

Introduction to the Monitoring, Control, and Protection Minitrack

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This minitrack focuses on topics related to the monitoring, control, and protection of electric power systems for real-time operations and short-term operations planning. This year the emphasis is on innovations in the area of large-scale dynamics and control for power systems and on distributed decision and control concepts for generation, storage, and loads.

The first session focuses on issues associated with large-scale power system dynamics and control. The power system is a large-scale nonlinear system consisting of hundreds of dynamic components including synchronous generators and their controls, nonlinear loads, and complex power electronic devices such as those found in inverter-based resources (IBRs) and flexible transmission controllers. Modeling and simulation of the underlying large-scale differential-algebraic equations are essential for understanding fundamental questions in power system planning and operations. Recent measurement based real-time monitoring and control algorithms are providing a renewed look at the dynamic phenomena of the interconnected power system through synchronized wide-area measurements provided by Phasor Measurement Units (PMUs). Recent events related to unplanned tripping of IBRs under transient conditions are pointing to the need for synchronized high-speed point-on-wave measurements and analysis. There is an urgent need to combine model-based power system dynamic research and measurement-based monitoring and control algorithms towards advancing real-time operational reliability and resiliency of electric power grids. This session will showcase recent developments in the area of large-scale dynamic research in the power system area.

The second session addresses distributed control concepts that can be integrated into a more decentralized command and control of existing critical energy infrastructures. The world will increasingly be required to manage heterogeneous and dispersed infrastructure-scale systems of systems such as our critical energy, power, computing and transportation systems. There is an emerging recognition of the need for new control techniques that will allow us to develop, test, protect, and integrate distributed resources with growing dispersed intelligence and diverging objectives. Moreover, these new control techniques must be secure against cyberattacks, including attacks where some of the distributed resources maliciously deviate from the proscribed control protocol or misreport measurements and calculations. Topics in this session include new control theory along with tools and testbeds that support the development of a sound scientific basis for controlling energy infrastructure using diverse resources including distributed generation and loads. This session also considers fundamental obstacles to generalizable methodologies for controlling complex engineered systems while economically and reliably achieving evolving local and global performance objectives.

The first set of papers in this year's program focus on addressing protection and control challenges in modern power systems. The papers examine control of grid-interfacing inverters, using neural networks for optimal voltage regulation, automatically evaluating power plant frequency and voltage control using PMUs, and validating adaptive protection for microgrid applications.

The second set of papers focus on the development and use of models to analyze power grids with modern techniques. Topics include sensitivity analysis of multiphase linear power flow models, the impact of lightning related features on outage prediction machine

learning models, models for grid-forming inverters, and analysis of combined transmission and distribution grid networks.