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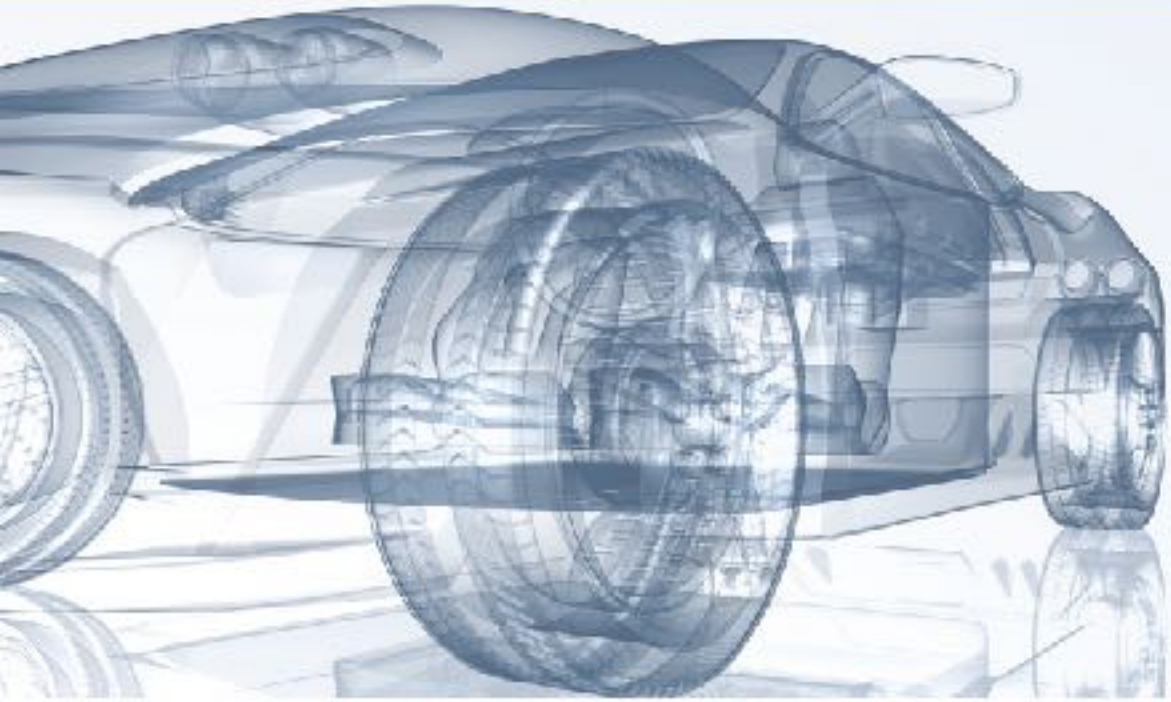

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Innovative Testing Process for Electric Vehicles

