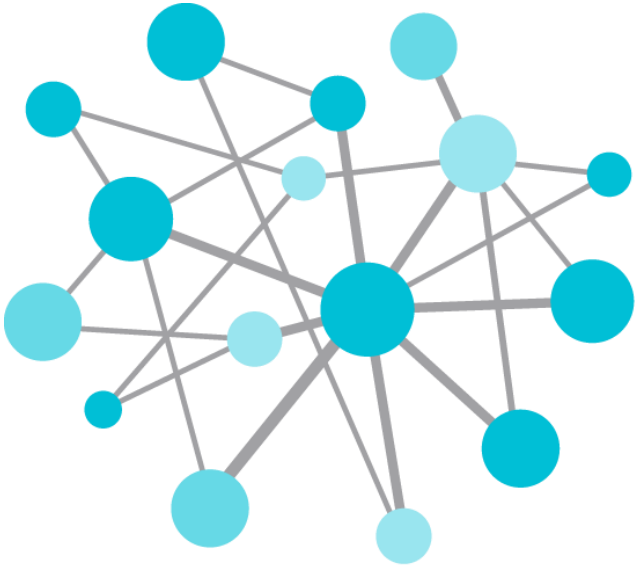

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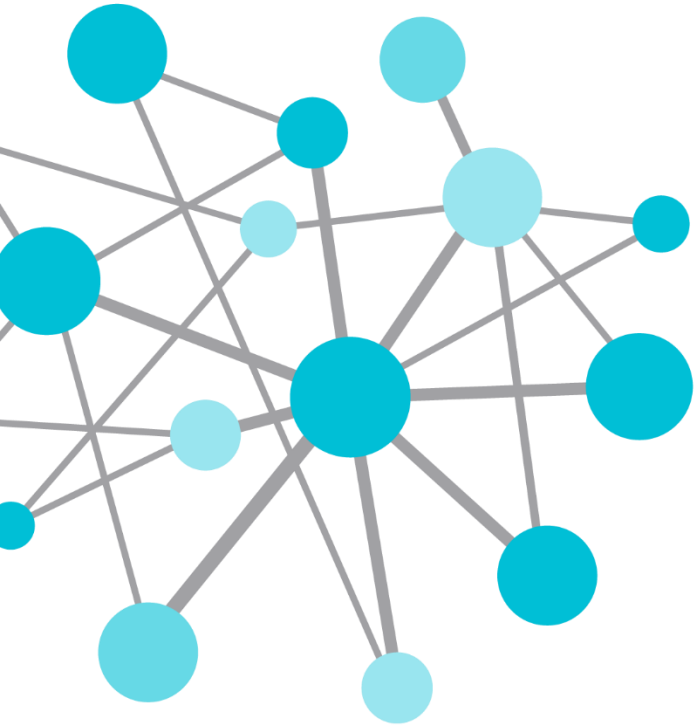


Grid Operations and Reliability Monitoring/Analysis at American Transmission Company

Presented by **Jim Kleitsch**

Principal System Operations Engineer

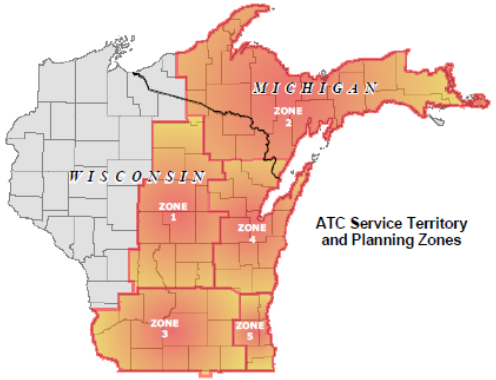
Discussion Topics

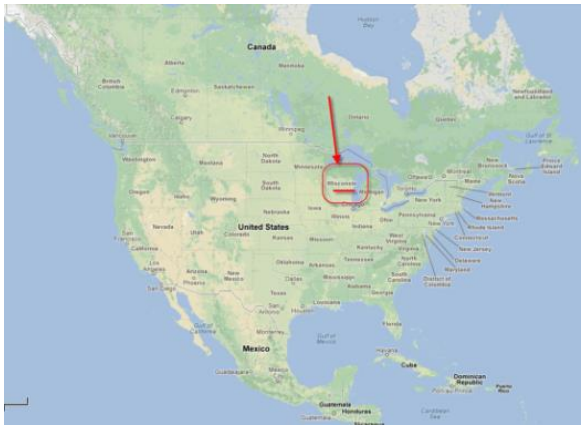
- ATC Company Overview
- ATC Grid Operations and Monitoring
  - SCADA/EMS Specifics
  - Information Management
  - Synchrophasor Project
  - System Protection Overview
  - Back to Back DC project
- Duke-ATC Partnership Proposed Projects

ATC Company Overview

American Transmission Company [ATC] is a transmission-only electric utility located in the upper Midwestern United States

- 9,440 circuit miles of transmission lines (69 Kv thru 345 Kv)
- Over 500 substations (wholly or jointly owned)
- Peak demand in footprint: 13,270 MW
- Service area includes portions of the states of Wisconsin, Michigan, Minnesota, and Illinois





ATC Company Overview (cont'd)

- Formed in 2001 – asset contribution encouraged through legislation
- 2,305 miles of line upgraded or built since 2001
- Growth from $550 million in assets in 2001 to $3.3 billion today
- Several Multi-Value Projects [MVPs] planned to enable the flow of renewable energy (Wind and hydro primarily) from the West and North
- www.atcllc.com

Owners

ATC is a privately owned company. Utilities, municipalities, municipal electric companies and electric cooperatives from Wisconsin, Michigan, Minnesota and Illinois have an ownership stake in ATC.

- Adams-Columbia Electric Cooperative
- City of Algoma
- Central Wisconsin Electric Cooperative
- City of Columbus
- Madison Gas & Electric Co.
- Marshfield Electric and Water Department
- Ontonagon County Rural Electrification Association
- Rainy River Energy Corp. – Wisconsin
- Rock Energy Cooperative
- Stoughton Utilities
- City of Sun Prairie
- Upper Peninsula Public Power Agency
- Wisconsin Power & Light Co.
- City of Wisconsin Rapids
- Alger Delta Cooperative Electric Association
- Badger Power Marketing Authority
- Cloverland Electric Cooperative
- City of Kaukauna
- Manitowoc Public Utilities
- City of Oconto Falls
- City of Plymouth
- City of Reedsburg
- City of Sheboygan Falls
- City of Sturgeon Bay
- Upper Peninsula Power Company
- Wisconsin Electric Power Co.
- Wisconsin Public Service Corp.
- WPPI Energy

ATC SCADA / Energy Management System [EMS]

SCADA / Energy Management System [EMS]

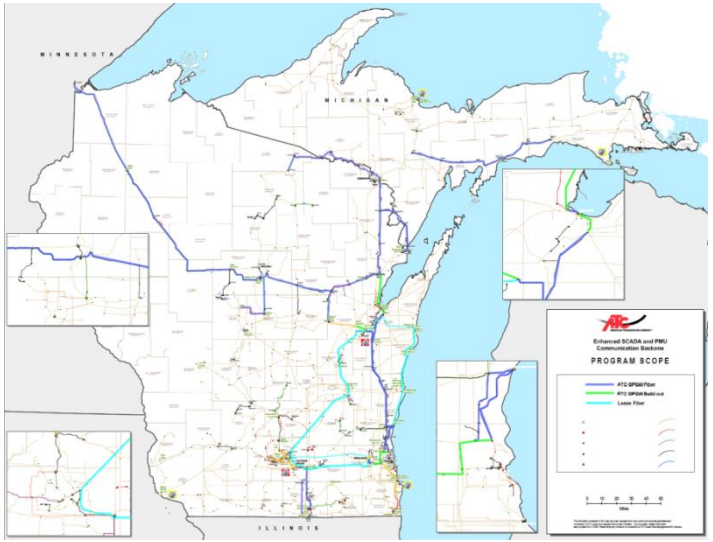
- ALSTOM EMS
- Two physically separate control centers with different areas of operational responsibility
- Each site has redundancy built into all important equipment and data links
- Most Remote Terminal Units [RTUs] direct scanned from both sites with mapping to allow data feed from one site to the other site
- Capabilities for control center backup at opposite site with minimal effort.

SCADA / EMS Information (cont'd)

- Direct Scan over 400 RTUS using DNP protocol (starting to look at IEC 61850 but no production installations to date)
  - Over 9,800 analogs and 51,500 status points
  - Over 3,400 controllable devices
- Inter-Control Center Communications Protocol [ICCP] links to 10 other entities including our Reliability Coordinator – Midwest ISO
- Total Point Counts (Includes ICCP, Calculations, direct scans, and pseudo status points)
  - 28,200 analogs / 82,500 status

SCADA / EMS Information (cont'd)

- Communications infrastructure includes company owned fiber loop in Southeast Wisconsin to support relaying and SCADA communications.
- Adding fiber facilities to tie our existing fiber loop to a new fiber loop in our northern system.
- We contract with communications vendors for frame relay communications where needed to enable SCADA and relay communications.
- Limited implementation of satellite communications for remote substations and for backup communications

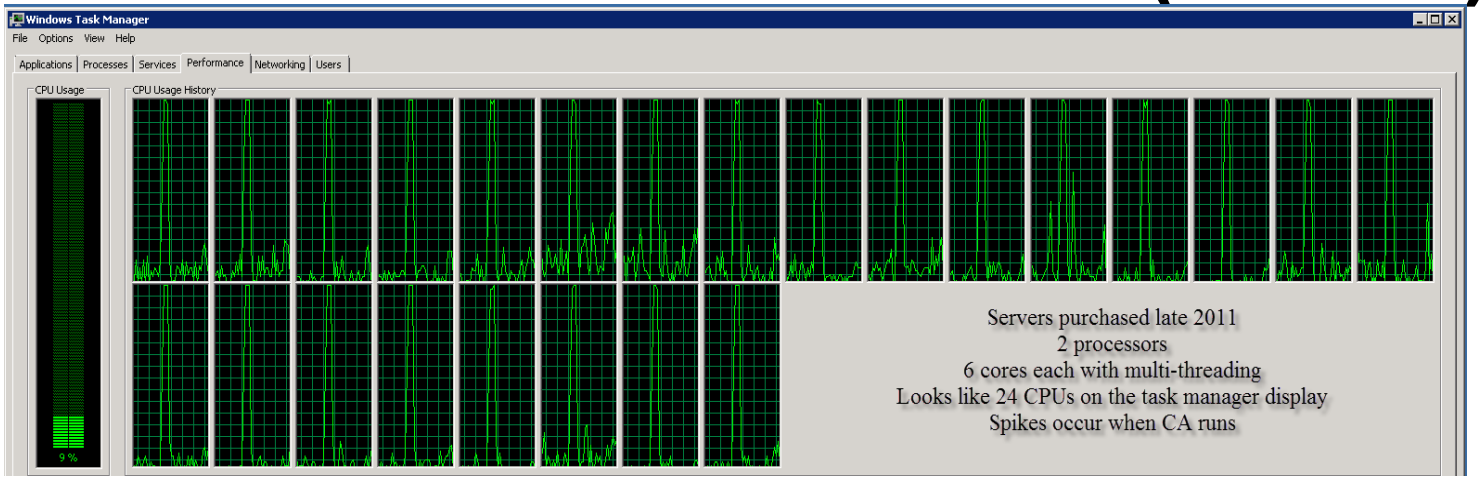


SCADA / EMS Information (cont'd)

Network Applications Summary

- Real Time State Estimator [SE] runs every 3 minutes
- Real Time Contingency Analysis [RTCA] runs every 3 minutes
- Voltage Stability scenarios run every 10 minutes on Western and Southern ATC interfaces plus internal interface to UP of Michigan (Siemens PTI tools)
- Study applications available using same displays as SCADA and State Estimator
- 7,000 bus / 10,000 branch / 100 GW load modeled

SCADA / EMS Information (cont'd)

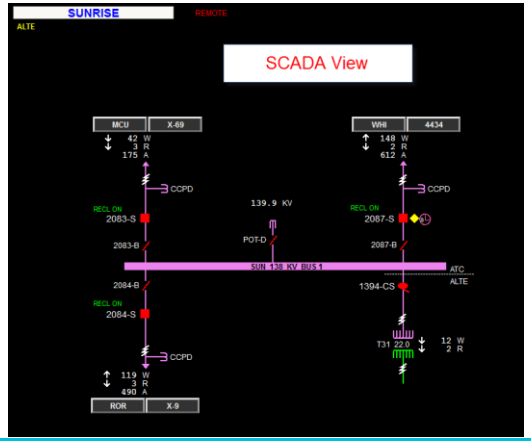


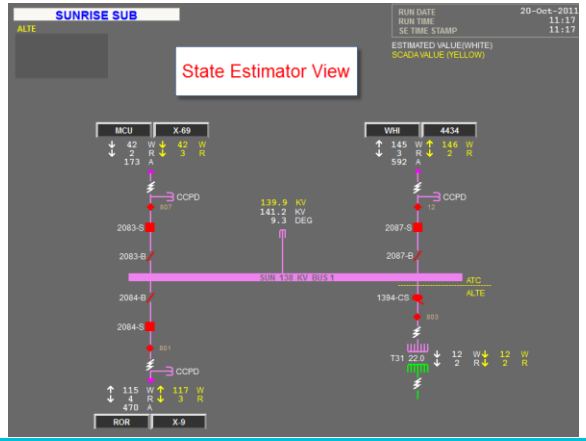
Network Applications Performance Statistics

