Synchrophasors in System Operations at Dominion Energy

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- 2.6 million customers in Virginia and northeastern North Carolina
- 6,700 miles of electric transmission lines
- 58,510 miles of distribution lines
- 31,000 megawatts (MW) of electric generating capacity
- Net Zero carbon and methane emissions by 2050
Synchrophasors in Dominion Energy

2009 – Kicked off synchrophasor initiative; DOE SGIG kickoff;
2012 – Began standardized relay/PMU sensor deployment
2013 – DOE SGIG Demonstration
  Linear State Estimator v1.0 released as OSS
2014 – CERTS Synchrophasor Data Conditioning and Validation Project
2015 – DOE FOA970 Kickoff
2017 – DOE FOA970 Demonstration
  Linear State Estimator v2.0
2017 – DFR PMU Conversion begins
  Total transmission system coverage
2019 – Scaling towards Sustainability
  High Performance Analytics Sandbox for Use Case Development

• Over 400 PMUs installed
• 5-year project to upgrade relay with PMU capability
• Data Analytics Engineering Group
• Synchrophasors in Operation
Synchrophasors in Operation

• Primary Drive
  ▪ Spare tire: system observability when losing EMS
  ▪ Ability to ensure EMS solutions and check questionable scenarios

• Expanded Functionality
  ▪ Wide area frequency monitoring
  ▪ Oscillation detection and mode monitoring
  ▪ Islanding detection and control
  ▪ System transient and dynamics monitoring

• 500kV Pilot Project – Full Observability
  ▪ Three main applications
  ▪ Real time contingency analysis
Pilot Project Applications

LSE
Direct matrix transform
Always solves
Serve its own downstream contingency analysis

Phase Angle Monitoring
System stress indicator
Prevent cascading events
Reclosing/Resynchronization

Frequency Monitoring
System power balance indicator
Major Generator Trip/Load Shedding
Oscillation Detection
Operator Acceptance - Training

- Cycle Training: Three Cycle Trainings last year
- Connection Point
  - Show Case
  - Historic Event seen by SCADA vs. Synchrophasor Data
  - Operational Concerns vs. Synchrophasors Solution
Operator Acceptance - Historic Event

Power Plant Oscillation

Blackout – Angle Separation
Operator Acceptance - Operational Concerns

Forced Oscillation from PV Islanding Scheme
CIP Implementation

• Architecture and data flow to support real-time and non-operational use cases.

• Ensure data flow is secure and meets all the security requirements:
  ▪ Comply with NERC requirements and guidelines for WAMS
  ▪ Comply with all relevant NERC CIP Security Requirements as required to utilize LSE inside of a SOC environment
  ▪ Other needs as surfaced from IT, security, networking, and compliance
Recommendation

• Relay PMU Standard
  ▪ Communication Protocol
  ▪ Relay setting and substation control drawing
  ▪ Substation PDC and OpenPDC Configuration
  ▪ Data check out process

• Relay PMU Data Quality
  ▪ Report and Maintenance
  ▪ Substation Technician

• Increase Support Head Count
  ▪ Compare to SCADA support for EMS system