Transmission Reliability Research Review

Integrated Security Analysis

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Objectives

- Identify new requirements for security assessment
  - Industry survey
  - Holes in tools
  - Future needs
- Explore new analysis alternatives and algorithms
  - Integrate complex tools
  - Exploit ANN technologies
  - Compare and assess accuracy and effectiveness

Stakeholders

- Independent System Operators
- Security/Reliability Coordinators
- NERC Regions
- Transmission Companies
- Generation Companies
- Control Area Operators
- Software Vendors
- Marketers

Major Accomplishments

- Functional requirements for a future framework have been identified
- Existing tools have been evaluated
- Holes in current security analysis have been identified
- New techniques for integrated security analysis have been developed and tested using ANN
  - Offline training for margin estimation
  - Tested on 39-bus, 4,000-bus and 6,000-bus systems

Organizations surveyed

American Electric Power
American Transmission Company
Baltimore Gas & Electric
BC Hydro
Bonneville Power Administration
California Independent System Operator
Commonwealth Edison Company
Duke Energy
Florida Power Corporation
ISO New England

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Organizations surveyed

Kansas City Power and Light

Mid-American Interconnected Network

Northern States Power

Ontario Hydro Services

PJM Interconnection

Rocky Mountain Desert SW Security Center

Salt River Project

Southern Company Services

Southwest Power Pool

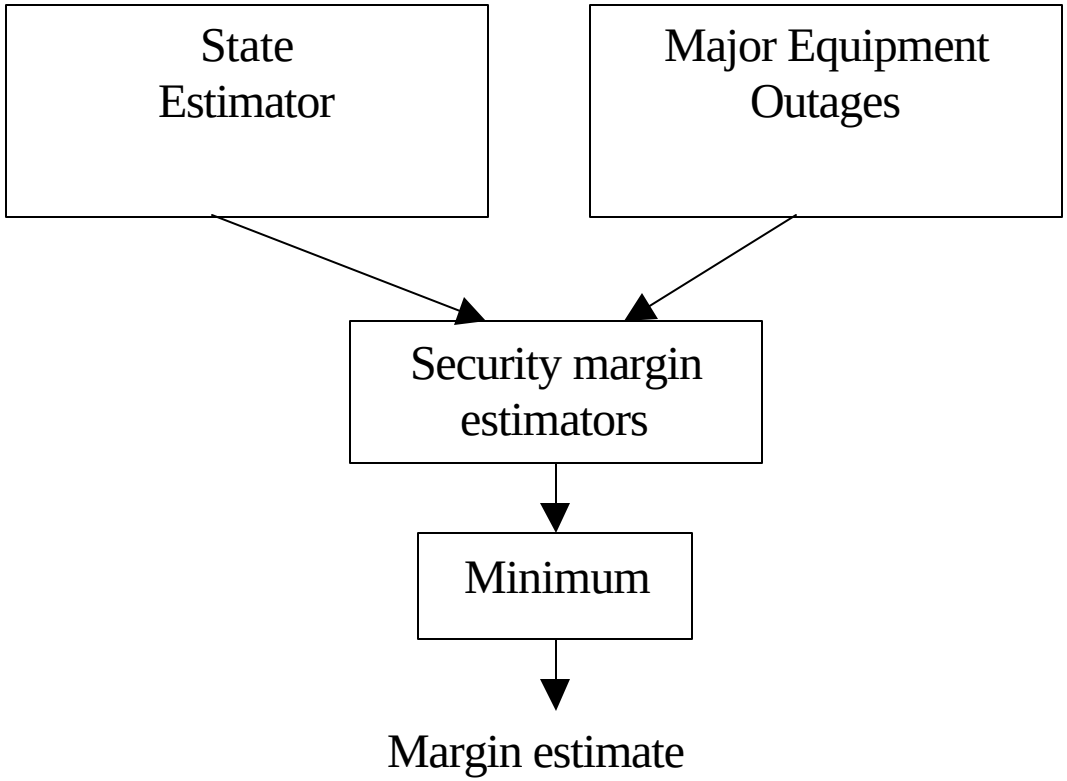
Security tools

- Power system model
- Network reduction
- SCADA
- Power Flow
- State Estimation
- Static contingency analysis
- Security constrained dispatch
- Optimal power flow (OPF)
- Security constrained OPF
- Voltage/VAR dispatch
- Transient stability analysis
- Mid-term stability analysis
- Long-term stability analysis
- Eigenvalue analysis

