



MISO

Smart Grid Investment Grant
Update

NASPI Work Group Meeting
October 12, 2011

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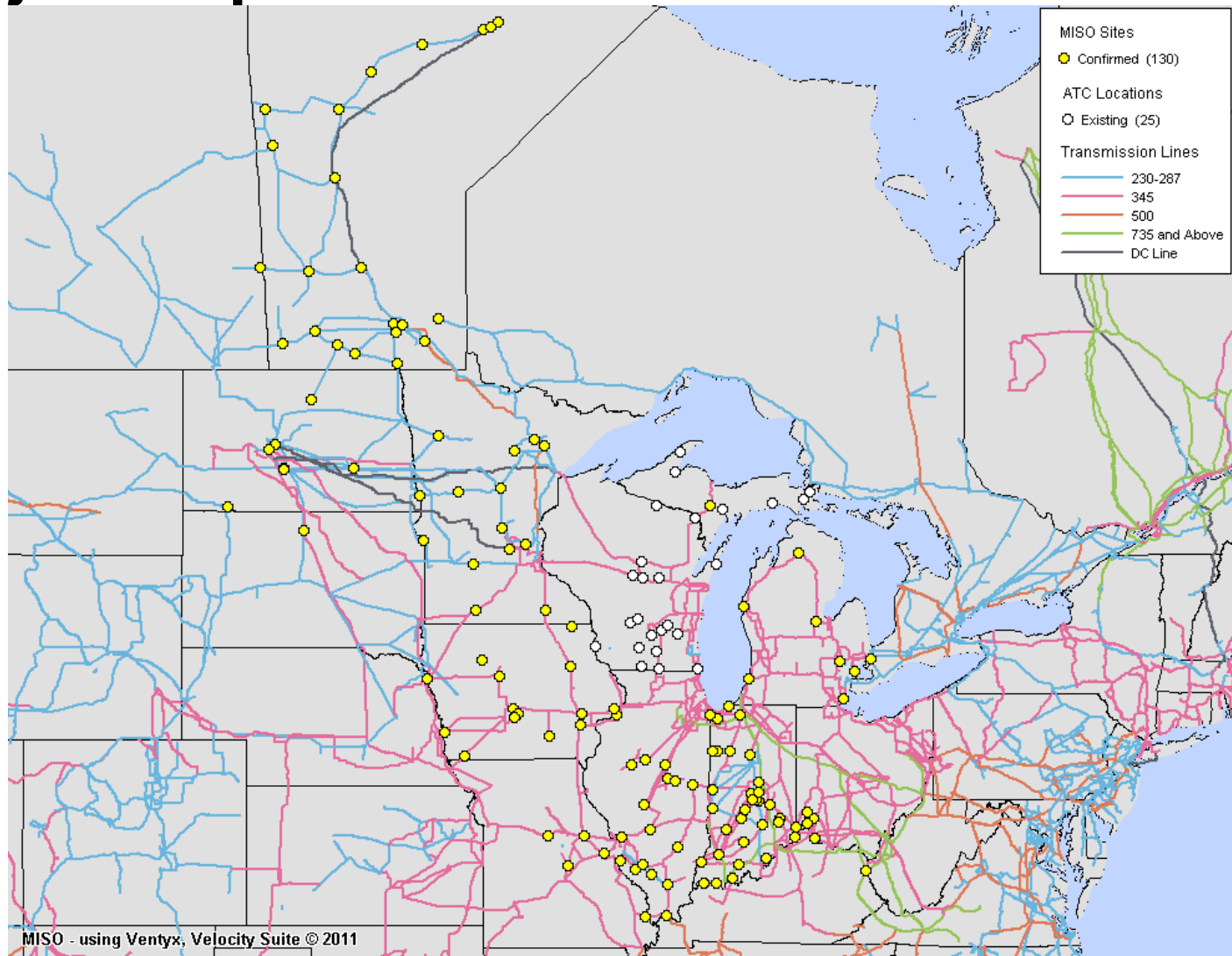
Project Participants

- **Lead sponsor**
 - David Zwergel, Project Sponsor, dzwergel@misoenergy.org
 - David Luedtke, Project Manager, dluedtke@misoenergy.org
 - Kevin Frankeny, Business Owner, kfrankeny@misoenergy.org
- **Research and Development Partners**
 - University of South Florida
 - Applications for Power System Protection
 - Dynamic State/Parameter Estimation
 - University of Tennessee at Knoxville
 - Deployment of FNET Devices
 - Frequency Monitoring Tools

