MHEB
Smart Grid Investment Grant Update

Tony Weekes

NASPI Work Group Meeting
October 17-18, 2012

Acknowledgement:

This material is based upon work supported by the Department of Energy under Award Number(s) DE-OE0000369

Disclaimer:

Manitoba Hydro

Topics of Discussion

- Project Overview
- Communications and Data – research projects
- Operational Applications
- Anomalies seen through improved situational awareness
- Challenges and Lessons Learned
- Next Steps

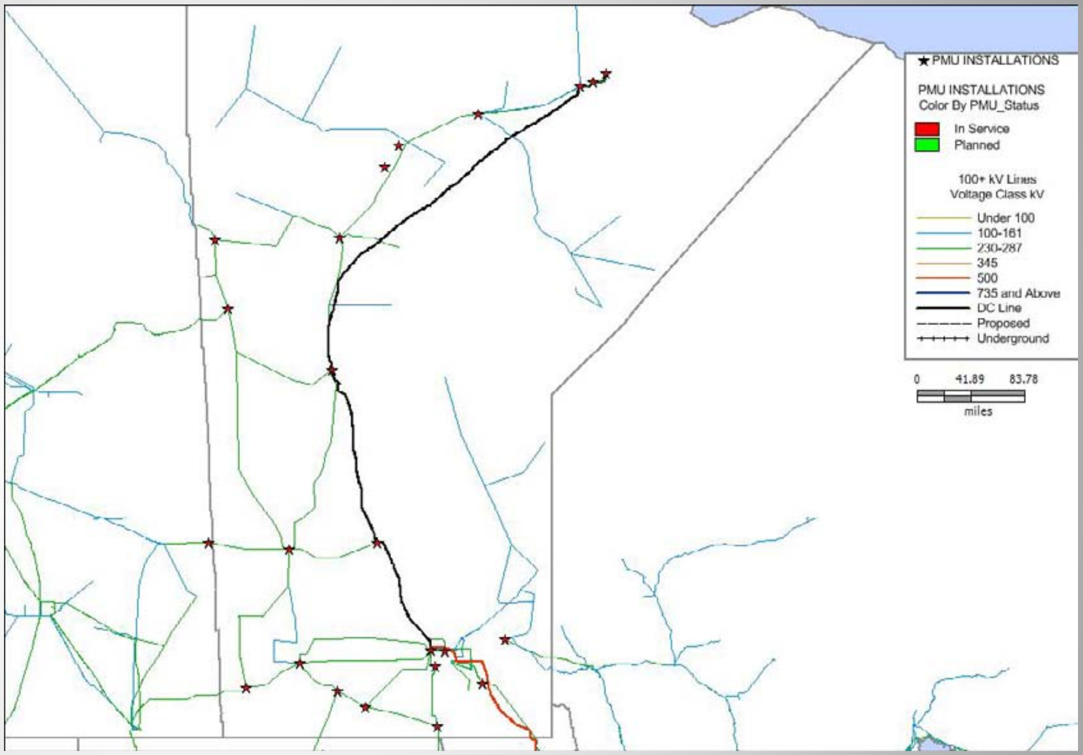
Manitoba Hydro

Project Overview

- Manitoba Hydro is under the MISO group of participants
- 30 of our 32 PMUs (already installed) to MISO
- Main and Back-up PDCs
- Communication System is internal
- MISO WAN to send data

