



Use of Synchronized Phasor Measurement for Model Validation

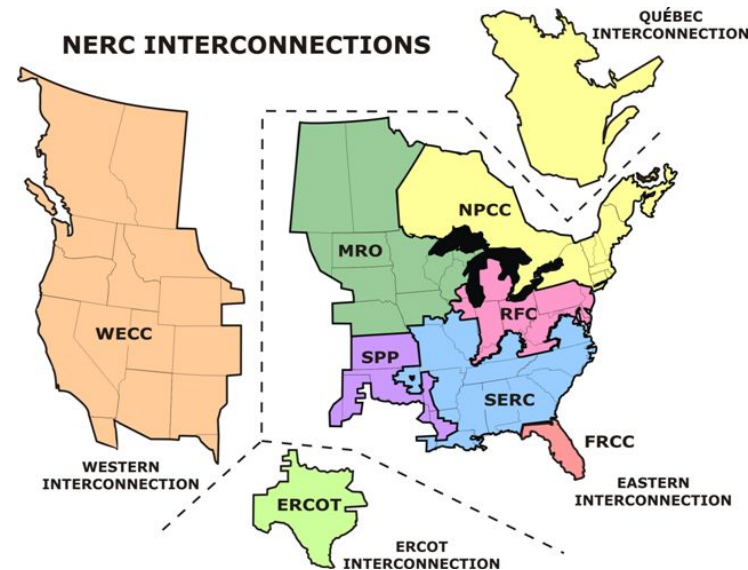
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ERCOT Operations Planning

NASPI Meeting
October 22 2013

Overview of the ERCOT System

ERCOT Capacity and Demand

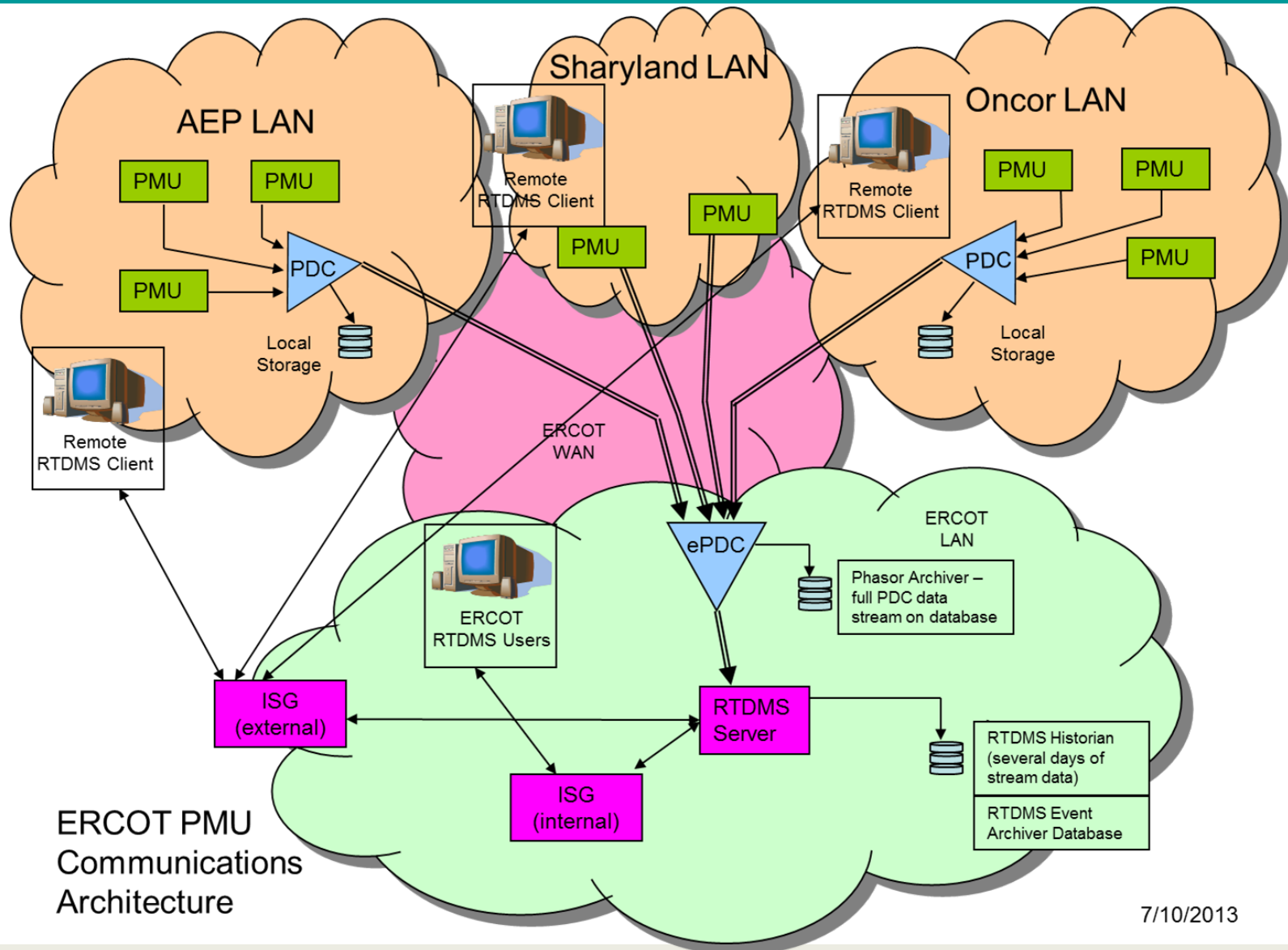
- **One of the largest single control areas in US**
 - 40,530 miles of transmission (345kV & 138kV)
 - 85% of Texas load
- **Capacity**
 - 84,000 MW total capacity
 - Wind capacity: over 10 GW – most in nation
- **All-time Peak Demand**
 - 68,379 MW peak load (Aug.3, 2011)
- **Market Size**
 - 23 million consumers
 - \$ 34 Billion Market



