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Synchronized Measurement Subcommittee Update

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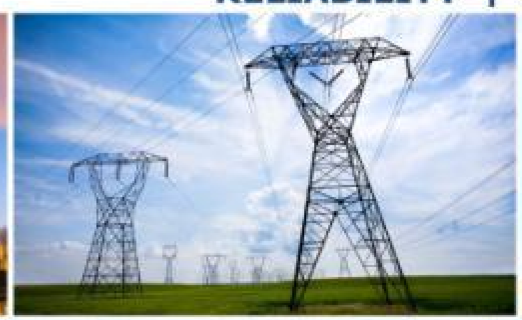
NASPI Work Group Meeting
April 2018

RELIABILITY | ACCOUNTABILITY



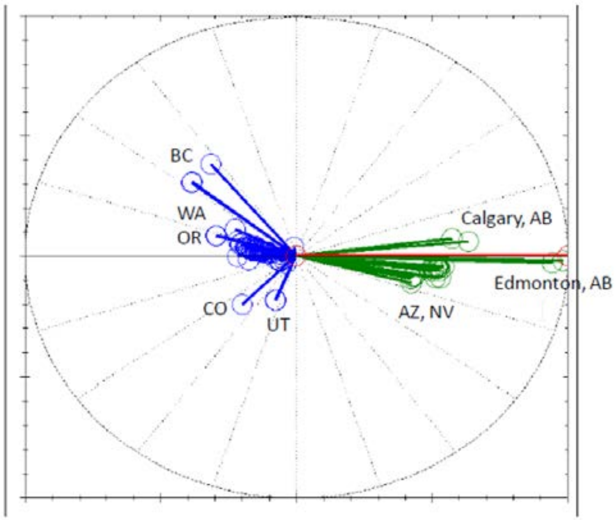


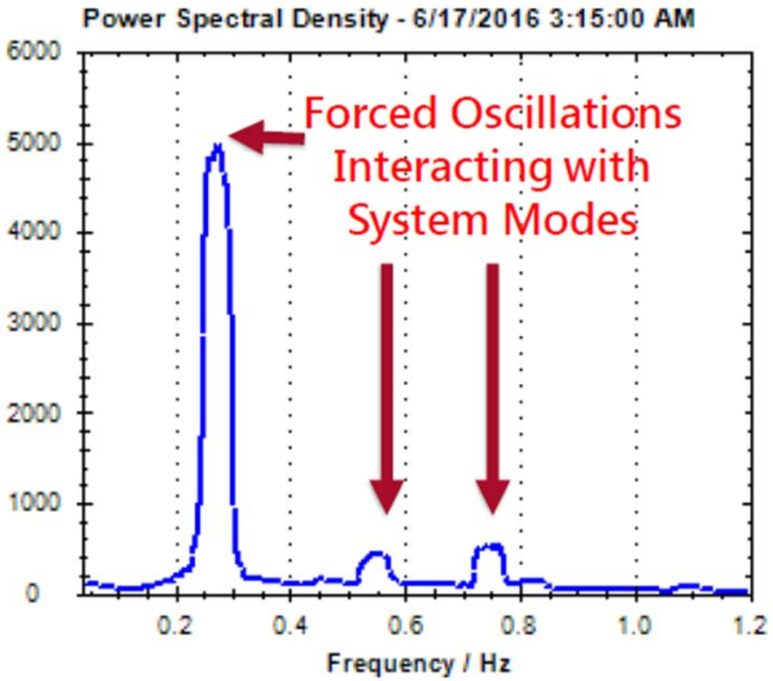

SMS Primary Activities

- Reliability Assessment: Interconnection-Wide Oscillation Analysis
- Primer on PMUs and State Estimation
- Compliance Implementation Guidance: Cyber Designation for Synchrophasor Systems

