CCET

Center for the Commercialization of Electric Technologies

"Discovery Across Texas"

New Technology Solutions for Wind Integration in ERCOT

Synchrophasor Project Status Update

Bill Muston
Oncor Electric Delivery
Bill.Muston@oncor.com

NASPI Work Group Meeting
October 12-13, 2011

NASPI North American SynchroPhasor Initiative

DOE Smart Grid Demonstration Project

- Title: ***Discovery Across Texas***: Technology Solutions for Wind Integration in ERCOT

- Prime contractor: Center for the Commercialization of Electric Technologies (CCET)

- Original Award Date:
  - 4 January 2010

- Award Number:
  - DE-OE-0000194

Total Project Overview

Goal:

- Demonstrate a synergistic approach to accommodating growing wind power in the ERCOT transmission grid through transmission and demand-side tools and approaches

Primary Components:

- Synchrophasors for better system monitoring capabilities, enhanced operator visualization

- Smart meter ecosystem providing 15-minute data and demand response communication platform

- Homes of two types: standard construction and advanced energy performance features, enrolled in demand response trial programs

Synchrophasor Project Participants

- Center for the Commercialization of Electric Technologies
  - Dr. Milton Holloway

- Project TO/asset owner partners
  - American Electric Power TEXAS - 6 PMUs, 2 PDCs
  - Oncor Electric Delivery - 4 New 2 existing PMUs, 1-2 PDCs
  - Sharyland Utilities - 3 PMUs, 1 PDC
  - Electric Reliability Council Of Texas (ERCOT) - 1 PDC, RTDMS visualization platform, ePDC data archiving, examine applications