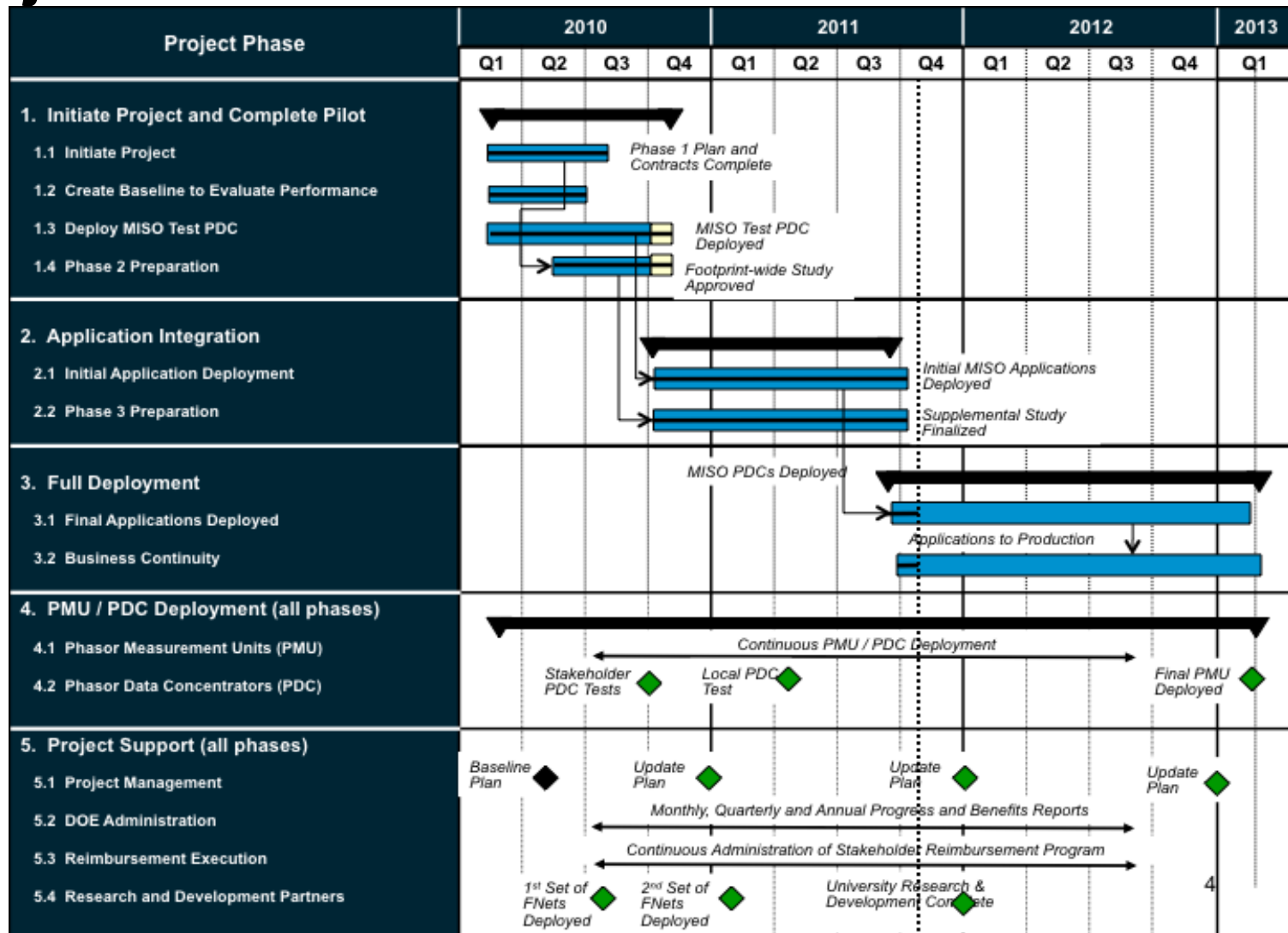
Project Transmission Owners

Organization	PDC		PMU	
	Contracted	Connected	Confirmed Sites	Connected Devices
Ameren	1	1	21	6
American Trans Co.	N/A	1	N/A	5
Duke Energy	1	1	16	4
Great Rivers Energy	1	1	8	2
Hoosier Energy	1	1	7	9
Indianapolis P&L	1	1	6	7
International Trans Co.	1	1	12	5
Manitoba Hydro	2	1	22	6
MidAmerican Energy	1	0	12	0
Minnesota Power	1	1	4	1
Montana Dakota Utilities	0	0	5	0
Northern Indiana Public Service	3	1	8	2
Ottertail Power	2	1	6	3
Vectren	1	0	3	0
WAPA	0	0	4	0
XCEL Energy	0	0	11	0
TOTAL	16	11	145	50

Project Map



Project Timeline

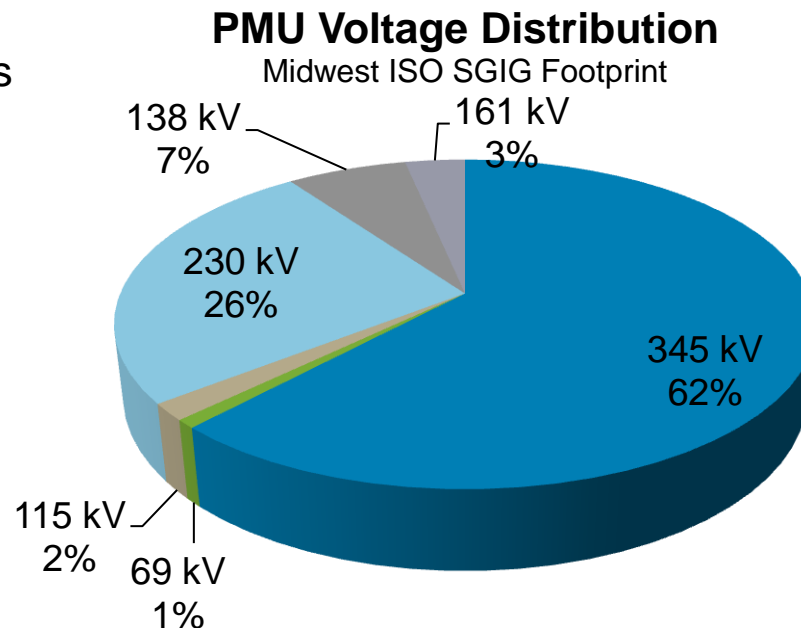


PMUs

- **There are 15 Transmission Owners on the project**
 - Original goal was 150 PMUs; the goal was increased to 165 PMUs
 - Each Transmission Owner is selecting their own PMU and PDC vendor
 - The PMU and PDC devices must meet the standards defined by MISO:
<https://www.misoenergy.org/Library/Pages/ManagedFileSet.aspx?SetId=341>

- **Transmission elements monitored by PMUs:**

The chart at right displays the percentage of total PMUs monitoring each kV level. The project targeted the 345 kV system, which accounts for 62% of PMU installations

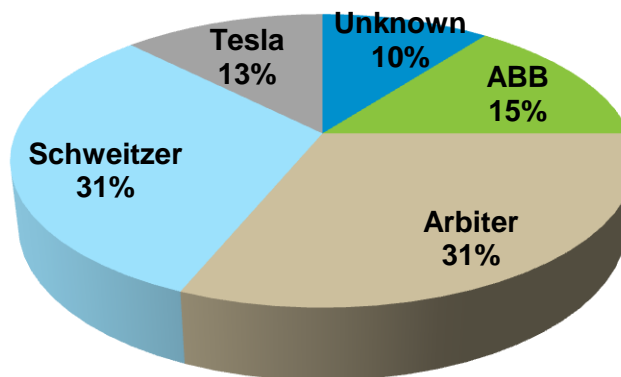


PMUs (continued)

- **At this type, approximately 9% of the MISO footprint is being monitored by PMUs**
 - By the end of the project, this number is expected to be approximately 30%
- **Currently, there are 42 substations that are streaming PMU data to MISO. There are additional substations with PMUs in the footprint that are legacy devices and are not part of the project**
- **The PMU sampling rate is 30 Hz**
- **MISO transmission owners are installing stand-alone PMUs, as well as both relay-based devices and DFRs with PMU functionality**

