Glossary

Conventions

The following conventions are used in this thesis for notation and symbols:

- A lower case character typeset in boldface, e.g., $\mathbf{x}$, represents a column vector.
- The number of elements in a vector $\mathbf{x}$ is indicated by $n_{\mathbf{x}}$.
- An upper case character typeset in boldface, e.g., $\mathbf{A}$, represents a matrix.
- A character typeset in calligraphics, e.g., $\mathcal{N}$, represents a set.
- A tilde over a variable, e.g., $\tilde{x}$, indicates a variable specified over a prediction horizon.
- A bar over a variable, e.g., $\bar{x}$, indicates that the value of the variable is known.
- A subscript i or j of a variable, e.g., x_i or x_j, refers to a variable of a control agent or subnetwork i or j, respectively.
- Subscripts max and min of a variable, e.g., $x_{\max}$ and $x_{\min}$, represent the maximum and minimum value of that variable, respectively.
- A subscript avg, e.g., x_{avg}, indicates that an average is considered.
- A superscript ι or ω of a variable, e.g., x^{ι} or x^{ω}, refers to a variable beloning to node ι or ω, respectively.
- A superscript T, e.g., $\mathbf{x}^{\mathrm{T}}$, indicates that a transpose is taken.

List of symbols and notations

Below follows a list of the most frequently used symbols and notations in this thesis. Symbols particular to power network applications are explained only in the relevant chapters.

$\mathbf{A}, \mathbf{A}_{\mathrm{c}}$	system matrices of linear time-invariant models
$\mathbf{B}, \mathbf{B}_1, \mathbf{B}_2, \mathbf{B}_3$	input matrices of linear time-invariant models
$\mathbf{C}, \mathbf{C}_{\mathrm{c},y}, \mathbf{C}_{\mathrm{c},z}$	output matrices of linear time-invariant models

$\mathcal{C}_{i,\mathrm{Loc}}^{\mathrm{Vars}}$	localized constraint type
d	exogeneous input
$\mathbf{D}, \mathbf{D}_1, \mathbf{D}_2, \mathbf{D}_3, \mathbf{D}_{\mathrm{c},y}, \mathbf{D}_{\mathrm{c},z}$	direct-feedthrough matrices of linear time-invariant models
$\mathbf{E}_1, \mathbf{E}_2, \mathbf{E}_3, \mathbf{E}_4, \mathbf{E}_5$	matrices of mixed-logical dynamic models
f	function
$\mathbf{f}$	vector with linear cost coefficients
$\mathbf{F}, \mathbf{F}_{\mathrm{c}}$	state-offset vectors of linear time-invariant models
g	equality constraint function
g_u	equality constraint function with all variables except u fixed
$g_{\mathrm{hard},i}$	equality constraint function of subnetwork i for an internal node
$g_{\mathrm{hard,ext},i}$	equality constraint function of subnetworks i for an internal node that is connected to an external node
$g_{\mathrm{soft},i}$	equality constraint function of subnetwork i for an external node
$\mathbf{G}, \mathbf{G}_{\mathrm{c},y}, \mathbf{G}_{\mathrm{c},z}$	output-offset vectors of linear time-invariant models
h	inequality constraint function
i	index of a control agent or a subnetwork
$\mathbf{I}$	identity matrix
j	index of a neighboring agent
J	objective function
$J_{\mathrm{add}}, J_{\mathrm{cycle}}, J_{\mathrm{rel}}, J_{\mathrm{sim}}$	additional, cycle, relative, and full simulation cost
$\mathcal{J}_{i,\mathrm{Loc}}^{\mathrm{Vars}}$	localized objective function term type
k	discrete time step or control cycle counter
k_{c}	control cycle counter
k_{f}	control cycle finishing step
k_{p}	prediction step counter
$\tilde{\mathbf{K}}_i$	interconnecting-output selection matrix of agent i
l	a control cycle counter within predictions
L_{aug}	an augmented Lagrange function
m_i	number of neighbors of control agent i
M, M_{lin}	prediction model and linearized prediction model
$\mathcal{M}$	mesh with candidate solutions
n	number of subnetworks
$n_{\mathbf{a}}$	number of elements in vector $\mathbf{a}$
N	length of a prediction horizon
N_{c}	length of a prediction horizon in control cycles
N_{init}	number of initial solutions
N_{iter}	number of iterations

