ERCOT Synchrophasor Communication Handbook

V1.1

July 17, 2015

Revision History

Date	Description	Version	Author(s)
03/26/2014	Original Draft	V0.01	Wei Liu
05/01/2014	Updated RTDMS client communication port	V0.02	Wei Liu
07/23/2014	Misc. update based on user comments	V0.1	Wei Liu
08/11/2014	EPG provided network connection data quality testing procedure	V1.0	Wei Liu
7/17/2015	ERCOT updated naming convention as discussed by PMTF.	V1.1	Patrick Gravois

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1 INTRODUCTION

ERCOT presently utilizes synchrophasor data for system oscillation detection, Generator Model Validation and post event analysis/reporting.

In the future, intended uses include voltage stability monitoring and other applications of synchrophasor data for grid operations.

The ERCOT Synchrophasor system is currently only installed in the Taylor control center; data redundancy is not available right now. However, ERCOT will implement a redundant system in the future.

Phasor is a quantity with magnitude and a phase angle (with respect to a reference) that is used to represent a sinusoidal signal, such as AC voltage, AC current, and AC power. In an AC power system, real power flows from a higher voltage phase angle node to a lower voltage phase angle node.

Phasor technology complements existing Supervisory Control and Data Acquisition (SCADA) systems to address the new emerging need for wide area grid monitoring and management, while continuing to use existing SCADA infrastructure for local monitoring and control. Traditional SCADA/EMS systems are based on steady state power flow analysis, and therefore cannot observe the dynamic characteristics of the power system. Phasor technology overcomes this limitation.

Phasor measurements provide time synchronized sub-second data which are ideal for real-time wide area monitoring of power system dynamics. The precise timing information of these data makes it useful outside the confines of the local substation buses where these measurements were taken. Additionally, they improve post disturbance assessment capability using high resolution time synchronized data. Phasor infrastructure is not a replacement for SCADA. The phasor infrastructure will provide some visibility should the operator primary tools fail.

The *ERCOT Synchrophasor Communication Handbook* sets practices, conventions, and fundamental parameters to guide Market Participants (MPs) to exchange streamed Synchrophasor data with ERCOT. Also, included in the Handbook is a description of the physical network infrastructure ERCOT has implemented to facilitate connections between ERCOT facilities and those of the Market Participants.

The Handbook specifies important configuration and functional requirements for Synchrophasor data link implementations so that the Market Participant's system will interoperate with ERCOT's system. Market Participants and, if applicable, their vendors will need this information to include the required features and to build the proper delivered configuration.

The *ERCOT Synchrophasor Communication Handbook* also addresses the guidelines for Phasor Measurement Units (PMUs) connecting to the ERCOT Wide Area Network (WAN). Other connections, such as VPN tunneling, are not supported by ERCOT anymore.

Specific Market Participant application requirements may drive higher requirements for some of the attributes specified in this handbook.

1.1 Glossary

Term	Definition
EMS	An Energy Management System (EMS) is a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation and/or transmission system. The monitor and control functions are known as SCADA; the optimization packages are often referred to as "advanced applications".
Synchrophasor	Synchronized phasors (synchrophasors) provide a real-time measurement of electrical quantities from across a power system. Applications include wide-area control, system model validation, determining stability margins, maximizing stable system loading, islanding detection, system-wide disturbance recording, and visualization of dynamic system response. The basic system building blocks are GPS satellite-synchronized clocks, phasor measurement units (PMUs), a phasor data concentrator (PDC), communication equipment, and visualization software.
PMU	A phasor measurement unit (PMU) is a device which measures the electrical waves on an electricity grid, using a common time source for synchronization. Time synchronization allows synchronized real-time measurements of multiple remote measurement points on the grid. In power engineering, these are also commonly referred to as synchrophasors and are considered one of the most important measuring devices in the future of power systems. A PMU can be a dedicated device, or the PMU function can be incorporated into a protective relay, digital fault recorder, or other device.
RTDMS	Real Time Dynamics Monitoring System (RTDMS) is a synchrophasor software application for providing real-time, wide-area situational awareness to Operators, Reliability Coordinators, Planners and Operating Engineers, as well as the capability to monitor and analyze the dynamics of the power system. RTDMS is developed by Electric Power Group (EPG).
PDC/ePDC	Phasor Data Concentrator (PDC) is a device that receives and time-synchronizes phasor data from multiple phasor measurement units (PMUs) to produce a real-time, time-aligned output data stream. A PDC can exchange phasor data with PDCs at other locations. Through the use of multiple PDCs, multiple layers of concentration can be implemented within an individual synchrophasor data system. ePDC is the next generation technology for PDCs. The ePDC is an open, platform independent software system, unlike hardware-based or proprietary legacy PDCs, and is available on Windows or UNIX/Linux systems.
ISG	Intelligent Synchrophasor Gateway (ISG) allows the third party/RTDMS clients to access the RTDMS data without directly connecting to Database. These services efficiently serve the real-time and historic data to the RTDMS client and third party applications.
RTDMS Client	RTDMS Client enables the user to visualize phasor measurement data by providing a wide range of displays to monitor real-time dynamics and system events within the grid. It provides operators and engineers with real-time wide area monitoring, visualization, situational awareness, metrics, alarms, events in power systems.
WAN	Wide Area Network. Refers to both the ERCOT MPLS Network and the ERCOT DACS Network. The MPLS Network is the primary network used by Market Participants to exchange data with ERCOT. The DACS network acts as a backup for the MPLS Network.
TCP	TCP (Transmission Control Protocol) is a set of rules (protocol) used along with the Internet Protocol (IP) to send data in the form of message units between computers over the Internet. While IP takes care of handling the actual delivery of the data, TCP takes care of keeping track of the individual units of data (called packets) that a message is divided into for efficient routing through the Internet.
VPN	A Virtual Private Network (VPN) extends a private network across a public network, such as the Internet. It enables a computer to send and receive data across shared or public networks as if it is directly connected to the private network, while benefiting from the functionality, security and management policies of the private network.[1] A VPN is created by establishing a virtual point-to-point connection through the use of dedicated connections, virtual tunneling protocols, or traffic encryptions.

