American Transmission Company
Smart Grid Investment Grant Update

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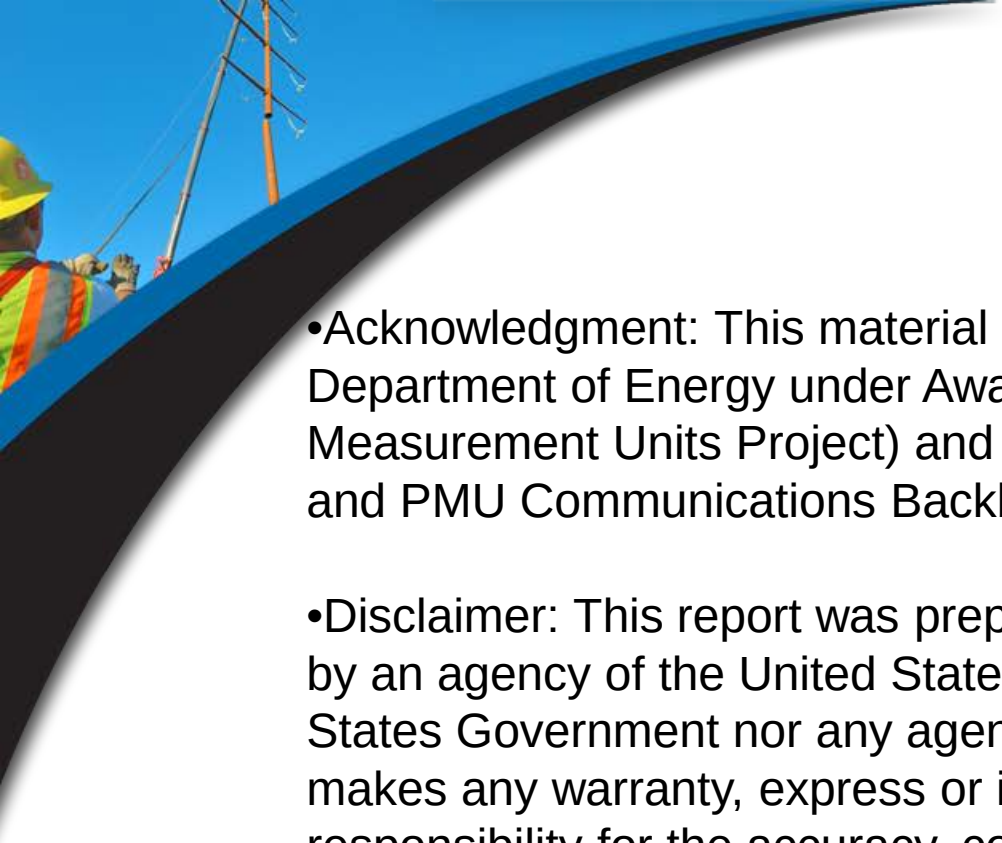

