Detecting Disturbances in Power Grid using Multiple PMUs

HITACHI
Inspire the Next

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Overview

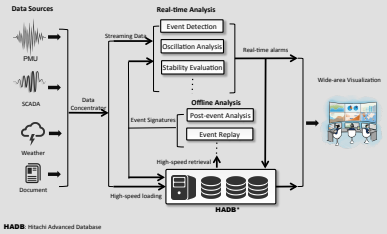
- Building a high-performance framework to facilitate big data analytics in the power grid
- Taking the first step to analyze the correlations among the data collected from multiple PMUs in a wide area
- Detecting disturbances in the transmission grid based on various patterns of PMU measurements in a wide area
  - Considering the abnormalities, such as small disturbances, switching events, and topology changes, which are usually hard to capture by operators.
  - Helping the operators to identify the root causes, locate the

Northeast blackout of 2003: The Challenge

- The second most widespread blackout in history
  - A tree branch in Ohio started an outage
  - From Michigan to New England and Canada
- Investigation Report
  - Caused by inadequate situational awareness for grid operators,
  - Recommended the use of PMU technologies to provide this real-time wide-area grid visibility

Big Data Analytics Platform for Power Grid

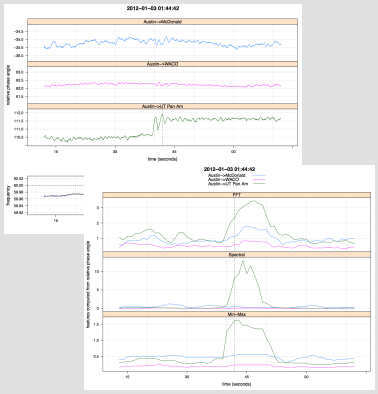
- Handling various types of data sources
  - Structured data: PMU, SCADA, …
  - Unstructured data: documents, logs, …
- Extendable analytics platform
  - APIs for data management
  - Data analytics libraries
- Smart decision support
  - Offline analysis: learning event signatures
  - Real-time analysis: event detection
- High-speed data access
  - x100 fast Database Engine
  - Ad hoc data retrieval



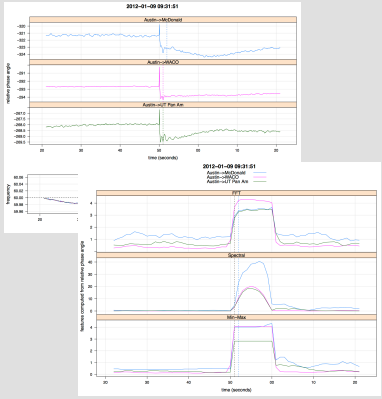
Event Detection

- Features:
  - Max FFT amplitude
  - Max spectral density
  - Max change
  - …
- For each PMU and each data series (e.g., "relative phase angle"), features are computed from a sliding window of data:
  - Depends on computational load: #PMUs, complexity of features
  - Easily distributed!
- Event screening
  - Adaptive detection threshold

Local Event

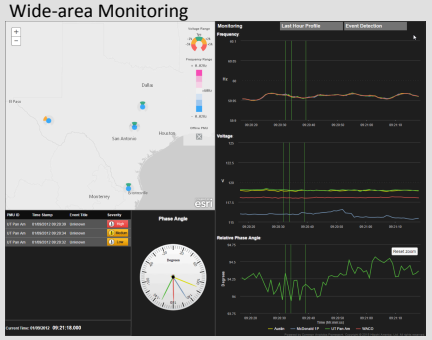


Global Event

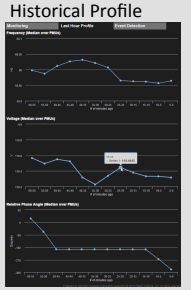


Decision Support System

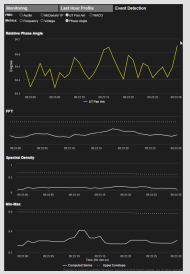
Wide-area Monitoring



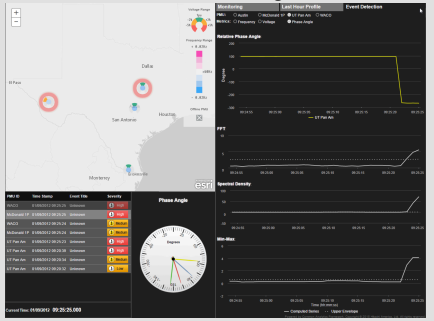
Historical Profile



Event Detection



Real-time Detection and Alarming



Future Plan

- Detecting, locating, and classifying disturbances
- Correlation techniques to identify failures
- Countermeasures Recommendation