Term	Definition
EMS	An Energy Management System (EMS) is a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation and/or transmission system. The monitor and control functions are known as SCADA; the optimization packages are often referred to as "advanced applications".
iTEST	ITest and Production are two EROCT computer system environments. Software are been tested on iTest systems before moved to Production.RTDMS is currently only run on iTest environment, and will be moved to Production in the future.
DMZ	A DMZ or Demilitarized Zone (sometimes referred to as a perimeter network) is a physical or logical subnetwork that contains and exposes an organization's external-facing services to a larger and untrusted network, usually the Internet. The purpose of a DMZ is to add an additional layer of security to an organization's local area network (LAN); an external attacker only has direct access to equipment in the DMZ, rather than any other part of the network. The name is derived from the term "demilitarized zone", an area between nation states in which military operation is not permitted.
MP	Market Participant of ERCOT, include Qualified Scheduling Entities (QSE) and Transmission Service Provider (TSP).
TSP	A Transmission Service Provider (TSP) is an Entity under the jurisdiction of the PUCT that owns or operates Transmission Facilities used for the transmission of electricity and provides transmission service in the ERCOT Transmission Grid.

2 ERCOT SYNCHROPHASOR SYSTEM

ERCOT has implemented a Synchrophasor system based on EPG's ePDC and RTDMS.

RTDMS receives the complete data stream in IEEE C37.118 format. Its driver has been designed to connect with the data source (ePDC) over a local area network, and to parse the data packets in real time by applying the appropriate scaling/offset factors that convert the data into engineering units, as well as to compute certain derived values (such as Megawatts (MW) & Megavars (MVAR)). The inbuilt Data Quality Filters are capable of removing suspect data as it is streamed to (1) the Real-Time Buffer in memory for temporary caching; (2) the Real-Time Alarm & Event Detector for real-time alarming and event detection; and (3) the long-term RTDMS Database for historical archival.

The Real-Time Buffer sorts and stores data by timestamp and provides high-performance data write/read capability for downstream applications. Information from various algorithmic modules as well as third-party applications can also be simultaneously cached into this buffer via its exposed interfaces.

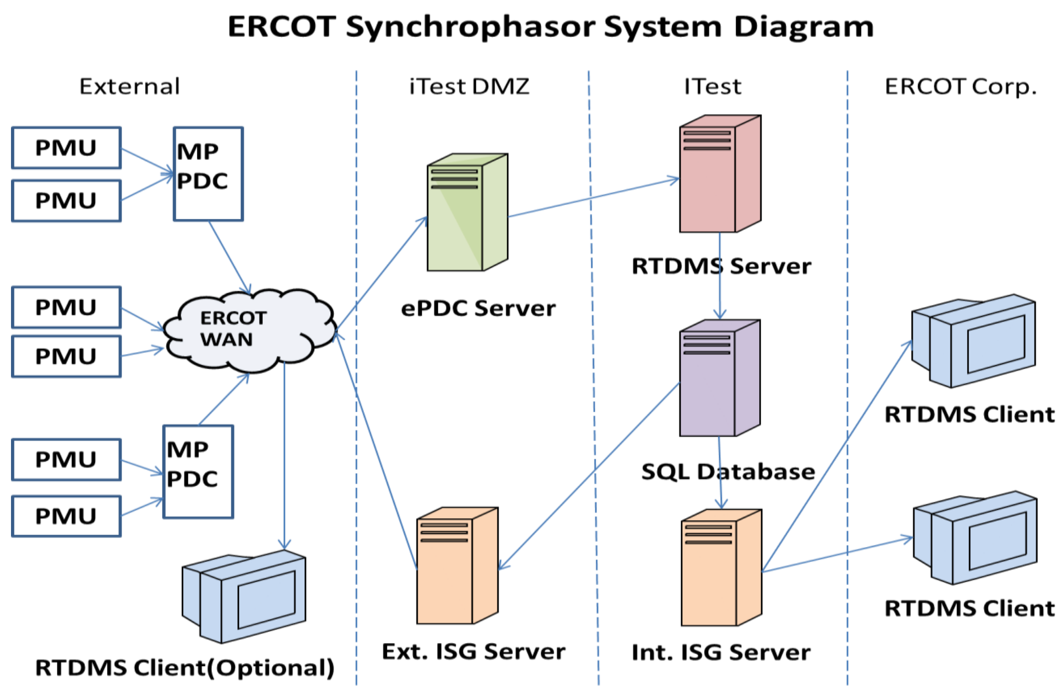
The Real-Time Alarm & Event Detector component is responsible for processing the real- time information against a set of alarming criteria & event detection triggers, and save these results back into the Real-Time Buffer for real-time alarming within the RTDMS Client applications, the RTDMS Database for offline report, and into an alarm log as text file. In case of event detection, the RTDMS Server will automatically save pre- and post-event data into binary Event Files, which could then be loaded into the RTDMS Clients for offline forensic analysis.

ERCOT ePDC receives phasor data from MPs through ERCOT's WAN. Any other network protocols, such as VPN, are not supported. MPs need to open their firewall on a certain TCP port to allow the incoming inquiry data from ERCOT's ePDC server.

ERCOT's ePDC will initiate the data link by sending requests to the remote PDC on a particular TCP port. The remote PDC will then accept the request and it will send back the PMU information, followed by the data stream. The ERCOT ePDC passes the received data to RTDMS via TCP. Meanwhile, all the raw data is saved into a local database as archive.

The RTDMS processes the phasor data and saves the processed data to an SQL server database. The RTDMS clients can connect to the ISG and request the data to display it.

All Synchrophasor servers and workstations are placed in different network zones, and firewalls are implemented between zones to maintain the cyber security.



3 Connecting to the ERCOT WAN

3.1 Network Topology Overview

ERCOT has implemented a TCP/IP based WAN that supports the transfer of data between ERCOT and Market Participants. ERCOT Staff or its contractors monitor and manage the ERCOT WAN. WAN Installation and maintenance responsibility is specified in the *Nodal Operating Guide Section 7*.

The ERCOT WAN will not allow the exchange of data directly between Market Participants.

The ERCOT WAN is a redundant network comprised of the following network architectures:

- Private MPLS Network; and
- Private Point-to-Point DACS Network.

Figure 1 is an overview of the ERCOT WAN.

