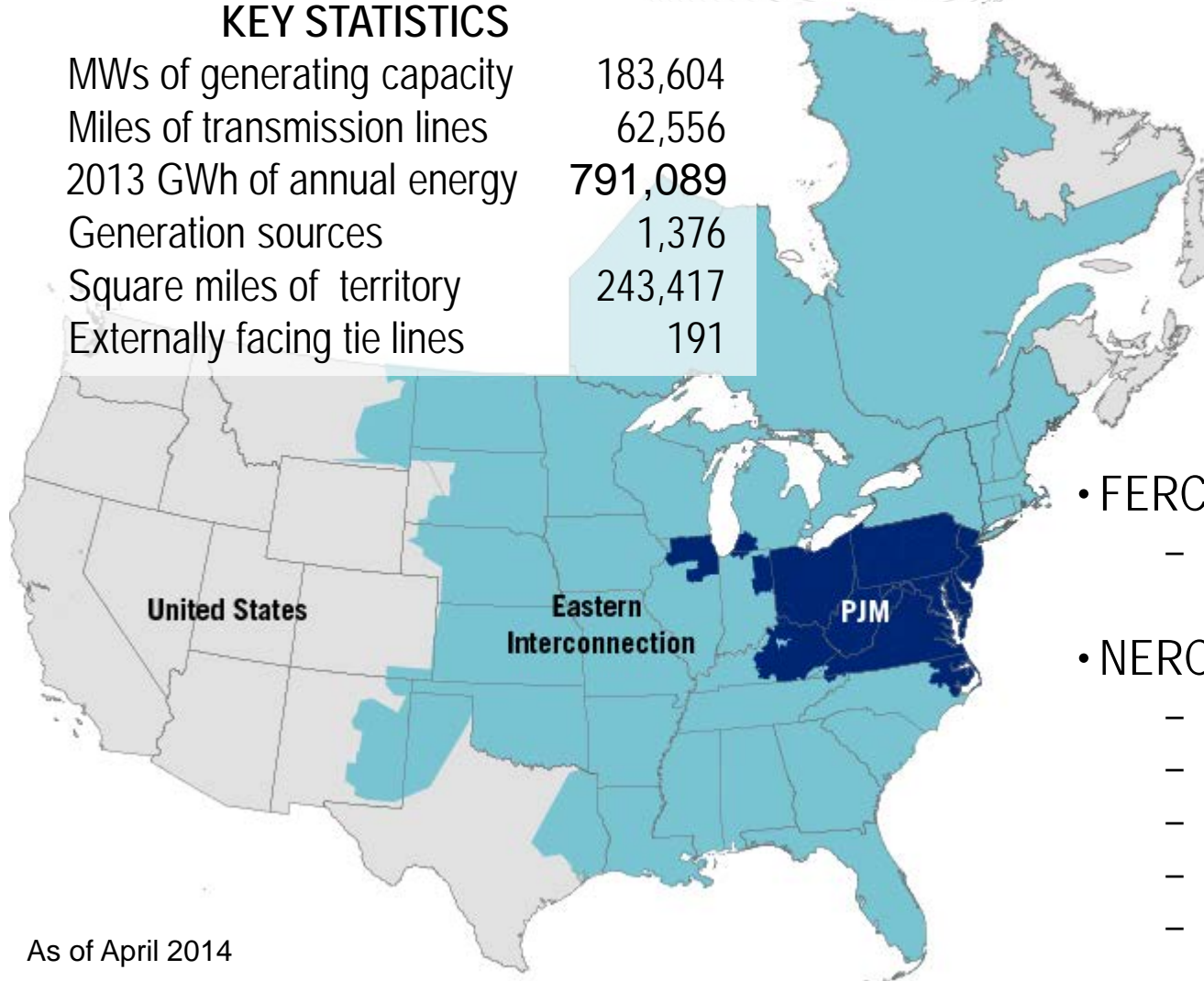


# Data Visualization, Daily Operations Review and Event Analysis

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NASPI  
Houston, TX - October 2014

