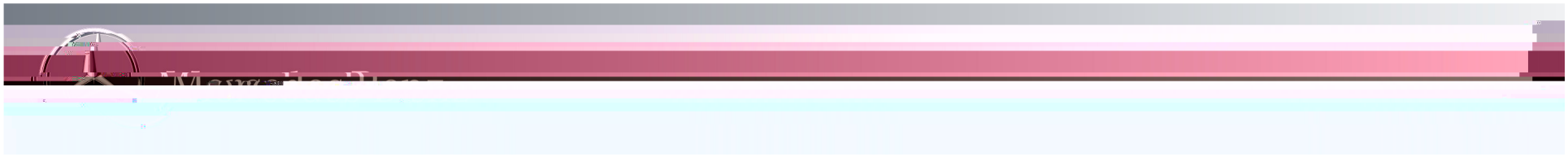


Software in the loop simulation at Daimler

Application area

- Testing and deployment of functional code
- Version update safequarding of functional code
- „Desktop“-application / -calibration
- Fault simulation
- Virtual endurance testing
  - ➔ safequarding of drivetrain components
  - ➔ calculation of load collectives for gearbox and drivetrain

Requirements

- Powerful, stable and fast simulation environment
- Easy to use by any engineer

Tool chain

SIL-tool

- Backbone (in house development)
- Silver (QTronic GmbH)

Plant model

- MSL 2.2 in Dymola 6.2 (Dassault Systèmes)
- In the future MSL > 3.1 with Dymola from v. 7.4 or SimulationX from v. 3.4 (ITI GmbH)

Test generator

- TestWeaver (QTronic GmbH)

Software integration platform

- Microsoft Visual Studio 2005 or 2008

SIL-environment / functionality

- The simulation is controlled by a special program (e.g. Silver) which guards the single modules
- Every module (called „Client“) sends its Outputs to Backbone und reads its Inputs from him, i.e. no direct communication between the modules occurs (except for the CANape-coupling with the control software)
- The communication step time is fixed and represents the lowest task time step of the functional code (5, 10 or 20 ms)
- The plant model is wrapped with a nummerical solver which calculates with smaller time steps
- Backbone waits after each communication step until all clients are finished so that the next step

Plant model

Description

Plant model: Modelica Libraries

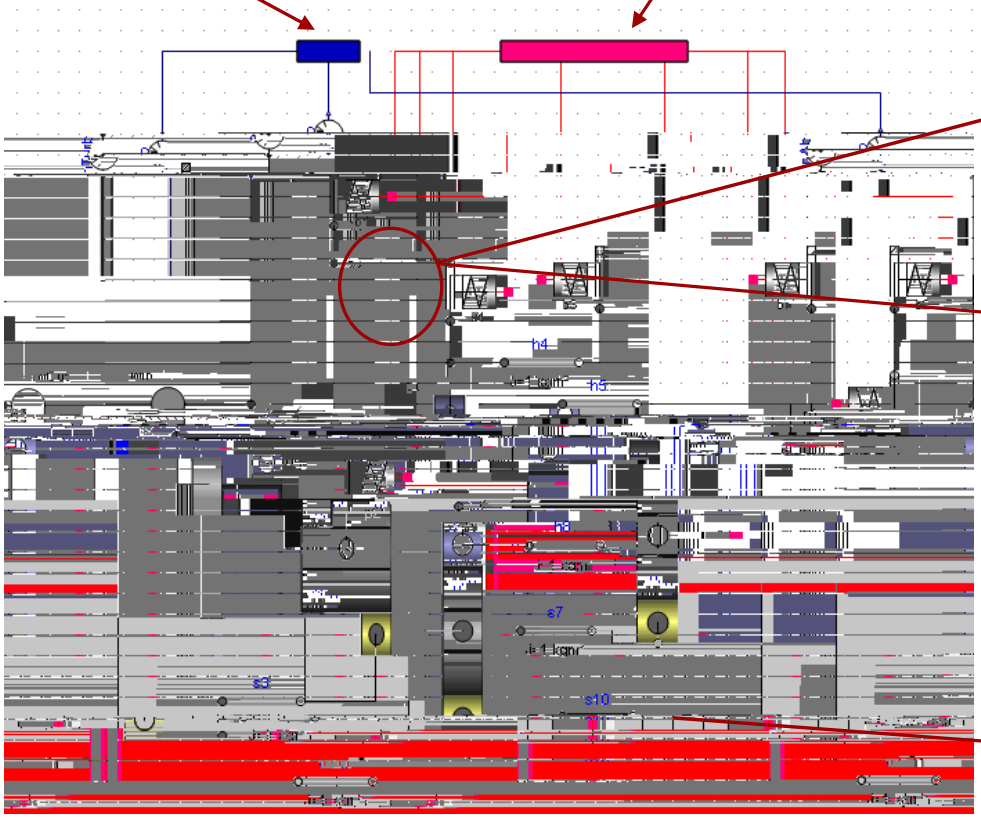
For the creation of the plant model, own devised

