American Transmission Company
Smart Grid Investment Grant Overview

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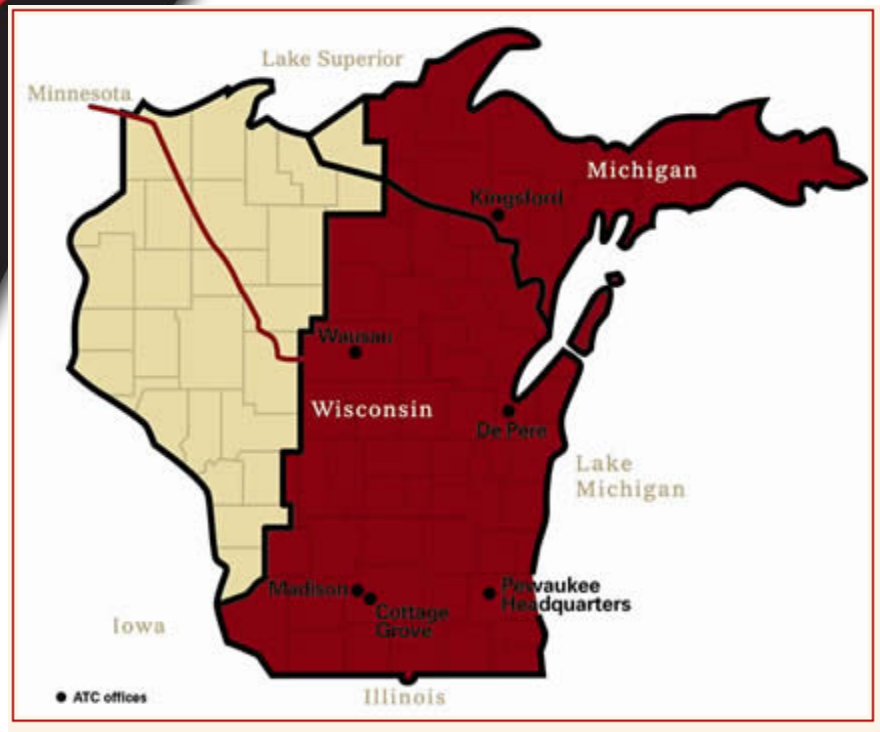
Disclaimer

ATC's DOE Agreements have not been finalized.

The information included in this presentation is based on ATC's grant application proposal which may be modified based on the executed agreements.

Company Information



ATC is a transmission-only utility

- 9,400 circuit miles of transmission line
- 510 substations (wholly or jointly owned)
- Peak demand in footprint: 13,170 MW
- Service area includes portions of Wisconsin, Michigan, Minnesota, and Illinois

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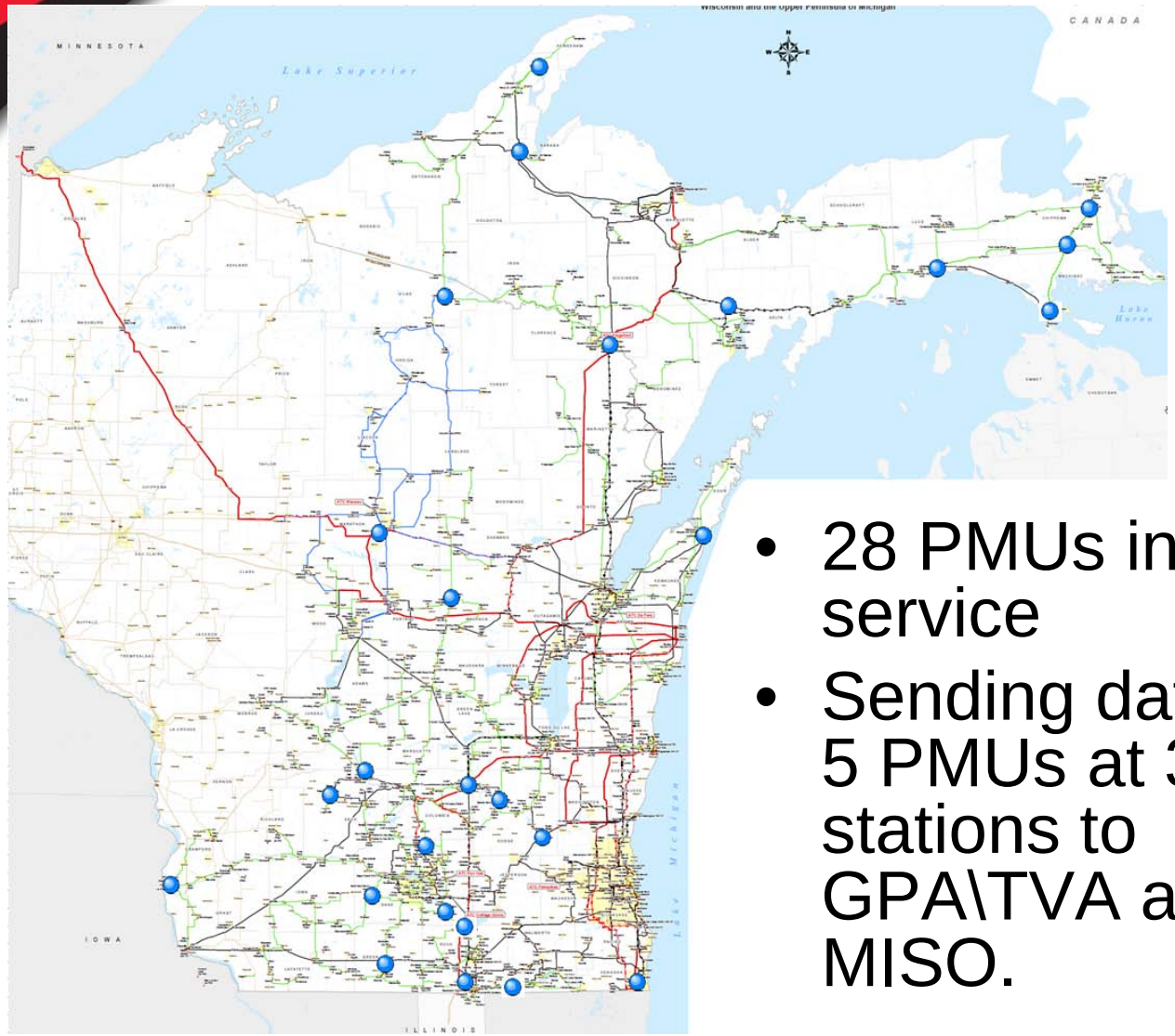
Legacy PMU Project