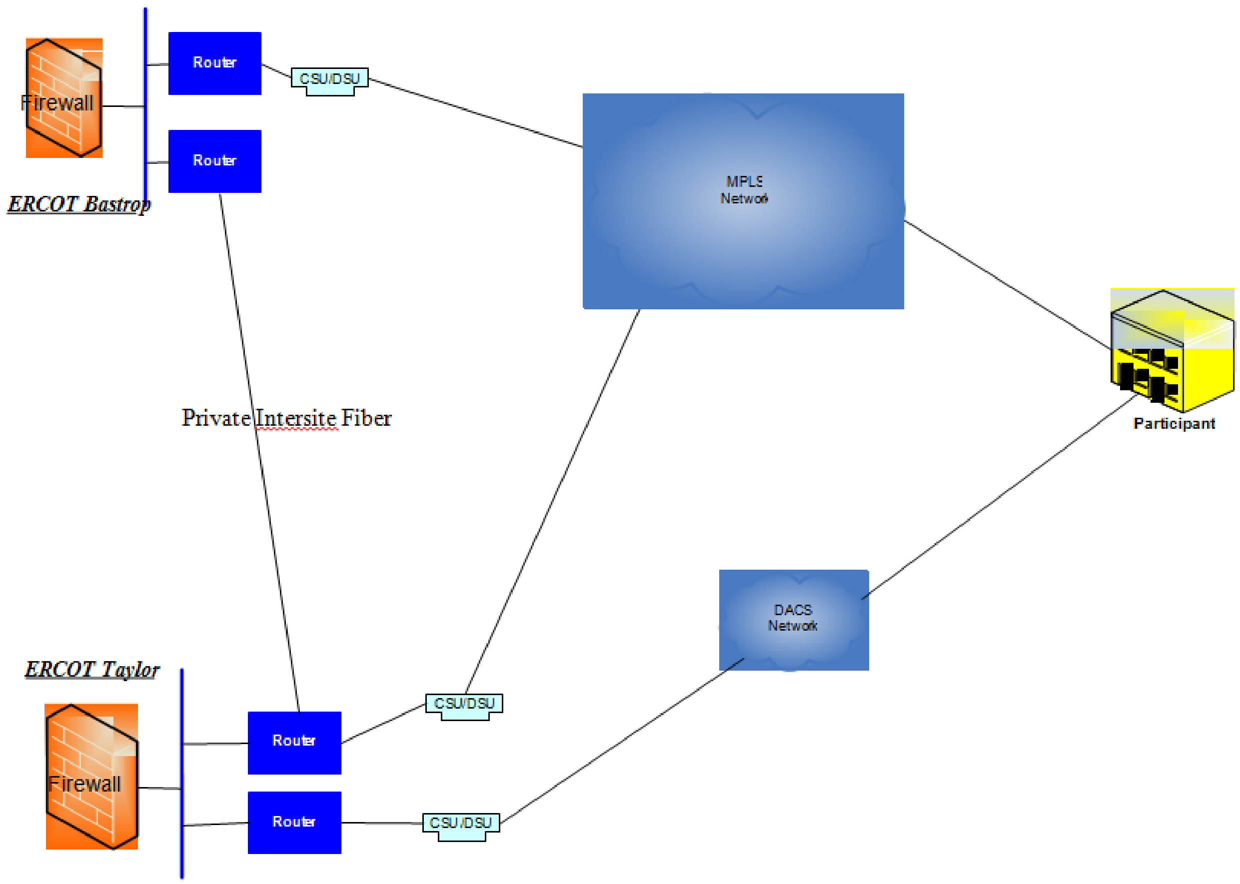


Figure 1 ERCOT WAN Overview

The MPLS network is the primary means of communicating with ERCOT. If a link on the MPLS network between ERCOT and a particular Market Participant fails, the MPLS link connecting the Market Participant through the alternate ERCOT site will be used. The DACS network will only be used if both MPLS links between ERCOT and a Market Participant fails.

3.2 Market Participant Site WAN Connections

Figure 2 describes the equipment and connections supporting operational, engineering, and market data exchange between ERCOT and Market Participants. This *Market Participant Site Diagram* illustrates the essential elements of the equipment and physical layer protocols used in the Market Participant's interface to ERCOT. All equipment shown in Figure 2 is located at the Market Participant's site.

