

ERCOT Synchrophasor Data Quality Study

Bill Blevins, ERCOT
Prashant Palayam, EPG
David Bogen, ONCOR
Carlos J Casablanca, AEP
Bill Bojorquez, Sharyland

March 11th 2014
NASPI



DATA QUALITY STUDY - OUTLINE

- **Introduction**
- **Background**
- **Study Objective**
- **Methodology and Approach Used**
- **Observations & Locations of Likely Cause**
- **Resolution Results**
- **Benefit & Success Story**
- **Summary**



Discovery Across Texas

Regional Demonstration Grant DOE-OE-0000194

- Center for the Commercialization of Electric Technologies
 - Dr. Milton Holloway - President
- Project TO/asset owner partners
 - American Electric Power Texas – 18 locations*, 1 PDC
 - Oncor Electric Delivery - 15 locations*, 3 PDCs
 - Sharyland Utilities - 3 locations*, 1 PDC
 - Electric Reliability Council Of Texas (ERCOT) - 1 PDC, RTDMS visualization platform, ePDC data archiving, PGDA event analysis
 - Texas Tech University – Wind Science and Engineering Center – wind and battery storage performance, 4+ PMUs, 1 ePDC, RTDMS, Security Fabric Demo
- Electric Power Group – synchrophasor tools & services
- Southwest Research Institute – project management services

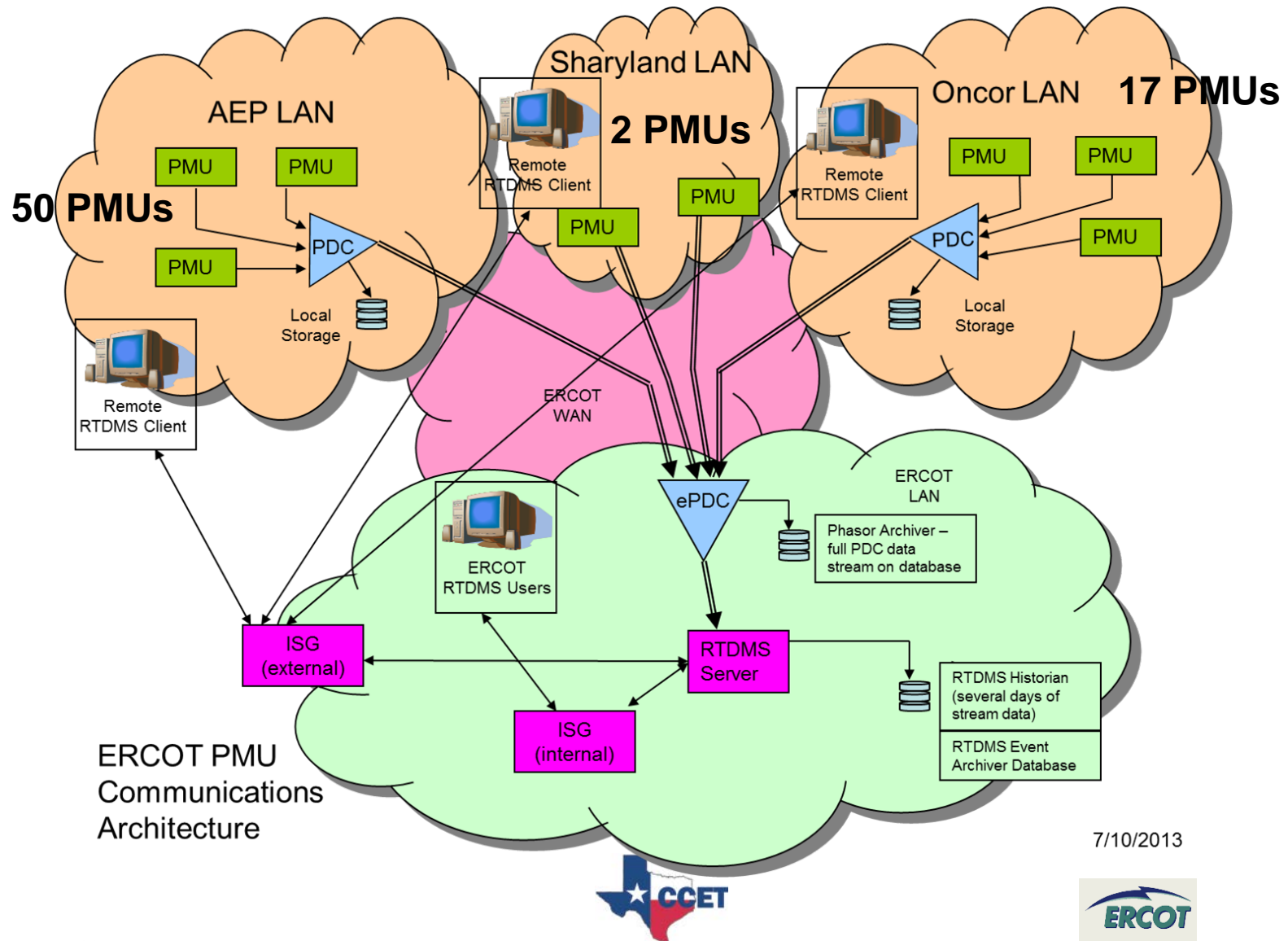
	Total Planned Locations	Committed for Cost Share
* AEP	18	4
Oncor	15	12
Sharyland	3	3
Texas Tech	5	-

