PMU Signal Validation – Needs and Ongoing Efforts

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WECC RC

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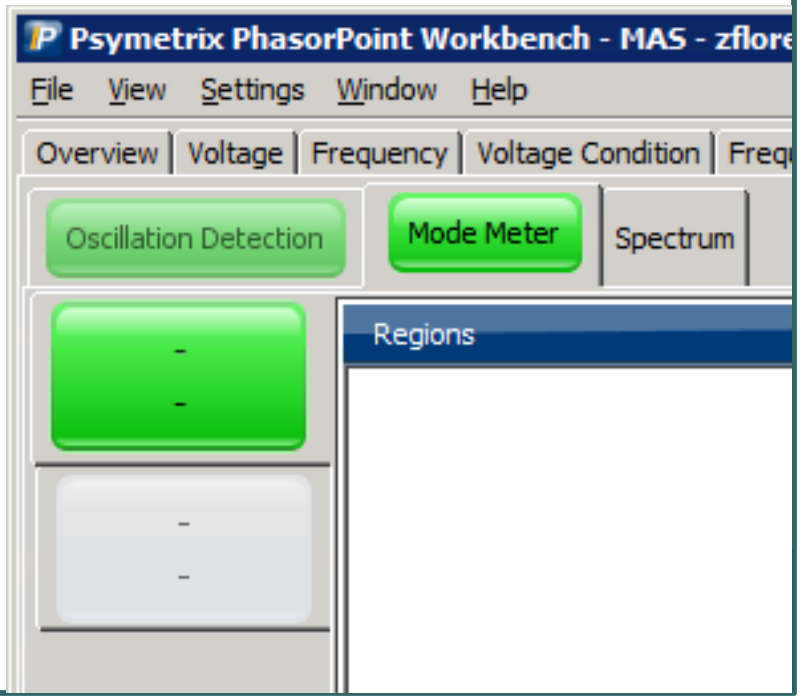
NASPI

Today's Objective

- Discuss the need for PMU data validation;
- Provide some real-life examples of bad data and what is being done to make it usable in operations; and
- Describe methods being used to measure signal quality

Quality Data Need

- Data must be reliable and available prior to operating staff trust and accept
- Applications are dependent on “good data”
  - o Oscillation Detection
  - o Mode Meter
  - o Voltage Stability Analysis
  - o State Estimator

