MANEUVER BASED VALIDATION OF BMW xDRIVE VARIANTS BY USING VIRTUAL VEHICLE INTEGRATION AND HIL TEST METHODS.

IPG TECHNOLOGY CONFERENCE, SEPTEMBER 18 -19, KARLSRUHE.
AGENDA.

• Basics xDrive.
• Testsystem.
• Integration engine-model.
• Maneuver based tests.
• Testautomation.
• Benefits and Outlook.
BASICS xDRIVE.
ACTIVE 4X4-SYSTEM.

DSC (Master):
Computation target torque with respect to the driving sit.
Send-out target torque on communication bus.

LMV (Actuator):
Receive target torque and actuate clutch.
Securing torque accuracy over temperature and lifetime.

Requirements xDrive:
– Maximum traction.
– BMW-typical driving characteristics.
– Reduced fuel consumption deficite.

All advantages of a 4x4 car without the typical disadvantages.
BASICS xDRIVE.
4X4 FUNCTIONS IN LMV-ECU.

Signal conditioning
Computation of internal variables

Abraison-model
(oil, coating)

Guardmodel
(thermal impact)

Torque controller

Degradation and fail-safe logics

Bussignals:
Target torque, Wheel speeds, ...

Bussignals:
Actual torque, ...

Diagnostics

Sensors, Terminals
(Current, $U_{\text{bat}}$, GND)

Control:
current + mechanics

MANEUVER BASED VALIDATION, 19.09.2012
BASICS xDRIVE.
LATEST MODELS WITH xDRIVE.

09/2009
7-Series

09/2009
X1

06/2010
5-Series GT

09/2010
5-Series

09/2011
6-Series

07/2012
3-Series

11/2012
1-Series
TESTSYSTEM.
INTEGRATED TOOLS AND MODELS.

CarMaker

TestManager

Engine-model

XCP on FlexRay

FlexConfig

Diagnostic

INCA

Flash Tool
TESTSYSTEM.
COMBINATION OF ECUS AND MODELS.

Gateway for signal-manipulation on flexray.
Residual-bus-simulation to provide all necessary bus signals.
Behaviour model (LMV/DSC): simplified model if one of the ECUs is not connected to the bus.
Compiled Simulink-model for CarMaker:

Soft-ECU

Layer: Communication via physical signals.

Physical environment-model of the engine.

INTEGRATION ENGINE-MODEL.
BMW ENGINE-MODEL.

MANEUVER BASED VALIDATION, 19.09.2012
INTEGRATION ENGINE-MODEL.
GENERATION ECU-MODEL.

C-Code  Matlab/ Simulink  ...

Code-Generator

*.c  Generated C-Code

GCC-Compiler

Sources for ECU

Compiler for ECU

Soft-ECU: simulation-model for Simulink
(based on Simulink S-functions and CarMaker specific libraries)
MANEUVER BASED TESTS. CATALOG.

Typical maneuvers:
- Different levels of grip.
- Understeering.
- High axle load.
MANEUVER BASED TESTS.
DEVELOPING A MANEUVER.

**Global settings:**
Setting global start values.
Script-Control call for interaction with 3rd party tools.
Global maneuver commands.

**Maneuver step settings:**
Teststeps (mini-maneuver).
Realtime expressions (state observer, end condition, operation functions).
MANEUVER BASED TESTS.
DEVELOPING A TRACK.

Creating a track step by step.
Import track data.
Import GPS data.
MANEUVER BASED TESTS.
TEST-EXECUTION.

IPGMovie: Starting on a hill with different levels of grip.
MANEUVER BASED TESTS. ANALYSIS.

Instruments

IPGControl

IPGMovie
Realtime-expression for signal evaluation criteria’s.

TestLog function to collect and display results (passed / failed).

TestManager can be remote controlled and modified from ScriptControl or TCP/IP socket.
BENEFITS.

• Frontloading.
• Functional and system-tests.
• Regression tests for new software.
• Testautomation.
• Fewer resources needed (cars, test-track).
• Documentation of test results.

OUTLOOK.

• Prepare test-system for the next generation of the xDrive-systems.
• Integration of the ECU model as AUTOSAR-component.
• Integration of DSC functions in CarMaker (no more ECU hardware is needed).
THANK YOU FOR YOUR ATTENTION. QUESTIONS?