Phasor Data Accuracy Validation

Simple, repeatable, techniques to test general accuracy of phasor values.

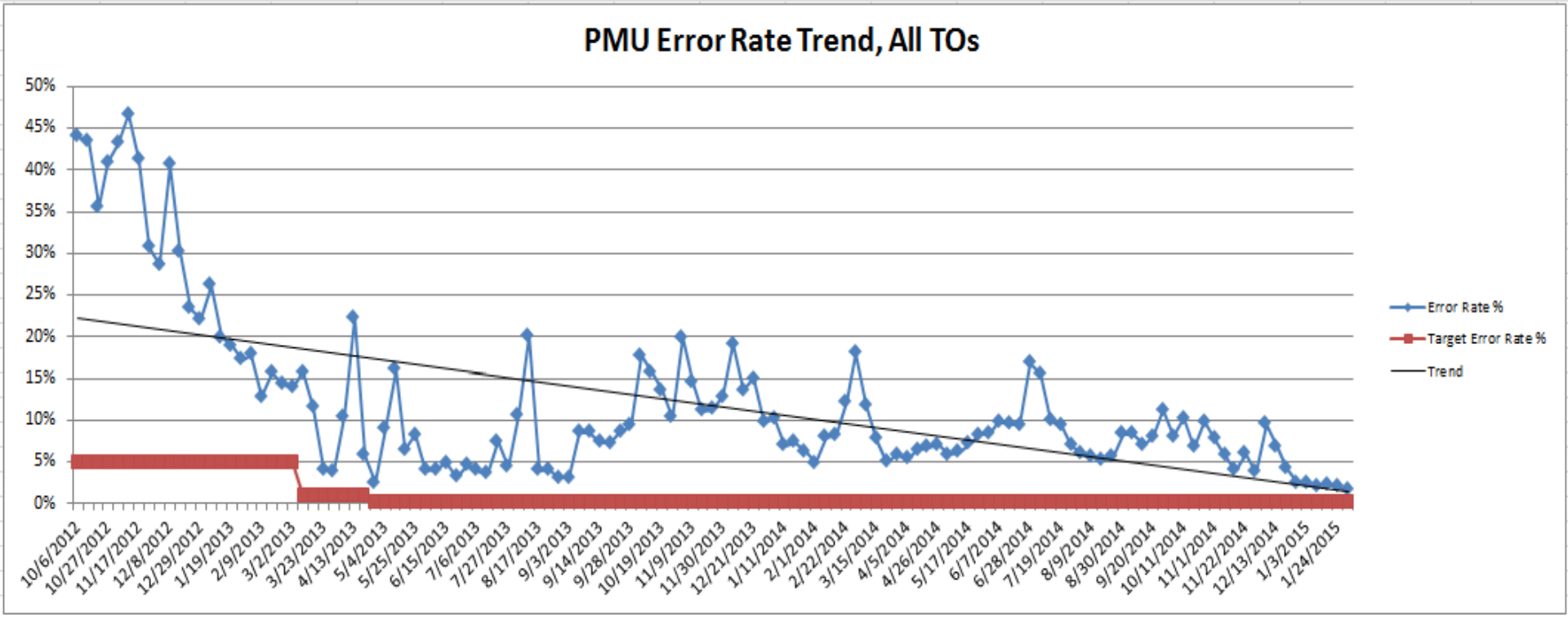
All PJM reporting and statistics to-date are based on the C37 stat word, the time stamp, or the actual TCP/IP packets (arriving late, not at all, etc.).