INTRODUCTION

- **Three** conditions must be met for a production quality real-time phasor monitoring system at any Utility/ISO. The data must be:
 1. **Flowing reliably from PMU's to Operator's console**
 2. Valid
 3. Monitoring the critical locations (right places).
- The Data Quality Study addresses the **first condition**



BACKGROUND – ERCOT PHASOR NETWORK



DATA QUALITY STUDY - NEED

- **Operators Need:**

- **Data Consistency** – For any phasor network, data sent must be same as data received and stored in both source and destination databases
 - **Common Visualization** and wide area monitoring by ISO and their transmission owners
- Initial Data inconsistencies were observable in
 - RTDMS Reports – Data Availability less than 24 hours
 - ePDC Management Tool – Data configuration inconsistency
 - RTDMS Watch dog messages – No pinpointed root cause
 - Study was initiated to investigate root causes of data problems, identify the possible locations of data issues in phasor network, and fix the problems



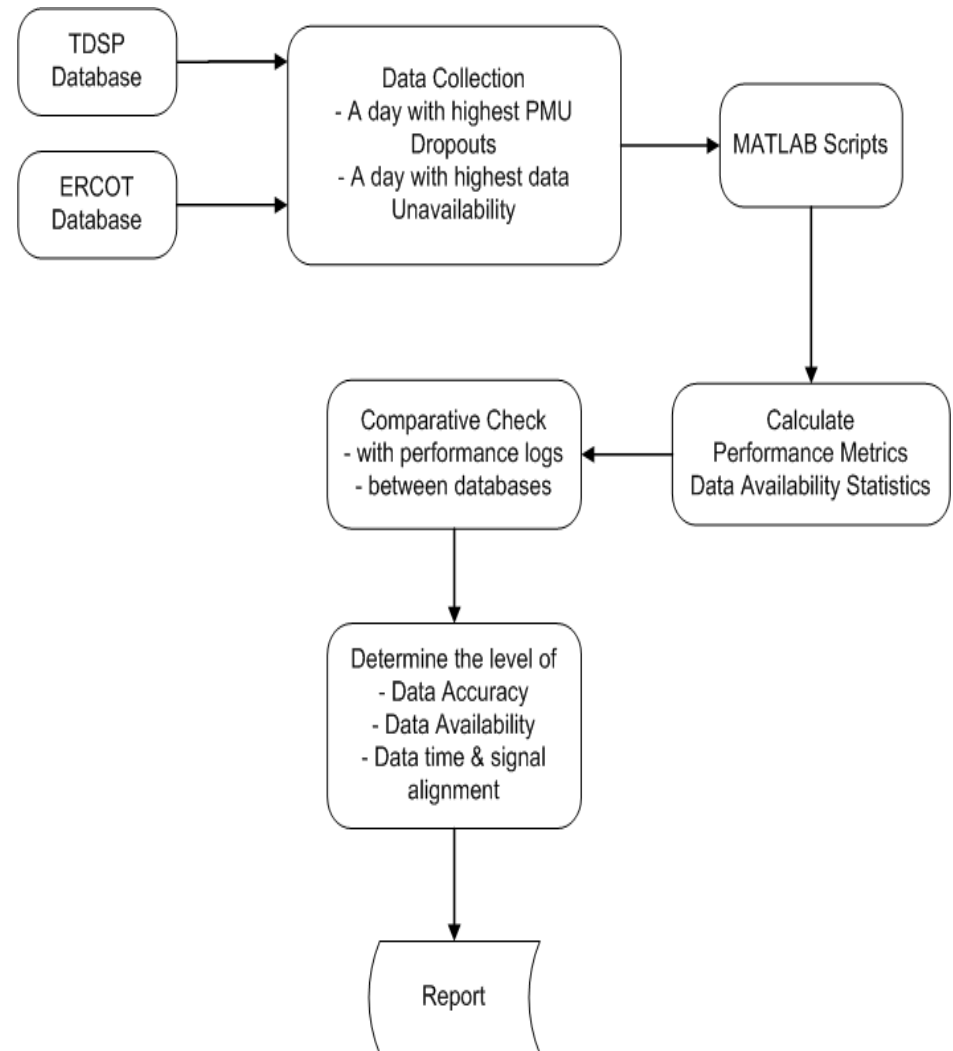
STUDY OBJECTIVE

- Achieve production quality data for real time monitoring
- Assure reliable data flow from the PMU's to operator's console
- Identify locations in phasor network affecting data availability (i.e., data dropouts, time skew, missing samples)
- Determine root causes of data quality issues at identified locations
- Propose solutions to help eliminate identified data problems



METHODOLOGY AND APPROACH

- **Collect representative data**
- **Compare data at sending and receiving end**
- **Identify differences**
- **Determine the root cause of differences**
- **Fix the problem**
- **Update the phasor system – settings, DB**



