Use of Synchrophasors and FNET at Dominion

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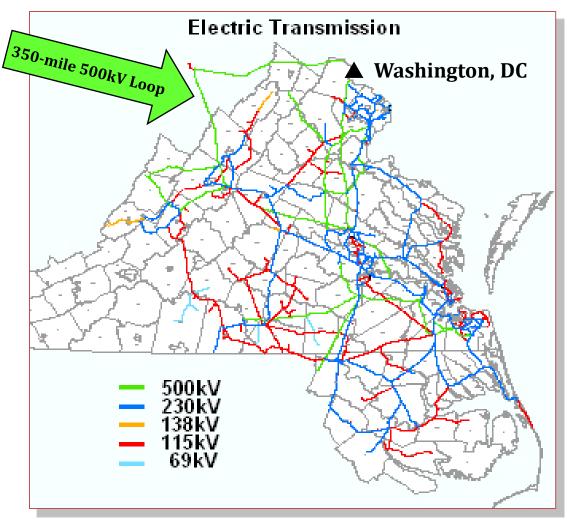


Dominion Electric Transmission System



Over 6,490+ miles of transmission line

- 6,490+ miles of electric transmission lines:
 - 500kV 1,275 miles
 - 230kV 2,775 miles
 - 115kV 2,275 miles
 - 138kV 65 miles
 - 69kV 90 miles
- 400+ transmission substations
- Dominion geographic footprint covers:
 - Major load centers
 - Government agencies
 - Military bases
 - Data centers



Synchrophasor Deployment

Initial focus on Transmission system

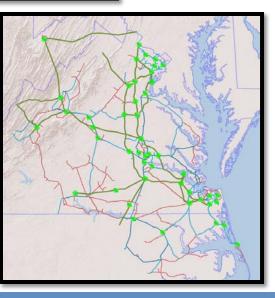
• DOE SGIG Projects

- 80 PMUs
- 21 500kV substations
- Sharing with PJM
- Advanced applications

• Standardization in 2013

- 300+ PMUs installed
- 230kV and 115kV systems
- < 0.5% of Total CapEx





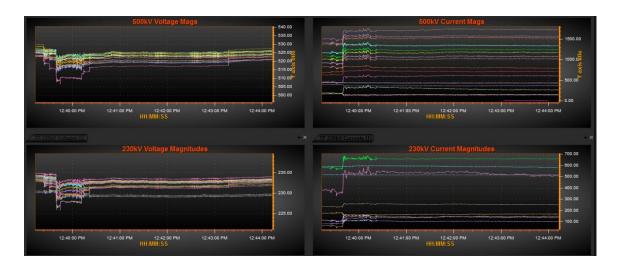


Synchrophasor Data & Applications

Dominion

Across the business unit

- Data available to all Electric Transmission departments
 - Transmission Planning
 - Protection & Control
 - Operations & Engineering



• Visualizations

 Deployed across all Electric Transmission





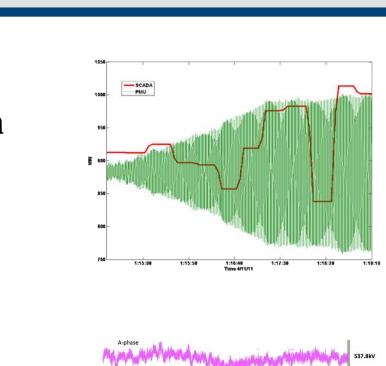
Synchrophasor Data & Applications

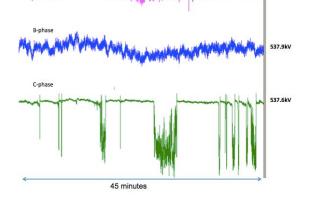
Across the business unit

- As transmission events occur, group responsibilities and responses are supported with synchrophasors
- Transmission Planning
 - Generator activity
 - Stability analysis
 - Model validation

Operations & Engineering

- Event analysis
- Root cause investigation





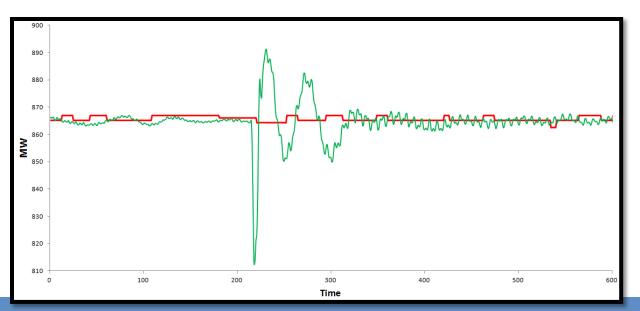


Event Analysis with Synchrophasor Data



- Main question always asked:
 - Why did generators swing?
- Any activity on Transmission system?
 - System faults
 - Transmission breakers opening
 - Activity in neighbor's system
 - DFR and other devices triggered?

