



WP1.2

Modelica Library for MPC

WP Leader: Lieve Helsen

Expert Meeting Berlin
February 27-28, 2018

THE TEAM

20 persons from 7 institutes/companies

Affiliation	Team members
KU Leuven	Lieve Helsen, Filip Jorissen, Damien Picard, Iago Cupeiro, Javier Arroyo, Jan Drgona
LBNL	David Blum, Michael Wetter David, Gerald (AEE Intec)
ENGIE Lab	Valentin Gavan, Jessica
SDU	Christian Veje, Muhyiddine Jradi, Krzysztof Arendt, Anders Clausen
ENGIE-Axima	Lisa Rivalin (now at LBNL)
PNWNL	Draguna Vrabie, Sen Huang
3E	Roel De Coninck
...	...

THE GOALS

Using Modelica,
an equation-based object-oriented modelling language

1. To develop an open-source **Library for MPC**
2. To develop a **framework** to test and assess MPC performance
3. To compare and **benchmark** different **MPC formulations**

THE WORK PLAN

WP1.2 Modelica Library for Model Predictive Control

Task 1.2.1:

Develop a framework to test and assess MPC performance

Taks 1.2.2:

Compare and benchmark MPC algorithms

Task 1.2.3:

Develop a Modelica library for MPC

THE WORK PLAN

Task 1.2.1: Development of a framework to test and assess MPC performance

Virtual test bed = architecture with detailed building emulator models which allow control by MPC

Two categories: Mainly air-based systems & Mainly hydronic systems

For each category: 1-zone residential, multi-zone residential, 1-zone office, multi-zone office, multi-zone office hybrid system

→ set of ~10 emulator models to test MPC algorithms

Outcome:

- open-source virtual test bed (BOP-TEST) composed of ~10 building emulator models hosted on <https://github.com/ibpsa>
- publications in the peer-reviewed literature

THE WORK PLAN

Taks 1.2.2: Comparison and benchmarking MPC algorithms

Virtual test bed developed in Task 1.2.1 is used to **test MPC formulations and solvers** on common emulators, which allows benchmarking the MPC algorithms using selected performance indicators

Outcome:

- set of well-documented and tested MPC algorithms (and corresponding performances as benchmarked)
- guidelines for good practice in MPC design
- publications in the peer-reviewed literature

THE WORK PLAN

Task 1.2.3: Development of a Modelica library for MPC

Library of models that can be used to efficiently solve optimal control problems for building and district energy systems (& that can be combined with parameter and state estimation algorithms)

→ All physical equations need to be at least twice continuously differentiable with bounded derivatives on compact sets

Outcome:

- Free open-source library for MPC hosted on <https://github.com/ibpsa>
- publications in the peer-reviewed literature

THE STATUS NOW

- ✓ Work plan defined
- ✓ Task Leaders assigned (Javier, Iago, David/Filip)
- ✓ Enquiry (David): Dynamic optimization in Modelica: Applications, recent developments and future challenges
- ✓ Inventories of:
 - ✓ Potential contributions of team members
 - ✓ Available emulator models & future plans
 - ✓ Performance indicators for MPC Toolchain and Algorithm evaluation
 - ✓ MPC formulations
 - ✓ Extra optimization experts: postponed
- ✓ First ideas on the approach to the infrastructure of organizing and disseminating the tests

THE PLAN FOR BREAK OUT SESSIONS

BS 1-1 Setting the scene - common goals and ambitions

Chair: Lieve **Welcome (goals - collaborations)**

Presentation institutes/companies

KU Leuven

LBNL

Engie Lab

Engie - Axima

SDU

Pacific Northwest National Laboratory

3E

Discussion - how can we create synergy? Which commitments do we take?

THE PLAN FOR BREAK OUT SESSIONS

BS 1-2	MPC performance assessment by emulators
	Introduction
Chair: Iago	MPC Formulations
	MPC formulation 1
	MPC formulation 2
	MPC formulation 3
	MPC formulation 4: Pareto frontier vs. cost function
Chair: Javier	Candidate Emulators
	Multi-zone residential building with hydronic system model présentation
	Multi-zone office building with hydronic system model présentation building
	INFRAX building: Multi-zone office building with hybrid system (hydronic+air based)
	Solarwind
	Multi-zone office floor with VAV air system
	3-floor office, 15-zone, VAV + chiller plant model
	Campus building with complex heating/ventilation rules: zone models + whole building

THE PLAN FOR BREAK OUT SESSIONS

BS 2-1

Discussion towards conclusion - Conceptual template

Chair: Filip

An approach to the infrastructure of organizing and disseminating the tests

high level MPC --> postprocessing needed

towards template for model

towards template for system description

selection of emulators for benchmarks

roadmap and timeline, collection results

THE PLAN FOR BREAK OUT SESSIONS

BS 2-2 Performance Indicators & MPC Library

Chair: Javier Performance Indicators

Discussion performance indicators - quantification

Mathematical formulation to quantify KPI - Objective function
in MPC formulation

Chair: Filip MPC Library

MPC library - presentation first draft

MPC library - discussion requirements & approach

THE PLAN FOR BREAK OUT SESSIONS

BS 2-3 Publication & Dissemination & Closure

Chair: Lieve Publication & Dissemination

MPC library - open source

BOP-TEST benchmarks -> ASHRAE standards?

recommendations MPC -> code of good practice booklet

Closure

Open issues

Agreement on further actions - Roadmap & Timeline

Time for further discussion

COLLABORATION

