DLR

IFS Institut für Verkehrsführung und Fahrzeugsteuerung

MBDC2005

MODELLING AND CONTROLLING THE STEERING FORCE FEEDBACK USING SIMULINK AND xPC TARGET

Dipl.-Ing. M. Brünger-Koch, 05/06/09

Model-Based Design Conference 2005

DLR

Agenda

1. Introduction

- Company and institute
- Motivation
- Laboratory environment

2. Force feedback steering control

- xPC Target
- Steering control model

3. Summary and outlook

- Summary
- Outlook

1. Introduction

German Aerospace Center (DLR)

Exploratory focuses

- Aeronautics
- Astronautics
- Energy
- **Transportation**

Budget

- 2002 1.153 Mio. Euro
- 2003 1.116 Mio. Euro

Scientific competence:

- Circa 5.100 employees, including about 2.300 scientists

Institute of Transportation Systems

Residence: Braunschweig

Since: March 2001

Director: Prof. Dr.-Ing. Karsten Lemmer

Employees:

Presently 54 employees from various scientific disciplines (expansion planned)

Fields of Research:

Automotive and Railway Systems

Range of tasks:

Basic research

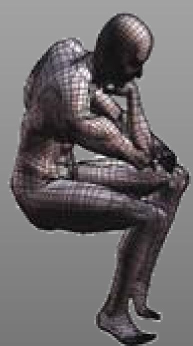
Creating concepts and strategies

Prototype development

What we do

Basics of driver assistance

- Driver modelling
- System architecture
- Driver – Traffic management



Which assistance is necessary?

Applied driver assistance

- Driver oriented design
- Human-machine interface
- Adaptation to driver and situation

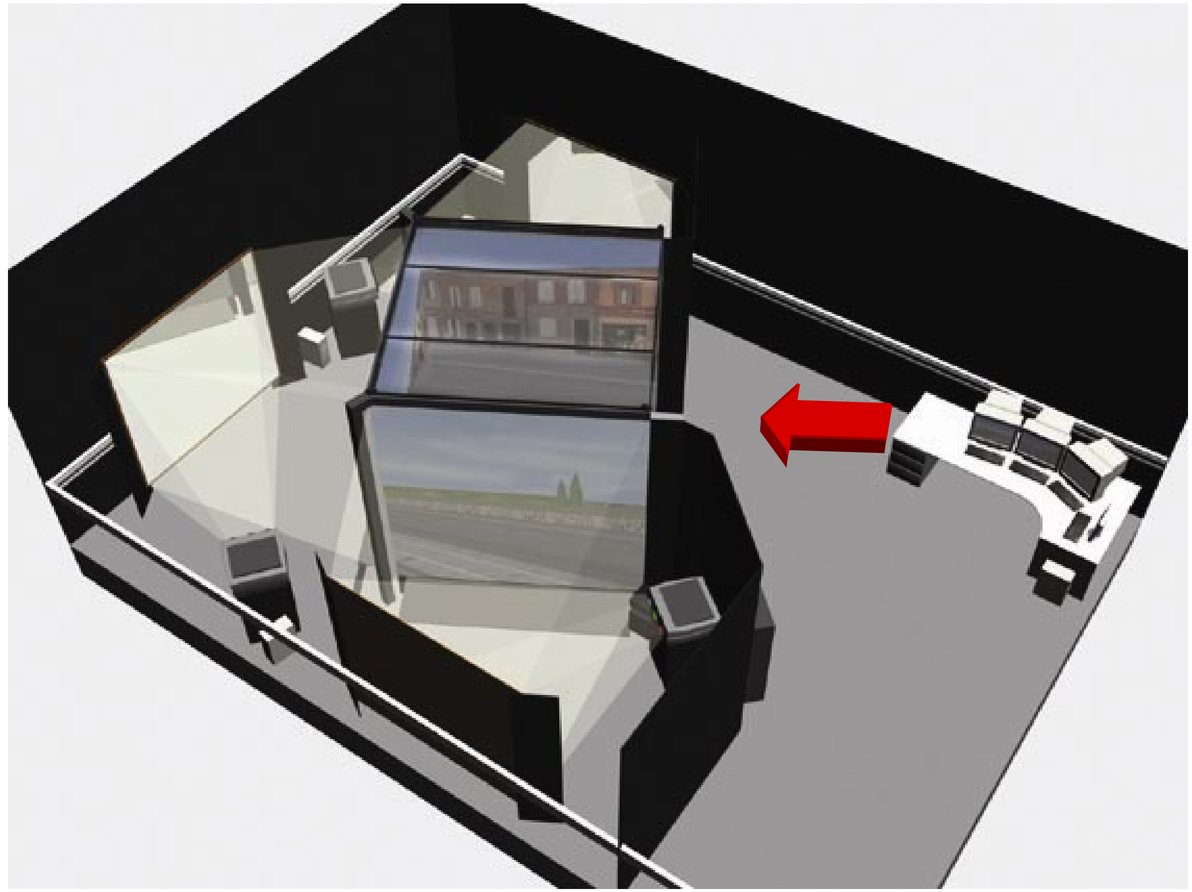
How should assistance be implemented?

