Model Based Homologation Process
with SIMPACK – Server based calculation

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Research
Driving Dynamics & Simulation Processes (ERVD)

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Agenda

- Special demands on commercial vehicle development
- The MAN Simulation Framework
  Centralized platform solution – MAN SimNavigator
  Introducing server based calculation execution
- Homologation: SimuLENK 4.00 - automated simulation of chassis variants
  User interface / architecture
  Calculation model (multibody simulation – SIMPACK)
  Server based calculation for SIMPACK
  Extraction and review of results
- Summary and perspective
Motivation

Special demands on commercial vehicle development
Diversity of commercial vehicle variants
Suspension systems and chassis

- Heavy, medium-heavy, light, offroad trucks and special-purpose vehicles
- City-buses, interurban-buses and coaches
- Up to 5 axles having different axle-formulas (driven/undriven configuration) and wheelbases
- Up to 3 steered axles (mechanical, hydraulic, electrical)
- Leaf-, air- and coildsprings
- Huge spread of unloaded and loaded vehicle weight (tractor/trailer: more than 30 tons)
- Huge variety of body-configurations (tractor/trailer, box, platform, tipper, swap body, silo, mixer, fire service, heavy duty, municipal utilisation, etc.)
Consequences for Development
Simulation of variants

Significant differences between commercial vehicle and passenger car

- Broad model diversity (currently about 175 basic models offered)
- Typically configurable by flexible model kit
  (currently almost 140.000 chassis-variants available)

„Special-purpose-engineering on wheels“

- All vehicles with series approval
- Exception: Special customer modifications

Virtual securing of variants before and after SOP

- Proof of function
- Design approval (homologation)
- Proof of vehicle performance requirements (e. g. fire service)
- Confirmation of fuel consumption and emission values
- Miscellaneous customer needs
Thousands of chassis variants require specific design layouts and, ideally each of them, an individual (e.g. virtual) proof of operation, concerning

- **Suspension** ➔ vehicle height, air-spring pressures, headlight-range-adjustment,…
- **Stabilization** ➔ roll stabilization, rollover resistance,…
- **Damping** ➔ driving safety, tyre comfort, roll behaviour,…
- **Loading** ➔ center-of-gravity, axle load distribution,…
- **Drivetrain** ➔ performance, fuel consumption, shifting strategy, climbing capacity,…

- **Axle-kinematics** ➔ self-steering response, vibrational characteristic, roll behaviour,…
- **Steering** ➔ agility, steering error, tyre wear, freedom of motion,…
Solution Approach
MAN Simulation Framework
Centralized simulation platform
Objective: central simulation platform
MAN Simulation Framework

Setting up a central simulation platform (MAN SimNavigator)

- Enable designers to use innovative simulation technologies by executing calculations on their own workstation
- Provide complex simulation methods by encapsulating them into user-friendly applications
- Corporate access to standardized MAN calculation tools and methods
- Modular design, high flexibility and expandability
Objective: central simulation platform
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Especially technical data and simulation models **being widely distributed within the company** are prone to security risks and have to be protected. In the scope of our simulation framework this means:

- Use code-generation functionality for models (e.g. translation into non-accessible binary executables)
- Encrypt technical data and corresponding datasets
- Provide a secure and centralized access to technical data
- Establish a flexible and powerful user rights management

**Due to decentralized execution of calculations,** necessary safety features and calculation environments require especially:

- Additional efforts in model-setup (e.g. avoid use of unsupported features for code-generation)
- Special requirements regarding software development and architecture
- Diverse IT-components having a lot of dependencies
Objective: central simulation platform
MAN Simulation Framework – centralized calculation execution

Objective: Set up an architecture for centralized execution of calculations (e.g. Homologation)

- Avoiding additional effort in model-setup by
  - Using native simulation models
  - Getting around code-generation as common solution
- Gaining flexibility, extensibility and support for a wide spread of simulation platforms (e.g. SIMPACK but in a future release also MATLAB, Dymola, etc.)
- Providing high security standards (especially concerning technical data and models) by
  - Avoiding transfer of models and delicate data to a client workstation

→ **Standard: serverbased calculation execution for standard-user**

→ **Advanced: local calculation execution for expert-user**
Objective: central simulation platform
MAN Simulation Framework - centralized calculation execution

Possibilities for the user
- Outsource long-lasting calculations (e.g. parameter variations)
- Process a bunch of calculations over night ➔ result notification by EMail
- Reduce load on own workstation
- Provide results to third parties (colleagues, other departments,…)
- Provide whole projects within a database as templates for other users
- Use database functions as personal result management ➔ re-use of work already done

Possibilities especially for Homologation
- Evaluate results stored in the result database ➔ extract key data
- Clear and rate published results
- Manage automated workflows
- Investigate results being relevant for model kit analysis

➔ Usecase: Homologation for 2007/46/EG using MAN SimuLENK 4.00 based on SIMPACK

(Calculation of turning circle/track circle/rear overhang sheer for more than 120.000 chassis variants)
Overall picture
The MAN Simulation Framework

User friendly applications
Core: calculation method / - model

MAN SimuLAST
MAN SimuLENK
MAN SimuLEA

... and more.