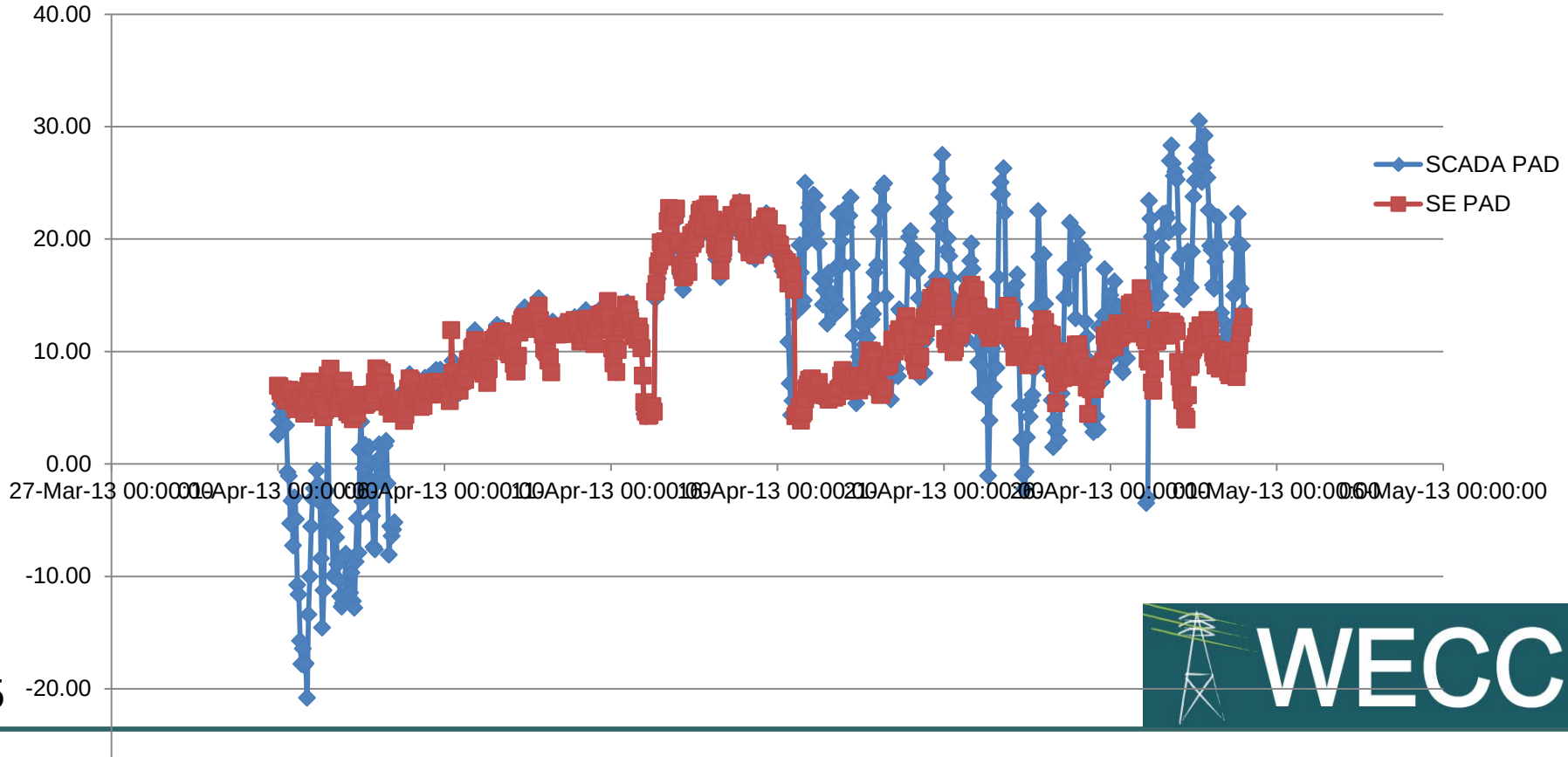


WECC RC Phasors

- RC collaborates with entities to set-up
- Nearly 1,000 phasors ready for evaluation
  - o From 15 entities
- RC analyzes each phasor

