Wide Area Control Systems

G. Zweigle, J. Guerrero, H. Chun and V. Venkatasubramanian
Washington State University, Pullman, WA 99164-2752

Research objectives

- Wide-area control techniques for future power system with large portion of renewable power generation and abundance of PMUs

- Algorithms for voltage stability, oscillatory stability and angle stability controls – formulation and simulation results on test cases

Context of research for future power grid

- To rethink traditional controls like AGC, voltage controls, and PSS with aid from PMUs such as from near real-time wide-area dynamic state estimation
- To handle unpredictable complex dynamic responses from large percentage of renewable power sources in the future power system.

Deliverables

Report on a comprehensive methodology for real-time controls in the large future power system for addressing voltage, small-signal and angle stability by exploiting wide-area real-time power system state information

Description

In the uncertain operating environments of the future with rapidly changing power-flows and with large numbers of diverse power electronic equipment, the complexity of operational reliability problems will force us to design wide-area controls that are designed and implemented in real-time for power system conditions at that time.

- Voltage controls: Coordinated dynamic voltage controls may be well-suited to this framework because decisions can be made using dynamic measurements from a local area around the substation of interest. Substation level PMU measurements along with data from neighbors, as needed, will be used for voltage security monitoring and controls.

- Wide-area oscillatory controls: Modal properties of the real-time system can change quickly and abruptly in future power systems because of inherent system uncertainty. Oscillatory controls will be designed “on-the-fly” based on real-time estimation of poorly damped modes and their modal properties.

- Wide-area angle stability controls: Because of large sudden fluctuations in power-flows across distant power systems, next generation of transient stability control designs will likely be response based emergency control schemes.

Project tasks

1) Control framework and formulation in the future power system
2) Merits of different controllers and recommendations
3) Substation level voltage controllers
4) Coordinated wide-area voltage controllers
5) Formulation of real-time designs for oscillatory controls
6) Distributed formulations of oscillatory controls
7) Coordinated designs for oscillatory controls
8) Formulation and first investigation of coordinated wide-area angle stability controls

Potential uses

Formulation of wide-area controls as well as specific control strategies for mitigating voltage stability, oscillatory stability and angle stability issues in the future power system