MPEL Seminar

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Resilient Distributed Optimization and Control Algorithms for Multi-Agent Power Grids

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ABSTRACT: The electricity grid is a large, complex, expensive, and critical cyber-physical infrastructure. Current electricity grid architecture is based on centralized intelligence and traditional SCADA (Supervisory Control and Data Acquisition) system paradigms, which exhibits the following limitations that affect the industry's capabilities for modernization through consumer empowerment, and limits the integration of distributed energy resources (DERs): 1) Centralized computation and control algorithms are not scalable to the control of massive numbers of renewable energy sources and storage devices needed to achieve sustainability objectives while maintaining reliability and economic optimality; 2) Centralized architecture constitutes a single point of failure, which is a cyber and physical security target; and, 3) It primarily uses dedicated communication links that are not appropriate for networks with large numbers of users or system components. To overcome these challenges, it is envisioned that future, smart grids will be populated with multiple hybrid producer-consumer (prosumer) agents, which can make strategic decisions empowered by a cyber-layer superposed on top of the physical grid. Under the prosumer-based framework, smart grids will be operated and controlled in a distributed way. The challenges are thus how to gracefully extend the current operation and control algorithms to smart grids comprised of thousands or millions of prosumers. In this seminar, I will discuss my recent efforts to address one technical aspect of multi-agent power grids, namely resilient distributed frequency regulation. I will first present a distributed architecture for frequency regulation and address the problem of how thousands of sparsely located agents can regulate frequency in a distributed and robust manner, even under an imperfect communication network. A resilient distributed algorithm is proposed to ensure a stable and fairly efficient operation of agents in the presence of a single contingency in the communication network. Next, I will discuss our current project by California Energy Commission to perform a large-scale demonstration and extensive assessment of an innovative energy management system based on Internet of Things (IoT) and Data Analytics in the Engineering and Computer Science (ECS) building, at California State University, Long Beach (CSULB). The CSULB-ECS building will serve as a prosumer, which can provide distributed frequency regulation and demand response during grid events, such as system-wide disturbances and natural disasters.