PMU Simulator for Operator Training

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**KEY STATISTICS**

- Member companies: 940+
- Millions of people served: 61
- Peak load in megawatts: 165,492
- MWs of generating capacity: 183,604
- Miles of transmission lines: 62,556
- 2013 GWh of annual energy: 797,461
- Generation sources: 1,376
- Square miles of territory: 243,417
- States served: 13 + DC

As of 6/1/2014

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**21% of U.S. GDP produced in PJM**
PJMs Synchrophasor Deployment

• +400 PMUs.
• +100 substations.
• GOs required to install PMUs.
Introduction: PMU Simulator

• Objectives:
  – Enhance Operator training.
    • Scenarios: islands, oscillations, GMD, cascading, gas-electric interdependency, etc.
  – Application testing.

Extended Transient Simulations

Real Time Data Visualization
Architecture

1) Extended Transient Simulation
   • PSS/E.
   • +70K bus system.

2) Mapping
   • +1000 Phasors.

3) Streaming
   • C37.118

PMU Simulator

PJM’s Synchrophasor Infrastructure
Modeling

- Enhancements to perform *extended* transient simulations.
- Protection:
  - OOS.
  - OEL.
  - Impedance encroachment.
  - UVLS.
  - Etc.
- Random load fluctuations.
- LTC.
- AGC.
Example 1: Islanding Event

• Inspired by Entergy’s experience with Gustav.

• Objective:
  – Recognize island.
  – Stabilize island.
  – Re-synchronize with the system.

Example 2: Large Oscillation

- Inspired by Surry event.
  - ~0.8 Hz.
  - 200 MW peak-to-peak.

- Objective:
  - Recognize oscillation.
  - Identify participating units.
  - Damp the oscillation.

- Oscillation detection tools.
Conclusion

• Question:
  – How to introduce synchrophasors to the control room?

• Answer:
  – Easy, enhanced training!

• PJM’s PMU simulator goes in production 2016.

• Complement traditional simulator (load flow based).