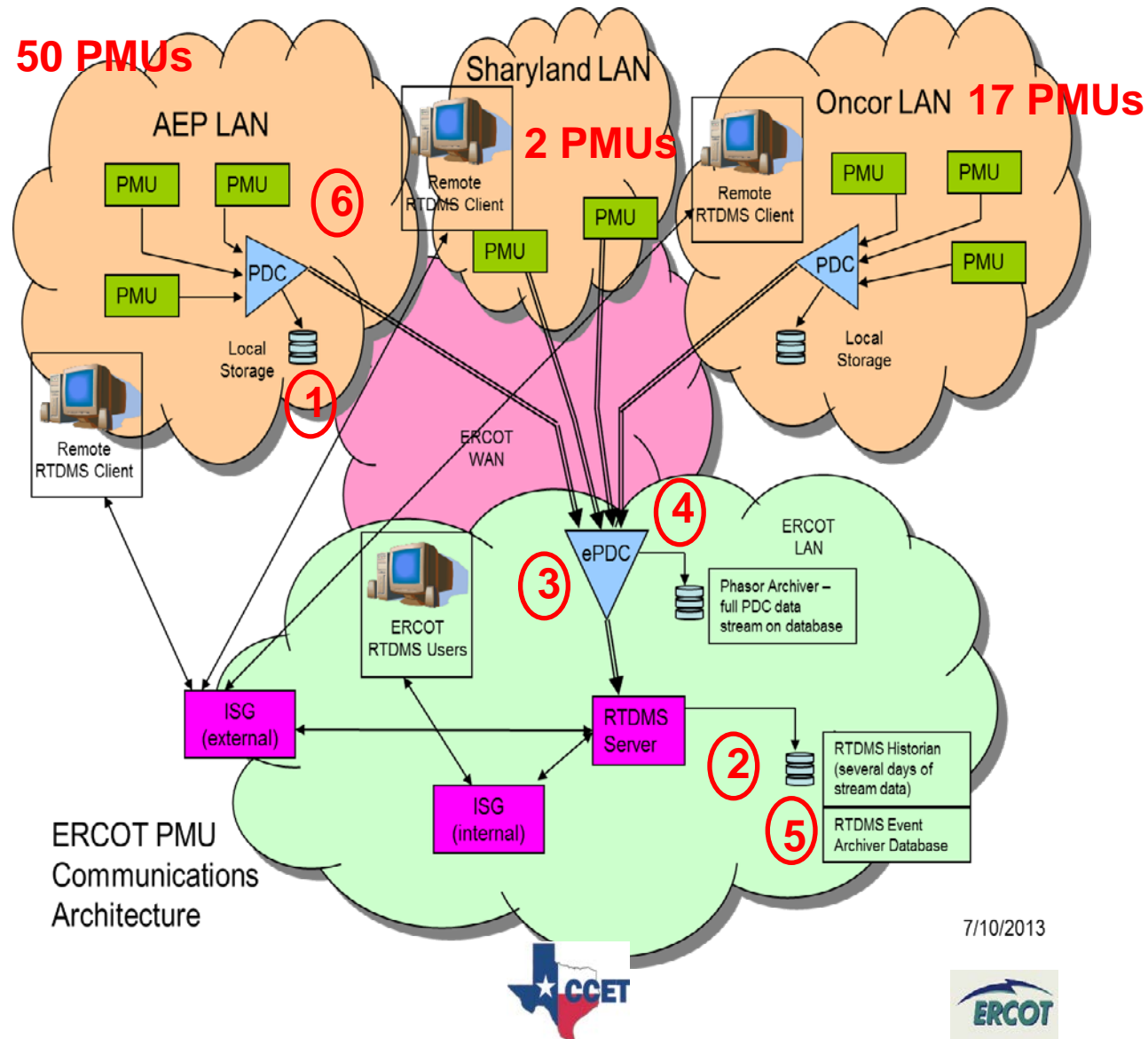
DATA PROBLEM AND SOURCE IDENTIFICATION

#	Observation	Observed in
1	Recurring Missing last second of each minute	AEP Database (DB)
2	Non-Recurring Missing samples	ERCOT DB
3	Mismatch, Missing signal headers and incorrect channel names	ERCOT DB
4	Mismatch in reported missing samples	ERCOT DB
5	Difference in data resolution	ERCOT DB
6	Data shifted in time (Time Skew)	AEP & ERCOT DB



MAPPING PROBLEMS TO LOCATIONS OF LIKELY CAUSE

#	Observation
1	Recurring Missing last second of each minute
2	Non-Recurring Missing samples
3	Mismatch, Missing signal headers and incorrect channel names
4	Mismatch in reported missing samples
5	Difference in data resolution
6	Data shifted in time (Time Skew)



RESOLUTION RESULTS

#	Observation	Root Cause	Resolution Results
1	Recurring Missing last second of each minute	Configuration/network problem	No Missing Samples
2	Non-Recurring Missing samples	Database insertion error and storage conflict	No Missing Samples
3	Mismatch, Missing signal headers and incorrect channel names	Incorrect configuration	No Difference in signal headers
4	Mismatch in reported missing samples	Progressive forward Padding	No Difference in dropouts reports
5	Difference in data resolution	Data storage (Integer vs floating point formats)	Option to store data in full resolution
6	Data shifted in time (Time Skew)	Configuration problem – Minimum Latency, Progressive forward Padding	Time Aligned data