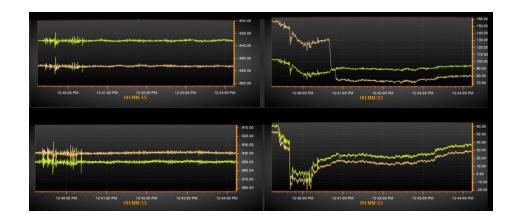
• Any similar activity on Distribution system?

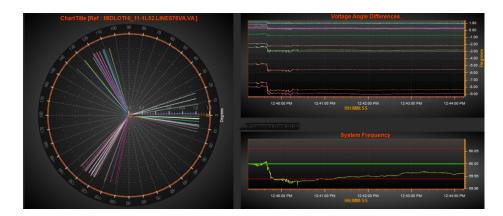


Event Analysis with Synchrophasor Data



- Instances occur where nothing occurred inside Dominion territory
- Faults far away are not typically observed, especially if cleared high speed
- Large frequency excursions are observed



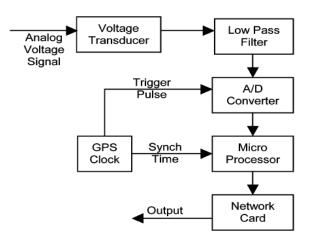




Application used to identify grid disturbances

- A network of Frequency Disturbance Recorders (FDRs) installed throughout the world
- Measures the voltage phasor from an electrical outlet
- Voltage magnitude, angle, and frequency is synchronized by GPS time reference
 - Produces voltage synchrophasors
- Data transmitted to servers at UTK and ORNL

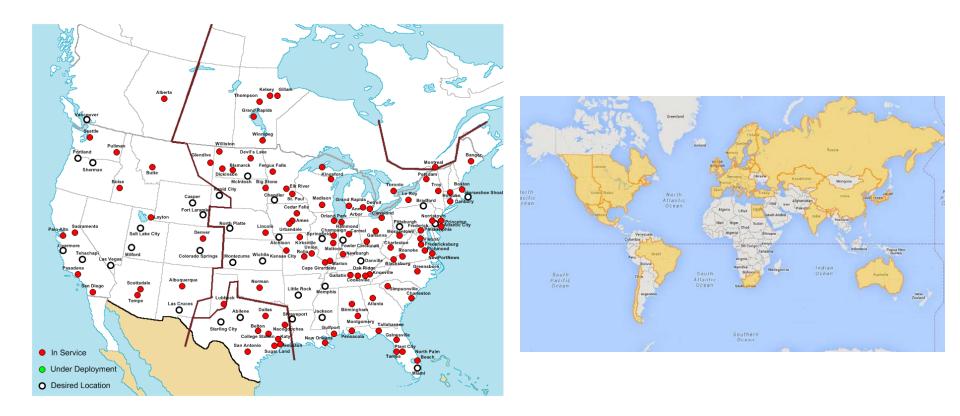






Application used to identify grid disturbances

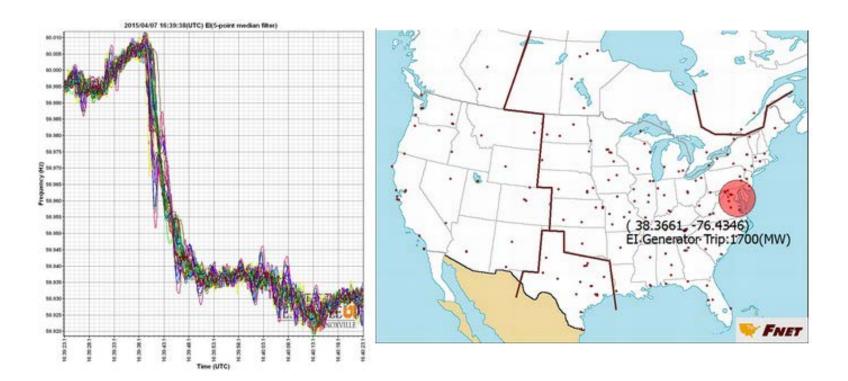




Automatic event disturbance detection



1700MW EI Generator Trip at 16:39:38 UTC, on mm/dd/yyyy near *name* Power Plant (city,state zip; Latitude: 38.3661, Longitude: -76.4346)



Immediate information to support many parties

- FNET processes data, detects events, and sends notification emails within 1-2 minutes of actual event
- Allows for immediate verification of observations seen in other data, such as synchrophasor and SCADA data
- When these large events occur, can quickly provide information to grid operators and plant operators
- Creates a database of significant grid events to use for further study
 - Generator model validation
 - FACTs model validation

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