TIP 345: Advanced Visualization for Improving State Awareness for the BPA Power System

Context

With the fast deployment of smart grid technologies, including renewable energy resources, the amount of data operators need to handle is growing rapidly. Meanwhile, operators face the challenge of integrating new mechanisms for handling intermittency, like 15-minute scheduling and probabilistic flow and load forecast systems. Today’s visualization tools are inefficient at extracting and presenting critical information. Therefore, there is a great need to develop advanced visualization tools to handle data complexity for different applications, in particular, the information associated with uncertainty.

Description

The fundamental approach for this project will be to identify the visualization needs based on practical cases, identify the critical information and the associated interface for the display, and develop prototype displays for evaluation against current control room tools.

The PNNL experts in power systems, ecology, hydrology, and visualization will coordinate with BPA operators and PNNL usability experts to develop the best visualization solutions for BPA’s current and emerging operating environments.

The project tasks are as follows:

- **Work with control center staff to solicit the initial visualization requirements.**
  Using systematic approaches, user researchers work directly with the end-users to understand their goals, tasks, job responsibilities, and the environmental and cultural pressures in which the users perform. By finding patterns among the users, personas and use cases are created to guide the development process

- **Develop a data framework to manage data streams.**
  Data management techniques will be developed to identify critical information for display. The critical information will be extracted from multiple data resources in different file formats. The project will develop an underlying data framework for managing both static and dynamic data.

- **Develop user-centric visualization techniques to present the data efficiently.**
  To address visualization requirements, we will adopt and adapt information and scientific visualization techniques to support power system operations, analysis, and decision making. For example, flow visualizations such as stacked charts and story flows would address a number of visualization requirements

- **Evaluate the techniques developed.**
  The project will conduct formal usability evaluations that will have system operators perform specific hydro operations, or grid operation and analysis use cases using their existing tools, visualization tools developed on the project, and other comparable open-source or commercial tools with related capabilities.

- **Create a transition plan for the developed technology.**
  We will work with stakeholders and BPA to review the tool and determine the transition plan to make the prototype a supported control room software tool.

Why It Matters

In today’s Federal Columbia River Power System (FCRPS), large amounts of data are used to evaluate the system state. There are challenges to getting the most relevant information in front of power system operators, especially about variable resources that contain uncertainty information. Much of the data fusion happens in an operator’s brain, encroaching on some of the bandwidth needed for decision making. With the new requirement of 15-minute scheduling and zonal/nodal scheduling, the amount of data will increase still further. The current display techniques that rely on numerical data and tabular displays will not be able to meet operators’ needs. Therefore, a novel data visual analytic design for the FCRPS can help fuse multidimensional data with uncertainty information for quicker informed decision making, maximizing the value of the FCRPS to all stakeholders.

Goals and Objectives

The goal of this project is to develop advanced user-centric modular visualization tools to help present critical information from a large amount of multidimensional data in an effective way for improved power system state awareness. Because they are modular, the visualization tools are suitable for other power grid applications such as transmission contingency management, which must also rapidly convert data to information.

The objective is to demonstrate the visualization tools through examples from pressing challenges for hydro operations as they integrate 15-minute scheduling and probabilistic flow and load forecasting.
Deliverables
The project will achieve the following:
• A final platform that is able to display synthesized data and enable visual analysis to support operators
• A demonstration of the developed prototype functions with the Alstom tool
• A project report on the overall project outcomes.

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Project Start Date: October 1, 2015
Project End Date: September 30, 2017

Funding
Total Project Cost: $500,000
BPA FY2016 Budget: $250,000

Reports & References

Links

Participating Organizations
Pacific Northwest National Laboratory
Alstom Grid
US Department of Energy

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