- SE (State Estimator) solution on 7000 bus model takes 5-10 seconds
- CA (Contingency Analysis) solution with full (no screening) processing on 2000 contingencies takes 25-30 seconds
- Using Dell servers with multi-threaded processing to allow full PF for all contingencies

SCADA / EMS Information (cont'd)

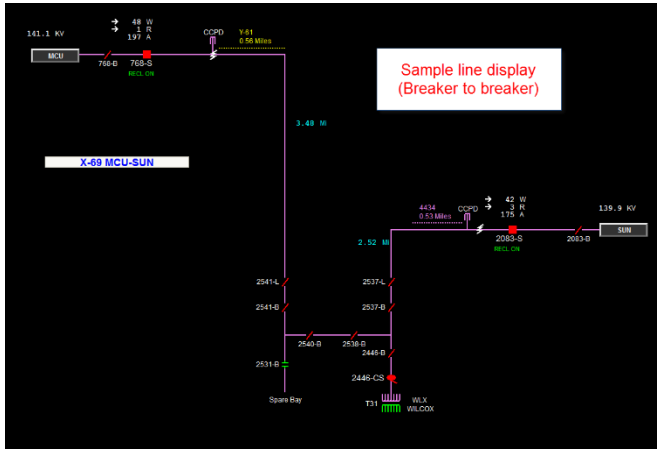
- Over 3,000 station one line and line displays per subsystem (SCADA/SE/…)
- Use one base display for stations and lines and overlay different data based on application





SCADA / EMS Information (cont'd)

- Line displays are drawn from breakered substation to breakered substation.
- Include additional details used for event analysis, sectionalizing, and troubleshooting
  - Line mileage
  - Double circuit information
  - Tap substation switching arrangement



SCADA / EMS Information (cont'd)

- We have a full set of development systems we can use to validate code and database changes
- We have a fully functional Dispatcher Training Simulator [DTS] with dedicated support staff. The DTS is used routinely to help our Operators meet increasing training requirements. It is also used to support regional black start /restoration drills

ATC Information Management

Information Management

- ATC implemented OSIsoft PI System in 2009 to collect and store all SCADA and PMU data.
- PMU and SCADA data have their own PI servers.
  - SCADA PI System licensed for 200,000 tags (unique data points). As reference Midcontinent ISO (MISO), our Reliability Coordinator, implemented its PI System with a 600,000 tag limit around that same time frame.
  - PMU PI System licensed for 5,000 tags.

Information Management

- Separate user interfaces for Operations/EMS network and Corporate network.
  - Operations/EMS users have direct access to data thru PI tools (PI ProcessBook and Excel PI DataLink)
  - CITRIX clients and separate mirrored server used to manage corporate access
- SCADA Data backfilled from existing ALSTOM archive files thru 1/1/2006

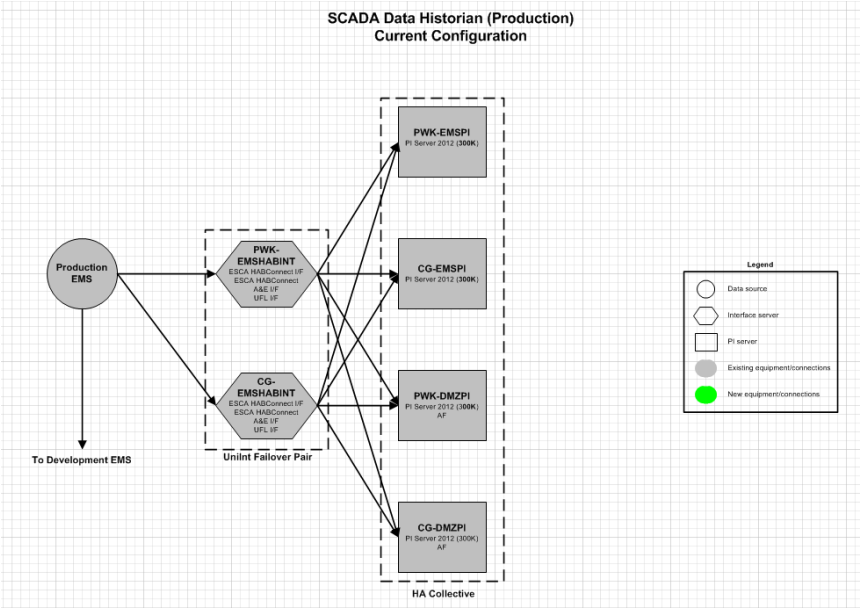
Information Management (cont'd)

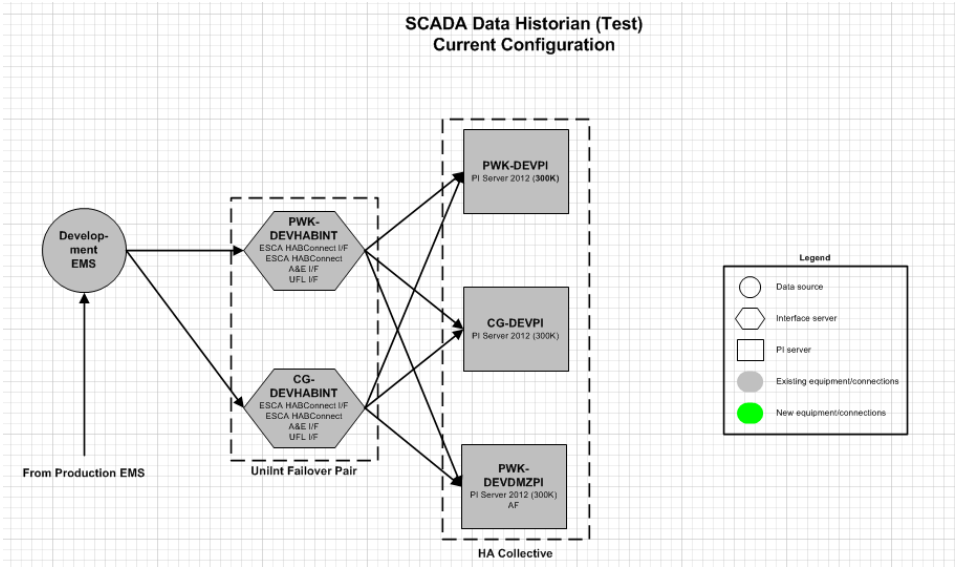
Advantages include data management and accessibility

- Improvements in displays, increasing clarity while incorporating additional capabilities
- Create new displays not currently possible on EMS or difficult to develop on EMS
- "One click" direct historical trend call-up through integration to our EMS displays
- The ability to leverage the experience of other users from 14,000 worldwide PI Systems

Information Management (cont'd)

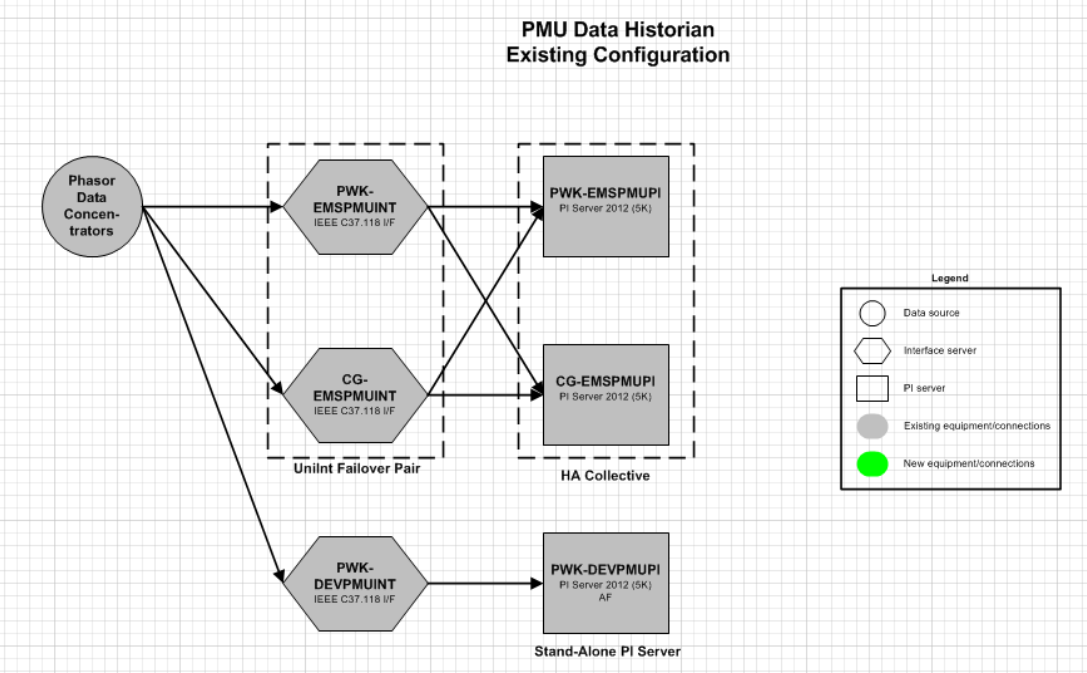
ATC System architecture – SCADA PI System





Information Management (cont'd)

ATC System architecture – PMU PI System

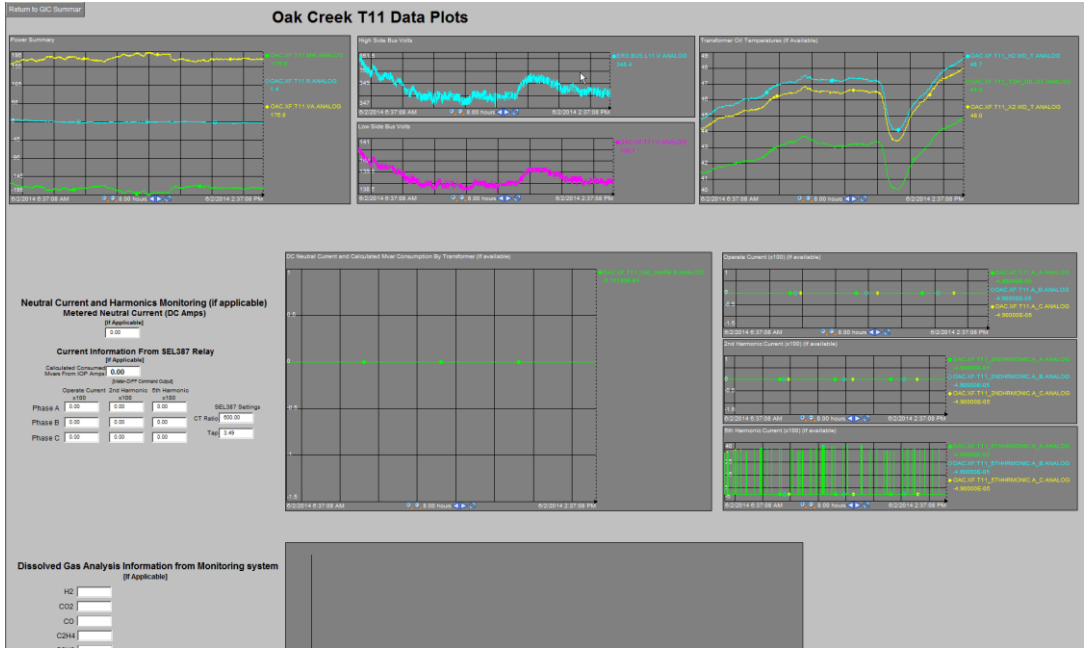


Information Management (cont'd)

ATC PI ProcessBook Displays – Transformer Monitoring

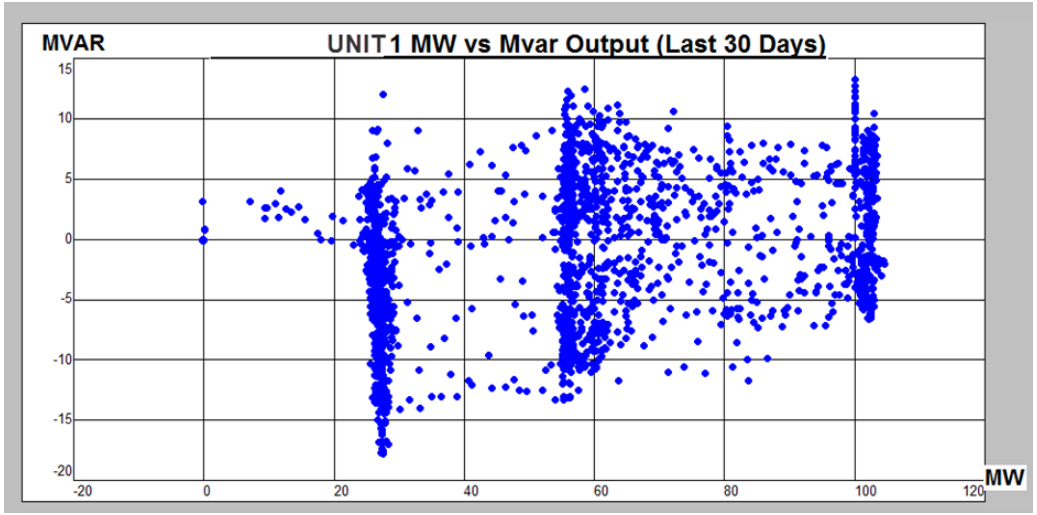
Common display for all transformers but only a subset of data available for each

