Smart Grid Investment Grant Update

Kevin Frankeny
kfrankeny@misoenergy.org

NASPI Work Group Meeting
October 22-24, 2013

NASPI North American SynchroPhasor Initiative

ARRA Disclaimer

"This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

Project Participants

- **Lead Sponsors**
  - David Zwergel, Project Sponsor, dzwergel@misoenergy.org
  - Kevin Frankeny, Business Owner, kfrankeny@misoenergy.org
- **Participating Transmission Owners**

As of October 17th , 2013

Ameren	American Transmission Company	Duke Energy	Great River Energy
Hoosier Energy	Indianapolis Power & Light	International Transmission Company	Manitoba Hydro
MidAmerican Energy	Minnesota Power	Montana Dakota Utilities	Northern Indiana Public Service
Ottertail Power	Vectren (SIGE)	XCEL Energy (NSP)	WAPA

- **Research and Development Partners**
  - University of South Florida
  - University of Tennessee at Knoxville

Project Map 2013

As of October 17th, 2013

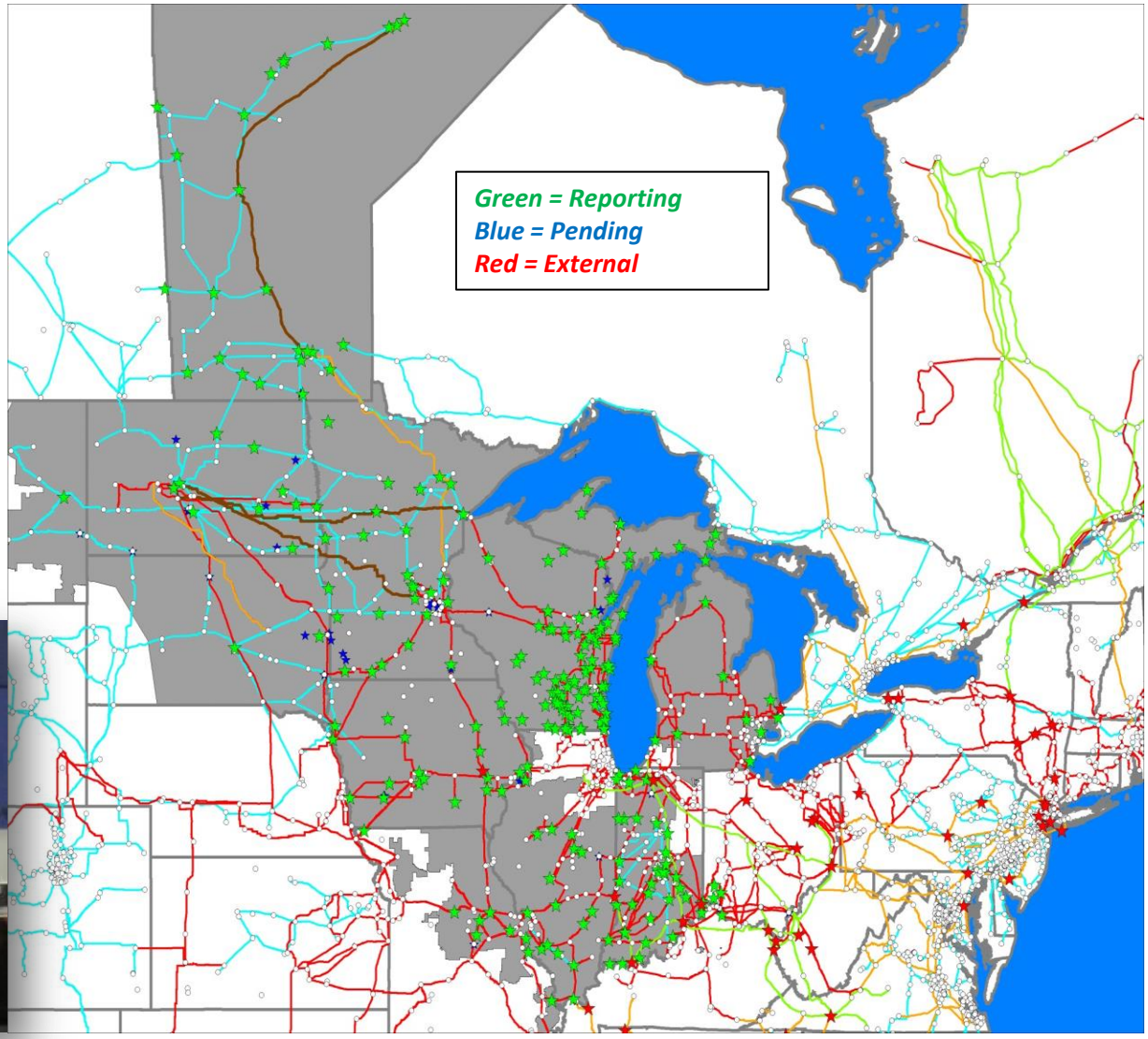
SGIG Project

- 265 PMUs Targeted
- 197 Installed (current)

