



How Virtual can Prototyping be?

Virtual Steering and Chassis Development
on a Realtime Ride Comfort Simulator

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Udine, Italy



Mercedes-Benz

Introduction



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M.Sc. Automation Engineering,
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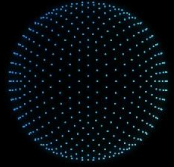
Aachen



Brisbane



The Project's Goal: From Replay to Realtime Simulation



Realtime Ride Comfort Driver-in-the-Loop Simulation on a Virtual Proving Ground

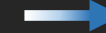
Today

High Performance Ride-Simulator



- Measurement replay of own and competitor vehicles
- 1:1 comparable to real vehicle
- Video replay representing visual environment
- Significant reduction of testing weeks

Goal



Replay of Timeseries
(Status quo)

**Driver-in-the-Loop
Simulation**

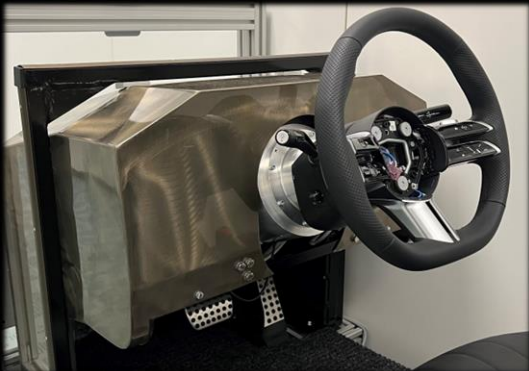
- Ride Comfort is highly customer relevant
 - On-center steering as part of steering feel
 - Closed-loop interaction with vehicle model and virtual control units (e.g. electric power steering)
 - Virtual proving ground for maximized realism
- ? Does realtime simulation and a steering wheel provide additional value?
- ? Up to what frequency is the system able to keep up with a real vehicle?

System Architecture – Core Components extending the Ride Simulator

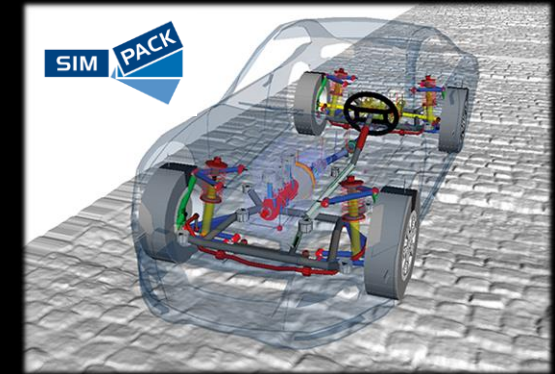
Realtime Computing



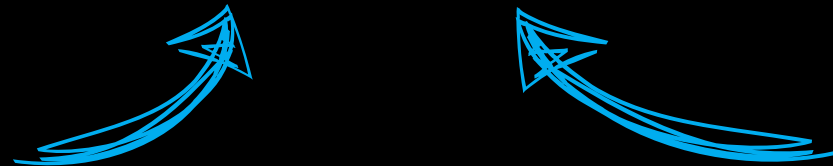
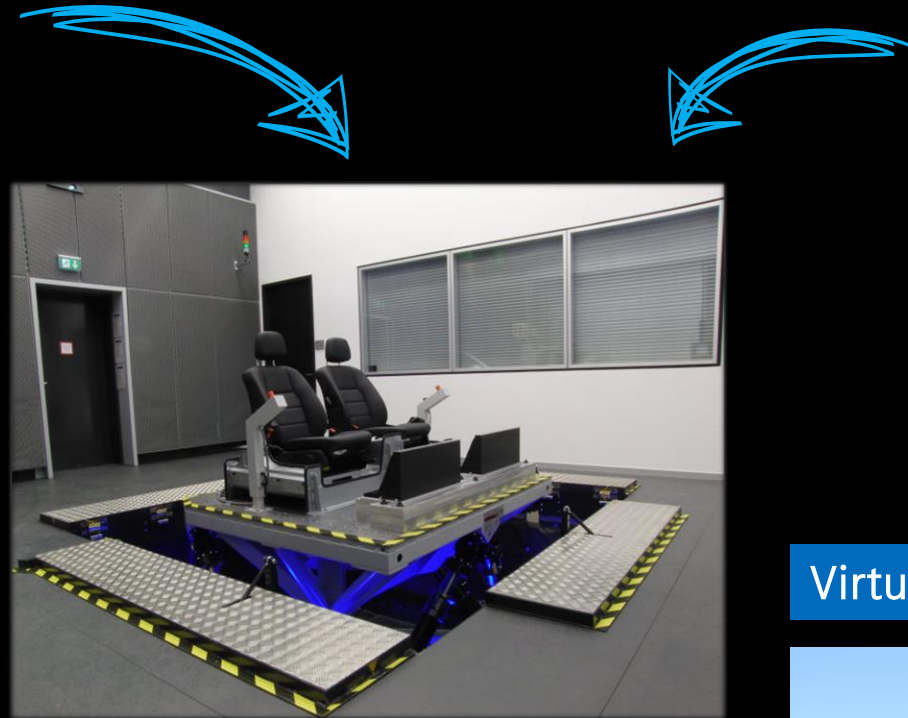
Steering Wheel