ARRA disclaimer

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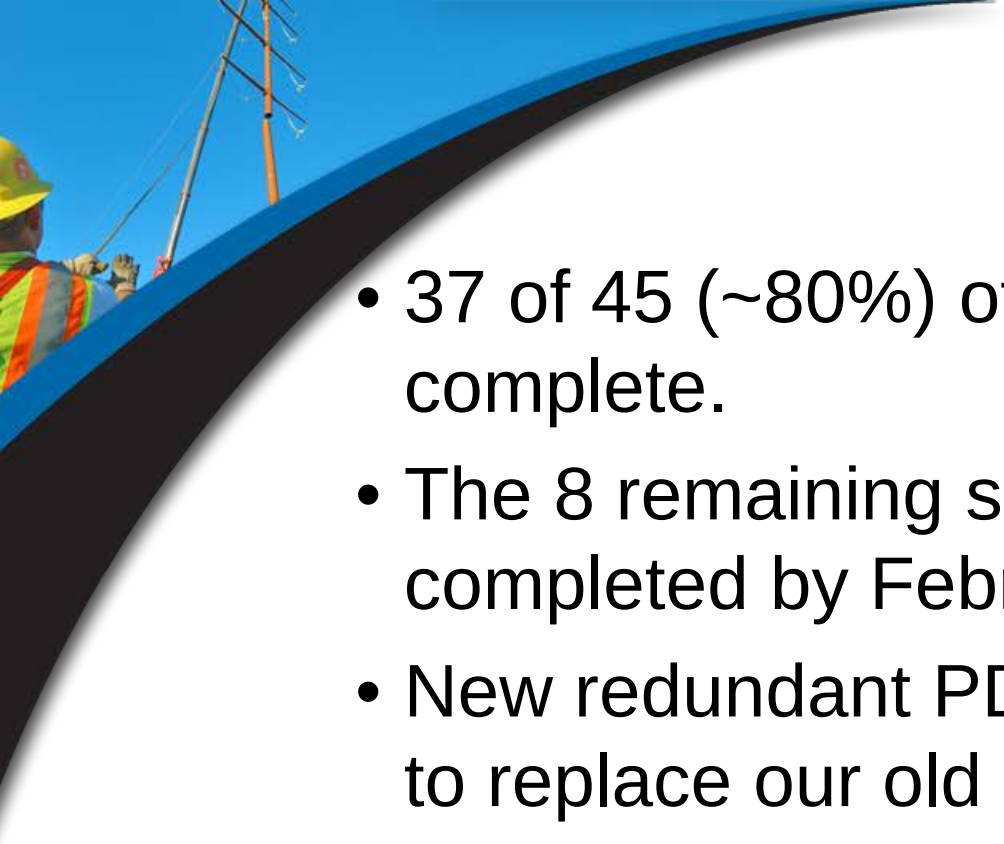
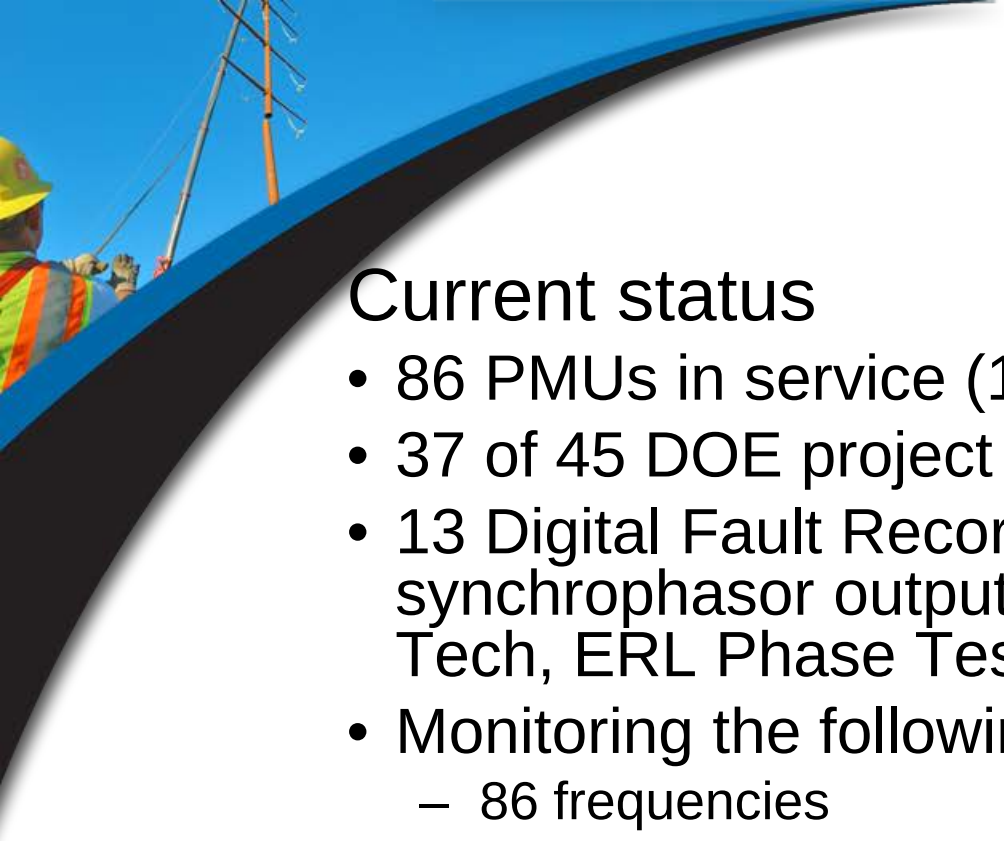


