# *Success Story: Advanced Grid Monitoring Analytics at ISO-NE using PhasorPoint*

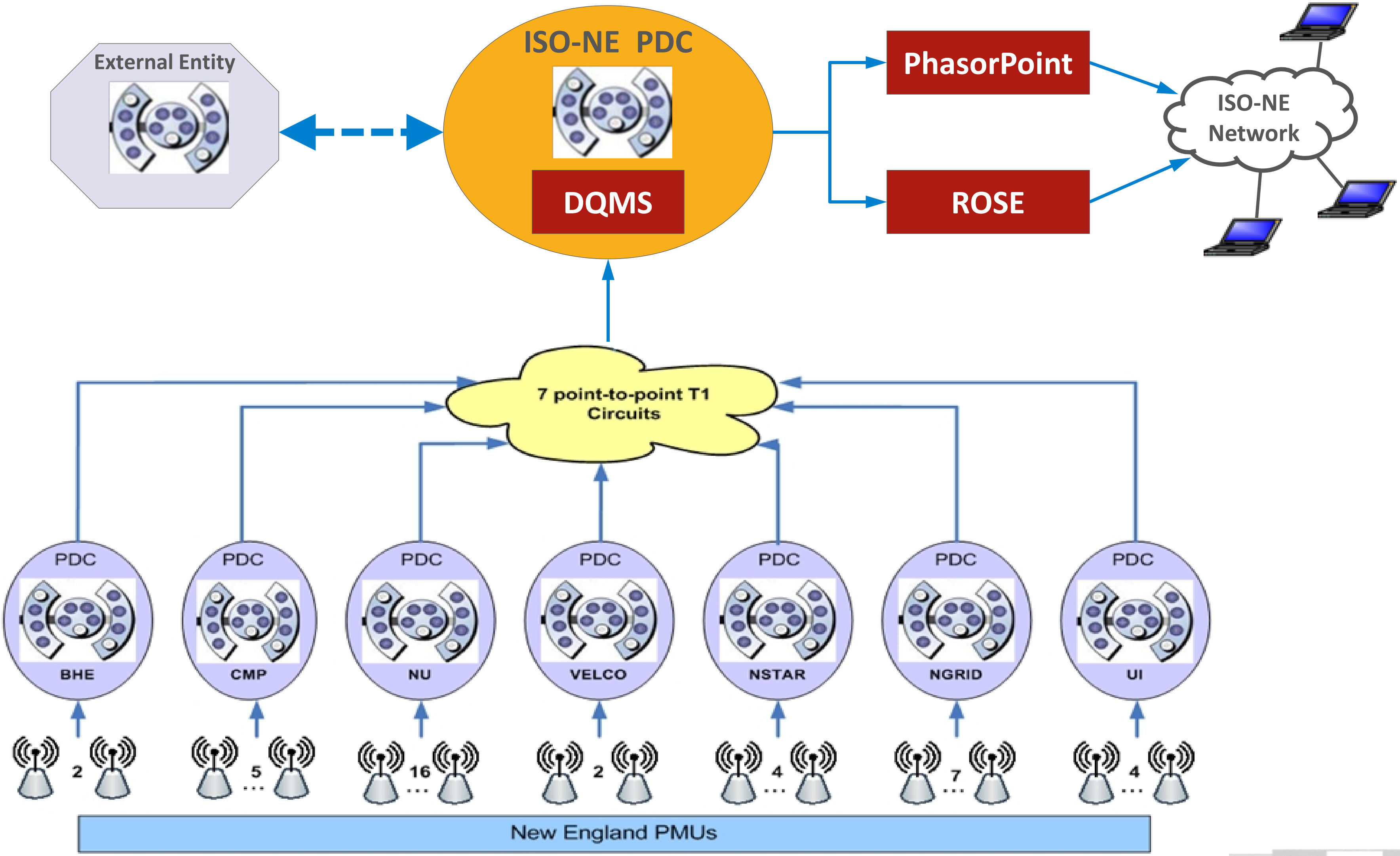
*NASPI Working Group Meeting*

Xiaochuan Luo, Frankie Zhang, Eugene Litvinov
Manu PARASHAR (Alstom Grid)
Douglas Wilson (Psymetrix Ltd)

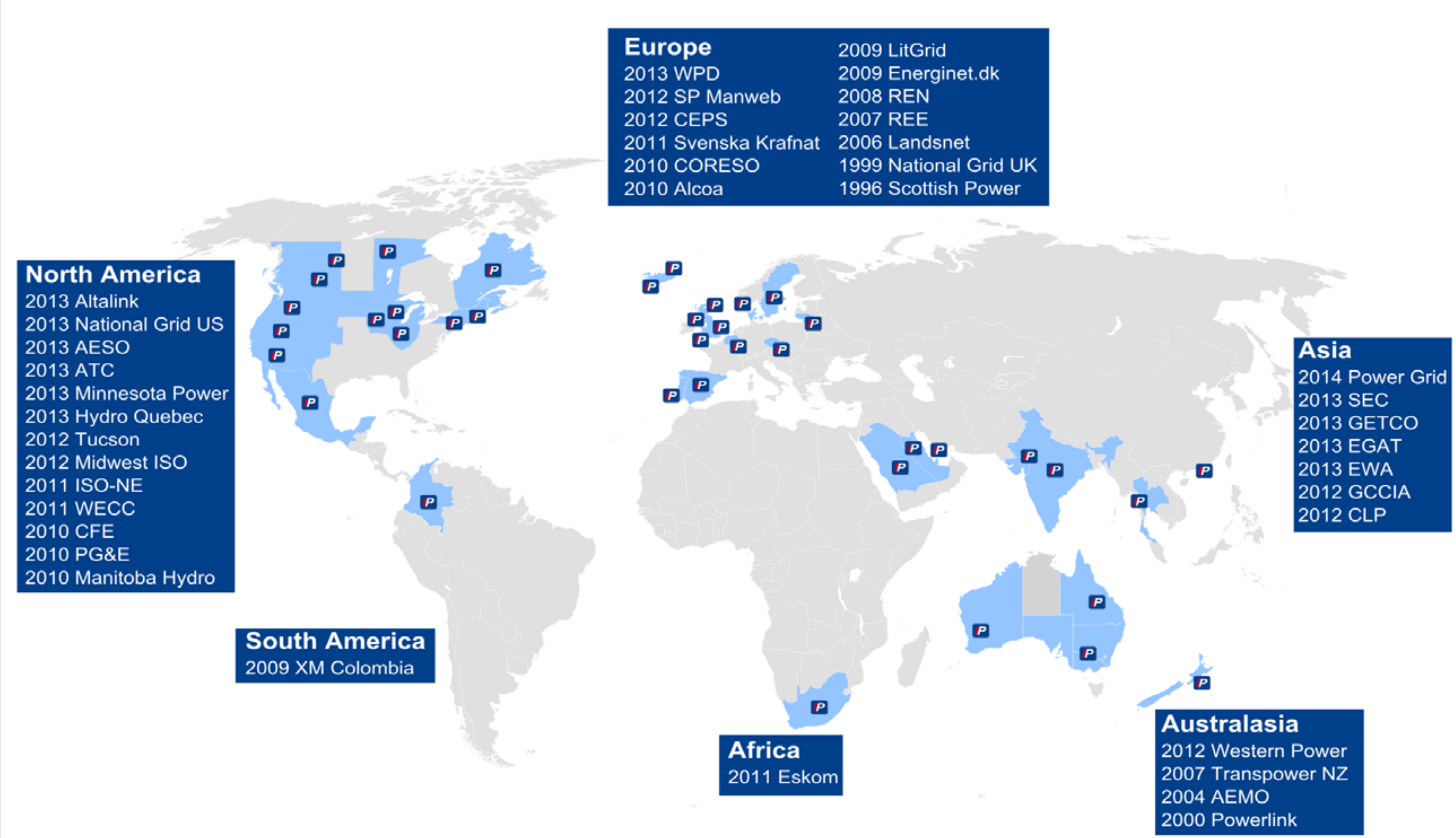
# Outline

- ISO-NE's Synchrophasor Infrastructure and Data Utilization (SIDU) Project
- Introduction of PhasorPoint application
- Engineering process to set parameters in PhasorPoint
- Success stories in grid monitoring using PhasorPoint
- Conclusions and future plans

