Introduction to the Resilient Networks Minitrack

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This minitrack focuses on measuring and enhancing the network resilience of future electric power infrastructure. The integration and adoption of advanced technologies in future energy systems requires sophisticated methods for understanding their integration into increasingly complex and dynamic infrastructure without compromising functional properties of the network. This year we emphasize papers that examine issues of modeling, assessment, and improvement for power system network resilience, including aspects of reliability, security, robustness, and survivability. The minitrack this year has eight papers organized into two sessions which both address these major themes.

The first session focuses on grid reinforcement, testbeds, and synthetic networks. The combined cascading failure of electricity and other infrastructure networks greatly increases the discomfort, safety, and economic loss to society. There are considerable challenges in modeling and coordinating important interactions (e.g., human, market, or economic factors) and quantifying the adverse interactions so that their risk can be estimated, mitigated and controlled. It is also important to verify and quantify these interactions in large-scale testbeds. An essential part of testbed design is the creation of synthetic networks of various infrastructures that allow the scale and complexity to be faithfully represented, allowing evaluation of novel robust solutions. Methods for reinforcing networks through hardening the physical components or offering distributed energy resources (DER) as network support are of interest as well.

The second session focuses on data analytics, machine learning, and artificial intelligence. With the increased adoption of grid modernization, demand response programs, and distributed generation that is often renewable, intermittent, and stochastic, system operators need to manage vast amounts of data in the presence of data inaccuracy and system uncertainties. This introduces new opportunities for various artificial intelligence (AI) and machine learning (ML) technologies including probabilistic AI/ML.

The first session's papers show development, use, and verification of different resilience related metrics and models in power systems. An emphasis in this session is on the model development including the experiments and testbed, toward assessing robustness of new technologies and the associated computational challenges. These papers features GPU-accelerated verification of machine learning models, ML-based data integrity attack detection and mitigation on distributed algorithms, a distribution grid simulation testbed for building and vehicle electrification, and a stochastic nodal adequacy pricing platform.

The second set of papers focus on data analytics, AI/ML, and application to make energy systems more resilient. The papers address requirements and challenges of data-driven methods within the electric power system as a safety-critical infrastructure system that must withstand numerous threats. The works address challenges arising from the wealth of data and variety of sources present, as well as the efficient use and management of both models and data to increase power system efficiency, reliability, and performance. These papers feature work on optimal distribution network reconfiguration, resource adequacy assessment, a reactive power inclusive robustness-oriented optimal power flow, and a sensitivity analysis of machine learning methods for outage risk prediction.

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