



Requirements, Architecture and Tools for Implementing Reliable Command and Control for a Demand Responsive Energy Grid

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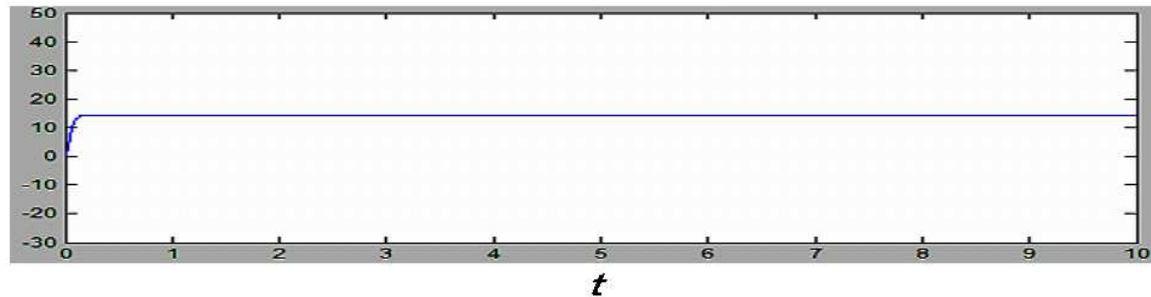
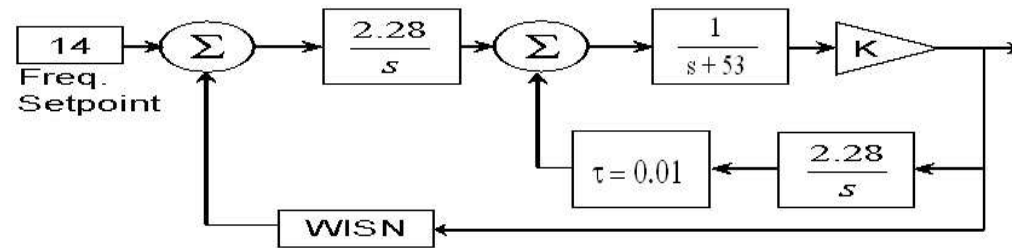


Problem Statement

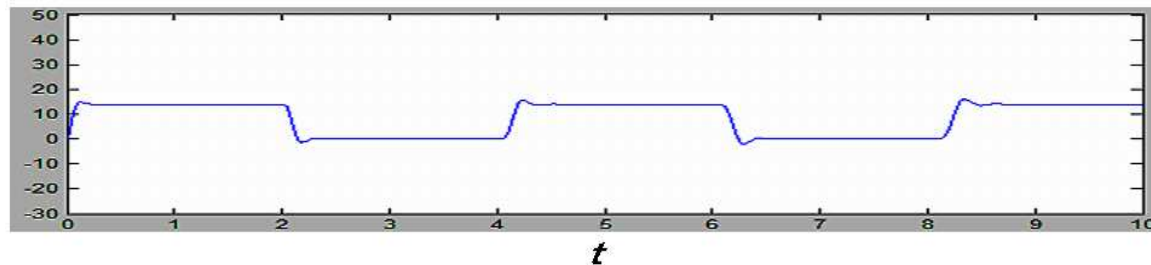
- ★ **California will increase its reliance on demand responsive resources to meet peak energy demand requirements.**
- ★ **Utilities and the CA ISO must have a means to accurately predict the amount of demand responsive load available at any given moment and dispatch it just like any generation resource if it is to replace traditional peaking resources**
- ★ **Communication latencies and other uncertainties in large distributed system such as a demand responsive systems have been shown to cause inherent system control instability in similar systems in military applications**



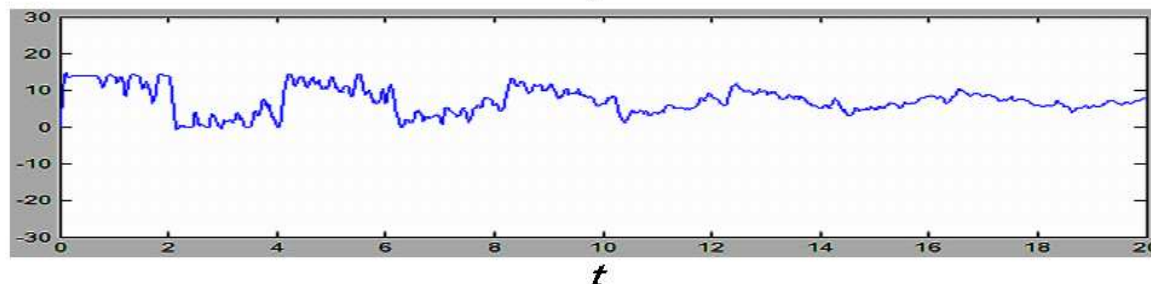
Impact of Latency on Control



No Latency



Fixed Latency



Random Latency



Project Objectives

- ★ **Develop a system modeling capability to explore the emergent chaotic behavior problem of a large distributed demand response control system**
- ★ **Develop methods to detect, avoid, and/or mitigate such control instabilities**
- ★ **Develop a set of tools and application building blocks usable by the CA ISO and utilities to be aware of available demand response resources at any moment and dispatch those resources (Distributed Resource Availability and Control System – DRACS)**



Project Approach

- ★ **Leverage military distributed command and control modeling experience to investigate the emergent chaotic behavior problem – Oak Ridge National Laboratory.**
- ★ **Develop an Open Source simulation platform based on the EPRI OpenDSS and DOE GridLab-D tool sets to simulate large scale demand response behavior including communications network interactions – EnerNex**
- ★ **Conduct workshops to capture requirements from California stakeholders (utilities, CA ISO, and demand response system providers and aggregators)**
- ★ **Develop a set of algorithms suitable for predicting demand response availability using information from utility AMI systems, aggregators, and other sources.**
- ★ **Develop algorithms and methods for reliably dispatching a specified block of energy for a specified time using demand responsive resources**
- ★ **Implement Open Source embodiments of those algorithms**



Expected Project Outcomes

- ★ **A behavioral model to account, at a minimum, for human interaction issues associated with latency, uncertainty, confidence, and decisional costs.**
- ★ **Inclusion of utility distribution company (UDC) and California Independent System Operator (CAISO) policies and operational procedures in the simulation environment.**
- ★ **Standard model and simulation practices to allow seamless integration of classical power system models (addressing state estimation, transient stability, and loading) with existing information backplane system models. This will include the ability to leverage existing physical sensor and communication models as appropriate.**
- ★ **Defined Information Exchange Requirements (IERS) to account for contextual changes in information.**
- ★ **Scalable models to capture the artifacts of a large scale deployment (And consequently, supporting high-performance simulation platforms).**
- ★ **Aggregate behavior representations to capture system-wide non-determinacy.**



Status and Next Steps

- ★ **ORNL has begun control system stability modeling work**
- ★ **EnerNex is coordinating with EPRI and DOE on simulation platform development**
- ★ **EnerNex has begun gathering related requirements documents from utilities**
- ★ **Workshop scheduling underway – announcements on time/places coming soon**



Questions?