TechReaL

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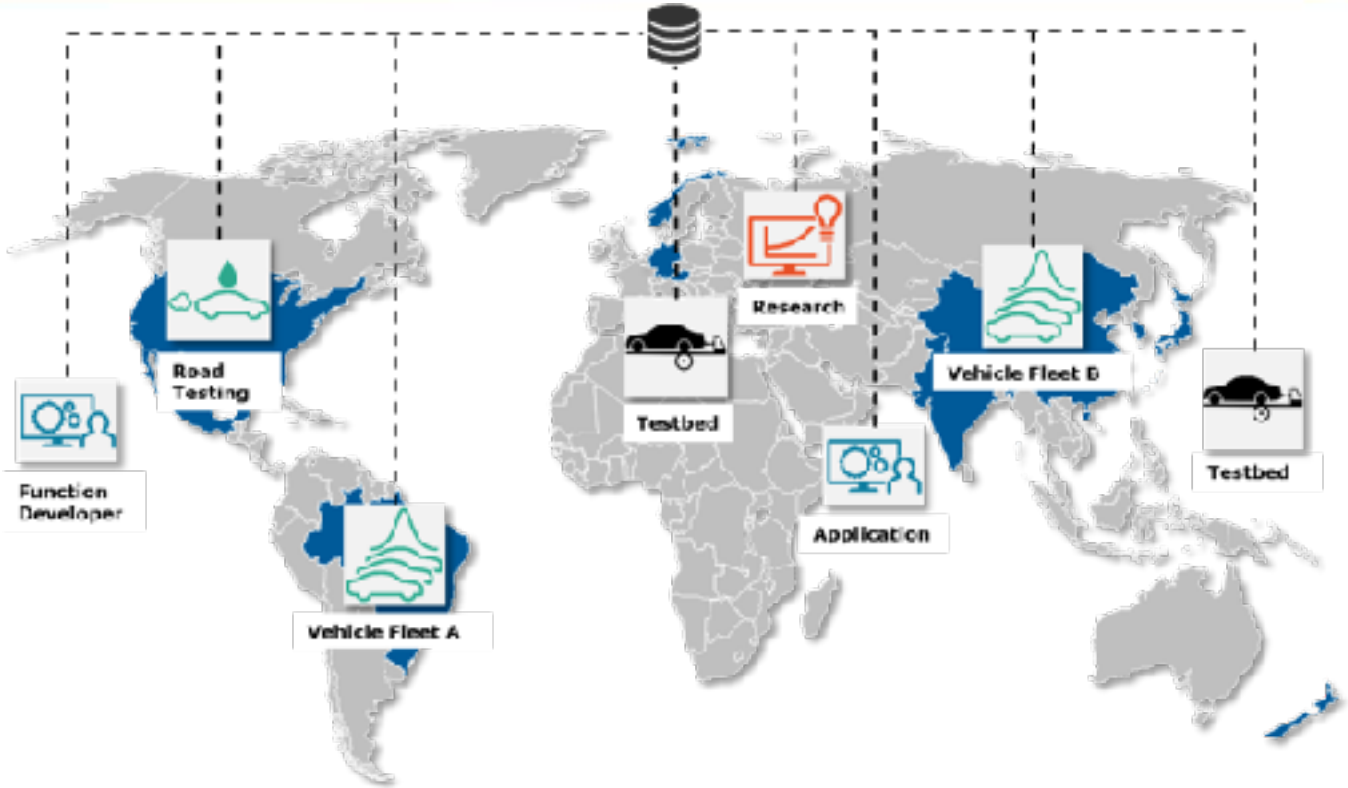
Agenda

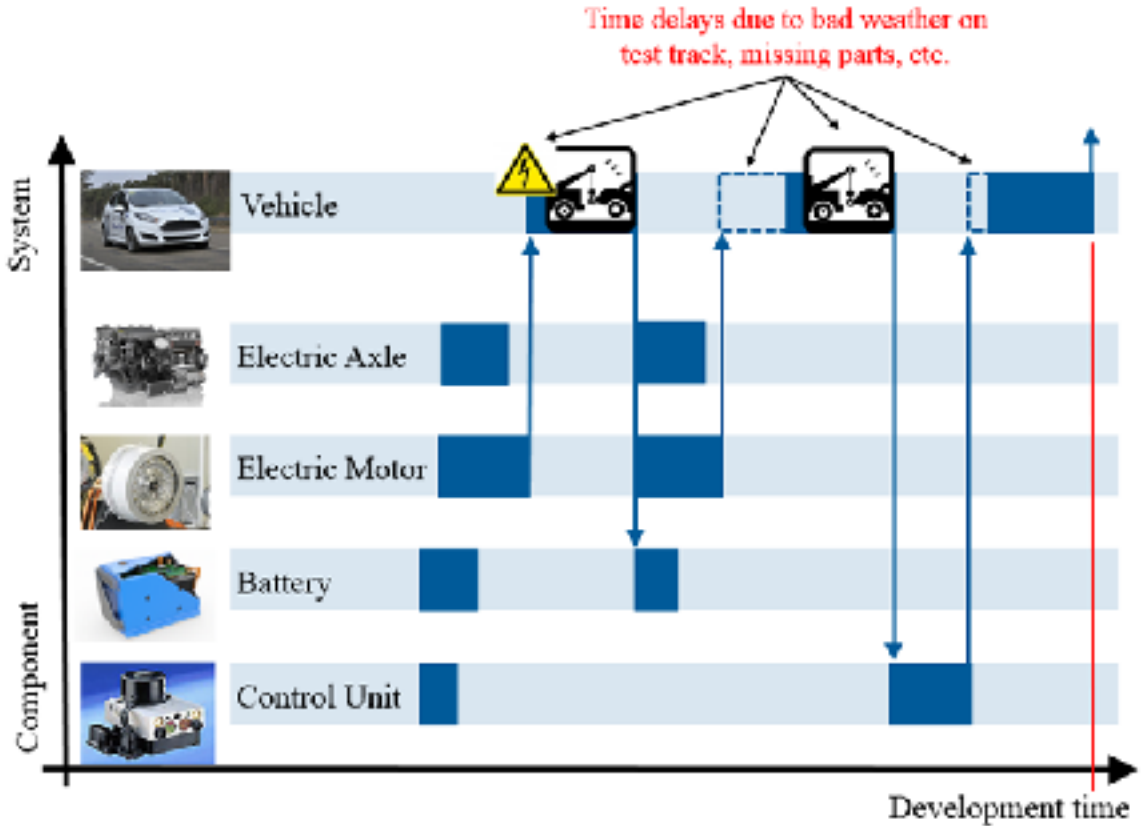
- ***Motivation for Building a Connected Validation Environment***
- ***Concept and Prototypical Implementation***
- ***Experimental Results***
- ***Summary and Outlook***

