

Benefits of Simulation for Operation of Large Power Systems and System Interconnections

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Abstract

Successful planning and operation of power systems and system interconnections depends largely on the engineer's skill to provide safe, reliable and economic solutions.

Simulation technologies provide useful means to the engineer for the design and analysis of the power system, assisting him in making reasonable decisions for a reliable configuration. Due to powerful software and advanced real-time simulators, it became possible to simulate dynamic behavior of large power systems including HVDC and FACTS, and to verify the performance of these complex systems with the original control and protection equipment in a fast and accurate manner. With the modern simulation technologies available today, large AC and DC transmission projects can be evaluated for delivering energy from different remote generation systems, such as hydro and thermal power plants, wind parks and photovoltaic systems.

The simulation covers all stages of development and operation of a power system, such as planning, design and also on-line operation. In the planning, demands are given on the analysis of network conditions, including investigations of the behavior and dimensioning of devices in the system. As the complexity of networks has grown, the demands on simulation technology have also risen considerably. Today, the simulation of electrical networks has reached a very high level. Excellent programs and real-time simulators are available, and their features are being constantly improved. Tools which can couple different types of real-time and software simulations have been developed and their feasibility has been shown. It is now possible to couple stability simulations of very large systems with detailed investigations of commutation processes of HVDC and FACTS in one single program, e.g. in NETOMAC. In addition, such advanced programs can even be coupled on-line with Real-Time Simulators like RTDS. Whenever this coupling cannot be used, NETOMAC provides a comprehensive tool for a systematic network reduction, in order to transfer parts from a large power system simulation in form of a reduced network into another program or into a real-time simulator, which cannot handle the full power system.

In the paper, advanced software and real-time power system simulation technologies will be presented and the benefits of the computer and real-time simulation for large power systems will be demonstrated. Practical examples which are study cases and real projects from UCTE and other parts of the world will be shown. Results of system extensions and interconnections with HVDC and FACTS and their combinations, dynamic equivalents, oscillation modal analysis and stability improvement as well as coordinated controls are given.

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