End-user panel meeting WIDE

Workpackage 4: Network-aware control and estimation

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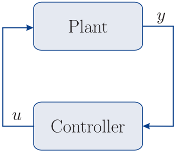
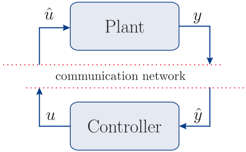
- Main tasks:
  - Task 4.1: Analysis methods of closed-loop systems operating over wireless networks
  - Task 4.2: Design methods for centralized and distributed network-aware MPC and estimation
  - Task 4.3: Prototype tools for network-aware and distributed control and estimation design

Networked control systems (NCS)





(i) Varying sampling/transmission interval

(ii) Varying communication delays

(iii) Packet loss

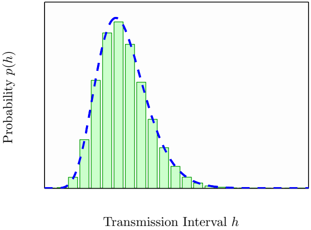
(iv) Communication constraints through shared network

(v) Quantization

- Task 4.1: Quantitative understanding effects on stability & performance
- Task 4.2: Design methods for network-aware control (MPC) and estimation

- Developed both Discrete-time and Continuous-time approaches for the modeling, analysis and controller synthesis for NCS

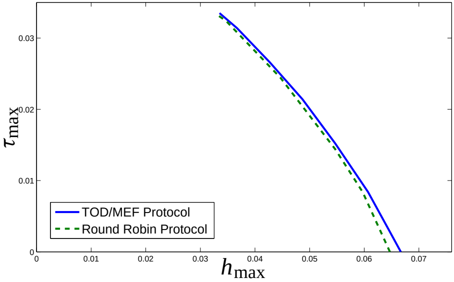
- Models for network-induced imperfections:
  - Robust results given bounds on network-induced uncertainties
    - Delays $\tau_k \in [\tau_{min}, \tau_{max}]$, Sampling intervals $h_k \in [h_{min}, h_{max}]$
    - Maximal number of subsequent dropouts $\bar{\delta}$
  - Stochastic models: Probability distribution function (PDF)



- RESULT: Effective and efficient Stability and Performance analysis given network characteristics

Example of how WIDE workpackage 4 results can be used:

- Stability analysis/ controller design in the face of
  - time-varying delays and time-varying transmission intervals
  - communication constraints (i.e. a protocol determines when certain sensor/actuator nodes obtain access to the network)

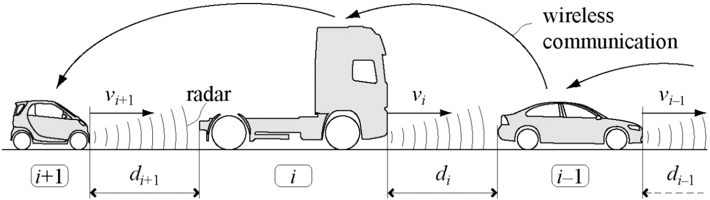


- Allows to make design tradeoffs between network properties, plant properties, controller properties, communication protocols

1. To spur academic and industrial usage, WIDE results have been implemented in a prototype Matlab toolbox
(still in progress)

2. Application of the results in industrial practice:
    - WIDE: Applying and verifying the ideas on the Barcelona water net case studies
    - BEYOND WIDE: Results are applicable to a broad range of wireless control problems in practice

- Human behaviour induces traffic shock waves $\Rightarrow$ more traffic jams, more accidents, higher CO_2 emissions
- Cooperative Adaptive Cruise Control (CACC) = Adaptive Cruise Control + Wireless Communication



- CACC can mitigate shock waves

Work performed in the Scope of the HTAS project Connect& Drive

- Wireless communication is THE enabling technology for CACC
- Networked Control Systems techniques developed in the WIDE project are very useful to design high-performance CACC controllers
- Real life tests with 7 Toyota Prius equipped with CACC show the benefit of CACC

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