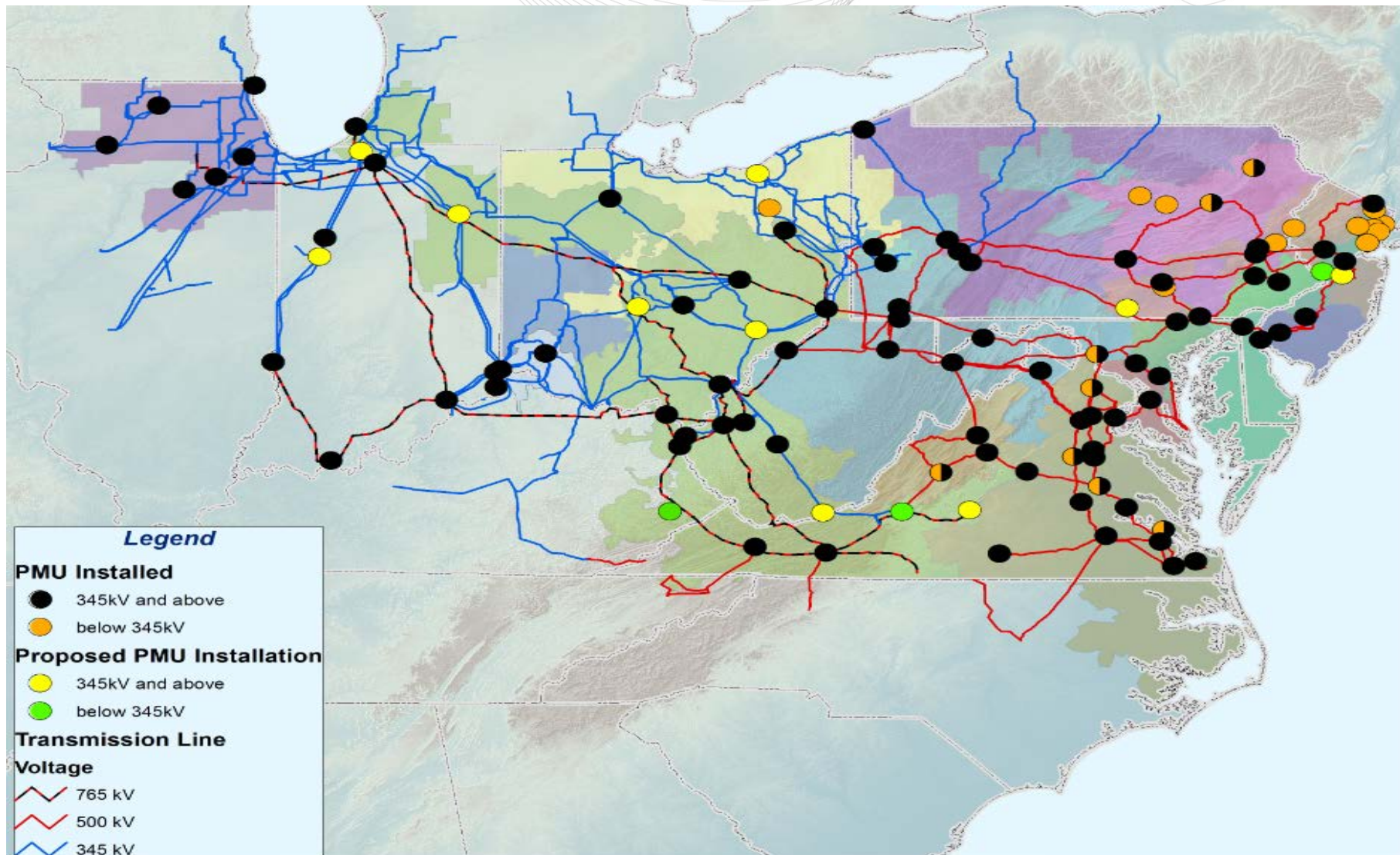
## KEY STATISTICS

MWs of generating capacity	183,604
Miles of transmission lines	62,556
2013 GWh of annual energy	<b>791,089</b>
Generation sources	1,376
Square miles of territory	243,417
Externally facing tie lines	191



- FERC
  - Regional Transmission Organization
- NERC
  - Reliability Coordinator
  - Balancing Authority
  - Transmission Operator
  - Transmission Planner
  - Planning Coordinator

As of April 2014



- Event Detection & Post-Event Analysis
- Operations Integration
- Data Exchange

- Develop Event Criteria that Triggers Analysis
- Develop Process, Tools, & Training
- Integrate into Daily Review Team

### Identify Significant Disturbances on the Grid

- Leverage NERC Established Event Criteria
- Frequency Deviations  $\geq 40$  mHz in any rolling 16 second interval (BAL-003 Frequency Response)
- EHV Transmission Trips / Outages – Initially monitoring EHV lines that are components of IROL transfer interfaces
- Large Generator Trips  $\geq 900$  MW (BAL-002 Disturbance Control Performance)



### Dashboard Metrics

[How are the Metrics calculated?](#)

