



TIP 324: Faster Than Real Time State Estimation with Forecast for Multiple Contingency Analysis

Context

With the fast deployment of renewable energy technologies, the impact of the wind/solar power on the power grid operation is increasing. While these renewable energies have significant contribution of clean energy and reducing the CO₂ emission, their intermittence and uncertainty bring new challenges to grid operation. For example, based on the BPA wind generation data provided by BPA, on 4/15/2014, the generation can change from in a range of 0 to 4,000 MW. From 2am to 2:05am the wind generation changed from 3027 MW to 3471 MW, a total of 444 MW in only 5 minutes. Such a difference cannot be ignored for improving grid operation and reducing the pay rate for custom price.

Traditionally, state estimation and contingency analysis functions (static and dynamic) in control center are based on sequential algorithms and do not involve energy and load forecast information. As a result, their execution time is usually longer than required for optimal decisions in real-time operation and does not consider projected energy information. This situation could cause problems when the uncertainty and the long-term prediction error of energy is large.

In order to bring predictive capabilities into grid operations, the energy and load forecasts must be considered within state estimation and contingency analysis, and solved with faster computational speed.

Description

The traditional state estimation and contingency analysis do not include forecasting of energy and loads. The state estimator is executed based on serial computation techniques. With the increasingly dynamic nature of the grid, today's tool would not be able to achieve real-time and predictive analysis of system events.

This project improves the performance of state estimation and contingency analysis (static and dynamic) by including forecasts of energy and loads into both functions and implemented with high performance computing (HPC) techniques, including multi-threading technique. The proposed technology will enable the capability of bringing forecast information of multiple contingencies in a short-time frame to improve situational awareness. The impact of uncertainties in forecasts will be quantified with

mathematically-based approaches, such as smart sampling technique.

There are three major tasks in this work

1. Development of state estimation and static and dynamic contingency analysis algorithms to include energy and load forecasts.
2. Development of smart sampling techniques to reduce the number of multiple contingencies to reasonable representative set and quantify the impact of forecast uncertainties in contingency analysis.
3. Development of an integrated prototype of faster than real-time state estimation and multiple contingency analysis with forecasting information with Alstom Grid EMS tool suite.

Why It Matters

Predictive capability will provide significant support for the Bonneville Power Administration's (BPA) transmission operations, ensure reliability while maximizing efficiency, and effectively reduce costs for BPA customers.

With the new capabilities BPA can expect:

- Enhanced situational awareness
- Improved grid reliability and efficiency by considering the near-future information into current operation
- Faster event analysis of an increasingly dynamic grid
- Increased transmission capacity that better utilizes transmission assets
- Better understanding of the behavior and operations of distributed and intermittent resources
- Better understanding of multiple contingency events and their impact

Goals and Objectives

The primary result of this project will be enhanced state estimation and contingency analysis functions that includes forecasts of energy and loads based on smart sampling techniques and HPC technologies. The functions will be interfaced with Alstom tool suite bi-directionally to show the feasibility of integration with Alstom tool. The successful development of such a capability can directly benefit BPA for bringing forecasting information to improve situational awareness

Deliverables

- 1) A prototype of developed tool that is able to execute multiple contingencies with forecast information much faster than today's tool and smoothly interface with Alstom tool to show the feasibility of integration with ALSTOM tool
- 2) A demonstration of the developed prototype functions with Alstom tool to show the tool effectiveness with
 - a. Near linear speed up performance for multiple contingencies
 - b. Uncertainty information in state estimation and contingency analysis to better describe the stochastic nature of today's power grid
- 3) A project report on the overall project outcomes

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Project Start Date: October 1, 2014

Project End Date: September 30, 2016

Reports & References (Optional)

Links (Optional)

Funding

Total Project Cost:	\$800,000
BPA Share:	\$400,000
External Share:	\$400,000
BPA FY2015 Budget:	\$200,000

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Participating Organizations

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Alstom Grid
U.S. Department of Energy

