ELECTRIC GRID RESEARCH

Project Summary

Scoping Study of Intelligent Grid Protection Systems

Context

System Protection state-of-the-art technology utilizes discrete microprocessor (digital) relays that can be programmed individually or to work in tandem to protect transmission lines, transformer banks and generation. Some of the more advanced digital protective relays incorporate GPS receivers, digital fault recorder capability, and phasor measurement unit (PMU) technology engineered into one relay. These relays are set based on a prescribed set of conditions assuming relatively normal system configuration. There are, however, conditions that can vary significantly from normal, and the protective relays can sometimes mis-operate, either operating when they shouldn't or failing to open when they should. In virtually all of the major blackouts in the last thirty years, protective relays have played a major role in causing the blackout, exacerbating the blackout or failing to mitigate the spread of the blackout.

There are, however, new and potentially more intelligent system protection technologies, utilizing phase angle (synchrophasor) measurement and other features, which can create a more "ductile" and adaptive grid system.

Goals and Objectives

The goal of this project was to perform a scoping study which would identify, evaluate and prioritize the system reliability, increased transfer capacity and other benefits that might be derived from the research, development, and field test validation of new intelligent system protection technologies.

Description

The general approach was to:

- Evaluate system protection issues, needs and opportunities in consultation with key stakeholders of the transmission system.
- Review the state-of-the-art in intelligent system protection technologies for addressing these issues, needs and opportunities with manufacturers and suppliers of promising system protection technologies;
- Review ongoing system protection R&D, field test validation projects and industry standards activities and explore opportunities to collaborate on RD&D that is synergistic with California's system protection issues, needs and opportunities;
- Develop prioritized recommendations for intelligent system protection R&D, field test validation and other related technology transfer activities that offer the potential to yield significant reliability, increased transfer capacity and other benefits for California's electricity consumers; and
- Review and obtain feedback on this recommended system protection R&D agenda from a Technical Advisory Committee, equipment manufacturers and other industry experts.

Key Results/Conclusions

Almost all protection and control schemes on the grid today are local in nature. The sensing and tripping typically take place in one substation. The primary interest in applying synchrophasors is from a wide area standpoint because the intelligence to detect a stressed system that is close to collapse can only be determined from a wide area. Potential applications that hold promise are wide area voltage control, small signal stability control and transient/dynamic stability control.

Special protection schemes (SPS) are the primary means of wide area control today. Current SPS schemes are prescriptive in that they are largely based on offline studies. A step forward would be to develop methods to control transient stability that are less dependent on off-line studies and use more on-line computation. What is recommended is to develop soft-computing techniques using pattern recognition, neural-networks and expert systems to decide upon the best control action. This type of approach for special protection schemes is unprecedented and would be considered a proactive type of scheme in that action could be taken ahead of time to prevent outages from occurring in the first place. Demonstrations of such approaches are a logical next step.

Why It Matters

Cascading blackouts, while rare, are extremely costly to virtually all stakeholders in the electric power system. The blackout of August 14, 2003 on the East Coast affected 50 million people at a cost to society of between $7 to $10 billion, and operation of protective systems was determined to be a significant factor contributing to the cascade. This research can lead to a more reliable electric system by reducing the frequency and scale of cascading power system blackouts.

{More details}

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Participating Organizations

Principal Investigator:

Stuart Consulting

Participating Researchers:

Washington State University

Research Advisors:

Bonneville Power Administration
California Independent System Operator
Pacific Gas and Electric Co.
Pacific Northwest National Laboratory
Schweitzer Engineering Laboratories
Southern California Edison Co.
Virginia Polytechnic Institute

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Reports

Final Report: *Scoping Study of Intelligent Grid Protection Systems*

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