Current Overall

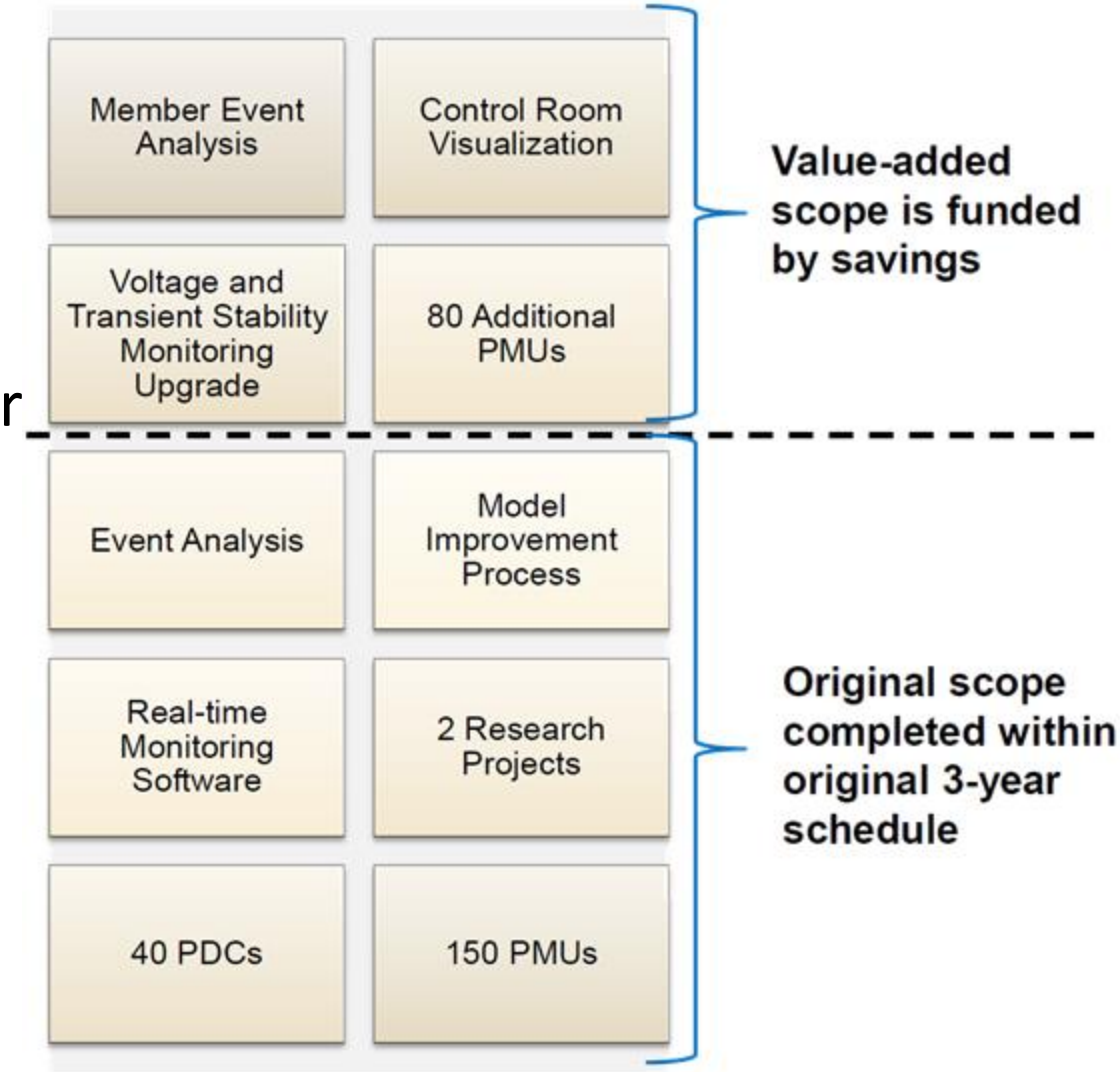
- 363 Total PMUs
- 248 Substations
  Including TVA, PJM, NYISO

PMU at Member Substation



Background

- MISO is one of 100 DOE Smart Grid Investment Grant (SGIG) recipients
- Original goals met under budget using:
  - Lower-cost equipment
  - Software
  - Project efficiencies