The chart at right depicts the percentage of PMU installations by Vendor

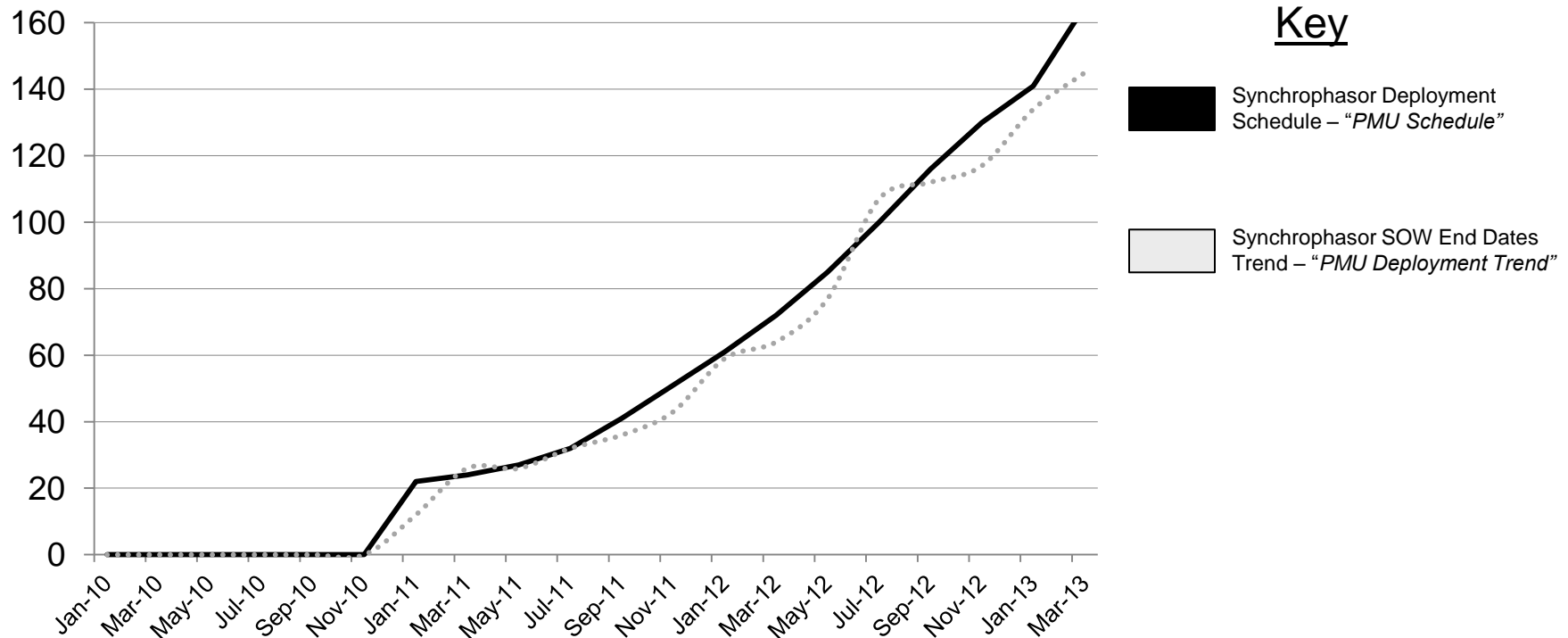
Current PMU Vendor Distribution
Midwest ISO SGIG Footprint



PMUs (continued)

PMU Installation Rate: The graph below illustrates the current PMU Schedule along with the PMU Deployment Trend. The Schedule is what is currently budgeted whereas the Trend is defined by existing PMU SOW end dates (for 2011) plus unscheduled confirmed sites. (for 2012 and 2013)

