Agent Based Control of Electric Power Systems with Distributed Generation

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English Summary:

Distributed generation, decentralized and local control, self organization and autonomy are evident trends of today's electric power systems focusing on innovative control architectures such as MicroGrids, Virtual Power Plants, Cell based systems, plug-in electric vehicles and real time markets. Situation in Denmark is even more interesting, with a current 20% penetration of wind energy it is moving towards an ambitious goal of 50% penetration by the year 2050. Realization of these concepts requires that power systems should be of distributed nature – consisting of autonomous components and subsystems that are able to coordinate, communicate, cooperate, adapt to emerging situations and self organize in an intelligent way.

At the same time, rapid development in information and and communication technologies (ICT) have brought new opportunities and elucidations. New technologies and standards have been developed particularly in the area of communication and distributed control. Electric power industry is eager to explore, evaluate and adopt these new advancements in ICT for improving its current practices of automation and control in order to cope with above mentioned challenges.

This thesis focuses on making a systematic evaluation of using intelligent software agent technology for control of electric power systems with high penetration of distributed generation. The thesis is based upon a requirement driven approach. It starts with investigating new trends and challenges in electric power systems brought by introduction of distributed generation (DG). It reviews innovative control architectures and precisely identifies the requirements in these control architectures which are interesting for application of the intelligent agents and maps them to the capabilities of the intelligent agents. It suggests a multiagent based flexible control architecture (subgrid control) suitable for the implementation of the innovative control concepts. This subgrid control architecture is tested on a novel distributed software platform which has been developed to design, test and evaluate distributed control strategies. The results have been discussed from case studies of multiagent based distributed control scenarios in electric power systems.

The main contribution of this work is a proposal for system design methodology for application of intelligent agent technology in power systems. The methodology consists of suggestions for redesign of control architecture, a prototype for a software platform which facilitates implementation of multiagent control and results from case studies of specific scenarios. The work also contributes to agent based control with an approach of model based agents. In this approach the agents contain a model of their environment in order to select and reason about implications of a control action. This approach has showed promising results to improve the fault diagnosis and automation in electric power system.