# ISO-NE's Synchrophasor Infrastructure and Data Utilization (SIDU)



# PhasorPoint Solution Maturity

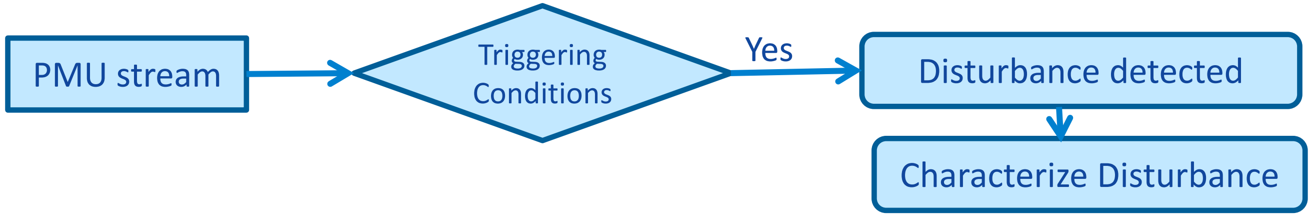



**APPROXIMATELY 40 PHASORPOINT DEPLOYMENTS WORLDWIDE**

# PhasorPoint Application

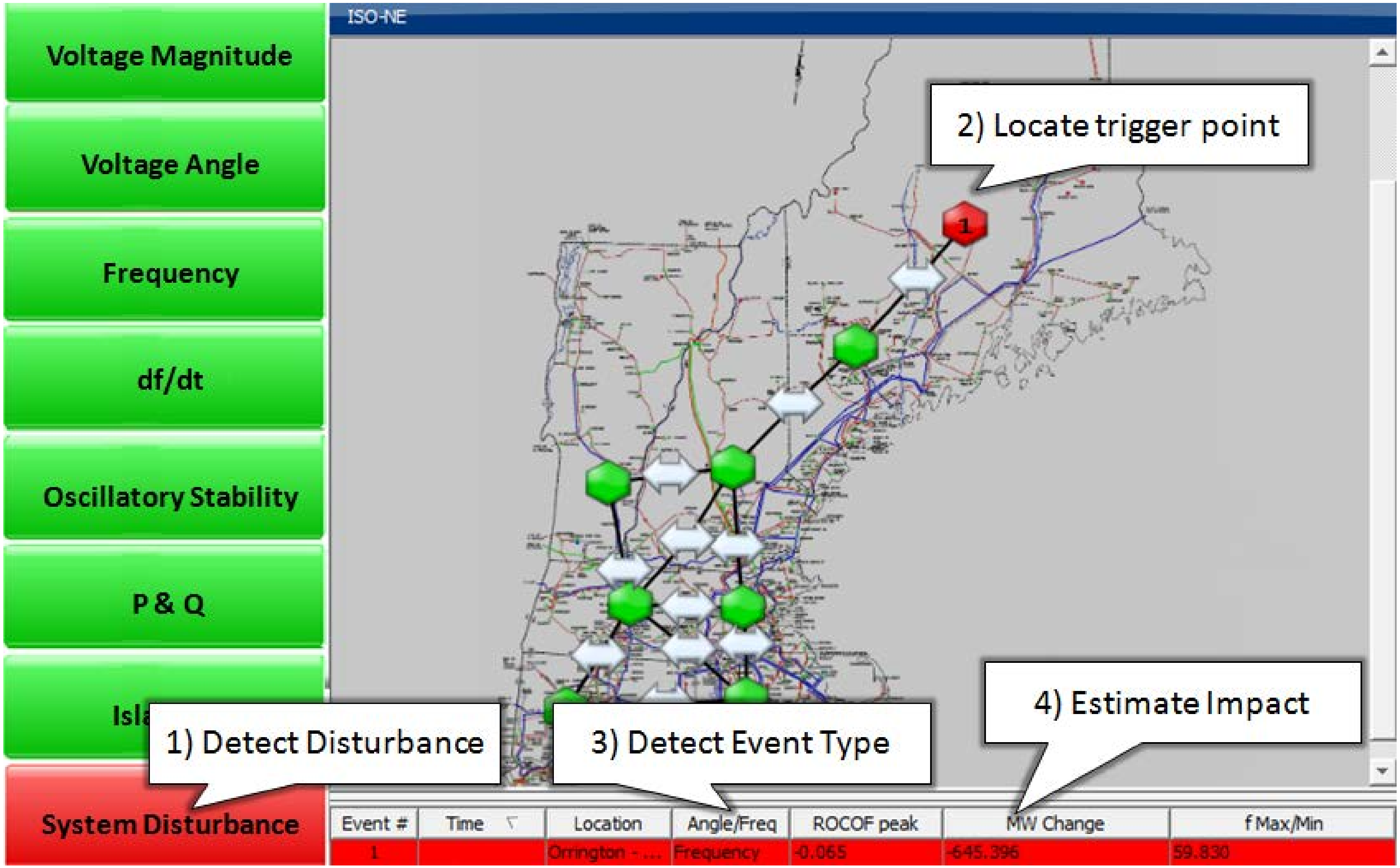
# System Disturbance Monitoring (SDM)

- Identifies, locates and characterizes a disturbance



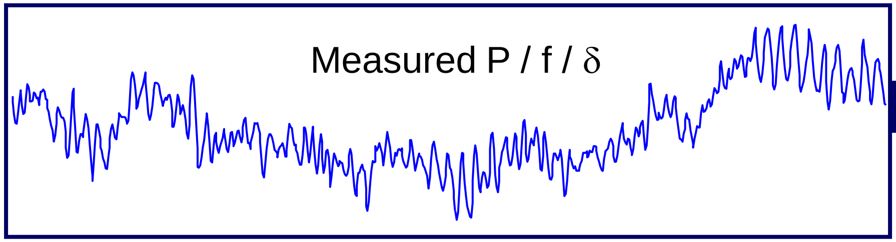

- Highly configurable triggering attributes
  - Rate-of-change of voltage angle
  - Rate-of-change of frequency
- Efficient and accurate disturbance monitoring depends on settings of triggering attributes
- Trade-off between sensitivity to detect significant disturbance and too many alarms for insignificant disturbances

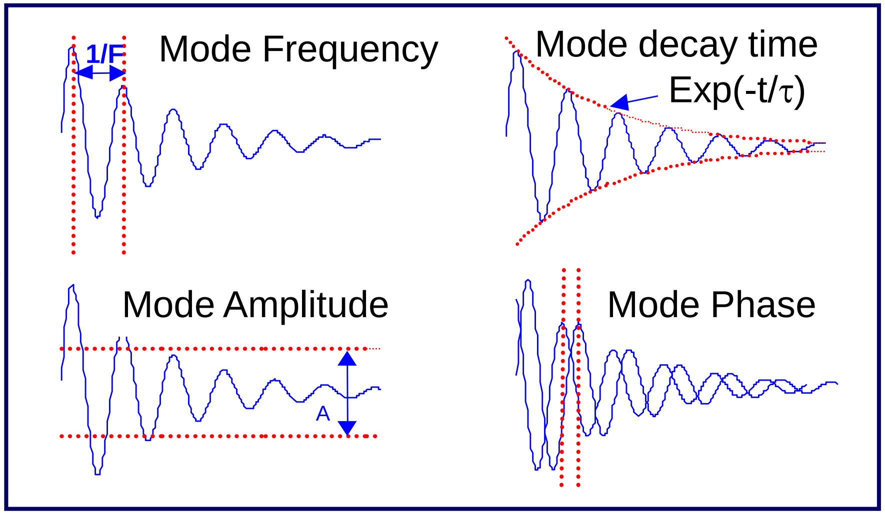
# System Disturbance Monitoring, cont.