BENEFIT AND SUCCESS STORY – ZERO MISSING SAMPLES

Date/Time 2013-01-25	PMU Signal	Good Samples	Received Samples	Missing Samples
Hour 11	LineX@FarWest9.Status	106200	106200	1800
Hour 11	LineX@West14.Status	106199	106200	1800
Hour 11	LineX@West14.Status	106199	106200	1800
Hour 11	LineY@West4.Status	106200	106200	1800
Hour 12	LineX@FarWest9.Status	106200	106200	1800
Hour 12	LineX@West14.Status	106200	106200	1800
Hour 12	LineX@West14.Status	106200	106200	1800
Hour 12	LineY@West4.Status	106200	106200	1800
Hour 13	LineX@FarWest9.Status	106200	106200	1800
Hour 13	LineX@West14.Status	106200	106200	1800
Hour 13	LineX@West14.Status	106200	106200	1800
Hour 13	LineY@West4.Status	106200	106200	1800

Before Resolution

Count of Missing samples

After Resolution

No Missing samples

Date/Time 2013-05-20	PMU Signal	Good Samples	Received Samples	Missing Samples
Hour 11	LineX@FarWest9.Status	108000	108000	0
Hour 11	LineX@West14.Status	108000	108000	0
Hour 11	LineX@West14.Status	108000	108000	0
Hour 11	LineY@West4.Status	107930	108000	0
Hour 12	LineX@FarWest9.Status	108000	108000	0
Hour 12	LineX@West14.Status	108000	108000	0
Hour 12	LineX@West14.Status	108000	108000	0
Hour 12	LineY@West4.Status	107939	108000	0
Hour 13	LineX@FarWest9.Status	108000	108000	0
Hour 13	LineX@West14.Status	107189	108000	0
Hour 13	LineX@West14.Status	106803	108000	0
Hour 13	LineY@West4.Status	106998	108000	0



BENEFIT AND SUCCESS STORY – 100% DATA AVAILABILITY

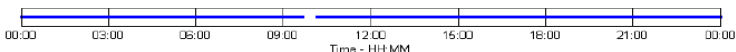
Before Resolution – Day Data Availability

DATA QUALITY

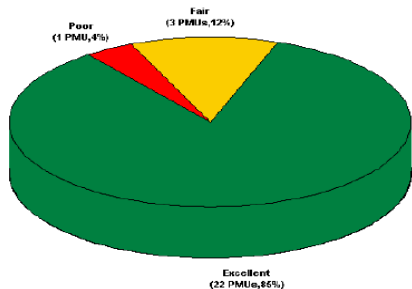
16.79 Hrs

Tuesday, April 16, 2013 (Central Daylight Time)

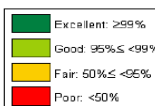
Data Availability (16.78 hours)



PMU Performance*



PMU Performance Category of Valid Data



*PMU Performance is based on Archived Data only. (PMU Performance(%) = Valid Data / Total Archived Data * 100%)

After Resolution – Day Data Availability 24 Hrs

DATA QUALITY

Sunday, August 25, 2013 (Central Daylight Time)

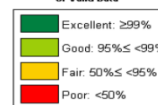
Data Availability (24.00 hours)