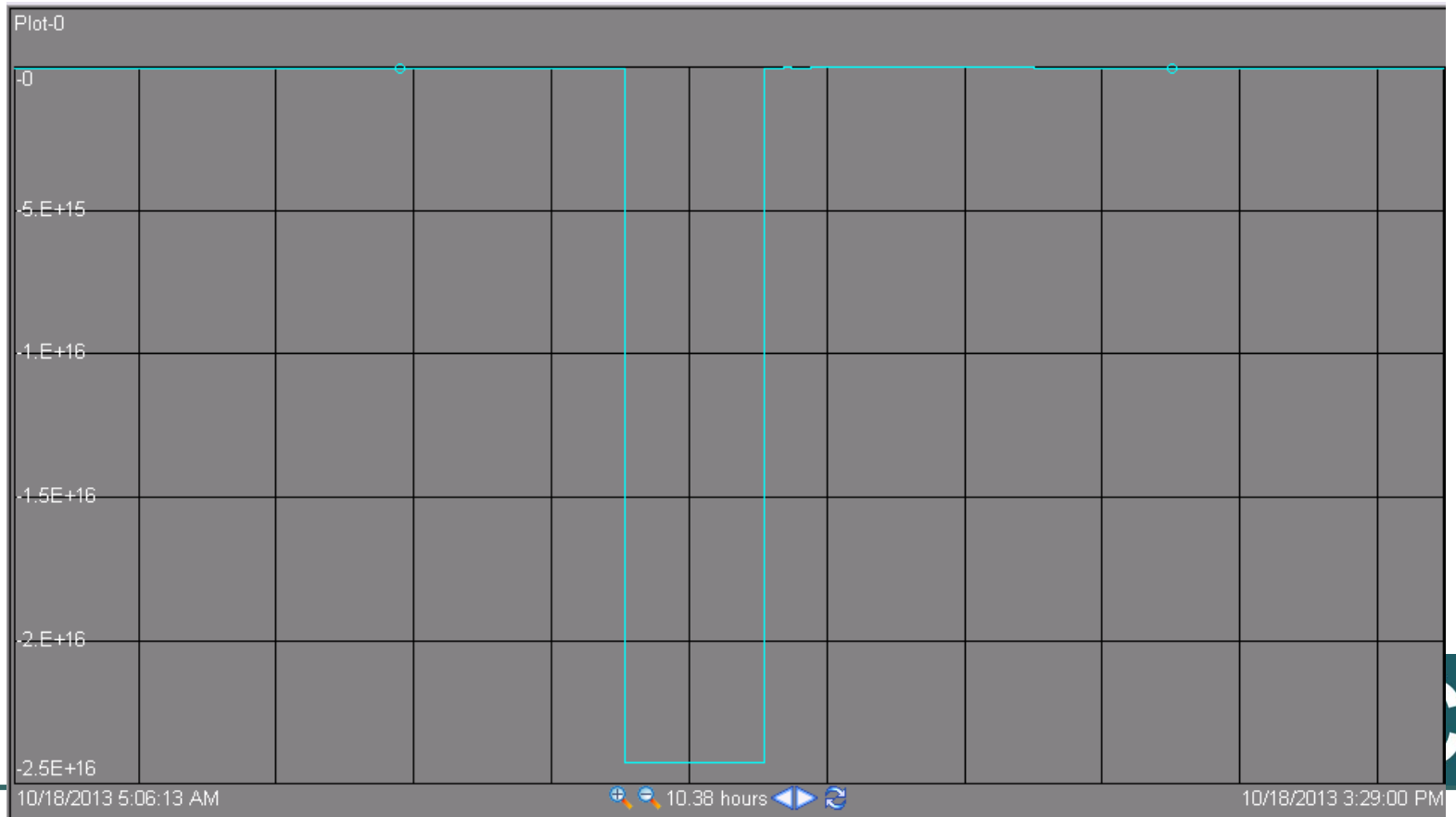
State Estimator Example

- Angle integration provides a much more consistent angle solution



State Estimator Example

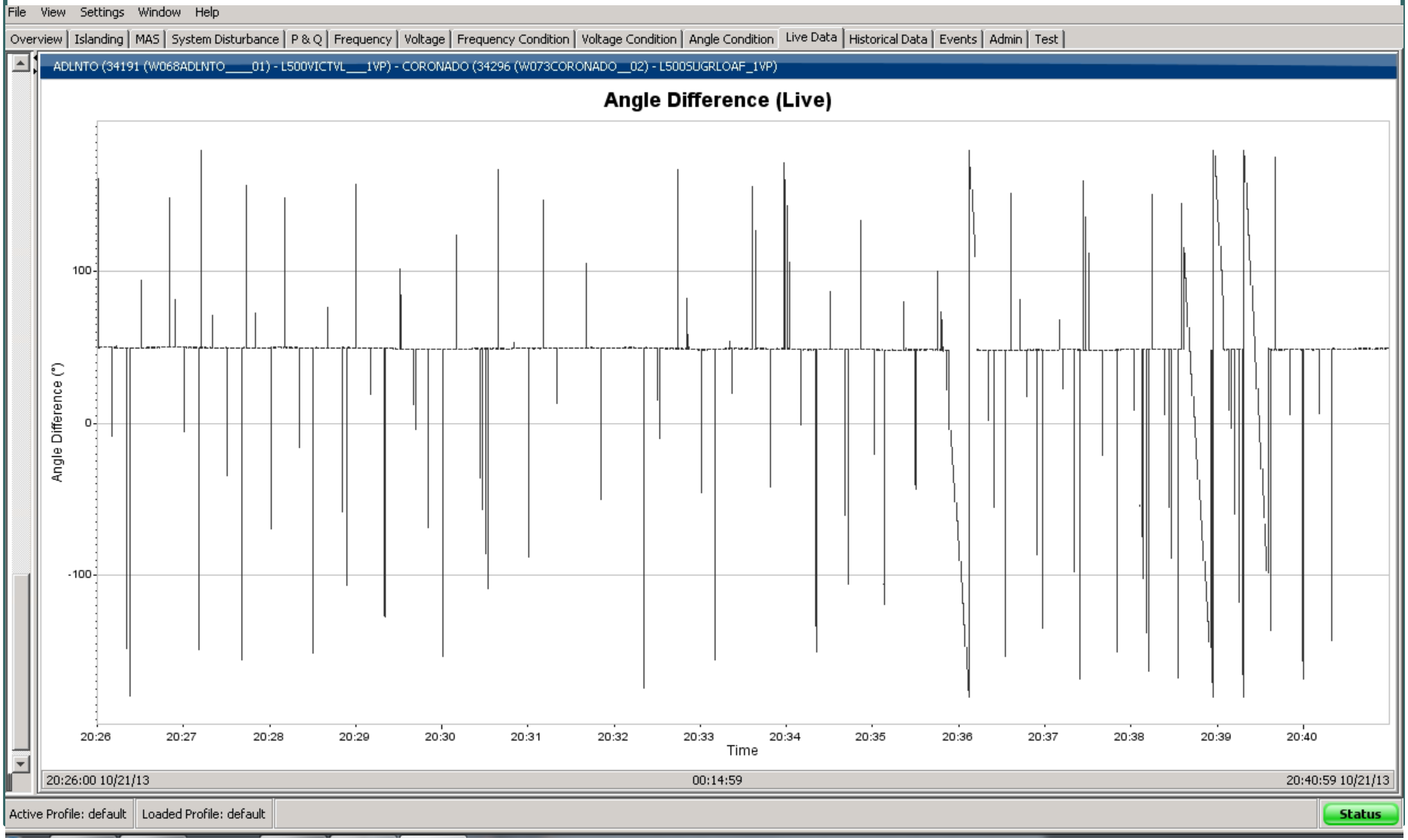
- Angle measurements need application level validation through reasonability checks