# Oscillation Stability Monitoring (OSM)

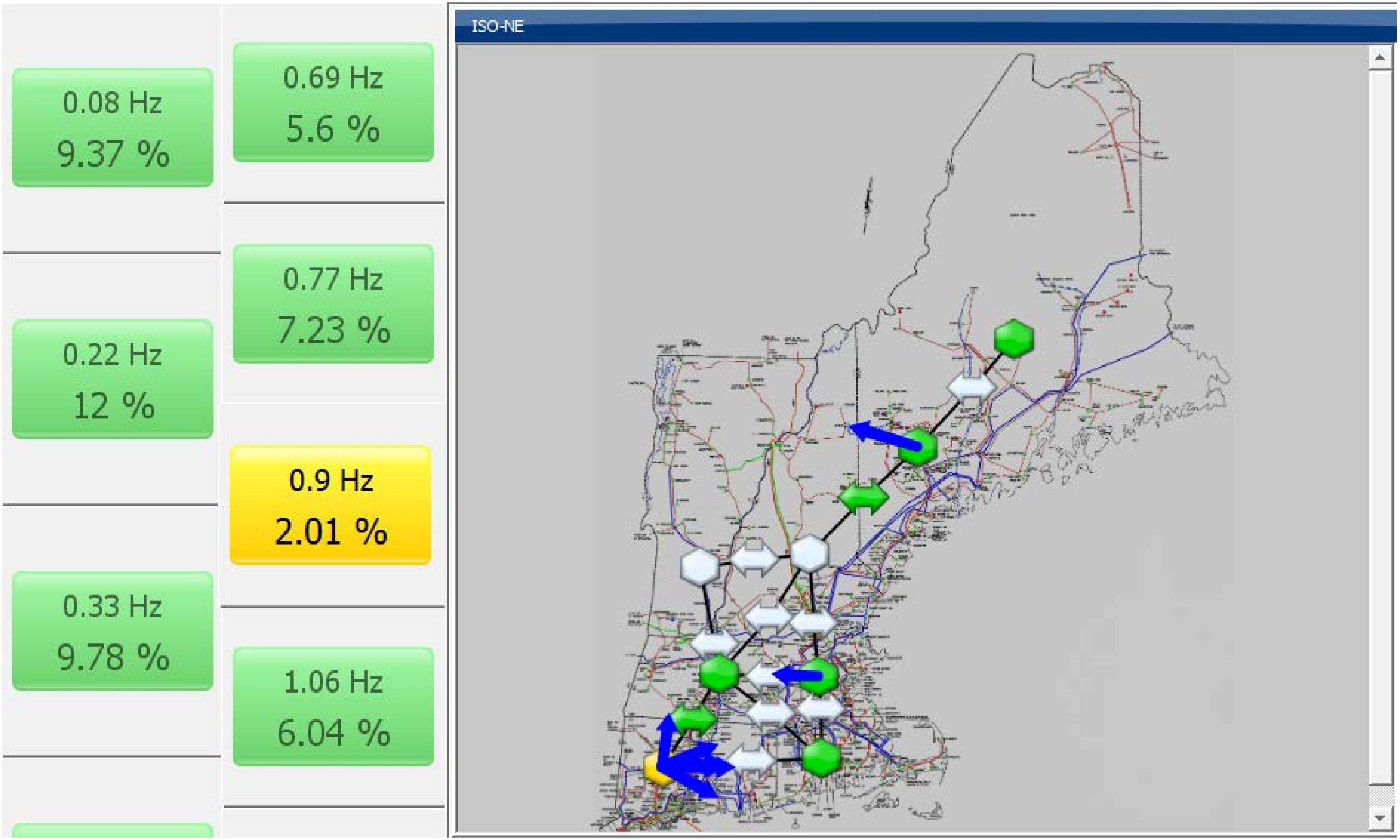
- Extracts frequency, damping, amplitude and phase of the main electromechanical oscillations in the band 0.04 – 4.0 Hz
- Configurable triggering attributes
  - Mode frequency sub-band
  - Mode damping ratio or decaying time
  - Mode amplitude
  - Hysteresis




- Efficiency of OSM depends on settings of triggering attributes

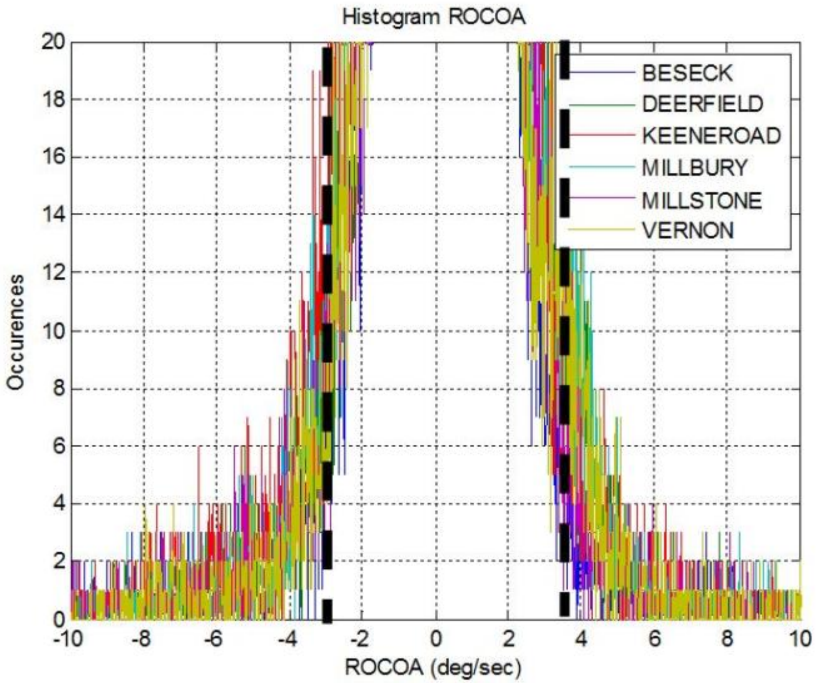
# Oscillation Stability Monitoring, cont.