Research infrastructure

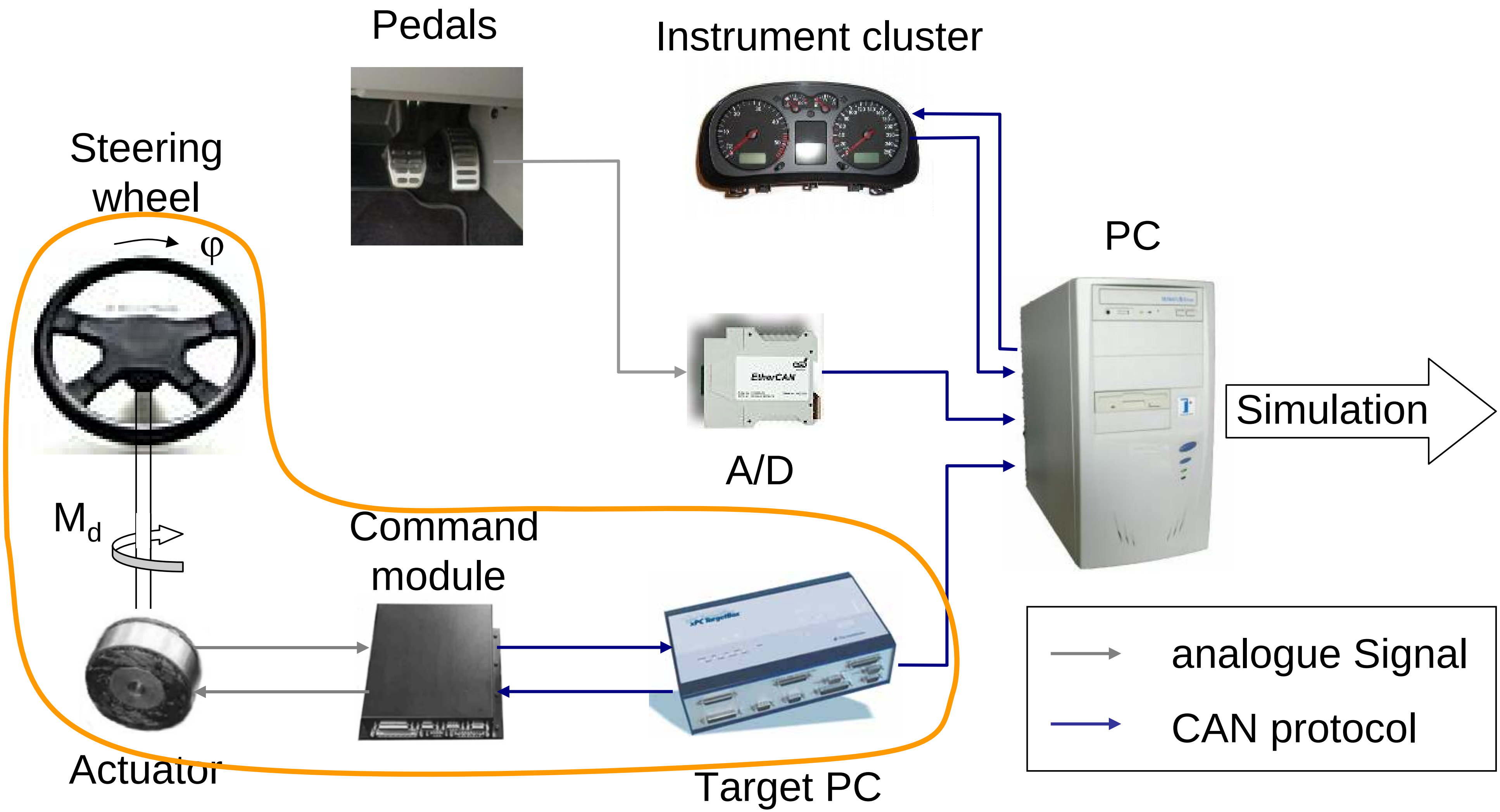
Dynamic Simulator

Measuring vehicle

Virtual Reality Laboratory (VR-Lab) ➢ Laboratory environment



Hardware set up (schematic)



2. Force feedback steering control

xPC Target box system features

Key features

• Provides a high-performance industrial PC system, optimized to run Simulink and Real-Time Workshop generated applications in real time