SOW Progress Against Deployment Schedule

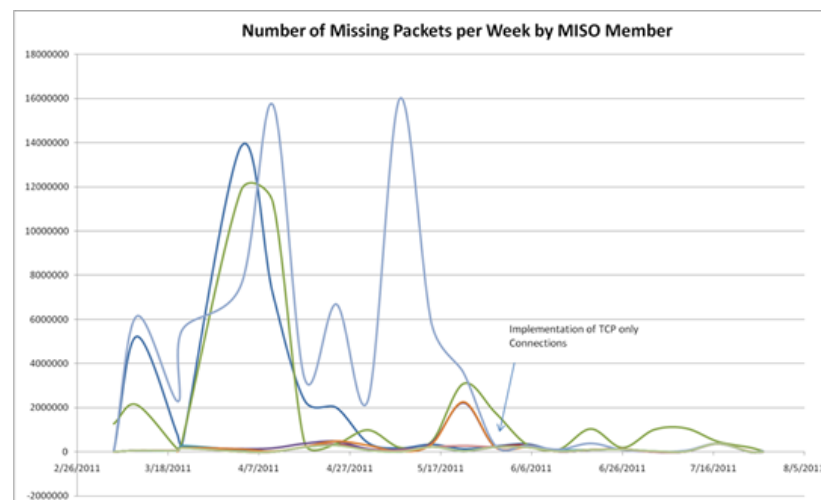


PDCs

- **MISO has both a “local” and “regional” PDC.**
 - The local PDC receives transmission owner data and the regional PDC receives data from other Regional Entities such as PJM and TVA
- **All Transmission Owners are required to have a PMU at their control center. MISO currently receives data from 11 Transmission Owners’ PDCs**
 - Additionally, MISO is funding highly available PDCs at TO control centers
- **MISO is using a temporary SQL Server database while a permanent, Oracle-based solution is being architected**
 - This database will be designed to store at least 7 years of Phasor data
 - Currently, MISO has all of the data collected since the first quarter of this year – data quality has been improving as more PMUs are added and validated

Communications

- **The project's communications approach is to leverage proven options**
 - MISO is using its existing WAN connections to its transmission owners for the transmission of Synchrophasor data. Detailed analysis was performed to ensure that there was adequate bandwidth
 - MISO is working through the NERC User Groups to identify opportunities to reuse ICCP tools and infrastructure
- **Regional data exchange and standards are important capabilities to MISO**
 - MISO has enabled a VPN connection with TVA and PJM to exchange PMU data. The purpose of this connection was to share data and work out data exchange standards. The connection is not a viable long-term option for production
 - MISO and Entergy plan to conduct a PMU data exchange test over NERCnet later this year
- **The recent transition from UDP to TCP has increased the robustness of Synchrophasor data network**



MISO Applications

PHASOR RTDMS

PSYMETRIX
PhasorPoint



Phasor Grid
Dynamics Analyzer

Voltage Angle
Monitoring

Power Flow Monitoring

Oscillation Monitoring

Oscillation Detection

Real-Time Alarming

Event Detection

Member Visualization

Frequency
Monitoring

Device
Performance
Monitoring

High Speed
Gradient Mapping

System Baselining

Resource
Integration

Frequency
Response Analysis

Stability
Assessment

Model Validation

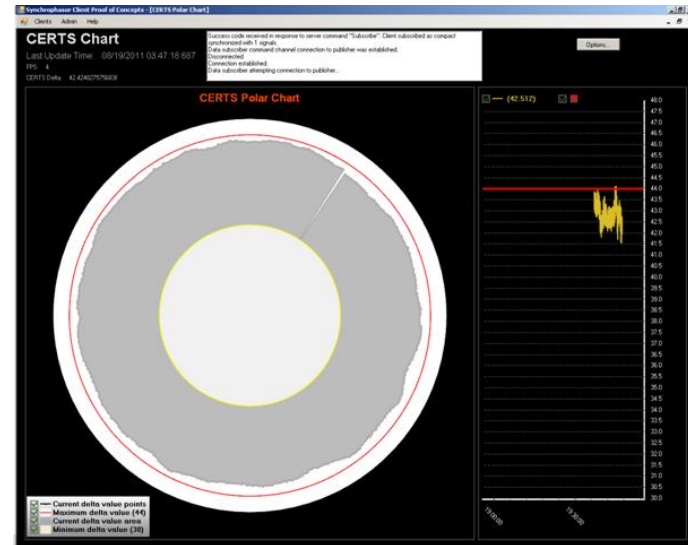
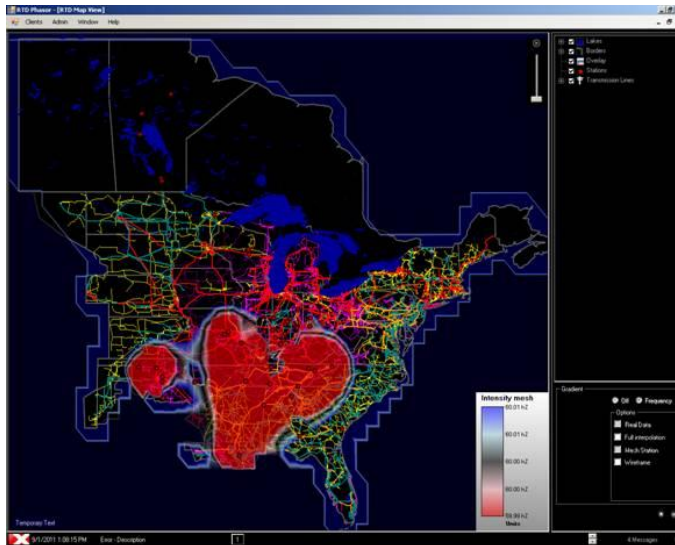
Root Cause
Analysis

