RWTH AACHEN UNIVERSITY

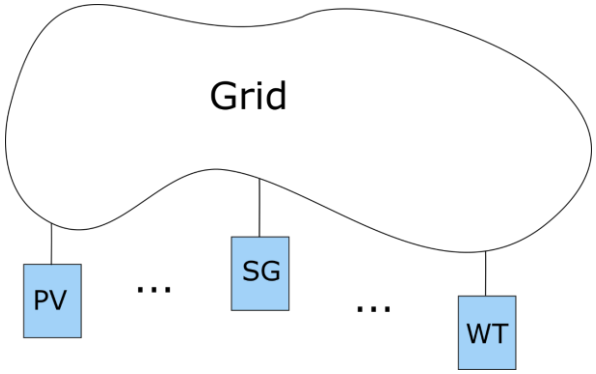
E.ON Energy Research Center
ACS | Institute for Automation of Complex Power Systems

Bachelor/Master Thesis:

Assessment of Power System Solvers for Transient Simulations with Nonlinear Components

Context:
The simulation of modern power systems requires the accurate representation of grid dynamics emerging due to additionally installed components such as distributed energy resources with low-inertia characteristics. Besides, large-scale simulations of scenarios with a high number of grid nodes allow to understand specific dynamic phenomena and to include as well lower voltage levels, but they are computationally more expensive.
To enable large-scale simulations with highest possible accuracy, the *Institute for Automation of Complex Power Systems* develops a power system simulator named *DPsim*. The power system simulator allows for electromagnetic transient simulations as well as for the application of a new simulation approach based on dynamic phasor models.

The main solution approach of the *DPsim* simulator follows the concept of Modified Nodal Analysis (MNA). During this, network elements and basic grid connected components are embedded in the MNA representation. More complex and nonlinear components are solved independently from this and considered in the system solution by their corresponding equivalents. While this solution approach is particularly suitable for simulations in real-time, it can lead to inaccuracies and instabilities.
Therefore, this thesis focusses on the integration of a differential-algebraic equation (DAE) solver for nonlinear systems. The DAE solver shall enable a system solution where all components are solved together. Finally, the thesis shall provide a comparative assessment of DAE and MNA solver in terms of aspects such as accuracy and computation time.



$$\dot{x}(t) = f(x(t), y(t), t)$$
$$0 = g(x(t), y(t), t)$$

Tasks:
The scope of the thesis can be adapted to be suitable for bachelor or master thesis. The key elements of the work will be:

- Integration of a DAE solver into an existing simulator
- Enhancement of grid component models for the solution with a DAE solver
- Configuration of the DAE solver and performance of transient simulations
- Comparison with an existing MNA solver
- Assessment of the different solvers in terms of stability, accuracy and computation time

Basic knowledge of C++ is mandatory. Experience in power system modeling and simulation is desired.

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