PJM SynchroPhasor Technology Deployment Project
PMU/PDC Testing

Rahul Chhabra
Applied Solutions
PJM Interconnection LLC
Test Purposes

Ensure PJM and TOs current and known future needs are met

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

Goal:
- Primary: Validation
- Secondary: Performance Analysis
PMU Testing

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
PMU Testing

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
- Sign-Off on various Testing Deliverables
- 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
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 PDC Testing

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

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
PJM PDC Testing

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
End-2-End tests performed by/at PJM
Questions?