Project Timeline

- 37 of 45 (~80%) of PMU Installs are complete.
- The 8 remaining sites are scheduled to be completed by February 2013
- New redundant PDCs being implemented to replace our old SEL 3306 units.
- Working with MISO to potentially monitor 5-10 additional sites with work starting in 2013.
- Testing visualization applications and rolling out training to Ops now



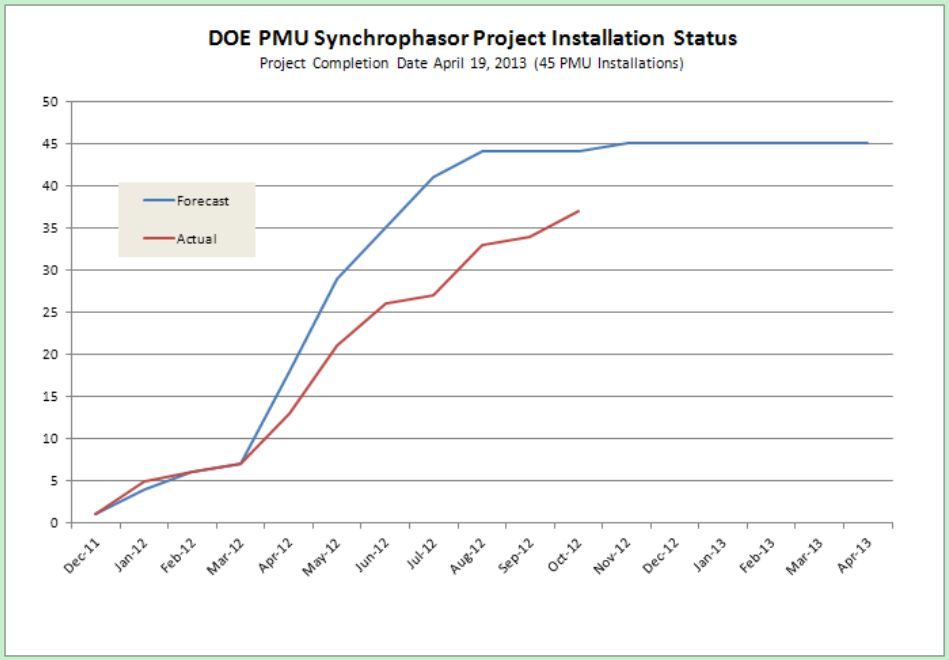
PMUs

Current status

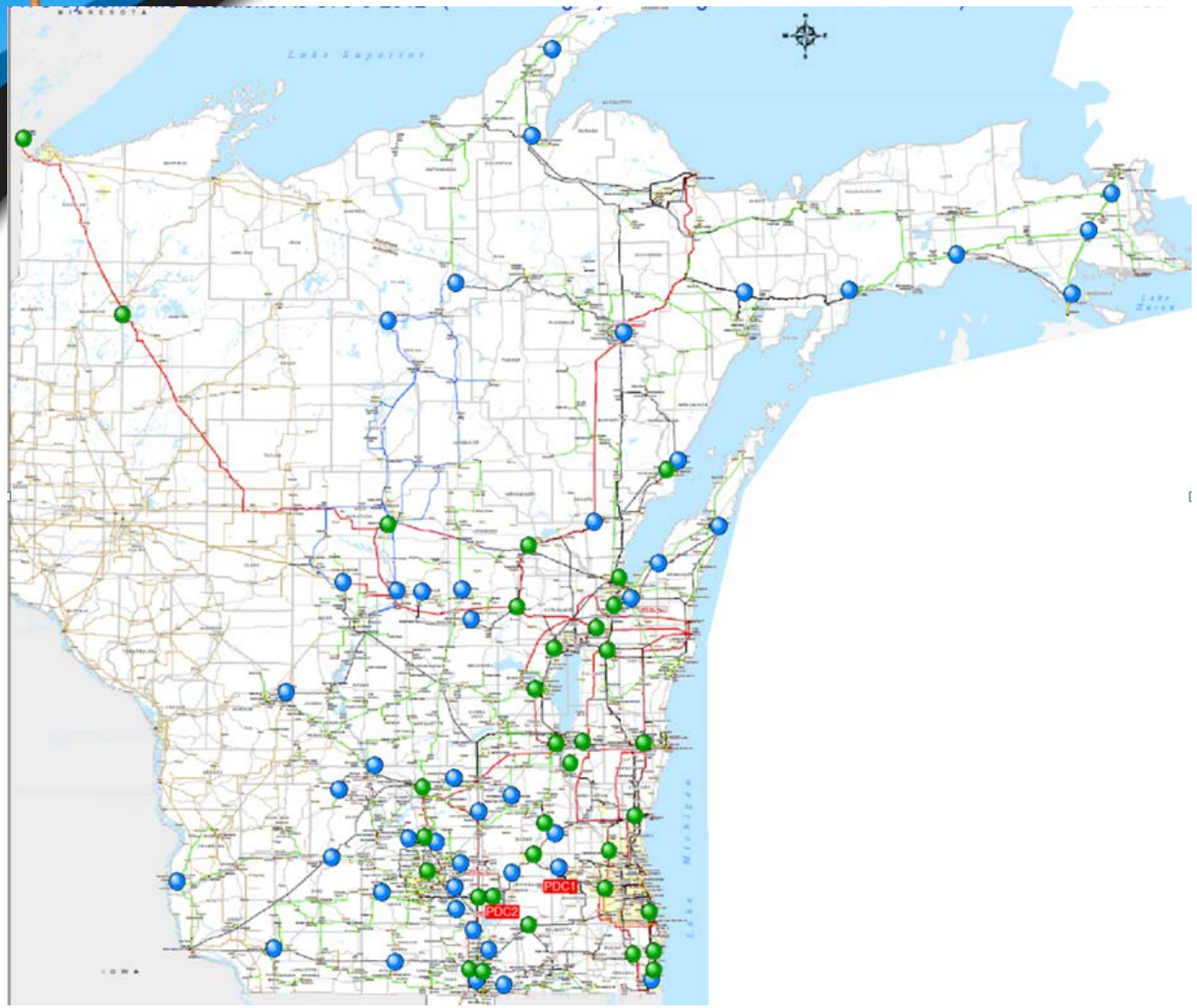
- 86 PMUs in service (16% of system stations)
- 37 of 45 DOE project sites in service
- 13 Digital Fault Recorders in service with synchrophasor output enabled (Includes Mehta Tech, ERL Phase Tesla, Qualitrol BEN)
- Monitoring the following measurements
  - 86 frequencies
  - 342 individual phase voltages
  - 363 individual phase currents monitoring
    - 20 Units (GSU high sides and wind farm collector xfmrs)
    - 17 Transformers
    - 59 Lines
- Sending data from 37 legacy sites to MISO with plans to enable DOE project data when MISO ready and we're out of "install mode"

PMUs (cont'd)

- PMU Installs occurring at a rate of 5 per month but that will drop off due to scheduling issues. Peak of 8 installs in May 2012
- New stand alone installs go quicker than our DFR upgrades but tradeoff provides more data from each site.



Project Map



PDCs and Communications

- PDCs
  - Final project will comply with MISO PDC standards
    - Redundant hot standby pair at control center
    - Cold standby PDC at backup site
  - 45 field PDCs will be in service when project is complete
    - No data storage
    - Data concentration
    - Security functions including access control
  - PDC availability rate (substation and control center) expected to be in high 90s. Too early to tell if 99.5% achievable based on current information but we will strive to match SCADA performance.
- Communications system
  - Use ATC owned and leased communications infrastructure for data transfer from the substation to the control center
  - Considerable fiber backbone internal to ATC. Augmented by frame relay and satellite communications
  - MISO link utilizes MISO managed communication infrastructure
  - Communications system availability rate has been high. We alarm on <95% right now and on normal days have very few issues. Again too early to tell 99.5% is achievable.