- 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)
- Minimal work in the field required
- Majority of sites involved capacitor bank protection relays so ATC did not bring back current measurements.

ATC Legacy Project PMU Map



- 28 PMUs in service
- Sending data from 5 PMUs at 345 Kv stations to GPA\TVA and MISO.

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DOE Project Status

- We signed our project agreement with DOE on April 20th.
- We are still negotiating the Project Execution Plan, Cyber Security Plan, and Benefits and Metrics agreements with DOE.

Project Team

Project Manager

- Carl “Chip” Harper

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DOE Contract Manager

- Jessica Basilio

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Technical contributors

- Cross functional internal project team including representatives from Corporate IT, System Protection, System Operations, and Project Management

DOE Project Overview

ATC's proposed project is 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.

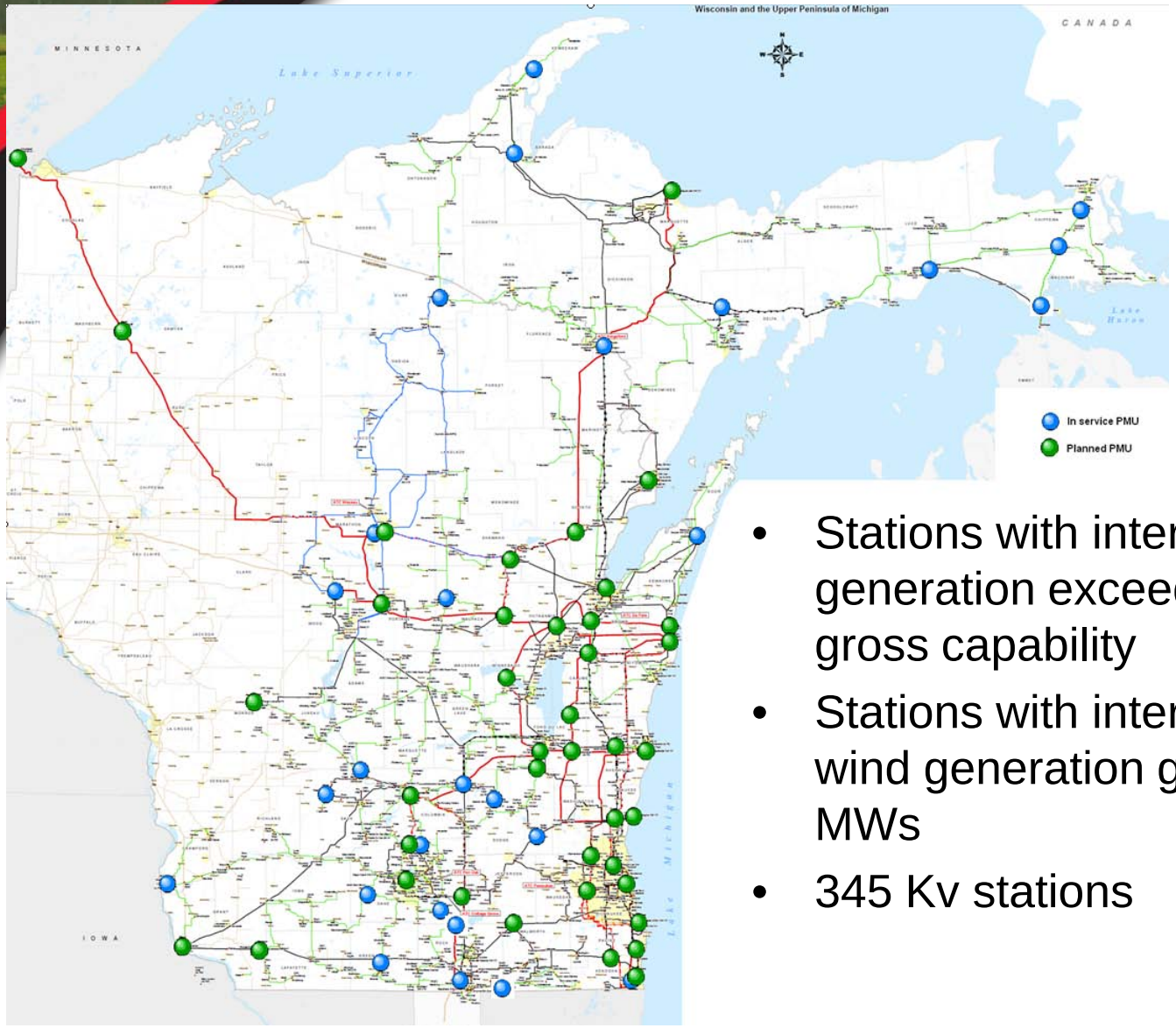
DOE Project Overview (cont'd)

