mosaik – a Framework for Smart Grid Co-Simulations

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Future energy systems will have to integrate large varieties and numbers of active components (generation and consumption devices as well as operational equipment) into energy management or operating schemes allowing for an automated on-line optimization of appropriate systems. Although the necessary Information and Communication Technologies (ICT) and automation technologies are well known and established in other application domains, their implementation and prolonged use in (safety-critical) future Smart Grids is hitherto untested and thus fraught with potential risk for relevant stakeholders in the energy domain, e.g., Distribution and Transmission System Operators. Therefore, novel ICT-based systems – e.g., for control and protection systems, adaptive ancillary service provision through decentralized units – have to be tested rigorously in advance in order to minimize uncertainties in their prospective adoption.
When addressing the key question of how and on what parts of the system to test ICT components, the scope of future Smart Grids is hard to determine. Future energy systems will depend not only on unit (generation and consumption) commitment and on the utilization of the operating equipment in between but also on weather phenomena, user preferences or strategies, the utilization and thus availability of the underlying ICT system, market prices, regulatory constraints and governance – to name but a few of the relevant facets. When taking complex interactions of these facets into account matters become even more complex. Omitting allegedly irrelevant facets might prove dangerous as even small effects quickly gain relevance through scaling a prominent example was the European 50.2 Hz frequency problem [1]. Formal analysis of such a system is not feasible anymore and realistic field tests or experimental hardware environments representative of the complex and interactive system too expensive. This paves the way for couplings of real hardware interacting with simulated environments (hardware-in-the-loop) or even pure software-based simulations in power system design and analysis. However, there is a need for proper simulation environments supporting the flexible integration of (oftentimes black-box-)models of various origin and representation (including hardware) into a functional environment.
In this talk we will present **mosaik**[1] – a flexible Smart Grid co-simulation framework for reusing and coupling existing simulation models and simulators to create large-scale Smart Grid scenarios yielding thousands of simulated entities distributed across multiple simulator processes. These scenarios may then serve as a test bed for various types of control strategies (e.g., Multi-Agent Systems (MAS) or centralized control) in complex an realistic scenarios. Following **mosaik**'s scenario design [2, 3] we will specify the state-of-the-art, identify current challenges with respect to modeling, simulation and uncertainty quantification in Smart Grid design and analysis.

References

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[1]http://mosaik.offis.de