Operations Metrics Dashboard - Sunday, April 13, 2014		
Metric	Metric Value	Metric Rating
<b>Load Forecast Shape - (RTO)</b>	97.76%	<b>Neutral</b>
1200 Forecast Fit %	97.36%	<a href="#">Create New Report</a>
1800 Forecast Fit %	98.17%	
<b>Transmission Actuals</b>	100.00%	<b>Good</b>
Total BES Events	0	<a href="#">Create New Report</a>
<b>IROL Exceedances</b>	0	<b>Good</b>
Total IROL Exceedances > 10 Seconds	0	<a href="#">Create New Report</a>
IROL Exceedances > 30 Minutes	0	
<b>Transmission Contingencies</b>	100.00%	<b>Good</b>
Total BES Events	0	<a href="#">Create New Report</a>
MISO Flowgates > 20 Minutes	0	
<b>Manual Dispatch</b>	-	<b>Good</b>
Total Wind Units	2	<a href="#">Create New Report</a>

Grid Disturbances & PMU Analysis		-	<b>Needs Review</b>
Frequency Deviations (>=40mHz)	2	<a href="#">Create New Report</a>	View Problem Reports (2)
EHV Transmission Trips (>= 500kV)	0		
Large Unit Trips (>= 900MW)	1		

Large Unit Trips (>= 900MW)	1		
<b>BAAL</b>	99.10%	<b>Good</b>	
Total Minutes	13	<a href="#">Create New Report</a>	View Problem Reports (1)
Longest Excursion (Mins)	6		
CPS-1	136.22 (Neutral)		

### Frequency Deviations

No	Event Start	Starting Freq	Freq Deviation	ACE Deviation	Gen Deviation
1	13APR14:13:25:02	60.0025	-0.0448	-1035	-677
No	Event Start	Starting Freq	Freq Deviation	ACE Deviation	Gen Deviation
2	13APR14:21:12:52	60.0208	-0.0611	-1100	-1171

### EHV Transmission Trips

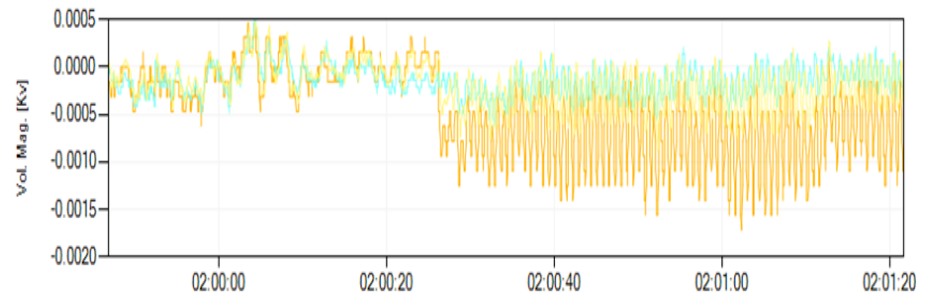
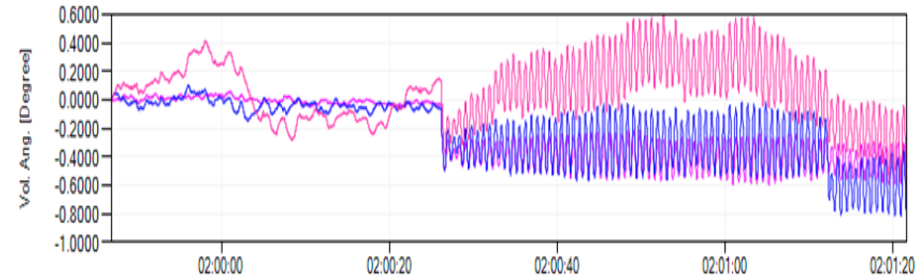
No Data Available

### Large Unit Trips

No	Event Start	Facility	Gen MW
1	13APR14:21:13:25	Anonymous Nuclear Unit in Eastern PJM	1238

[Return to Previous Report](#)