• Supports all xPC Target capabilities

• Offers various I/O options

Specifications

• Pentium III 700 MHz

• 128 MB RAM, 32 MB FlashRAM

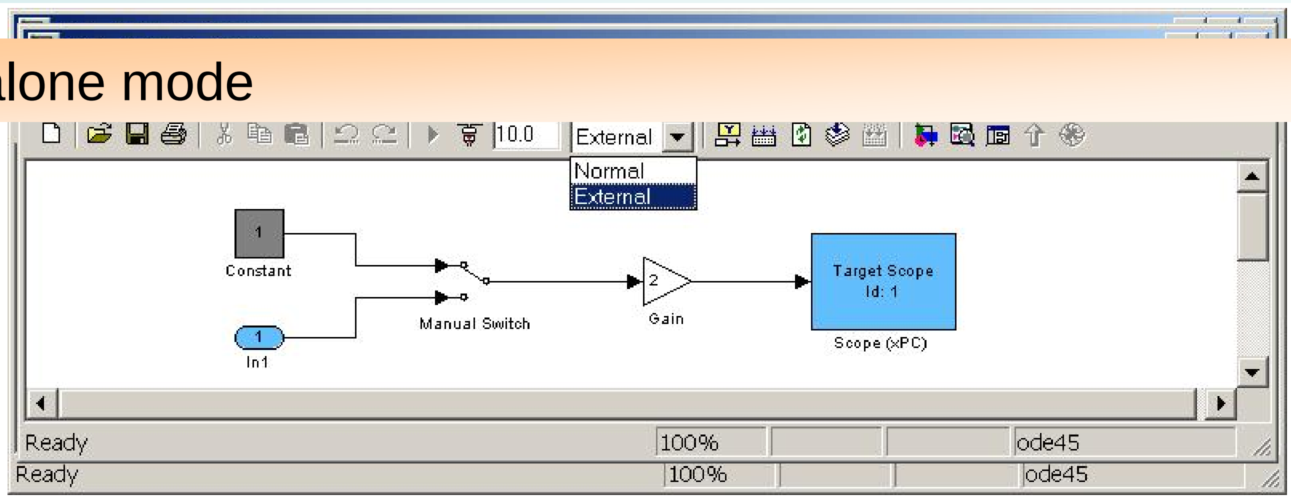
http://www.mathworks.com/products/

xPC Target toolbox features

Matlab®
- **Simulink®**
  - **Real-Time Workshop®**
    - **xPC Target**
      - **xPC Target Embedded Option**