Distributed Development of Powertrain Components

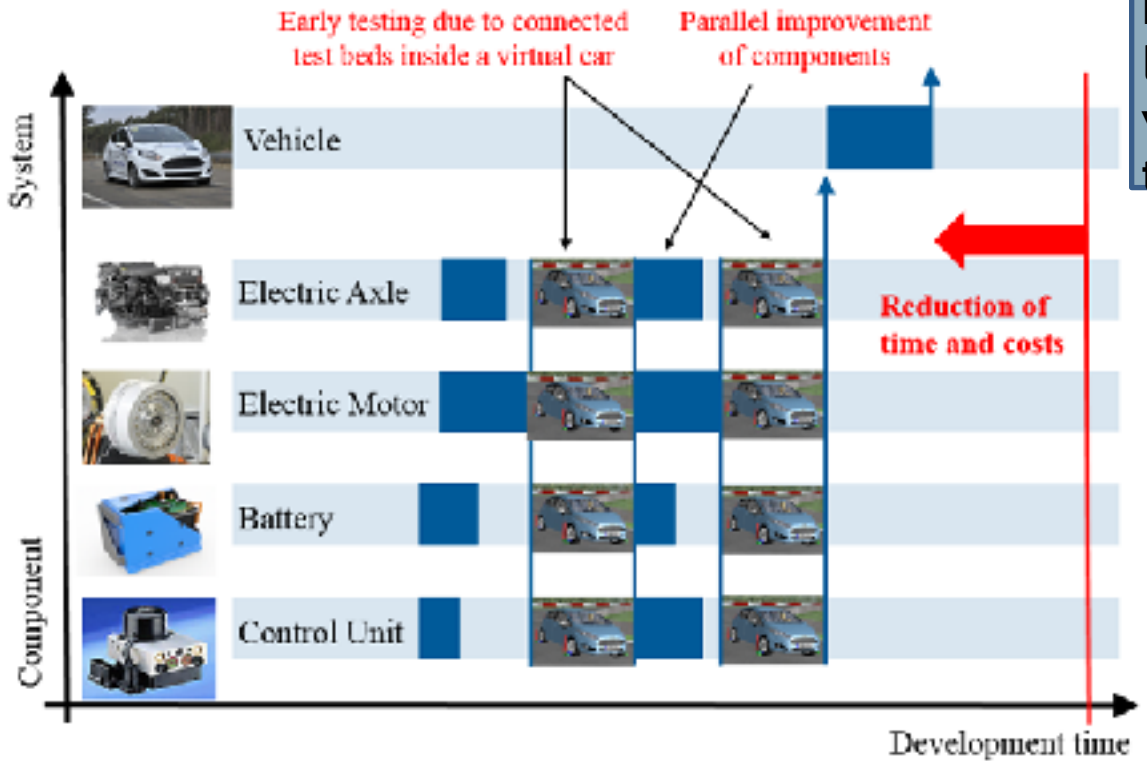


- Broad landscape of testing environments
- Increasing **complexity** (rising scope of functions & interconnectivity of components)
- Keep **overall system** in focus
- **Distributed development**