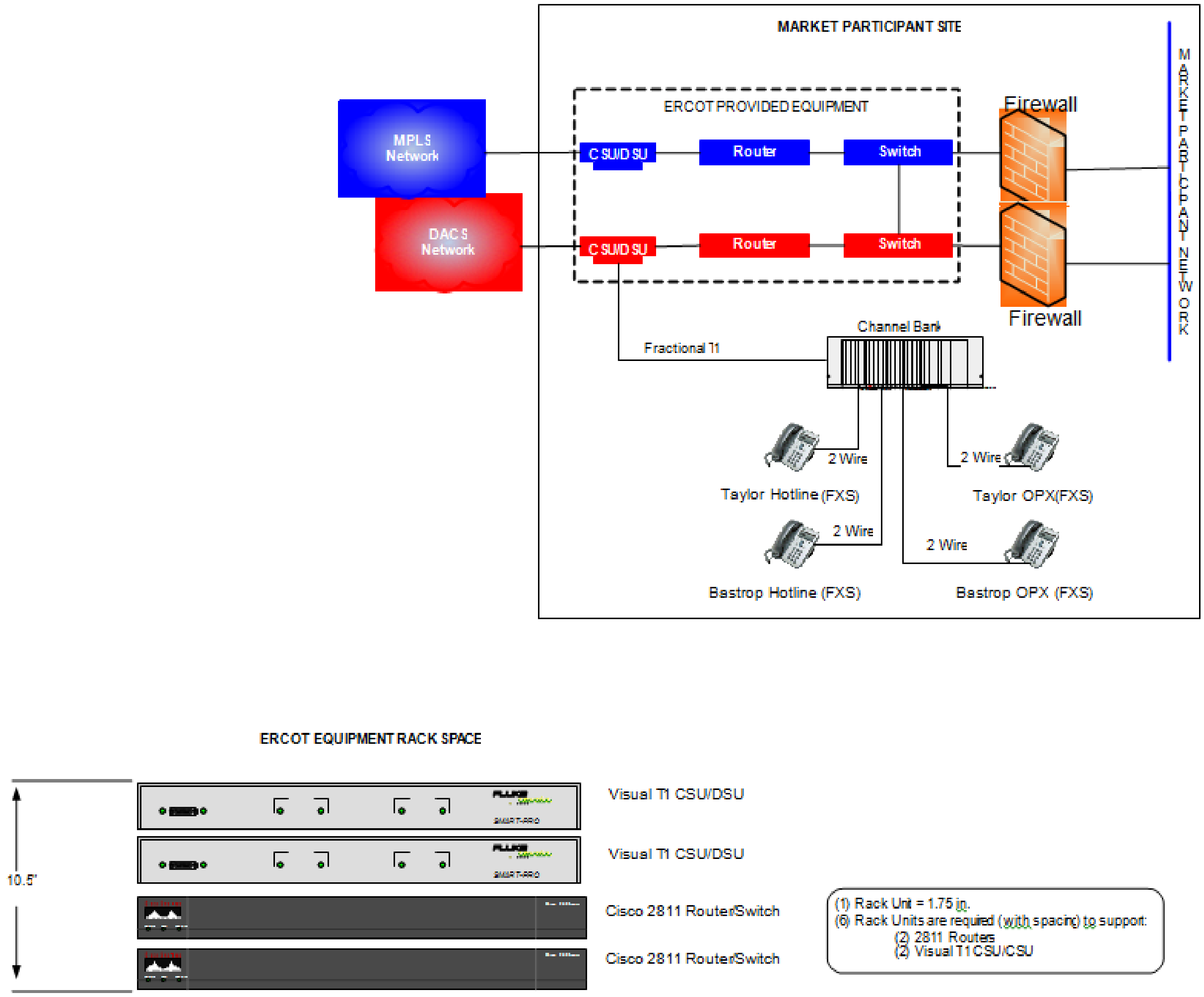


Figure 2 Market Participant Site Diagram

In the network infrastructure connection, ERCOT sets its line of demarcation to be a connection between a redundant pair of Ethernet switches provided by ERCOT and the firewall provided by the Market Participant. The interface "across the line of demarcation" between the ERCOT switch and the Market Participant's firewall is provided by a Category 5 10/100 BaseT (or better) Ethernet cable. The ERCOT switches auto-negotiate for network bandwidth (10 or 100 Mbps) and Duplex (full/half).

It can be seen in Figure 2 that the ERCOT-provided equipment brings the redundant infrastructure into the Market Participant's site that is necessary to meet the reliability requirements stated in the *Texas Nodal Protocols*. On the Market Participant's side of the line of demarcation, it is the Market Participant's responsibility to provide an internal network infrastructure that also meets the *Texas Nodal Protocol's* communication reliability requirements[1]. Therefore, the Market Participant is free to choose routers, firewalls, and other network equipment that best meets these requirements.

The interconnecting Ethernet Switches form a Routing LAN that supports the routing of traffic over either the MPLS network or the DACS network. Traffic from the Market Participant's system is exchanged over this network using ICCP, Synchrophasor, HTTPS, FTP, or other Application protocols as required by the various application services. This handbook details the use of Synchrophasors only.

3.3 Implementation Procedures

Implementation of the ERCOT WAN is defined in the ERCOT ICCP Communication Handbook. A Market Participant must use the ERCOT WAN to transfer real-time Synchrophasor data to ERCOT.

4 Synchrophasor Data Exchange Requirements

4.1 Synchrophasor Data Exchange Standards

Synchrophasor data acquisitions are defined in the following main IEEE standards and guides:

- C37.118.1-2011 – Measurement requirements

  Synchrophasor measurements including frequency and rate of change of frequency
- C37.118.2-2011 – Synchrophasor communications

  Extension of the original synchrophasor standard (2005)
- IEC 61850-90-5 – Phasor measurement communications

  Technical Report that adds wide-area capability for phasors
- C37.242-2013 – Guide for PMU utilization

  Installation, testing, synchronization & measurement error issues
- C37.244-2013 – Guide for PDC

  Definitions and functions used in PDC units
- IEEE 1588 – Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

4.2 ERCOT Synchrophasor Data Format

The ERCOT Synchrophasor data format minimum requirements for transmitting data to ERCOT are defined in the following table. Specific Market Participant application requirements may drive higher requirements for some of these attributes.

Parameter	Value
Data Format	C37.118-2011 (recommended) C37.118-2005 (required)

Buffer Size	30 Seconds
Data Rate	30 Samples/Second
Sort Data By	Time
ERCOT data-transmitting PDC Wait Time (maximum)	1 second
PMU-ERCOT Latency (maximum)	2 seconds
Time Base	1000000
Communication Protocol	TCP

PMU Name (this needs to be coordinated with NDSWG)	QSE ICCP Object Naming Conventions The ERCOT convention for generation control and regulation ICCP Object names exchanged with QSEs is illustrated in the following name descriptor. The object name is composed of five fields as follows: AASSSSSSSSVMEEEE Where: AA is the 2-character code for the company name (Company code assigned by ERCOT) SSSSSSSS is the 8-character station name (9 is 69 kV, 8 is 138 kV, and 5 is 345 kV) M is a device type (L=line,B=bus,T=transformer,G=generator,C=capacitor,F=FACTS device, R=reactor,M=multi-element) EEEE is the 4-character equipment name Unused spaces should be replaced with a "-" The following is a typical example of a PMU name:

A	A	S	S	S	S	S	S	S	S	V	M	E	E	E	E
0	7	A	U	S	T	R	O	P	-	5	L	1	8	5	-

4.3 ERCOT Synchrophasor Communication Parameters Definition

These communication parameters are required by MPs to connect to the ERCOT Synchrophasor system.

MPs should configure their firewall to allow TCP communication from the ERCOT ePDC to their PDC on port 6000 (default port number, may change upon request).

One parameter is not defined but is very important: PMU & PDC time. All PMUs and PDCs must have very good time synchronization from satellite standard time signal. Best practice in this area would dictate the use of multiple high precision time sources that meet or exceed the PRC-002 time signal requirement for the PMU to avoid the possibility of GPS signal failure or spoofing.

Parameter	Value	Notes
ePDC Server ERCOT WAN IP	192.168.172.37	
ePDC Data Request Port	6000	6000 is the default port, other ports are also allowed upon request.
ISG Server WAN IP	192.168.172.36	
ISG Server Outbound Port	808 and 80	
RTDMS Client ISG URL	192.168.172.36/rtdms_isg	

4.4 Off-line Synchrophasor Data Provision

On an ad-hoc, as-needed basis, synchrophasor data may be requested by ERCOT from an MP for an off-line PMU which does not transmit real-time data. The provision of this data shall be accomplished in the following manner…

5 Synchrophasor Network Data Quality

In order for ERCOT and their Market Participants to achieve a production quality phasor network system that can be relied upon in real-time operations, it is important to check whether the data link that is established between a market participant and ERCOT carries data flow reliably to ERCOT. The Data Quality Test will address the prior condition and will certify whether data sent from Market Participants is received and archived same at ERCOT.

Once a reliable synchrophasor network is established, it is also important to check the performance of each PMU on a continuous basis. The reliable synchrophasor network ensures high data availability but may not have high PMU performance. A highly reliable synchrophasor network may still have PMUs reporting with flagged data which cannot be used in real time operations. The occurrence of flagged data from the PMUs (or PDC) can be recurring or non-recurring (repeating or non-periodic respectively). It is important to check and correct the occurrence of flagged data in order to establish a reliable synchrophasor network with high PMU performance.