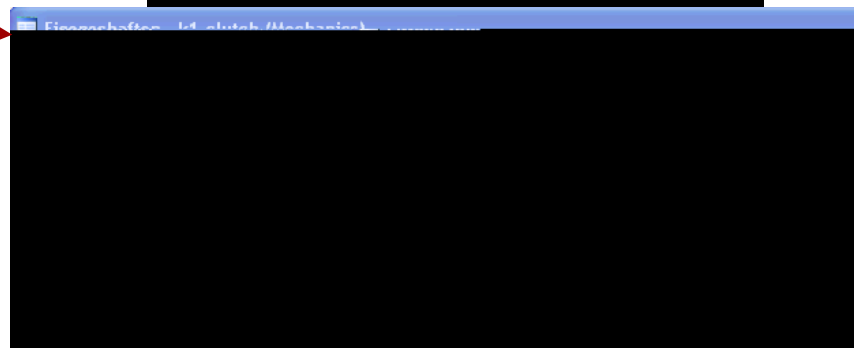
Plant model: mechanics

Hydraulic interface (from the hydraulic control unit)

Sensor interface
(rot. speeds)

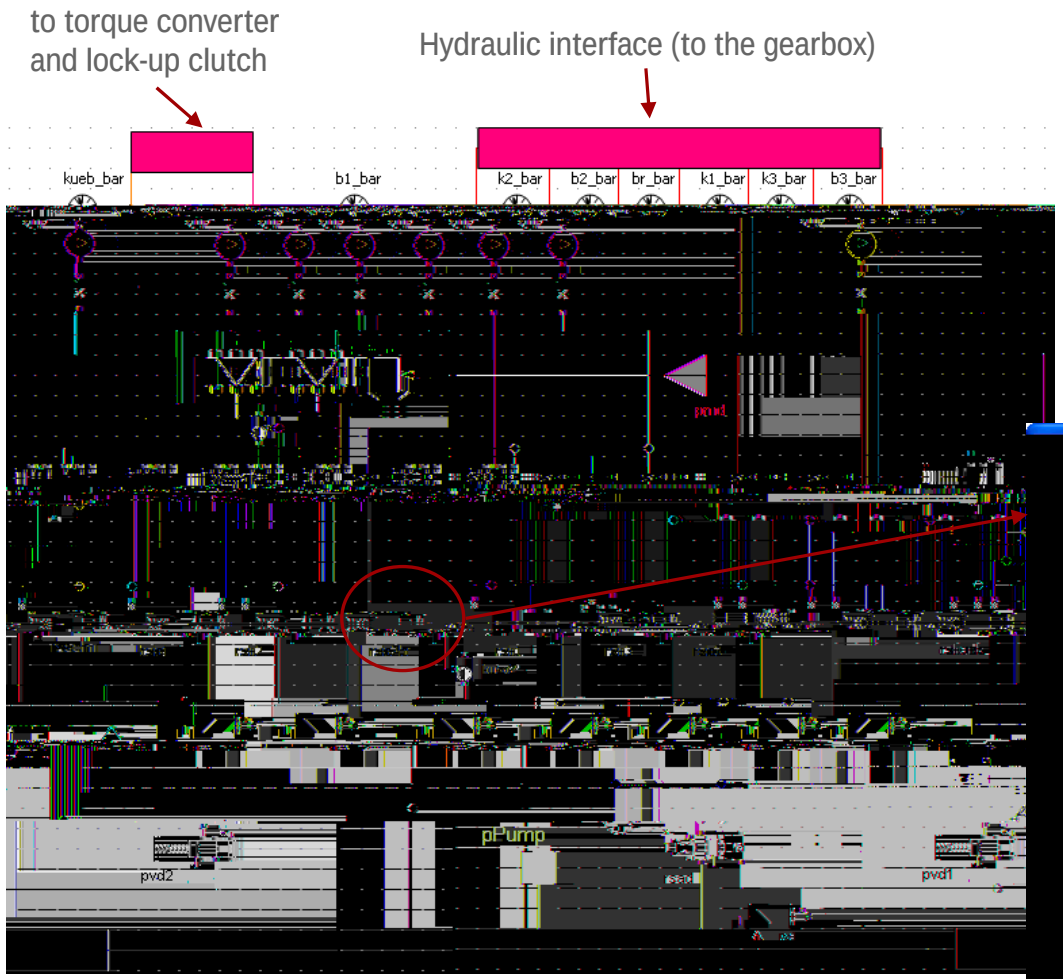
parameter masks of a clutch model





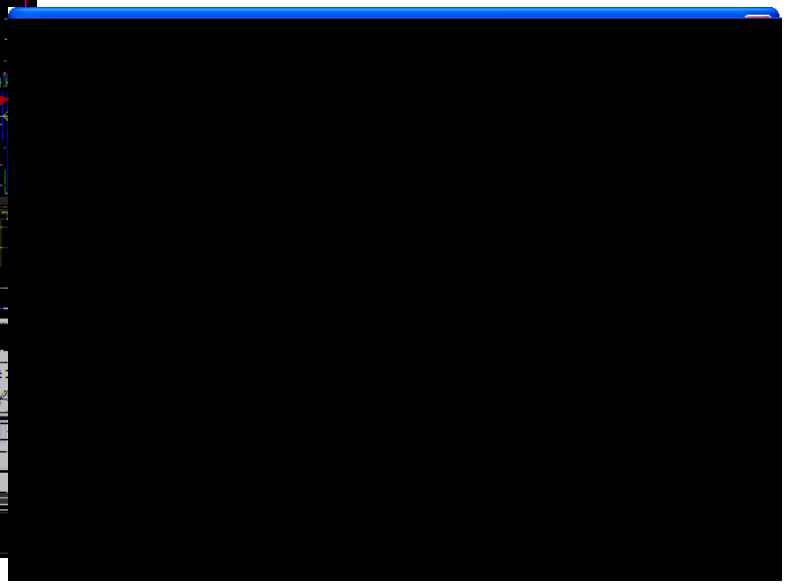
All independent inertias of the gearbox are explicitly modeled

Plant model: hydraulics (control unit)



The electro-hydraulic control model has been modeled phenomenologically (control logic, no dynamics) for the sake of simulation performance. However, many components such as orifices, shifting valves, fluid volumes etc. have a physical model description in order to accurately describe important effects in the simulation (filling, draining, pressure switch, stucking valves etc.)

