ELECTRIC GRID RESEARCH

Project Summary

Advanced Protection Systems Using Wide Area Measurements

Context

Recent blackouts on power systems of North America and several other systems throughout the world have shown how critical a reliable power system is to modern societies, and the enormous economic and societal damage a wide spread blackout can cause. It has been noted that during the cascading phenomena which lead to blackouts, some protection systems operate in an unanticipated fashion and such operations are often an important contributing factor in the sequence of events leading to cascading outages. Considering the very large number of relaying systems in existence (by a rough estimate over 5 million on the North American Power Grid), it is to be expected that some of these unanticipated operations are due to failures in the protection system that are masked by other system disturbances. This has been documented as "the hidden-failure phenomenon in protection systems", and has been recently investigated. Other contributing factors to catastrophic failures are unexpected power system configurations which have not been foreseen when protection systems were initially configured, errors in setting and calibration of relays, or undiscovered design flaws in the protection systems.

In recent years, innovations in the field of power system protection and power system operation have made possible new potential proactive approaches to the supervision of protection systems so that the likelihood of catastrophic failures of the power grid are significantly reduced, the regions of the power system affected by such events are limited, and the power system restoration process can be speeded up.

Goals and Objectives

This 3 year project seeks to research, develop and evaluate the use of synchrophasor technologies to monitor, supervise, and modify the protection systems in real-time based upon the information about the state of the power system provided by the measurements.

The objectives of this project are to develop algorithms for each of these applications and to demonstrate through simulation that each application can provide real improvements of protection systems in general and California systems specifically.

Description

This project will research, develop and analyze the performance and reliability and other benefits of three new, complementary, and potentially high-impact adaptive electric grid protection technologies that could reduce the probability of cascading blackouts.

Each of these protection applications exploits the expanded intelligence about grid operational conditions provided by wide-area synchrophasor measurements, coupled with rapid analysis and optimized selection of effective grid control actions, to significantly improve the overall performance of grid protection systems and avoid cascading blackouts.

For each application, the project will analyze the sensitivity to location and develop lists of critical locations for synchrophasor measurements. Algorithms for each application will be developed and then evaluated on appropriate models of the California transmission grid.

Three specific applications of the protection system supervision and control have been selected for research:

1. Adaptive Relaying: On-line adjustment of protection system's security-dependability;
2. Real-Time Alarms: Encroachment of relay trip characteristics; and
3. Adaptive Out-of-Step Relays: Out-of-step generator protection on critical tie-lines.

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 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

Principle Investigator:

Virginia Polytechnic Institute

Advisory Team Representation:

Pacific Gas and Electric;
Southern California Edison;
California Independent System Operator;
Bonneville Power Administration;
U.S. Department of Energy;
Pacific Northwest National Laboratory
Georgia Tech;
Schweitzer Engineering Laboratories;
General Electric;
Elequant;
Infrasource, Inc.;

Project Start Date: October 14, 2006

Project End Date: September 30, 2010

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Reports

Final Report: Advanced Protection Systems using Wide Area Measurements (Not yet available)

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Funds for this project came from a $609,000 award by the California Energy Commission (CEC) through the Public Interest Energy Research program (PIER)

For More Information, Contact

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