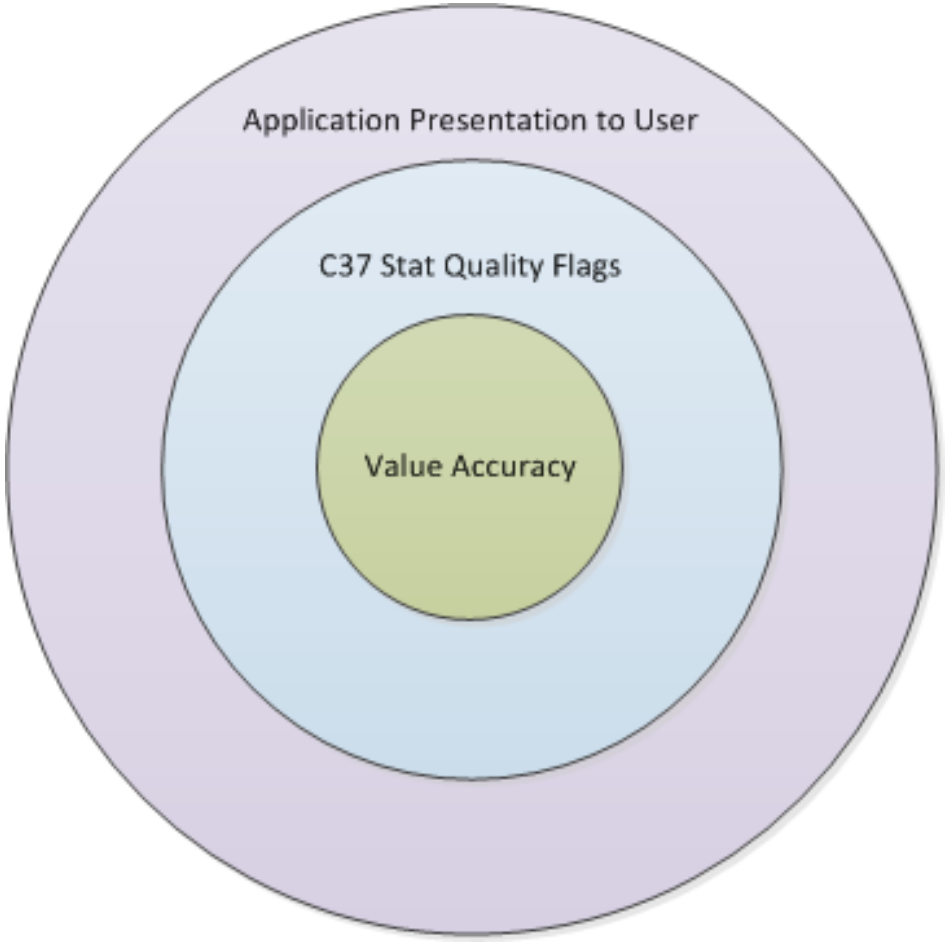
This does not directly address data value accuracy. Inaccuracy in the absence of data validation may only manifest when attempts to use the data fails.

Quality Reporting

TO	Total Error %	Drop Error %	Data Invalid %	Transm. Error %	Synch Error %	Time Error %	Cross-TO Error %	Average Latency	Min. Latency	Max. Latency
COMPANY A	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	65	0	3098
COMPANY B	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	93	84	3099
COMPANY C	0.02%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	127	76	3100
COMPANY D	0.04%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	160	94	2511
COMPANY E	0.06%	0.03%	0.01%	0.00%	0.01%	0.02%	0.00%	262	77	3100
COMPANY F	0.27%	0.02%	0.08%	0.16%	0.00%	0.00%	0.00%	352	307	3065
COMPANY G	0.32%	0.02%	0.28%	0.00%	0.02%	0.00%	0.00%	123	104	3092
COMPANY H	0.61%	0.01%	0.60%	0.00%	0.00%	0.00%	0.00%	198	70	2408
COMPANY I	0.63%	0.38%	0.23%	0.00%	0.02%	0.00%	0.00%	117	89	3098
COMPANY J	2.92%	2.00%	0.00%	0.04%	0.88%	0.00%	0.00%	1004	233	3100
COMPANY K	5.23%	0.04%	5.06%	0.00%	0.13%	0.00%	0.00%	1327	197	3100
COMPANY L	24.58%	0.02%	24.52%	0.00%	0.04%	0.00%	0.00%	1022	17	3100
COMPANY M	99.82%	65.19%	0.04%	0.09%	0.00%	34.51%	0.00%	2477	1000	3100