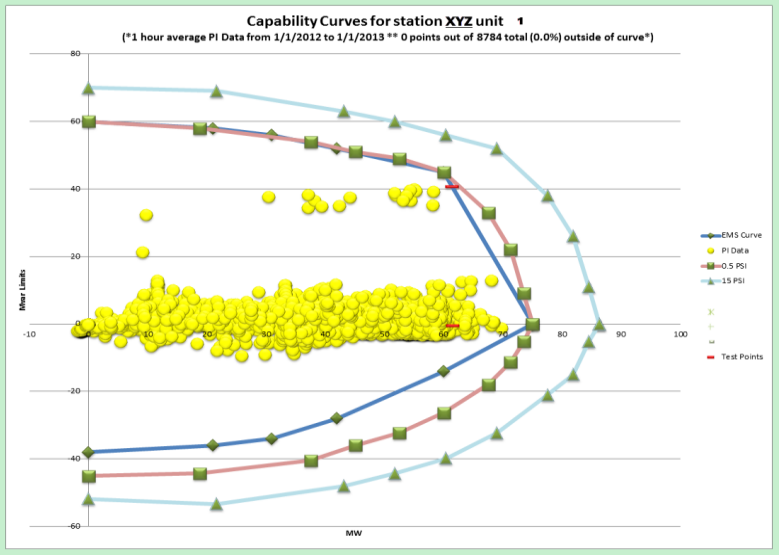
- Load data
- Voltage data – high and low side
- Oil temperature – top oil and winding
- Relay calculated harmonicas data
- Dissolved Gas Analysis [DGA]



Information Management (cont'd)

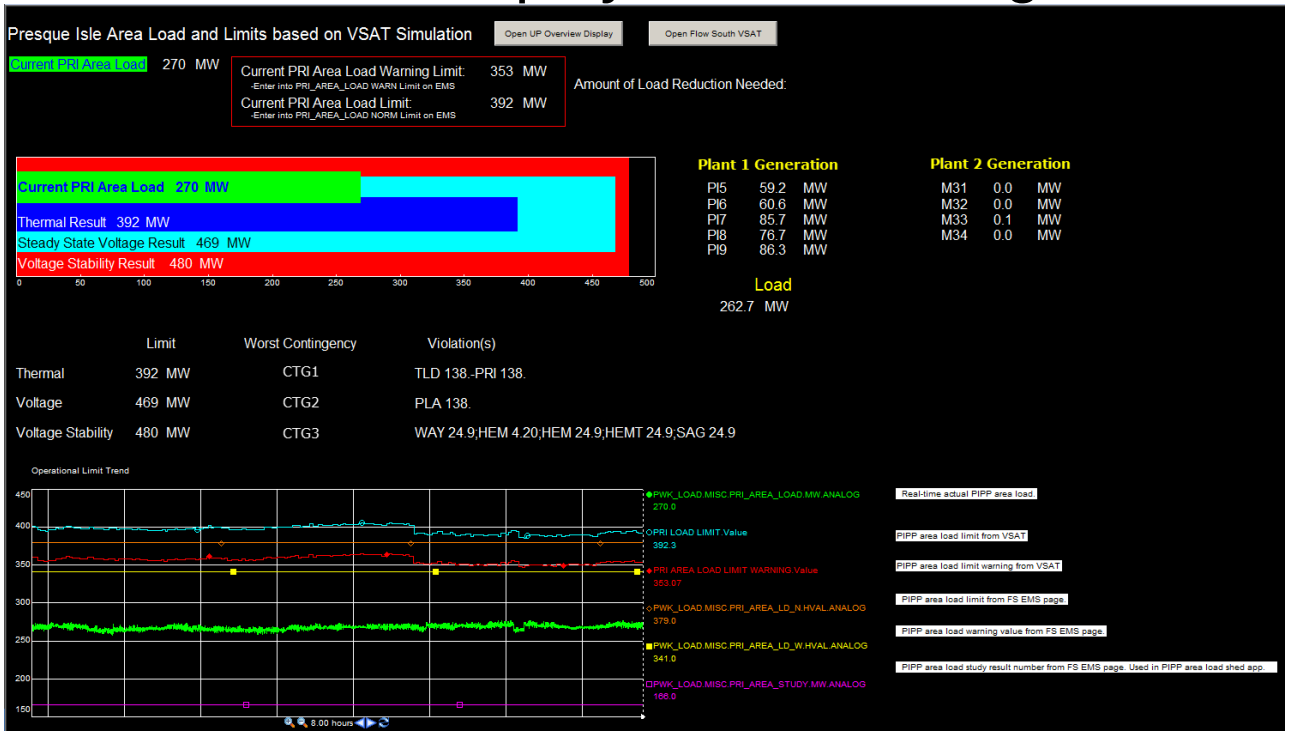
ATC PI Displays – Unit Mvar Capability Tracking with PI ProcessBook and PI Datalink





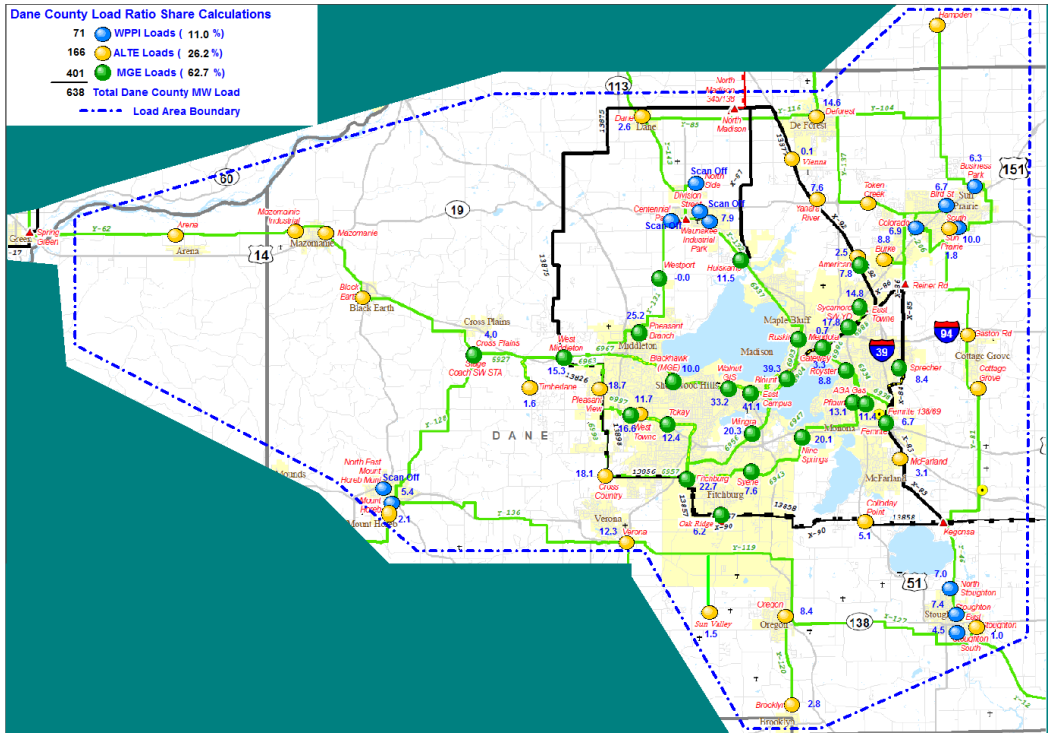
Information Management (cont'd)

ATC PI ProcessBook Displays – Visualizing VSAT Results



Information Management (cont'd)

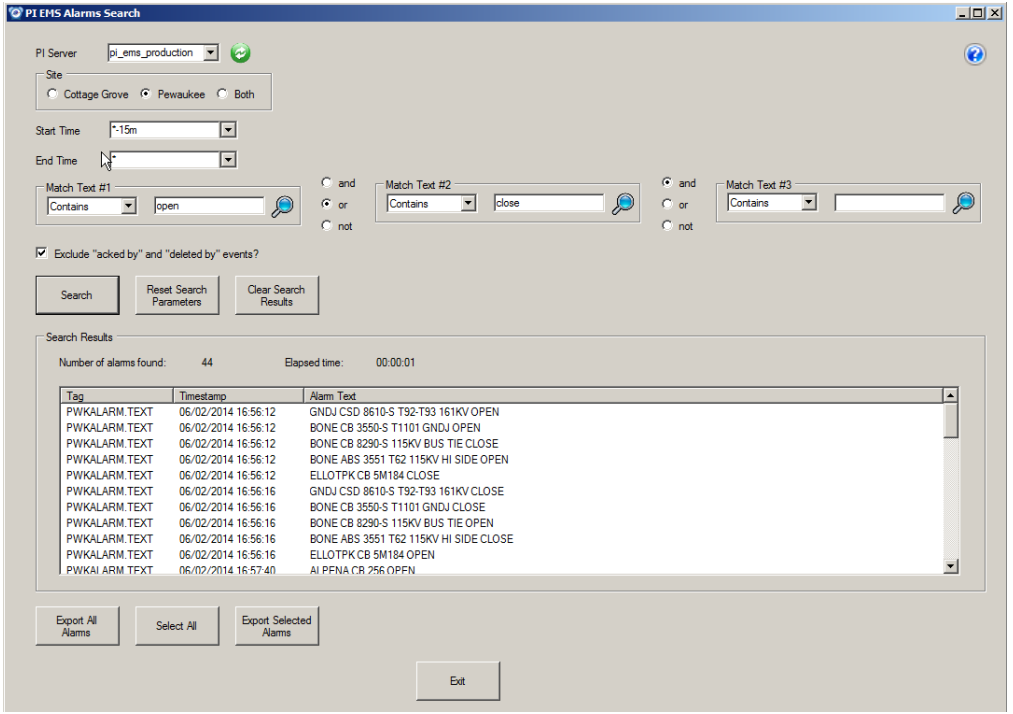
ATC PI ProcessBook Displays – Load Allocation Calculations



Information Management (cont'd)

ATC Developed PI Tools – Alarm Search Application

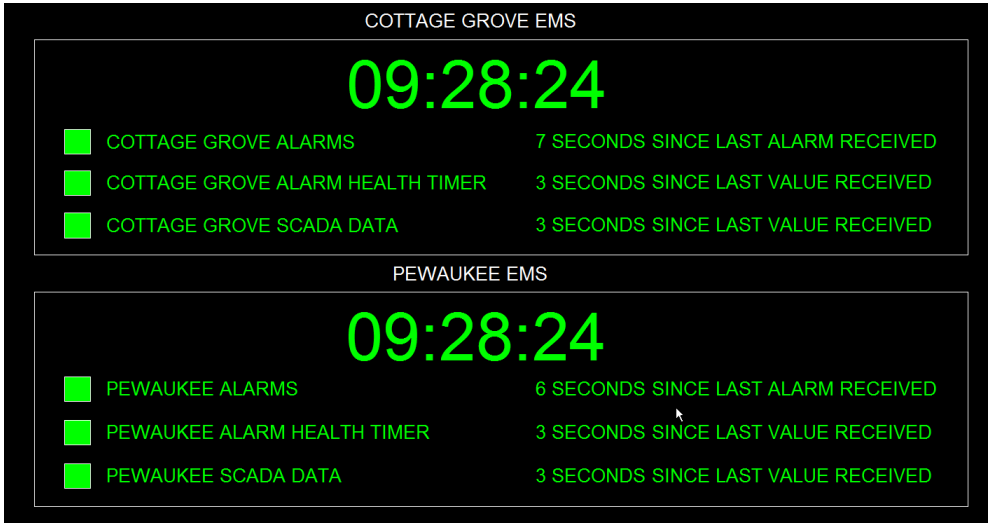
- All alarms stored under one PI tag – date/time and alarm text only
- Alarm search application (Visual Basic code) written in house to extract data more efficiently than EMS alarm tools
- We can now search through a month of event data in less than a minute (10k events stored per control center per day)



Information Management (cont'd)

ATC Developed PI Tools – EMS Health Monitor

- How do you know when your EMS alarm system isn't working?
- PI ProcessBook display developed that is used to query EMS alarm data
- Provides independent verification that the alarm subsystem in EMS is functioning



Information Management (cont'd)

ATC Developed PI Tools– Transformer DGA Data Distribution

- Dissolved Gas Analysis [DGA] Data is sourced from online monitors installed on the transformers, scanned by the front ends into SCADA on the EMS hosts, and then transferred into PI.
- Use scripts to extract the DGA data for a number of large transformers from PI. Scripts pull the data from PI several times per day, transfer it to the corporate LAN, and upload it to an online transformer oil analysis vendor for processing.
- We will investigate using PI to direct-scan asset data such as this from the field devices without requiring it to first go through the EMS.