- Total Planned PMU Installs Associated with the project – 48 Sites
- Field Hardware
  - Primarily using SEL-351A-1 dedicated phasor measurement units.
  - ~10 Digital Fault Recorders may also be upgraded to provide data. Comparable costs to upgrade versus install new stand alone equipment.
- SEL 3306 Phasor Data Concentrator

Estimated Project Cost - ~$2.66 M

Estimated DOE Funding - ~$1.33 M

ATC Proposed PMU Installs



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

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Project Goals

Proposed PMU Data near term use:

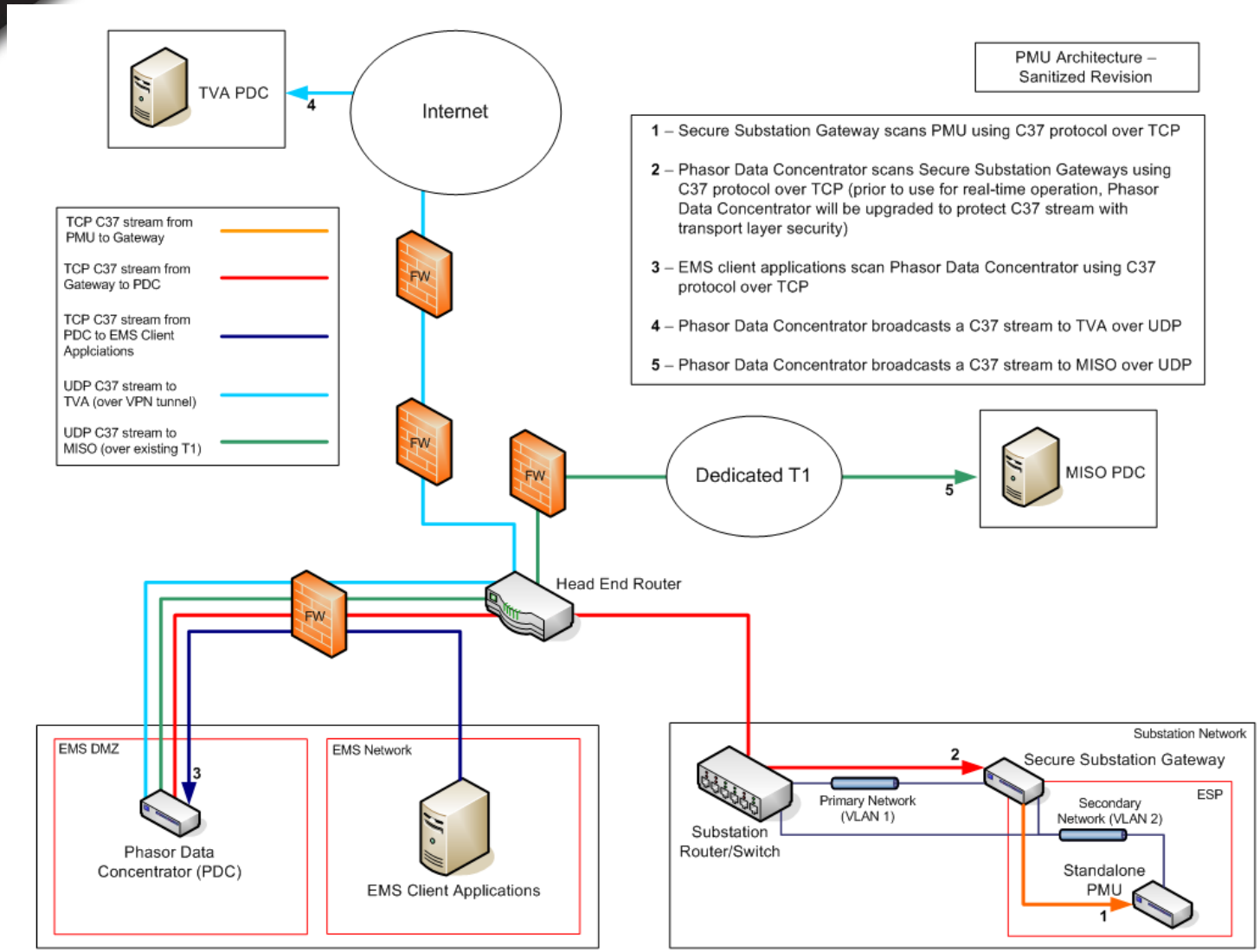
- Post electrical system event analysis
- Wide area overview for ATC System Control real time operations
- Data sharing with:
  - Midwest ISO
  - TVA/GPA
  - Others that have FERC-based reliability requirements
- Detection of “electrical islands” due to unplanned outages of one or more elements of the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

Project Goals (cont'd)

ATC envisions other uses (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

System Design



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System Design (cont'd)

- Communications will be over existing leased frame relay or company owned fiber.
- Separate DOE project also in negotiation phase to expand our company owned/leased fiber network to facilitate PMU data traffic and other data flow. This will include company owned fiber in most cases with satellite communications (12 dishes planned) to remote sites where fiber is not cost justified
- PI Historian is being used for data storage and retrieval. ATC working to determine if we can store all data indefinitely. (It's only terabytes….)

