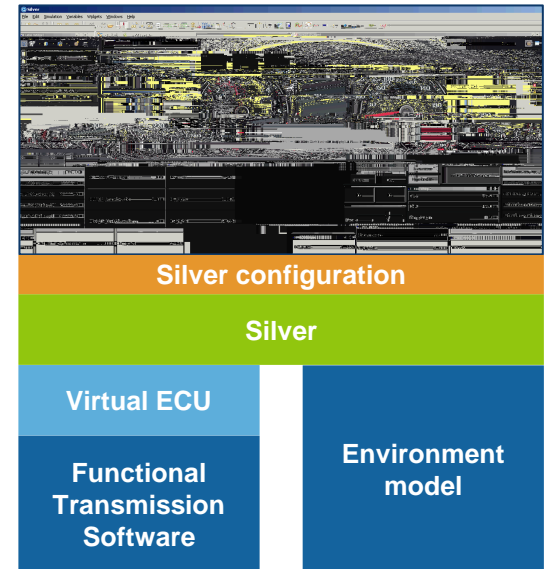


- **Characteristics**

- 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“

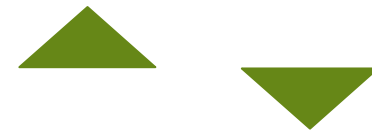


# Virtual ECUs for Automotive Software Debugging



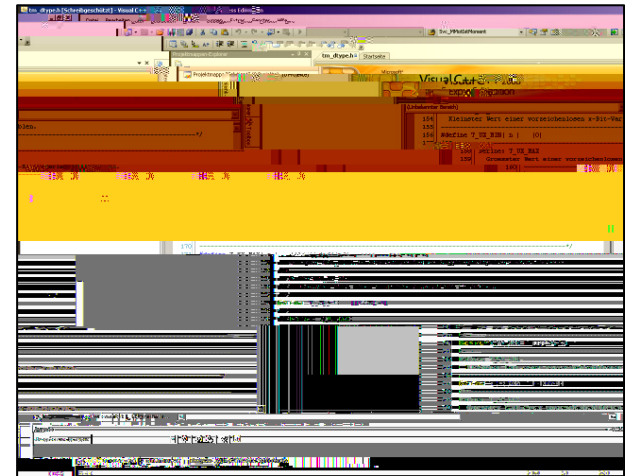
- **Silver Signal debugging**

- 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

## Experience: Build up and maintenance

---



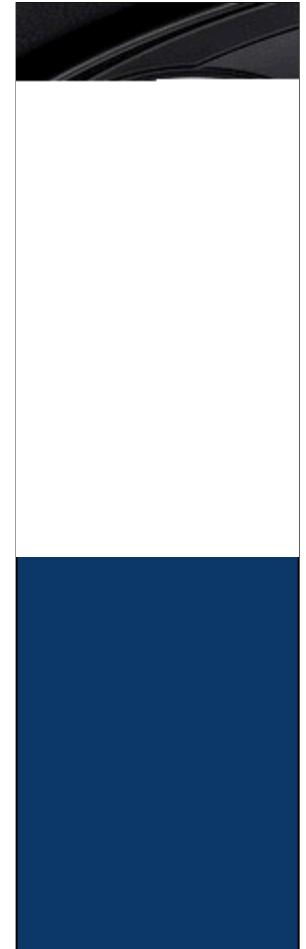


# Virtual ECUs for Automotive Software Experience

---

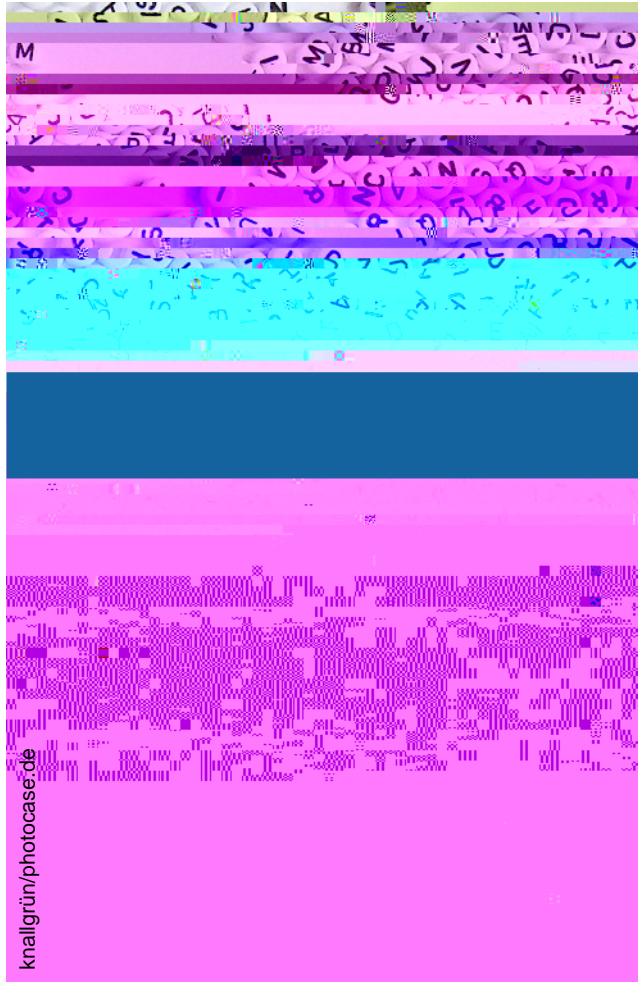


- Added value from debugging
  - New quality of debugging
    - Step through code
    - Full access to all variables
    - Full history of signals in Silver
  - Analysis times reduced
  - Faster change-analysis-change cycles
- User acceptance
  - Growing acceptance
  - Advantages are fully accepted
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



# Virtual ECUs for Automotive Software

## Agenda



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

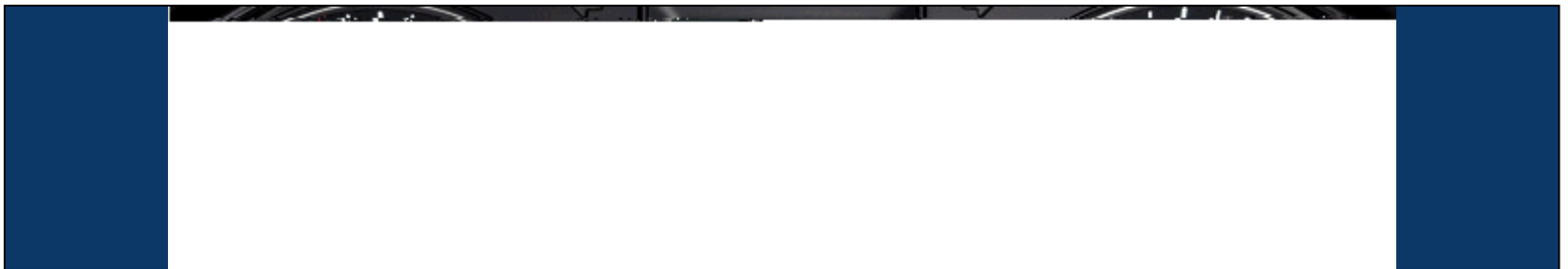
# Virtual ECUs for Automotive Software

## Conclusion

---



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



# Thank you!

---

**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)