PMU Performance*



PMU Performance Category of Valid Data

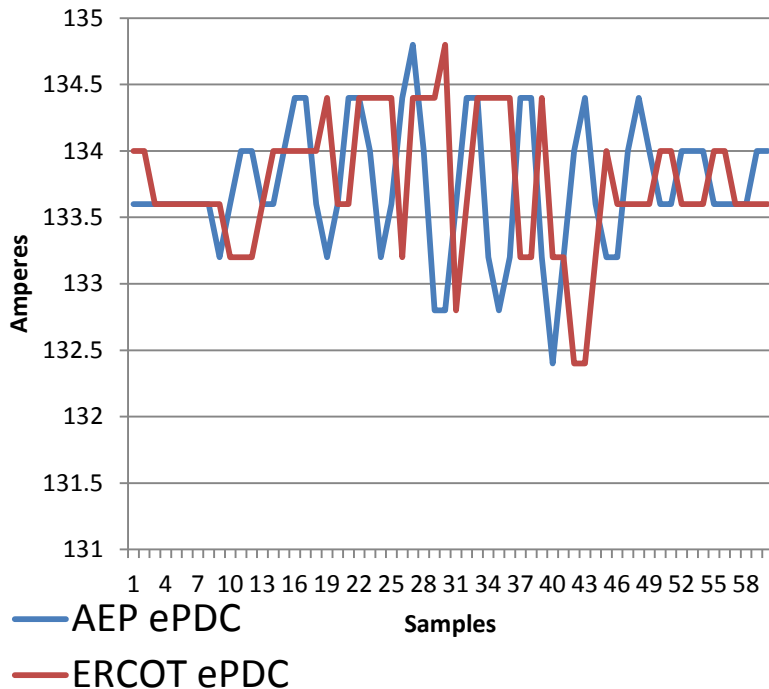


*PMU Performance is based on Archived Data only. (PMU Performance(%) = Valid Data / Total Archived Data * 100%)

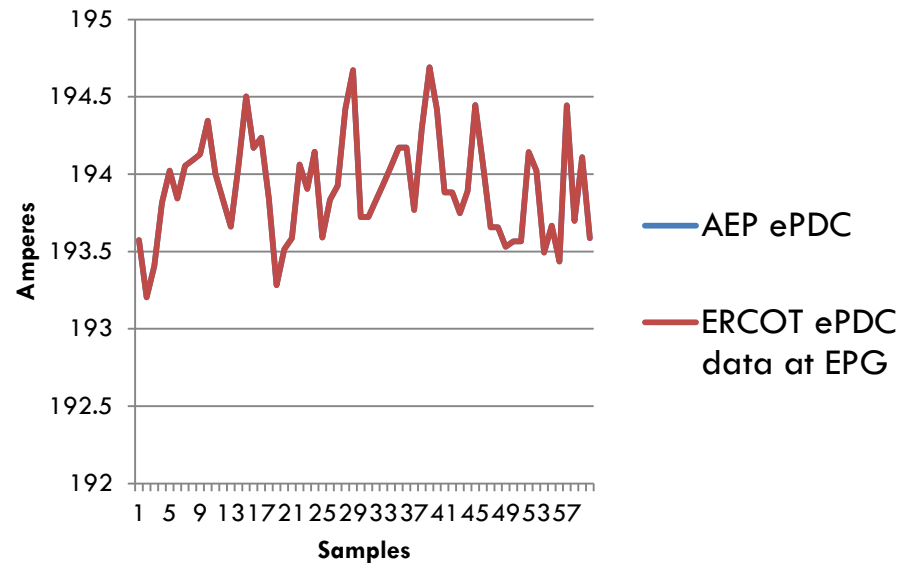


BENEFIT AND SUCCESS STORY – NO TIME SKEW

Before Resolution – Time Skew



After Resolution – No Time Skew



SUGGESTIONS

Utility/ISO with a phasor network should

- Validate the data quality and data flow – don't assume it is good
- Validate data storage on received data samples
- Check for missing samples – Received Vs. Reported
- Verify data time alignment between databases
- Verify data accuracy and sufficient resolution between databases
- Verify signal name consistency between databases
- Fix data quality issues in a timely manner
- Conduct periodic validation of data quality
- Also plan to validate the data measurements



SUMMARY

- **Three** conditions must be met for a production quality real-time phasor monitoring system at any Utility/ISO. The data must be:

1. Flowing reliably from PMU's to Operator's console

This was achieved through the Data Quality Study

2. Valid

The Baselining studies will address this **second condition!**

3. Monitoring the critical locations (right places) – Requires review of PMU Location vs Needed Observation Points for Visibility



Thank You.

Any questions ?