* PEP Version 5

Project Highlights

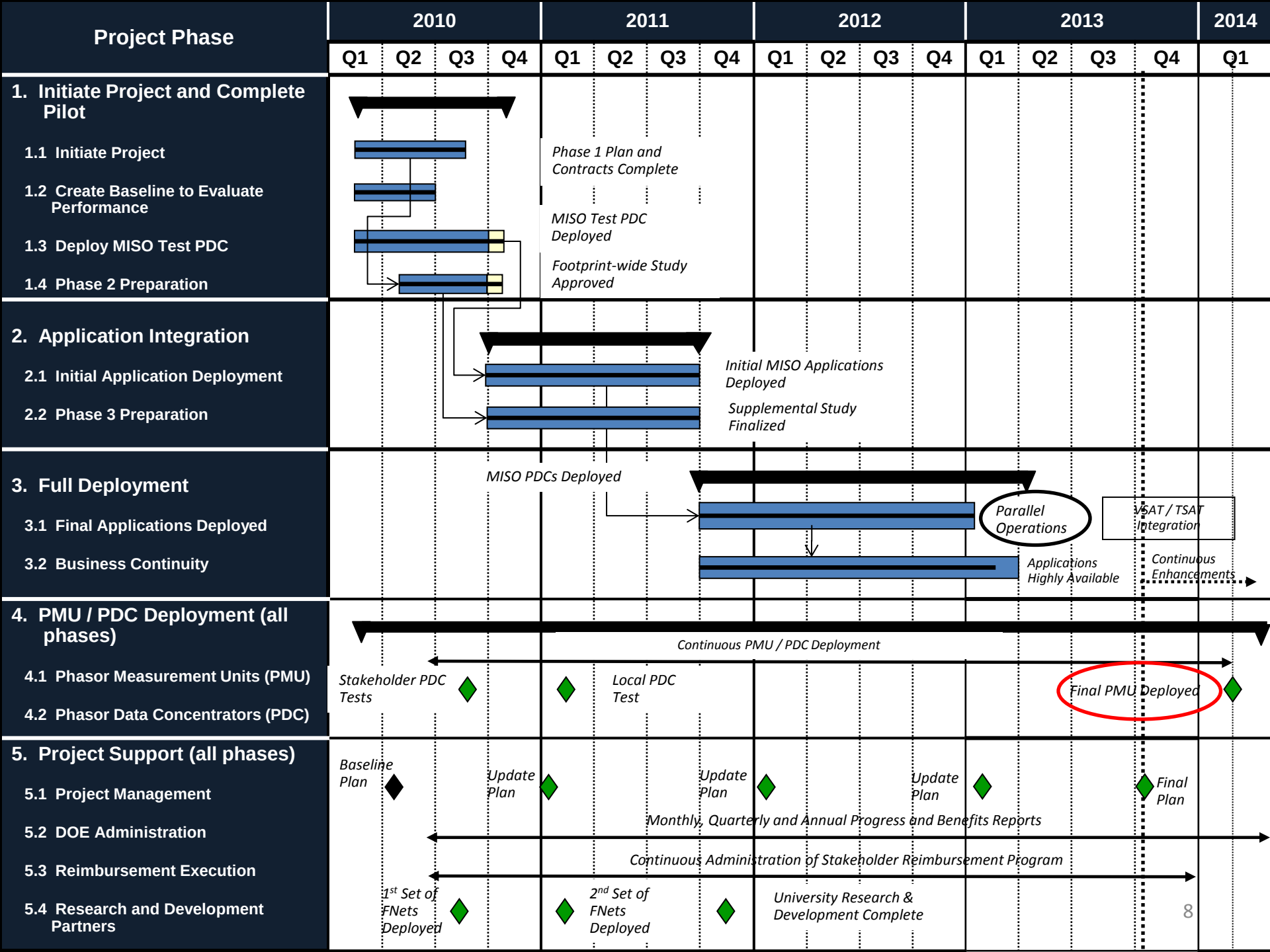
- **Project continues to be managed effectively and efficiently**
  - One year extension through March 2014
  - Concentrating on final installations and value-add initiatives
- **Baseline solutions deployed in production**
  - Deployed applications to Real-Time Operations
    - Real-Time Monitoring and Enhanced displays
    - Continuous staff training
    - MISO-hosted TO applications facilitate data sharing
  - After-the-Fact Event Analysis and Dynamic Model Improvements in 2012

Project Highlights (cont.)