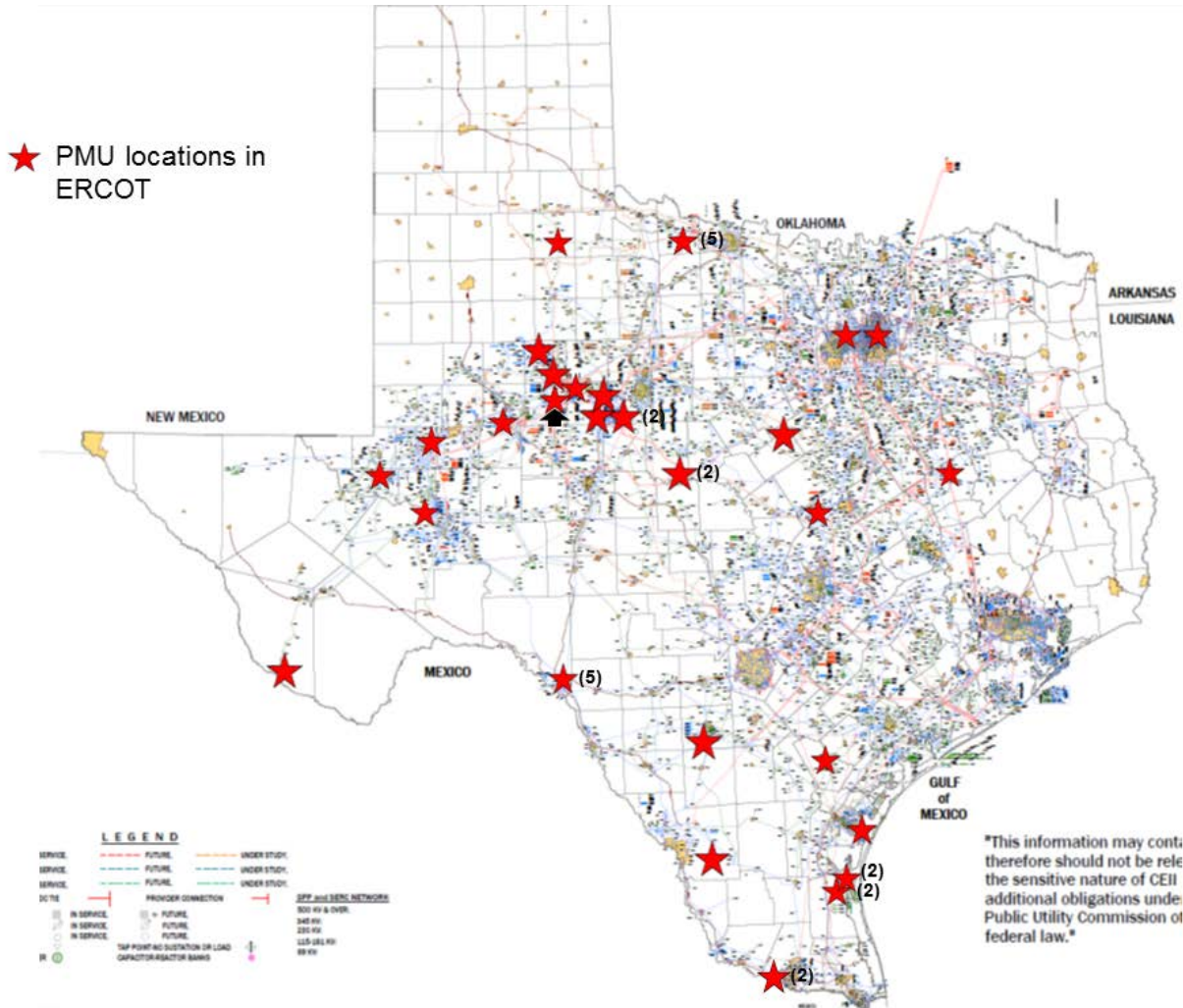
The ERCOT Synchrophasor (PMU) Project

- Started as a pilot project in 2008
- A collaborative effort including:
 - ERCOT
 - Transmission companies: ONCOR, AEP, Sharyland
 - Software vendor: EPG
 - Project coordinator: CCET
 - University: UT-Arlington