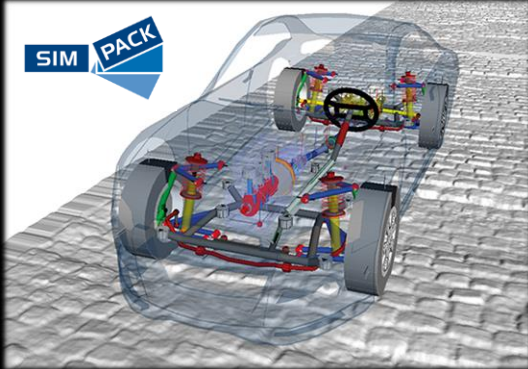
MBS Vehicle Model



Virtual Proving Ground



Realtime Multibody Simulation



- Validated model originates from ride simulation team
- Component oriented full vehicle model (> 250 DoF)
- SiL controller models embedded and validated (e.g. EPS)
- Realtime and interface adaptation
- Integration stepsize: 1 ms
- Realtime factor: ~ 0.85

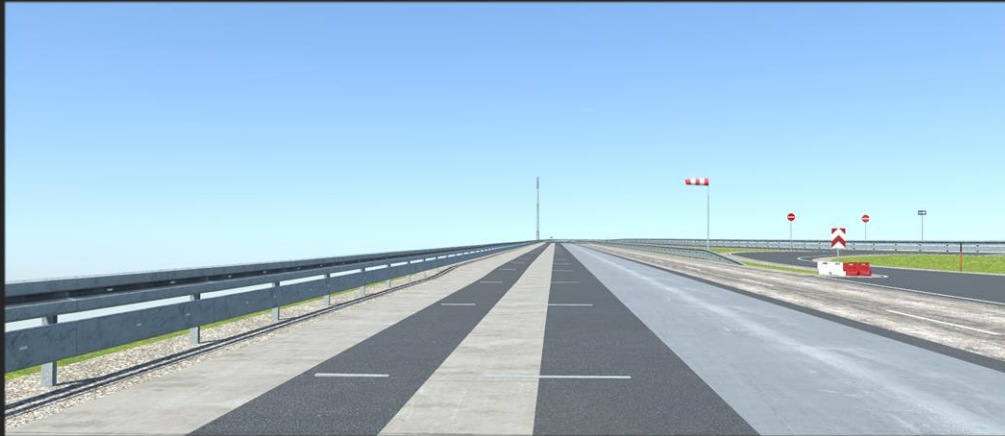


- High-end RedHawk Linux system: 16 Cores @ 3.9 – 4.5 GHz
- 8 cores MBS model – 1 core OS – 1 core I/O communication
- Hard realtime computation of MBS model and custom code
- C-code enables computation of custom models and scripts
- Point-to-point ethernet connection to hardware component

Virtual Proving Ground - Digital Immendingen



Virtual Proving Ground - Digital Immendingen



Full representation of straight roads for ride evaluation

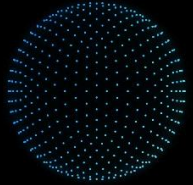


CRG road surface data providing road excitation

Framerate of > 240 fps @ 4k resolution

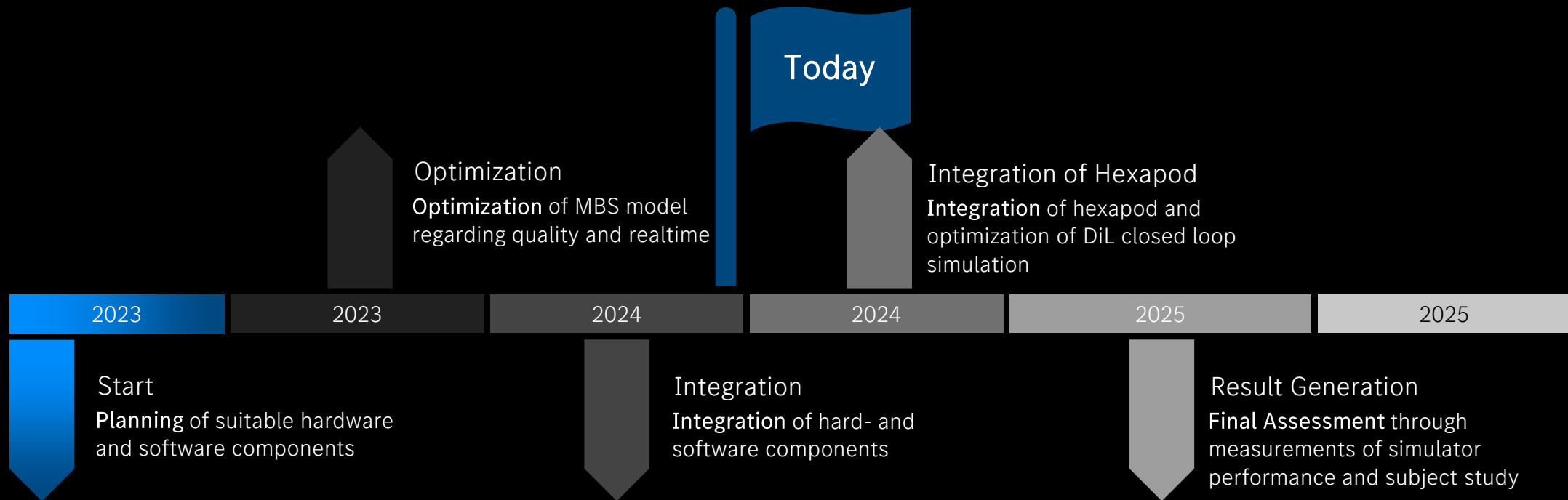
Full representation of proving ground for maximum immersion