## Phasor Grid Dynamics Analyzer (PGDA)





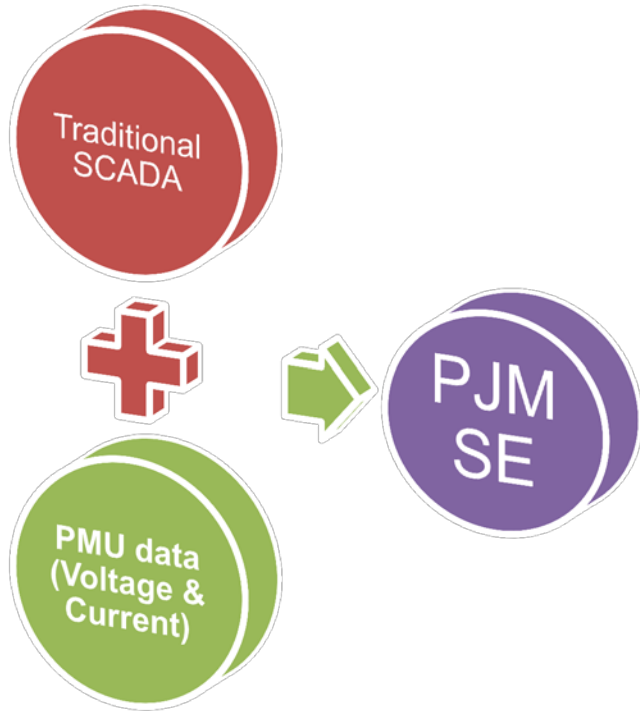
- Consists of Managers, Supervisors, Engineers, & Economists from Operations & Markets Divisions
- Review Daily Dashboard Metrics & Dispatcher Logs
- Discuss Previous Day's Operational Performance & System Events
- Discuss Events that had Market Impacts
- Discuss Anticipated Current Day & Day Ahead Operations

Integrate PMU data into:

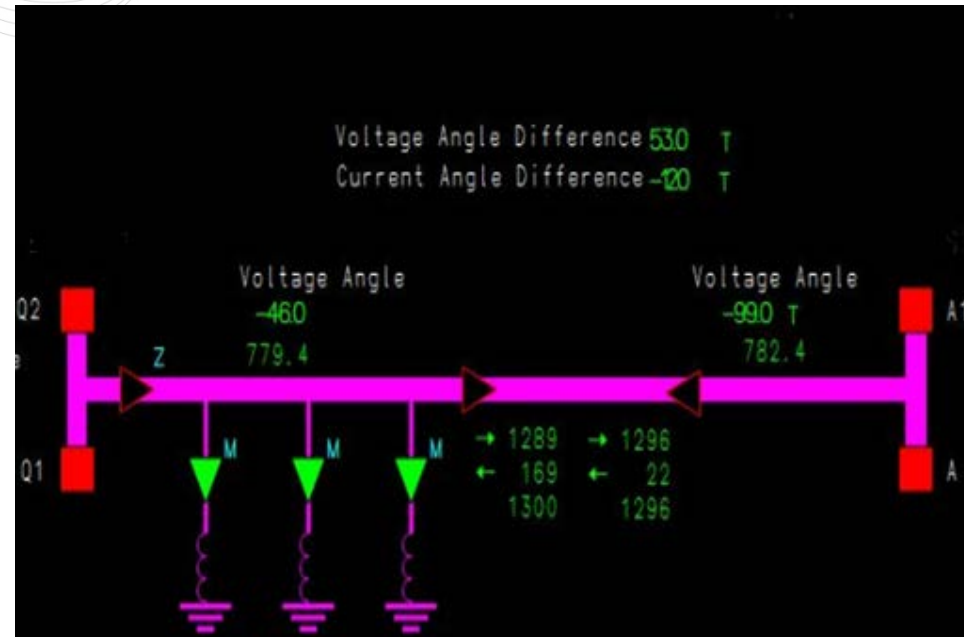
- PJM's Energy Management System (EMS) and assess impact
- One-line Displays
- Intelligent Event Processor to provide alarming

## EMS Incorporation – State Estimation (SE)

- Incorporated configuration changes to include phasor measurements (Voltage & Current Magnitude/Angle) within PJM State Estimation
- Data feed to provide PMU data to PJM SE is now in place
- Currently in the process of evaluating the impact of the including PMU data within our SE calculation in our stage system.