- Over 79% of targeted MISO SGIG PMU devices are verified and streaming data
- Data exchange with 16 TOs, PJM, NYISO, and TVA

As of October 17th, 2013	**TOs**	**PMUs**	**PDCs**	**Total**
Participating Stakeholders	16			
Signatories to Master Services Agreement	17			
Target Devices		254	40	294
Streaming MISO SGIG Devices		201	32	233

- Devices are deployed on highly available and secure infrastructure
- Working on enhanced data quality, reliable data transfer, archiving, and compliance processes


Project Phase
2010
2011
2012
2013
2014
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1
1. Initiate Project and Complete Pilot
1.1 Initiate Project
1.2 Create Baseline to Evaluate Performance
1.3 Deploy MISO Test PDC
1.4 Phase 2 Preparation
Phase 1 Plan and Contracts Complete
MISO Test PDC Deployed
Footprint-wide Study Approved
2. Application Integration
2.1 Initial Application Deployment
2.2 Phase 3 Preparation
Initial MISO Applications Deployed
Supplemental Study Finalized
3. Full Deployment
3.1 Final Applications Deployed
3.2 Business Continuity
MISO PDCs Deployed
Parallel Operations
VSAT / TSAT Integration
Applications Highly Available
Continuous Enhancements
4. PMU / PDC Deployment (all phases)
4.1 Phasor Measurement Units (PMU)
4.2 Phasor Data Concentrators (PDC)
Continuous PMU / PDC Deployment
Stakeholder PDC Tests
Local PDC Test
Final PMU Deployed
5. Project Support (all phases)
5.1 Project Management
5.2 DOE Administration
5.3 Reimbursement Execution
5.4 Research and Development Partners
Baseline Plan
Update Plan
Update Plan
Update Plan
Final Plan
Monthly, Quarterly and Annual Progress and Benefits Reports
Continuous Administration of Stakeholder Reimbursement Program
1st Set of FNets Deployed
2nd Set of FNets Deployed
University Research & Development Complete