Systems in PMU set-up

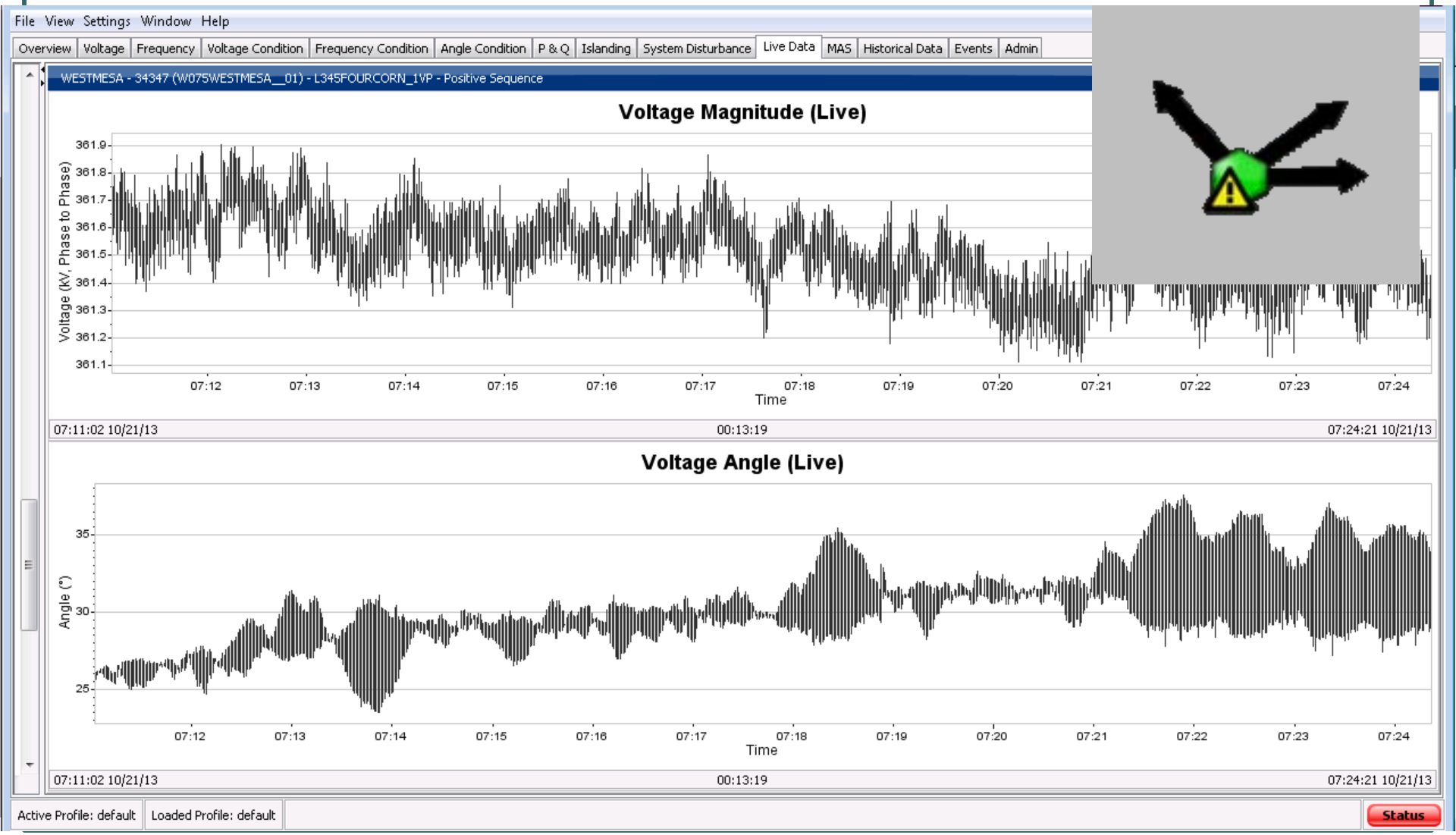
- There are five general types of systems involved in data transfer:
  - o Measurement units (PMUs);
  - o Signal collection units (PDCs);
  - o PMU data analysis and display (VSA, WAV, PP, eTV);
  - o Network infrastructure (WAN); and
  - o Data archive and configuration (PI, Registry).

Data Error Examples - Spikes



Data Error Examples – Missing Frames

Data Error Examples – Angle Error



Collaborations

- The setup process involves these roles:
  - Entity participant users;
  - Modeling engineers;
  - Application Support engineers (ASE);
  - EMS support engineers; and
  - Harris Corporation network engineers (WAN connectivity).

