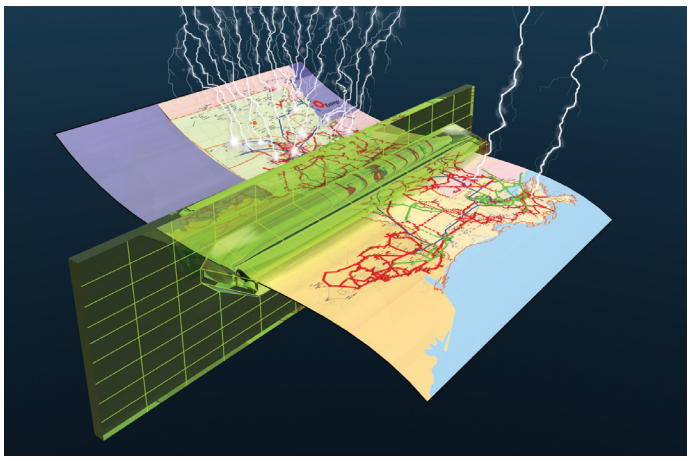
EPRI | ELECTRIC POWER RESEARCH INSTITUTE

innovators WITH EPRI TECHNOLOGY

Entergy Pioneers Use of Fast Fault Screening Tool to Identify Severe Contingencies for Transient Stability Studies



Fast Fault Screening quickly scans thousands of potential transmission fault locations and identifies the most severe locations.

Results and Benefits

- Fast Fault Screening (FFS) is a software-based methodology that screens thousands of potential transmission fault locations for grid stability analysis and quickly identifies the most severe locations for more-detailed time domain simulation studies.
- FFS saves power system planning and computation time. On average, Entergy found a reduction in computation time of at least 50%.
- Entergy estimates savings of 300 man-hours and $27,000 for NERC Reliability Standards compliance-related studies.
- FFS provides a practical tool to perform transmission system transient stability studies required under the forthcoming NERC standard TPL-001-1
- Collaborative development of FFS resulted in a methodology that utilities can adapt and apply to screen faults on their transmission systems
- The SERC 2007 Audit report recognized Entergy's proactive efforts in developing the innovative methodology
- As part of Entergy's Continuous Improvement Program (ECI), FFS was recognized as a "Success Story".

The Challenge: Identifying the Grid's Weak Points

Increased power transfers, uncertainty in dispatch, high load growth and the addition of new power plants at weak locations in the grid can make power systems more vulnerable to transient stability violations. To ensure transmission system reliability, utilities need to identify weak points in the system—i.e., severe fault locations—to understand their potential impact on grid stability and, where necessary, mitigate them.

For grid stability studies, the traditional approach for identifying weak points was to perform time domain simulation at different locations based on engineering judgment, a very time-consuming method that can miss key problem areas if system characteristics have changed. Power system planners and operators need a faster way to assess grid stability and identify the most severe fault locations.

Emerging regulations also underscore the need for better fault-screening tools. NERC, as the Electric Reliability Organization, is developing a new transmission planning standard (TPL-001-1) that will require utilities to study transient stability over a broader range of scenarios than they had previously analyzed. Faster fault screening would enable utilities to comply with the standard in a timely and cost-effective manner.

Proactive, Collaborative Innovation

As the standard was being considered and proposed, Entergy saw the need for improved fast fault-screening capability. When independent power producers began building generation plants in Entergy's service territory in the early 2000s, the utility's transmission planners realized that existing methods were inadequate to assess the impact of the additional generation on grid stability.

Entergy staff were familiar with an advanced EPRI methodology called Probabilistic Reliability Assessment (PRA) from their participation in the 2000 Grid Reliability Initiative. PRA combines a fast contingency screening tool with risk-based reliability assessment methodology for steady-state power flow analysis. Entergy's Sharma Kolluri and Sujit

> "FFS is a first of its kind tool in the industry and a powerful one for finding stability problems in large and complex power systems."
>
> Sharma Kolluri
> Manager, Transmission Planning
> Entergy

Mandal met with EPRI's Stephen Lee to develop a similar approach to screen transient stability problems. "With a high influx of new generation in our system, we are seeing the potential for new stability concerns," says Kolluri. "Our challenge is to identify these problems and come up with the right mitigation plans."

Entergy and EPRI collaborated with a software vendor to develop and apply a methodology called Fast Fault Screening (FFS) to quickly locate and rank the most severe faults in the Entergy transmission network. The team focused on three-phase faults, which are the most problematic because they can cause generator tripping and cascading outages that could lead to costly and disruptive regional blackouts.

The methodology first determines fault locations using a heuristic approach based on two criteria: 1) the difference between power flow through a bus and generator power output in the vicinity of the bus, and 2) the magnitude of real power leaving a bus. Next, FFS ranks the severity of the identified faults using a ranking index (RI). The RI is based on critical factors that impact the dynamic stability of a power system, including generator kinetic energy, electrical torque, and voltage.

The project team added the FFS methodology to the Physical Operational Margin Transient Stability (POM-TS) dynamic simulation software tool. POM-TS is a fast and user-friendly comprehensive dynamic simulation tool that determines transient stability limits after a disturbance is applied to the power system network. The researchers then performed a study to validate the proof of concept using the Entergy load flow and dynamics data, and benchmarked the FFS results using full time-domain simulation.

Results, Benefits, and Application

- The FFS screened over 1300 buses and took less than a minute to locate and rank the most severe faults in the Entergy power system.
- The fast-screening approach enables real-time transient stability analysis to focus on the most severe faults and reduces run time for grid planning studies.
- FFS significantly reduces the time required to perform NERC Reliability Standards compliance-related studies.
- FFS gives system planners a systematic method to screen from a large number of possible fault locations and identify those that are potentially most problematic. Planners can then analyze the most high-ranking faults using detailed time domain simulation to determine the faults' impact on system stability and, as necessary, mitigate problems to ensure system reliability.

Benefits of Entergy's Applications

- Entergy estimates savings of 300 man-hours and $27,000 for NERC Reliability Standards compliance-related studies.
- Cost savings in assuring soundness of contingency screening.

Related Work

In an ongoing collaboration, Entergy and EPRI are adding capability to FFS to apply the methodology for screening single-line-to-ground faults. This is being done in anticipation of the requirements of the emerging TPL-001-1 transmission reliability standard. EPRI is also collaborating with a New York State organization to demonstrate the FFS methodology on a large-scale transmission network in the state. This New York State project will build on the Entergy results and yield additional lessons useful to other utilities interested in applying FFS.

EPRI Perspective

The FFS offers a unique capability to determine a user-selected number of the most severe faults in less than one minute. Thus, it may be used for real-time transient stability assessment. Developed through a model collaborative R&D effort that built upon existing methodologies and software, this practical methodology is available to EPRI members and can be implemented by any software vendor in their commercial software.

Says EPRI's Stephen Lee, "With the success of the FFS implementation at Entergy, EPRI can now move to extend this methodology to consider system stability and inter-area oscillations." Interested utilities are welcome to participate in the next phase of the collaborative development effort.

Further Reading

Applying Smart Logic for Fast Fault Screening to Entergy's Power System (1014544)

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

Technical Contact

Stephen Lee at 650.855.2486 (slee@epri.com).

1018728 February 2009

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com