Project Timeline - 2022-2025

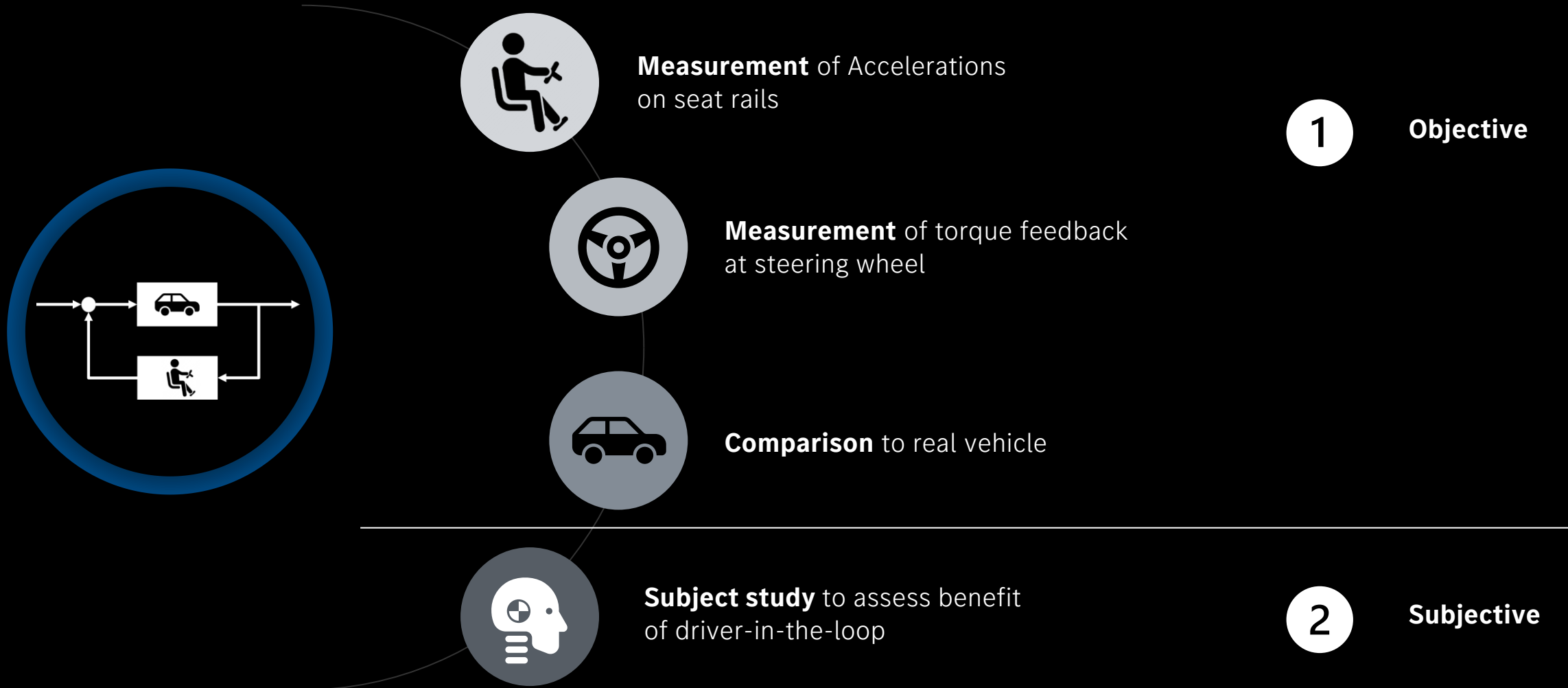


Realtime Ride Comfort Driver-in-the-Loop Simulation

Extended Digital Pre-Development of Mercedes-Benz Driving Character



Realtime Ride-Simulator Validation



Outlook



Planning



Optimization



Integration HW & SW



Integration of Hexapod

Results

Stay tuned and...
... attend ZPS 2025!