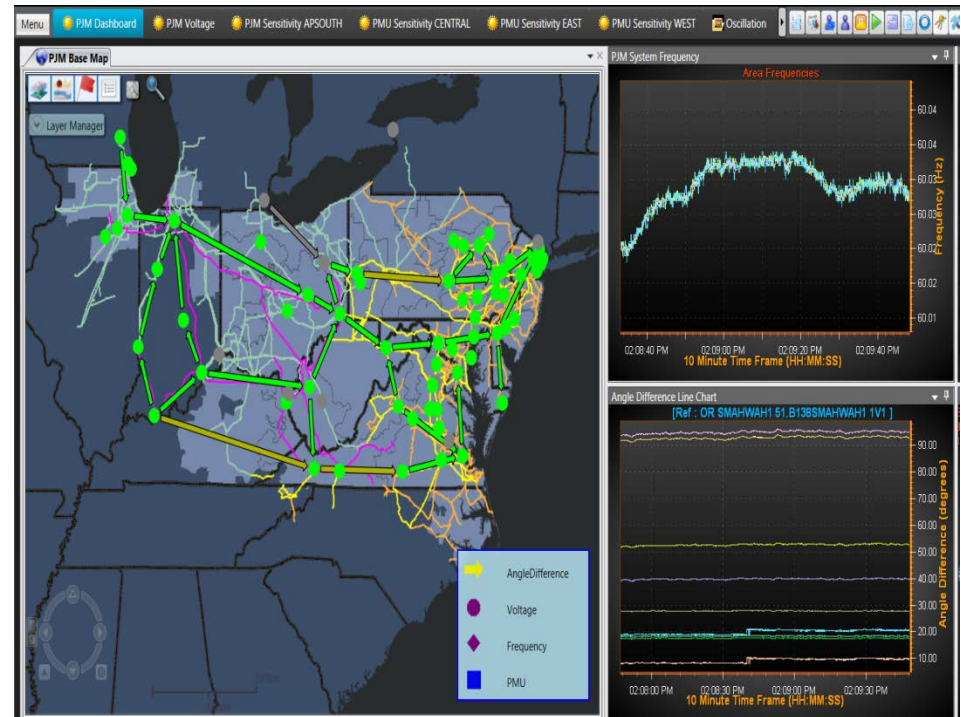
- Select PMU data will be displayed within PJM SCADA.
- Including Phase Angle data.
- Refresh rate is being determined. It will be down-sampled from 30/sec!
- Initial effort will be to incorporate 765kV & 500kV data with associated *Tryback* display for a given facility.

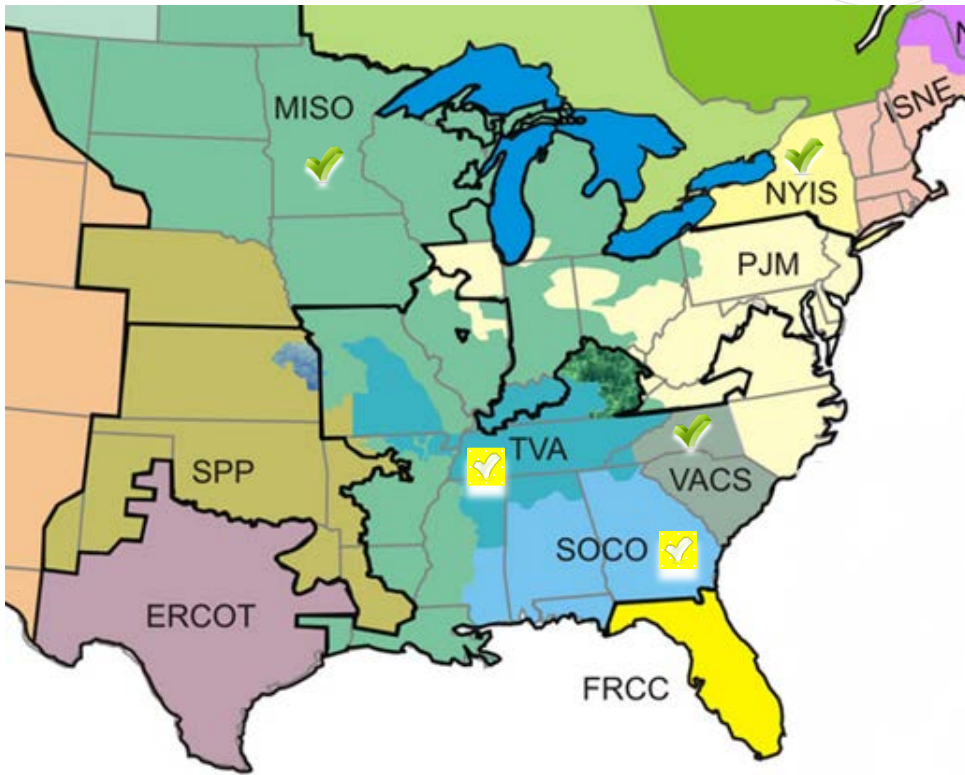


PJM & Majority of our 12 TO's with PMU data are capable of sharing real time Wide Area Monitoring Systems [WAMS] views via EPG's RTDMS application.

- Fine tuning alarm triggers via base-lining efforts.
- Adding Rate of Change of Frequency alarming.