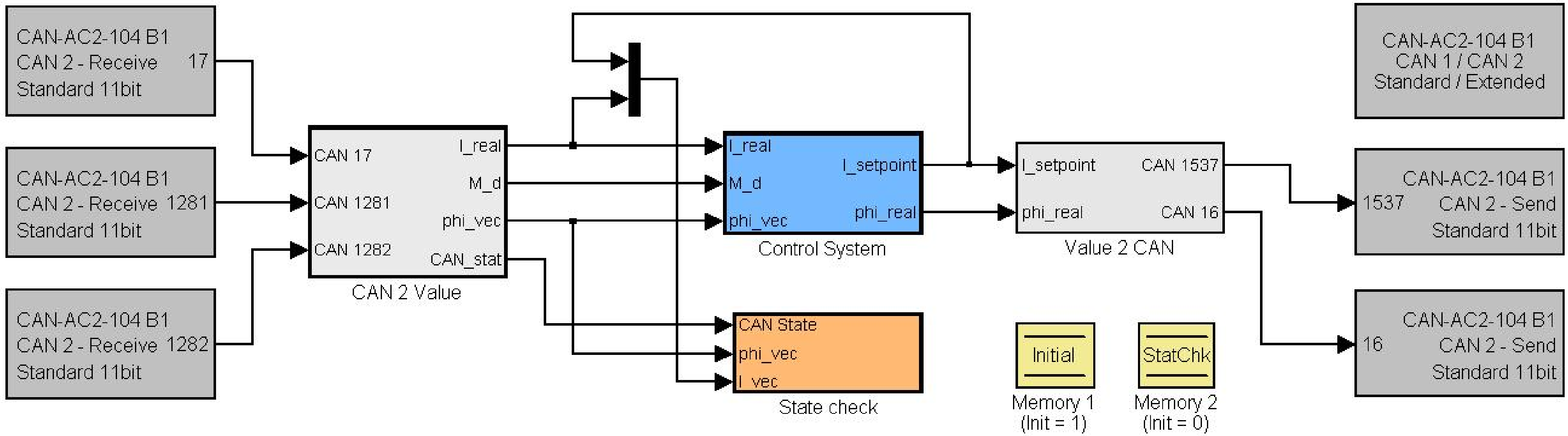
- Enables host-target communication (via RS-232 or TCP/IP)
- Supports more than 250 standard I/O boards
- Simulink external mode for parameter tuning