Communications and data

- Data flow
  - For our DOE project all PMUs at substation route thru substation PDC (No data storage at substation – just data concentration)
  - Substation PDC sends data to Control Center PDC
  - Control Center PDC provides data to applications (PI Historian, PhasorPoint, RTDMS, ..) and remote sites (MISO). There is no queuing up of the data.
- Data storage
  - Data being stored in our dedicated PMU PI Historian – 8 Gbyte files created every 15 hours (4.7 TBytes per year)
  - We are now using compression and exception processing to reduce storage requirements
  - Storing all data (no compression) for voltage phase angle and frequency
  - Intent is to keep all data available online for now. We will decide on online retention once we have a better handle on needs
  - Data access query process is mature and workable for small time periods. We still need to develop COMTRADE output from PI for larger time frames.

Data quality and availability

- ~90% of PMUs delivering good quality data
  - Some issues with loss of time synch
  - Vendor specific data quality issues we are working to address
  - Suspect current data at low loads

- % of PMUs delivering timely data
  - Currently using the data post event so “timely” isn’t an issue
  - Having said that we are having issues with our data feed to one of our visualization applications which may be related to delays. Still troubleshooting but that could be our first issue.
  - As new applications are envisioned we will need to better determine latency between source and PDC to make sure they meet the application needs

- % of good, timely data relative to total data flow possible
  - Our experience has been that if things are working the data quality is very close to 100%. (Losing less than 100 data samples an hour out of 108000 possible)
  - When things go bad they go really bad.

Phasor data-sharing

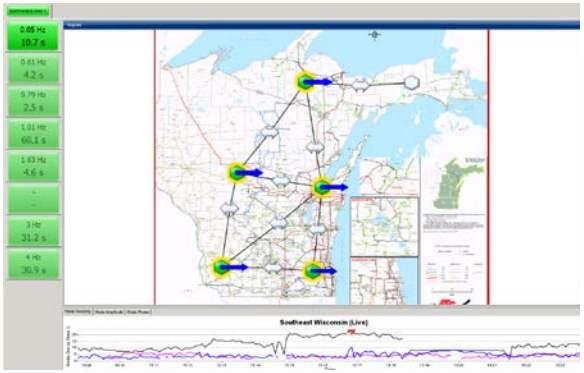
- We share data in real time for 37 legacy PMUs with MISO.
- We do not enable applications output that results from processing real-time phasor data to anyone and there are no plans to do that
- We are working with Karl Reinhard from University of Illinois on a PMU data quality and availability modeling study. We are in the initial stages of that study.

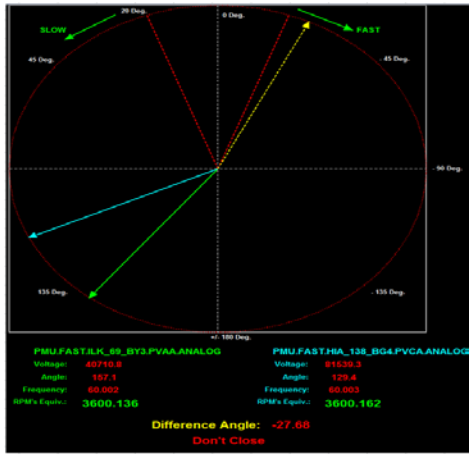
Major operational applications using synchrophasor data

- Post Event Analysis
  - Using synchrophasor data to analyze events and to start identifying odd behavior on the system
  - Getting actual event and real time data in front of Ops early on to show the value
- State estimation enhancement
  - Voltage Angle data flowing to our ALSTOM EMS (EMP Version 2.6)
  - Also storing solved state estimator voltage angles each run so we can compare model results to scanned data
  - Will be testing the use of the voltage phase angles as an input to SE late 2012/early 2013
  - System can accept the data now. We will test to make sure we have our weighting/accuracy class definitions configured properly before implementing.