The good practices on the two phasor data test on the synchrophasor network are briefly explained below. The Data quality test ensures reliable synchrophasor network between the Market Participant and ERCOT. The PMU Performance Test will improve the occurrence of good data and reporting from PMU & PDCs itself.

The testing method listed here is specific for EPG RTDMS product.

5.1 RTDMS Data Quality Test

The Data Quality Test is an end-to-end analysis between the Market Participant (or any data sender) and ERCOT. This end-to-end analysis is a direct comparison between the data sent by Market Participant and the data received and archived at ERCOT. In order to conduct the study, it is most important that Market Participant and ERCOT archive data at both ends.

It is recommended to capture one hour of data (minimum) or more from both ends for two different days (minimum) or more. The data collected at both ends for the same time duration will help to conduct the data quality test. Some of the common findings on data quality issues between data collected at both ends are as follows:

1. Missing Samples
2. Missing PMUs & Signals
3. Mismatch in PMU & Signal Headers/Names
4. Data Shift in time (Time Skewed)
5. Difference in Data Resolution
6. Difference in Count of Flagged Data

Missing Samples

1. Verify the count of samples reported matches the received rate

   For example – If the phasor data reporting rate is 30samples per second, then the count of samples expected for duration of 1 hour is equal to 108000 samples.

2. Compare the results at both ends to verify
   a. There are no local archiving issues
   b. There are no communication issues between MPs and ERCOT

Missing PMUs

1. Verify the count of PMUs sent matches the received PMUs

   For example – If the MP is sending 10 PMUs to ERCOT, then ERCOT should be receiving data for all the 10 PMUs.

2. Verify the count of signals sent under each PMU matches the reported received signals under that PMU
3. Compare the results at both ends to verify

   There are no lost PMUs/Signals during the communication

Mismatch in PMU & Signal Headers/Names

1. Verify whether PMU headers/names sent matches the received PMU headers/names
2. Verify whether Signal headers/names sent matches the received Signal headers/names under each PMU
3. Compare the results at both ends to verify
   a. There is no mismatch due to configuration changes
   b. There is consistent PMU naming convention
   c. There is consistent name for a PMU and its signal for common displays and analysis

Data Shift in time (Time Skewed)

1. Verify whether PMU signal data reported for a timestamp matches exactly at both ends

   For Example: Plot and Compare same PMU signal data from both ends for a duration of time

2. Compare the results at both ends to verify

   a. There is Time alignment – PMU Signal data at both ends should be identical (they will lie on top of each other when plotted)

   b. There is no Time Skew – PMU Signal data from one end will be time shifted from other and will not lie on top of each other when plotted

   c. If there is time skew, it could possibly be latency issue related to the PDC

Difference in Data Resolution

1. Verify whether the PMU signal data value matches (magnitude and phase angle) at both ends for a duration of time

   For Example: Calculate the Difference between PMU signal data from both ends for a duration of time (Assuming there is no time skew)

2. Compare the results to verify

   a. There is no difference in resolution at both ends

   b. There are no data conversion issues at the PDC

   c. There is no mismatch in scaling factors used at the PDC

Difference in Count of Flagged Data

1. Verify the count of flagged data matches at both ends

   For Example: If the count of data samples, flagged good, sent by MP were 108000 in an hour, then ERCOT should receive the same count of good data samples during the same hour

3. Compare the results to verify

   a. There are no communication issues causing data dropouts

   b. The count of flagged data at the receiving end matches the count at the sending end

   c. There is consistency of flagged data samples at both ends (data is flagged identically for the same time interval)

   d. There is no communication delay between both ends

Flagged Data Samples

The C37.118 data stream includes quality information for all the signals for each PMU in a Status flag. The Status flag is represented by hexadecimal integer 0x0000. The left most hexadecimal integer carries the quality information for the PMU data (0x0). Below table shows the findings on different types of observed flags on data samples.

#	Types of Flags	Description – The data is flagged bad due to
1	‘0x0’	Good Quality data
2	‘0xF’	Dropouts (set by the ePDC)
3	‘0x8’	Data Invalid
4	‘0x1’	Time Alignment Error (Sorted by Arrival and not by Timestamp)
5	‘0x2’	GPS Sync Error
6	‘0x3’	GPS Sync Error + Time Error
7	‘0xE’	Data Invalid + GPS Sync Error + PMU Error

The data quality test is needed to be expanded to the following

1. Within ERCOT Synchrophasor Network – Between ePDC and RTDMS
2. Between PMU and MP, if there are local archives at PMU level

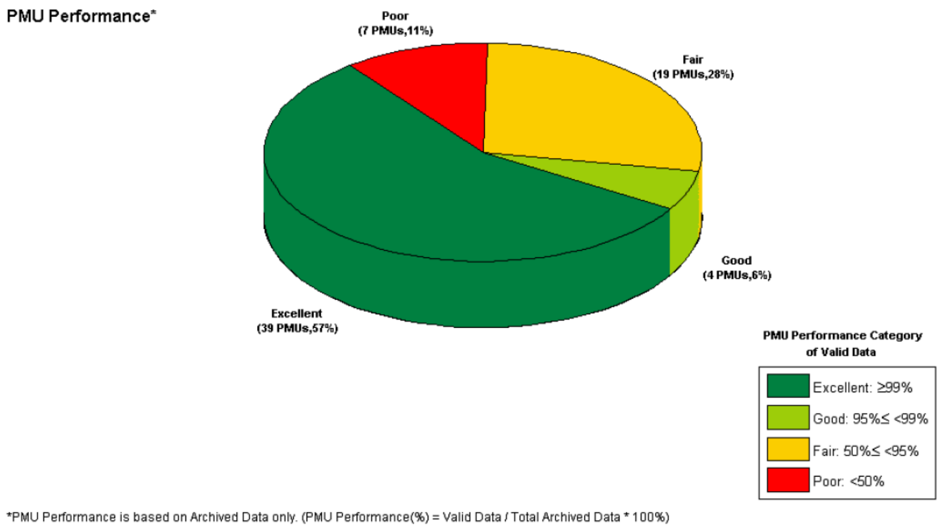
5.2 RTDMS PMU Performance Test

A highly reliable synchrophasor network may still have PMUs reporting with flagged data which cannot be used in real time operations. The occurrence of flagged data from the PMUs or PDC can be recurring or non-recurring (repeating or non-periodic respectively). It is important to check and prevent the occurrence of flagged data to establish a reliable synchrophasor network with high PMU performance.