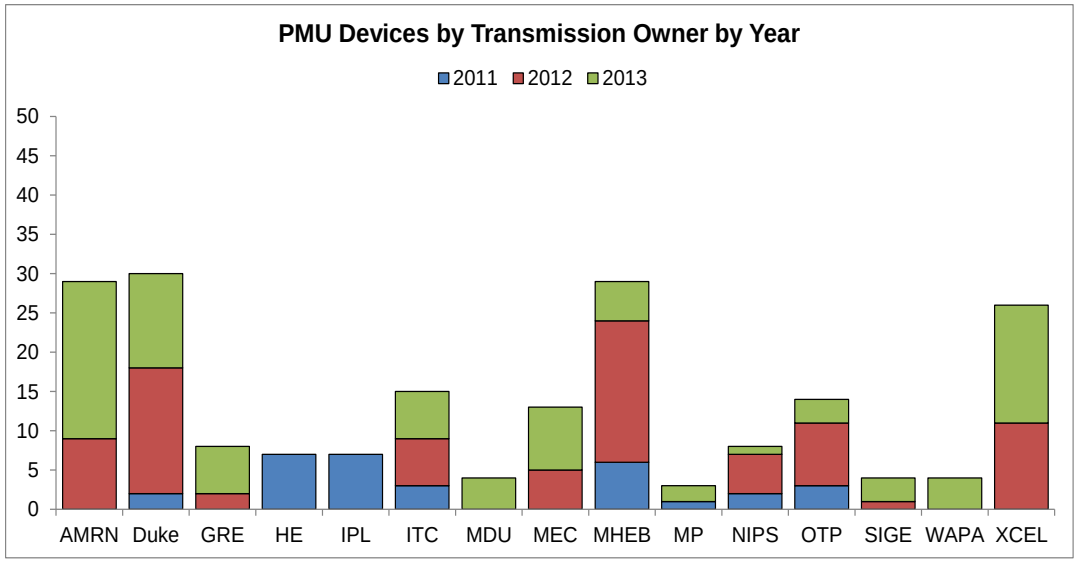
Devices By Participant

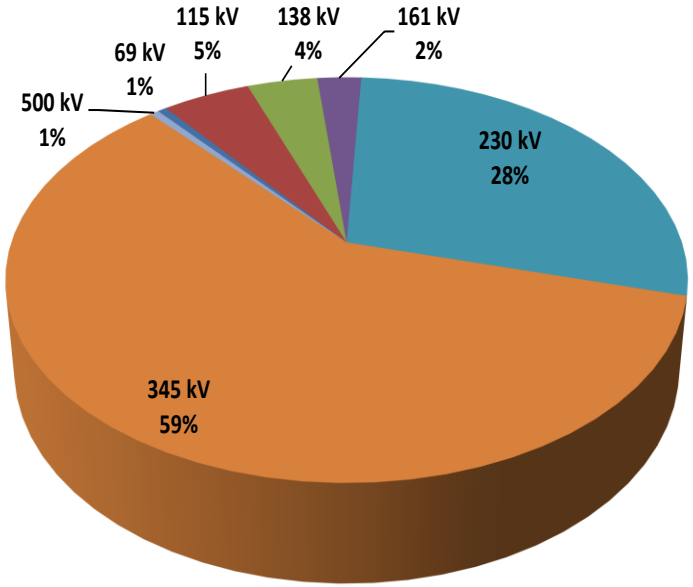
Transmission Owner	MSA Executed	MISO SGIG PMUs	Other PMUs	Streaming PDCs
Ameren	Yes	29	6	3
American Trans Co.	Yes	0	97	0
Duke Energy	Yes	30	2	3
Great River Energy	Yes	8	2	1
Hoosier Energy	Yes	7	2	3
Indianapolis P&L	Yes	8	0	1
International Trans Co.	Yes	15	0	2
Manitoba Hydro	Yes	29	2	3
MidAmerican Energy	Yes	13	0	1
Minnesota Power	Yes	3	0	2
Montana Dakota Utilities	Yes	4	0	1
Northern Indiana Public Service	Yes	8	0	3
Ohio Valley Electric Corporation	Yes	0	0	0
Ottertail Power	Yes	14	0	2
Vectren (SIGE)	Yes	4	0	2
WAPA	Yes	4	0	2
XCEL Energy (NSP)	Yes	25	0	3
TOTAL	17	**201**	**111**	**32**
PROJECT TARGET	16	254		40

PMUs

As of October 17th, 2013

- **Targets**
  - 254 PMU devices
- **Validated and Streaming**
  - 201 MISO SGIG PMU Devices, 111 Legacy devices
- **Transmission elements monitored**
  - 178 PMUs at 230 kV and above
  - 23 PMUs below 230 kV



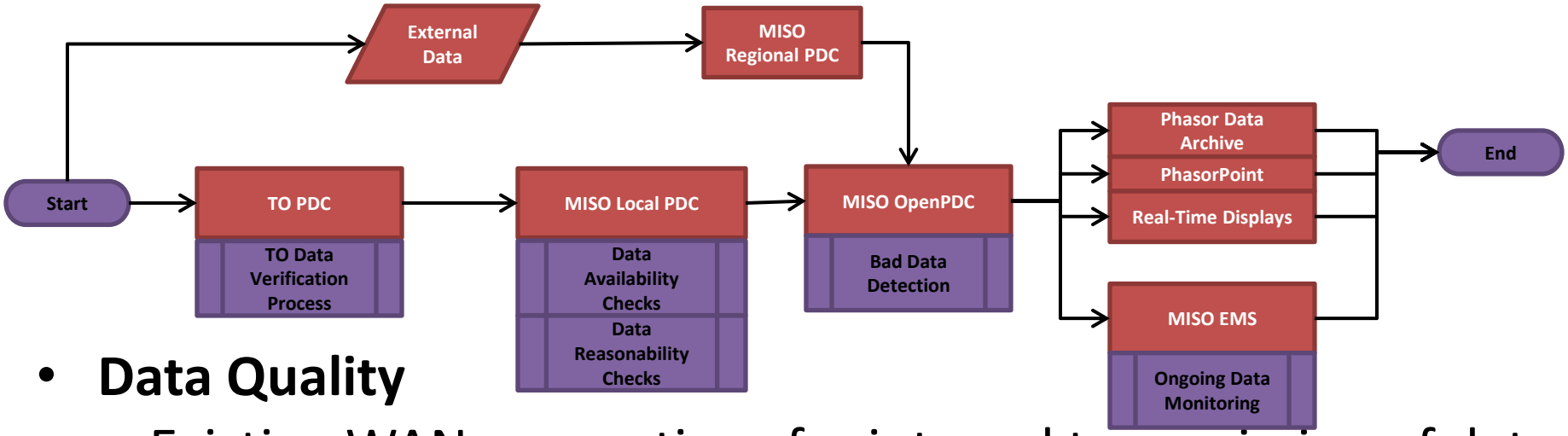


PDCs

As of October 17th, 2013

- 40 total PDCs under contract
  - 32 validated devices
  - 16 Transmission Owners have PDCs with contracts for Highly Available PDCs
- MISO has both a “local” and “regional” PDC
  - Local PDC receives transmission owner data
  - Regional PDC receives data from other Regional Entities
- Incorporating existing infrastructure, where applicable
  - Sampling rate of 30 Hz
  - Approximately 313 GB of data streamed per day
  - Majority of PDCs are above 99.9% availability
    - Less than 5% of data is lost due to prolonged issues

Data



- **Data Quality**
  - Existing WAN connections for internal transmission of data
  - 96% of data is Excellent
  - 4% of data lost due to long term or GPS issues
  - Data check process implemented to address quality issues
- **Data Archive**
  - Oracle-based archive solution
  - Designed to store at least 7 years of Phasor data
  - Redundancy and security

