



Collaborative Project
Small-medium-scale focused research project (STREP)

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# WIDE
## Decentralized and Wireless Control of Large-Scale Systems

Starting date: 01 September 2008 Duration: 3 years

| | |
|---|---|
| Deliverable number | **D3.5** |
| Title | **Prototype design tools in MATLAB for decentralized / distributed /hierarchical control and estimation** |
| Work package | WP3 – Multilayer distributed control and model management |
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| Dissemination level | |
|---|---|
| →**PU** | Public |
| PP | Restricted to other programme participants (including the Commission Services) |
| RE | Restricted to a group specified by the consortium (including the Commission Services) |
| CO | Confidential, only for members of the consortium (including the Commission Services) |

**Executive summary**
This report reviews the Matlab prototypes for decentralized / distributed / hierarchical control and estimation.

## Contents



# 1 Introduction

The prototypes for decentralized / hierarchical / energy aware / distributed model predictive control and prototype for network aware Kalman filter are the part of Wide toolbox, which can be downloaded from WIDE project web pages:

http://ist-wide.dii.unisi.it/index.php?p=toolboxsp

The following sections describe the individual prototypes.

## 1.1 Decentralized MPC prototype

Decentralized MPC is prototyped in as a Matlab class (dlincon), which extends Hybrid toolbox class (lincon) towards decentralized control.

Starting with an user defined decentralization, the toolbox automatically creates the corresponding set of decentralized lincon controllers of appropriate dimension. The user is requested to provide a starting configuration for the centralized controller (using the same parameters as in in lincon) and that will be readapted, in proper dimension, to each subcontroller. Moreover each subcontroller can be customized according to needing as it is a lincon class instance.

Prototype:
`<WideToolbox>\Classes\@dlincon`
Documentation:
`<WideToolbox>\Classes\@dlincon\html\dlincon.html`
`<WideToolbox>\doc\WIDE Toolbox Manual.pdf`
Demo:
`<WideToolbox>\Examples\DHMPC\Decentralized MPC\dlincon_example.m`
Demo Documentation:
`<WideToolbox>\Examples\DHMPC\Decentralized MPC\html\dlincon_example.html`
`<WideToolbox>\doc\WIDE Toolbox Manual.pdf`

## 1.2 Hierarchical MPC prototype

Hierarchical MPC is prototyped as a Matlab class (HiMPC), which implements paradigm presented in:

Davide Barcelli, Daniele Bernardini, Alberto Bemporad: *Synthesis of networked switching linear decentralized controllers.* CDC 2010: 2480-2485.

Prototype:
```
<WideToolbox>\Classes\@HiMPC
```
Documentation:
```
<WideToolbox>\Classes\@HiMPC\html\HiMPC.html
<WideToolbox>\doc\WIDE Toolbox Manual.pdf
```
Demo:
```
<WideToolbox>\Examples\DHMPC\Hierarchical MPC\himpc_example.m
```
Demo Documentation:
```
<WideToolbox>\Examples\DHMPC\Hierarchical MPC\html\himpc_example.html
<WideToolbox>\doc\WIDE Toolbox Manual.pdf
```

## 1.3 Energy aware MPC prototype

Energy aware MPC is prototyped as a Matlab class (EAMPC). This class provides an implementation of an explicit MPC controller, where communications between controller and sensor nodes are subject to an energy-aware policy intended to lower the number of transmissions and, ultimately, save sensor nodes battery.

The class is based on the following papers:

D. Bernardini and A. Bemporad, *Energy-aware robust model predictive control based on wireless sensor feedback*, in Proc. 47th IEEE Conf. on Decision and Control, Cancun, Mexico, 2008, pp. 3342-3347.

D. Bernardini and A. Bemporad, *Energy-aware robust model predictive control with feedback from multiple noisy wireless sensors*, 10th European Control Conference, Budapest, Hungary, 2009, pp. 4308-4313.

Prototype:
```
<WideToolbox>\Classes\@eampc
```
Documentation:
```
<WideToolbox>\Classes\@eampc\html\eampc.html
<WideToolbox>\doc\WIDE Toolbox Manual.pdf
```
Demo:
```
<WideToolbox>\Examples\DHMPC\Energy Aware MPC\eampc_example.m
```
Demo Documentation:
```
<WideToolbox>\Examples\DHMPC\Energy Aware MPC\html\eampc_example.html
<WideToolbox>\doc\WIDE Toolbox Manual.pdf
```

## 1.4 Network aware Kalman filter prototype

Network aware Kalman filter is prototyped as Simulink blocks.

Prototype:
```
<WideToolbox>\Classes\NKF\
```
Documentation:
```
<WideToolbox>\Classes\NKF\doc\NKF.pdf
```
Demo:
```
<WideToolbox>\Classes\NKF\YU_Channels_Sim_PID_03.mdl
<WideToolbox>\Classes\NKF\Y_Channel_Sim_PID_04.mdl
```

## 1.5 Distributed MPC prototype

Distributed MPC prototype is a part of the demonstration specified in D5.2. The prototype is a combination of Matlab code and C++ code running on the proprietary real-time industrial control platform (Honeywell Unified Real-Time platform). The prototype is installed in the control center of Barcelona water network operator Agbar. The documentation of the prototype installation is in the deliverable D5.5 and the test case evaluation report concerning the prototype is in the deliverable D5.6.