PMU Performance Chart shown below is a pie chat from the RTDMS Daily Report showing the performance of PMUs under different performance categories. The objective of the PMU Performance analysis is to

1. Make all PMUs perform excellently
2. Identify plausible reasons for those PMUs that don’t have excellent data quality
3. Find consistent patterns that affect PMU Performance
4. Identify any other inconsistent data quality issues affecting PMU Performance on a continuous basis

This study may identify issues with PMU devices and their supporting instruments, network issues transporting data within the synchrophasor network and many more.



PMU Performance Chart – RTDMS Daily Report

The PMU Performance analysis is done at the ERCOT level to identify the PMUs that are not performing well (as reported in the data delivered to ERCOT) and report to MPs on consistent data quality issues for improved performance. It is recommended to

1. Use one month of data collected at ERCOT
2. Count occurrence of flagged data (see above list of flagged data types), good samples, received samples and missing samples on a daily basis for all PMUs
3. Find patterns of data quality issues over the month

Some of the common findings on data quality issues affecting PMU Performance are as follows:

1. Daily Dropouts between MPs and ERCOT
2. Daily Dropouts between Specific PMUs and MPs
3. Specific PMUs showing GPS Sync Error
4. Specific PMUs reporting more count of flagged data

Daily Dropouts between MPs and ERCOT

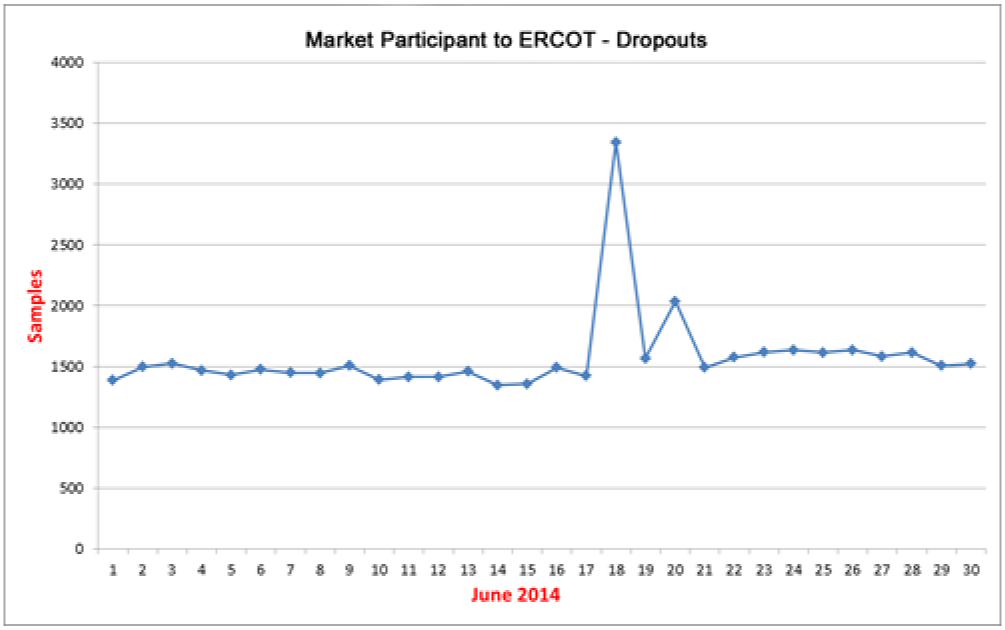
The data samples are flagged bad as dropouts when they don't reach the destination due to communication issues. It is likely that the PDC sets the flag. Some of the common patterns of dropouts are

1. Daily Consistent Dropouts for entire stream from MP
2. Daily Irregular Dropouts for entire stream from MP

Daily Consistent Dropouts for entire stream from MP

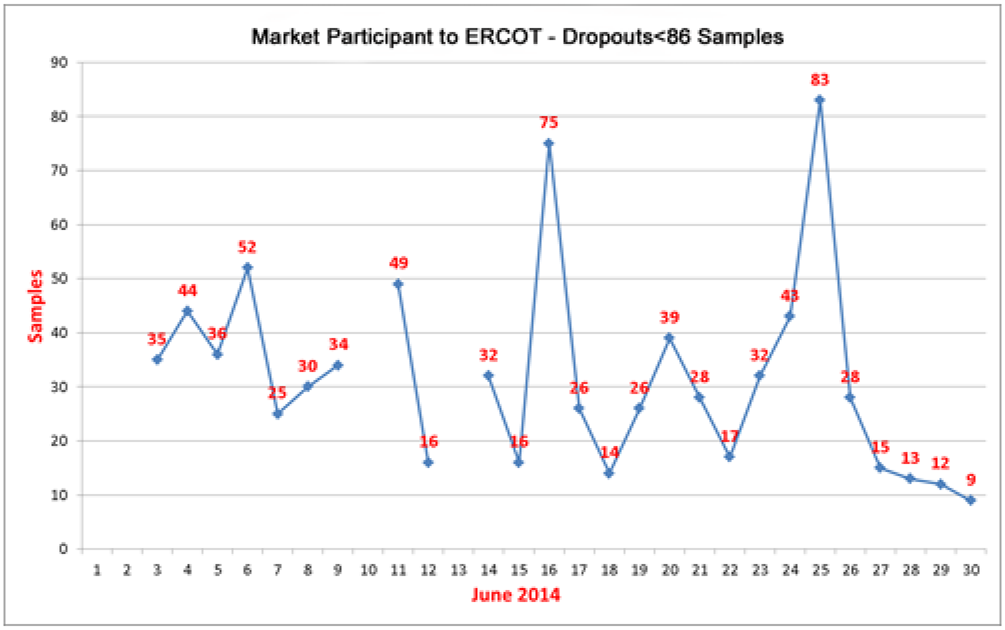
1. If all the PMUs in the stream from MP shows same dropouts, it is more likely that there is communication issues between the MP and ERCOT

2. If the dropouts are consistent over the entire month, then there is most likely there are communication issues between MP and ERCOT on a daily basis.
3. For Example: Below figure illustrates the scenario that a certain Market Participant is having consistent daily dropouts for their entire data stream to ERCOT.



