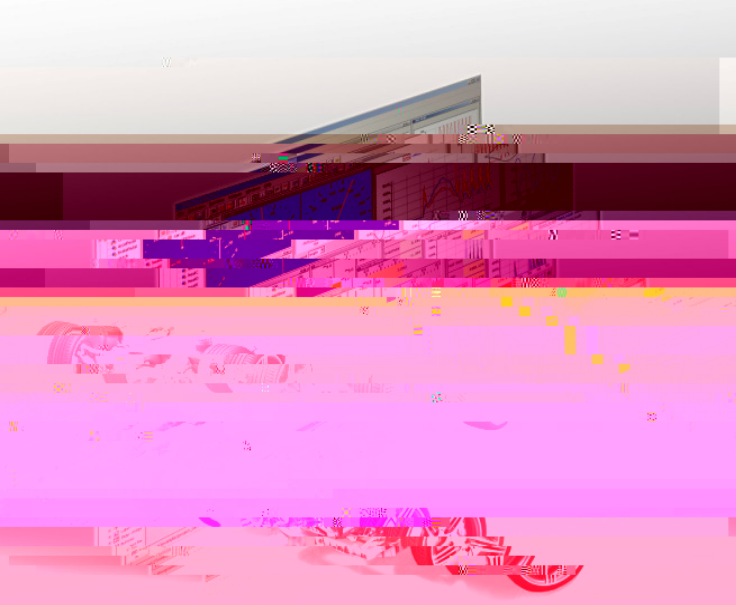


Virtual ECUs for Developing

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

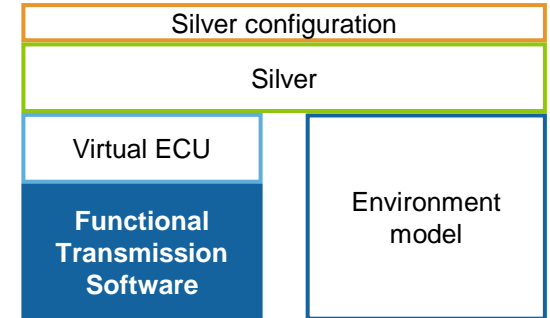
Virtual ECUs for Automotive Software

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

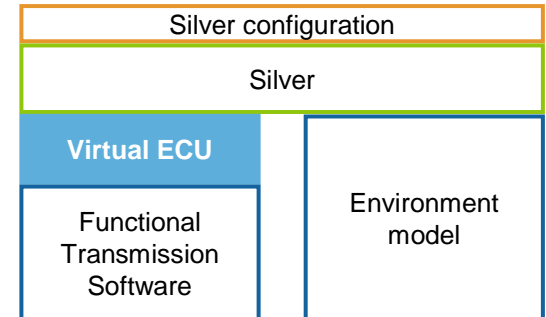
- BIOS functionality

- Non-volatile memory

- SiL task

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

- New: Virtual CAN



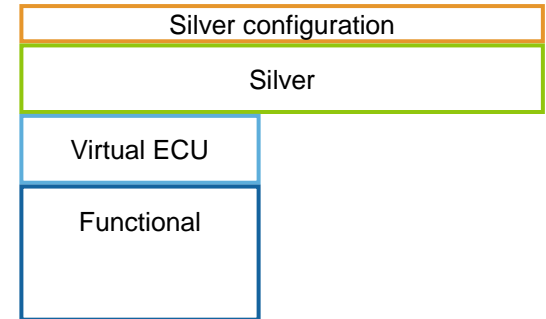
Virtual ECUs for Automotive Software

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



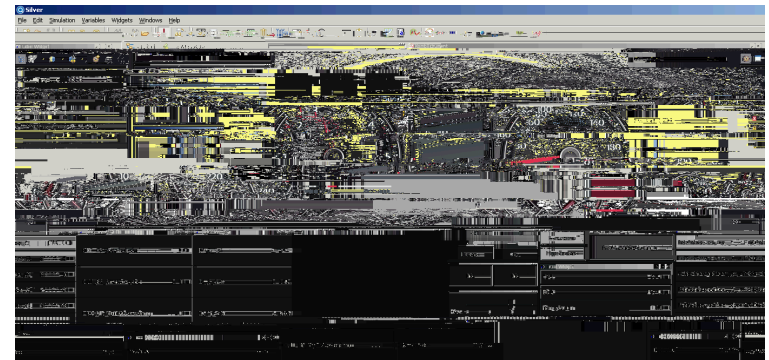
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SiL Setup: Silver Configuration