Information Management (cont'd)

PI Notifications

- Automated statistics on PMU performance
- Overvoltage issues on underground cables
- State Estimator solution issues
- Considering using to issue non-critical alarms outside EMS environment

From: ems@atcllc.com
To: Kleitsch, James
Cc:
Subject: PMU Availability Summary [PRODUCTION]

Server: piaf_production
Database: pi_pmu_production
Start Time: 3/26/2014 6:10:00 AM Central Daylight Time (GMT-05:00:00)
Trigger Time: 6/4/2014 6:10:00 AM Central Daylight Time (GMT-05:00:00)

PMU	Last Hour Availability %	Last Hour Timestamp	Last Hour Availability Violation?	Last 24 Hours Average Availability %	Last 24 Hours Minimum Availability %	Last 24 Hours Maximum Availability %
9 Mile	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.95216	99.53148	100
Arcadian	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.99467	99.90186	100
Arpin	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.99591	99.90186	100
Arrowhead	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.99591	99.90186	100
Artesian	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.95274	99.76111	100
Bain	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.99591	99.90186	100
Boscobel	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.99591	99.90186	100
Brick Church	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.83098	99.28426	100
Butler Ridge	100	6/4/2014 6:00:00 AM Central Daylight Time (GMT-05:00:00)	-	99.99448	99.90186	100

From: ems@atcllc.com
To: Kleitsch, James
Cc:
Subject: Pewaukee RTNET Solution Quality Notification generated a new notification event. [PRODUCTION]

Name: Pewaukee RTNET Solution Quality Notification
Server: piaf_production
Database: pi_ems_production
Start Time: 6/3/2014 10:13:25 PM Central Daylight Time (GMT-05:00:00)
Trigger Time: 6/3/2014 10:16:44 PM Central Daylight Time (GMT-05:00:00)
Target: Pewaukee RTNET Solution Quality
State: OutsideControl
Priority: AboveNormal

Solution State: SOLVING at 6/3/2014 10:16:44 PM Central Daylight Time (GMT-05:00:00)

Solution Quality Report:

Item	Results	Threshold	Violation?
Total Unit MW Error	25.81245	500	False
Total Unit MVAR Error	52.0657	500	False
Total Tie Line MW Error	28.48189	500	False
Total Tie Line MVAR Error	23.37901	500	False
Company MW Injection Deviation	3.147032	500	False
Company MVAR Injection Deviation	2.402603	500	False
Solution Cost Index	2510572	500000	False
Data Availability %	82.79873	69	False

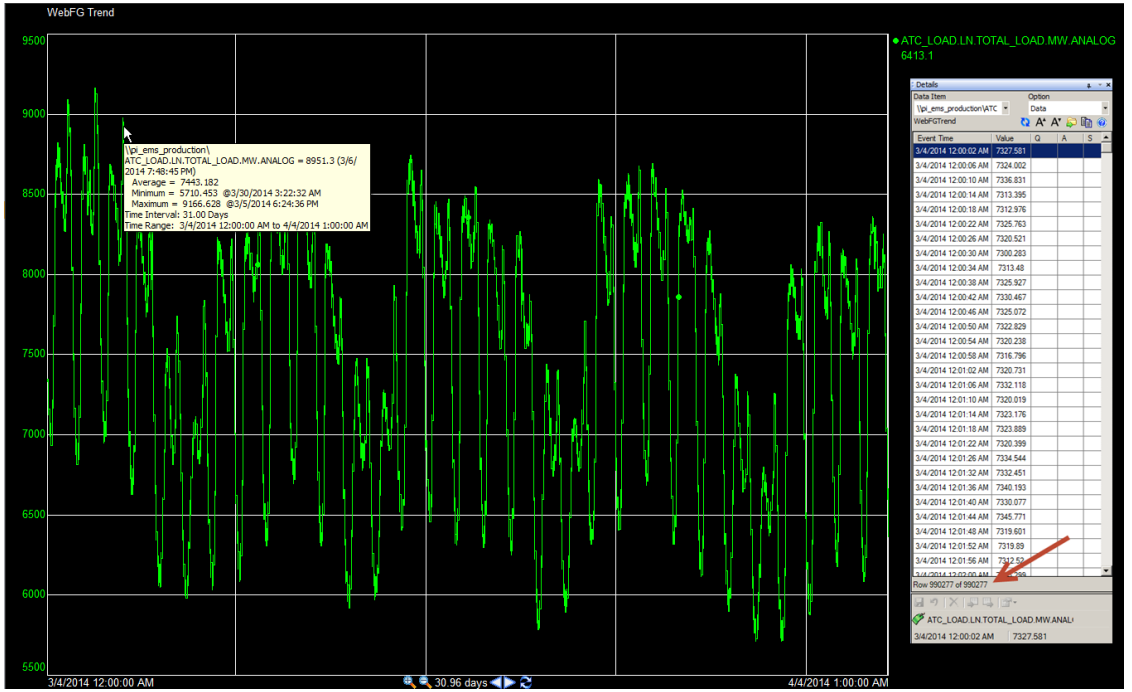
Global Quality Check:

Item	Results	Threshold	Violation?
Max MW Mismatch	544.2997	500	True
Max MVAR Mismatch	28.95592	500	False

Information Management (cont'd)

SCADA Summary

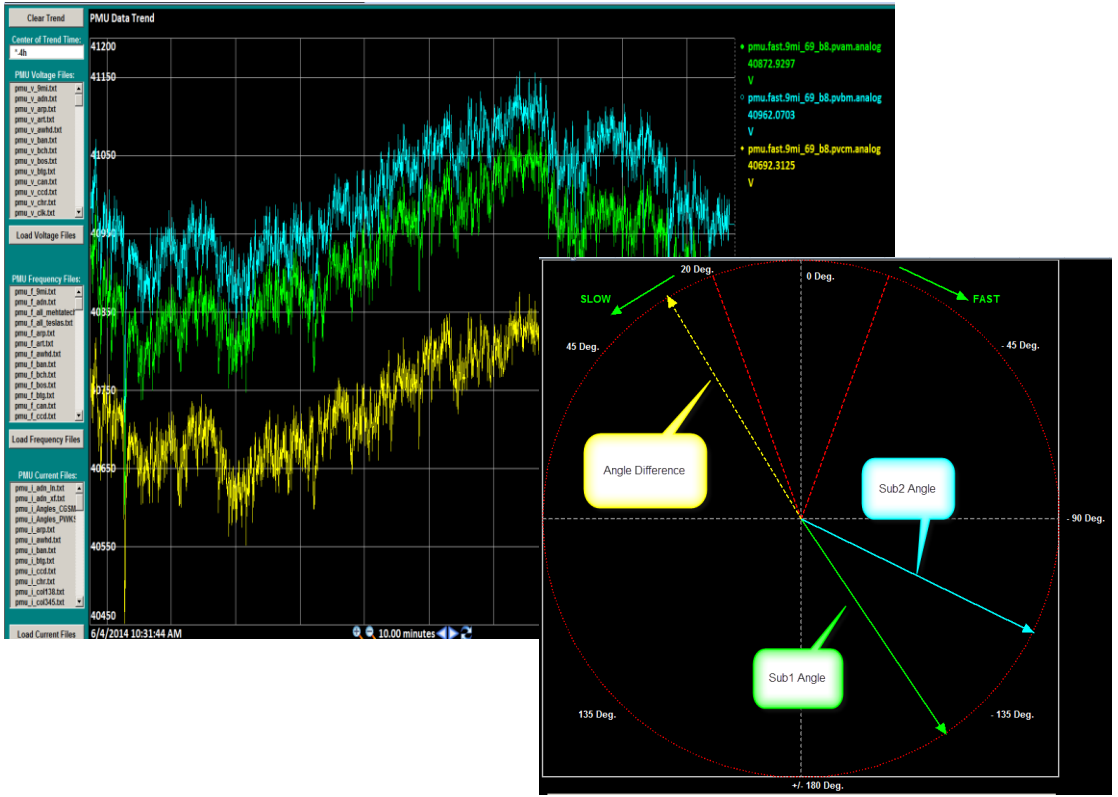
- Saving 3 GB of SCADA data per month (270 GB per year)
- Can retrieve one months worth of analog data into a PI ProcessBook display in less than 10 seconds. (990,000 samples in example shown) PI DataLink retrievals take a little longer
- PI ProcessBook displays provide max/min/average statistics and allows a quick review of data to catch outliers



Information Management (cont'd)

PMU Summary

- Saving 24 GB of PMU data per day (9 TB per year) with minimal compression
- Able to develop PI ProcessBook tools to better visualize the data (Synch scope, event review tool)



ATC Synchrophasor Project

Synchrophasor Project (cont'd)

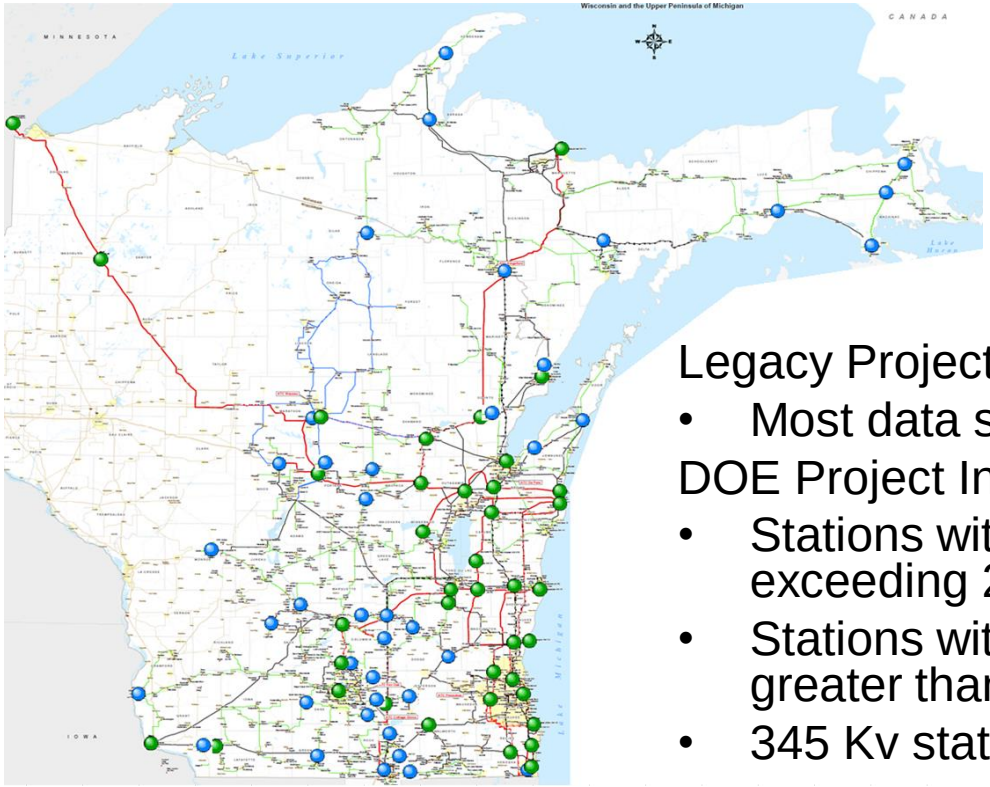
- Legacy project established in early 2009 to install Phasor Measurement Units (PMUs) at sites with PMU capable devices (SEL 400 series relays, 1 Tesla DFR)
- Used existing communications to substations (increased bandwidth where needed)
- Minimal work in the field required
- Majority of sites involved capacitor bank protection relays so ATC did not bring back current measurements.

Synchrophasor Project (cont'd)

- ATC applied for Department of Energy [DOE] Smart Grid funding for additional PMU installations in August 2009. Approved for negotiations with DOE January 2010. Signed work agreement May 2010 to install PMUs at 45 additional sites.
- ATC's project designed to expand the collection of real time PMU data from geographically disparate sites to provide ATC's Control System with additional data and tools needed to assess the dynamic state of the electric transmission system.

Synchrophasor Project (cont'd)

Combined DOE and Legacy Project Map



Legacy Project Installations

- Most data sourced from cap bank control relays

DOE Project Installations

- Stations with interconnected generation exceeding 200 MW gross capability
- Stations with interconnected wind generation greater than 50 MWs
- 345 Kv stations

Synchrophasor Project (cont'd)

Proposed PMU Data near term use at project inception:

- Post electrical system event analysis
- Wide area overview for ATC System Control real time operations
  - Data sharing with: Midcontinent ISO
  - Others that have FERC-based reliability requirements
- Detection of "electrical islands" due to unplanned outages of one or more elements of the electric transmission system.