Operational Applications

Deployed enhanced solutions in production:

Centralized Situational Awareness

- *Enhanced Real-Time Displays (eRTD)*

Wide-Area Monitoring and Visualization

- *Phasor Point*
  - Oscillation Detection and Monitoring
  - Frequency Stability Monitoring
  - Voltage Stability Monitoring
  - Disturbance Detection and Alarming

After-The-Fact Event Analysis and Model Validation

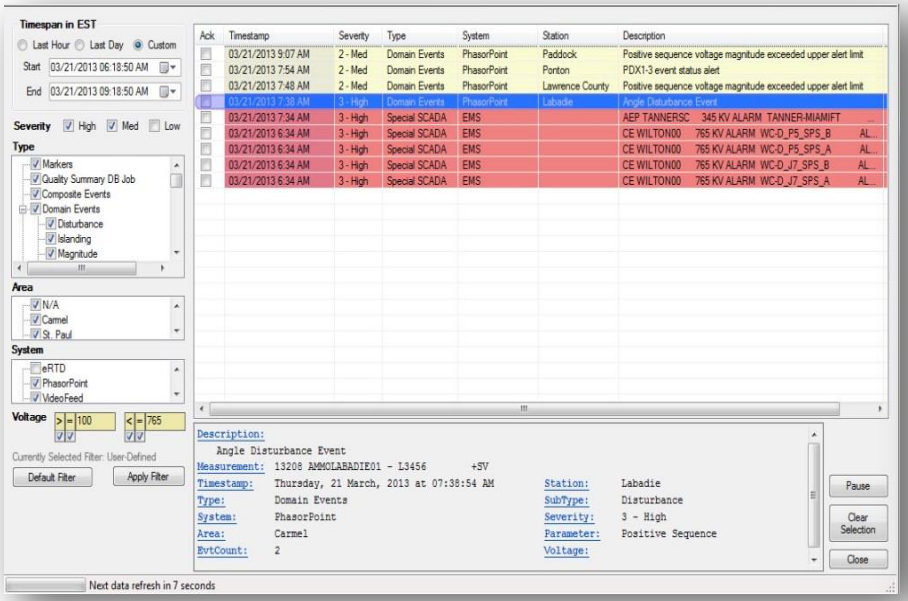
- *Phasor Grid Dynamics Analyzer (PGDA)*

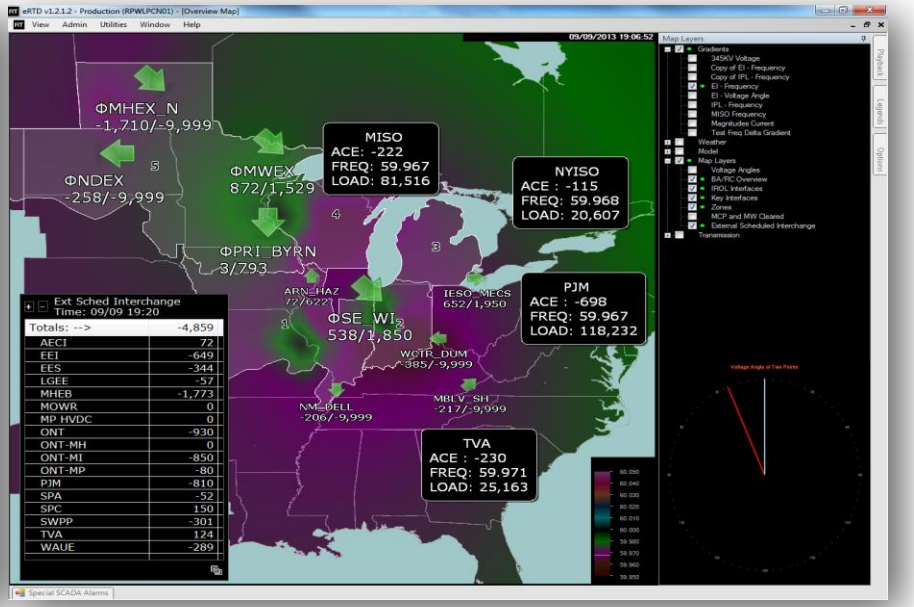
Operational Applications (cont)

- **Renewable Generation Integration**
  - Several PMUs near wind resources
  - Study affects of increased wind on system-wide small signal stability
- **Line Monitoring and/or Dynamic Line ratings**
  - Out of scope
- **State Estimation**
  - Plans to integrate data into EMS platform in the future