The Synchrophasor Data Communication Network



Current Status of the Synchrophasor Network



Applications of Synchrophasor Data

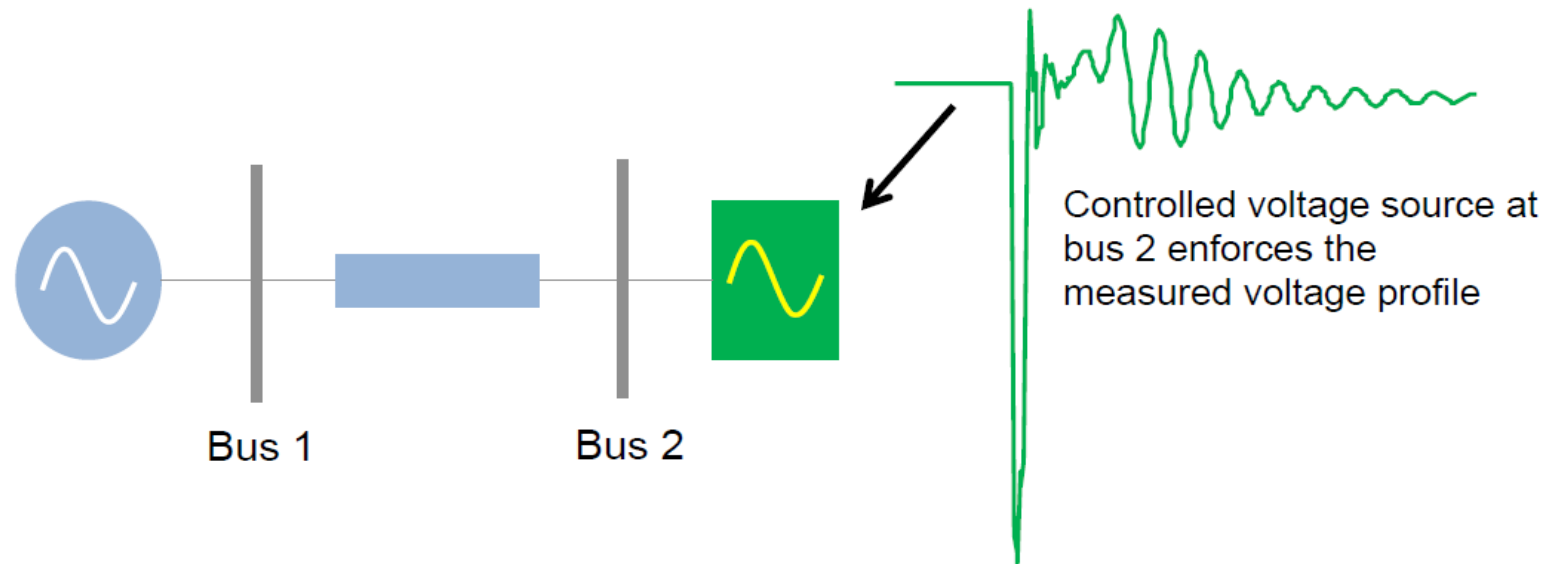
- Phasor measurement data has been used in ERCOT system for three purposes:
 - Post-event analysis
 - Real time system monitoring
 - Generator model validation