Interconnection-Wide Oscillation Analysis

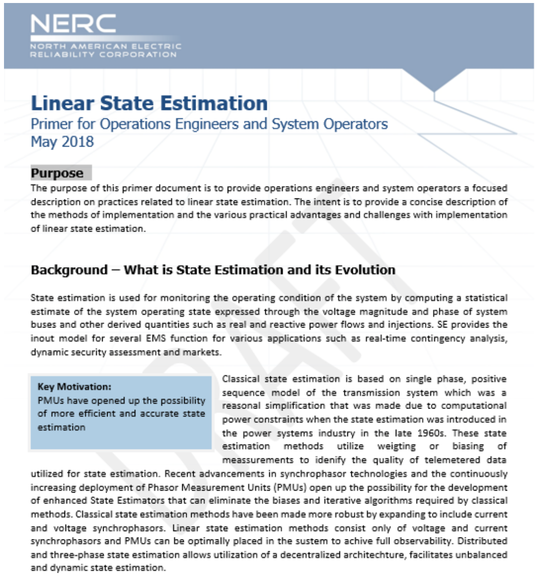
- Inter-area mode determination (ringdown analysis)
  - Mode frequencies, damping ratios, mode shapes
  - Locational aspects, transfer path considerations
- Benchmarking with models





WI Dominant Mode Comparison				
	Dominant Mode 1 Simulated	Dominant Mode 2 Simulated	Dominant Mode 1	Dominant Mode 2
Frequency (Hz)	0.37	0.25	0.71	0.37
Damping Ratio (%)	8	16	18.9	13.5
Relative Energy (%)	72	27		

Primer on Synchrophasors and State Estimation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Linear State Estimation
Primer for Operations Engineers and System Operators
May 2018

Purpose

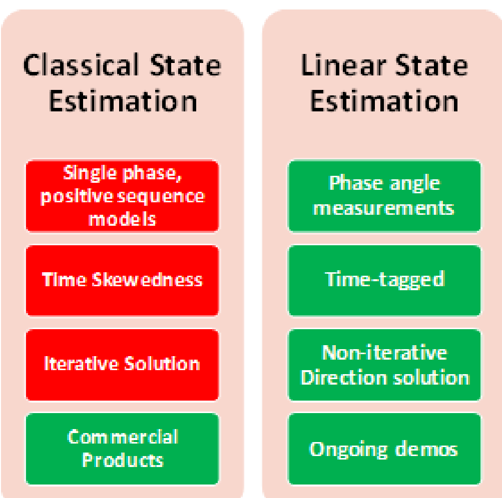
The purpose of this primer document is to provide operations engineers and system operators a focused description on practices related to linear state estimation. The intent is to provide a concise description of the methods of implementation and the various practical advantages and challenges with implementation of linear state estimation.

Background – What is State Estimation and its Evolution

State estimation is used for monitoring the operating condition of the system by computing a statistical estimate of the system operating state expressed through the voltage magnitude and phase of system buses and other derived quantities such as real and reactive power flows and injections. SE provides the inout model for several EMS function for various applications such as real-time contingency analysis, dynamic security assessment and markets.