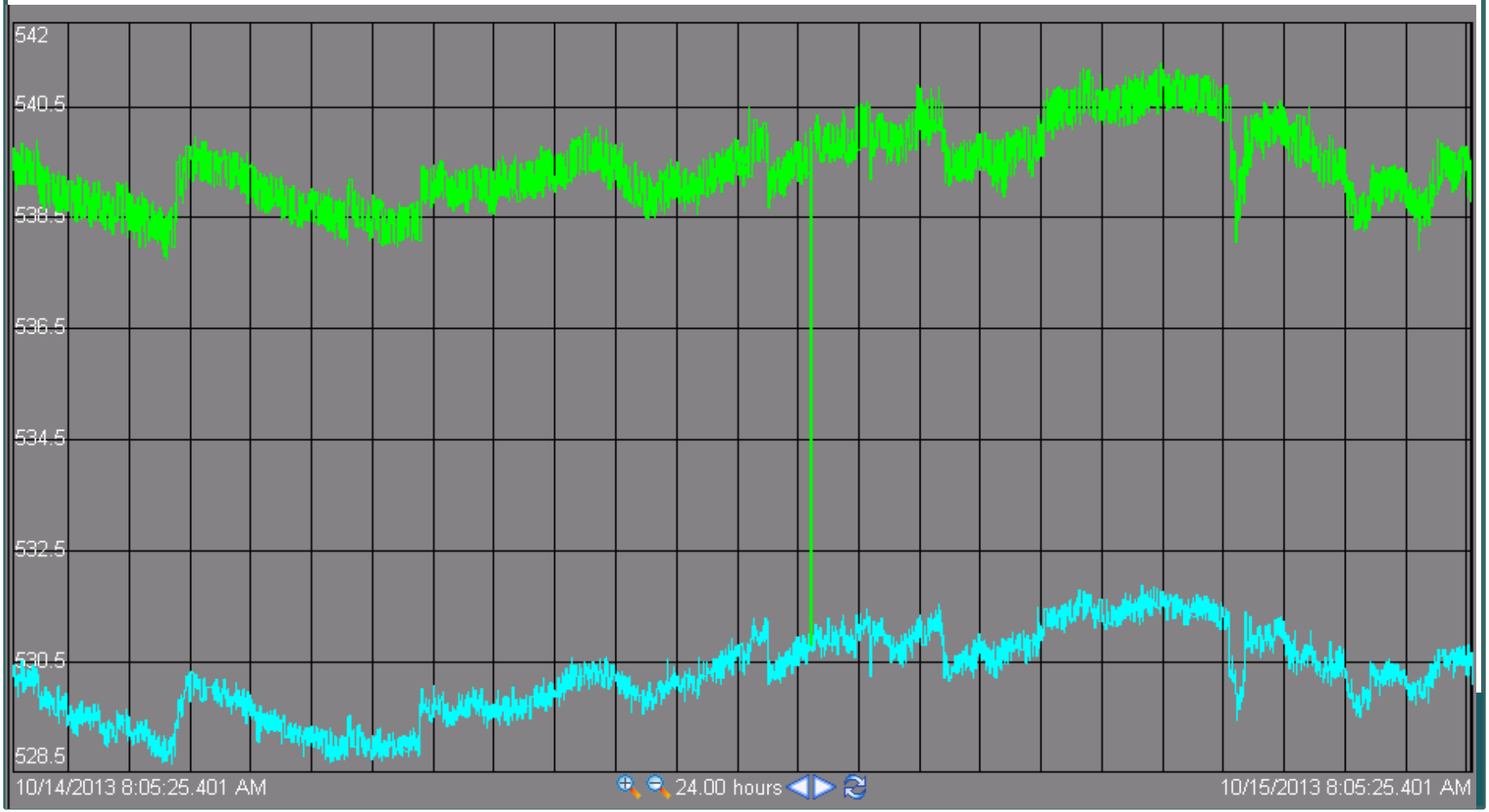
Phasor Validation

- First validation test includes:
  - o Naming Convention
  - o Latency
  - o Missing Frames
  - o Positive Sequence
  - o No analog or digital signals
  - o Flat line
  - o Spikes

Phasor Validation

- Reasonability Check
  - o Phasors are polar
  - o Voltages are volts
  - o Currents are amps
- Second validation test includes:
  - o Names align with actual equipment being metered
  - o Within a tolerance of SCADA or SE values
  - o Angles align with interconnection

SCADA vs PMU


542
540.5
538.5
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532.5
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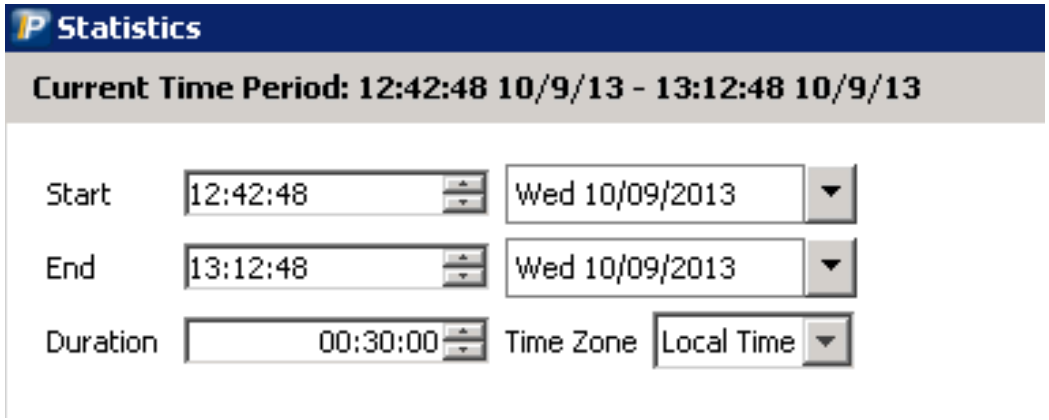
10/14/2013 8:05:25.401 AM
24.00 hours
10/15/2013 8:05:25.401 AM

