Technology Innovation Project

Project Brief

TIP 305: Data Integrity and Situational Awareness Tools (DISAT)

Context

The recent increase in the deployment of high-speed time-synchronized measurement devices such as phasor measurement units (PMU), provides a great challenge and opportunity to the power grid community.

Significant challenges include managing the substantial amounts of data, cleaning that data, and then creating insightful analyses and displays. There is a great opportunity to provide system engineers real-time tools that increase their understanding of the current state of the grid and refine predictions of future grid behavior.

Pacific Northwest National Laboratory (PNNL) has undertaken substantial research efforts investigating these challenges in collaboration with many utilities and the Department of Energy (DOE).

Description

This project focuses on PMU data management architecture, identifying and correcting data errors, and building real-time situational awareness tools to enhance grid visualization. These tools will provide power system engineers an increase in their understanding of the wide-area dynamic state of the grid, predictions of future grid behavior (potential types of violations, their probability, critical contingencies, and time to violation), as well as actionable advisory information such as preventive controls to help manage potential problems such as grid instability.

The project evaluates alternative architectures and provides a recommendation for a database environment capable of supporting both real-time analysis of "recent" data records and offline analysis of large historical data sets.

The next step is handling the data quality. In our previous experience working with PMU data, we validated four data cleaning filters: 1) flags within the data, 2) missing data, 3) constant values, and 4) white noise. Should more bad data be identified when working directly with system engineers, additional filters can be added.

As data is determined to be missing or bad, existing algorithms will be applied and new logic will be constructed to identify suspect data values as unavailable for all future analyses. New types of data filters will be investigated to confidently synthesize a corrected data value.

The project will then employ, enhance, and test two tools that have been developed at PNNL: 1) SitAAR (Situational Awareness and Alerting Report), a data-driven multivariate approach to situational awareness; and 2) WAMN (Wide-Area Multidimensional Nomogram tool) which is combined with a characteristic ellipsoid (CELL) tool providing a wide-area, predictive, and actionable view of a power system.

Interactions with power system engineers will allow the project team to tune these algorithms and improve their usefulness, robustness, and predictability of the system behavior.

Why It Matters

Synchronized phasor measurements provide an opportunity to monitor dynamic behavior of a power system in real time. PMUs measure synchronized voltage and current phasors, frequency, and other data. Potential uses of sub-second PMU data collected from various locations within a power grid promise endless benefits for applications that target reliable operation of the system. Typical application areas of phasor measurements in power systems include state estimation, stability analysis, security assessment, event identification and fault location, and others. Among the applications, rapid and accurate detection and identification of transient events is increasingly important to secure operation of the system.

Current development of the synchrophasor wide-area measurement system (WAMS) necessitates development of much-needed industry-grade applications using PMU measurements.

A significant part of this problem is bad or missing data points, lagging and time aligning issues, large quantities of PMU information, and data processing problems. Failing to properly handle these problems will continue to hinder any robust and continuous analyses of the data. The proposed data quality filters and methods developed within this project will greatly increase the usability and application-related value of the data.

Analytical techniques can handle any missing variables and look at multivariable relationships and issues. The data-driven and model driven approaches will give system engineers insight into the current system that had not previously been available.

Goals and Objectives

The project will create databases to handle large amounts of PMU data. Data cleaning filters will be adapted and applied to this data to help capture the true meaning of the contained information.

Data mining techniques will be applied to this data. Unusual events will be identified and typical baseline behavior will be established.

Analytical tools will be developed to help the power system engineers investigate the data. These tools will focus on providing insight into unusual data events and understanding into typical behavior.

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Reports & References (Optional)

Links (Optional)

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Participating Organizations

Pacific Northwest National Laboratory
United States Department of Energy (DOE)