## *Electric Power Group's [EPG] Real Time Dynamics Monitoring System [RTDMS]*

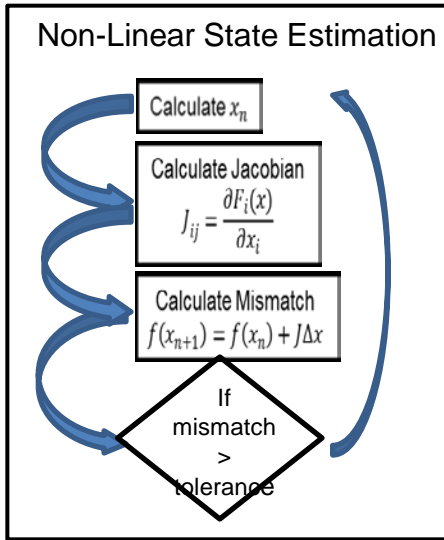




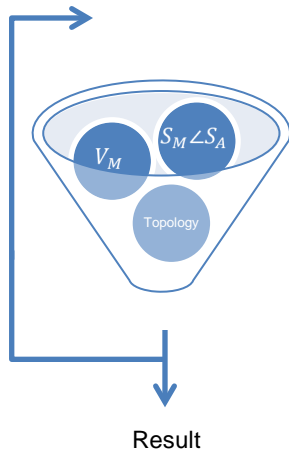
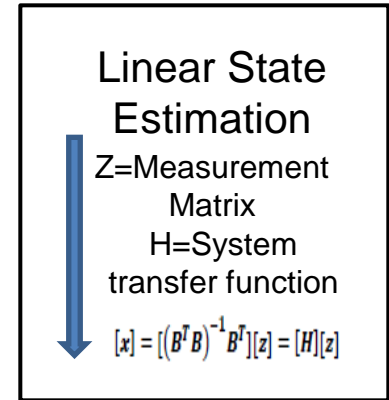
- PJM is exchanging data with neighbors DUKE/VACAR, NYISO, MISO. TVA is in progress.
- We are working with SOCO to exchange data as a non-contiguous neighbor



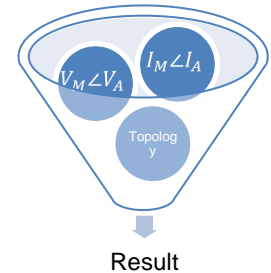
**Fabian.robinson@pjm.com**



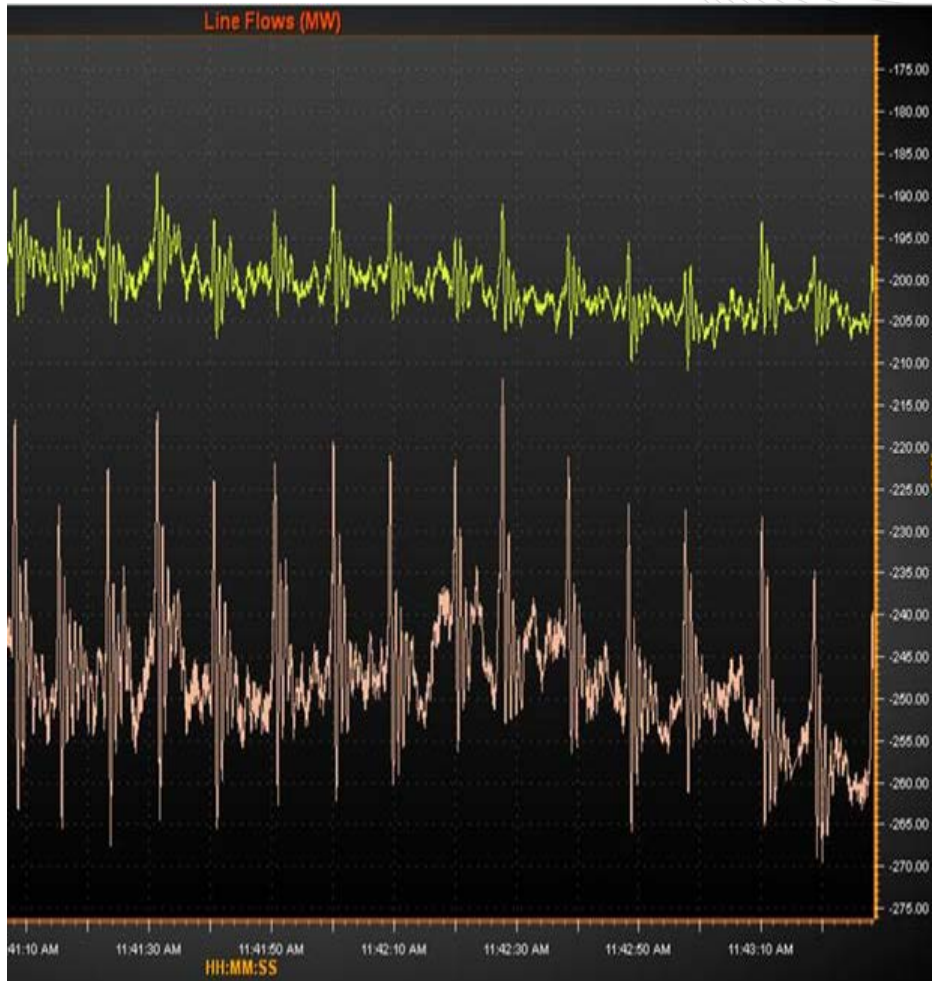
- PJM has developed an in-house Linear SE beta application based off similar work being done at DOM & VA Tech.
- Initial use will be as a feedback mechanism and trigger for Data Quality related issues & reporting.
- Potential use as Data Conditioning Tool for any PMU data prior being used in PJM Traditional SE.