Data Validation Tools

- PhasorPoint



ID	Name	%Available	%GPS Locked	%Data Valid
34401	W017HALLEN____06	100	100	100
34283	W030CRANBROK__01	100	100	100
34442	W030DUNSMUIR__01	100	100	99.998
34284	W030INGLEDOW__01	100	100	99.998
34286	W030MICA_____01	100	100	100
34440	W030MINETTE___01	100	100	0
34287	W030NICOLA____01	100	100	0
34288	W030REVELSTK__01	100	100	100

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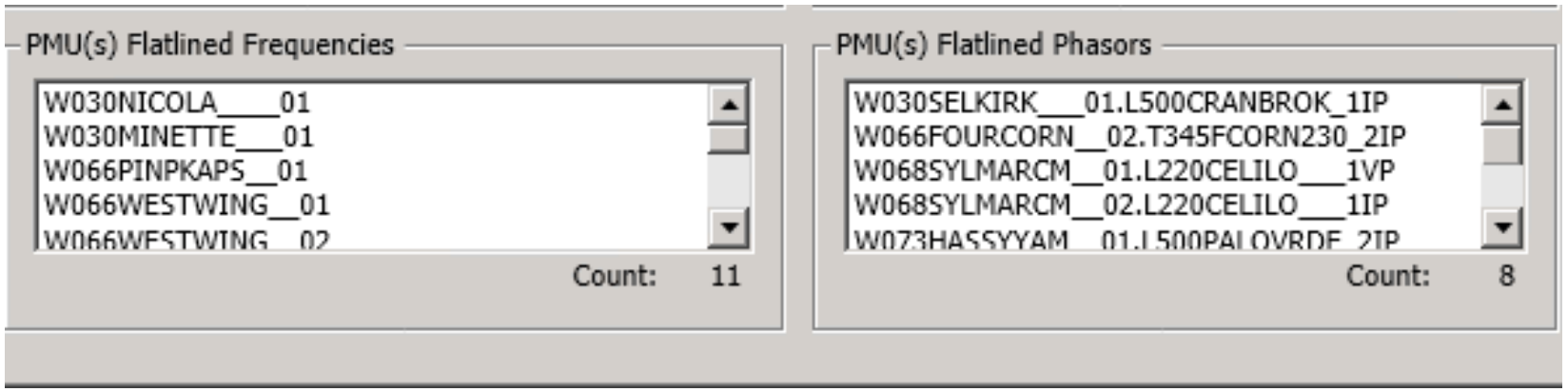
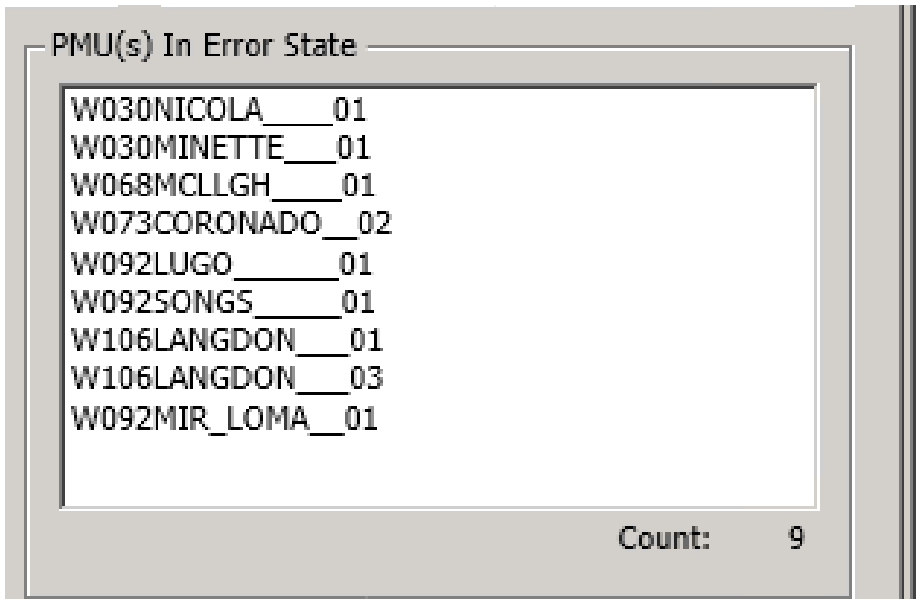
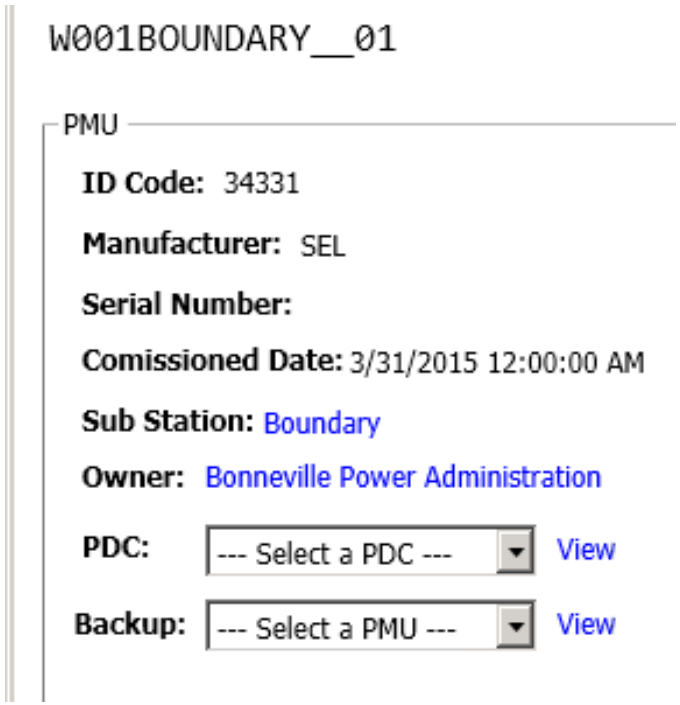
PDC Data Dashboard