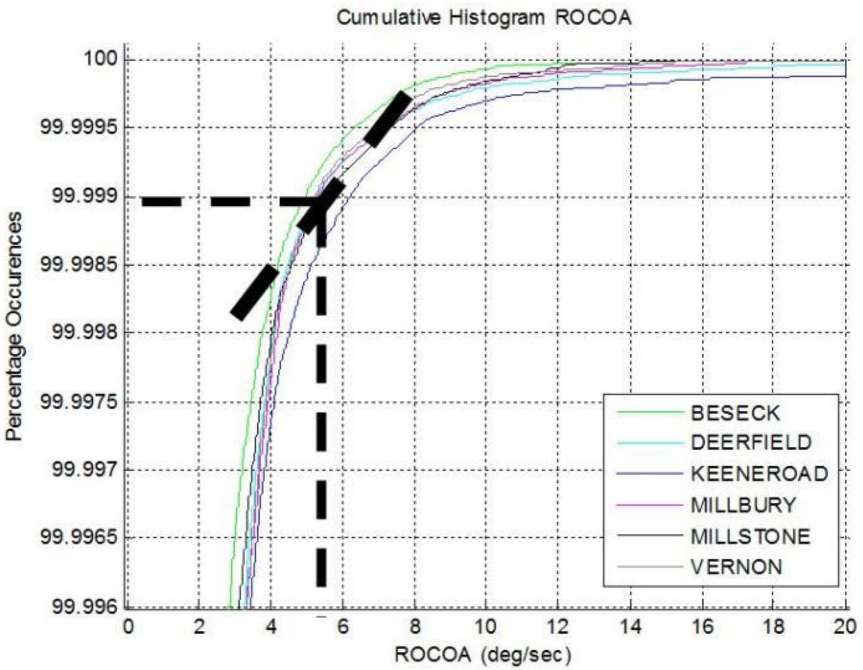


# Engineering Process to configure SDM and OSM Attributes

- A representative period of ISO-NE’s PMU data was used to setup SDM and OSM attributes
- Principles
  - ✓ Normal parameters variations do not trigger an alarm
  - ✓ Significant disturbances (generation trips and line trips) are detected
  - ✓ The generation/load loss estimates are broadly correct
- Histograms and cumulative histograms of ROCOA and ROCOF were extracted from PMU measurements
- An estimate of system inertia is used to quantify MW load/generation loss

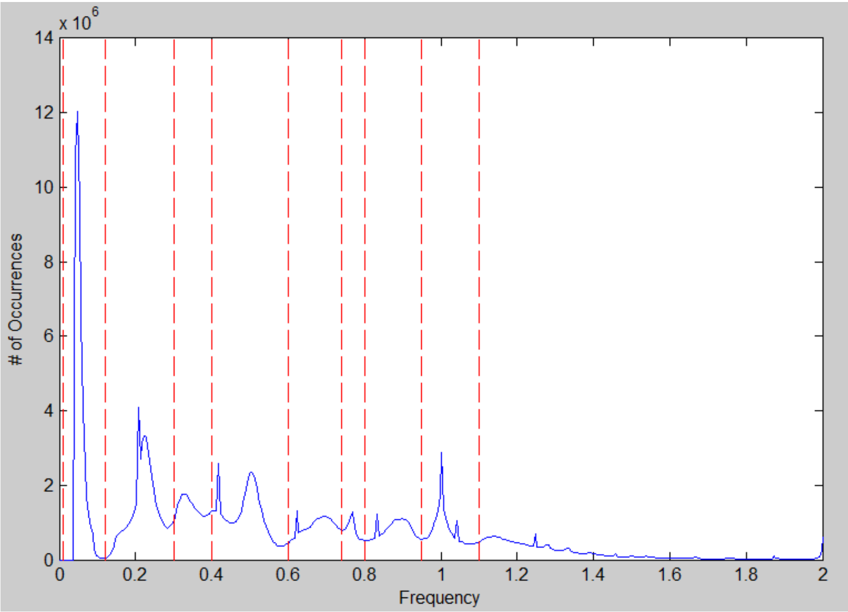
# Engineering Process to configure SDM Attributes, cont.



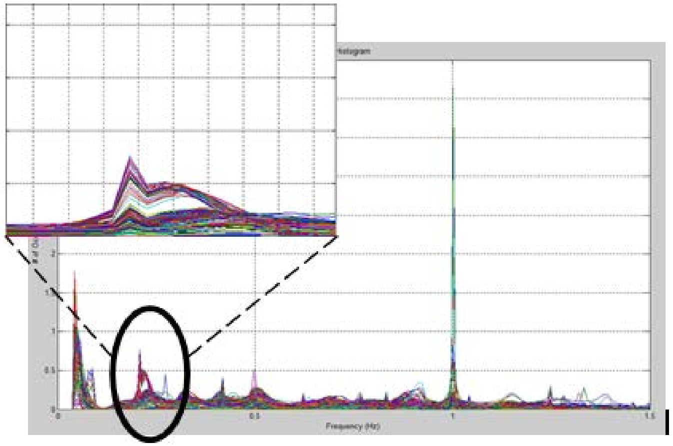

- Most of the ROCOA was contained within -3 to +3 $^{o}$/sec
- Inflection point is selected around the 99.999% of occurrence approximately corresponding to a 5$^{o}$/sec ROCOA
- Trade-off between sensitivity and too many alarms for insignificant events