Challenging Integration Process



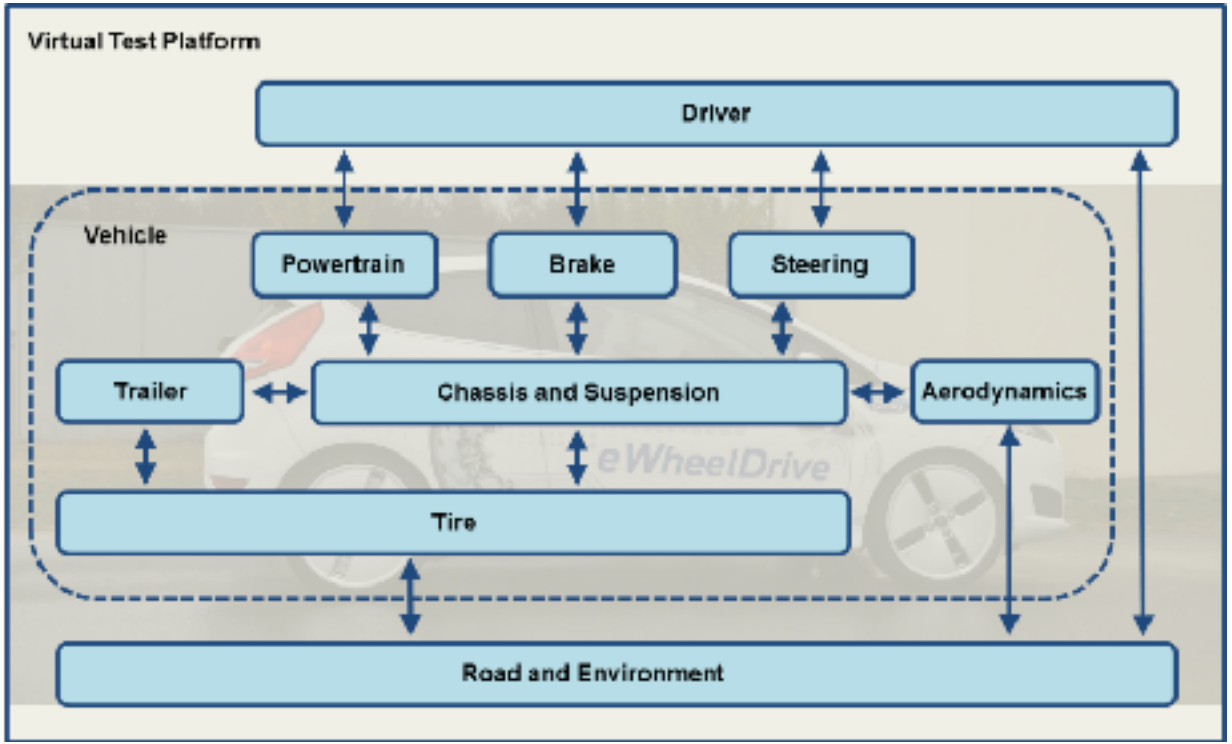
- **Parallel development** of components/subsystems by different suppliers
- First **integration** in **vehicle prototype**
- Expensive prototype (high effort)
- Upcoming issues have to solved on the test track
  → stringent schedule
  → constrained accessability
  → limited availability of experts



Increase technology readiness level by early, realistic validation through integration testing

- **Component interaction** can be observed early on
- **Reduce transport** of valuable prototypes
- Alternative to building and parametrizing highly sophisticated models