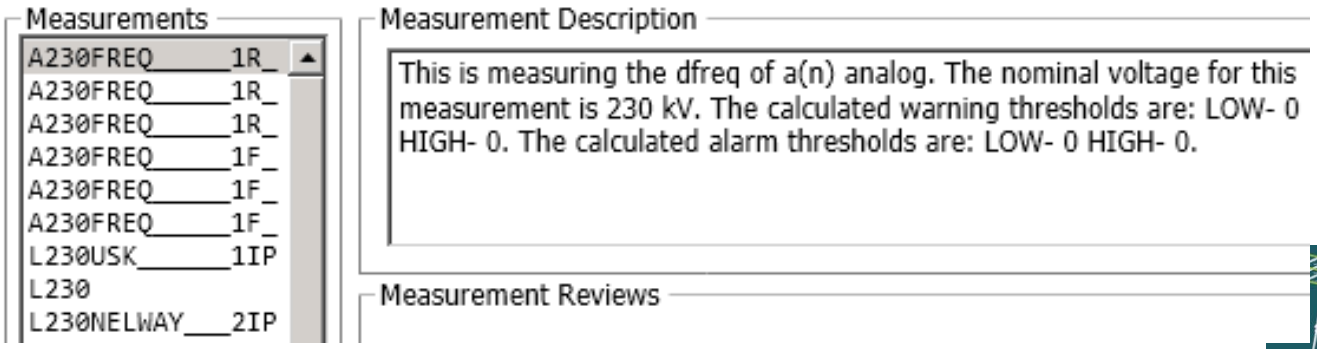
- Disconnected PDCs
- Flatlined signals
- PMUs in Error State