- Electric Power Group – synchrophasor tools & services

- Drummond Group – interoperability services

- Southwest Research Institute – cyber security services

PMUs in Texas
- ★ Installed
- ★ Planned
- ★ Not in Service

ERCOT
TRANSMISSION NETWORK
OF TEXAS
(with Future Projects)
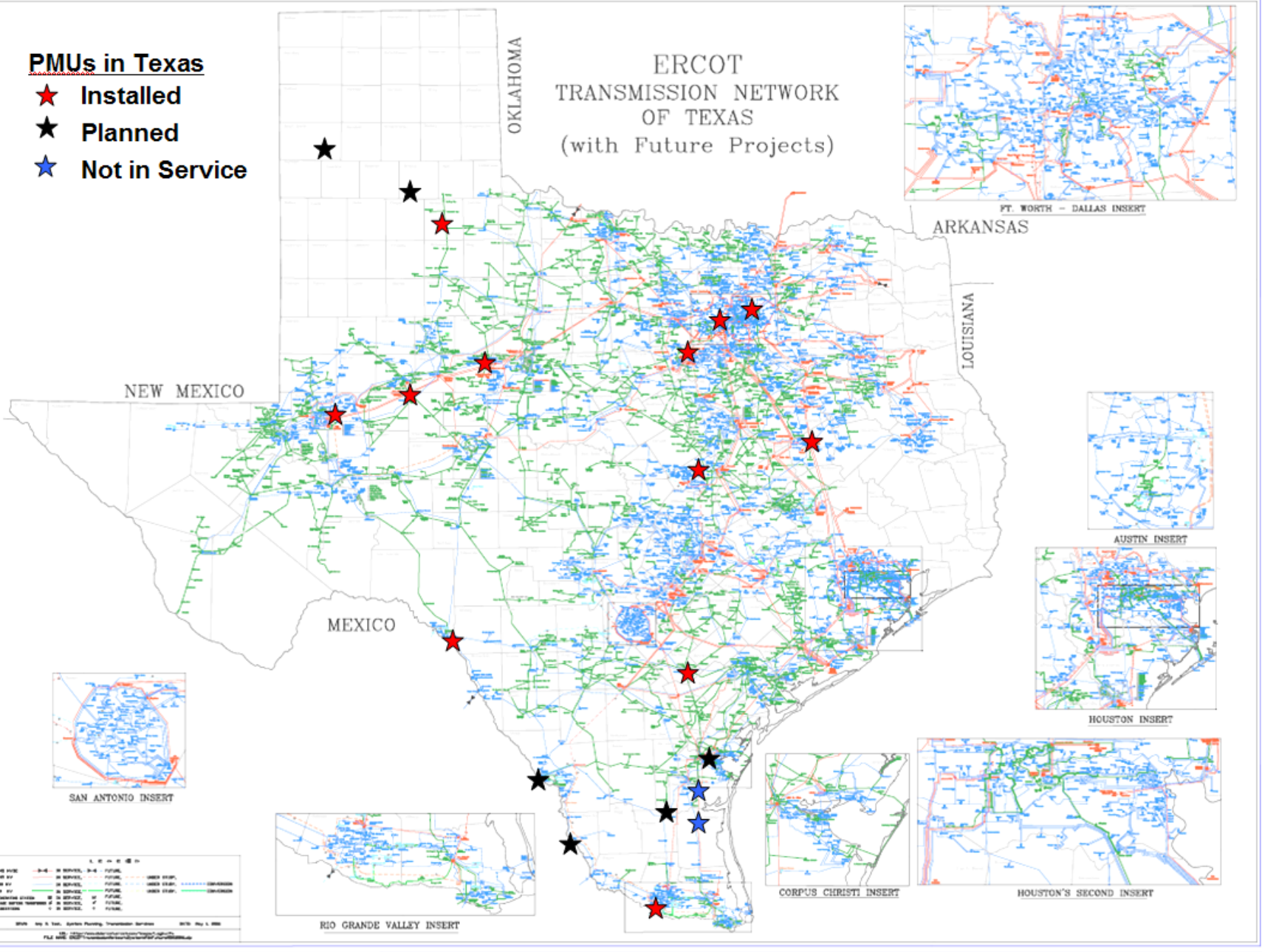
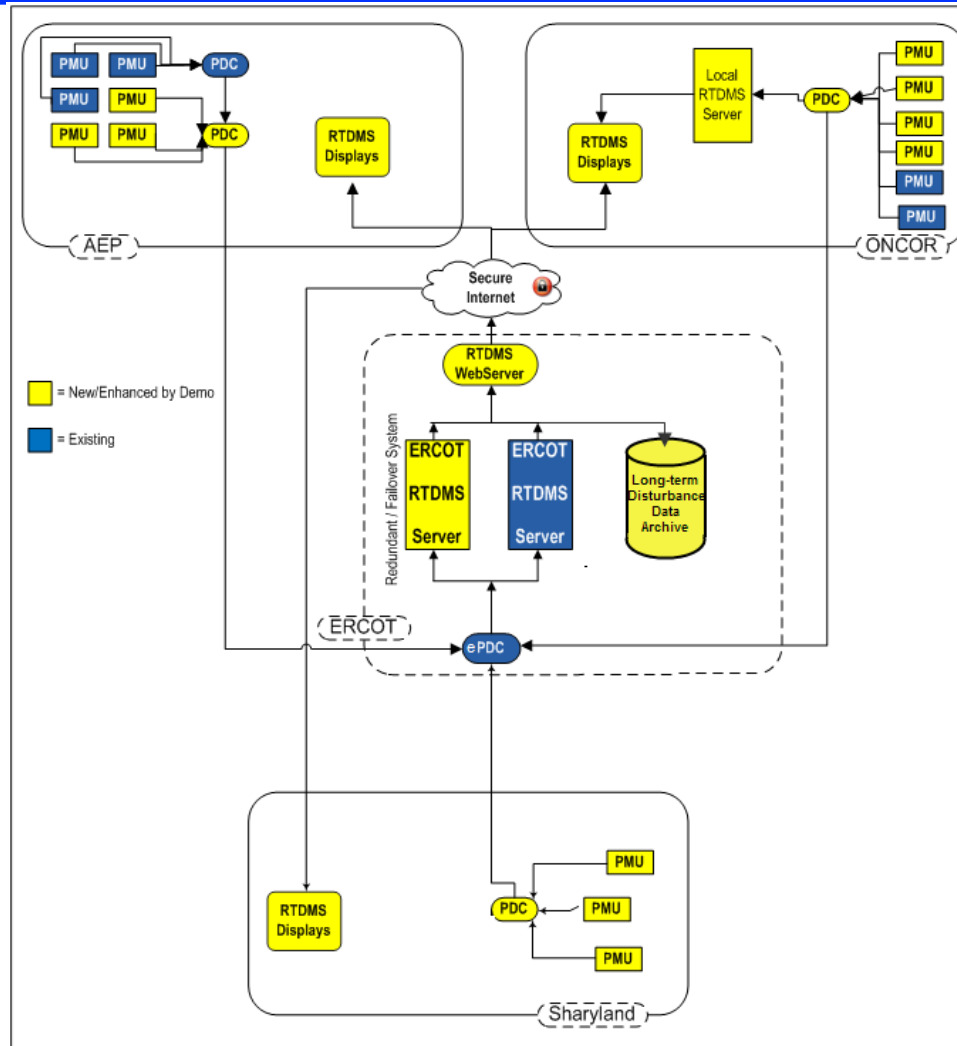# PMU → PDC →RTDMS Architecture

