Model-Based Eco-Driving and Integrated Powertrain Control for (H)EV

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Outline

1. Introduction TNO
2. Motivation
3. Driver efficiency
4. Eco-Driving
5. Integrated Powertrain Control
6. Conclusions
Introduction TNO

- TNO is the Netherlands’ Organization for Applied Research
- Independent R&D organization
- Spin-off companies (e.g. tass)
- Over 75 years of experience
- 4,000 employees world-wide
- HQ in Delft, the Netherlands
- Annual turnover approx. 550 M€

TNO Powertrains – R & D

- Detailed Powertrain Modelling
- Energy and Emission Management
- Battery modelling and state estimation
Motivation

Increasing number of (H)EV’s

*Light Duty: BEV, PHEV and HEV will roughly triple over the next 7 years*

*Electric busses: annual growth rate of 26%, meaning that by 2018, 75000 electric drive busses will be on roads worldwide*

Energy efficiency and limited range:

Driver-Route-Vehicle

*Assist driver to perform more energy-efficient*

*Offer accurate range prediction*

*Energy management*
Significant influence of driving style on energy consumption

- Clear correlation driver/energy
- Variations up to 50%

Human factors: driver support and interface quality

- Acceptance (driver types and personalization)
- Distraction
Approach

Eco-Driving

Vehicle Parameter Estimation
Road Load Estimation
Dynamic Surrounding Recognition

Vehicle Model
Optimization Algorithm

Human-Machine Interface

Driver Performance Analysis

Driver

WHAT'S GOING ON?
WHAT SHOULD YOU DO?

ADVICE
CONSTRANTS

VEHICLE & SURROUNDINGS

HOW DID YOU DRIVE?

ANALYSIS

VEHICLE

Organized by
Hosted by
In collaboration with
Supported by
Context

- New technology (e.g. hybridization) helps CO$_2$-reduction
- But: increased complexity
  - More DoF
  - More real-world variance
- IPC offers solution
- Exploitation of system interactions in a systematic and modular way
Integrated Powertrain Control

Online optimization based on all relevant component states:

*Integrated powertrain control (IPC)*
Integrated Energy & Emission Management

- Drivetrain control
- WHR control
- Fuelling
- Air manag.
- DPF control
- SCR control

Benefits model-based approach:
- Exploit synergy subsystems
- Reduced development time
- Reduced calibration time
- Reduced system costs

Fuel consumption, power output
Tool chain

- Powertrain hardware
- Simulation model (ADVANCE, DYNAMO, simcat)
- Engine dyno tests
- Fit Tools
- Testing
- Calibration
- Control prototyping
- Algorithm development
Conclusions

- Model-based approach improves energy efficiency for both driver and vehicle
- Combination of driver assistance and advanced powertrain is preferred
- Less emissions (HEV) and less range anxiety (EV)!
Thank you for your attention!

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You are also welcome at the booth G710