Project Map

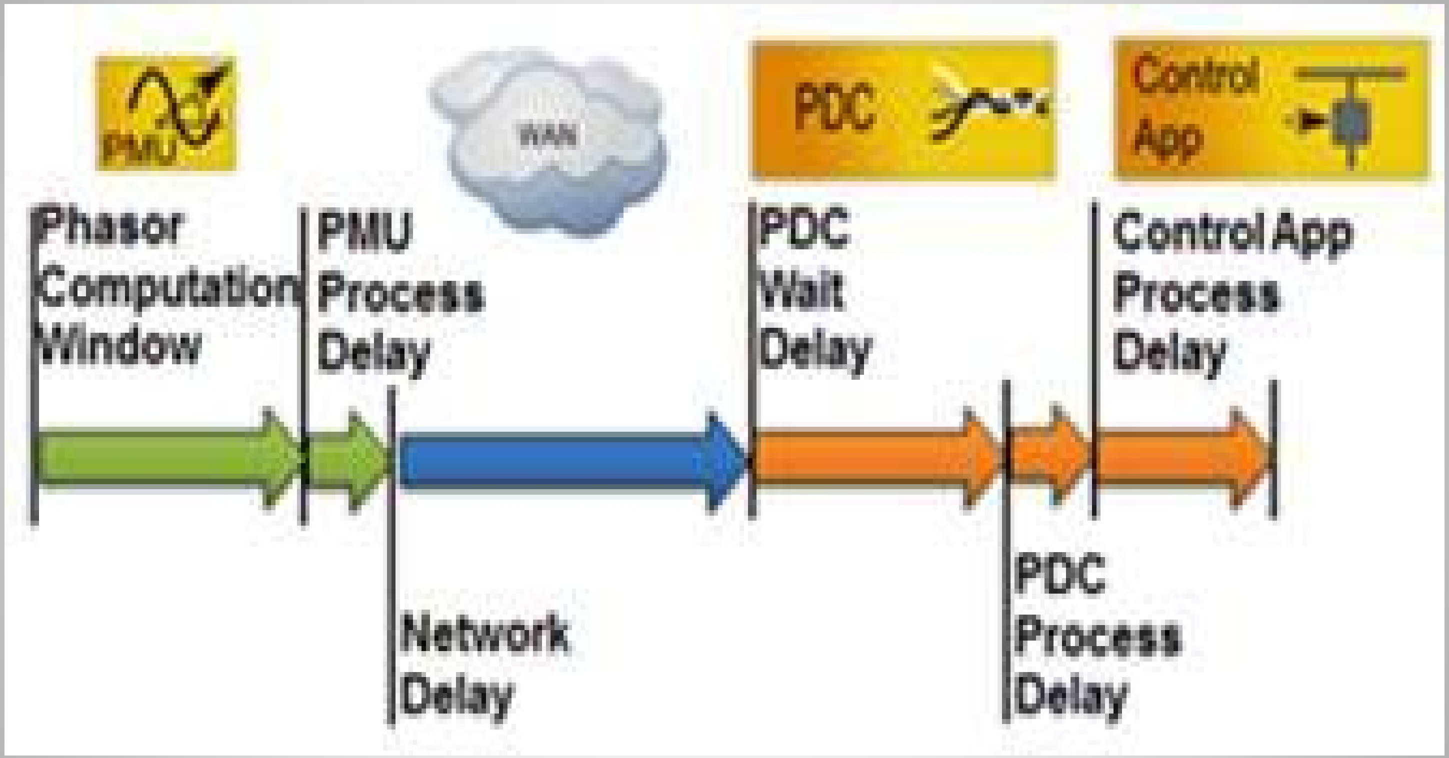
MB
Hydro
PMU sites



Phasor data-sharing

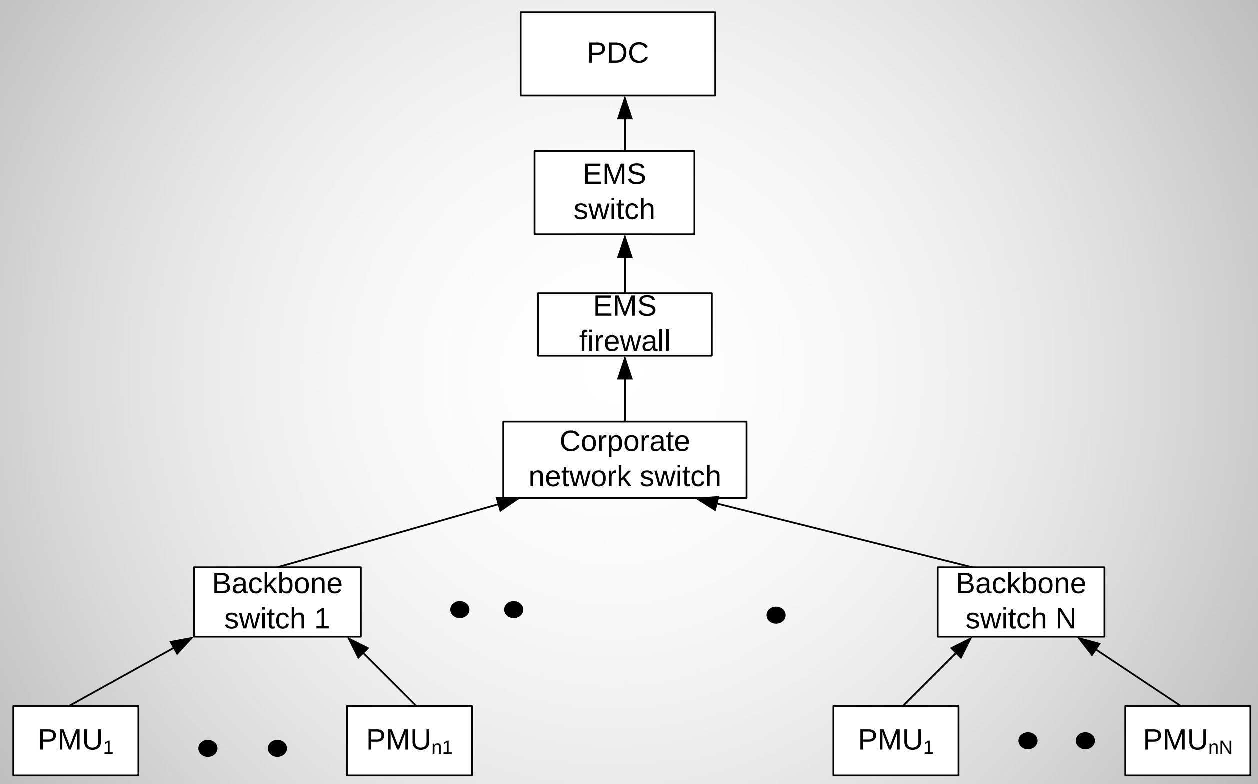
- University of Manitoba –
  - 1st project : communication network research model. Components developed and MB Hydro network modeled.
  - 2nd project: to apply machine learning algorithms to develop transient stability boundaries given PMU data.
- MISO – Allows us to see rest of the PMU network stretching even outside of the MISO footprint.