Accessible using SimNavigator

Calculation Execution Architecture
OpenSource Software and InHouse Development

Calculation Server
Scheduler
Result Database
ResDB

Central Data Supply
MAN InHouse Development + Files

MAN Panda
(parameter)

MAN SimRequestor
(MAN HOST and IWH)

Data Supply

CAE
- models
- methods

IT components

Automation

Simulation Framework

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IT components

Automation

Simulation Framework
Homologation with
MAN SimuLENK 4.00
Overview - software architecture

- Strict separation of model and parametrization
- Database-supported parametrization using a graphical user-interface
- Complete configuration is stored within a project file
- Standardized postprocessing
Homologation 2007/46EG: SimuLENK 4.00

UI-configure MBS-model

- User guidance
- Documentation & error checking
- Visualization of the current configuration
Universal SIMPACK model

- **Main Features**
  - 2 – 5 active axles
  - Max. 4 driven axles (8x8)
  - Max. 3 steered axles
  - Fully parameterized steering trapeze + axle geometry
  - Complete representation steering linkage +
  - EHLA (Electro-Hydraulic Steering System)

- **Maneuvers**
  - Circular course (left/right)
  - Bus stop exit

- **Results**
  - Turning circle/ track circle
  - Swept areas, rear overhang sheer
  - Steering errors, slip angle
  - Dynamic wheelbase
  - …
Homologation 2007/46EG: SimuLENK 4.00
Automated execution

Architecture (fully automated calculation of variants with SIMPACK for Homologation)

- **MAN SimuLENK**
  - Core
  - Project File (.zip Container)

- **Central Data supply**
  - MAN Panda (parameters)
  - ChassisDB (configuration)

- **Automation Component**

- **Serverbased calculation execution**
  - Open project file
  - Calculation (MBS)
  - Archive project file (with results)
  - Logging
  - Notification

- **All generated data is added to the project file**

- **MAN ResDB Analyser**

- **Configuration based on project file**

  - **ResDB**
Homologation 2007/46EG: SimuLENK 4.00
Workflow – Server Based Calculation

Architecture available for various SIMPACK versions and models

- Automation Component
  - SIMPACK 9.7
  - Model B, Version 2
  - Homologation 2007/46EG

- Automation Component
  - SIMPACK 8.9
  - Model A, Version 3
  - Homologation 2007/46EG

SIMPACK Server Pool (Workstations)
- Load Balacing
- Scheduling
- Configuration based execution

- Available Servers
  - Software Versions
  - Handled Models
  - Available Slots
  - Status

- Results
  - Archived Projects

Information about ServerPool

Core

Automation Component

Available Servers

Software Versions

Handled Models

Available Slots

Status

Available Servers

ResDB

Available Servers

DB IFace

App A

App B

Architecture available for various SIMPACK versions and models
Homologation 2007/46EG: SimuLENK 4.00
Workflow – Server Based Calculation – Execution Low Level

Phase 1
Presimulation: Client

InputData generation
Generate Description
JobDescription.xml

Phase 2
Simulation: Client or Server

Model copy
InputData → Model
Calculation
Result reading
Result conversion
Result processing

Database
EMail
...
Rating of results – Homologation information of all chassis variants
Generated by SIMPACK

Software tool: MAN ResDB Analyser
- Loads results out of result database
- Loads threshold, comparative values and warning limits
- Visualization of loaded data
- Rating by categories
- Highlighting of the particular result which is responsible for warn or error rating.

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Summary

Perspective
Summary

- Certification in Progress (TÜV Süd)
- Automated handling of results enables responsible departments to approve technical variants
  ➔ realized for 2007/46EG Homologation
- SIMPACK is used as simulation platform
  - Good integration possibilities in MAN processes
  - Stability / Calculation speed
  ➔ but: fast ASCII export of results is missing
  (like .csv result generation in former CodeExport)

Perspective

- Integration of SIMPACK RT is investigated
  (ABS/ESP Homologation)
- Architecture is capable to be expanded using further simulation techniques or models
- Planned: Simulation of longitudinal dynamics with focus on fuel consumption
Any questions?

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