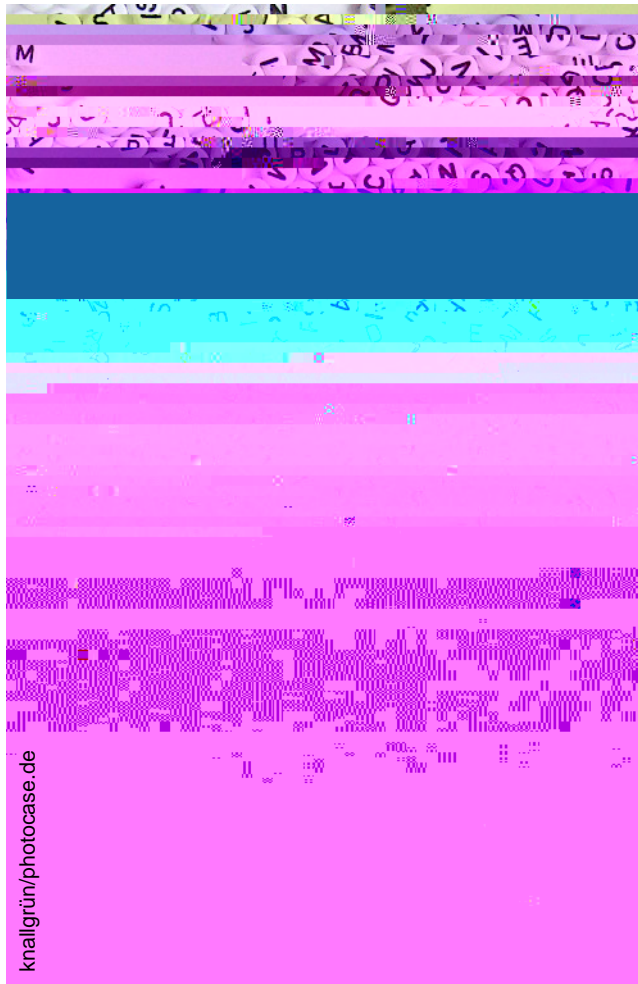
- **Silver configuration**

- 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

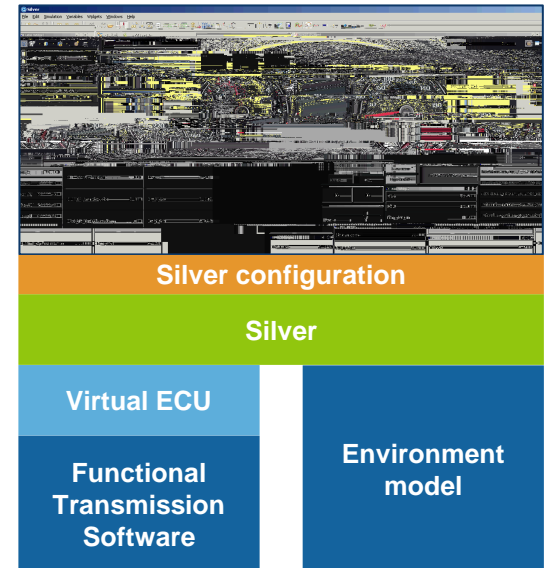


- **Characteristics**

- 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“

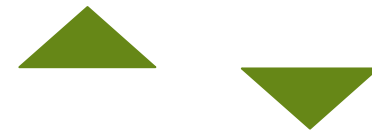


Virtual ECUs for Automotive Software Debugging



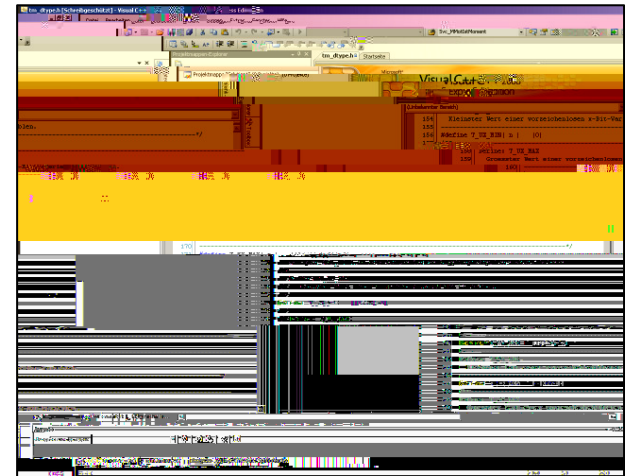
- **Silver Signal debugging**

- 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

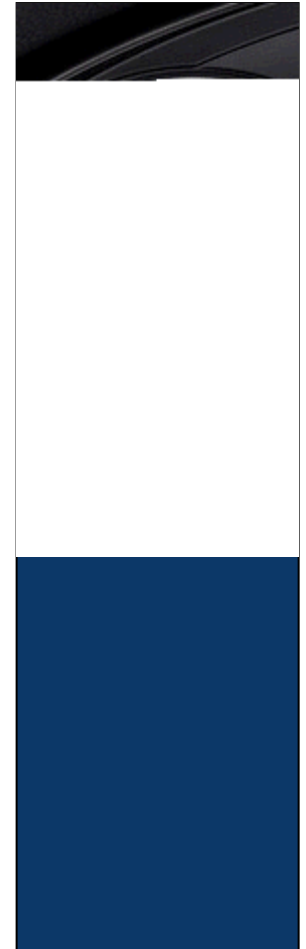
Experience: Build up and maintenance



Virtual ECUs for Automotive Software Experience

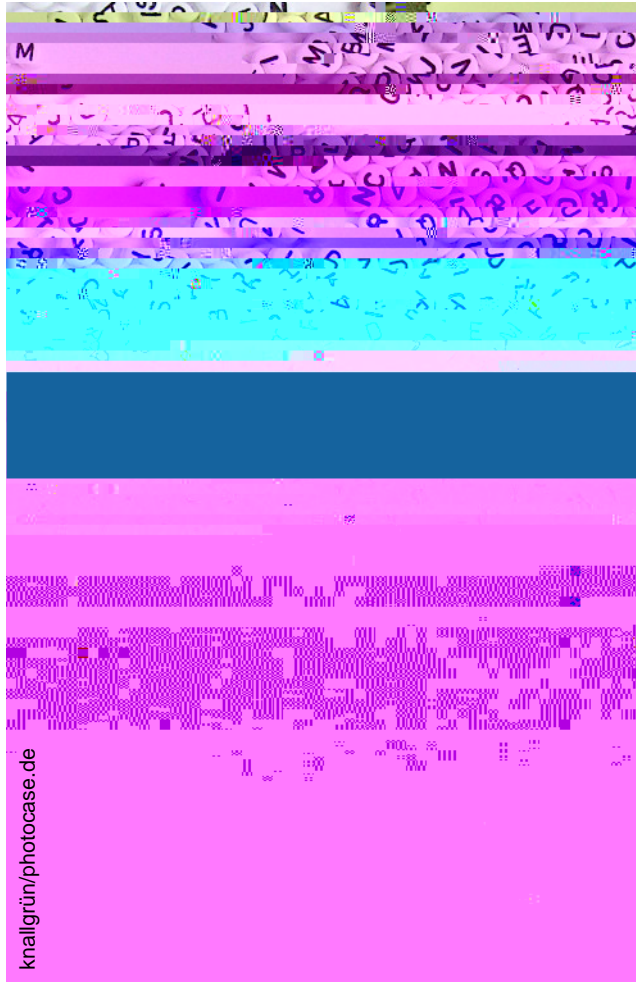