Communications and data



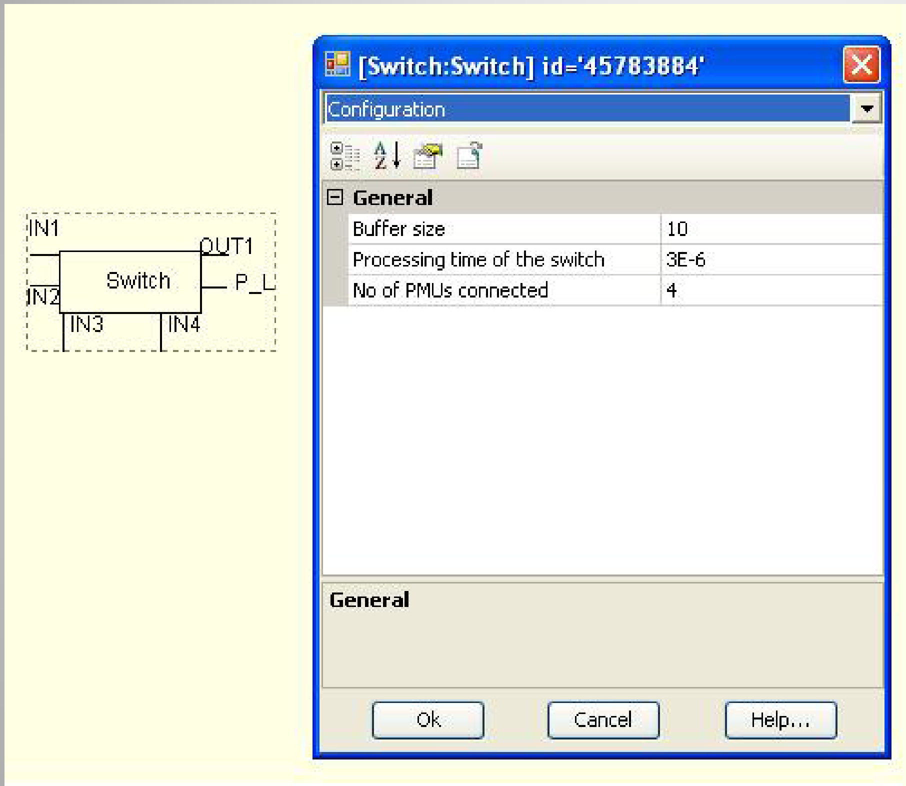
Manitoba Hydro

Communication Network Research

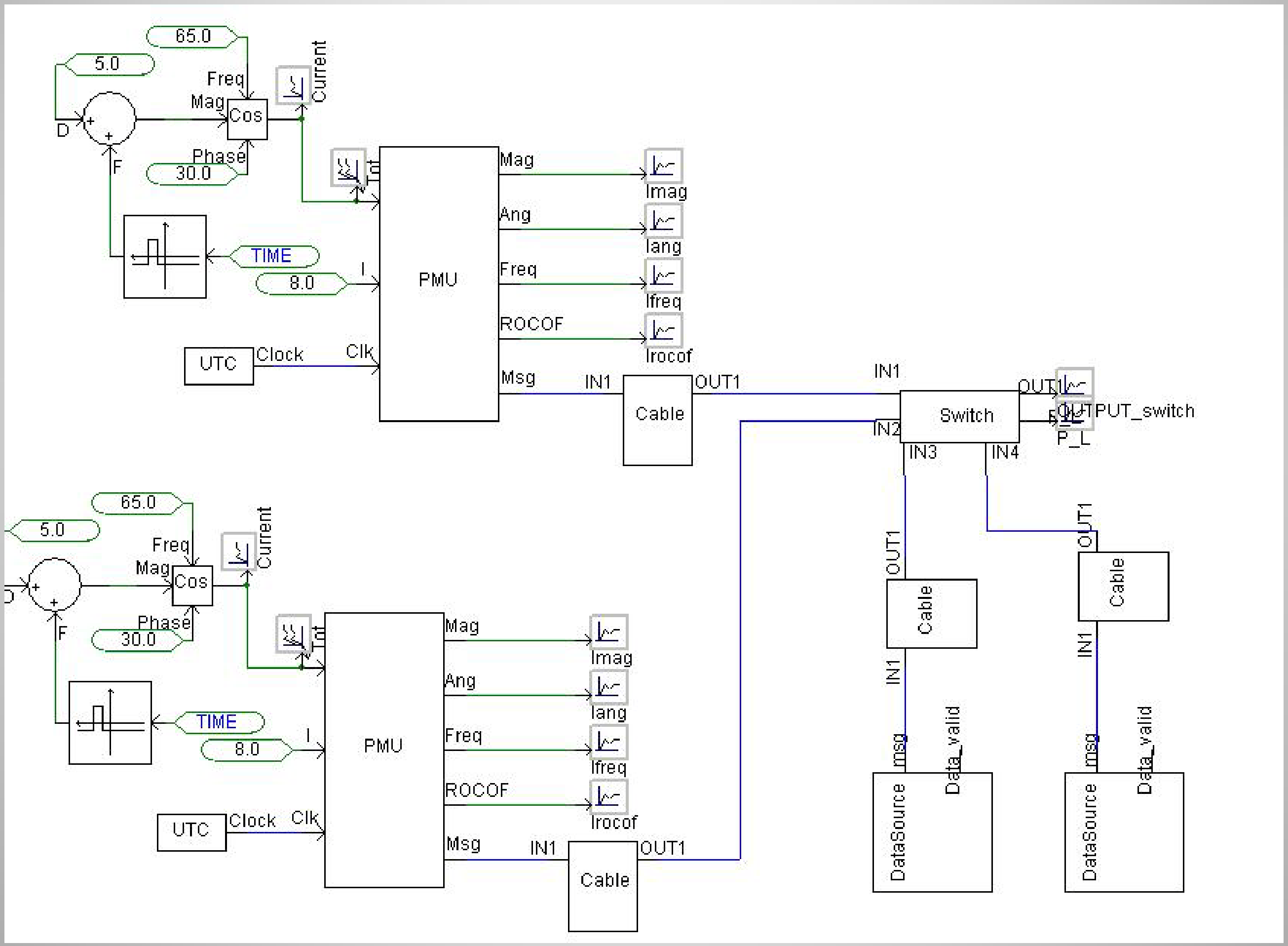


Manitoba Hydro

Switch


IN1
OUT1
Switch
P_L
IN2
IN3
IN4
[Switch:Switch] id='45783884'
Configuration
General
Buffer size
10
Processing time of the switch
3E-6
No of PMUs connected
4
General
Ok
Cancel
Help...

Integrated Simulation



Major operational applications using phasor data

- Wide-area situational awareness
  - Software/vendor used Alstom
  - Integrated into other control room applications? Not yet
  - Operational date Used by operating and Planning staff for post event investigations ,model improvement, commissioning. To be used to improve EMS SCADA later. Move to the control room last , after we fully understand our system and eliminate nuisance alarms.
- Small Signal Stability

  - Aiding in commissioning of various PSSs of our system.

  - **Question was raised that you do not need PMUs to do small signal stability** – unsynchronized monitoring works but with PMUs get more than the mode observability – ie more than freq, amplitude, and damping:

1. also get mode shape
2. also get participation
3. Phase relationships between oscillations in frequency (or angle) and power help identify contributions. Insight to where best to control the mode.
4. Finally, the infrastructure allows us to see these in real time (true with unsynchronized also, point is it was not there even if possible before)