Modular Concept based on XiL-Approach

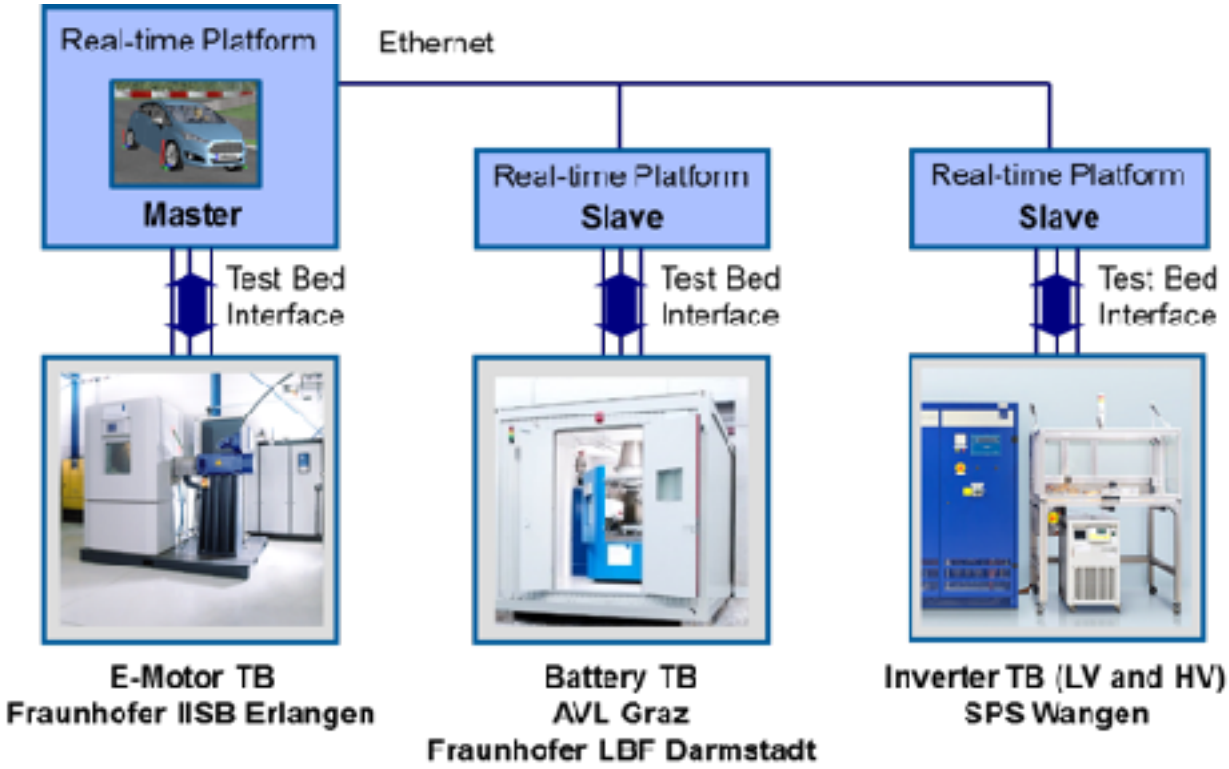


Modularization and Integration in virtual environment with driver simulation using XiL

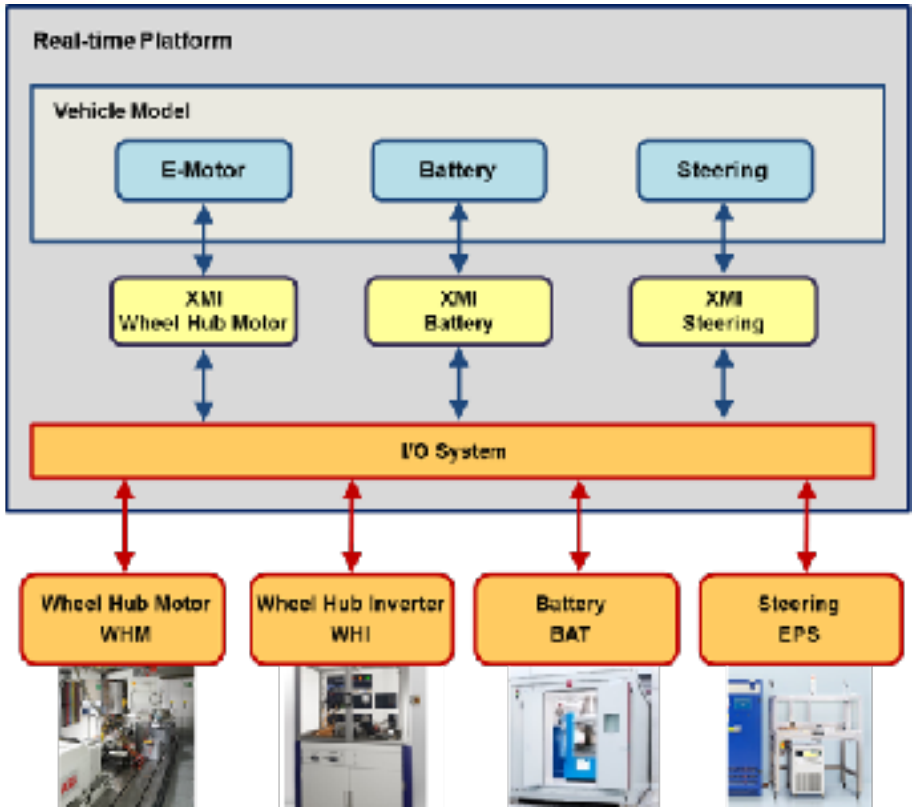
- High flexibility for different configurations
- Maneuver based testing
- Fast exchange of components
- Adaptability of models

Prototypical Implementation

- Cross-site connection based on **existing network infrastructure**
- Each test bed is linked to a **local real-time platform** for model execution and signal routing
- Master-Slave-Architecture
- IP/UDP for cross-site communication



XMI-Structure for Flexible Coupling



Vehicle Model Level

- physical/logical signal exchange between vehicle component models
- Model Management