Synchrophasor Applications

- PI ProcessBook and DataLink used now to display data stored in our PI Historian database for post event analysis
- ATC will test to see if we can achieve significant state estimator improvements on AREVA EMS
- No Plans to use PMU data for any type of control systems.

Metering Philosophy

- If possible we want to measure net output of all large generating units and wind farms connected to our transmission system to allow validation of dynamic models. Not always easy as a transmission only company to access needed metering equipment.
- Unit dynamics monitoring is our top priority. We will choose equipment to be monitored at non-generation stations that help us fill in the gaps after the equipment to be monitored at generating stations has been defined. (1 PMU per site at non-gen stations)

Security Approach

Physical and Cyber security

- ATC's view:
  - PMU data is no more important than traditional SCADA data. As such we are applying the same security standards to PMU data that we have in place for SCADA. That may change long term if/when data used for real time control or to help make real time decisions.
  - Our project plan includes the addition of a secure substation gateway device to allow tracking of access to the PMUs and provide security on data transfer to the PDC which is not built into our PMU devices

Project Timeline

- Construction scheduled to start 1Q11 with the following tentative schedule for in service installations:
  - 12 Sites in 1Q11
  - 12 Additional Sites in 2Q11
  - 12 Additional Sites in 3Q11
  - 12 Additional Sites in 4Q11

Project Timeline (cont'd)

- Development of Wide Area Overview Operations Interface will be ongoing.
- State estimator testing will most likely begin in late 2011 to have sufficient data to identify impacts.
- Project closeout work scheduled to be completed year end 2011.

Most Important Synchrophasor Applications

Post Event Analysis

- Our PI Historian database and associated applications are already production grade so historical event data is available.
- We are capturing significant event data and routing it to help show the value the data can provide if used.
- We have cycle training for our Ops group and will continue to provide information on the tools available during those training sessions.

Most Important Synchrophasor Applications (cont'd)

Dynamic Model Validation

- We plan to use PMU data to confirm dynamic response of our larger interconnected units and the validity of our dynamic models.
- Develop comparison tools using PI Historian data and PSSE dynamic output results.
- Initial development will begin in 3Q2011 or sooner if actual event data is available for analysis.

Most Important Synchrophasor Applications (cont'd)

State Estimator Enhancements

- Our planned PMU installed base will provide complete coverage of our 345 Kv system.
- We plan to use PMU data to improve our SE accuracy and help identify model errors.
- Testing will begin 4Q2011 when the majority of our PMUs are in service.
- Vendor involvement may be pursued if funding allows.

Challenges - Concerns

- Accessing data for facilities we don't own (TO vs GO issues we deal with as a TO) may prevent us from bringing back the data we'd prefer to have especially for generating units
- Initial project installation cost estimates are higher than initial estimates
- C37.118 Price Inflation Concerns
- Data sharing and model sharing roadblocks

ATC Event Data Examples

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

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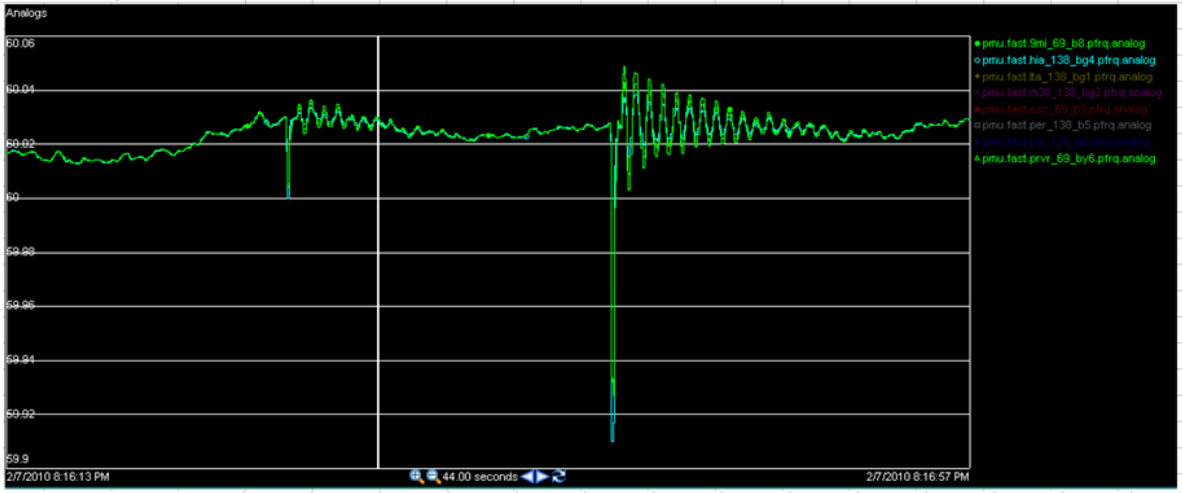
ATC Event Data Examples (cont'd)