# Engineering Process to configure OSM Attributes



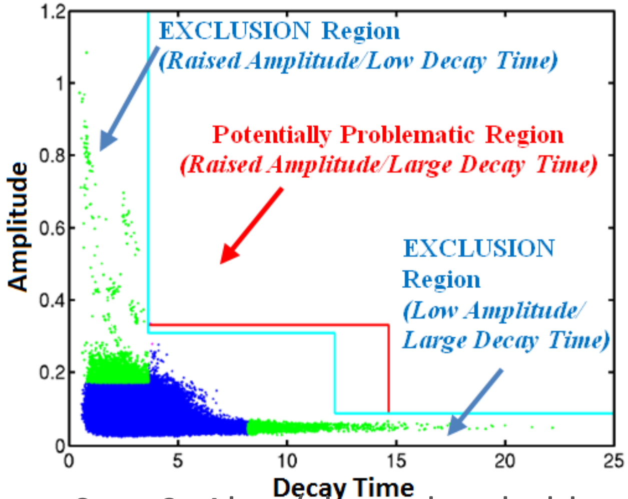

Step 1: *OSM frequency band setting*

*Goal: capture all dominant modes*



Step 2: measurement selections

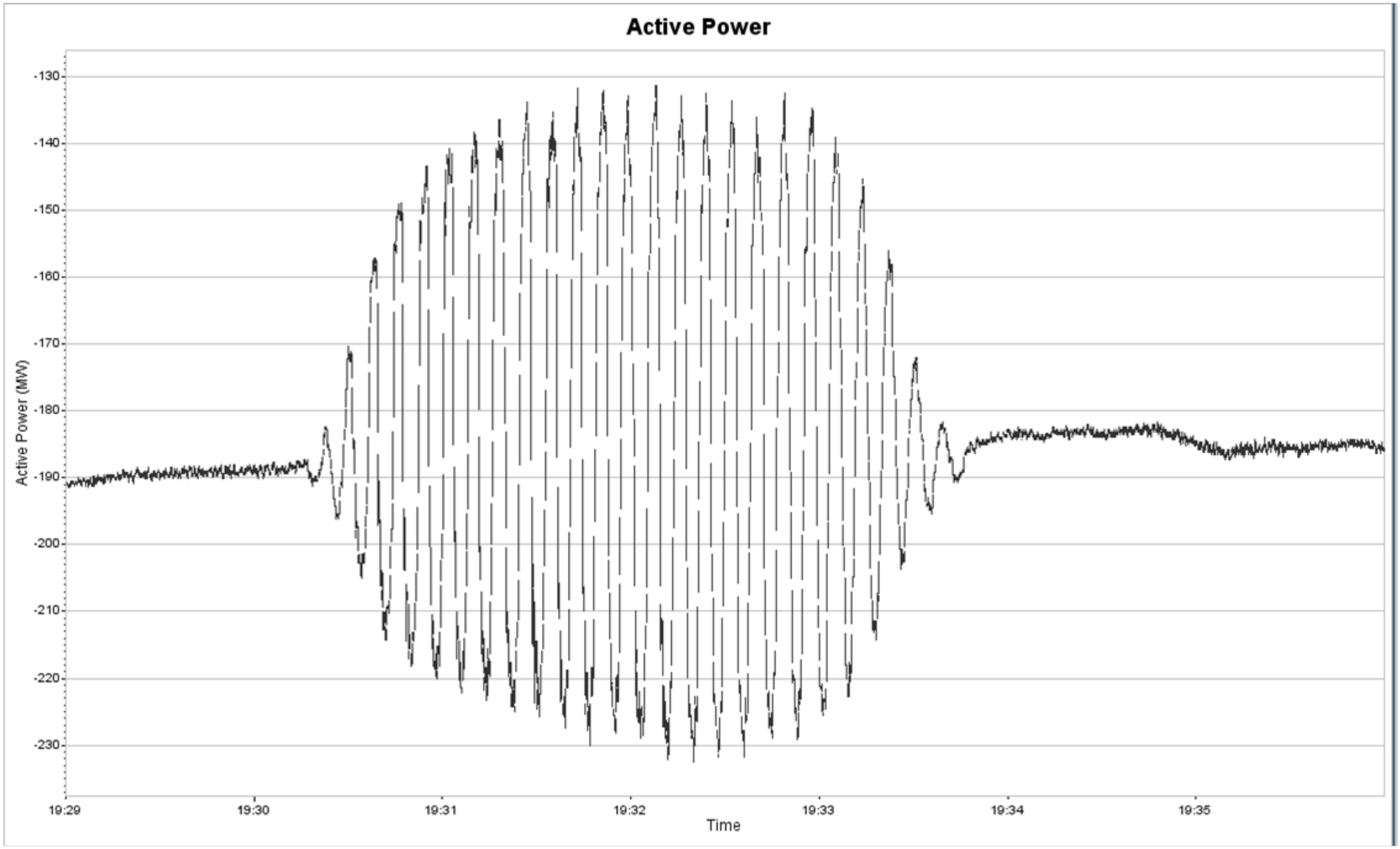
*Goal: observability for all dominant modes*




Step 3: Alert/alarm threshold settings

*Goal: alarm for important events only*

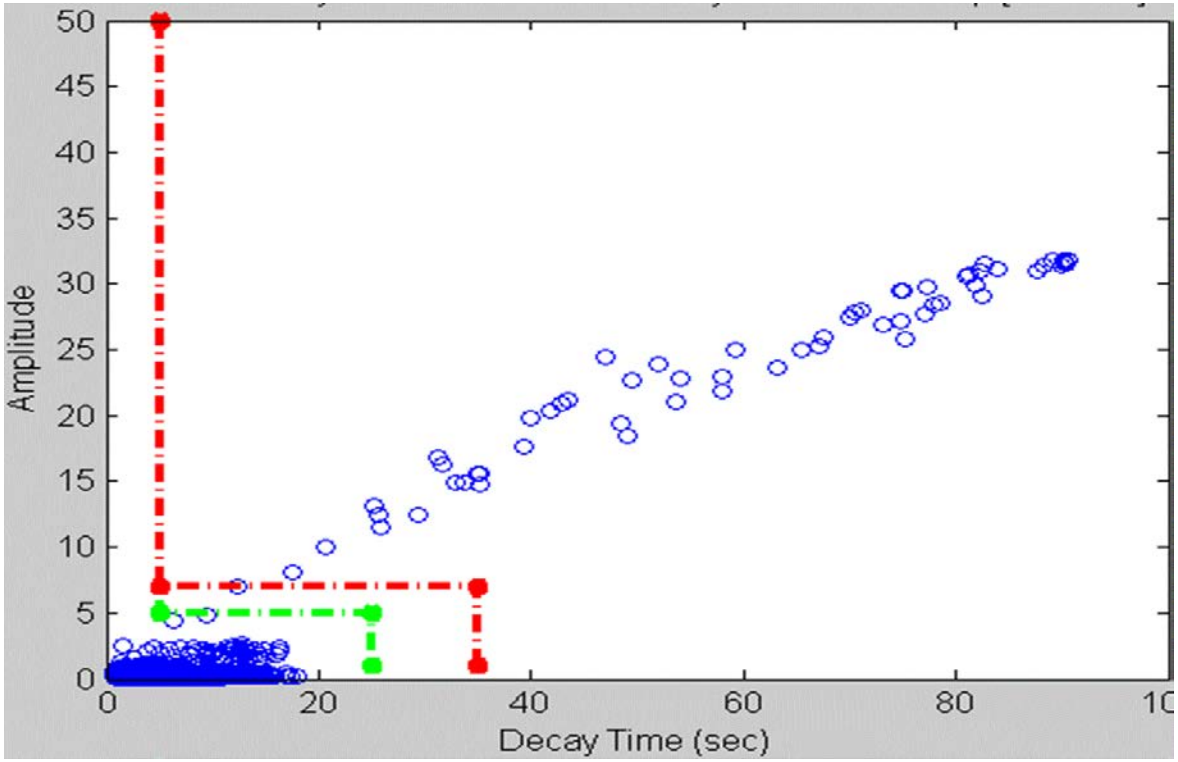
# Grid Monitoring using PhasorPoint - OSM




- “Forced oscillation” 0.12 Hz with almost 100 MW peak-to-peak amplitude
- Never observed before from simulations or measurements

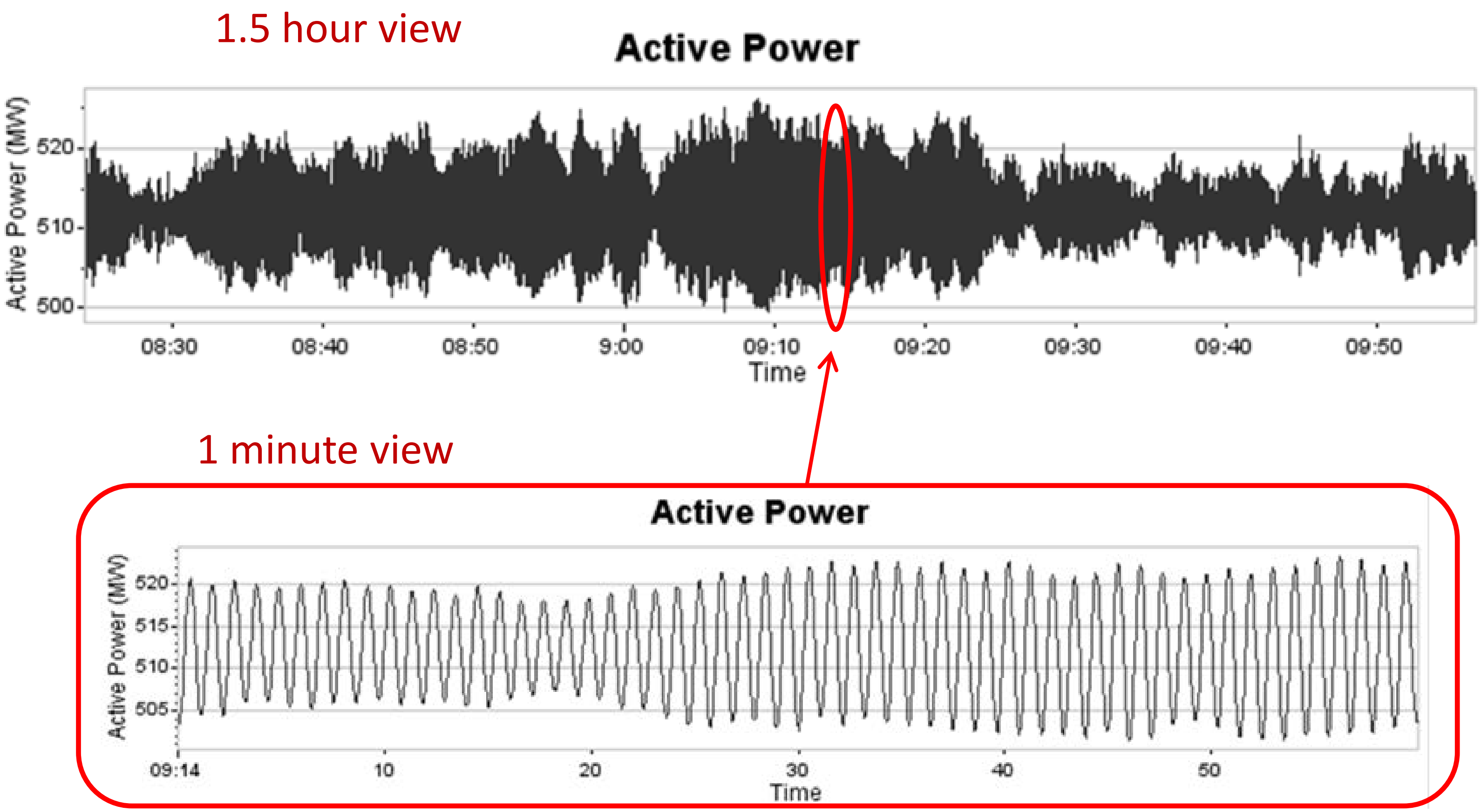
# Grid Monitoring using PhasorPoint – OSM, cont.