XMI Level

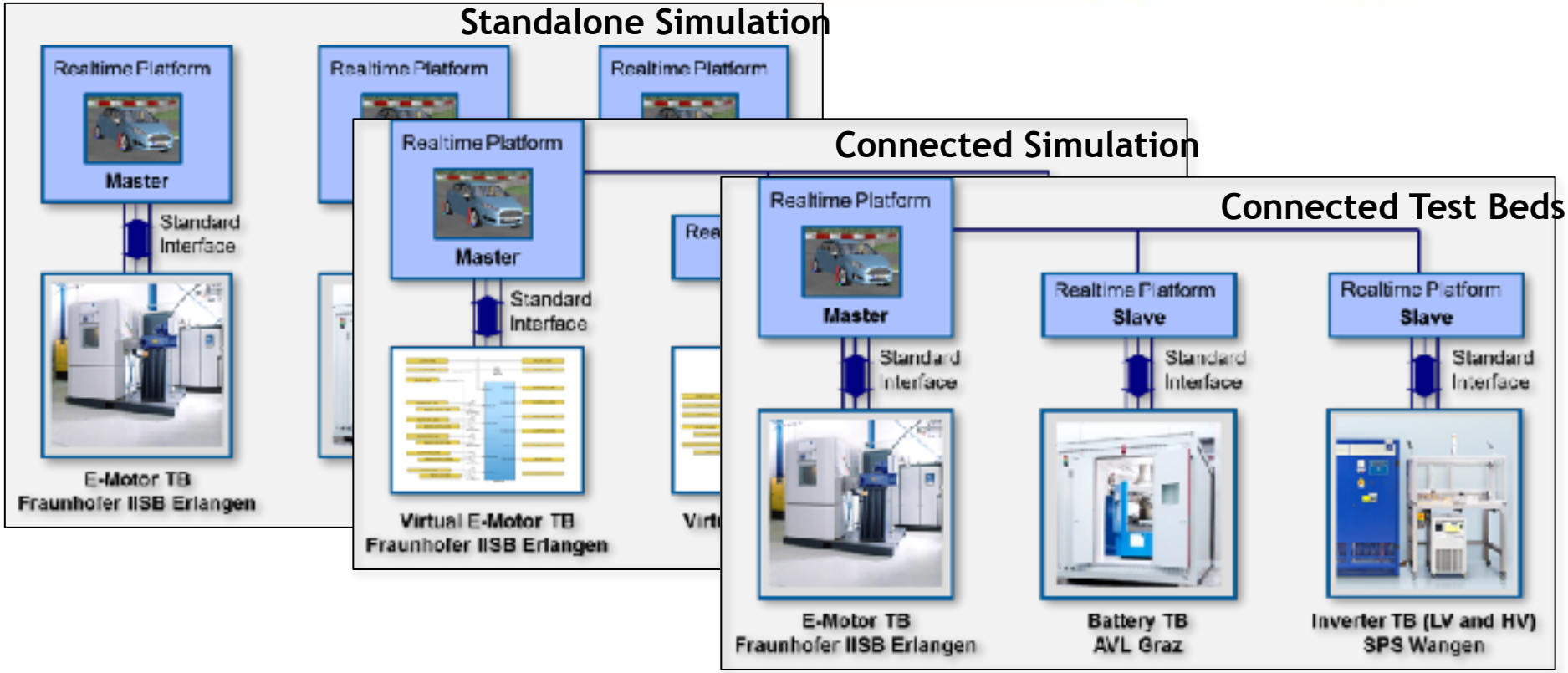
- signal mapping from the vehicle model to the I/O system
- State/logical handling of the test bed interface

I/O System Level

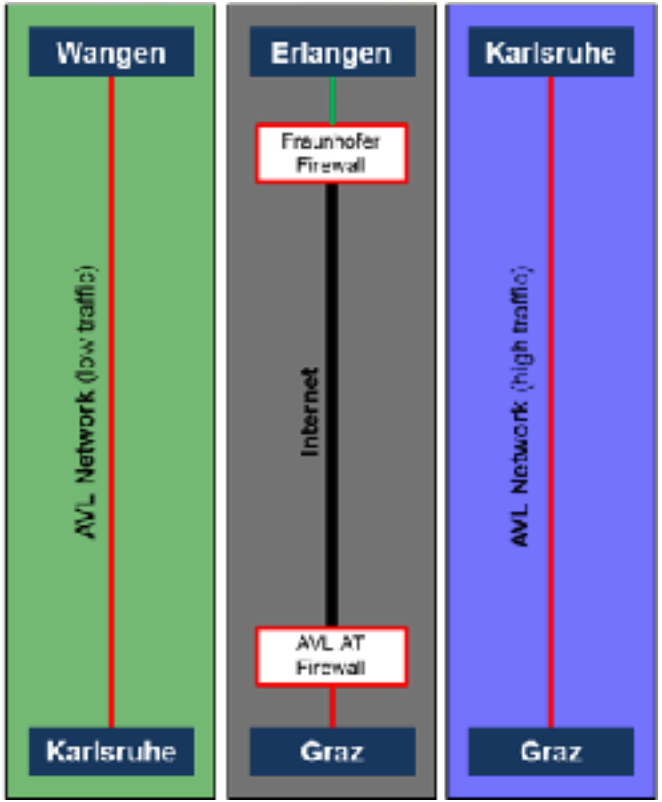
- I/O signal exchange between real-time platform and connected test beds/UUT