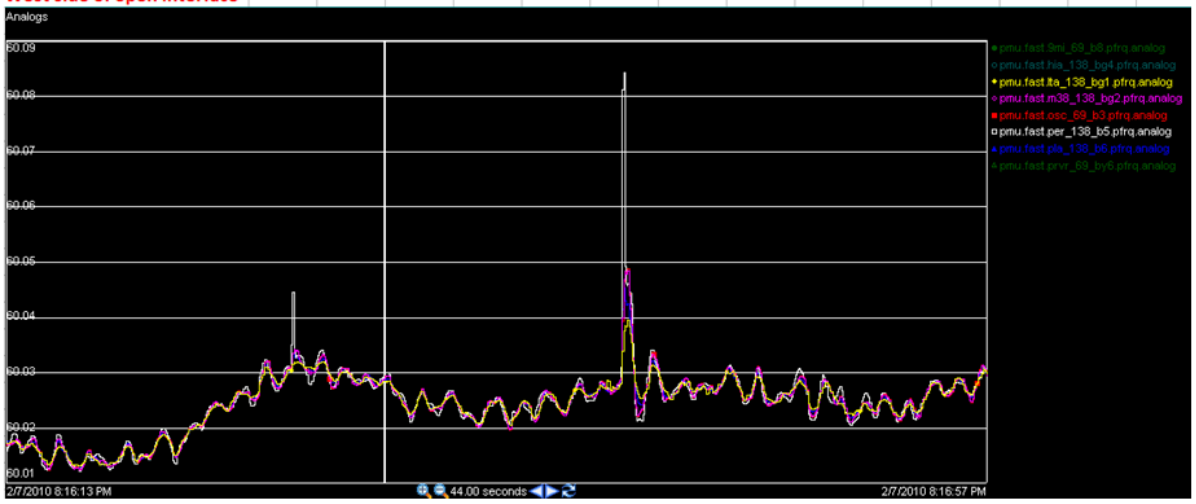
East side frequency drops from ~60.03 Hz to ~59.91 Hz. Oscillations around EI system frequency occur for ~ 7 seconds

West side frequency rises from ~60.03 Hz to ~60.09 Hz. Oscillations gone within one second.

East side of open interface



West side of open interface



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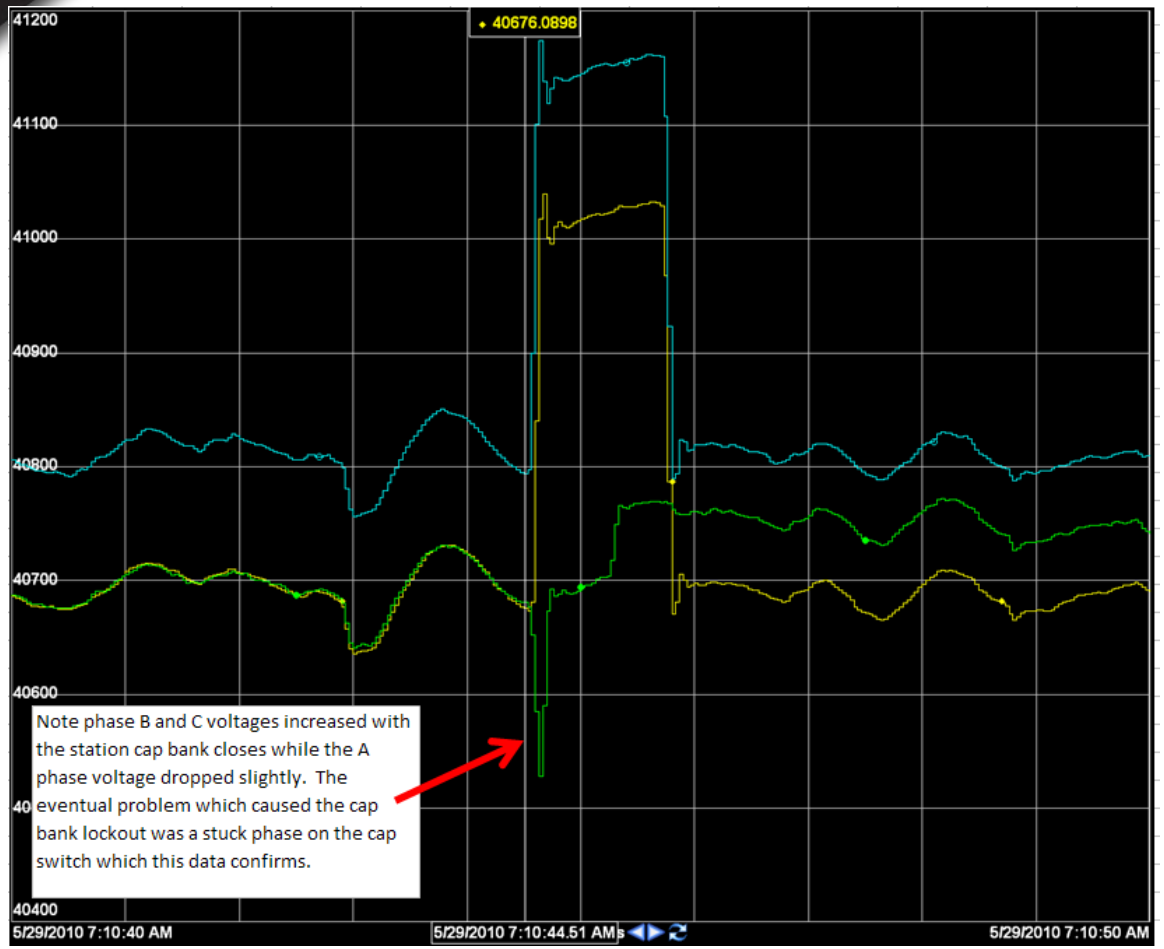
ATC Event Data Examples (cont'd)



Voltage traces from a nearby station could have been used to confirm a stuck phase on a cap bank switch that was closed in and eventually tripped back out.