- Stand-alone mode



Simulink model - overview

➢ Steering control model



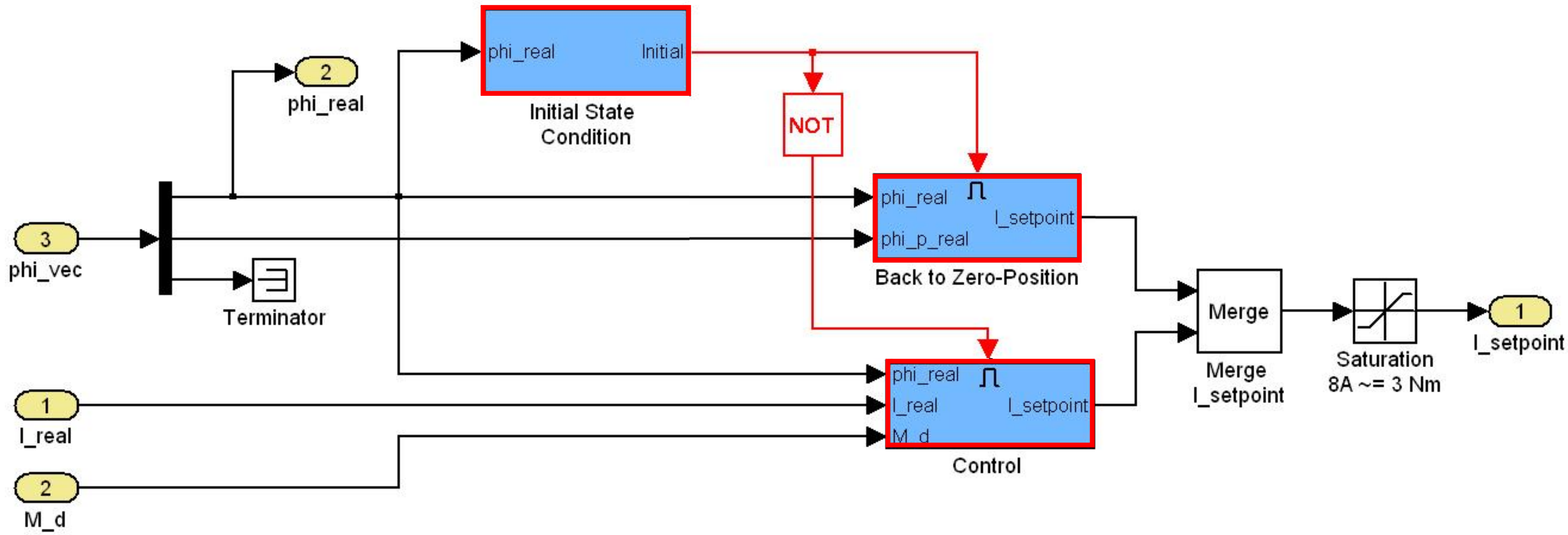
Communication

Control System

State check

Control system

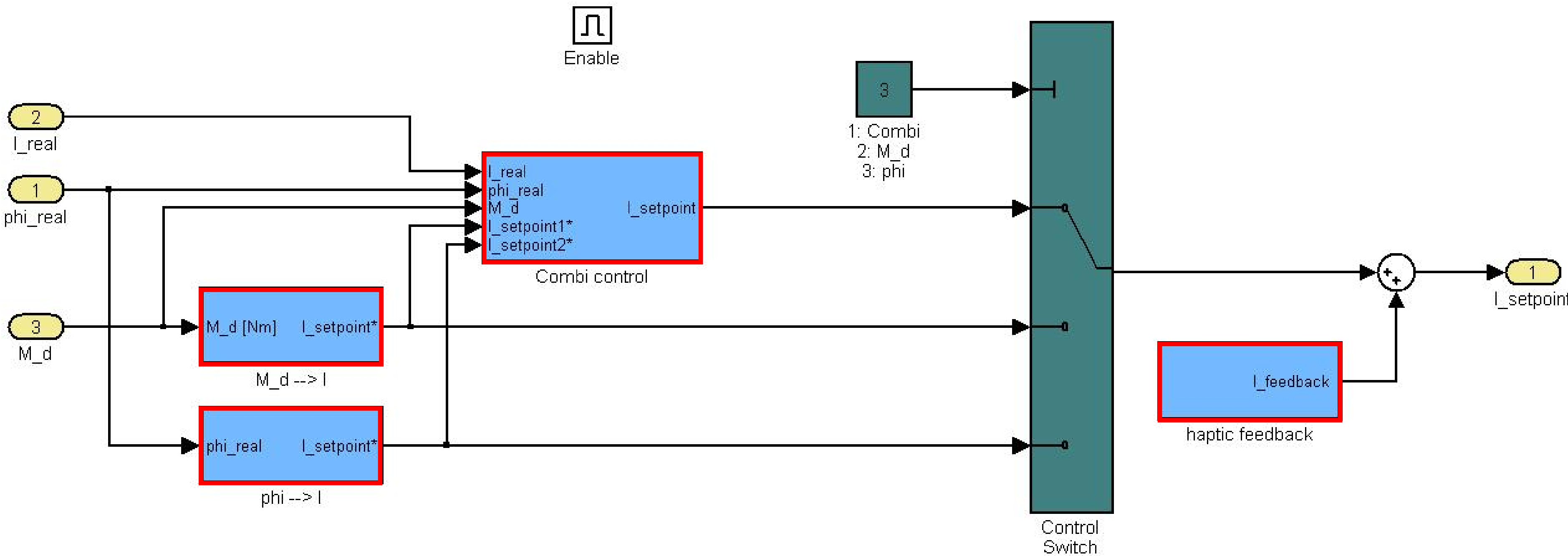
➢ Steering control model



Initial State	Differentiation of the state condition
Back to Zero position	The Steering wheel moves into neutral position with low speed and force
Control	The chosen controller calculates the setpoint current

