RWTH AACHEN UNIVERSITY

E.ON Energy Research Center
ACS | Institute for Automation of Complex Power Systems

Master-Thesis:

Multi-frequency converter control for the energy packet based power system

Multifrequenzumrichtersteuerung für ein energiepaketbasiertes Energiesystem

Background:
A recent paper [1] describes the Energy Packet Approach for a new, digital power system concept. It is based on the idea of energy routing, i.e. „the possibility to actively control the dispatching of a given amount of energy in one given electrical line. Such concept requires the implementation of an energy router. … The operation of routing can be applied to regular continuous power flow or, an even more advanced concept, it could include the option of quantizing energy introducing the idea of an Energy Packet.“
The idea can be applied to DC or AC networks, and both applications pose several challenges. The thesis will focus on AC networks.

Challenge:
The basic idea to realize the packet concept in AC networks for one „packet generator” and several “packet users” would be to control the generator as a grid forming converter (ensuring voltage and frequency control), and the users as grid feeding converters (that are power-controlled).
One of the challenges of realizing the concept in more realistic situations is to manage overlapping packet transmission actions, i.e. situations where there are several „packet generators“ and „packet users“ transmitting and receiving packets at the same time, at the same line, maybe some entities even acting as generators AND users concurrently.
One option is to control converters so that they can act in grid-forming and grid-feeding modes at different frequencies simultaneously. More precisely, they should work in grid forming mode at some frequencies, and in grid-feeding mode at some other frequencies.
This way the separate packet transmission actions could be moved to separate frequencies (channels).

Your tasks:
The student shall

- Elaborate and implement (preferably in SIMULINK) the converter controller that allows a converter to work in grid-forming and grid-feeding modes at different frequencies simultaneously.
- Demonstrate the operation of the controller in a simulation environment with multiple converters and packet transmission scenarios
- Analyze interferences, stability, power quality.
- Outline the concept of a higher-level control (e.g. assigning priorities, managing packet transmission over multiple voltage-levels, coordination of channels – since the power system is not designed for high frequency transmission/distribution, the number of frequency channels will be limited).

The student will receive an introduction in order to start quickly with the required tools. During the work the student will be supervised and advised by the research associates of the Institute.

Requirements:
For this task the student should have a fair knowledge of power electronics with focus on the implementation of PWM converters and their control in Matlab/Simulink.

Language:
The work and documentation language can be either German or English.

Reference:
[1] A. Monti, E. De Din, D. Müller, F. Ponci and V. Hagenmeyer, "Towards a real digital power system: An energy packet approach," 2017 IEEE Conference on Energy Internet and Energy System Integration (EI2), Beijing, 2017, pp. 1-6; doi: 10.1109/EI2.2017.8245741

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