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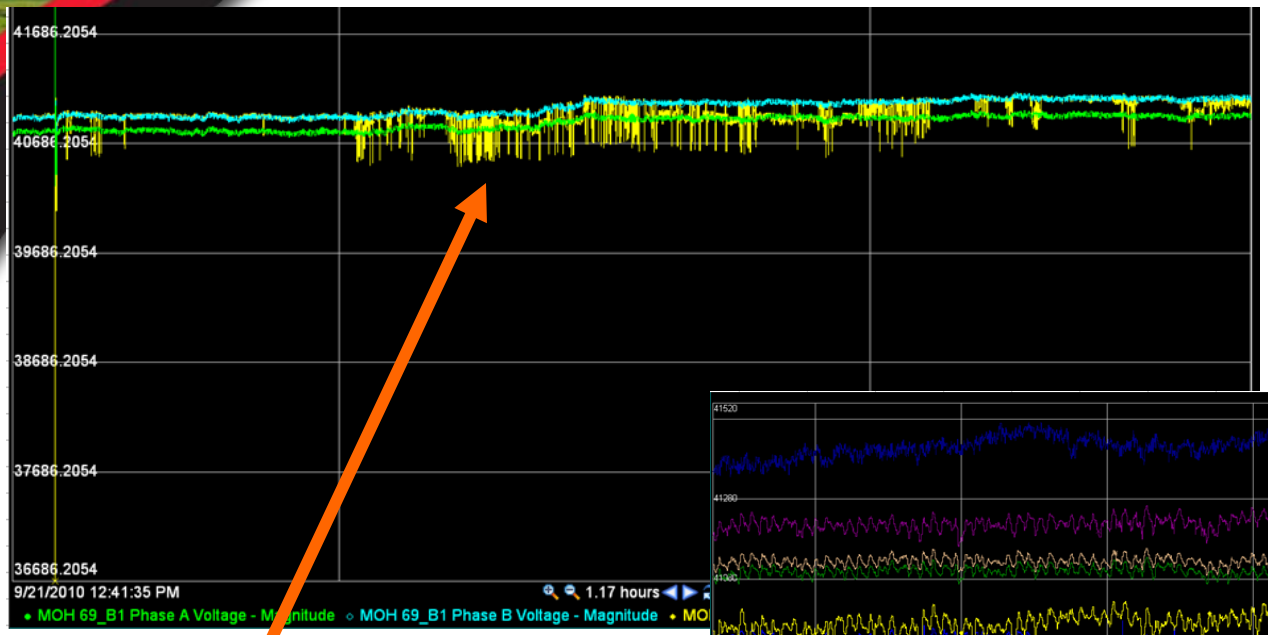
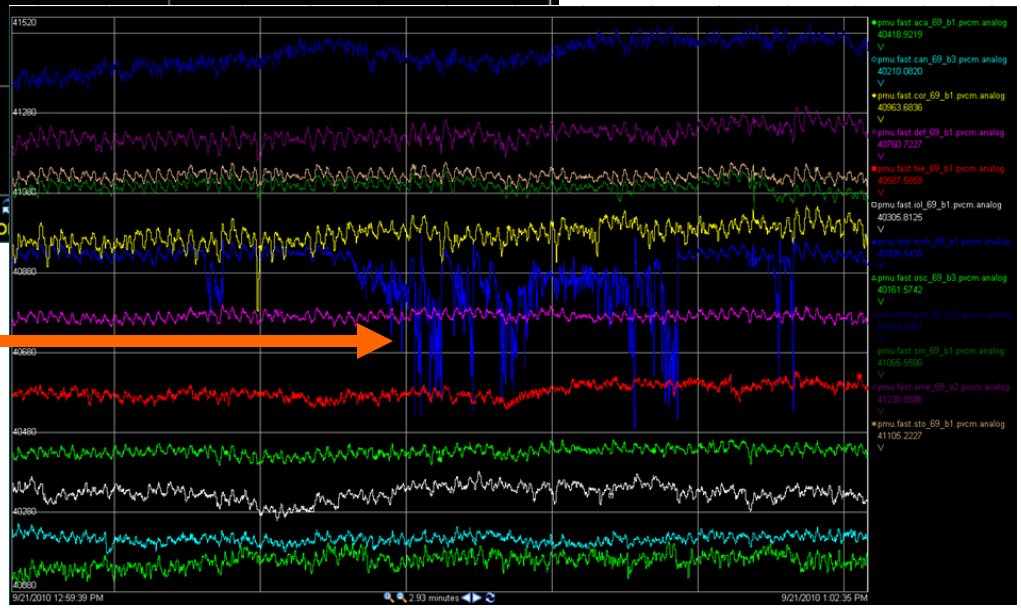
ATC Event Data Examples (cont'd)





Voltage traces showed significant noise following a 69 Kv line fault. This noise was traced to a switch that was found to be arcing at a tap pole at a nearby station.