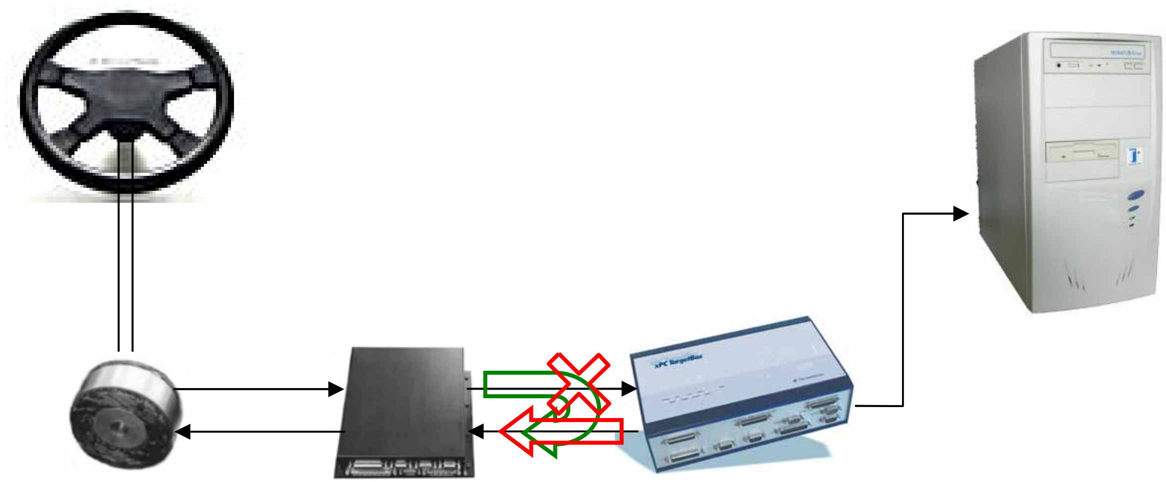
Control

➢ Steering control model



Control 1	Angular position input (φ)
Control 2	Driving torque input (M_d)
Combined control	Control 1 for small angles – Control 2 else
Haptic feedback	Superposed signal

Status check



Emergency check 1:	Monitors the progression of the steering wheel angular acceleration
Emergency check 2:	Compares the real and setpoint current values
State check:	Ensures sending activity of the actuator module