Major operational applications using synchrophasor data (cont'd)

- Wide-area situational awareness
  - Working with ALSTOM to test their PhasorPoint suite





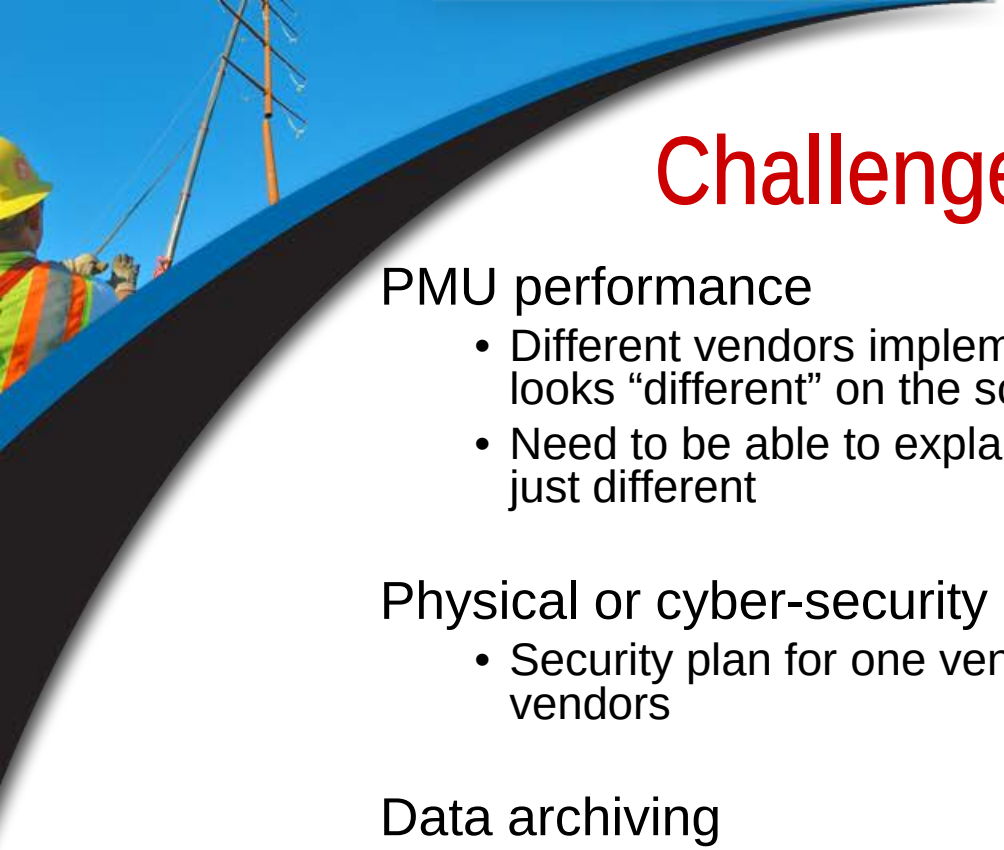
  - Working with EPG on RTDMS
  - Integration with ALSTOM EMS Displays
  - Home grown PI displays

Major operational applications using synchrophasor data (cont'd)

- Operators and operations support engineers are not actively using these applications.
  - They do request information after the fact but the system has not reached a level of stability where they've come to rely on it.
  - Ops Engineering sees more value than the real time desk at this time. (My opinion)

- Expected benefits:
  - Confirmation of SCADA information
  - Review system behavior for periods "between the scans"
  - Model validation

- Obstacles:
  - Need to show the value to get more buy in from real time ops
  - Need to show the value under normal operations and when significant events occur to get the screen space in the ops environment



Challenges and lessons learned

PMU performance

- Different vendors implement the protocol differently so the data looks “different” on the screen (Integer vs. real data types, etc..)
- Need to be able to explain this to end users. Different isn’t bad – just different

Physical or cyber-security

- Security plan for one vendor does not necessarily work for all vendors

Data archiving

- “It’s only TerraBytes” works until your data center starts running out of space

Know Your Transmission System

- You’re going to see data you may not understand. Need to make sure you can explain things before you put them in front of Ops as they will ask the questions and expect answers.

Other things we should know about your project?

What happens after 2013?

- Shift from getting data flowing to analysis and implementation
- Ongoing communication with Ops to help make the use of the data and associated applications a part of their daily work routine
- Determine where we have visibility issues with our current installed equipment and add/update equipment as needed to fill in the gaps
- Extend our visibility outside our operational footprint