Centralized Situational Awareness

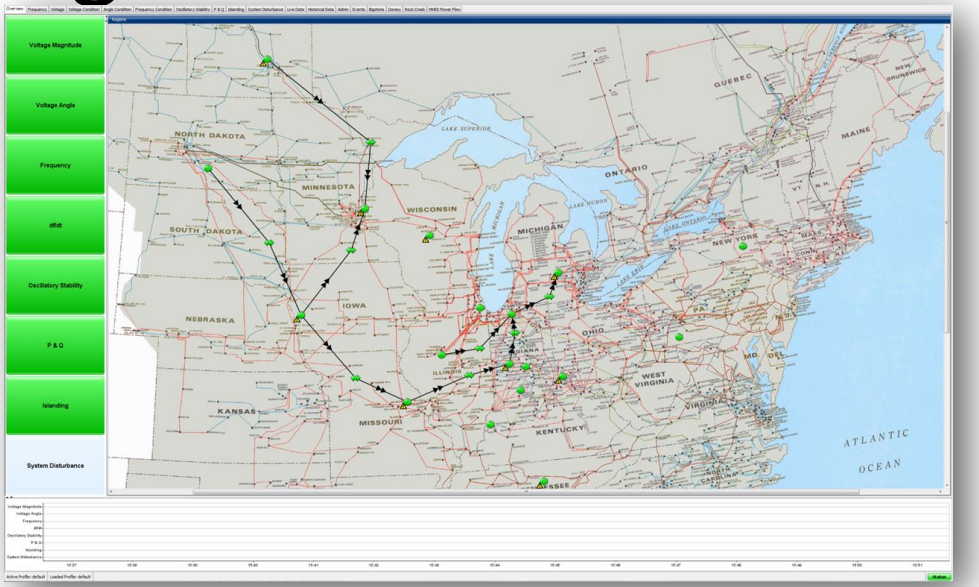
- **Internally developed Enhanced Real-Time Displays (eRTD)**
  - Aggregates alerts into a single display
  - Provides more information in less space at lower cost and higher flexibility
- Deployed in 2013 after parallel operations and staff training
- Correlates with EMS and stability monitoring alerts

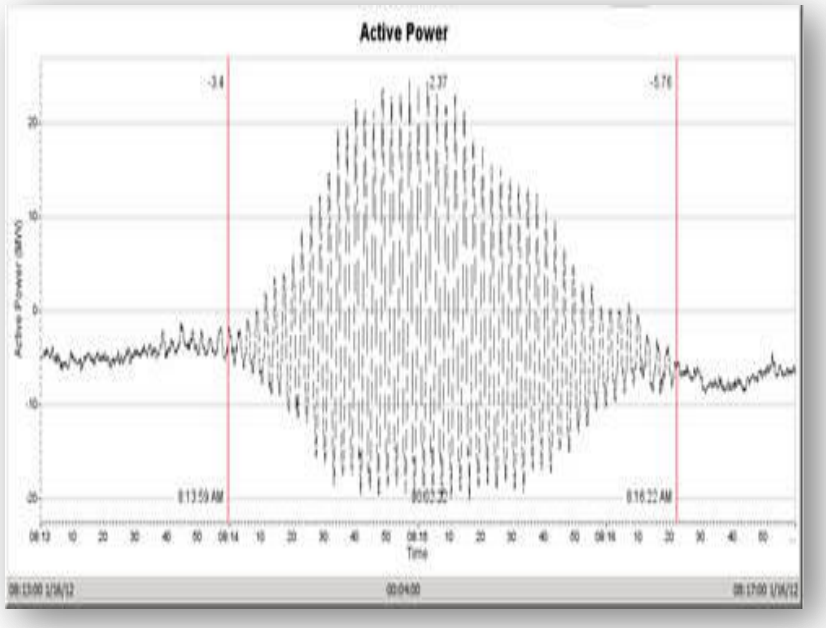




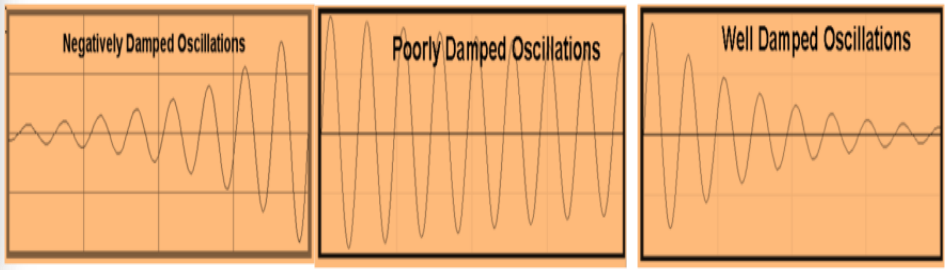
Wide Area Monitoring and Visualization

- Uses PhasorPoint software
- Helps verify Phase Angles are within thresholds
- Helps alert operators when oscillations not being damped