Project Timeline

- PMU Installations
  - 17 PMUs installed, 11 fully operational, 6 resolving communications issues
  - Additional 3 PMUs planned by 6/2012
  - Additional 3 PMUs planned by 12/2012
- PDCs
  - 3 PDCs installed and operational (two TOs and ERCOT)
  - 1 PDC planned by 12/2012 (TO)
- Communications
  - TOs using internal utility networks between PMUs and TO.PDCs
  - ERCOT Private WAN being used for all TO.PDC—to—ERCOT.PDC communications – fully operational
- Real Time Dynamics Monitoring System (RTDMS) deployed at ERCOT
  - RTDMS presently used for monitoring
  - TOs have client access to ERCOT displays
  - RTDMS deployment into ERCOT Control Room in 2012

PMUs

(At Project Completion)

- Sparse network of PMUs touching ~60% of regional grid footprint for wide-area applications
- Three transmission owners in project and total of 22 PMUs (planned)
  - Each TO is selecting its own PMU specs and vendor
- Transmission elements monitored by PMUs
  - 7 substations at 345 kV
  - 11 substations at 138 kV
  - 2 substations at 69 kV
  - 20 substations with PMUs
- Minimum PMU sampling rate – 30 samples/second
- PMU types
  - Using SEL 421 and GE D60 relays as PMUs
- PMU with communication circuit installation rate
  - 17 installed by 9/30/11, (some PMUs pre-dating this DOE project)
  - 6 installed (new) by EOY 2012

CCET   ERCOT

PDCs and Communications

(At project completion)

- PDCs
  - One ePDC at ERCOT Control Center
  - All three TOs will have central PDCs
  - No planned field PDCs to date
  - Archive/database status
    - RTDMS Data Base sized for 90 days of stream storage
    - ePDC Data Archiver sized at 500 MB, sufficient for 6 months
    - Data is being replicated from Data Archiver onto off-line storage
      - Current plan is to retain full resolution stream data for at least three years
- Communications system
  - PMU communications circuits include both utility-owned and leased circuits, with 56 k baud as typical bandwidth
  - PMU data streams aggregated via PDC at each utility, and delivered over ERCOT Private WAN to PDC at ERCOT

Major Operational Applications Using Phasor Data

- Wide-area situational awareness
  - RTDMS system (Electric Power Group) installed at ERCOT
  - Currently planned to be used as monitoring system
    - Integration into other control room applications to be determined
  - RTDMS will be implemented in Control Room in 2012
  - All three TOs will have access to all ERCOT RTDMS displays via remote client