N_p	length of a prediction horizon in discrete time steps
$N_{\Delta s}$	number of iterations between parameter updates
N_ι	number of control agents that have node ι in their subnetwork
$\mathbb{N}$	set of natural numbers
$\mathbb{N}^+$	set of positive natural numbers
$\mathcal{N}_i$	set of indexes of neighboring agents of agent i
$\mathcal{N}^\iota$	set of indexes of neighboring nodes of node ι
p	parameter
$\mathbf{Q}, \mathbf{Q_a}$	weight matrices for quadratic costs
$\mathbb{R}$	set of real numbers
s	iteration number
$\mathbf{s}, \mathbf{s}^+$	solution vector and a new solution vector
t	continuous time instant
$t_0, t_\mathrm{f}, t_\mathrm{fault}$	initial, finishing, and fault continuous time instant
T_c	length of a discrete control cycle in seconds
T_comp	computation time in seconds
T_opt	finishing time of an optimization in seconds
T_p	length of a discrete time step in seconds
u	input variable
u_b	binary input variable
u_c	continuous input variable
$\mathbf{U}$	vector with input vectors of all agents
$\mathcal{U}$	domain with integer values
v_i	local remaining variable of subnetwork i
$w_{\mathrm{in},ji}$	interconnecting input of subnetwork i
$w_{\mathrm{out},ij}$	interconnecting output of subnetwork j
$\mathbf{w}_{\mathrm{in},i}$	vector with all interconneting inputs of agent i
$\mathbf{w}_{\mathrm{out},i}$	vector with all interconnecting outputs of agent i
$\mathbf{W}_\mathrm{in}$	vector with the interconnecting inputs of all agents
$\mathbf{W}_\mathrm{out}$	vector with the interconnecting outputs of all agents
x	state variable
x_b	binary state variable
x_c	continuous state variable
$\mathbf{X}$	vector with states of all agents
y	output variable
y_b	binary output
y_c	continuous output
$y_\mathrm{desired,max}, y_\mathrm{desired,min}$	desired upper and lower bound

y_{err}	maximum of the violation of an upper and lower bound
$\mathbf{Y}$	vector with output variables of all agents
z	auxiliary continuous variable
z_∞	auxiliary variable for computing an ∞-norm
$\mathbf{z}_1$	auxiliary variables for computing a 1-norm
$\gamma_{\text{b}}, \gamma_{\text{c}}$	positive penalty coefficients
γ_{contr}	contraction factor
γ_{exp}	expansion factor
$\gamma_{\text{m}}, \gamma_{\text{M}}$	minimum and maximum of a function
γ_{mesh}	mesh size change
γ_{s}	sensitivity threshold
$\gamma_{\Delta\text{c}}$	multiplication factor for γ_{c}
$\gamma_{\epsilon,\text{mach}}$	small postive constant close to machine precision
$\gamma_{\epsilon,\text{term}}$	small postive constant used for determining termination
δ	binary variable
ι	index of a node
$\lambda_{\text{in},ji}$	Lagrange multiplier of an interconnecting input constraint
$\lambda_{\text{out},ij}$	Lagrange multiplier of an interconnecting output constraint
$\lambda_{\text{hard,ext},i}$	Lagrange multiplier of a constraint of subnetwork i for an internal node that is connected to an external node
$\lambda_{\text{soft},i}$	Lagrange multiplier of a constraint of subnetwork i for an external node
$\mathbf{\Lambda}_{\text{in}}$	vector with Lagrange multipliers of all agents
ν	number of nodes in a network
ω	index of a neighboring node

List of abbreviations

The following abbreviations are used in this thesis:

AVR	Automatic Voltage Regulator
DAE	Differential-Algebraic Equations
FACTS	Flexible Alternating-Current Transmission System
MPC	Model Predictive Control
PSS	Power System Stabilizer
SVC	Static Var Compensator
TCSC	Thyristor Controlled Series Compensators
μCHP	micro Combined Heat and Power