Enhanced Reliability

MISO Applications (continued)

- **Wide-area situational awareness**

- MISO is evaluating Wide-area monitoring options. The final solution will involve a mixture of vendor and in-house visualization tools
- Synchrophasor data will be integrated into MISOs “Real-Time Displays.” These displays are developed in-house and deployed in the control room
 - MISO is currently defining requirements for new displays that will make better use of phasor data
 - Operators will be able to see phasor data trended alongside current RTU data



- Additionally, MISO will map it's Synchrophasor points into SCADA as a back-up to current RTU data
- These capabilities will become operational in mid-2012

MISO Applications (continued)

- **Renewable Generation Integration**
 - By the end of the project, MISO will have several PMUs near wind resources
 - Ideally, the MISO planning team will be able to study the effect of increased amounts of wind resources on system-wide small signal stability
- **State Estimation**
 - MISO currently uses ALSTOM's EMS platform. Data will be integrated into the EMS beginning next year, but will only be used as backup measurements
 - MISO may begin to use PMU angle measurements for state estimation in the future, but not during the time frame of the project

Transmission Solutions Applications

- **As part of the project, the MISO will host applications for its Transmission Owners. The project will also distribute PMU data**
- **The project will provide Transmission Owners with a subset of the data being collected by the MISO local and regional PDCs in *C37.118 format*, down-sampled to 1 sample per second**
 - This is a change from the initial approach that called for the data to be provided via ICCP
 - Providing data in C37.118 format will allow the timestamp to be preserved, which will protect the accuracy of phase angle measurements
- **MISO will also host a subset of its wide-area visualization capabilities that TOs will be able to access via CITRIX**
 - These displays have not been finalized by are targeted to be deployed in 2012



Transmission Owner Solutions (continued)

- **Additionally, MISO will host the Phasor Grid Dynamics Analyzer (PGDA), an historical phasor-data event analysis tool, and provide TOs with access to the application and data to analyze**
- **Users will be able to analyze events and save them to the MISO Extranet for later access**
- **The timeline for hosting PGDA includes:**
 - Pilot selected events with first TO by Q2 2012, and have deployed to all TOs by the end of 2012
 - Data archive available for analysis by Q3 2012
 - PGDA training for TOs to start in 2012
 - First session will be instructor-lead, later session will be hands-on