Locus plot of the 0.12 Hz "forced oscillation"




- Results satisfying trigger threshold generated an OSM alarm event

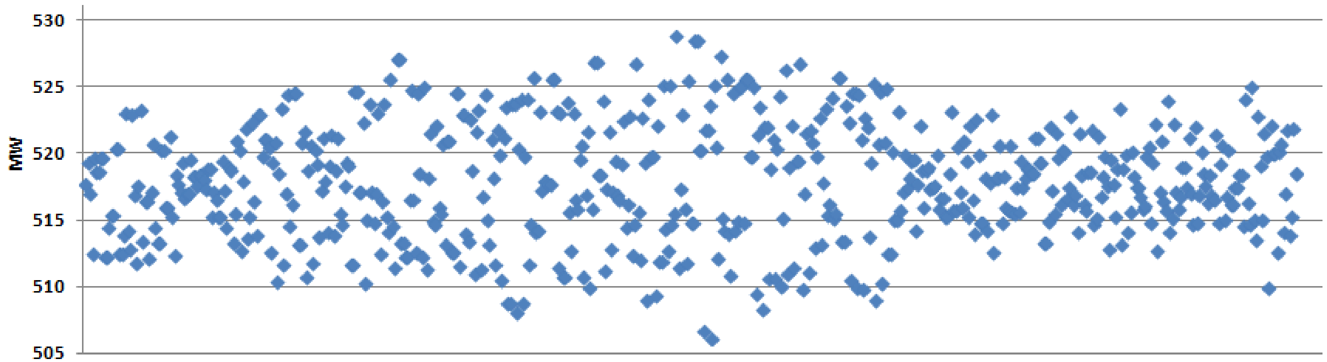
# OSM event – sustained 1.0 Hz oscillations with significant amplitude