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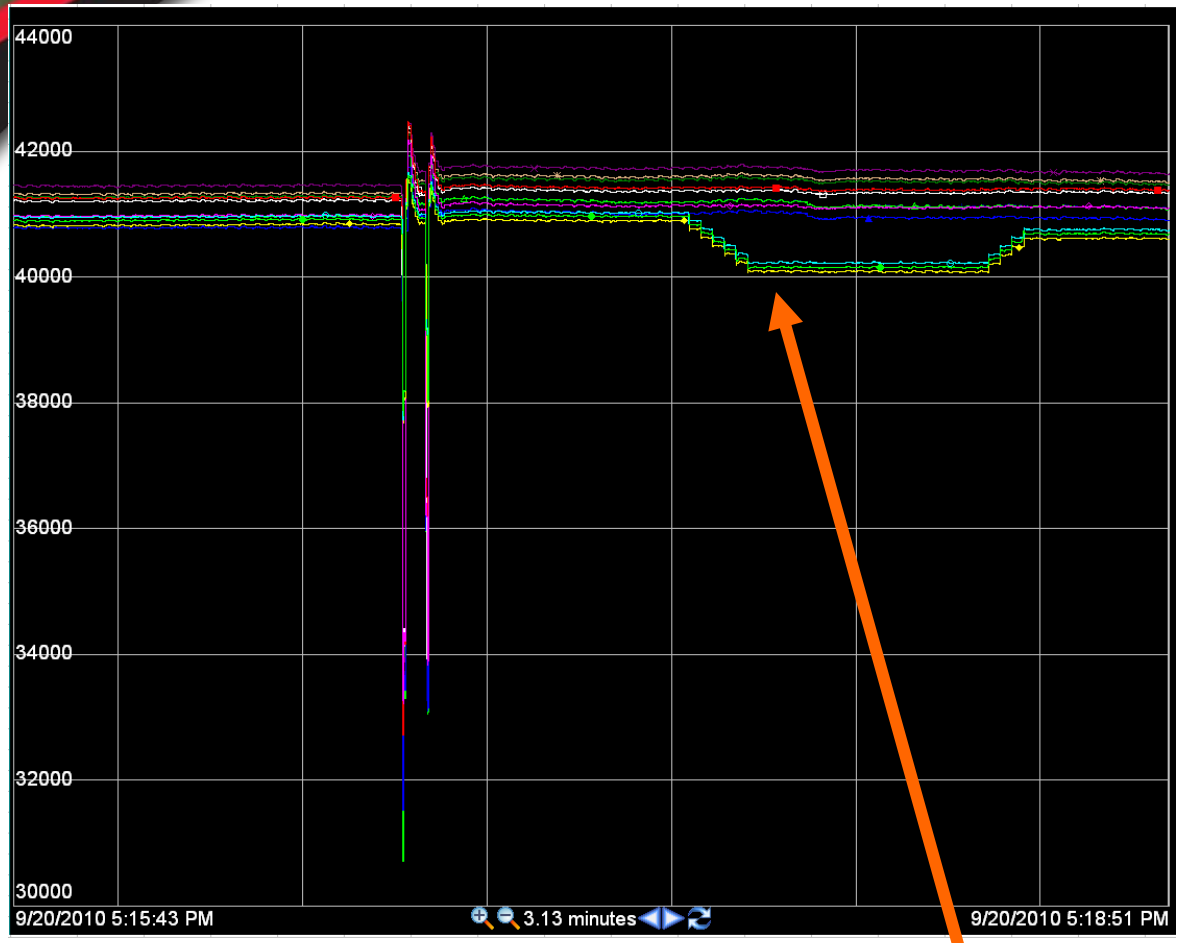
ATC Event Data Examples (cont'd)



A significant fault on the 69 Kv system caused an incorrect LTC operation at a nearby bus a short time after the event. Having the time synched data allowed easy correlation of events whereas this would have been undetected prior to PMU data being available.