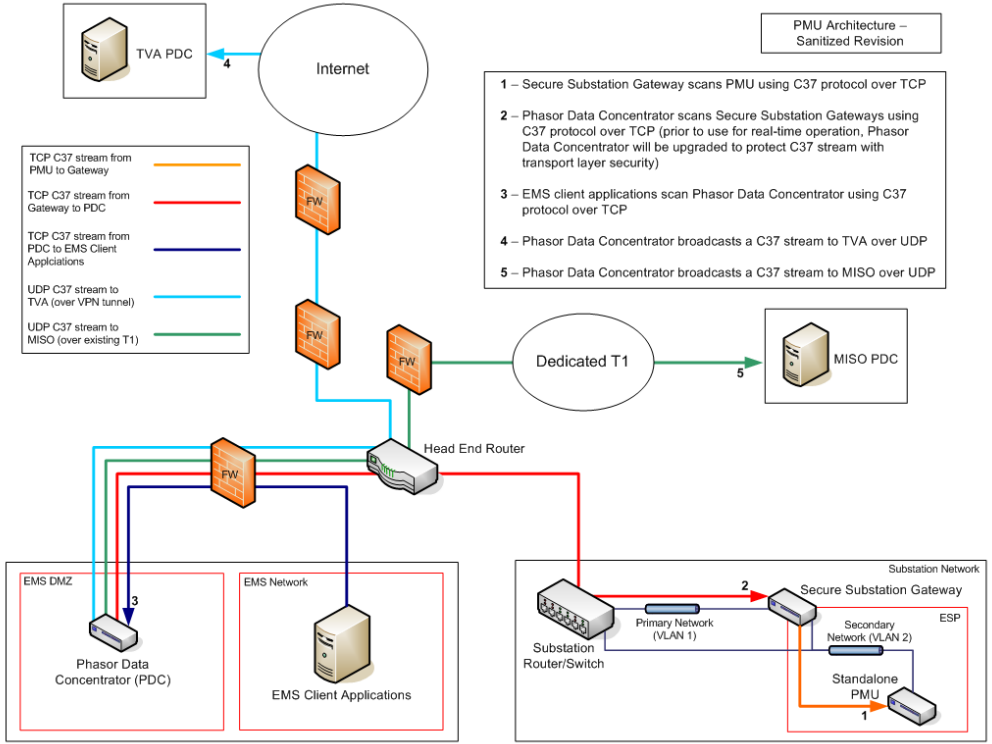
Synchrophasor Project (cont'd)

ATC envisions other uses for the data (long term):

- Dynamic electric transmission system computer model verification.
- Support for enhancement of state estimator solutions.
- Information to help in power system restoration events.
- Develop Operating Guideline parameters to allow higher grid utilization
- Provide Insight and operating information regarding intermittent resource dynamics

Synchrophasor Project (cont'd)

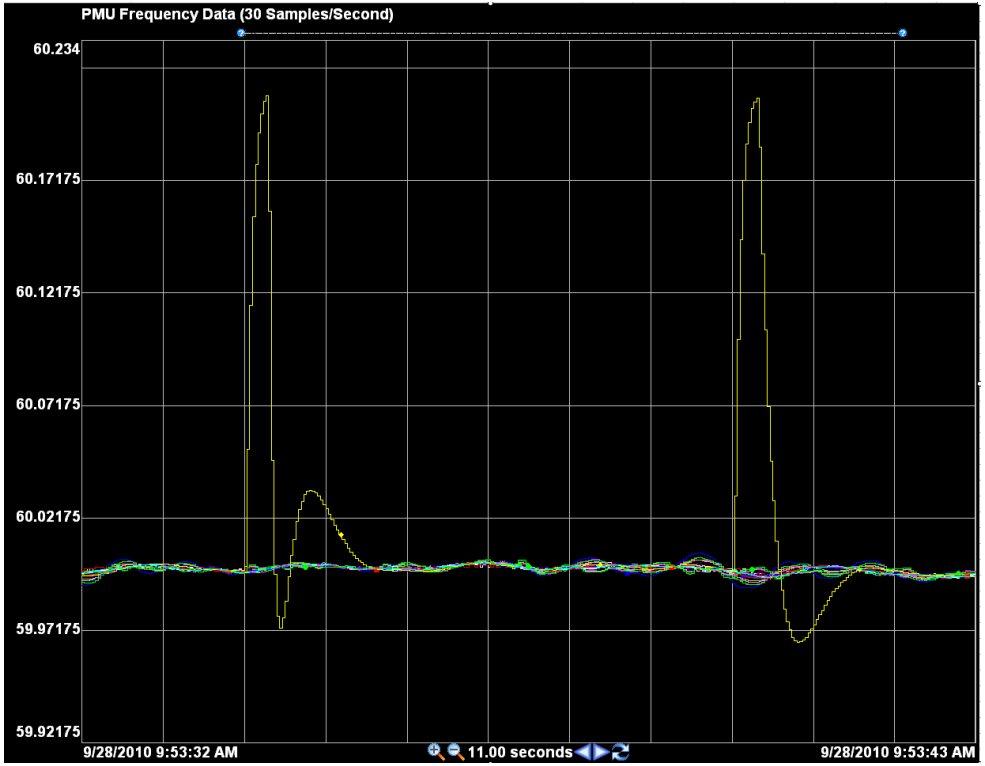
ATC System Design



Synchrophasor Project (cont'd)

ATC System Design

- We noticed significant frequency excursions from several of our first installed PMUs that were found to be due to a firmware issue in these older devices. These occur when GPS clock signal is lost.
- This issue drove us away from multi-function relay/PMU devices as addressing issues like this would require that we update firmware in a production protection relay which may require line outages and significant relay testing.



Synchrophasor Project (cont'd)

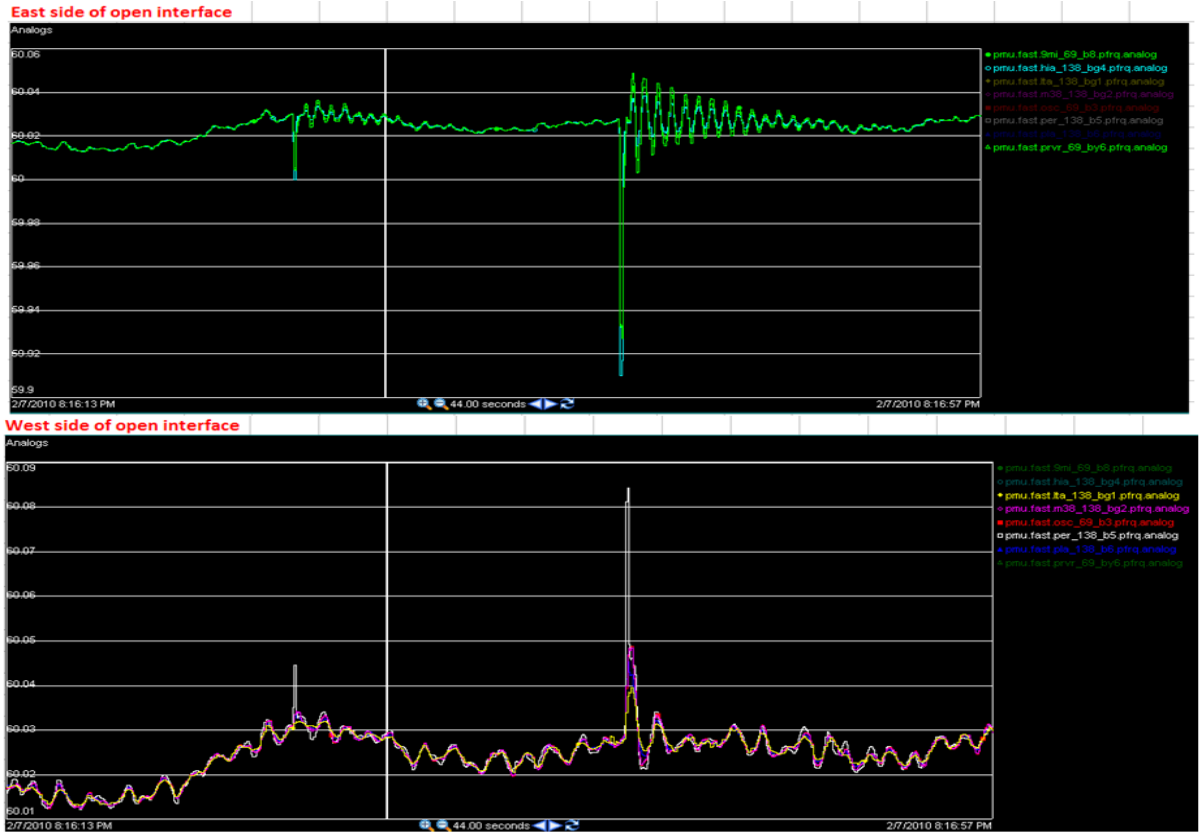
ATC Data Examples

Frequency Oscillations during system separation of our Upper Peninsula [UP] of Michigan system

Synchrophasor Project (cont'd)

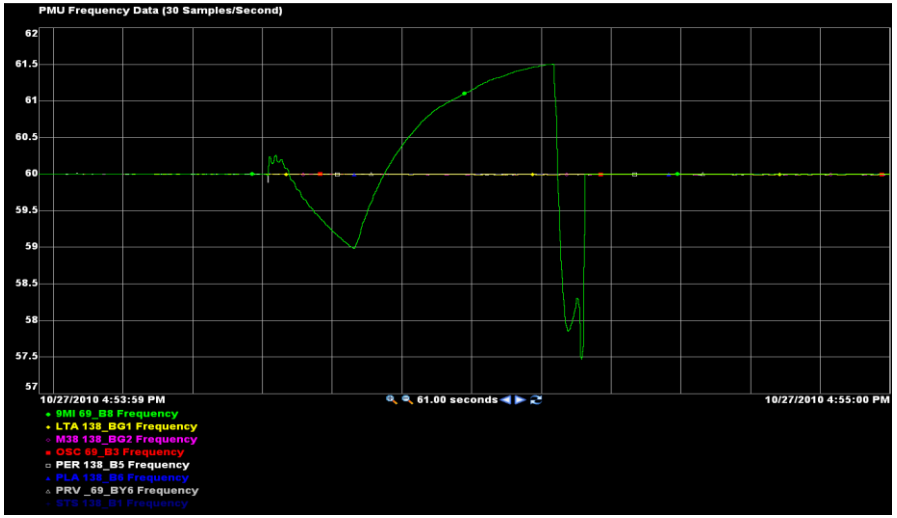
ATC Data Examples

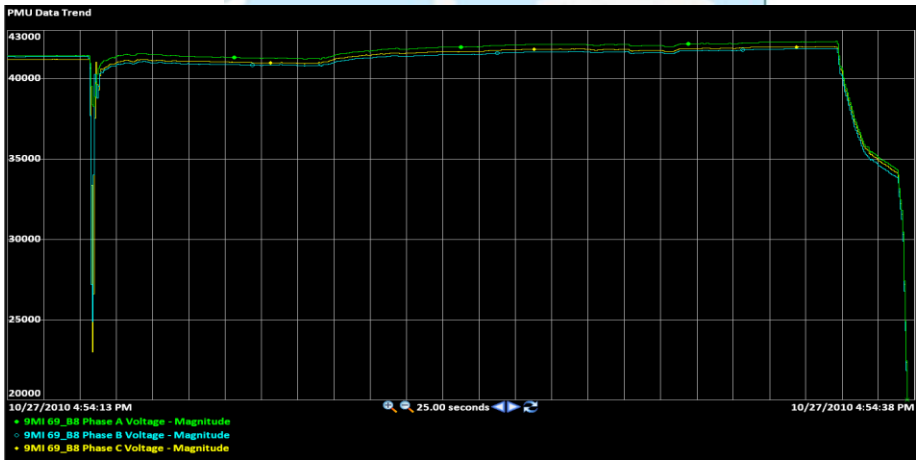
- East side frequency drops from ~60.03 Hz to ~59.91 Hz. Oscillations around EI system frequency occur for ~ 7 seconds
- West side frequency rises from ~60.03 Hz to ~60.09 Hz. Oscillations gone within one second.



Synchrophasor Project (cont'd)

ATC Data Examples - Eastern UP Islanding Event

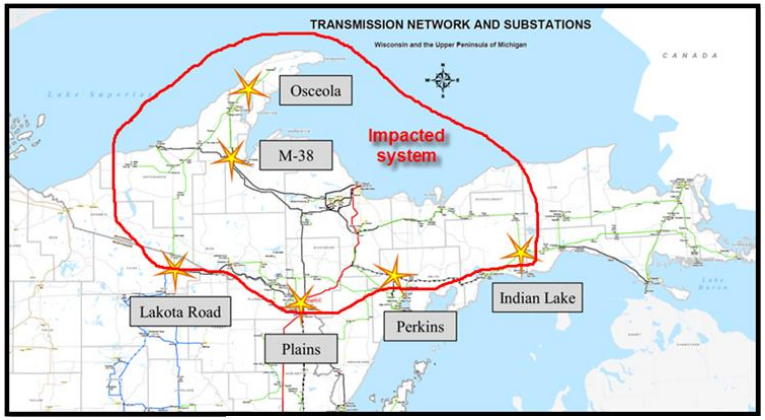




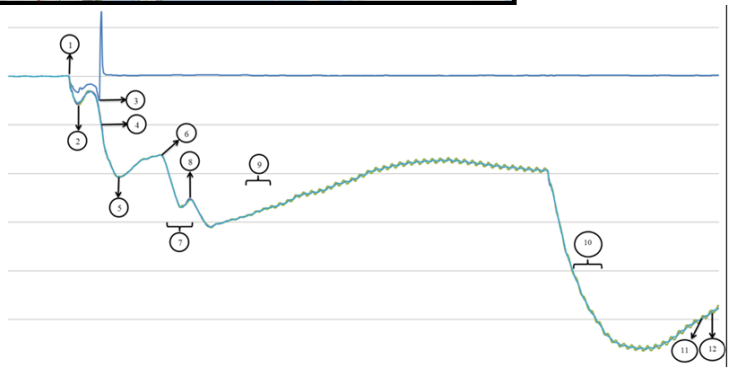
The island only existed for about 25 seconds. If the island had stabilized we could have monitored frequency and voltage using synchrophasor data.