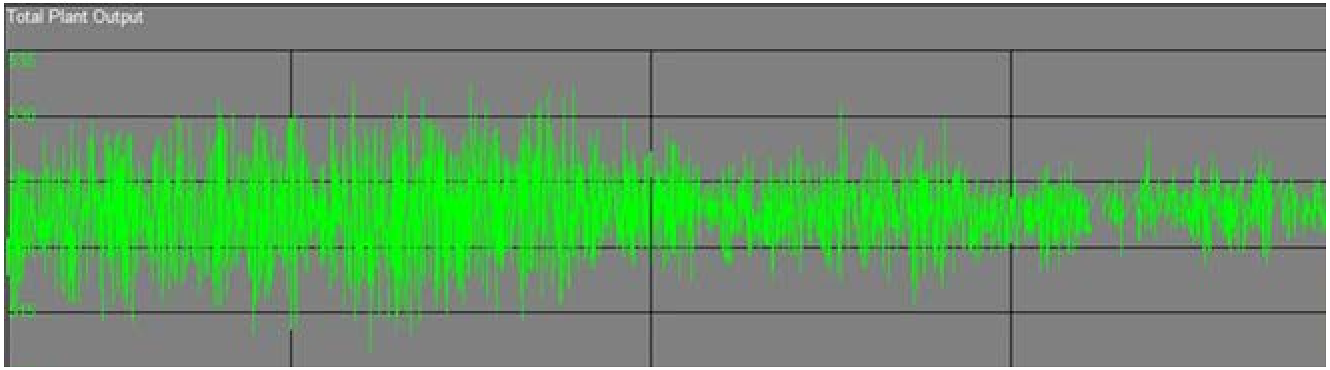

- New capability: detection and detail characterization of oscillations

# OSM event – sustained 1.0 Hz oscillations with significant amplitude, cont.

- SCADA view

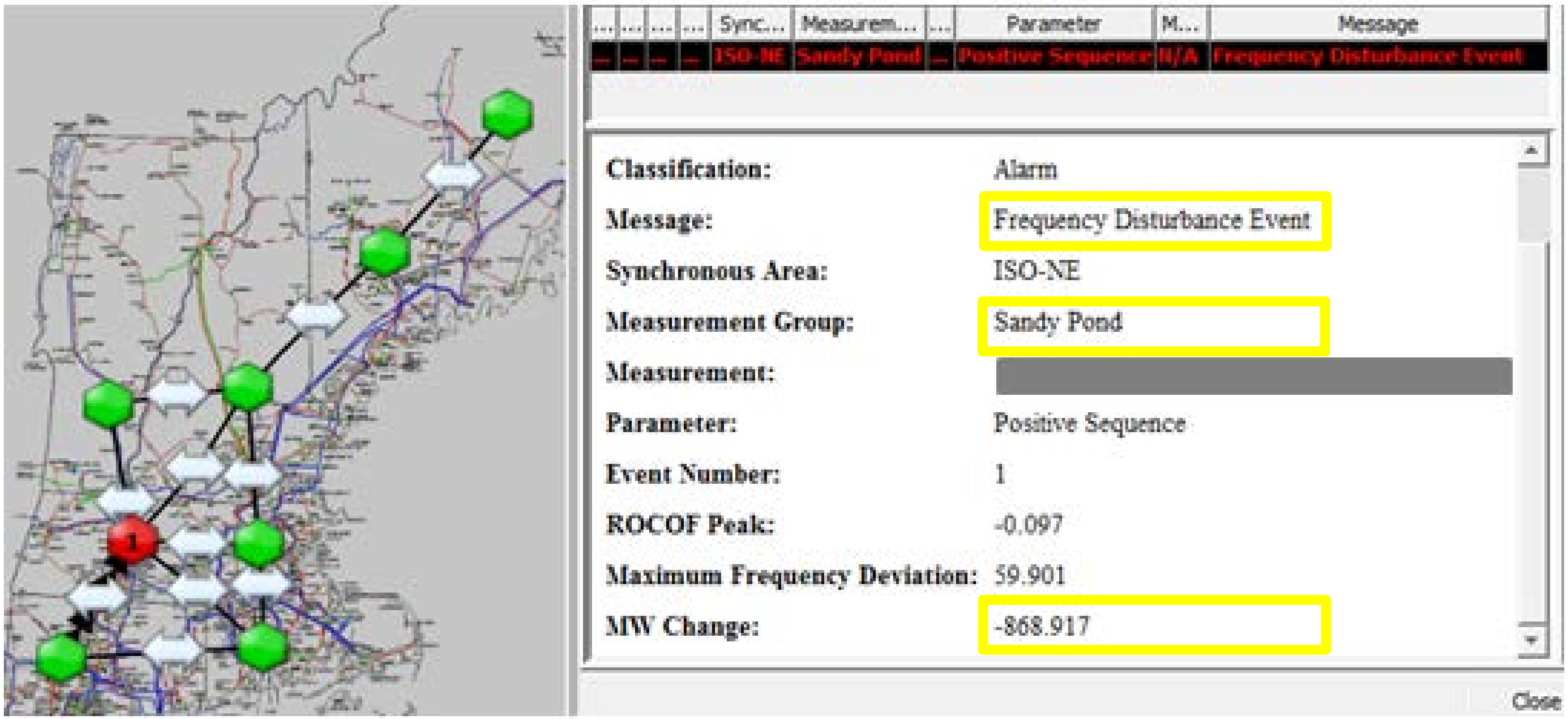



- Power Plant view



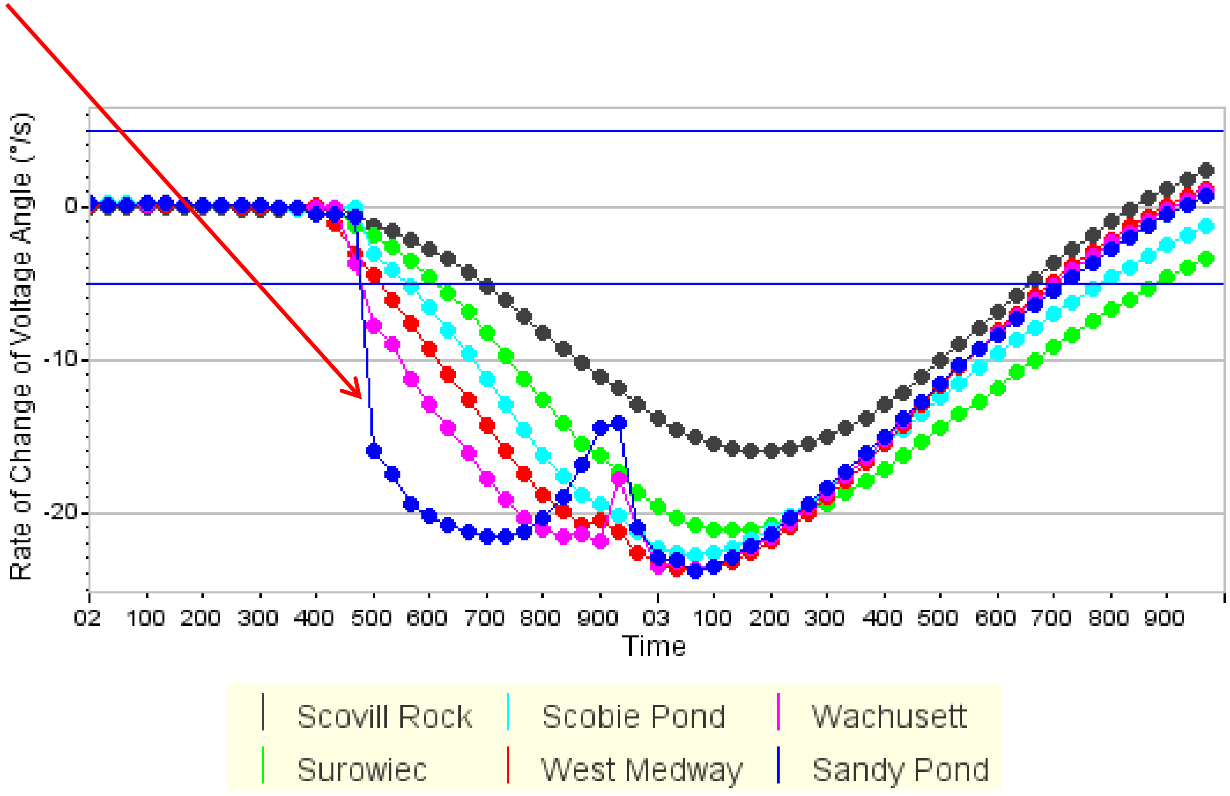
# Grid Monitoring using PhasorPoint – SDM

- Sandy Pond HVDC single pole tripped, lost about 800 MW



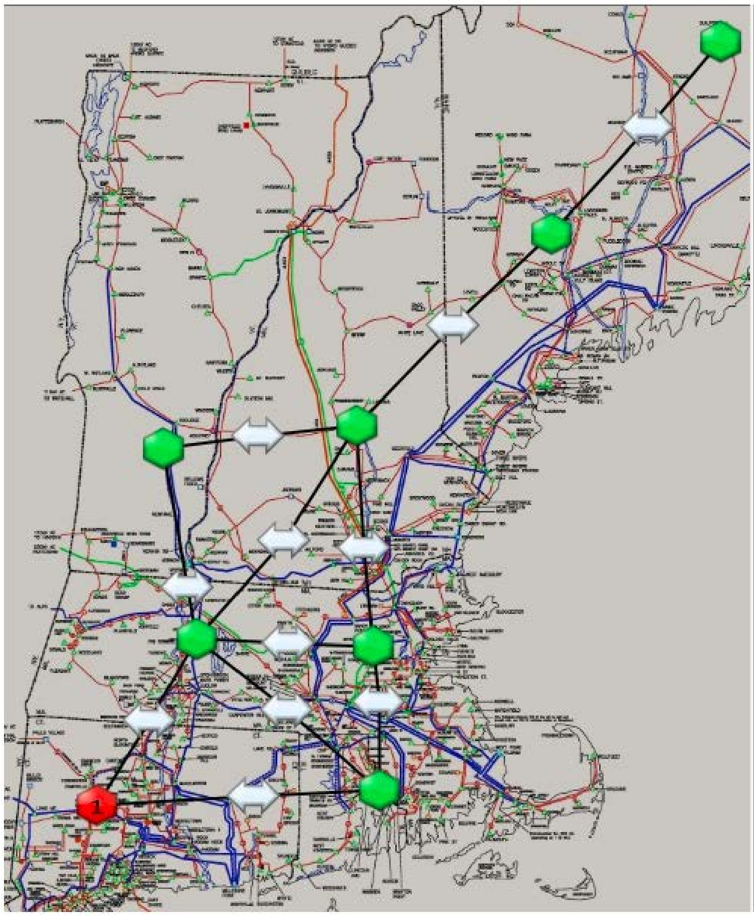
# Grid Monitoring using PhasorPoint – SDM, cont.

