Centre for intelligent electricity distribution
- to empower the future Smart Grid

PhD: Assessing dependability of distributed and centralized control of smart grid operation

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Challenge and objectives

The distribution grid is moving towards decentralization, both in the power supply and control domains. Although this is expected to increase the reliability of the grid, it will put different requirements on communication and coordination between different components and actors in the grid. It might also introduce new threats, for example inconsistent views of the state of the grid between different local controllers.

Research tasks

The main objective of this PhD project is to find methods and frameworks for assessing the reliability impact of different control and communication architectures in a smart distribution grid. In particular, the trade-off between centralized and decentralized control will be investigated.

Approach

The approach is primarily based on modeling using formalisms like Stochastic Activity Nets and Markov models, as well as a novel modelling framework[2]. Both power systems and ICT components are included in the same model to capture interdependencies. Results are obtained by discrete event simulation where an analytic approach is infeasible.

[1] R. Muka, F. B. Haugli, H. Vefsnmo and P. E. Heegaard, "Information Inconsistencies in Smart Distribution Grids under Different Failure Causes modelled by Stochastic Activity Networks," *2019 AEIT International Annual Conference (AEIT)*, Florence, Italy, 2019, pp. 1-6, doi: 10.23919/AEIT.2019.8893378.

[2] F. B. Haugli and P. E. Heegaard, "Modeling framework for study of distributed and centralized smart grid system services," *2021 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm)*, Aachen, Germany, 2021, pp. 321-326, doi: 10.1109/SmartGridComm51999.2021.9631997.

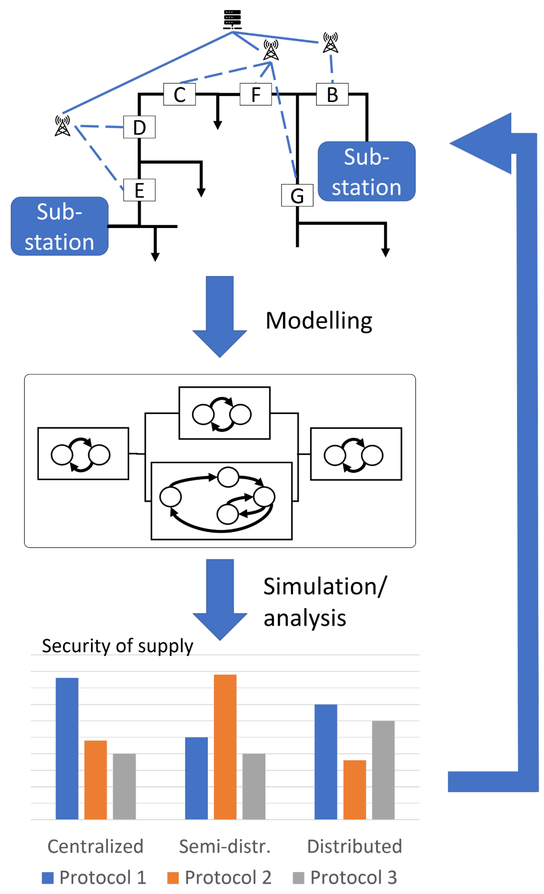
Significant results

Initial work was towards investigating the consequences and effects of value failures in smart distribution grid controls. A model of a remote-controlled disconnector was made and analyzed in collaboration with Romina Muka, Poul Heegaard and Hanne Vefsnmo to look at inconsistencies between the real and observed state of a smart grid component [1].

A framework for modelling interconnected distributed services has been developed. The models can be simulated to obtain dependability metrics for the various services[2]. The framework is currently being extended to include the propagation of incorrect, but valid data in the system.

Illustration

The figure illustrates the goal of having a tool for modeling both the power system and the ICT-portion of a smart grid, analyzing it based on relevant metrics and using the results from this to guide the design of the grid.



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