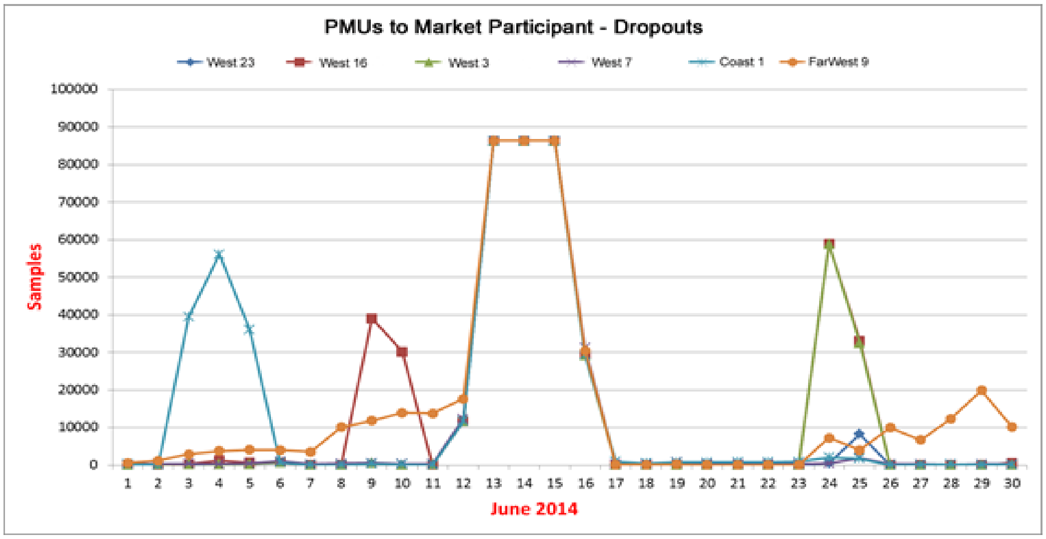
Daily Irregular Dropouts for entire stream from MP

1. If all the PMUs in the stream from MP shows same dropouts, it is more likely that there is communication issues between the MP and ERCOT
2. Sometimes the dropouts are not consistent over the entire month and are found to be irregular over the entire month
3. For Example: Below figure illustrates the scenario where a certain Market Participant is having inconsistent daily dropouts for entire stream to ERCOT



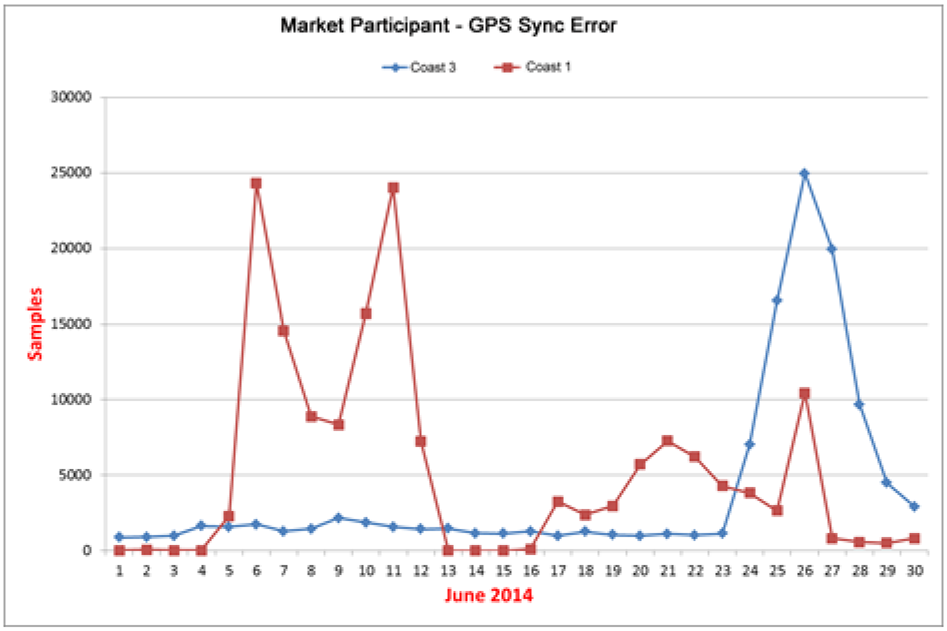
Daily Dropouts between Specific PMUs and MPs

1. MP sent PMU data stream as a single stream to ERCOT. So when there is a communication link failure, then all the PMUs are subject to be flagged as dropouts.
2. If specific PMUs in the stream from MP show dropouts, it is more likely that there are communication issues between the specific PMUs and MP PDC
3. It is most likely the dropouts are not the same for all PMUs as they represent dropouts from specific PMUs and are found to be irregular over the entire month.
4. Sometimes dropouts are the same for specific group of PMUs, if they are sent from a substation PDC or on a common communications path
5. For Example: Below figure illustrates the scenario where certain Market Participant is having inconsistent daily dropouts for specific PMUs to their PDC



Specific PMUs showing GPS Sync Error

1. PMU data samples are flagged bad as GPS Sync Error if the PMU loses synchronization with its GPS clock.
2. The occurrence of flagged data samples under this category may be consistent or non-periodic over the entire month for each PMU.
3. Identifying the PMUs which frequently lose synchronization with the GPS clock can enable the MP to correct the GPS clock in order to improve the PMU performance.
4. For Example: Below figure illustrates the scenario where two PMUs from AEP were showing frequent counts of flagged data samples. The plot below illustrates that Gulf Wind (in blue) had a consistent count of samples flagged bad every day of the month and Airline (in red) was irregular over the month.



Specific PMUs reporting higher count of flagged data

ERCOT might notice data samples from specific PMUs that are flagged bad as ‘0xE’, most likely set by the MP’s PDC and sent to ERCOT. It was found that those flagged data samples were flagged and archived as good at the MP database. It was observed that ERCOT was receiving a greater count of flagged data samples under this category, and this condition needs to be monitored.