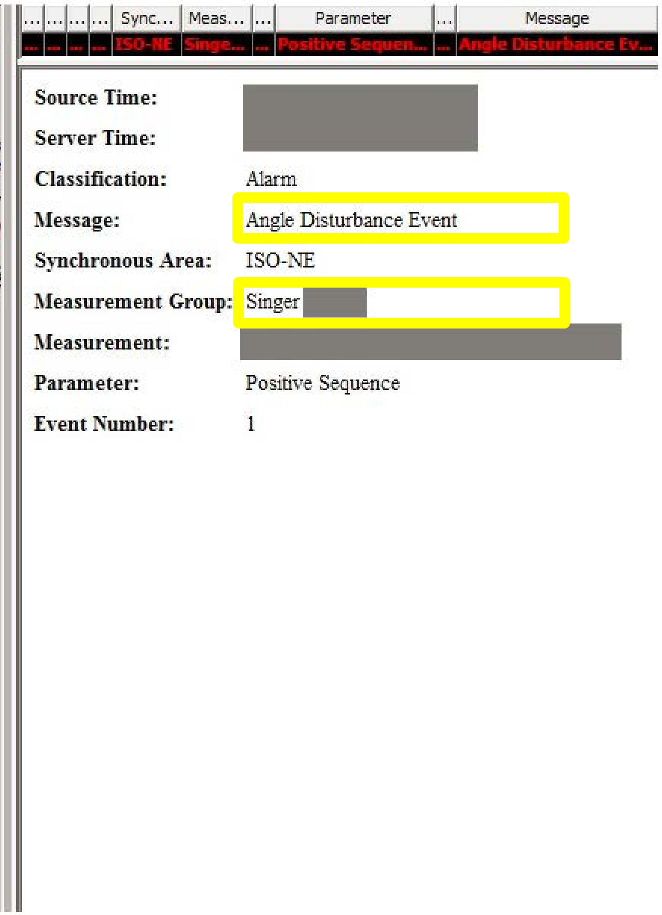
- Location: Sandy Pond ROCOA reached triggering conditions first



# Grid Monitoring using PhasorPoint – SDM, cont.

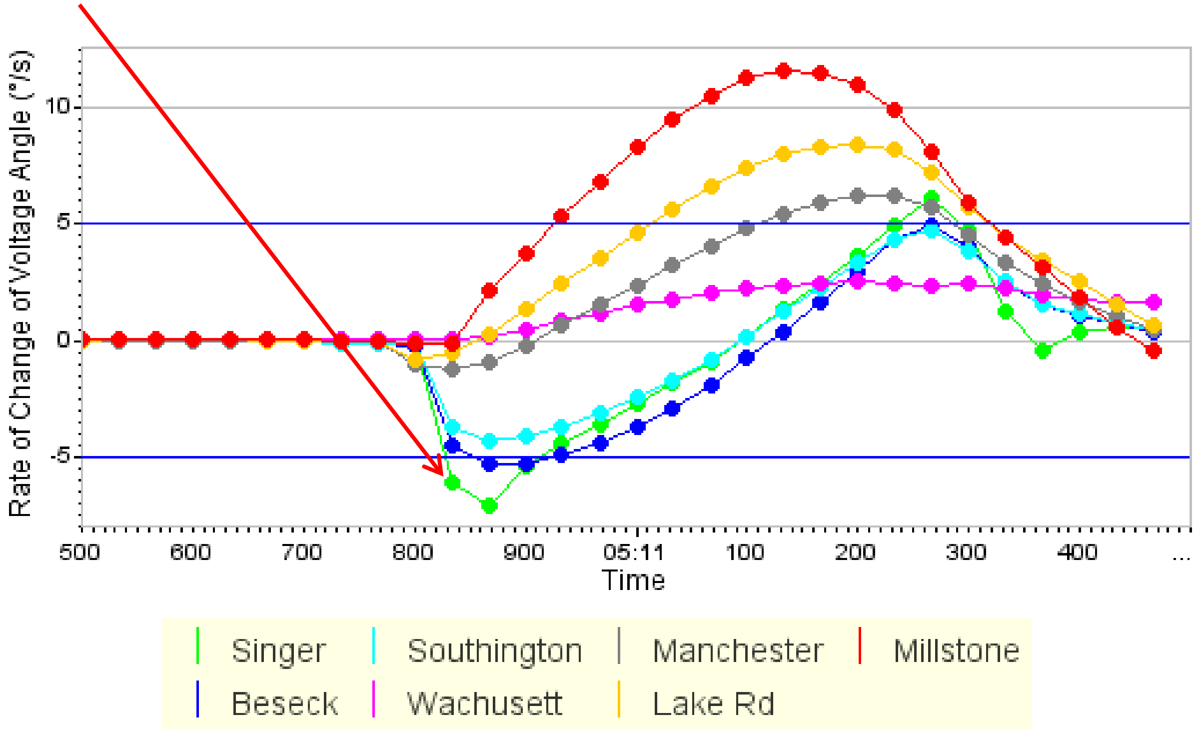
- Line trip event (Beseck – Millstone)





# Grid Monitoring using PhasorPoint – SDM, cont.

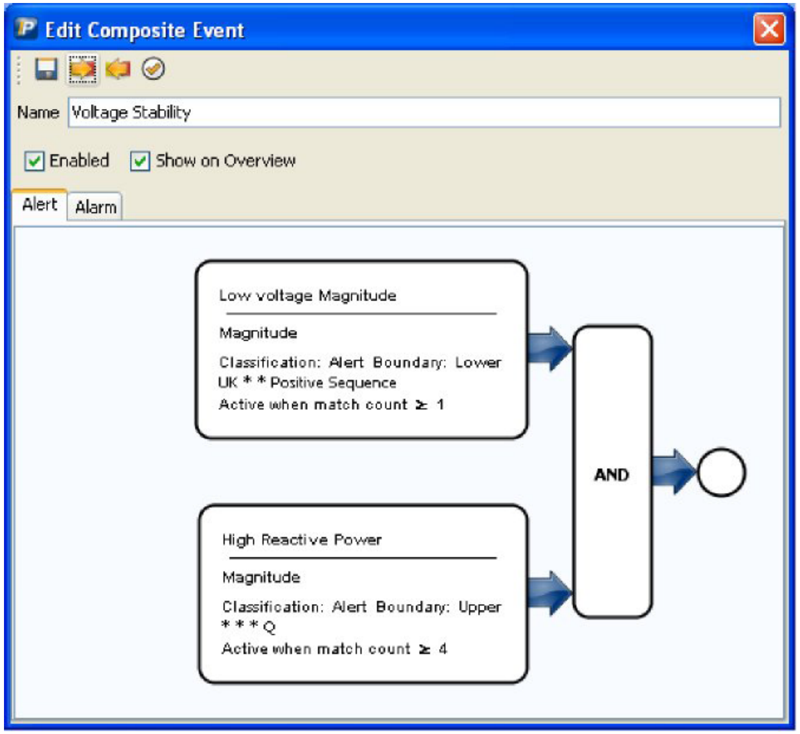
- Selection of Singer as location is based on triggering conditions




- Correct location is Beseck or Milstone
- Potential area of improvement

# Composite Events

- Powerful tool to build complex triggering conditions
- Goal: provide single alarm per system event




- Toolbar
- Composite Event Name
- Enable and Display Options
- Alert/Alarm Configuration Tabs
- Composite Event Editor

| | |
|---|---|
| AND | Logical AND operator |
| OR | Logical OR operator |
| Magnitude | Magnitude event primitive |
| PDX1-3 | PDX1-3 domain event primitive (if available) |
| PDX1-3 Validity | PDX1-3 validity status primitive (if available) |
| Islanding | Islanding event primitive (if available) |
| Connection State | PMU connection state primitive |
| PMU Validity | PMU data validity status primitive |
| Time Quality | PPMU time quality status primitive |
| Composite Event | Another Composite Event as a primitive |
| Digital State | A C37.118 digital signal. |

# Conclusions and Future Plans

- The PhasorPoint application has been successfully deployed at ISO-NE and demonstrated high efficiency for wide area monitoring and situational awareness
- PhasorPoint has detected system dynamic behaviors which were not observed before from simulations or measurements; ISO-NE has contacted plant owners to investigate the root causes
- Engineering process to set SDM and OSM attributes has been established. The process will be repeated periodically in the future
- WAMS applications such as SDM and OSM will greatly benefit from interconnection-wide PMU data exchange
- PhasorPoint is mainly used by operation engineers today. ISO-NE has developed synchrophasor technology roadmap to migrate the technology into control room

# Questions