XMI: Extended Model Interface

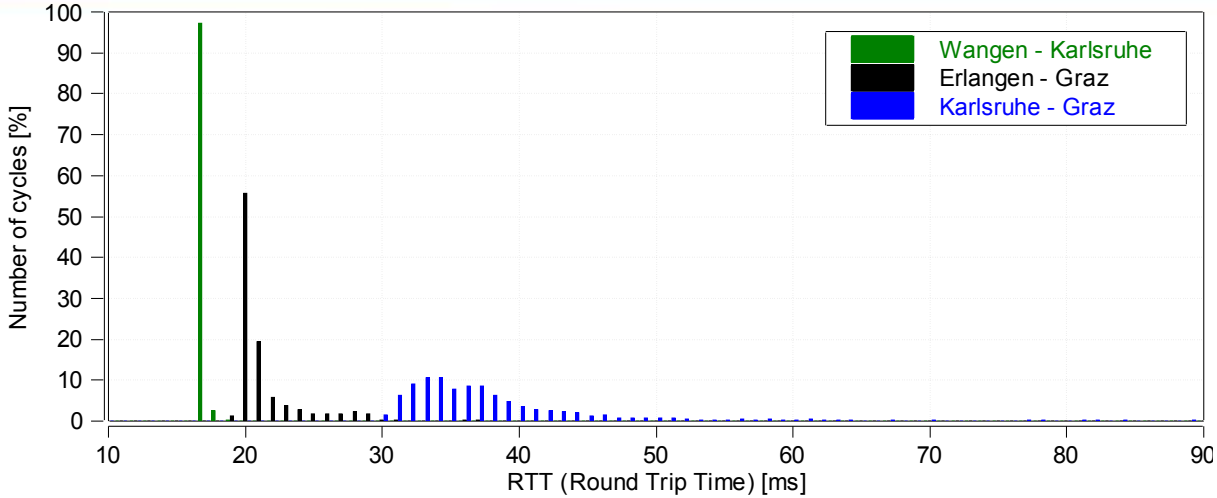
Step-by-Step Commissioning of Connected Test Beds



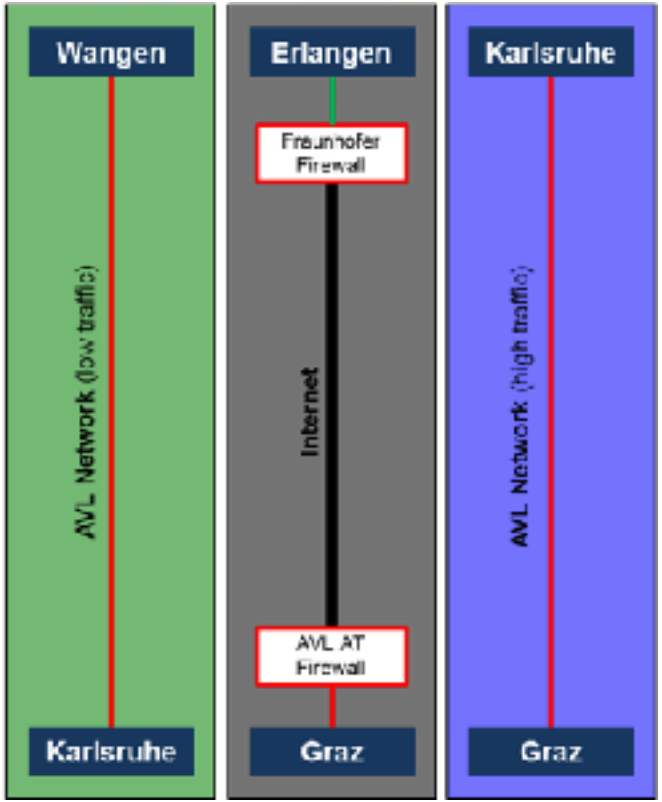
- „TechReaL“-Network contains three different types of connections
  - Wangen – Karlsruhe: example for **fast in-company** connection via fibre optics (high bandwidth, low traffic)
  - Erlangen – Graz: example for **cross-company** connection via **internet**
  - Karlsruhe – Graz: example for **highly loaded in-company** connection (low bandwidth, high traffic)
- Classification of the connection by measurement of round trip time (RTT)