Generator Model Validation

- Both operations and planning engineers rely on dynamic simulation tools to study the behavior of the power system and identify the stability issues in the grid.
- The accuracy of the dynamic models is the key to achieve correct and reliable study results.
- Electric Device (IED) such as DFRs and PMUs can provide dynamic information with high resolution, which makes online dynamic parameter identification become valid option.

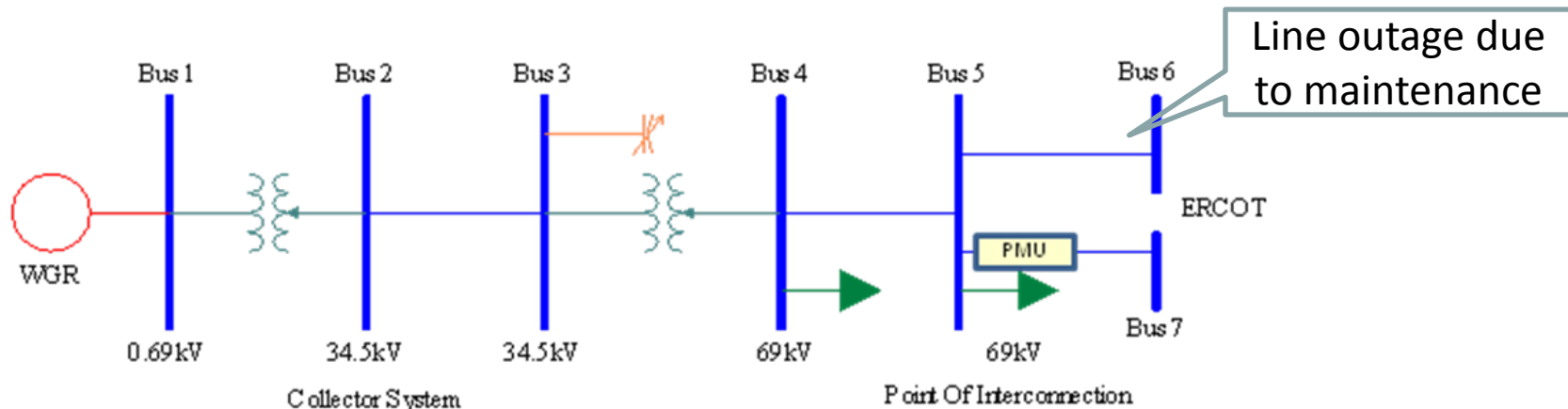
Generator Model Validation – Advantages of PMUs

- Provide additional high accuracy measurements for comparison against simulation
- Enable model verification of online events that may not be observable in off-line field testing
- Reduce model complexity by allowing model components to be replaced with a data driven component