Quality Reporting

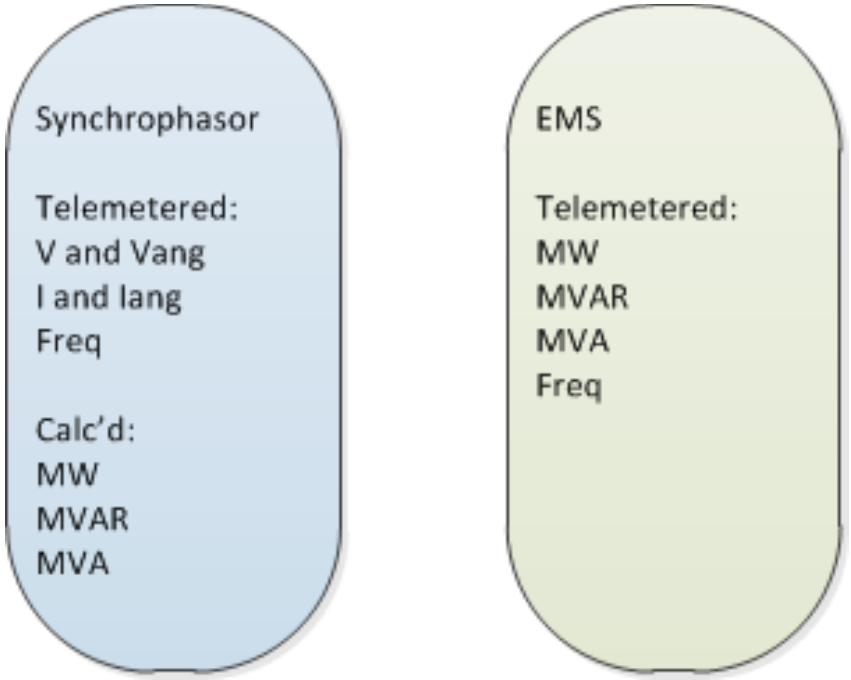



Application Presentation to User
C37 Stat Quality Flags
Value Accuracy

- EMS data is “trusted” because it “works”.
- Phasor data is “suspect” because it is “unproven”.

- EMS data value accuracy is questioned when the EMS State Estimator fails.
- Starting very recently, synchrophasor data value accuracy also will be questioned when the Synchrophasor State Estimator fails.
- But in order for Synchrophasor State Estimator to solve initially, phasor data must meet some *pre-state-estimation minimum quality threshold*.

To achieve *pre-state-estimation minimum quality threshold*, use common sense comparisons of phasor data values to something trusted – EMS.



Check Voltage and Current Levels Against EMS

Compare:

1. Synchrophasor freq, V and I magnitude w/ EMS freq, V and I magnitude
2. Synchrophasor-derived MW, MVAR, VA w/ EMS telemetered MW, MVAR, VA:

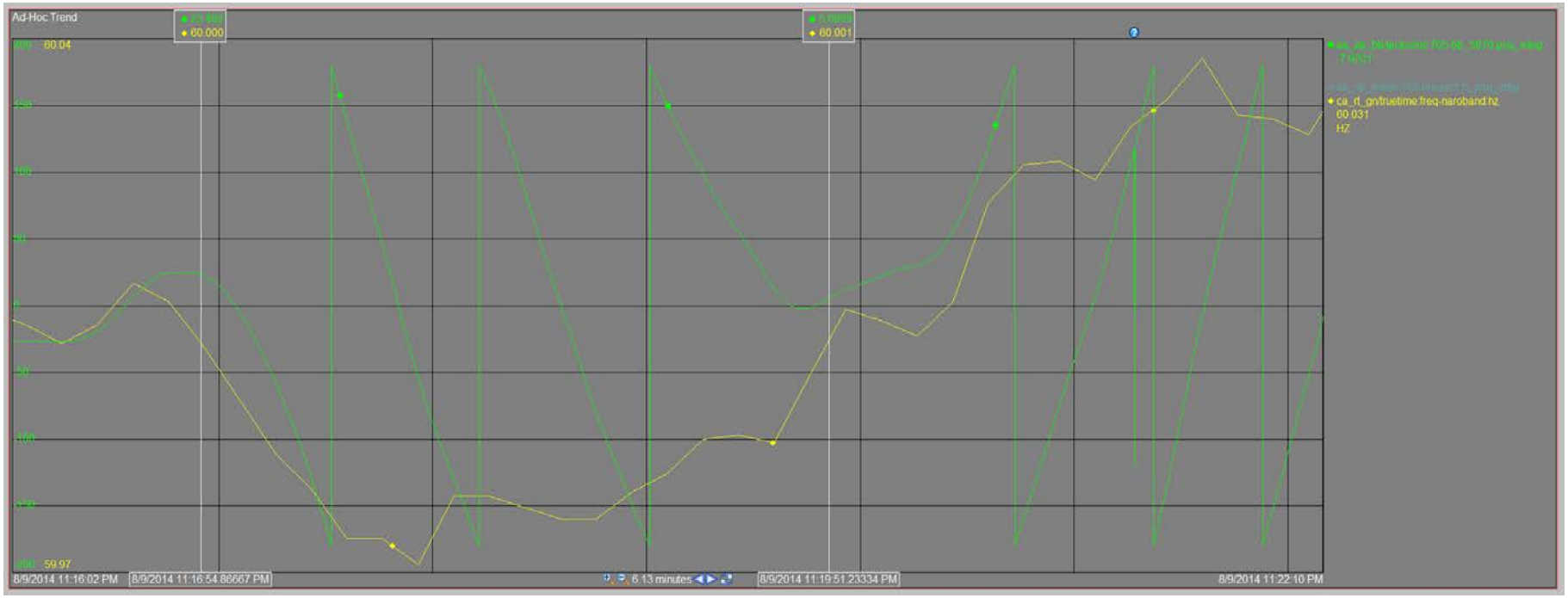
$$S = 3 * V_{(\text{line to neutral})} * I_{(\text{line})}$$

$$MW = S * \cos(V_{ang} - I_{ang})$$

$$MVAR = S * \sin(V_{ang} - I_{ang})$$

Compare Voltage Phase Angle w/ System Frequency

EMS and Synchrophasor 60HZ should align w/ (dθ/dt = 0) events.