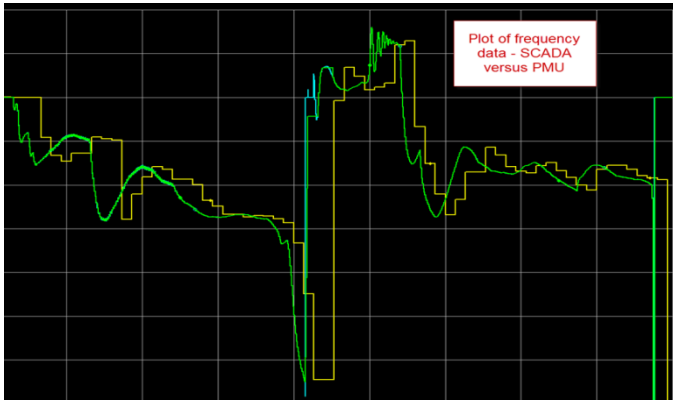
Synchrophasor Project (cont'd)

ATC Data Examples- Western and Central UP Islanding Event



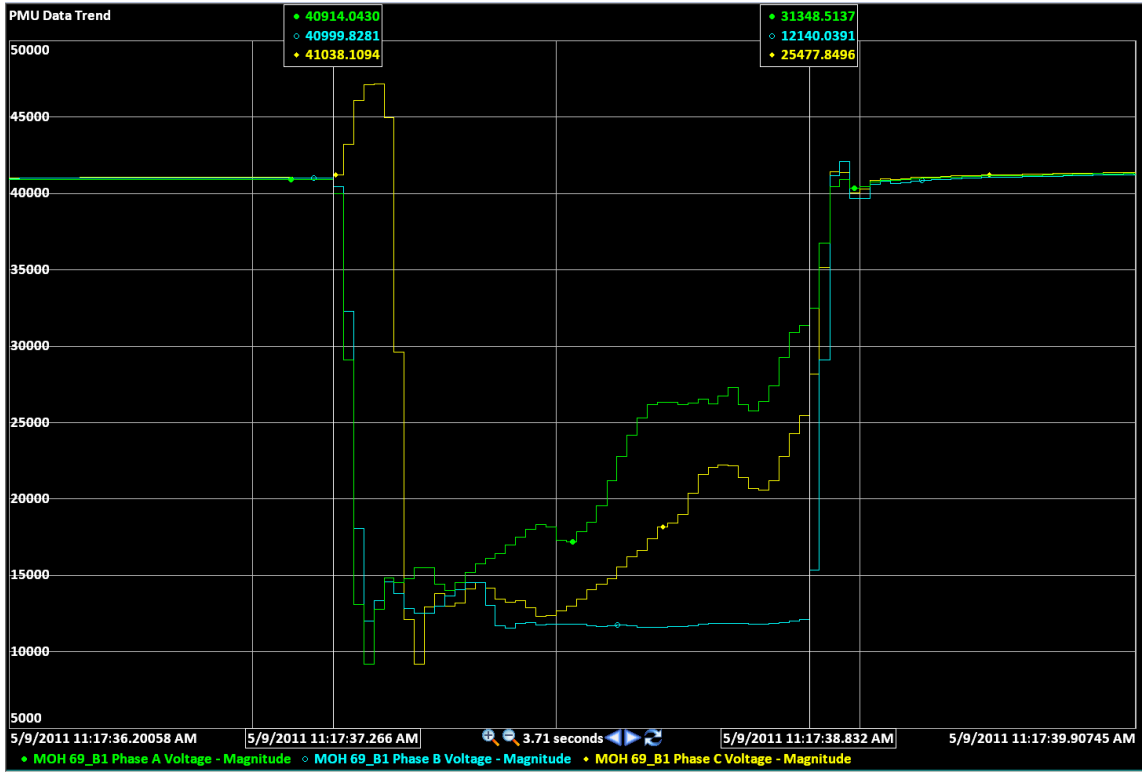
- PMU data was available from 4 sites within the island that was formed.
- Helped analysis team correlate unit trips and load shedding to synchronized time from PMUs.
- Frequency charts shown below:





Synchrophasor Project (cont'd)

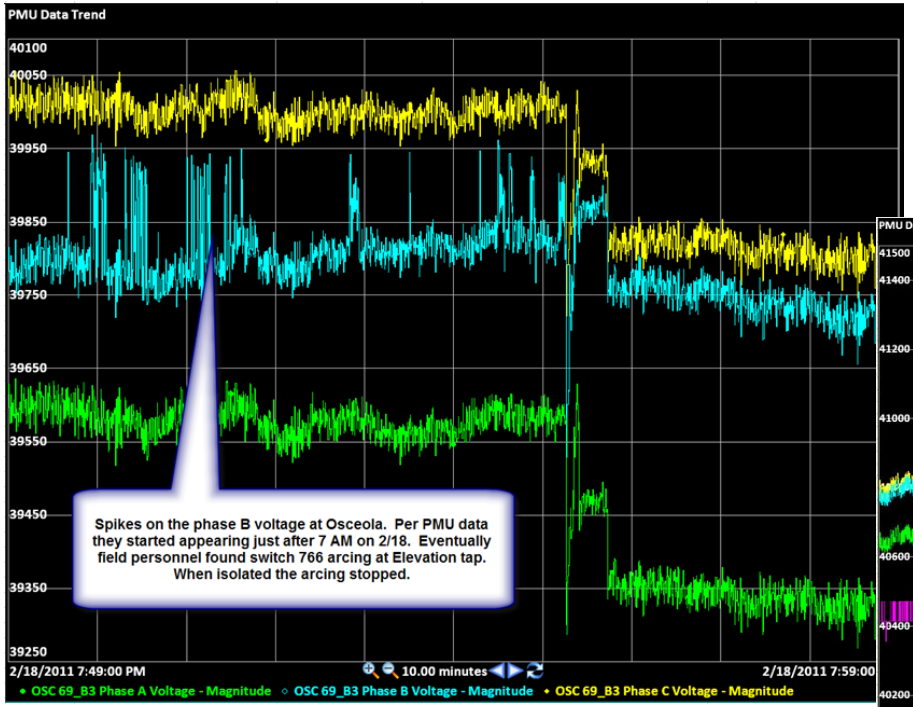
ATC Data Examples – Identifying slow protection actions



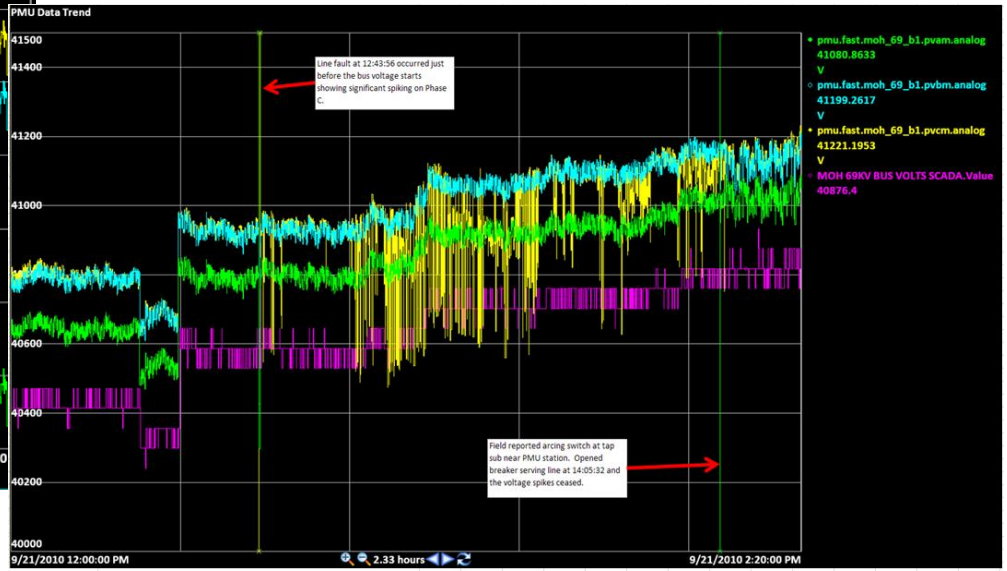
Voltage traces from a PMU located close to a line trip helped identify a slow breaker trip that was eventually traced back to a dirty breaker contact. We would not have seen this misoperation without the PMU data.

Synchrophasor Project (cont'd)

ATC Data Examples – Arcing Switch Identification

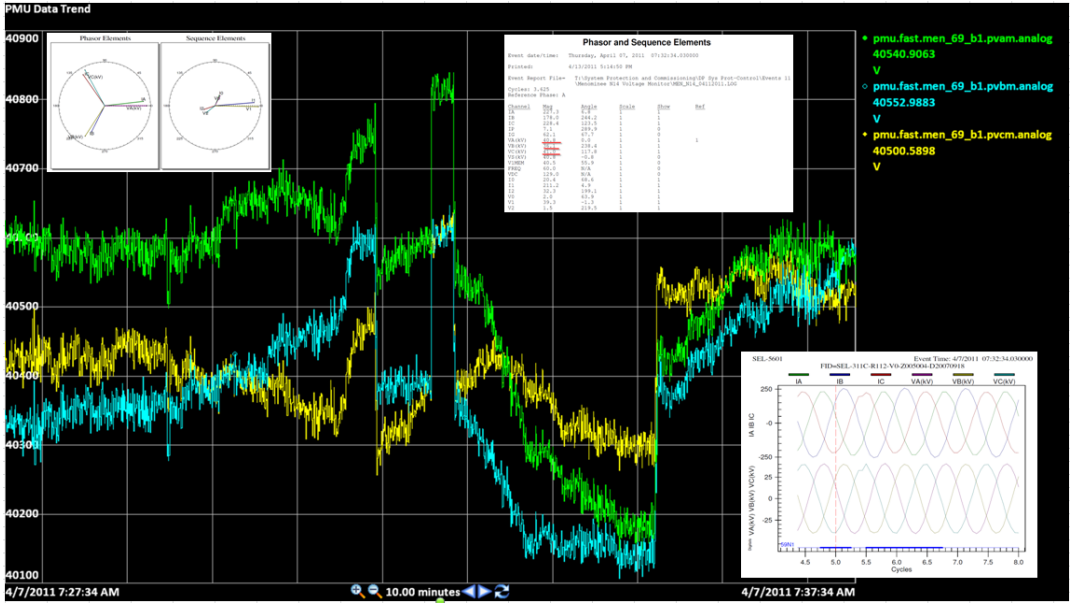


We've had two separate events where a voltage trace was displaying noise/spikes that were eventually traced back to an arcing switch.



Synchrophasor Project (cont'd)

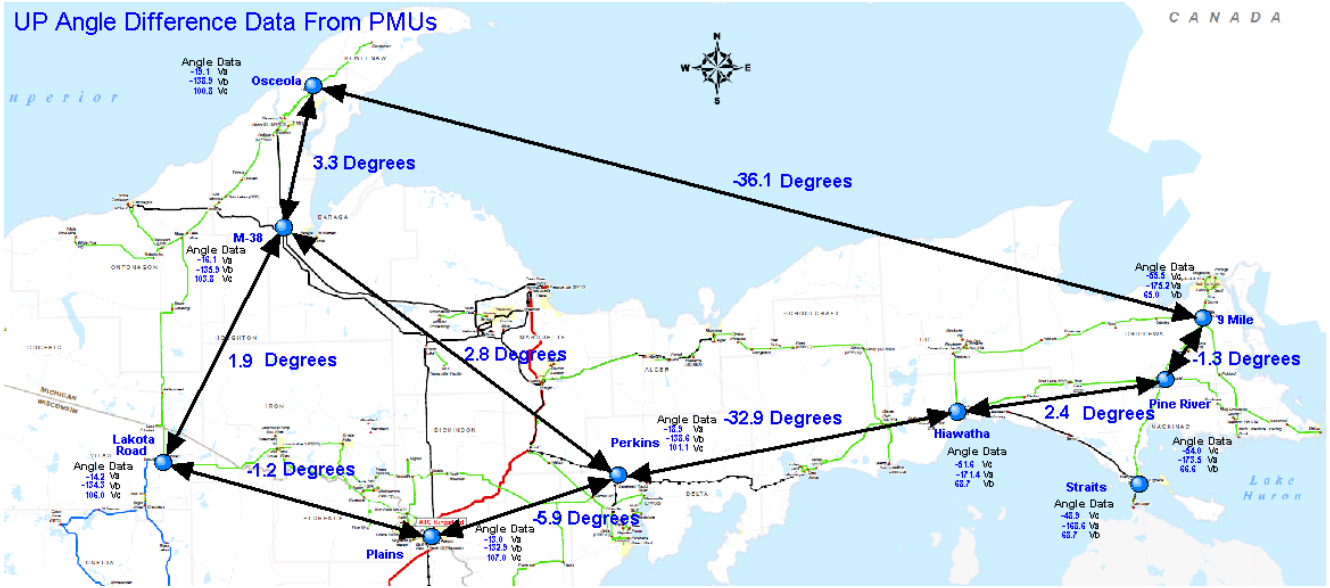
ATC Data Examples - Voltage Unbalance Monitoring



We have been observing odd voltage behavior at the Menominee substation due to a foundry load located nearby. Used SEL Relay triggers to identify when unbalances occurred and then used PMU data to help analyze the events.