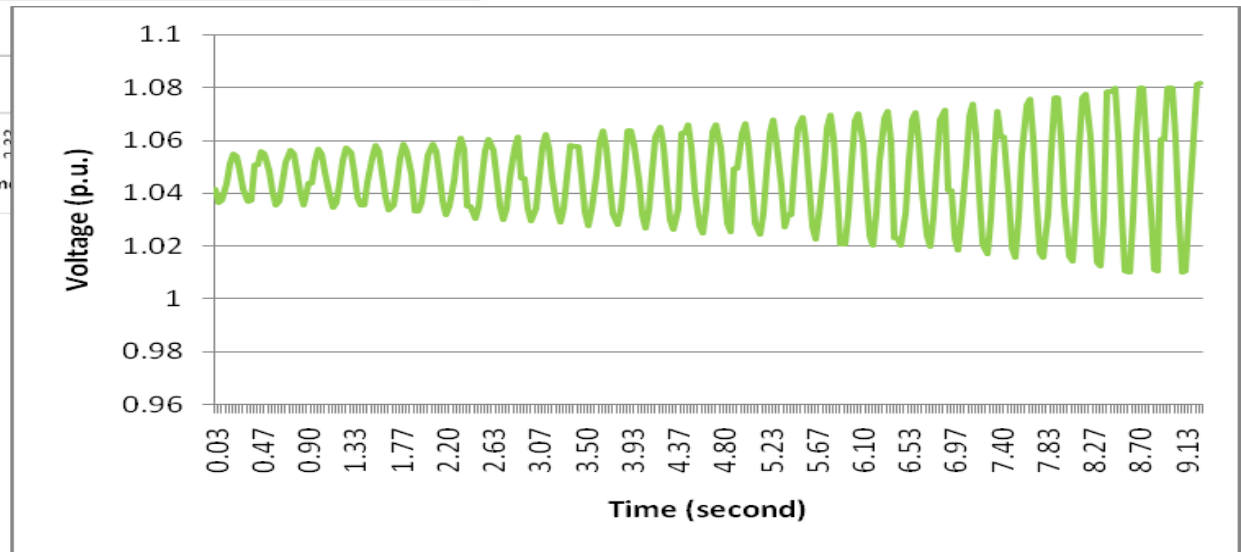
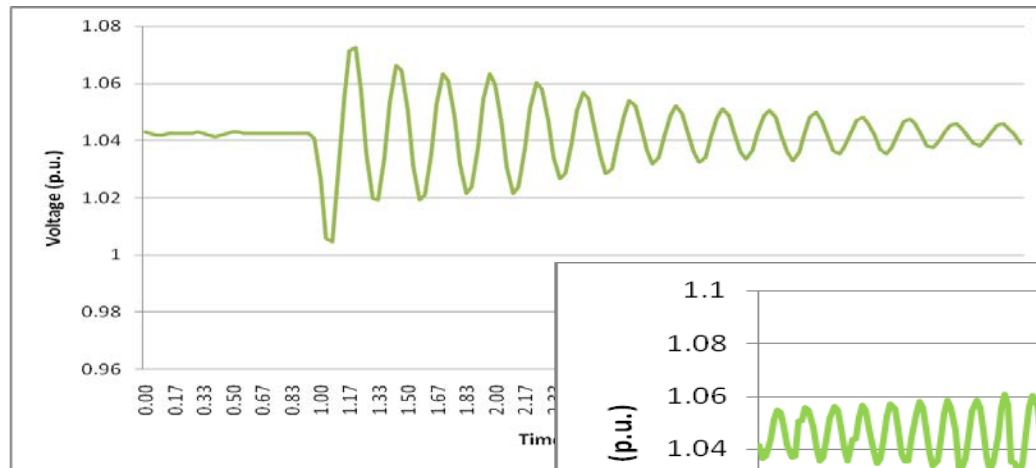
Example: Use PMU Data to tune a Wind Model

- Simplified network topology of the wind power plant



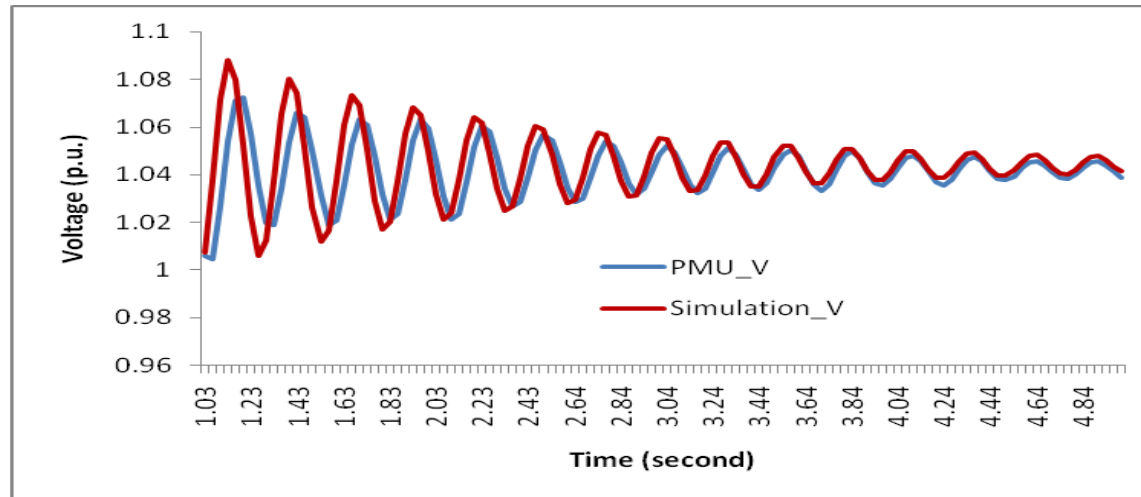
Example: Use PMU Data to tune a Wind Model