PDC Data Dashboard

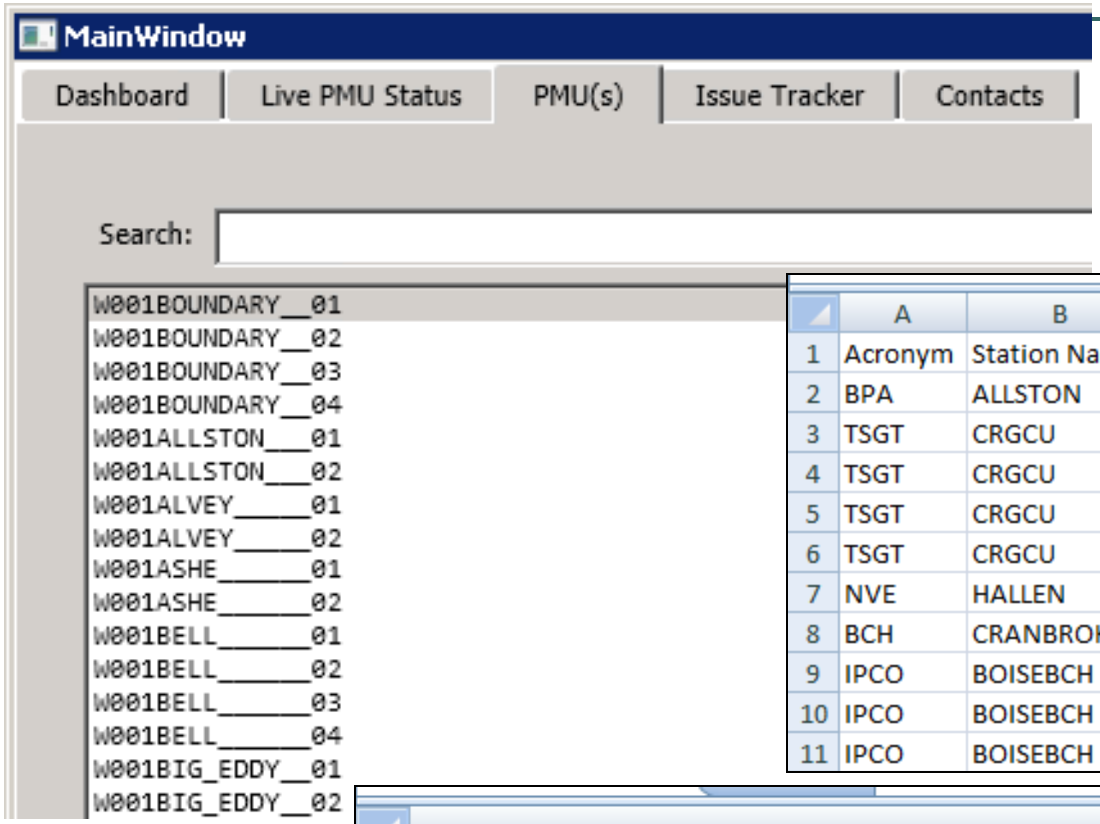


Individual PMU details include:

- Manufacturer
- Signals
- Owner
- Substation



PDC Data Dashboard



- Export csv

	A	B	C	D
1	Acronym	Station Name	PMU Name	Signal Name
2	BPA	ALLSTON	W001ALLSTON___01	A500FREQ_____1R_
3	TSGT	CRGCU	W010CRGCU_____01	A345FREQ_____1R_
4	TSGT	CRGCU	W010CRGCU_____01	A345FREQ_____1F_
5	TSGT	CRGCU	W010CRGCU_____01	L345AULT_____1IP
6	TSGT	CRGCU	W010CRGCU_____01	L345AULT_____1VP
7	NVE	HALLEN	W017HALLEN____01	A500FREQ_____1R_
8	BCH	CRANBROK	W030CRANBROK__01	A500FREQ_____1R_
9	IPCO	BOISEBCH	W034BOISEBCH__01	A230FREQ_____1F_
10	IPCO	BOISEBCH	W034BOISEBCH__01	A230FREQ_____1R_
11	IPCO	BOISEBCH	W034BOISEBCH__01	B230BUS______1VP

	A
1	10/9/2013 11:44:03 PM - [Error] - W001JOHN_DAY__03.B500EAST_____1VP could not be found in the registry
2	10/9/2013 11:44:03 PM - [Error] - W001JOHN_DAY__03.B500WEST_____1VP could not be found in the registry
3	10/9/2013 11:44:04 PM - [Error] - W001MALIN_____03.L500CAPTjACK_1IP could not be found in the registry
4	10/9/2013 11:44:04 PM - [Error] - W001MARION____03.L500ASHE_____2IP could not be found in the registry

Excel and PI

- Calculates statistics only on application signals
  - o Phase Angle Difference monitoring, Mode Meter, and VSA

Bad Phasor Point Data Statistics- 30 Days Sampling

Based on below filter angle and non-numerical values.

180 Click F9 to Recalculate When Data Have been Modified or CLICK Autocalculate bu

-180

SUBSTN	Bad Points	% Bad Points
AULT	457	5.3
COLSTRIP	3748	43.4
CUSTER	45	0.5
HALLEN	64	0.7
HASSYYAM	783	9.1
INTMTN	46	0.5
LANGDON	3534	40.9
MALIN	45	0.5
MIDPOINT	48	0.6
MIGUEL	45	0.5

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VBA and PI with Excel Interface

- Utilizes VBA to run multiple loops through both Phasor and EMS PI historians

ICCP Tag Name
SUBSTN.NICOLA.ZBR.MICA_NIC__19Z2.MEA.KV
PMU Tag Name
W030NICOLA____01.L500MICA_____1VP.M
ICCP Total Points
1352
PMU Total Points
2583315
ICCP Expected Points
PMU Expected Points
% Good PMU Performance
% PMU Error Performance

PMU Error Data				
PMU Error Duration (s)	PMU Error Value	PMU Total Errors	PMU Error Start Time	PMU Error Cleared Time
	I/O Timeout		9/5/2013 16:32	9/26/2013 9:22
	I/O Timeout		9/26/2013 9:22	9/29/2013 0:57

ICCP Deviation Data		PMU Deviation Data		
ICCP Time	ICCP Value (KV)	PMU Deviation Time	PMU Deviation Value (KV)	PMU Total Deviations

Challenges

- The massive amount of data and the collaboration involved requires new tools and processes
- Send results to entities
  - Verify results on their end
  - Work together to correct issues
- What is “good data”?
  - What values should be used for tolerances?

Questions?

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