3. Summary and outlook

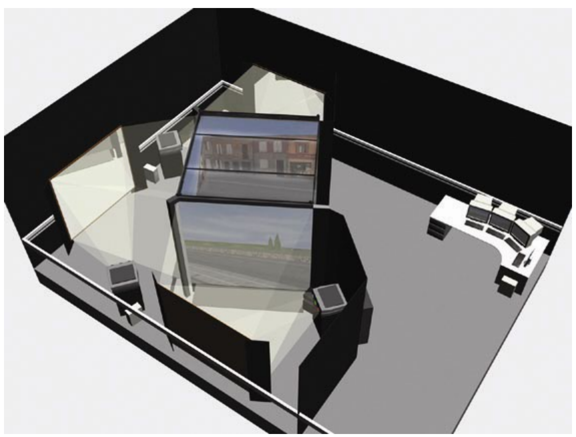
What we did

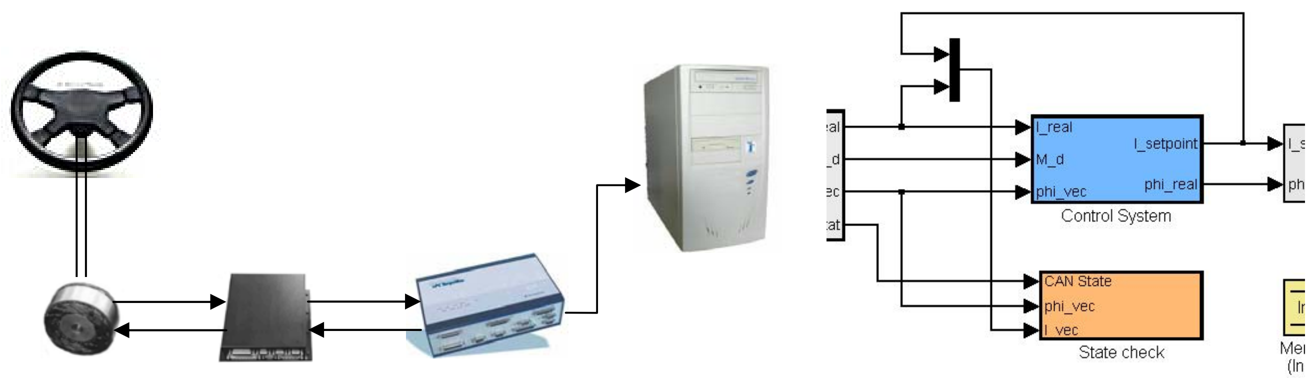
- Laboratory environment construction

  Support of advanced driver assistance systems development
- Force feedback steering wheel

  Control via simulink and xPC Target
- Monitoring

  State differentiation and emergency handling





What we plan to do

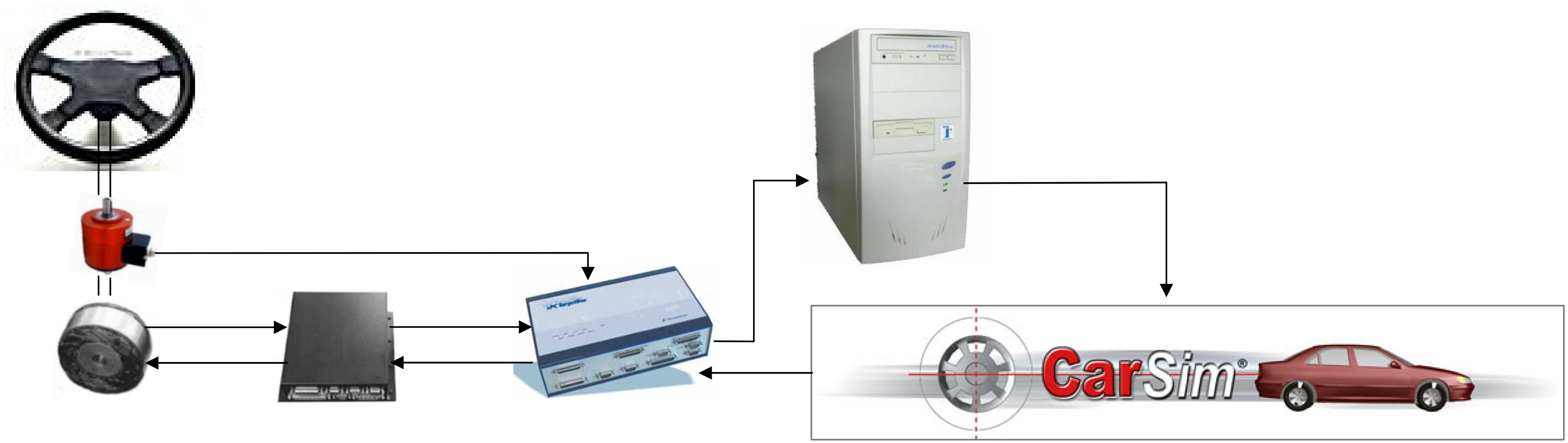
- Evaluation

  Virtual vs. real driving behaviour (e.g. steering)

- Driving dynamics simulation feedback

$$M_d = f(\varphi) \quad \Rightarrow \quad M_d = f(vehicle\ speed, street\ properties, ...)$$

- Torque sensor integration



Thank you for your attention!

Questions?