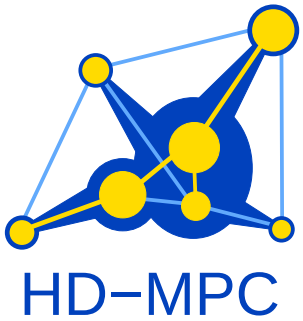
HD-MPC Industrial Workshop – Opening

Leuven, June 24, 2011



1. Overview of the HD-MPC project
2. Schedule of the workshop

Motivation:

Large-scale networked systems (such as manufacturing & transportation systems, power & road networks, process plants)

- composed of multiple subsystems, many embedded sensors and actuators;
- complex dynamics and mutual influences

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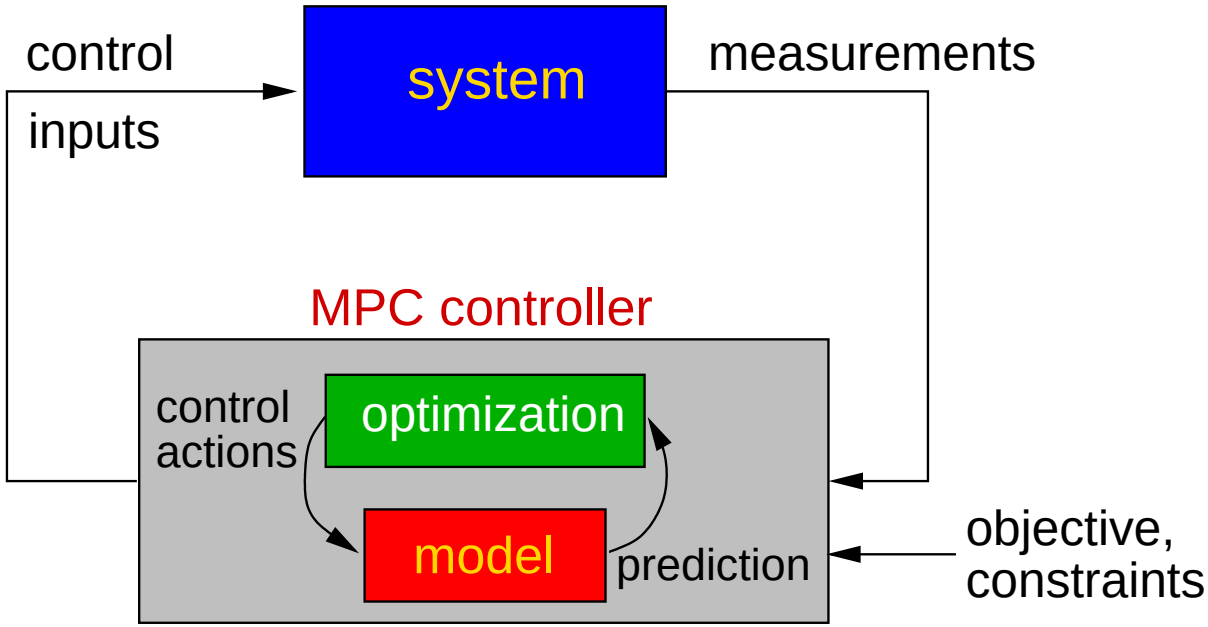
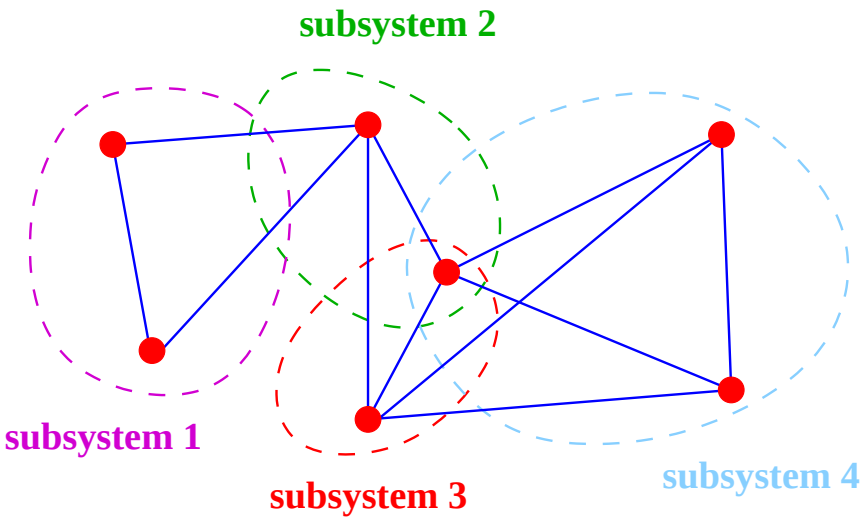
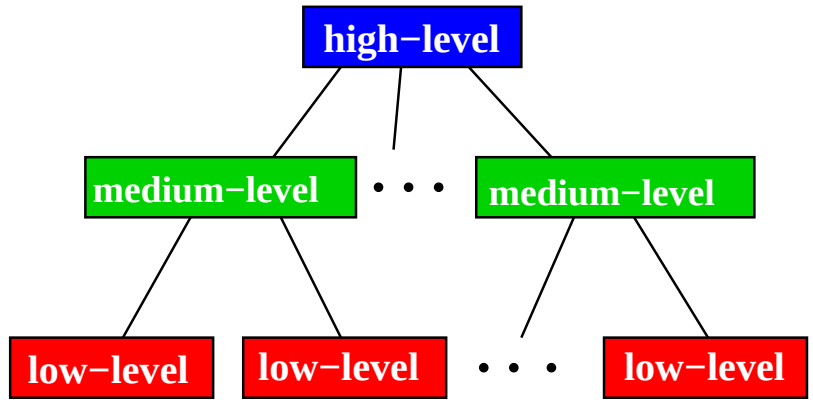
Goal: achieve safe, efficient, and robust operation

