The parallel full-approximation-scheme in space and time for electromagnetic transient simulation

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Abstract. Power systems are used in the generation, distribution and storage of electricity. A monitoring of the supply demands a simulation faster than real-time to be able to react and act quickly. Since modern power systems are more and more complex due to modern power electronics devices, it is difficult to simulate them in real-time. High frequency switching devices require a small time step to imitate the switching process. In order to handle this, parallel-in-time techniques can be utilizied to speedup the simulation. A famous example of a parallel-in-time scheme is the parareal algorithm [LMT01], which was first introduced in 2001. The algorithm computes a numerical solution using a coarse and a fine propagator. The coarse propagator is usually a less expensive numerical scheme propagating with a coarser time step than the fine propagator, that is a more expensive numerical method with higher order of accuracy. It was already applied to electromagnetic transient simulation (for example, in [GKNS19]). In the past, speedup was shown when applying the parareal algorithm [SNC18].

In this presentation, the focus lies on a DC microgrid, which consists of the Pi-model line and the DC/DC converter. A schematic of the microgrid can be seen in Figure 1.

The Pi-model line is a transmission line to transfer voltage through the power grid. In order to balance the voltage, the DC/DC converter reduces the household's output voltage to a target output value, which is being done by switches. In case of high switching frequencies, only a small time step can be chosen to imitate the switching process as accurate as possible. Controlling of the output voltage requires a very precisely switching at every time to ensure a correct emulation of the current drain. Furthermore, the controller has to respond and act in real-time to provide voltage for electronic devices in each household.

The presentation will demonstrate the application of the parallel full approximation scheme in space and time (PFASST) in this field. The PFASST algorithm [EM12] produces a solution via Spectral Deferred Correction (SDC) [DGR00] on a coarse level called SDC sweep, which will be then interpolated to a fine level. This interpolated value is used to correct a current fine solution. Results for applying PFASST on the components of a DC microgrid and the microgrid itself in view of accuracy and speed will be presented.

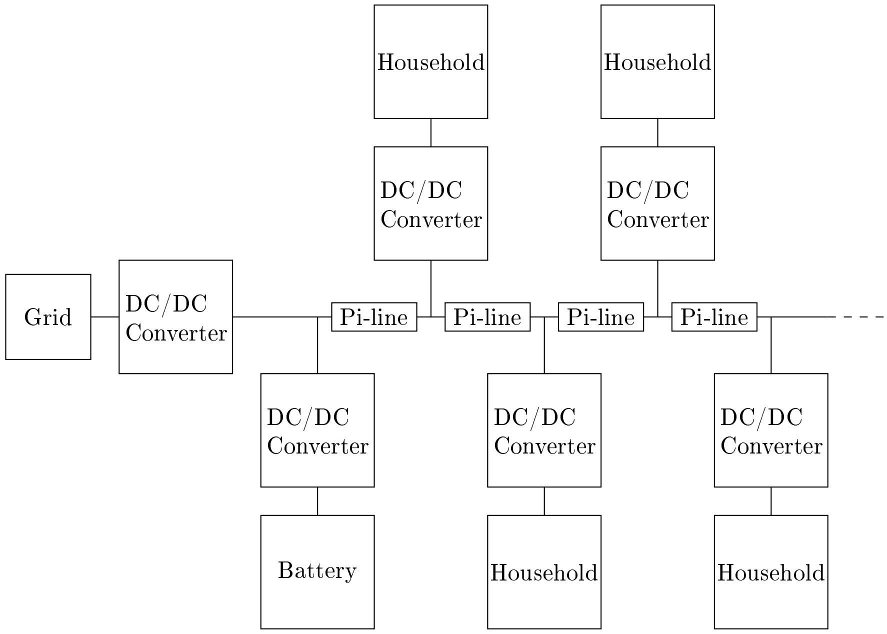

Figure 1: DC microgrid constisting of the Pi-model line and DC/DC converters in front of each household.

References

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