Synchrophasor Project (cont'd)

ATC Data Examples - Wide Area phase angle monitoring display

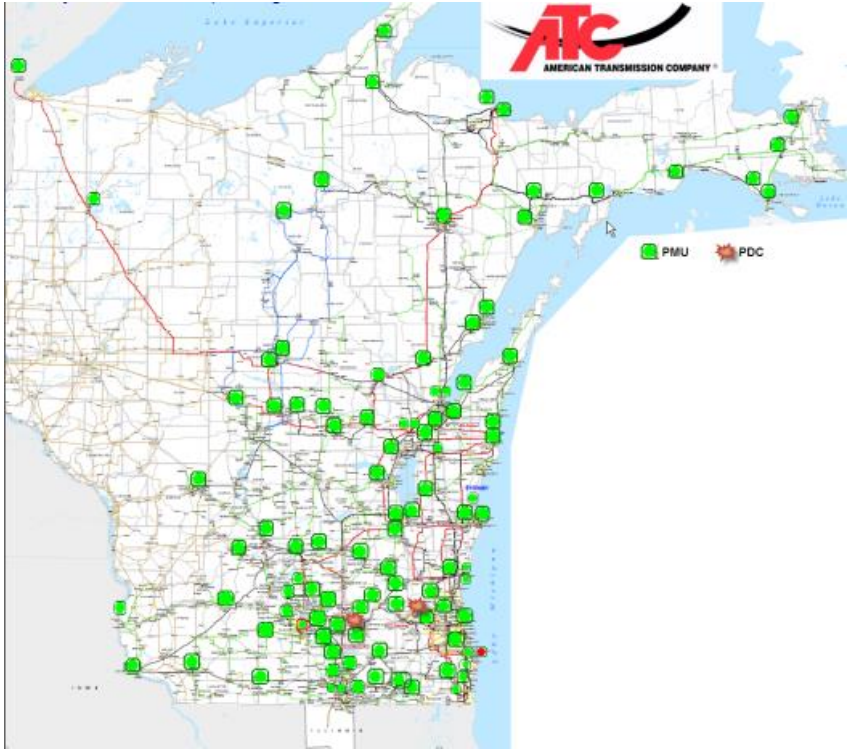


PI ProcessBook file could be used to monitor the difference in phase angles across a pre-defined system. In this example the UP is split and the phase angle across the split is around 33 degrees.

Synchrophasor Project (cont'd)

ATC PMU System Overview As Of 6/1/2014

- 110 PMUs in service providing data
- Devices spread across the state of Wisconsin and the Upper peninsula of Michigan. Higher concentrations in metro areas.
- Synchrophasor data is being used to fill in a visibility gap between 4 second scan rate data and high speed fault recording equipment because DFRs don't always trigger when you need higher resolution data



Synchrophasor Project (cont'd)

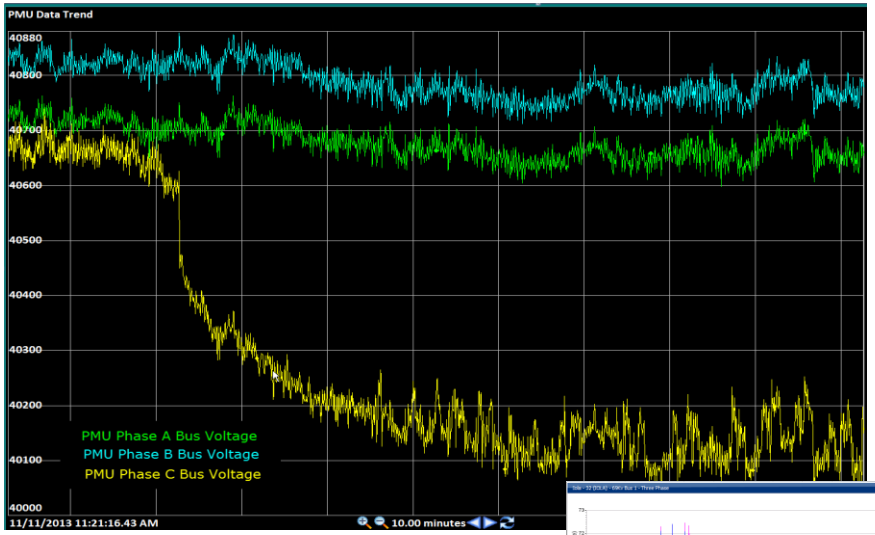
Failing potential transformer

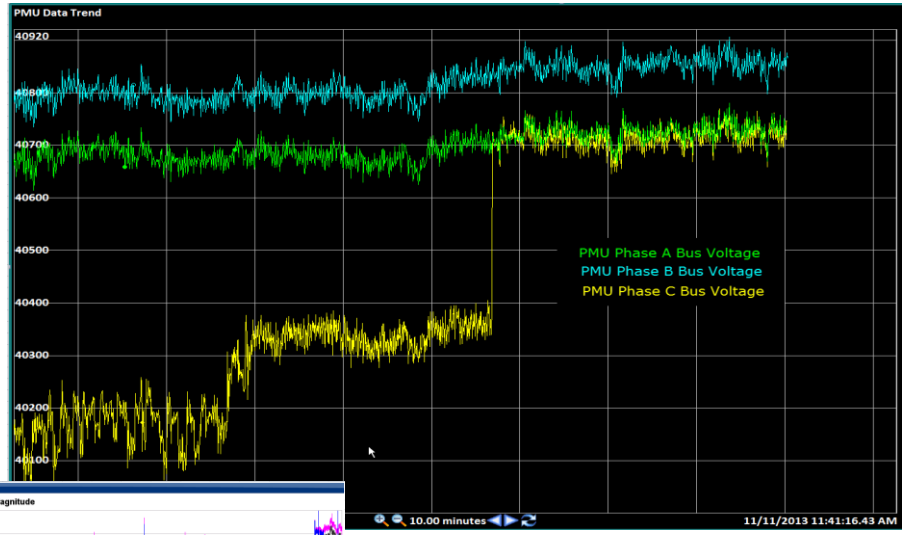
Background:

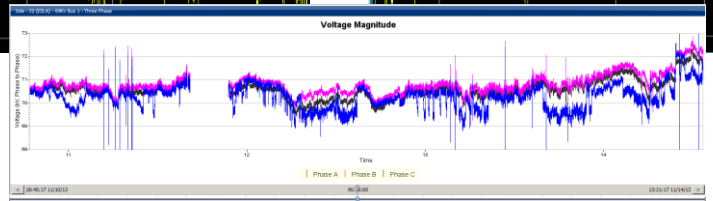
- Stumbled across odd voltage signature from a PMU monitoring one of our 69 Kv substations while reviewing fault operations
- Slow voltage decay on one phase which eventually jumped back to "normal"
- Confirmed same issue present on both secondary windings for the PT. Determined it was an issue with primary winding.
- All connections verified good so determined this was an internal primary winding issue on the PT

Synchrophasor Project (cont'd)

Failing potential transformer







Synchrophasor Project (cont'd)

Failing potential transformer

- Decision made to replace defective PT before it failed
- Substation could not be back fed from distribution system so we were able to schedule a mobile transformer and serve the load while we replaced the unit before we had a failure
- We believe we avoided an extended outage by catching this before it failed and saved money as we were able to replace during normal work hours
- Disclaimer – The high level tests we did on the suspect PT did not show an obvious issue but we were not certain it would due to the intermittent nature of the failure/short

Synchrophasor Project (cont'd)

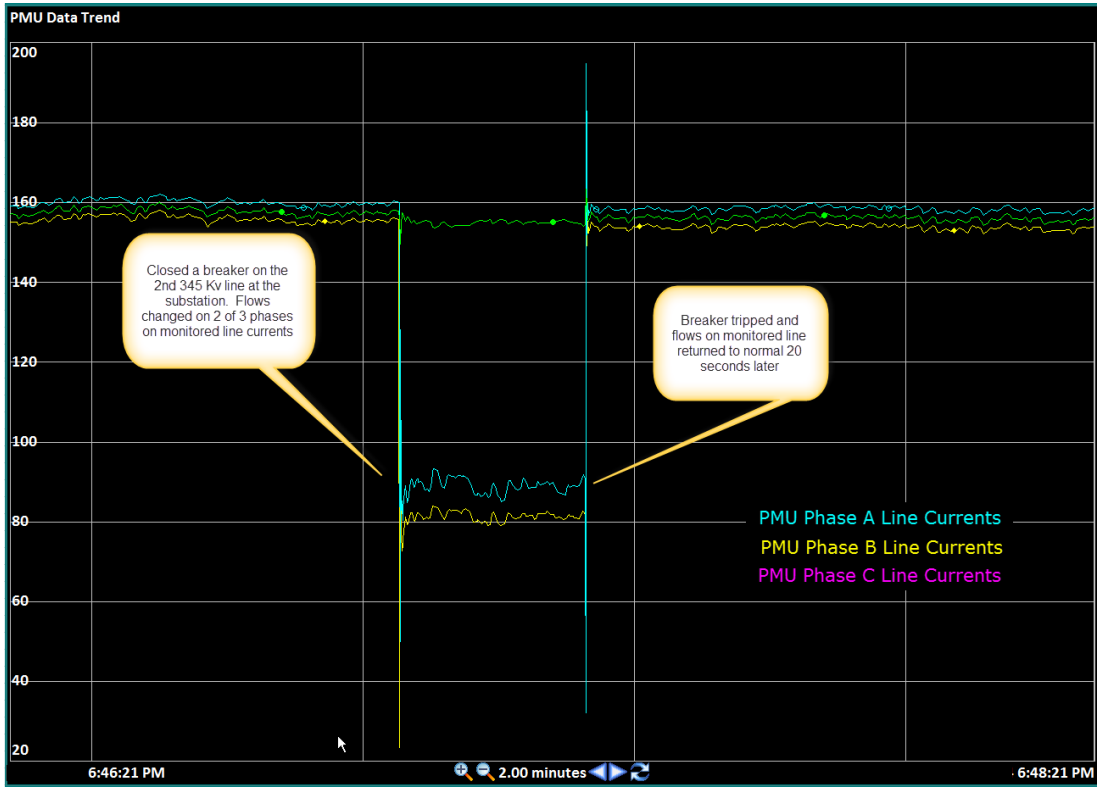
Identifying issues with open phases on breakers

Background:

- Work being done on breaker feeding one of two 345 Kv lines at a 345 Kv / 138 Kv substation
- When re-energizing the line and picking up load the breaker closed and tripped open within 20 seconds
- The line monitored by our PMU saw unbalanced phase currents while the other breaker was closed
- No digital fault recorders triggered for this. No relay event files available to explain what happened. One open phase alarm which we questioned initially based on the lack of data
- Very hard to troubleshoot without the PMU data

Synchrophasor Project (cont'd)

Identifying issues with open phases on breakers



Synchrophasor Project (cont'd)

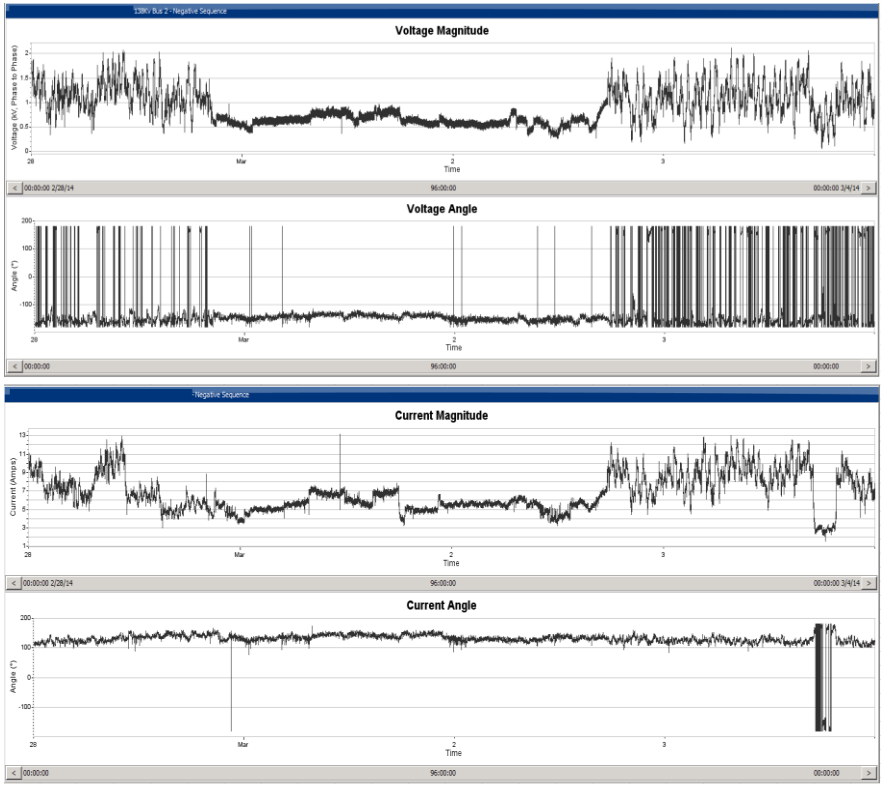
Negative sequence concerns

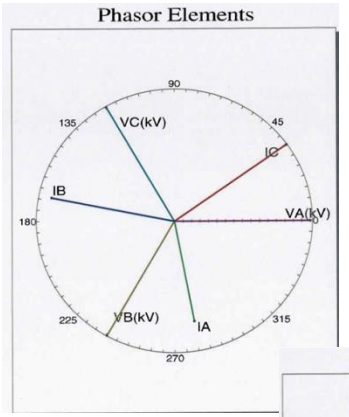
Background:

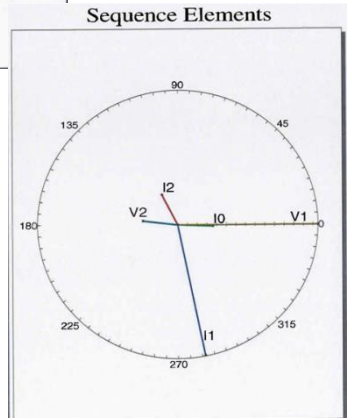
- Generation Plant Operator receiving negative sequence alarms
- System protection engineer able to trigger an event record and show unbalance but no history on normal performance
- Data available from generator interconnection station PMU to allow viewing of data over the weekend to identify any oddities in system
- Able to use PhasorPoint application to derive negative sequence data and plot to provide Generation Owner with clarity as to what was happening.
- Single phase arc furnace loads in area