← 2015





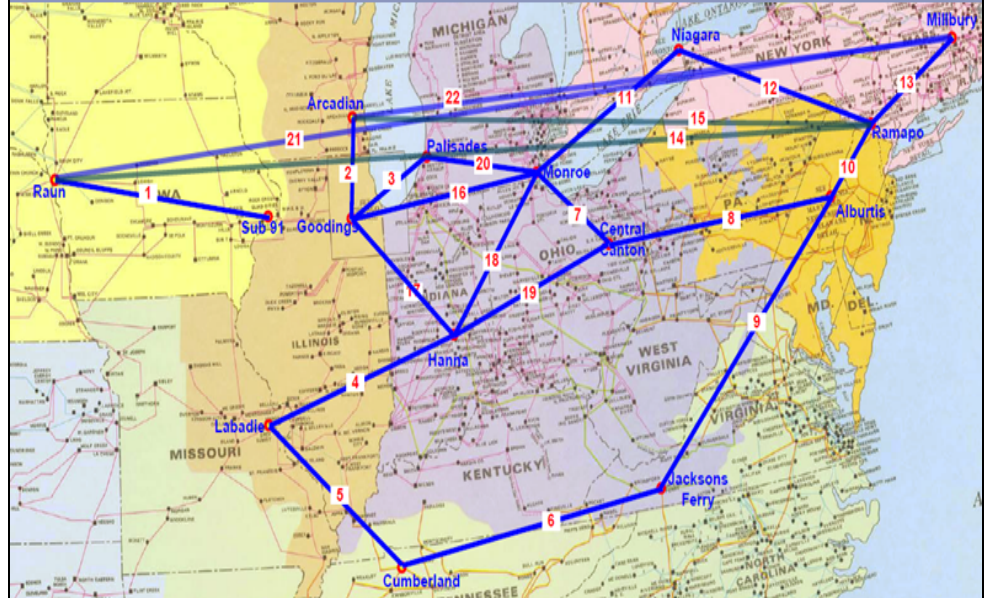


- New oscillation detection algorithm based off PNNL's Oscillation Detection module;
- Aiding in detecting Oscillations in near real-time and distinguishing between Forced & Transient Oscillations.
- In place within production RTDMS by 2015;
- Operator Training & Procedures in effect by 2015.