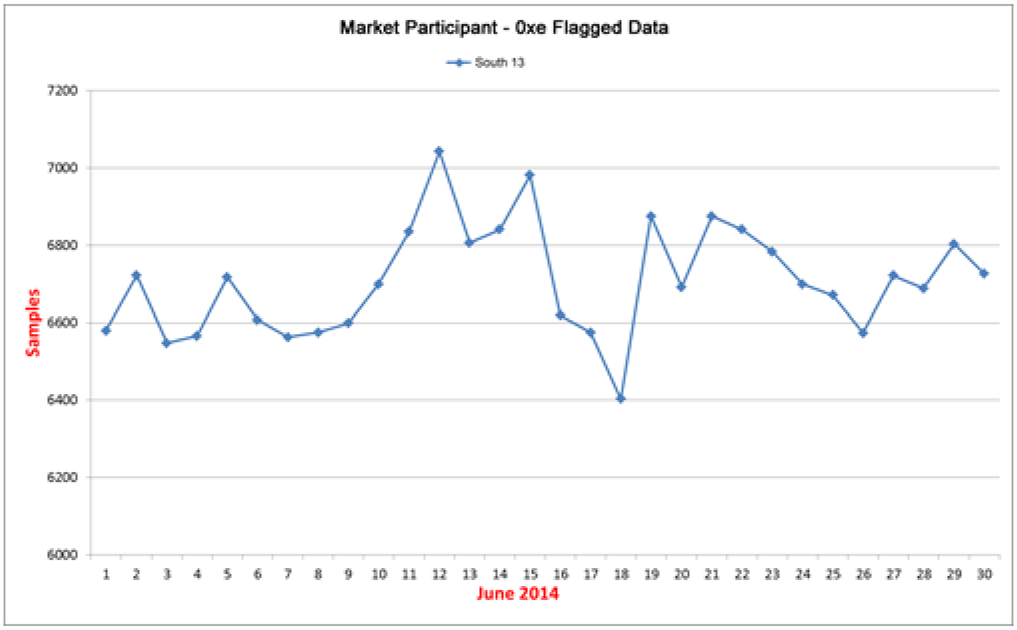
It is likely that the PDC sets the flag. Some of the common patterns of ‘0xE’ are

1. Daily Consistent Pattern from specific group of PMUs
2. Daily Irregular Pattern from specific group of PMUs

Daily Consistent Pattern from specific group of PMUs

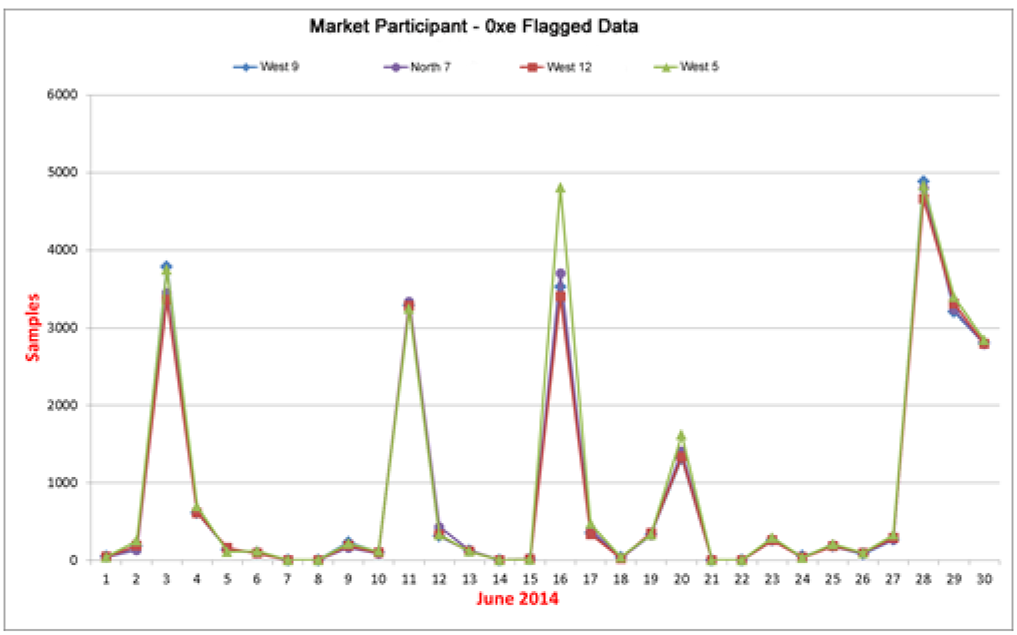
1. Identifying the PMUs which frequently have flagged data samples can be notified and corrected to improve the PMU performance.

2. For Example: Below figure illustrates the scenario where a PMU from Sharyland was showing a consistently high count of flagged data samples over the entire month.



Daily Irregular Pattern from specific group of PMUs

1. Identifying the PMUs which frequently have flagged data samples can be notified and corrected to improve the PMU performance.
2. For Example: Below figure illustrates the scenario where a specific group of PMUs from ONCOR were showing irregular counts of flagged data samples over the entire month, but the irregular patterns were very similar for the entire group over the entire month.



The PMU Performance analysis can be expanded to other types of flagged data samples as tabulated in the previous section. This analysis can pinpoint which PMUs are the "bad actors" sinking the overall PMU performance. The data quality test and PMU performance test on a continuing basis can drive to a reliable and high performance synchrophasor network. It is also a good practice to include other non-duplicative findings that are of concern based on future observations.

6 ERCOT Market Participant Data Availability

Within ERCOT, ERCOT's legal staff has reviewed this topic and the opinion is that phasor data is treated similarly to other real-time telemetered data (e.g. ICCP). As a result of this, phasor data sharing and exchange is covered under the ERCOT Nodal Protocols section 1.3 Confidentiality.

Synchrophasor data not directly attributed to a Resource Entity (e.g. synchrophasor data obtained from a transmission switchyard) is not considered to be Protected Information.

Synchrophasor data derived directly from a Resource Entity is considered to be Protected Information per:

> *(c) Status of Resources, including Outages, limitations, or scheduled or metered Resource data. The Protected Information status of this information shall expire 60 days after the applicable Operating Day;*

Generator market-sensitive data is treated as confidential for sixty days. Transmission non-market-sensitive data is able to be shared sooner. CEII data, including PMU data, shall not be released to parties without proper authority, e.g. NERC, FERC, TRE, etc. ERCOT TSPs are able to exchange phasor data amongst themselves at their own discretion, subject to Nodal Protocol requirements governing market-sensitive data. One example of ongoing inter-utility phasor data sharing is through the CCET project, whose members are subject to an NDA which includes Synchrophasor data.

All ERCOT PMU data will be available to all TSPs. TSP users can access the data using EPG RTDMS client. Users must send access request to ERCOT. After the request is approved, ERCOT will provide the logon username and password.

ERCOT will keep PMU archive data online for one year, and keep advanced calculation data for one month.

ERCOT currently does not support TSPs to receive all PMU data directly from the ERCOT ePDC.

One data access path shall be provided per MP via the ERCOT WAN. Secondary connections for support staff shall be provided via standard commercial Internet-based access.

7 Appendix: PMU data communication request form

The form below is used for both initial communication setup and new PMU update. The form shall be submitted to your company's ERCOT Client Services Representative.

ERCOT PMU Data Communication Request Form

Company Name:					
Contact Name:		Phone Number:		Email Address:	
ePDC Server WAN IP:				Port Number:	(Default is 6000)

PMU Data

#	PMU Name	Substation	Enable?	Base KV	Longitude	Latitude	Remote Location	Notes
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
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