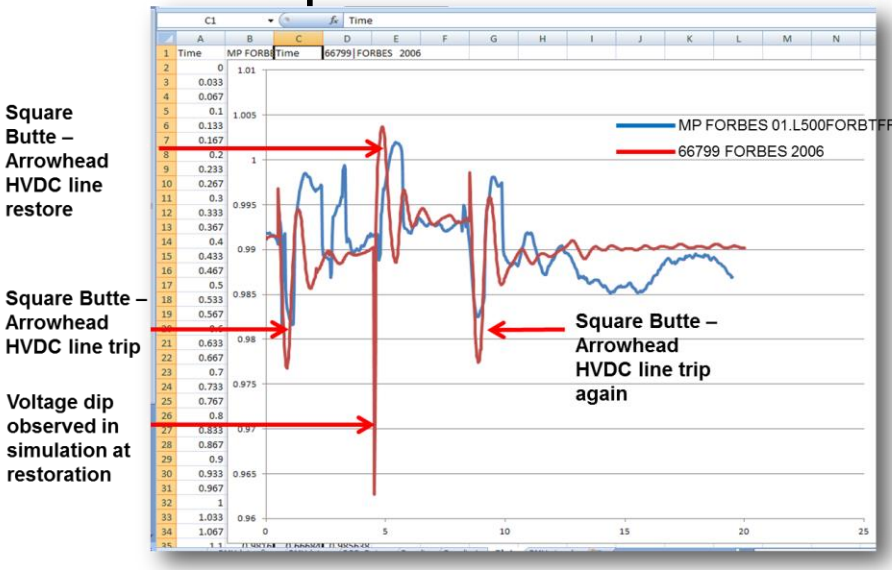


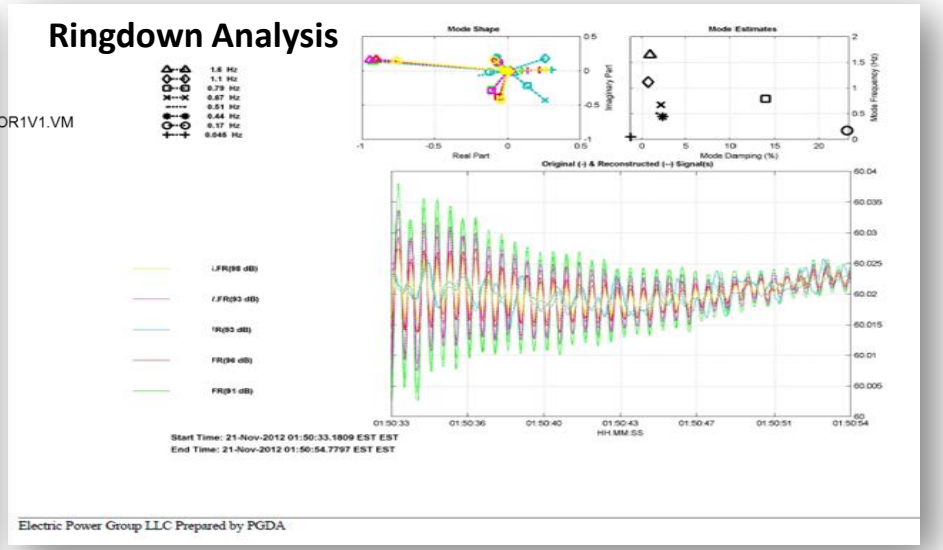
- PowerTech Voltage Stability Assessment Tool (VSAT) and Transient Stability Assessment Tool (TSAT) monitor the dynamic state of the Grid



After-The-Fact Event Analysis and Model Validation

- Helps to understand system reaction to actual events by comparing dynamic responses to simulated responses
  - Diagnose problems and illustrate impacts to the area transmission system
  - Improve planning models and gain better efficiencies and protections
- University of South Florida working to automate the current manual process





Challenges and Lessons Learned

- Implementing a process to ensure the highest quality data is used in applications
  - Member data quality checks prior to streaming data
  - Availability and reasonability checks before the applications
  - Customizable, application-specific bad data detection

Project Next Steps

- **Value-Add Initiatives In-Progress**
  - Increase collaboration with Transmission Owners
    - Add additional PMU devices and highly available PDCs
  - Continued enhancement of Real-Time applications
  - Deploy a modeling tool to automatically analyze event data
  - Integrate phasor data from Entergy
- **Additional Opportunities**
  - Integrate data into the state estimator tool
  - Share data and collaborate with the entire Eastern Interconnection
  - Maximize data quality by incorporating mitigation and validation processes
  - Continue reliable data transfers and redundancy
  - Compliance processes and cyber security