Use Model Predictive Control (MPC)



Use Model Predictive Control (MPC) in combination with hierarchical/distributed control set-up
$\rightarrow$ control tasks are distributed over time & space





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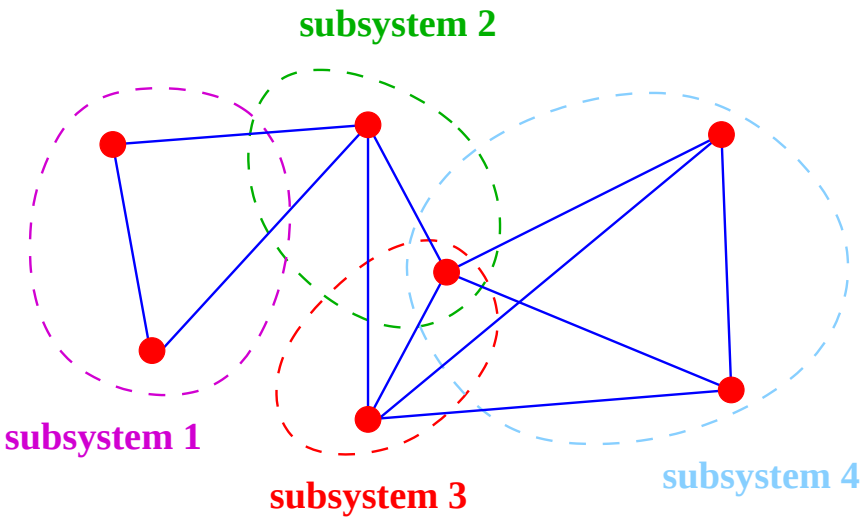

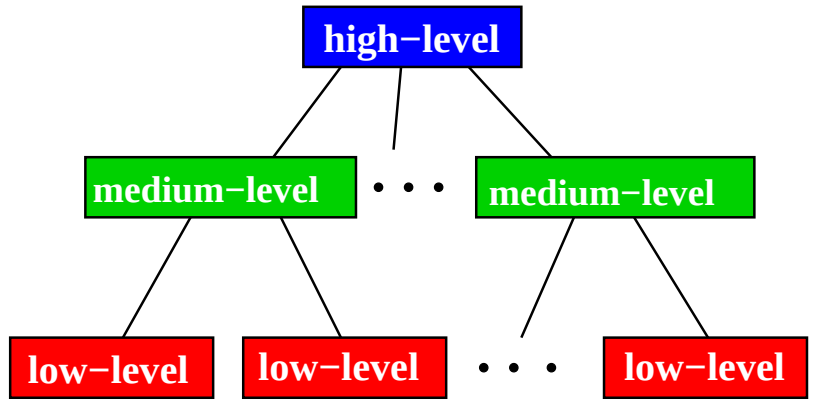

Currently:

computational, coordination, and communication problems

Aim of this project is to address these issues:

develop new and efficient methods and algorithms for distributed and hierarchical model-based predictive control of large-scale, complex, networked systems