- Added value from debugging
 - New quality of debugging
 - Step through code
 - Full access to all variables
 - Full history of signals in Silver
 - Analysis times reduced
 - Faster change-analysis-change cycles
- User acceptance
 - Growing acceptance
 - Advantages are fully accepted
 - High availability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



Virtual ECUs for Automotive Software

Agenda



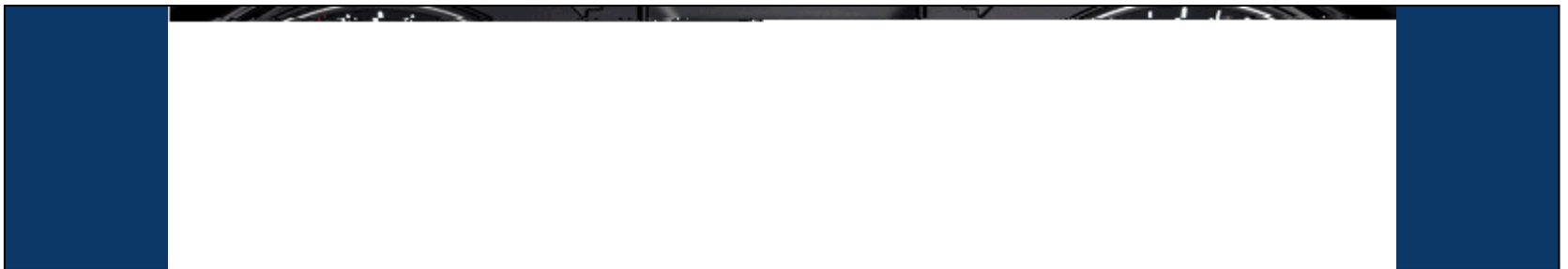
- Motivation
- SiL setup
- Debugging
- Experience
- **Conclusion**

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 planed 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