Abstract

The growing amount of deployed distributed energy resources and the ongoing developments in the area of intelligent control mechanisms lead to a ubiquitous increase of the cyber-physicality of electrical power systems. Thereby, the need for an alternative to costly and complex real world experiments for the development and evaluation of innovative ideas arises. Computer simulations, especially when executed in real-time, prove to be a proper tool for fast and cost-effective prototyping, while introducing a high level of convenience for the evaluation and optimization of complex systems. When the complexity of the system exceeds the capabilities of a single simulator, cosimulation approaches, i.e. simulations consisting of multiple coupled simulators, promise to tackle the complexity by utilizing specifically optimized simulators to model individual parts of the system. Therefore, this thesis provides the concept and an evaluation for the coupling of two simulators for electrical power grids, operating in different model domains, i.e. the dynamic phasor and steady-state domains. As a use case, the two simulators DistAIX and DPsim, both developed at the Institute for Automation of Complex Power Systems (ACS), RWTH are coupled via the cosimulation gateway VILLASnode, which is part of the VILLASframework that is developed at the same institute. Thus, a concept for the electrical coupling of the participating simulators is given and three synchronization approaches, fitted to the coupling of two simulators with different inherent real-time capabilities, are introduced and compared with each other. All concepts and approaches are evaluated with respect to the scalability and real-time capabilities of the resulting cosimulation. The results show, that a simple exchange of two complex values per simulation step suffices for the electrical coupling of two power grids, modeled in the dynamic phasor and steady-state domain. The presented synchronization approach can maintain an adequate simulation error for real-time simulation of different step and grid sizes. It is also shown that this cosimulation enables further studies of the influence of swarm-based control decisions in distribution grids, onto the higher level grid, which they are attached to. As the increasing cyber-physicality of electrical power grids evokes the need for intelligent control mechanisms, the importance of such studies increases as well.