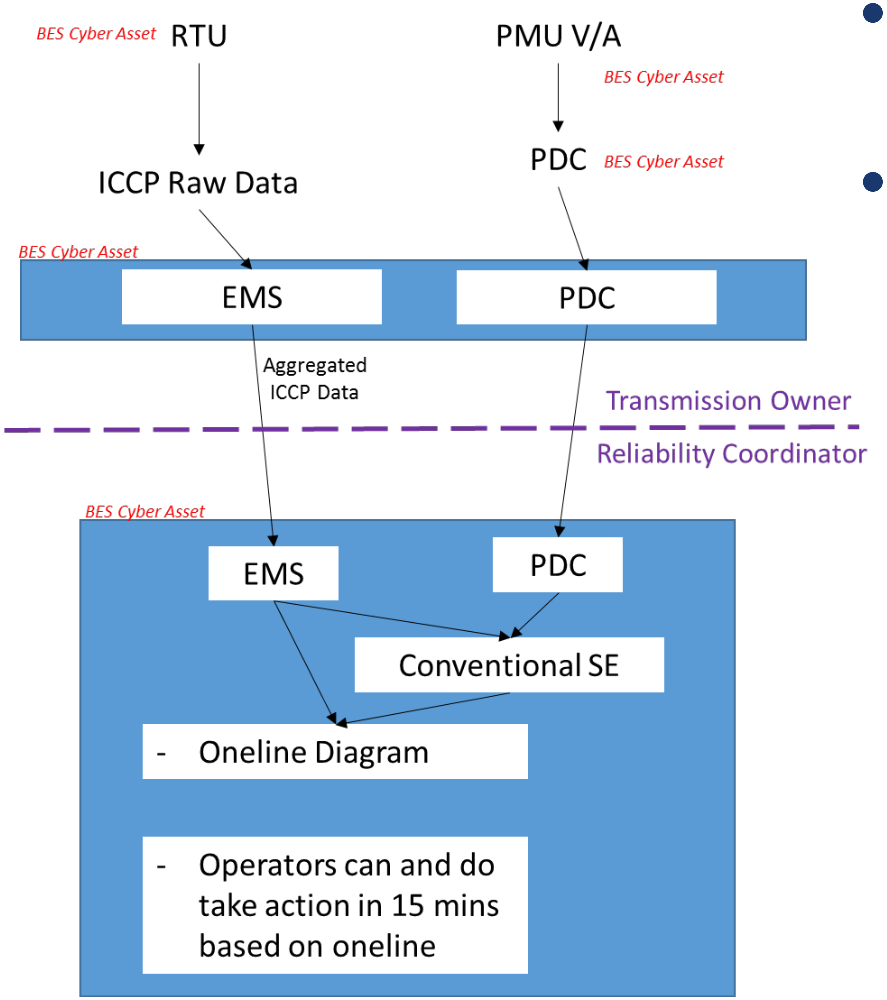
Key Motivation:
PMUs have opened up the possibility of more efficient and accurate state estimation

Classical state estimation is based on single phase, positive sequence model of the transmission system which was a reasonal simplification that was made due to computational power constraints when the state estimation was introduced in the power systems industry in the late 1960s. These state estimation methods utilize weigting or biasing of meassurements to idenify the quality of telemetered data utilized for state estimation. Recent advancements in synchrophasor technologies and the continuously increasing deployment of Phasor Measurement Units (PMUs) open up the possibility for the development of enhanced State Estimators that can eliminate the biases and iterative algorithms required by classical methods. Classical state estimation methods have been made more robust by expanding to include current and voltage synchrophasors. Linear state estimation methods consist only of voltage and current synchrophasors and PMUs can be optimally placed in the sustem to achive full observability. Distributed and three-phase state estimation allows utilization of a decentralized architechture, facilitates unbalanced and dynamic state estimation.



- For engineers and system operators
- Focus on:
  - Challenges with Traditional State Estimation
  - Benefits of utilizing PMU data for SE
  - Comparison of Traditional SE with LSE
  - Challenges and Benefits of LSE
  - Future uses of LSE

Implementation Guidance: CIP Designation for Synchrophasor Systems



- CIP designation for synchrophasor systems and components
- Example scenarios of applications and how that impacts cyber asset designation

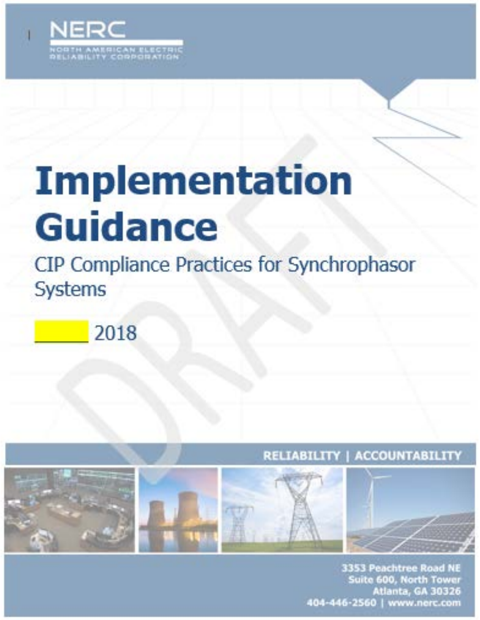


Illustration purposes only

Questions