- Voltage oscillations observed at the PMU
 - Poor-damped oscillation at low output
 - Un-damped Oscillation at high output



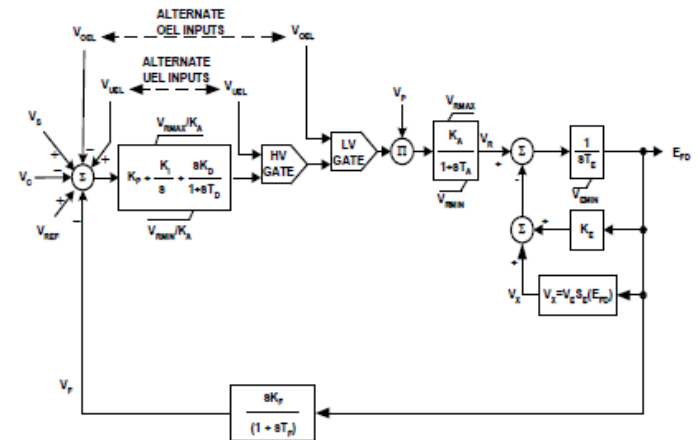
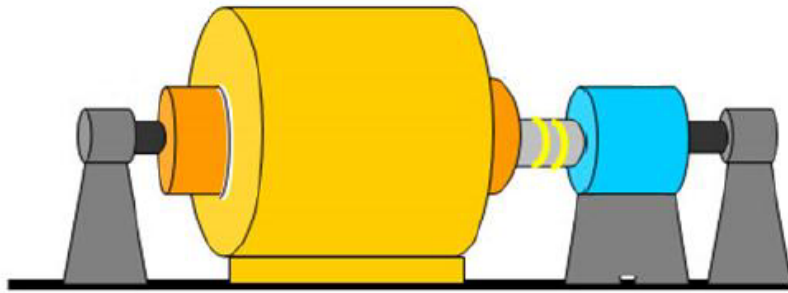
Example: Use PMU Data to tune a Wind Model

- Post Event Analysis
 - Re-create the oscillations as captured by the PMU using simulation tools such as MATLAB and Powertech Tools
 - Identify the cause and solutions to mitigate the oscillations
- Benchmarking of tuned model using PMU data –



Generator Model Validation

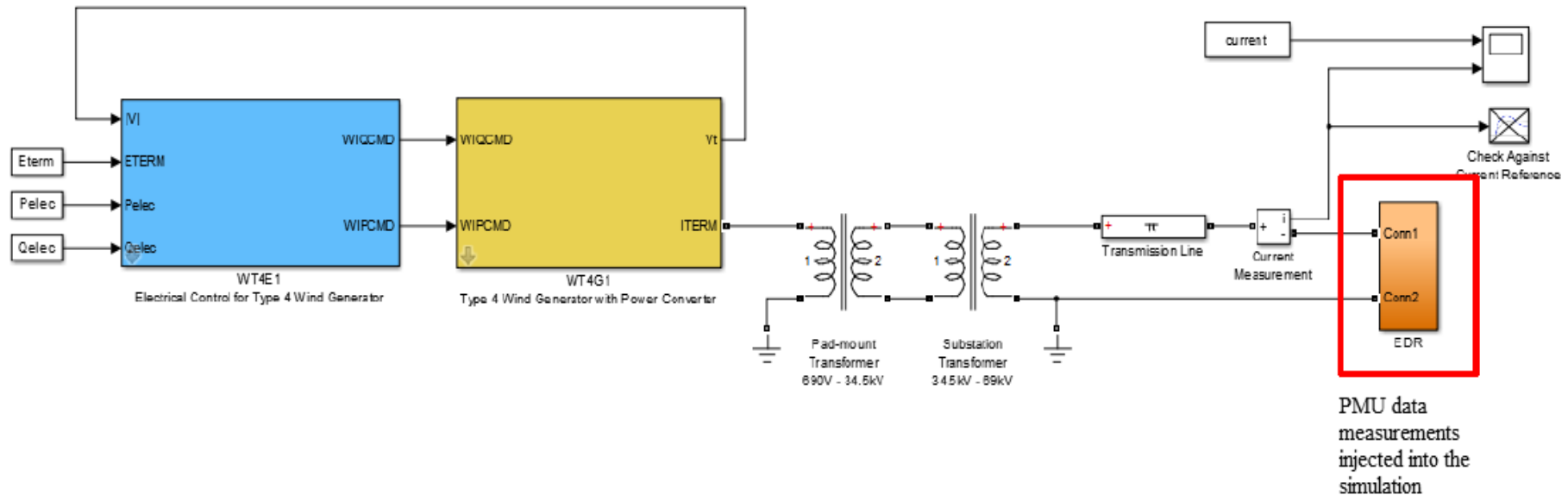
NERC Regulation (MOD 26/27) Generator/Exciter Modeling & Validation



