PJM SynchroPhasor Technology Deployment Project PMU/PDC Testing

Rahul Chhabra
Applied Solutions
PJM Interconnection LLC

TO PMUs

TO PDC

PJM PDC

Ensure PJM and TOs current and known future needs are met

Test for:
- Verification
- Interoperability
- Scalability
- Redundancy
- Availability

Goal:

Primary: Validation
Secondary: Performance Analysis

TO PMUs

TO PDC

PJM PDC

Test For

- IEEE C37.118 Compliance

- Positive sequence Calculations

    - Voltage

    - Current

- Sampling Rate (30 fps and 60 fps)

- Time Synchronization Functions

- Storage (Verify Only)

- Steady State Tests

- Dynamic Performance Tests

Test Types

- General tests
    - Message frames check
    - Flags check
    - Reporting rate check
- Steady-state tests
    - Frequency variation
    - Magnitude variation
    - Phase angle variation
    - Harmonic distortion
    - Out-of-band signal interference
    - Unbalanced Phase
    - Unbalanced Magnitude
- Dynamic performance tests
    - Signal modulation
    - Magnitude step
    - Phase angle step
    - Frequency ramp test

TO PMUs

TO PDC

PJM PDC

Virginia Tech

- Create Test Lab
- Configure Equipment
- Create Test Procedures
- Execute Test Procedures
- Record output data
- Conclusion Reports

PJM Interconnection

- Provide Subject Matter Expertise
- Create Test Approach
- Review/Approve Test Procedures
- Review test results
- Schedule PMUs for each test cycle
- Sign-Off on various Testing Deliverables
- Coordinate delivery of PMUs
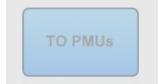- Distribute test results to stakeholders

Quanta Technology

- Provide Subject Matter Expertise
- Review/Contribute Test approach
- Review/Contribute Test procedures
- Review test results

Member TOs

- Work with vendors to provide PMUs
- Review test approach/procedures/results

2011.06.04

TO PMUs
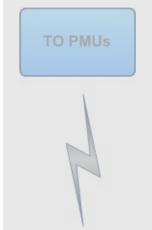
TO PDC

PJM PDC

Test performed by a typical TO

- Data Path (from the substation to the central PDC) is tested for pass-through traffic.

- Data Encapsulation (from the substation to central PDC) is tested for other traffic

- Physical security tests (substation and data center) are/will be performed per TO corporate guidelines

- Firewall equipment functional tests are/will be performed per cyber security requirements

- Connectivity tests between TO and PJM

TO PMUs

TO PDC

PJM PDC

PDC Functional Tests

- Aligned Data tests
- Unaligned Data tests
- Verify PJM requested Data
- Verify Measurement adjustments
- Verify all flags (for aligned and unaligned)
- GPS Clock tests
- Latency

- Command Signal Tests (PJM PDC turning on/off TO PDC
- Command Signal tests (TO PDC turning on/off a PMU)
- Naming Conventions (PMU Tests and PDC Tests)
- Config file changes (Both at PMU and PDC)
- Down Sampling Tests
- Performance parameters tests

Testing to be performed by Virginia Tech with subject matter expertise provided by PJM, Member TOs and Quanta Technology

PJM Communications Testing

TO PMUs

TO PDC

PJM PDC

Set-up Tests

At PJM

- Confirm Telecomm Requests Forms (TRF) are filled out correctly
- Verify PJM router installation is within TO Physical Security Perimeter (PSP)
- Initial configuration and tests on the router (all components, interfaces etc.)

At TO location

- Once router is placed, dial in and check connectivity
- Remote configuration and connectivity tests
- Security and readiness tests

Tests performed by PJM telecom team members in coordination with telecom provider and member TOs' telecom team

Test Categories

- Data Tests
- Configuration Tests
- Communication Tests
- Storage and Retrieval Tests
- Security implementation Tests

Test System

- Replica of Production
- Smaller storage
- VM Ware

Basic PDC functional tests to be performed by/at Virginia Tech
All PJM specific functions and scalability tests performed by/at PJM

TO PMUs

TO PDC

Test Categories

- Interoperability Tests
- Application Tests
- Interfaces Tests
- Scalability Tests
- Latency Tests
- Security Tests
- End-2-End Tests

PJM PDC

End-2-End tests performed by/at PJM

Questions?