Synchrophasor Project (cont'd)

Negative sequence concerns







Synchrophasor Project (cont'd)

Summary

- At ATC the use of synchrophasor data for post event analysis is gaining acceptance from our Ops Engineering and System protection groups (they know the data is there and ask for it…..)
- The little things we use the data for now will help pave the way for future development of tools using the data
- We will continue to find applications for the data we didn't envision especially when others understand what data is available

ATC System Protection Overview

ATC System Protection Overview

Almost half our relays are microprocessor based - primarily used for protection and post event analysis

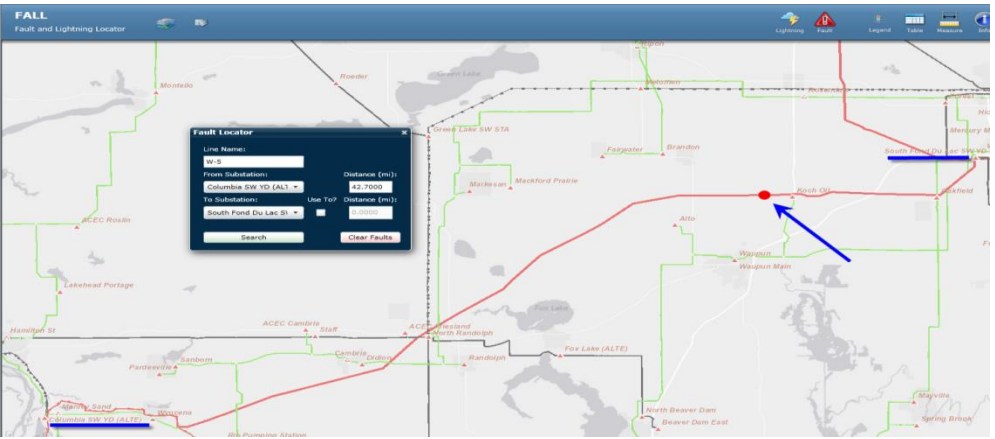
- The majority of 345 and 138kV lines are protected with microprocessor based relays
  - The majority have microprocessor based relays on both ends
- Metering values, MW, MVar, Amps, Bus Voltage, Bus Frequency, and Battery DC voltages are extracted by the RTU to eliminate costly transducers
- Relay alarms (Reclosing Status, Loss of Bus Voltage, Open Phase and fiber Communications) are extracted by the RTU and presented to the Operator
- Fault location data (distance and type) is extracted by the RTU and presented to the Operators
- Remote access to detailed relay fault data is available securely to Engineers through RTU and WAN

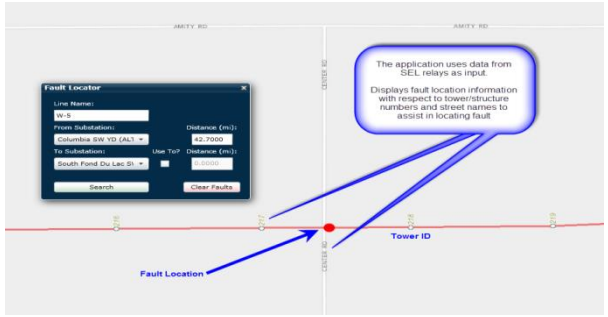
ATC System Protection Overview (cont'd)

Potential Upgrades

- Expand the installations of microprocessor based relays and digital devices
- Existing 300 series Schweitzer Engineering Laboratories [SEL] relays are not compatible with IEC 61850 communications. Use SEL 400 series or retrofit SEL 300 series?
- Data collection could be automated but "noise" would need to be addressed
- Review incorporating routine breaker timing tests to support predictive maintenance

ATC System Protection Overview (cont'd)





- Microprocessor based relays (SEL primarily) used to protect the line also calculate distance to fault
- Tool uses distance info as input and correlates fault to location on line
- Reduce outage times and enable field personnel to find source of problems so they do not recur.

ATC System Protection Overview (cont'd)

Other Opportunities

- Additional equipment health monitoring systems are under evaluation to assist with predictive maintenance of breakers and battery systems
  - Review available products for reliable operation
  - Develop history of successful prototype operation
- Where appropriate consider use of remote sag and tension monitoring capabilities
  - Validates ratings
  - Enhances ability to assess remaining life
- Develop ability to remotely monitor conductor susceptible to galloping

ATC System Protection Overview (cont'd)

Other Opportunities

- Develop temperature and pressure monitoring capabilities for underground lines
- Develop dynamic line rating capability
  - High risk. Heavily dependent on accurate weather forecasting, line direction, sheltering, relay protection, etc
- Review use of adaptive relaying capability in limited situations
  - High risk. Training, prototype development and testing needed before proceeding

ATC
Back to Back
HVDC
Project

ATC Back to Back HVDC Project

Background

- The transmission system in the Upper Peninsula [UP] of Michigan is significantly impacted by external influences including the Ludington generation plant in NW Michigan as well as generation shifts in the upper Midwest.
- The significant addition of wind generation in the Iowa and Minnesota regions and the abundance of hydro generated power in Canada have also resulted in an increased system bias from the upper Midwest to the central and east central United States which also impacts the operation of the UP system.
- ATC needed to implement something to help manage these flows both from West to East and East to West, within the limits of the existing UP and Lower Peninsula [LP] of Michigan systems.

ATC Back to Back HVDC Project (cont'd)

Background

- The solutions examined also had to help manage voltages in the UP including low voltages observed at moderate to high flow and high voltages during very low flow conditions.
- The systems also had to play well with the UP system which is saturated with capacitor banks and has no dynamic var sources.
- The connection between the UP and LP consists of submarine cables which have a high sensitivity to voltage changes and also sudden load changes which any new equipment would have to work well with.

ATC Back to Back HVDC Project (cont'd)

After reviewing options available selected the addition of a Back-to-Back HVDC device with Voltage Source Converter technology to be located in the eastern UP. The Back to Back HVDC installation:

- Splits the Upper Peninsula from the Lower Peninsula so that there is no direct AC path between the systems. This allows MISO Operations to dispatch flows as needed for system reliability
- Provides two STATCOM devices, one at each Converter/Inverter that provides a badly needed dynamic var source for the UP
- The operation of the system is very compatible with the submarine cables as it provides smooth MW ramping versus discreet steps provided by a phase shifter.

ATC Back to Back HVDC Project (cont'd)

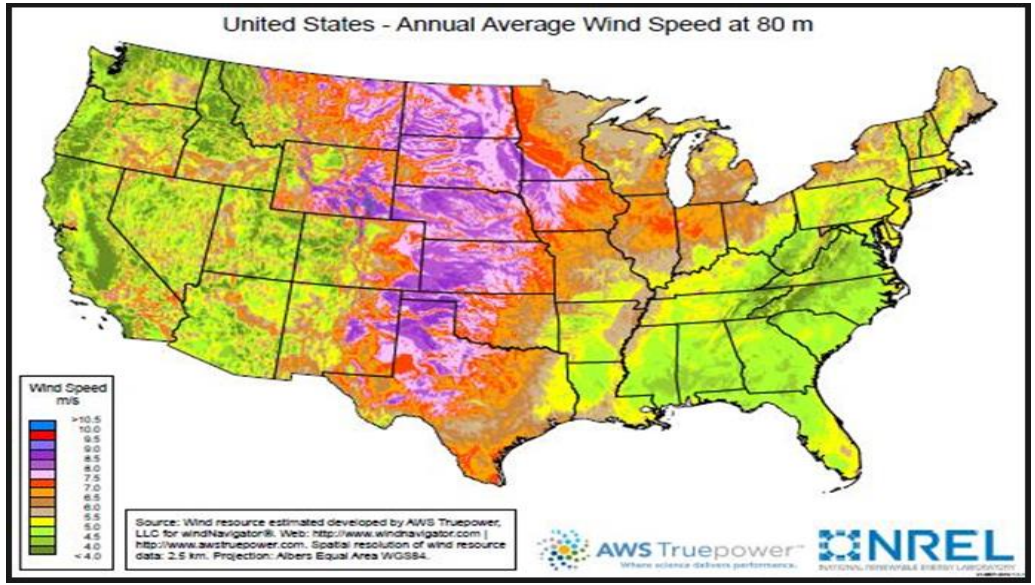
- System can operate to maintain an islanded system in the Eastern UP if needed
- AC Line Emulation controls used to return the system to a stable operating state after large disturbances
- Testing started April 2014 and is ongoing. Commercial operations planned for Summer 2014.

Duke – ATC Partnership

Duke-ATC Partnership

- In April 2011 ATC formed a strategic partnership with Duke Energy to pursue joint transmission project development. http://www.datcllc.com/
- Announced projects September 2011 to help move energy from renewable projects in the Midwestern US to load centers in the central and eastern US. (See map on following page)
- Mix of high voltage AC (230 Kv, 345 Kv, 500 Kv) and HVDC facilities.
- Competition with other projects that hope to accomplish the same goal.
    - 765 Kv “thoroughfare”
    - 345 Kv system upgrades and expansion
    - What is the “best” answer solution?

Duke-ATC Partnership (cont'd)

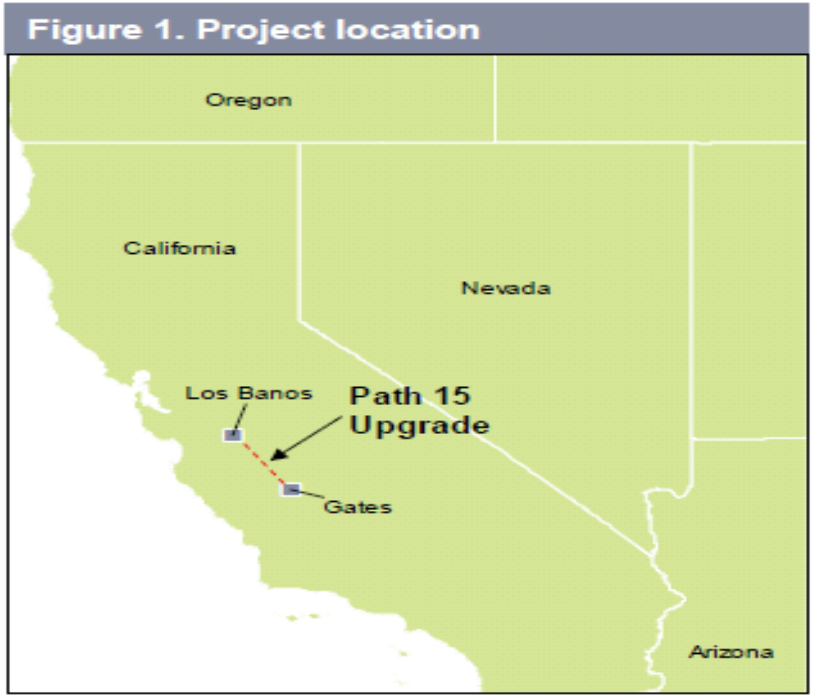


DATC
DUKE American Transmission Co.™

Proposed DATC Projects

- Midwest projects 1 thru 8 enable flow of wind energy from the plains to load centers in the east
- Project 9 provides a pathway for power to flow from a large proposed wind farm in Wyoming to the western load centers
- Project 10 is the Path 15 line purchased in 2013

Duke-ATC Partnership (cont'd)



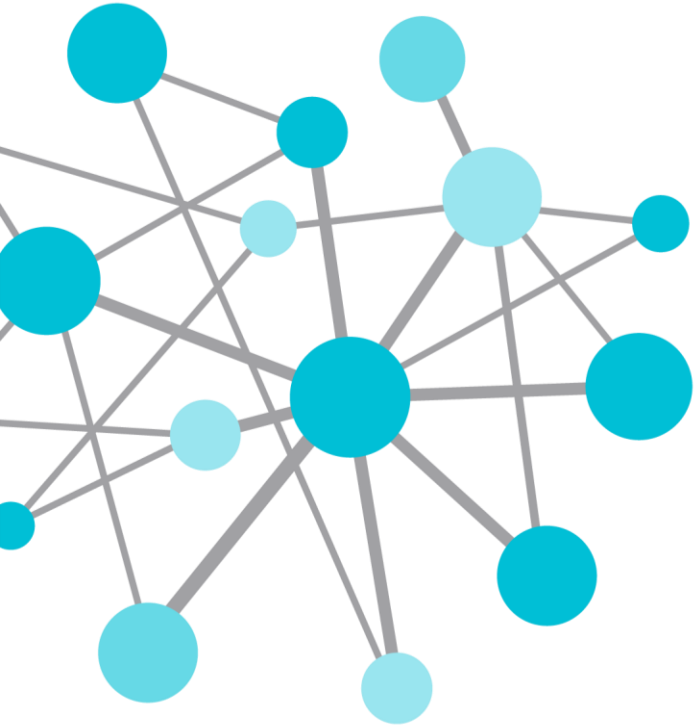
www.datcllc.com

California Path 15

- DATC acquired 72% economic interest in existing 84-mile, 500-kV line in Central California
- Fully integrated into CAISO
- 1,500 MW capacity (customers: PGE, SCE and SDGE)
- Maintains regional reliability, market efficiency
- Connects grids between northern & southern California
- Access to several California load centers

Questions?

- Jim Kleitsch (JKleitsch@atcllc.com)
- Principal System Operations Engineer
- American Transmission Company



THANK YOU

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