Challenge: Build a good dynamic model for a Generator/Excitation System that matches the actual equipment in the field and validate it through offline/online testing

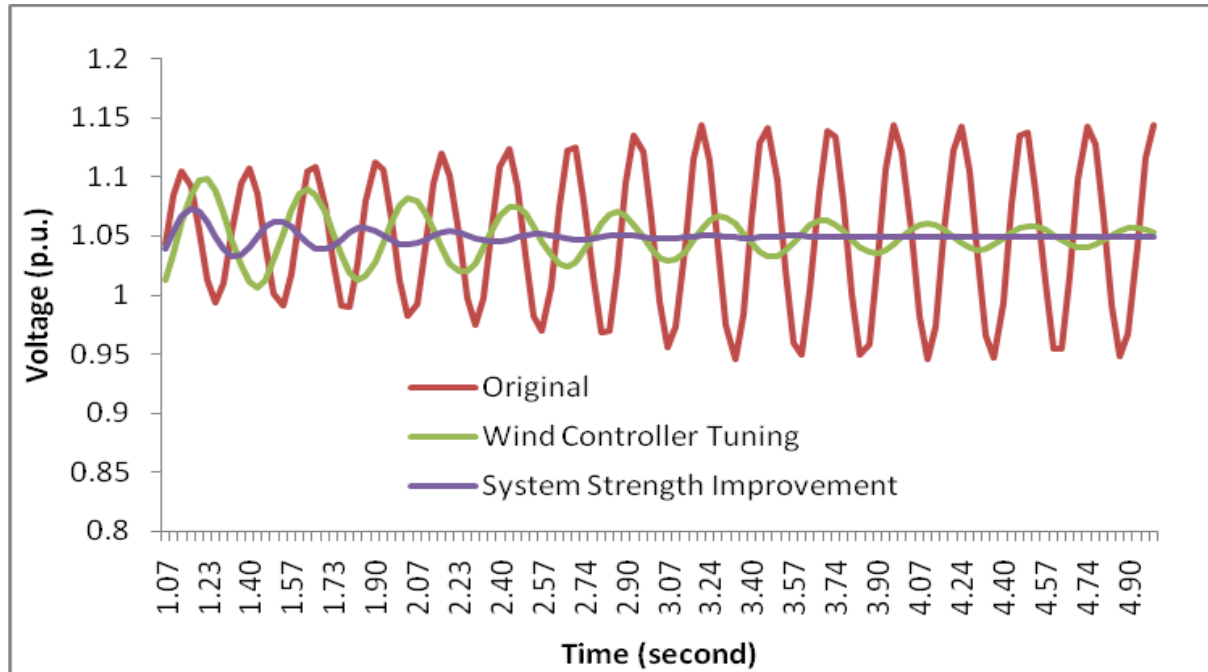
Example: Use PMU Data to tune a Wind Model

- Representation of the wind farm (generic equivalent model) and the simplified topology in MATLAB/Simulink framework



Example: Use PMU Data to tune a Wind Model

- Proposed solution based on simulation studies



Conclusions

- Synchrophasor measurements allow for parameter estimation and verification of generator models.
- Reduction of system models to a time-series data component greatly simplifies the process.
 - Possibility of online parameter estimation and verification
- Automation of the process using software tools like MATLAB greatly eases the workload associated with matching simulation models with measured response.



Q&A