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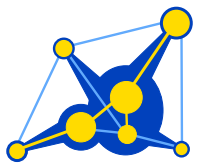
Key challenges:

- develop new, efficient, robust, and scalable methods for on-line, real-time hierarchical and distributed control of large-scale systems;
- deal with computational complexity issues, uncertainty, and coordination and cooperation within and across control levels;
- integrate developed methods within currently deployed embedded sensor and controller structures;



Objectives and contributions:

- Development of new control methods based for networked and hierarchical control systems with enhanced scalability, performance, safety, and efficiency, and improved fault-tolerance;
- Implementation of resulting methods in hardware and software structures;
- Validation in a number of test benchmarks (combined cycle power plant, hydro-power valley, water capture system, . . .);
- Easier deployment of predictive control technology in large industrial systems.

Case studies

Expected impact:

- Increased efficiency, productivity, and security
  $\rightarrow$ local controllers with intelligent coordination & model-based control systems
- Increase in size of tractable problems by factor 10
  $\rightarrow$ efficient control architectures & massive parallel computing
- Reduction in design effort by factor 10
  $\rightarrow$ dividing into subproblems & well-structured and systematic design methods

Project information

HD-MPC: Hierarchical and distributed model predictive control for large-scale systems

- Duration: 3+ years (Sept. 1, 2008 – Dec. 31, 2011)
- Coordinator: Bart De Schutter
- Total budget: k€ 2769
- Web site: http://www.ict-hd-mpc.eu
- 10 research teams involved

Research teams:

- Delft University of Technology (TUD) – Coordinator
- Electricité de France SA (EDF)
- Katholieke Universiteit Leuven (KUL)
- Politecnico di Milano (POLIMI)
- Rheinisch-Westfälische Techn. Hochschule Aachen (RWTH)
- Universidad de Sevilla (USE)
- Universidad Nacional de Colombia (UNC)
- École Supérieure d'Eléctricité (SUPELEC)
- INOCSA Ingeniería, S.L. (INOCSA)
- University of Wisconsin-Madison (UWM) – Cooperation partner

Work packages and WP coordinators

1. Management and coordination (TUD)
2. Definition of the hierarchical architecture for control design (POLIMI)
3. Development of hierarchical and distributed MPC methods (RWTH)
4. Optimization methods for hierarchical and distributed MPC (KUL)
5. Distributed state estimation algorithms (POLIMI)
6. Hardware and software implementation, and benchmarking (USE)
7. Validation and applications on simulated plants (EDF)
8. Dissemination (KUL)

- 09:30–10:00 Bart De Schutter: Opening
- **Session 1 – Theory of Hierarchical and Distributed MPC**
  10:00–10:50 Carlos Bordons: Introduction to MPC
  10:50–11:20 Coffee break
  11:20–12:10 Bart De Schutter: Distributed and hierarchical MPC: Main concepts and challenges
- **Session 2 – Methods and Software for Hierarchical and Distributed MPC**
  12:10–13:00 Moritz Diehl: Algorithms for nonlinear MPC of large scale systems
  13:00–14:00 Lunch
  14:00–14:50 Holger Scheu: Dynamic real-time optimization
  14:50–15:40 Riccardo Scattolini: Distributed predictive control and simplified implementations
  15:40–16:20 Coffee break

- **Session 3 – Industrial Application of Hierarchical and Distributed MPC**

  16:20–17:00 Laura Sánchez: HD-MPC approach to irrigation channels

  17:00–17:40 Damien Faille: Optimization of combined cycle plants and hydro-power valleys

  17:40–18:00 Carlo Savorgnan: Hydro Power Valley demo

- 18:00– Good-bye coffee