Decomposition, Localization and Time-Averaging Approaches in Large-Scale Power System Dynamic Simulation

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Present-day interconnected electric power systems are the largest machines in the world. Guaranteeing a stable supply of electric power is vital for modern societies: power systems must be able to withstand plausible disturbances. A certain number of simulations of the post-disturbance behavior are routinely executed by some transmission system operators to assess that the system is operated in a secure way. Usually this assessment has to be performed within a predefined time frame, using the available computing resources. Improving the simulation speed allows the operators to perform a wider assessment, thus making better use of the available computational power. A large part of this research took place in the context of the PEGASE project, supported by European Commission (Seventh Framework Programme) and has resulted in some novel algorithms for faster dynamic simulations, one of the PEGASE project main goals. First, this thesis revisits the Newton method used to solve the differential-algebraic model. Then, three original algorithmic improvements are presented, namely (i) decomposition, (ii) localization and (iii) time-averaging of the system response. Finally, the combination of these approaches is shown to provide a fast and reliable tool for dynamic security assessment. All the presented techniques have been thoroughly tested on an academic system, a large real-life system and a realistic system of unprecedented size, representative of the whole continental European synchronous grid.