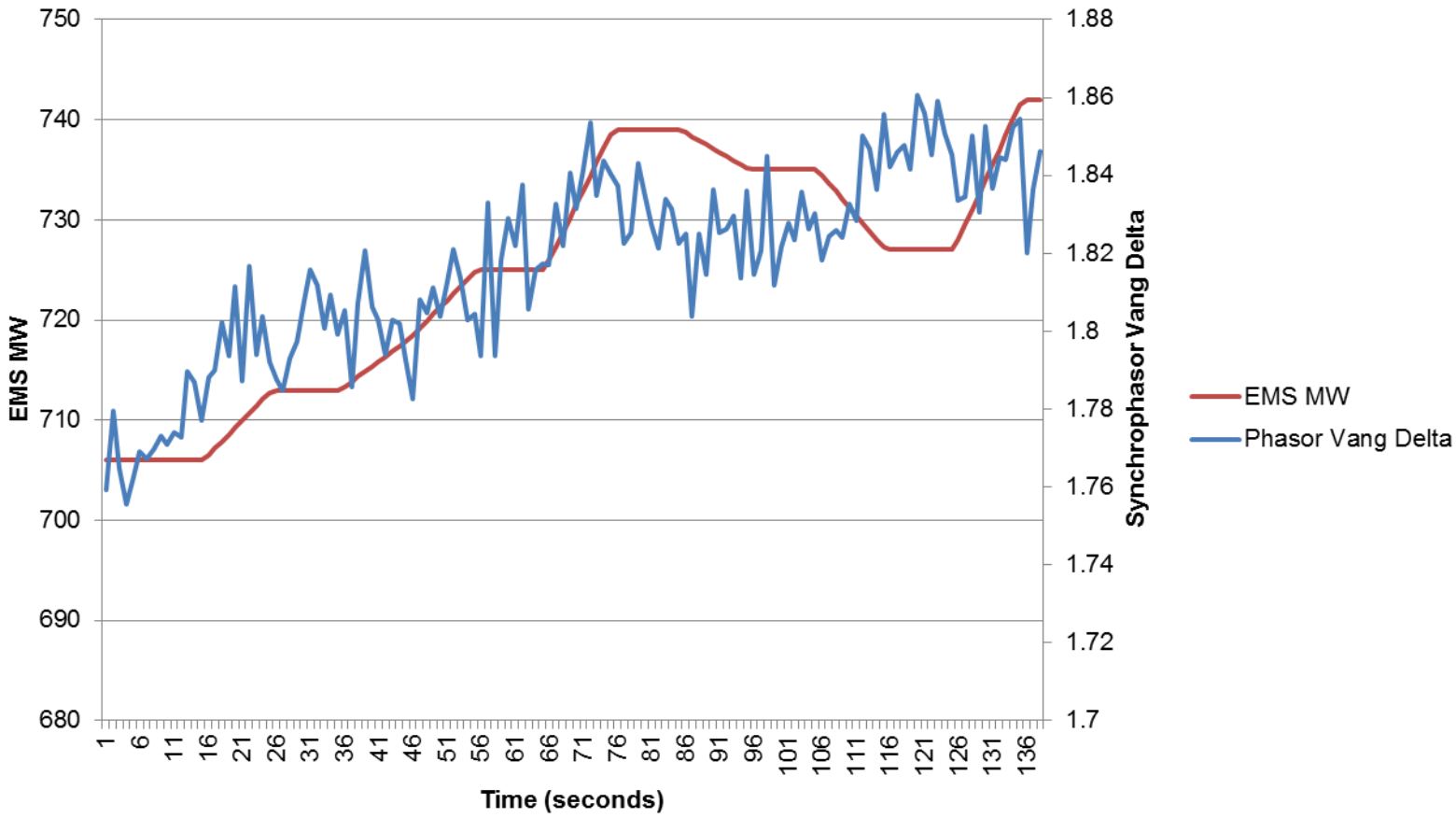


Voltage angle difference will increase with:

- MW flow increase
- Reduced line capacity

So if the MWs stays the same, but the voltage angle increases, something bad might have just happened to the line.

For data validation though, we should see *MW and voltage angle delta trend together* typically.


750
740
730
720
710
700
690
680
EMS MW
1.88
1.86
1.84
1.82
1.8
1.78
1.76
1.74
1.72
1.7
Synchrophasor Vang Delta
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96 101 106 111 116 121 126 131 136
Time (seconds)
EMS MW
Phasor Vang Delta

- Correct mapping of phasor measurement point to an EMS-model location.
  - PMU registry accuracy
  - Consistency across all systems (EMS, PI, phasor apps, SQL, etc.)
- Datalink-level and data-level monitoring and alarming (w/ PI).
- Troubleshooting data accuracy problems that are short-duration and intermittent.

- Handling planned outages for PMU/PDC.
  - Fair and accurate reporting
  - Impact on SE
- Maximize robustness via redundancy optimization:
  - MPLS circuit redundancy
  - PDC redundancy (dual-primary/clusters/backups)
  - Redundant control centers (dual-primary/DR)

- Intermediary stop points in the data chain where the data might be:
  - Massaged
  - Corrected
  - Normalized
  - filled-in for missing values
    (good intentions can make troubleshooting much more difficult)