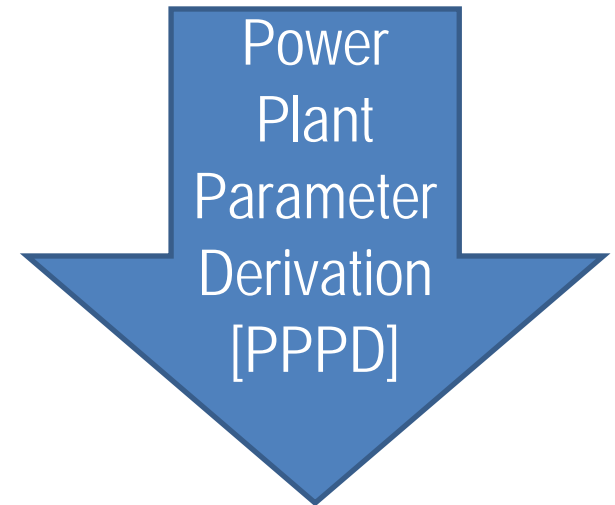
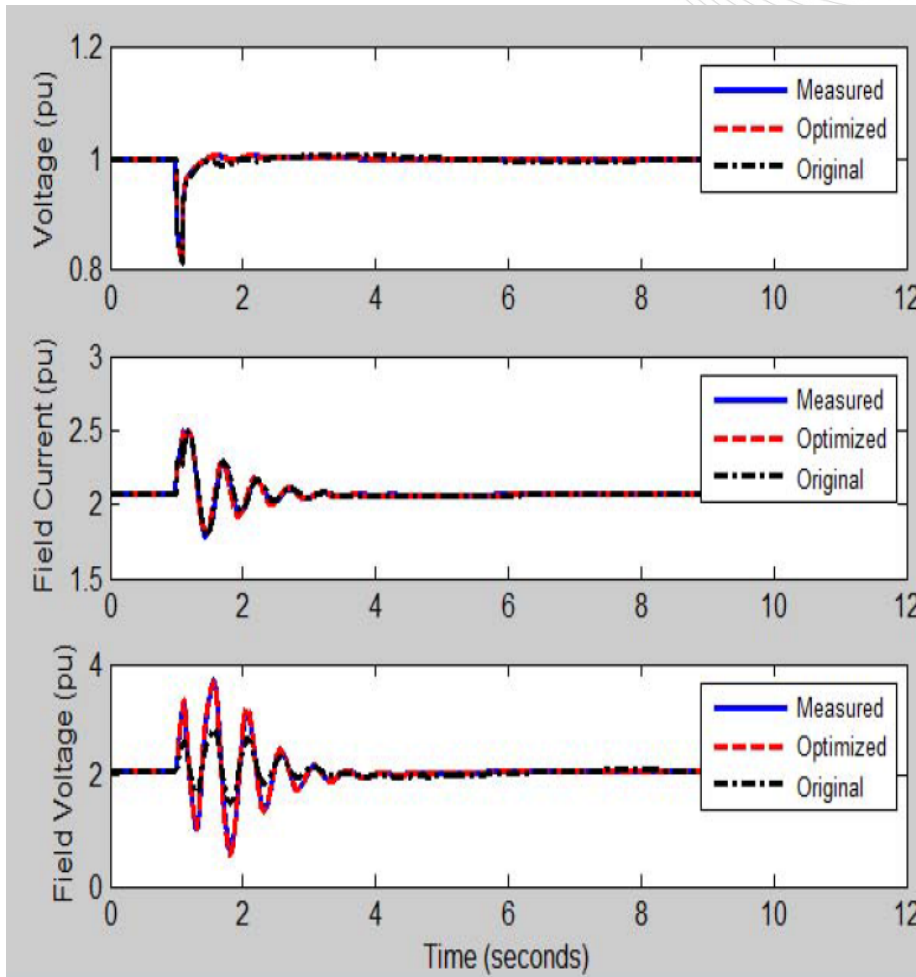
- Eastern Interconnect Data Sharing Network is a replacement for NERCNet.
- SCADA and PMU data sharing.
- Expected to replace the existing network in 2015
- Facilitates agreed upon monitored angle pairs for the Eastern Interconnection with all ISO/RTO's having visibility. [CERTS/DOE project]

### Wide Area Angle Pairs Covering Four ISOs



Index	From bus	To bus	Reason
1	Raun	Sub 91	IA Wind Transfers
2	Goodings	Arcadian	WI-Chi Transfers
3	Goodings	Palisades	Chi-MI Transfers
4	Labadie	Hanna	West to East Transfers
5	Labadie	Cumberland	St Louis South Transfers
8	Jacksons Ferry	Cumberland	TVA to PJM (Southwest) Transfers
7	Canton Centr.	Monroe	SE MI Transfers
8	Alburdis	Canton Centr.	West to East Transfers (Lake Erie Loop)
9	Alburdis	Jacksons Ferry	Southwest to East Transfers
10	Alburdis	Ramapo	PJM to NYISO
11	Niagara	Monroe	NYISO to MISO
12	Niagara	Ramapo	West to Southeast Transfers

Index	From bus	To bus	Reason
13	Ramapo	Millbury	NYISO to ISONE
14	Raun	Ramapo	MISO to NYISO
15	Arcadian	Ramapo	MISO to NYISO
16	Goodings	Monroe	Close the loop
17	Goodings	Hanna	Close the loop
18	Hanna	Monroe	Close the loop
19	Hanna	Canton Centr.	Close the loop
20	Palisades	Monroe	Close the loop
21	Raun	Millbury	MISO to ISONE
22	Arcadian	Millbury	MISO to ISONE



- PJM Planning trained on use of Tool.
- Tool validated using external generation data.
- 1<sup>st</sup> PJM generator side PMU data targeted for late 2015, early 2016.

- Detection of Planning Criteria Violations
  - Oscillation Frequency & Damping Ratio
- Continue to Improve PMU Data Quality
  - PDQTF – Phasor Data Quality Task Force
- Enhancement of Analysis Tools & Training