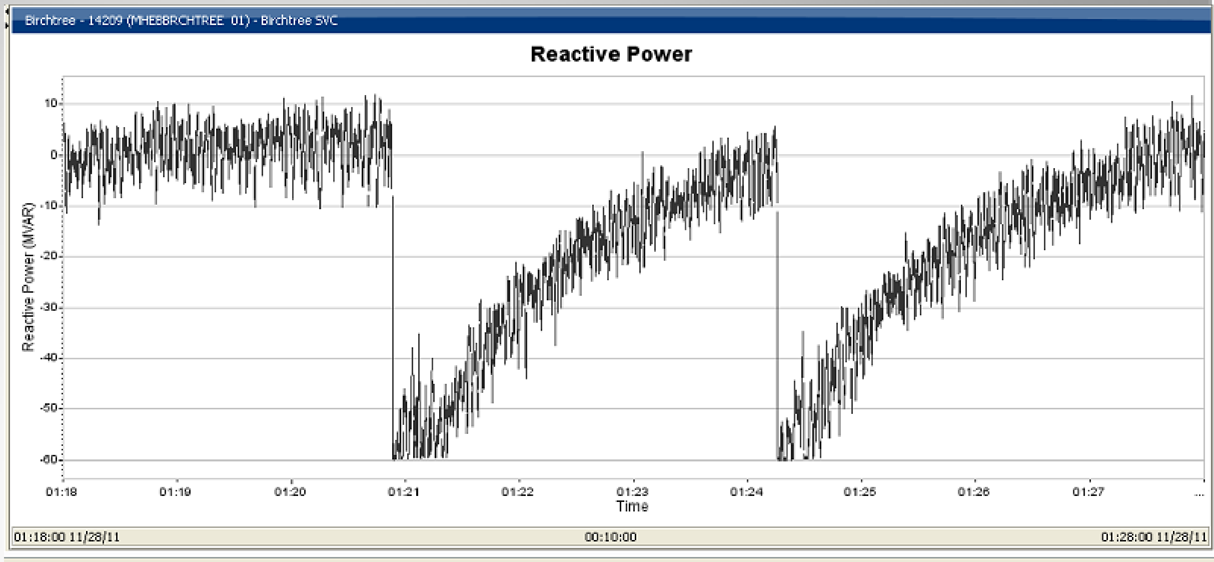
Manitoba Hydro

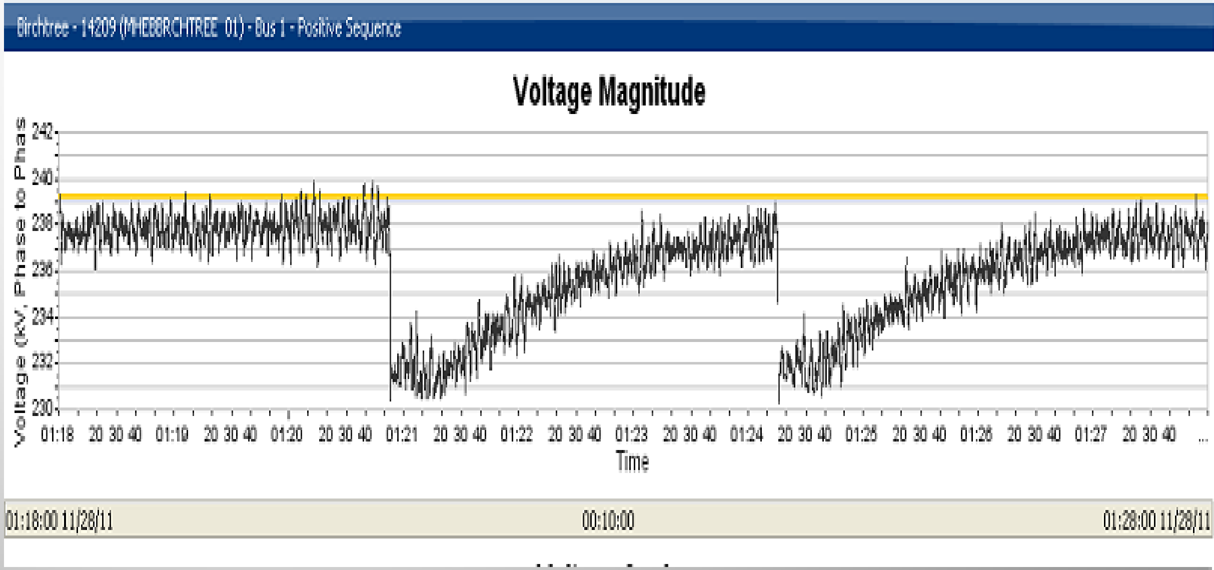
Anomalies seen through Improved Situational Awareness

SVC Instability

Instability noted (cycling) when POD>threshold

- originalVref
- Original Vref + SSR contribution
- Original Vref
- Etc.

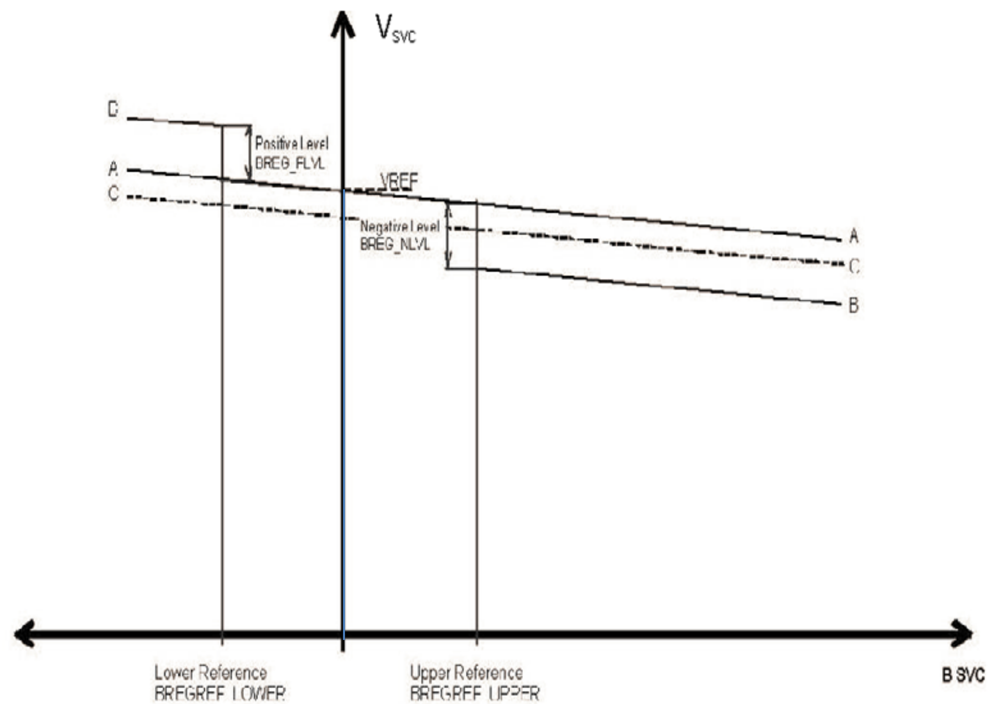




Solution

1) Increase the range of MVArs for Vref
2) Freeze the last value before POD>threshold

