How to Manage and Use Synchrophasor Data in a Meaningful Way in Real Time Environments.

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Team Background

**MISO**
- Business knowledge and direction
- Business and operational requirements
- Operational expertise and experience
- Corporate and project vision

**Utilicast**
- Program / Project Management
- Application and Integration Lead
- Infrastructure Lead
- Operations Engineering Support
• PMU Deployment
  – MISO expects to have the largest collection of phasor measurements in the country
• After-the-Fact Data Analysis
  – Forensic Event Analysis
  – System Model Improvements
• Real-Time Operations
  – Oscillation and Angle Monitoring
1) Manage PMU installation
2) Buy Software
3) Train Staff
4) Done 😊
What we found

• All PMUs are not created equal
• There sure is a lot of data
• Operators were skeptical
• Software was immature
• Uncharted territory
• Complicated new technology with many avenues to explore and understand
• Realization of complexities caused the team to reevaluate and hone the project scope
• New displays would need to displace existing ones on the video wall
• Was our goal to use data in the control room too ambitious?
• What was really most important to MISO, its Members and the Interconnect?
Restructure

Split team into two tracks.

- Track 1: Build a set of technology and tools that could be used to manage, monitor and visualize not only phasor data, but a combination of existing data matched with phasor data.

- Track 2: Develop a very detailed understanding of the PMU data end-to-end, which requires understanding vendor differences and the underlying causes of data quality issues. The same team was also responsible for defining how phasor data could in Real-Time Operations today, as well as in the short to mid term.
The best visualization appears obvious once complete. However, it is anything but straightforward to invent.
The solution involves purchased, open-sourced, and custom developed applications integrated with existing systems.
Problem #1: Operator Trust in new Data

Solution: Eliminate false positive alarms to the fullest extent possible

- Automated bad data detection/monitoring
- Composite alarms
- Show PMU data and calculations alongside of existing data to build trust
- Utilize existing processes and teams (evolutionary over revolutionary solutions)
- Comprehensive training – emphasize that real-time PMU data is useful because of its high fidelity - deemphasize high speed and low latency.
Problem #2: PMUs are not as ubiquitous as SCADA data

Solution: Make it easy to use Synchrophasor Data alongside of existing data
EMS Alarms and PMU Frequency

SCADA and PMU Frequency
Problem #3: Speed and fidelity of PMU data can be overwhelming to operators and engineers.

Solution: Use technology and human factors engineering to simplify visualization:
- Advanced data smoothing (averaging, filtering, ...)
- Visualization techniques like gradients and animations
- Context based displays – highlight what is important and allow drill down
- De-clutter – Roads and streams do not add to situational awareness
- Avoid use of 3D without overwhelming benefit
- Complex event processing (CEP) – Ability to process data on the fly instead of round tripping to the database for a better user experience
The success at MISO can be attributed to:

• Building the right team
  – Committed with authority to make actionable decisions
  – Based in real-time operations
  – Small size combined with being highly skilled
• Deep understanding of the business and data
• Selecting the proper problems to solve – do not get distracted
• Evolutionary and Agile development
• Understand technology, applications and standards are all evolving
• Use knowledge gained in after-the-fact analysis to enhance control room visualization
• Learn from one another
Questions?