Parameter mask of a control valve



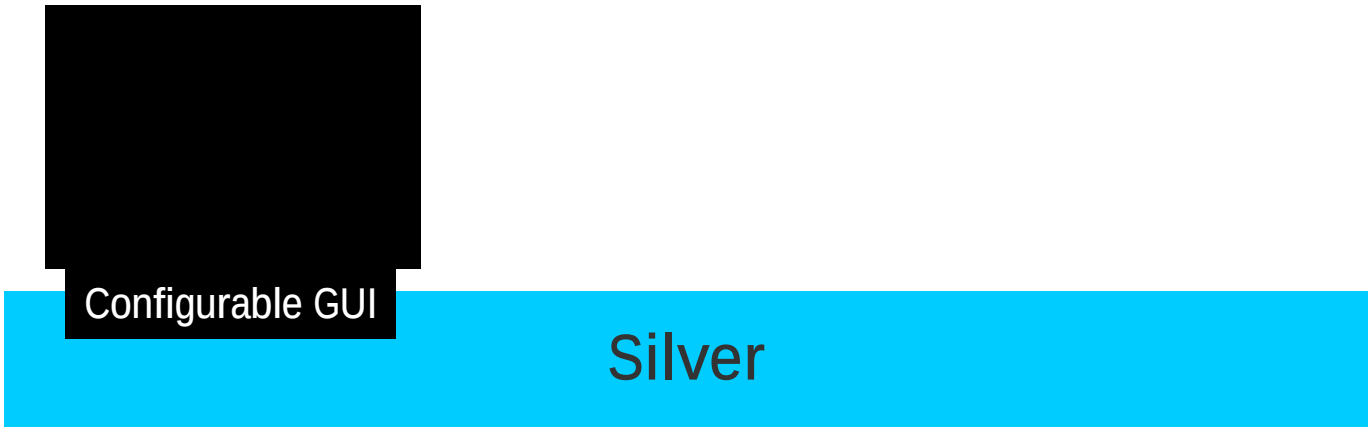
Integration of a SIL-Project

SiL environment

- Simulation: Silver (QTronic)
- Measurement: CANape (Vector)
- Debugging: Visual Studio (Microsoft)
- Automated Test: TestWeaver (QTronic)
- Code Coverage: CTC++ (Verifysoft)

graphical user-interface:

- interaction of driver / user with simulated car
- accel pedal, steering, etc. can be controlled
- plotter, breakpoints, scripting, file in / out, ...



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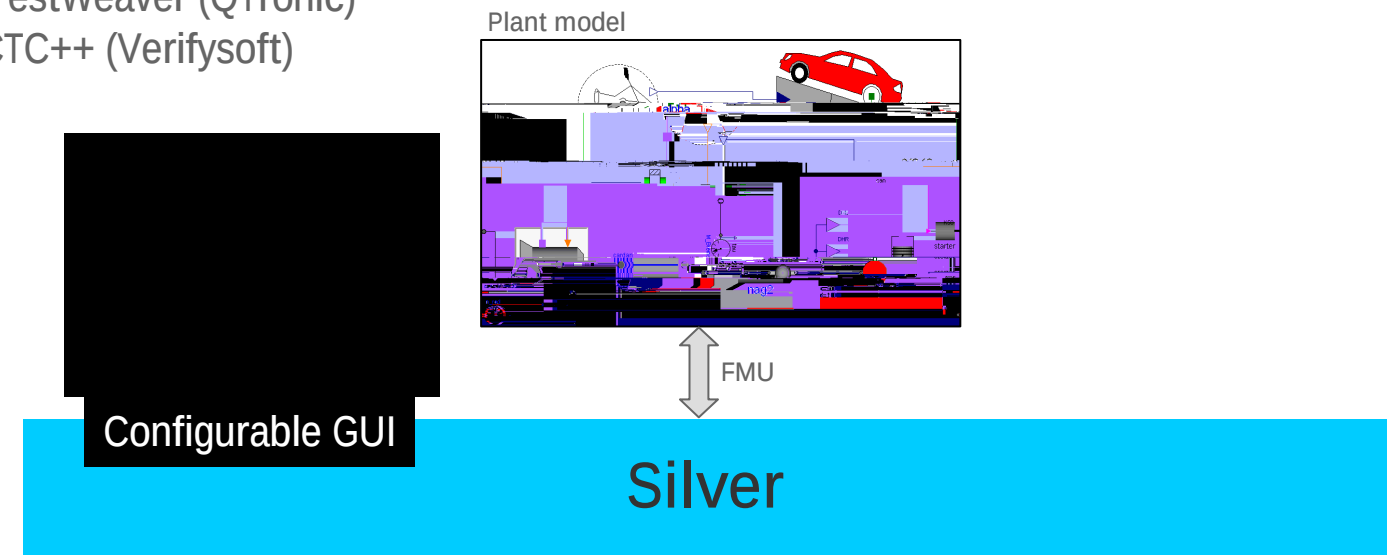
hardware DLL:

- simulated vehicle, engine and transmisssion
- Dymola / SimulationX



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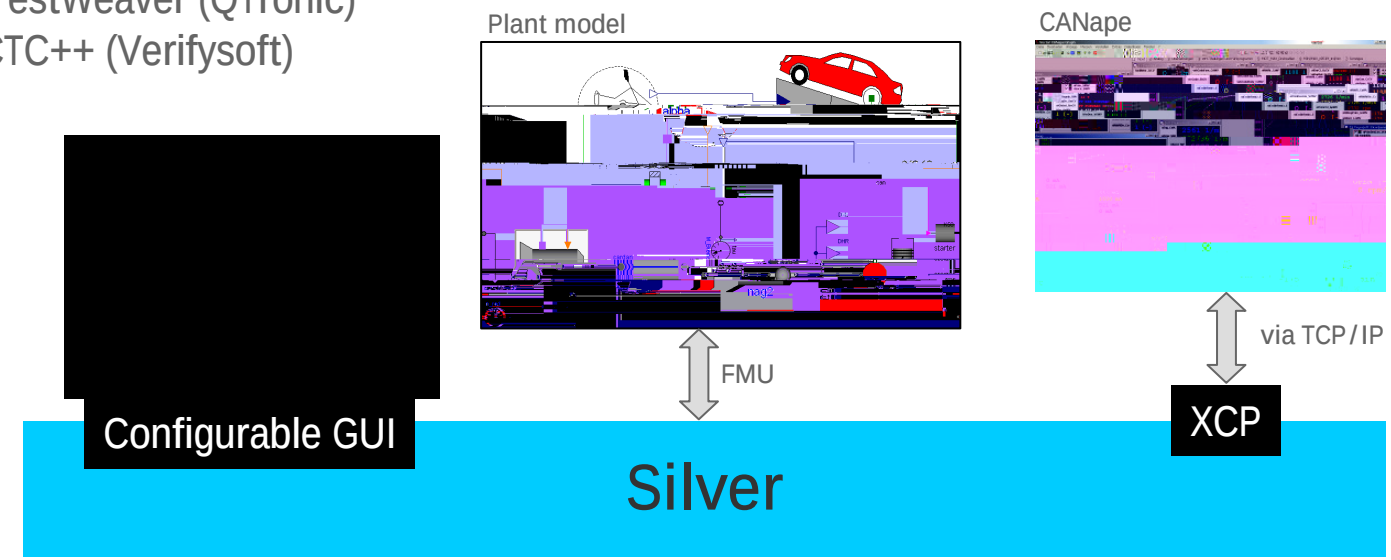
XCP with Canape / INCA:

- XCP measurements via TCP / IP
- no limitation of bandwith as with CAN
- online calibration of parameters



Summary

- SIL is an essential tool in the gearbox development at Daimler
- For the creation of the SIL plant model, Dymola (MSL 2.x) has been used
- Upgrade of the model to MSL 3.1 enables full compatibility to SimulationX v. 3.4
- For the plant model export to SIL the new Modelisar-FMI can be applied
- SIL integration of the functional code (TCU) is done by wrapping the original code with the Silver-API and emulating the frame software
- Silver offers the possibility to measure and calibrate TCU-internal signals either directly in the Silver GUI xVj3w p/qy3(„BxwEd(jyBVq33pjyFFj„„Fw p/qy3(„Bxwop/VBl coyVV(BwipjyBVVyV‘