Birchtree SVC

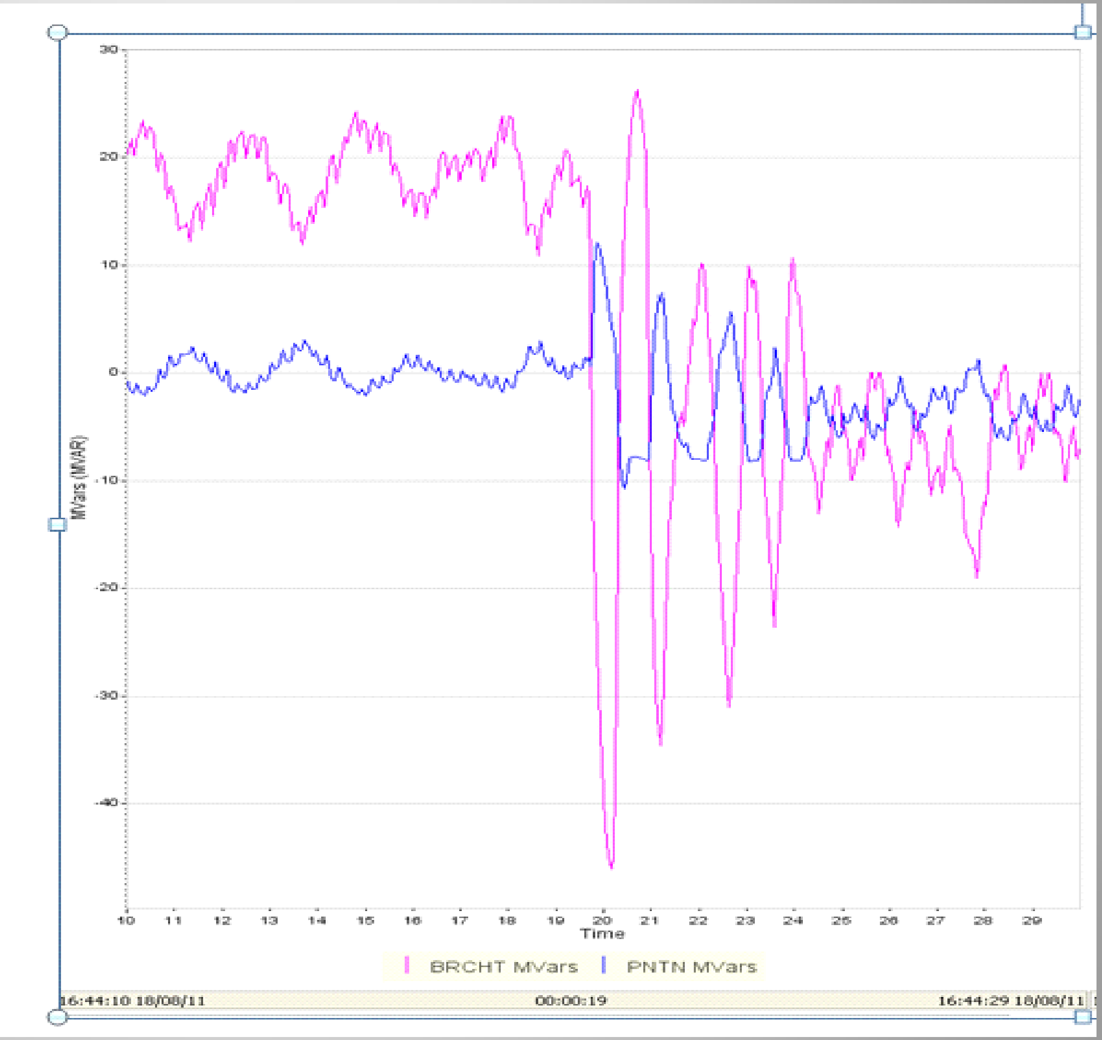


SVC operating characteristic with supplementary controller

• Dynamic Response

Eg. Line opened (vars changed)