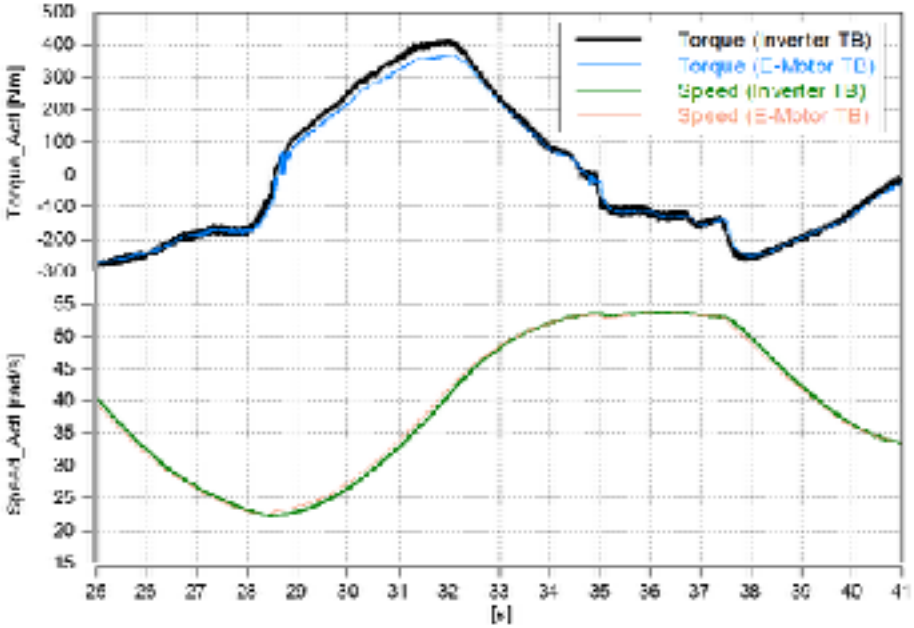
Network Performance

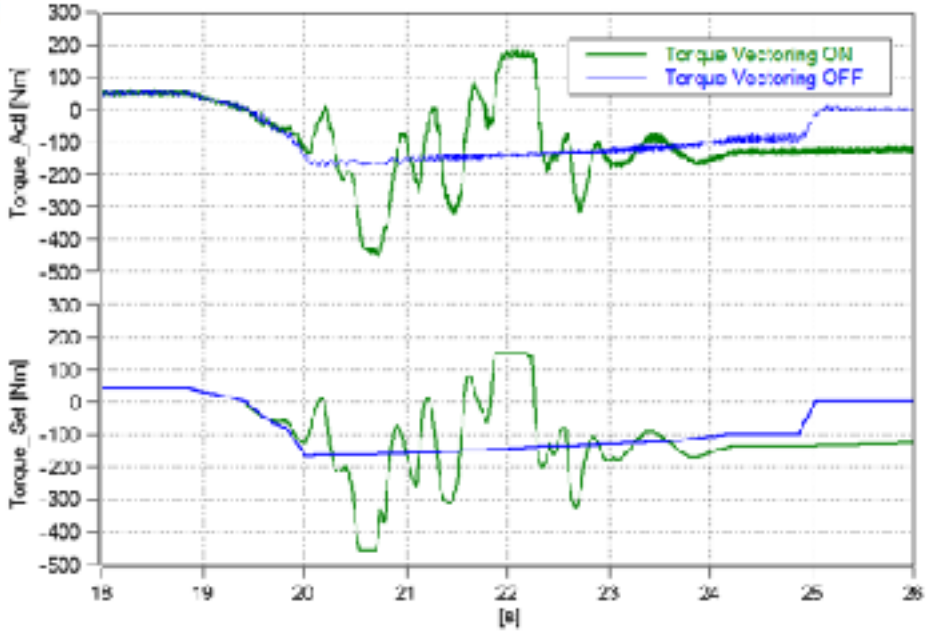


	Wangen – Karlsruhe	Erlangen – Graz	Karlsruhe – Graz
Min	17	19	15
Max	20	46	96
Mean	17.0	21.4	38.2
Std	0.2	2.7	8.4



Experimental Results





- Integrated e-motor and standalone inverter interact with the same battery
- Reproducable, comparable results

- Increased dynamic load on the vehicles components by using torque vectoring
- High impact on durability

Summary and Outlook

- Test and validation of **early prototypes**
- **Connected testing** with respect to **slow dynamic behaviour** of components
  - ➢ **Fast iteration cycles** for testing of early prototypes on system level
  - ➢ **Reduced travelling** and **transport** effort
  - ➢ Increased **expert knowledge availability** at local test beds
  - ➢ **High accessibility** for measurements on component test beds
  - ➢ **Extended usage** options for existing test beds
- **Standardization** of interfaces, network architecture and setup process
- Compensation of network latencies for **a robust validation environment**