PJM Interconnection
Smart Grid Investment Grant Update

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PJM Project Participants

• **PJM Leads:**
  – Project Manager: Bill Walker (walkew@pjm.com)
  – SynchroPhasor Technical Lead: Mahendra Patel (patelm3@pjm.com)
  – Operations Management: Dave Souder (souder@pjm.com)

• **Vendor Partners:**
  – Electric Power Group (PDC and visualization software)
  – Quanta Technology (engineering/project management)
  – Virginia Tech University (PMU/PDC device testing)
Project Summary

• 12 Transmission Owners installing measurement devices at 81 substations
  – TO’s selected their own vendors
• Transmission Elements Monitored
  – 64 SS > 345kv
  – 17 SS < 345kv
• Approx. 20% of regional footprint monitored
• Installing PMU’s, Relays, DFRs, DDRs
<table>
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<tr>
<th>Transmission Owner</th>
<th># of Substations with PMU Installations</th>
<th># of Central PDCs</th>
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<td>Allegheny Power</td>
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<td>American Electric Power</td>
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<td>Baltimore Gas &amp; Electric</td>
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<td>Commonwealth Edison</td>
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<td>Duquesne Light</td>
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<td>Public Service Electric &amp; Gas</td>
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<td>Orange &amp; Rockland Electric</td>
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<tr>
<td>VA Electric &amp; Power (Dominion)</td>
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<td>2</td>
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<tr>
<td>Duke Ohio</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
Installing PMUs at 100+ substations; Building support for 150+ substations
BIG PICTURE
Project Priorities From Here

• Key Tasks:
  – Complete connections and configurations
  – Improve Data Quality and Availability

• Phasor Application Use:
  – Phase Angle display in Control Room
  – Feed Intelligent Event Processor (IEP)

• Measure of Success:
  – Data Validation and Event Analysis
  – Operations Integration
  – Data Exchange with neighboring RC’s
Success Stories So Far

• Database design
  – New ways to move and store large amounts of data

• Virginia Tech Testing
  – Provides insight into performance specs for multiple vendor product (PMU and PDC)
Challenges and Lessons Learned

- TO Installation Schedule Changes
- Multiple vendors h/w and s/w in use
- Data Quality and Availability
- Coordination of all project stakeholders
  - TOs, Vendors, ISO/RTOs, DOE
- Ensuring the architecture is scalable
- Storage, Storage, Storage
- R&D approach vs. “touch it once” approach
- Data Exchange with other RTO/ISO’s
Synchrophasor Training

- Phased approach to Training
  - Trained on applications as introduced
- Information sessions delivered to OPS
  - High-level introduction to SynchroPhasors
- Remote view training to TO’s
  - RTDMS functionality for remote access to views
  - Repeat/refresh needed
- Building new training modules
Project Timeline

• **Q4 2013 & Q1 2014**
  – Connect remaining substation pmu’s
  – Improve Data Quality and Availability
  – TO Operator Training/Release PJM-Wide views
  – Install additional data storage hardware
  – Data Exchange
  – Roadmap
Phasor Data-sharing

• Data Exchange with MISO
  – Receiving 250 pmu’s
  – Sending 314 pmu’s

• Data Exchange with NYISO
  – Establishing network connectivity

• Receiving data from 12 PJM TO’s
  – 314 pmu’s from 82 substations now live
DETAILS

North American SynchroPhasor Initiative
PDCs and Communications

• PDCs
  – 12 (+6) TO Control Centers with Central PDC
  – Archive Database Status
    • Storage Size – 220 TB (approx. 3 years retention)
    • Data archive considerations
      – 90 days real-time; 1 year near-real-time; 7 year archive
  – PJM PDC Availability: 99.86%

• Communication System
  – 12 (+6) dedicated/redundant links to TOs (T1 lines)
  – 2 dedicated MPLS Clouds; 1 Verizon and 1 AT&T
  – System Availability: 99.99%
* Target of .2%.
Data Quality and Availability

• Overall 91% of data is received without errors
• 50% pmu’s - “Good” [maintain < .2% avg. error]
• 58% pmu’s - “Timely” [latency <500ms]

• Poor Quality – Root Causes
  – PMU Calibration - Loss of telecom connection
  – GPS Clock issues - Server overload
  – Data Name limitations - Aliasing at PDC
  – Loose cables - PDC configurations

• Lessons Learned
  – Establish test criteria to use at installation
  – Ensure data quality at TO PDC before sending data
Major Operational Applications Using Phasor Data

• EPRI PPPD - Generator Model Validation
• Bigwood Systems - Network Model Validation
• Siemens State Estimator
  – Current and Voltage Phasor measurements
  – Testing impact of “bad” phasor data
• EPG RTDMS
  – Real-time phase angle displays, oscillation detection
• Intelligent Event Processor (IEP)
  – Alerts and Alarms through PI
Thank You