Slow Susceptance control must not interact with Power Oscillation damping

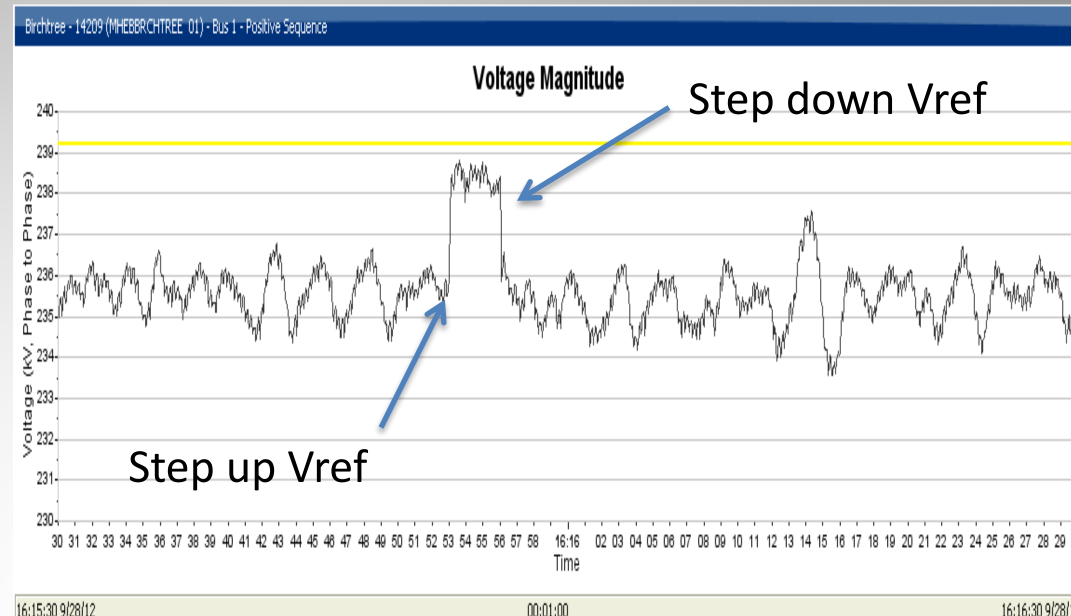


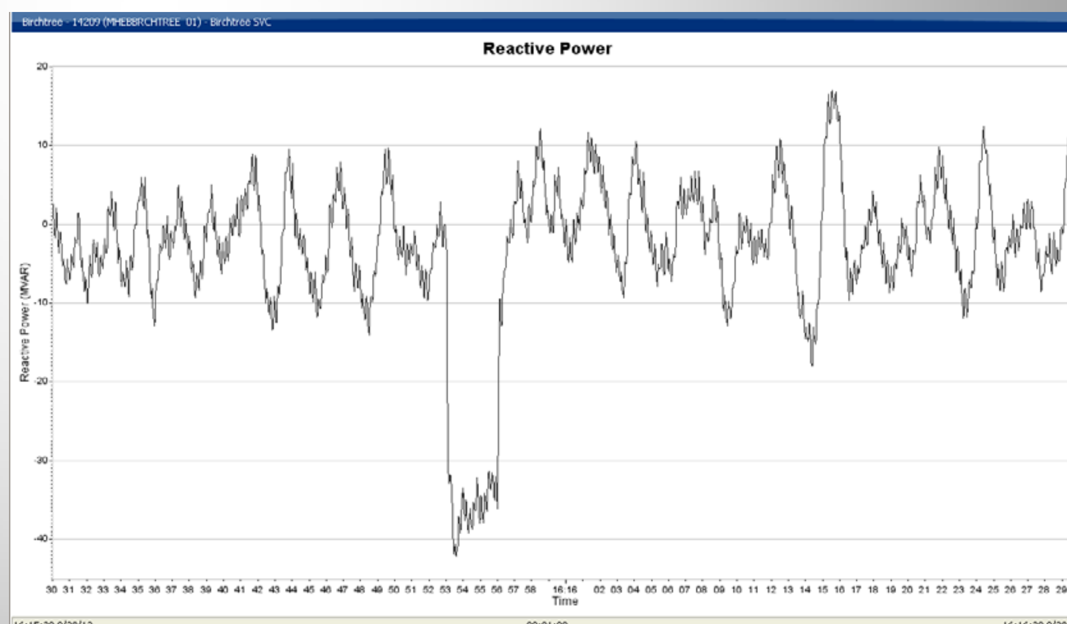
Testing Our Solution

1.5% Step Up and Down of Vref

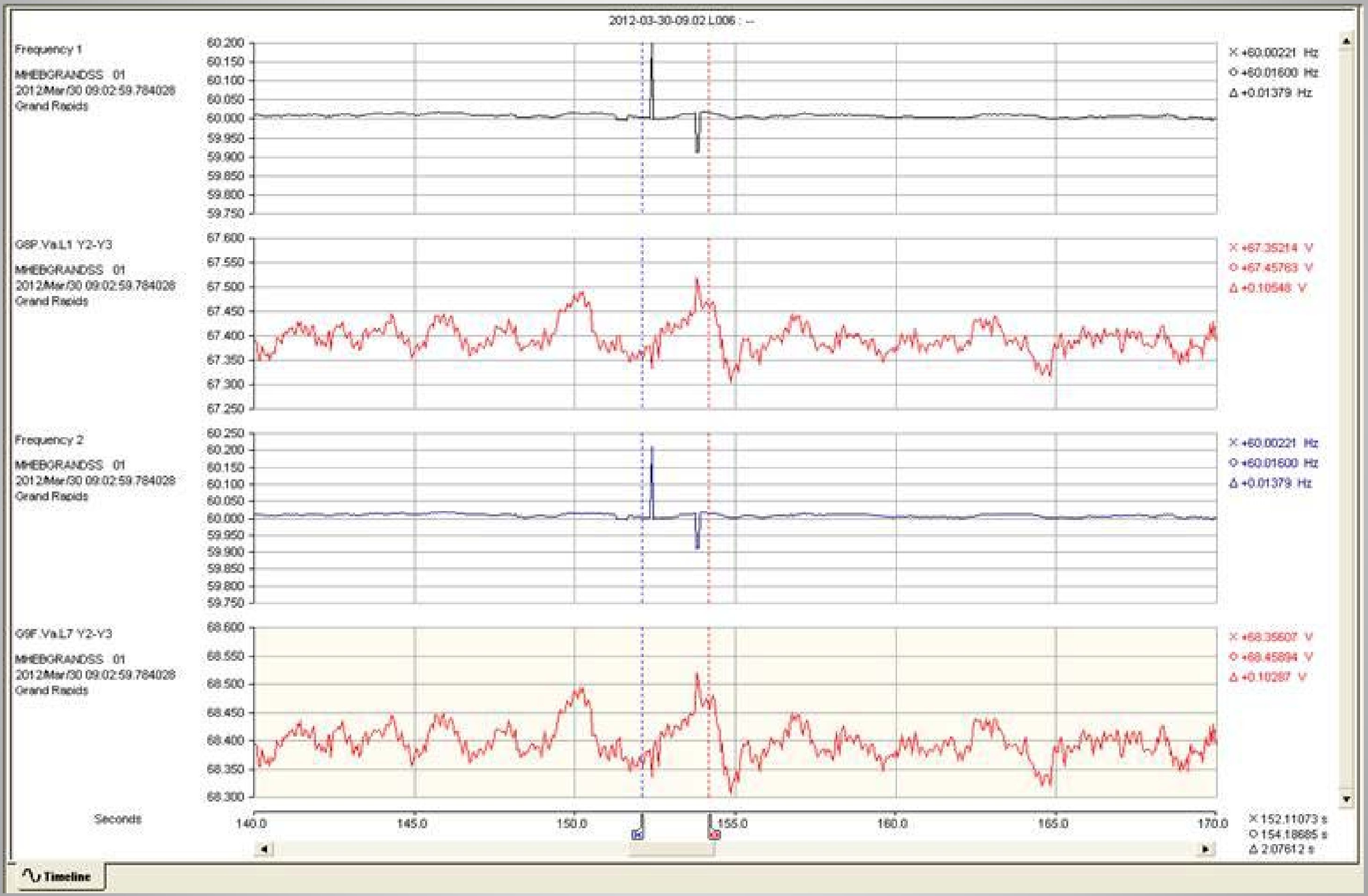
No instability seen

Here: the POD output was >threshold





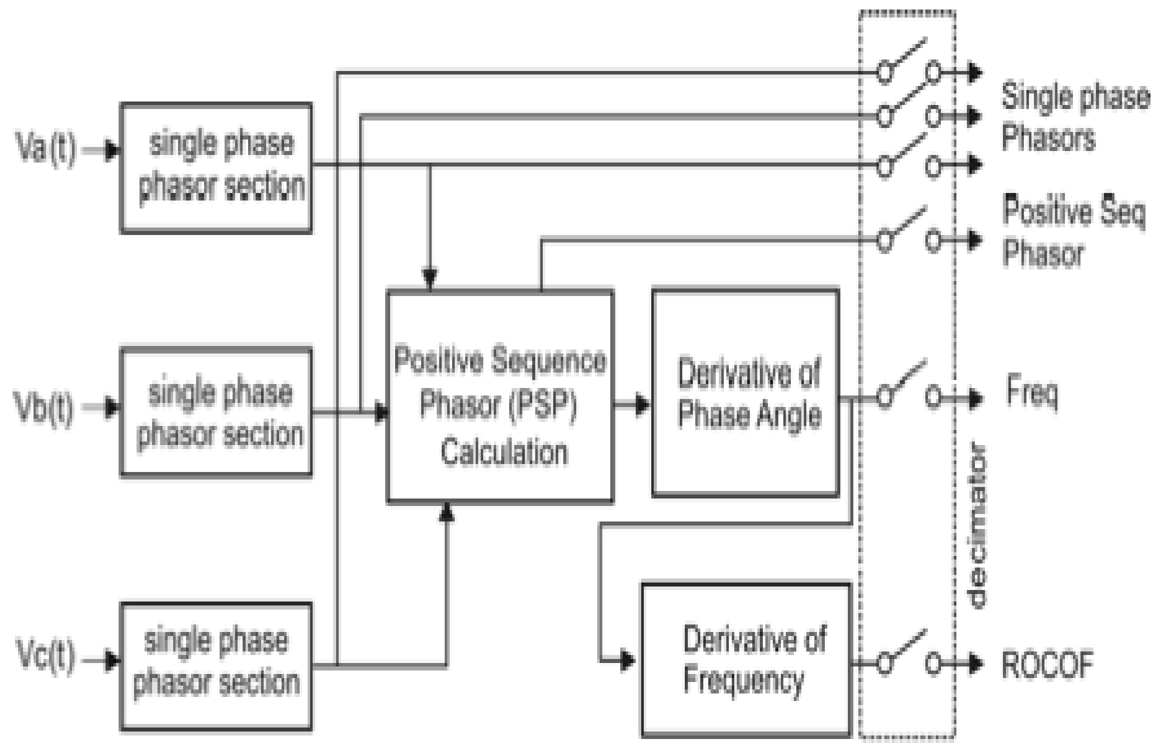
Frequency Anomalies at PMU



Manitoba Hydro

Frequency Estimation and Filters….

C.4 Positive sequence, frequency, and ROCOF



$$\Delta F(i) = \{6[\theta(i)-\theta(i-1)] + 3[\theta(i-1)-\theta(i-2)] + [\theta(i-2)-\theta(i-3)]\}/[20\pi \times \Delta t] \quad \text{(C.3)}$$

$$DF(i) = [\Delta F(i) - \Delta F(i-1)]/\Delta t$$

Challenges and lessons learned

- Other lessons or insights about
  - Frequency issues filtering solutions
  - Communications – resolve test results
  - Physical or cyber-security? Presently treating the same as EMS SCADA data through MISO WAN but do not know if this is problem in the future

- Research needs – Improved EMS State estimation is in the future. We do not expect to be into the control room until operators are comfortable with other real time tools (time frame 3-5 years).

Manitoba Hydro

Next Steps

- Next steps are evaluating the benefits and metrics to look at our return on our investment. PSTT sub task team is looking into this area.

Thank You

Any questions??