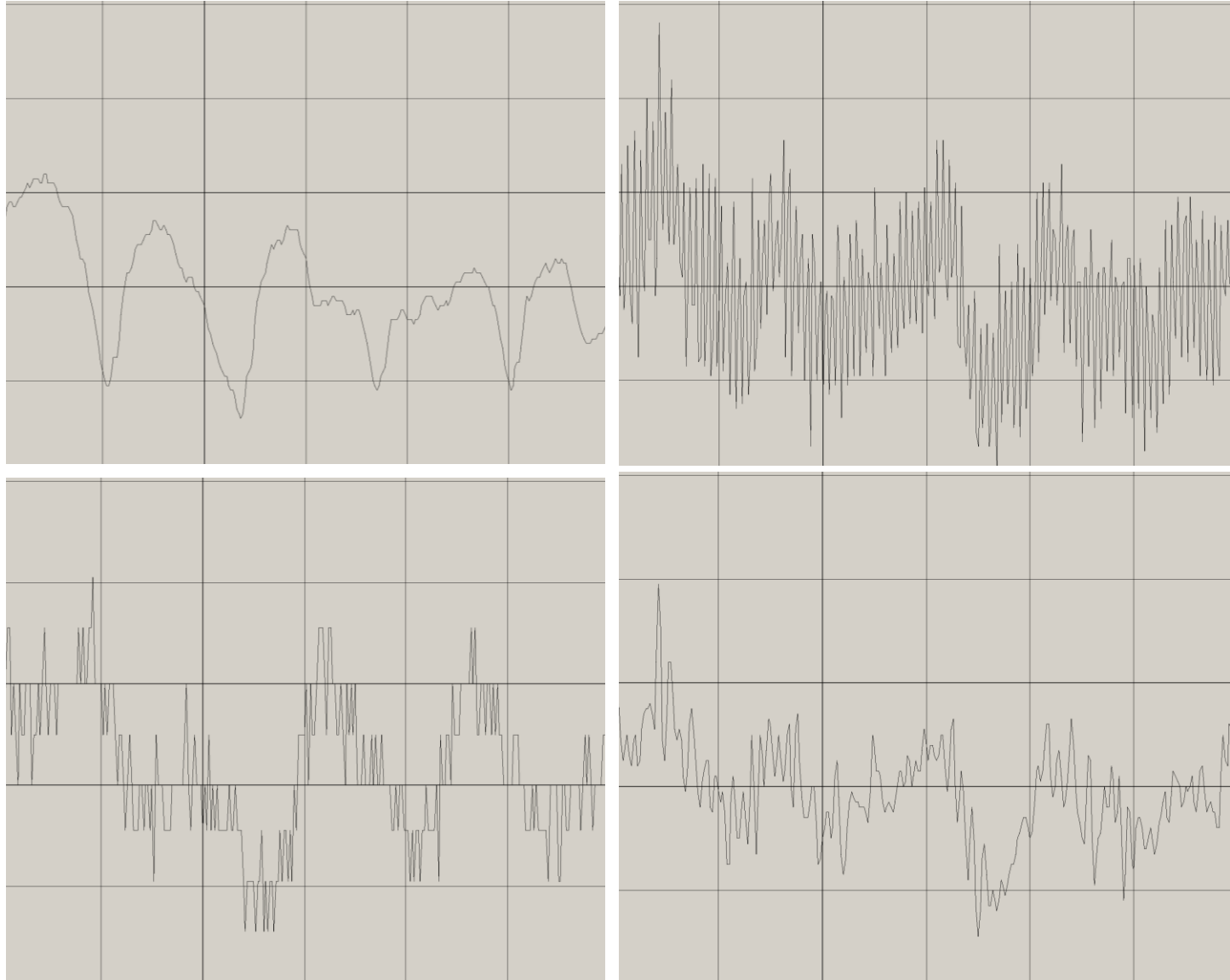
Challenges and Lessons Learned

- **Some of MISO's biggest technical challenges have involved getting the phasor data to be of operational quality.**
 - This required aligning the positive sequence phase angle between each company
 - Another challenge was learning how to distinguish between data quality issues and possible "events"
 - Signals that are received can appear very different depending on the PMU vendor used and the way each particular PMU is configured
 - MISO has begun a process of requesting PMU settings from each of its Transmission Owners to be able to identify particular settings that could cause problems
- **One of the biggest programmatic challenges has been getting devices installed on time.**
 - Some TOs have been reluctant to participate in the program and accept grant funding
 - Getting the right TOs in the right locations was critical to getting adequate coverage of the system
 - Fortunately, two additional companies recently signed on to participate, and other members who were hesitant to confirm a large portion of their candidate sites, have recently committed to additional installations
- **Budgeting for TO installations has also been a challenge.**
 - PMU and PDC installations have cost significantly less than expected
 - TOs reported that installations were less burdensome and less costly than they predicted
 - As a result, the project has been able to increase the number of targeted installations

PMU Network and Configuration Review

Example:

Various
frequency data
patterns from
four different
MISO
Transmission
Owner PMUs



Manitoba Hydro Profile

MISO is proud to have Manitoba Hydro as a member of its SGIG project

Manitoba Hydro has been a model team member:

- **Largest number of confirmed PMU installations (22)**
- **Part of first group to pursue high available PDC solution**
- **Strategic geographic location for PMU placement**
- **Strong member of NASPI community**