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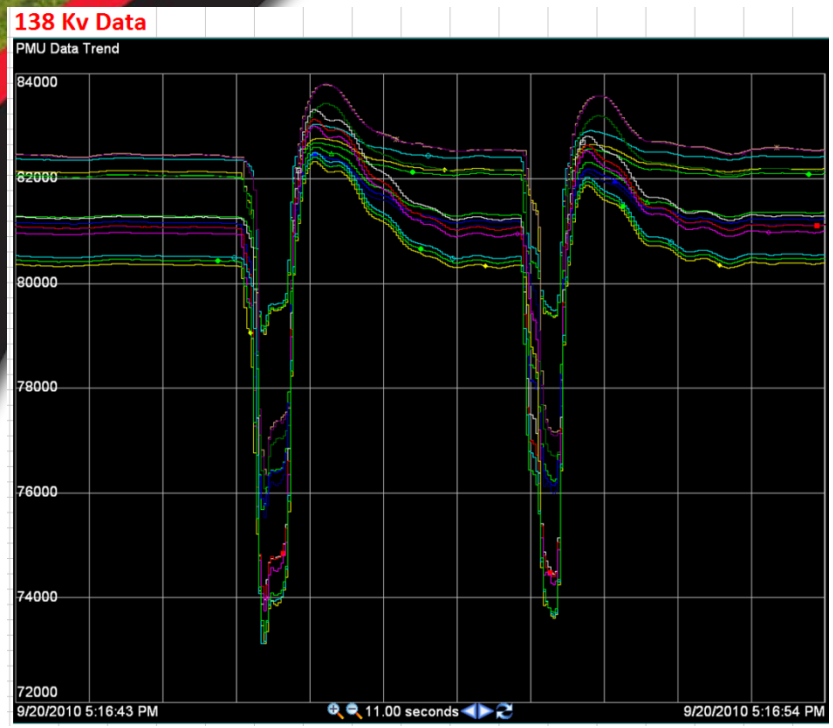
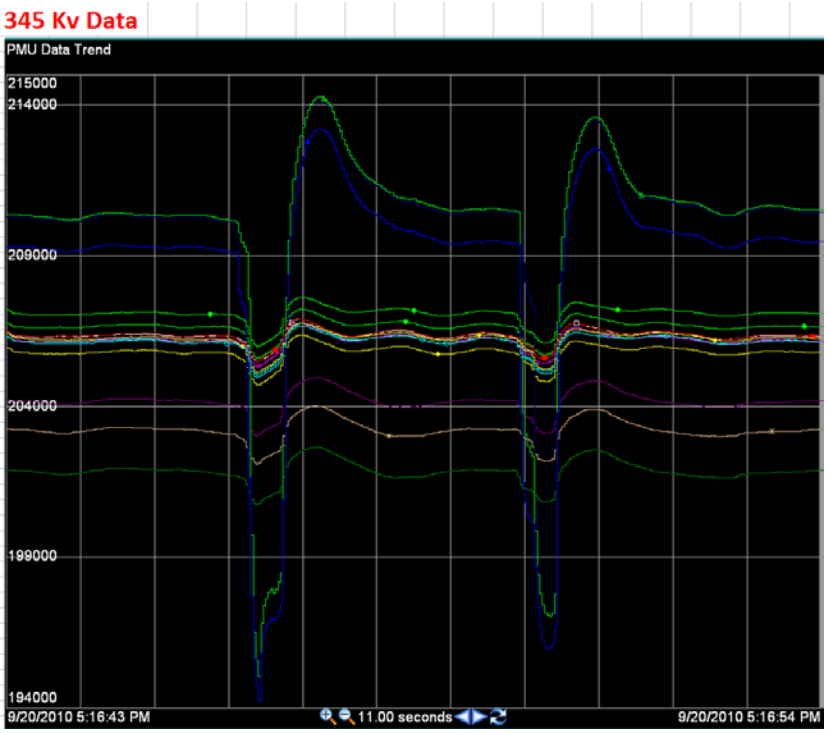
ATC Event Data Examples (cont'd)





A recent three phase 69 Kv fault occurred in south central Wisconsin. We were able to observe the impact at stations scattered across our footprint. The 138 kv and 345 kv voltage traces are shown above.

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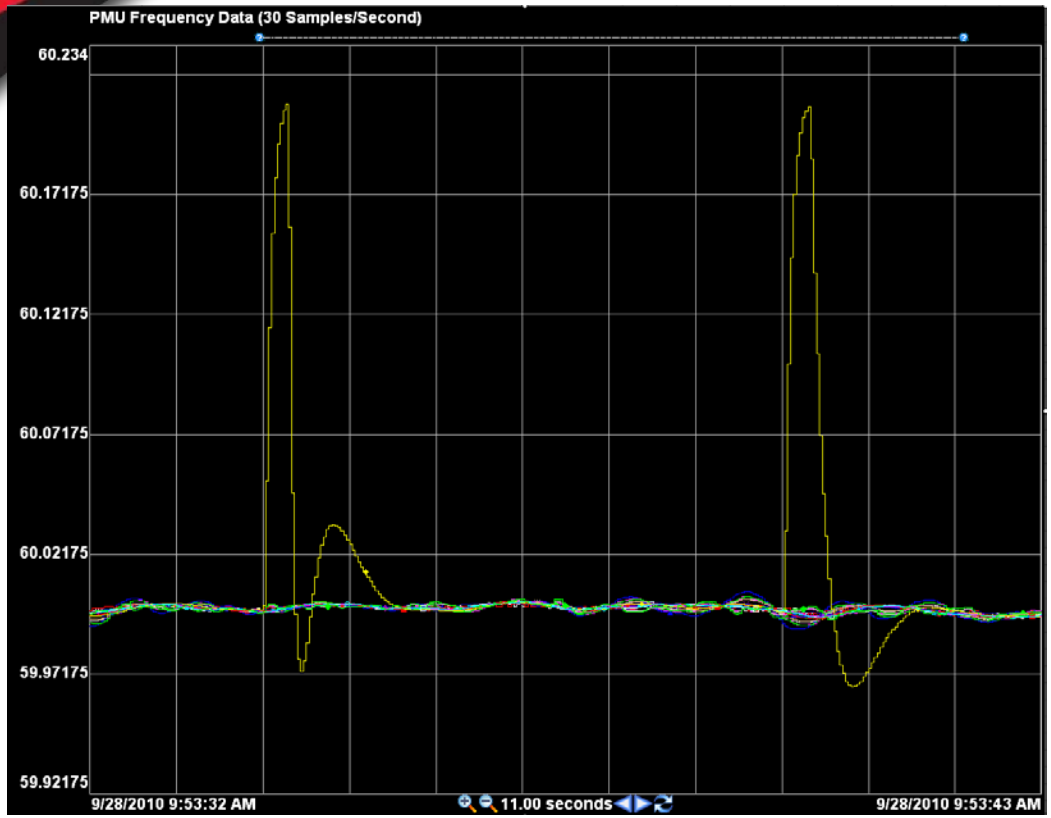
ATC Event Data Examples (cont'd)



We noticed significant frequency excursions from several of our installed PMUs that were found to be due to a firmware issue in our PMU devices. These occur when GPS clock signal is lost.

This issue drove us away from combined relay/PMU devices as now we need to update firmware in a production protection relay which may require line outages and significant relay testing.

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Questions?

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