- Event Analysis
  - Matlab (at ERCOT) & Phasor Grid Dynamics Analyzer (at EPG) are being used to analyze ERCOT grid events after the fact, focusing on the interactions between wind generation levels and …
    - Inertial frequency response and governor response
    - Oscillation modes and damping
    - Angle-pair swings across network

- Model Validation

Challenges and Lessons Learned

- Biggest technical challenges:
  - Identifying and eliminating a latency issue caused by use of serial connectors instead of ethernet connectors between PMUs and the communications circuits
    - The serial connectors were buffering data, causing latency problems and loss of data
    - Ethernet connections do not buffer data, so the stream was timely
  - Finding communications services providers willing to support the PDC data stream volume (removing or raising data rate limits)
- Biggest execution challenges:
  - Managing the firewalls and routers that connect the TO PDCs to the ERCOT PDC
    - Changes that were supposed to be transparent resulted in complete loss of data for extended periods
    - Getting the right personnel at each end of the connection engaged in resolving the connection problems
  - Inadequate communications bandwidth to support PMU data stream encryption from the substation to TO PDC
    - Two PMUs have been removed from service due to inadequate bandwidth available to support encryption from the substation

Other Observations

- When the communications are functioning properly, the PMU data quality is very good

- Loss of a TO.PDC data stream cripples the ability to analyze the grid, given sparse nature of PMU locations

- Daily monitoring of PMU performance is expected to improve the overall quality of the phasor data
  - What gets measured gets done (or at least maintained)!

- Close coordination is required between TOs and ERCOT when new PMUs are added to the data stream
  - Configuration in WAMS/RTDMS system, Daily Report, etc
  - Entry of appropriate meta data

Cyber Security Approach

- PMU network was not intended to be "production grade" for use by system operators at the outset of the project

- Address initial challenges of establishing a functional network with PMUs, communications, and PDCs as initial priority

- Cyber security assessment has now begun, perhaps leading to future adjustments

Interoperability & Security

- Standards: IEEE C37.118, possible future use of IEC 61850

- Interfaces: PMUs, PDCs for TOs and ERCOT, Substation PDCs, RTDMS, data historian

- Physical and cyber-security of the PMU to TO.PDC networks will be provided by each TO.

- Cyber-security of the TO.PDC to ERCOT.PDC communications via the ERCOT Private WAN will be managed by ERCOT

- Physical and cyber-security of the ERCOT.PDC, RTDMS server, data historian, etc will be provided by ERCOT

Cyber Security Assessment Approach

- Executing DOE-approved Cyber Security Plan

  - Additional guidance from webinars and seminars

- NIST IR 7628
  - Abstract architecture and high-level requirements
  - Effective cyber security strategy development

- Security Profile for Wide-area Monitoring, Protection, and Control (WAMPAC) Synchrophasor-system-specific requirements

- NIST IR based methodology
- Identify appropriate standards and best practices
- Identify relevant actors and logical interfaces
- Determine high-level security requirements from logical interfaces
- Review documentation, including test plans and results
- Assess and determine if appropriate security controls are implemented

Contacts

Bill Muston
Oncor Electric Delivery
Bill.Muston@oncor.com

John Ballance
Electric Power Group
Ballance@electricpowergroup.com

Milton Holloway, Ph.D.
Center for the Commercialization of Electric Technologies
MHolloway@electrictechnologycenter.com

CCET Overview

- **Texas 501(c)6 non-profit**

- **Formed** with 4 founding members in September 2005

- **Current Membership**:

  - 20 electric and high technology companies

  - 5 collaborating universities

- **Mission**:

  - To enhance the safety, reliability, security, and efficiency of the Texas electric transmission and distribution system through research, development and commercialization of emerging technologies

- **See website for additional information:**

- http://www.electrictechnologycenter.com/