Survey results

- Lack of current external data and data exchange
- Lack of coordinated alarm processing and decision tools
- Lack of systematic on-line fault current analysis
- Lack of visualization aids
- Minimal voltage collapse analysis capability
- Minimal voltage/VAR dispatch programs
- Minimal dynamic security assessment capability
- Minimal security-constrained OPF
- Minimal on-line operational guidelines
- Minimal risk-based contingency processing
- Minimal use of uncertainty

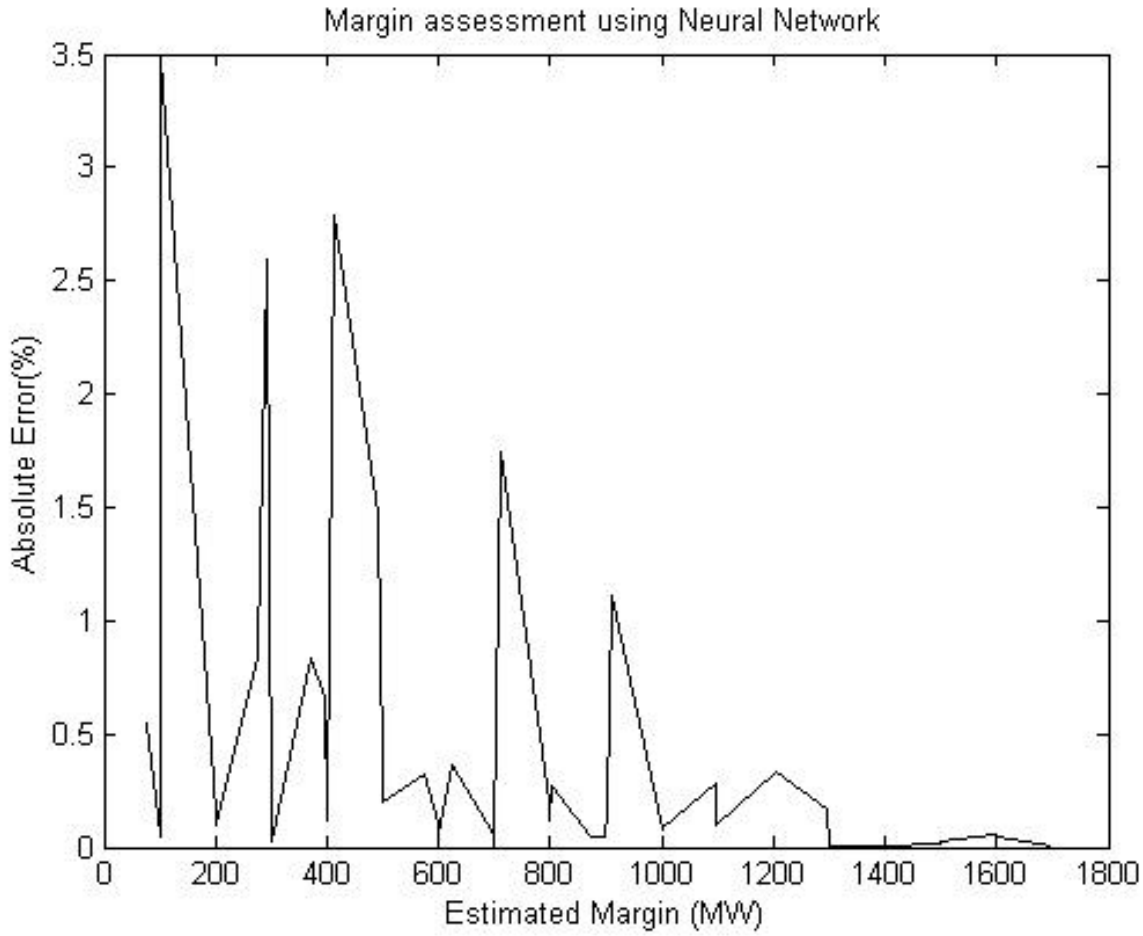
Security margin estimation



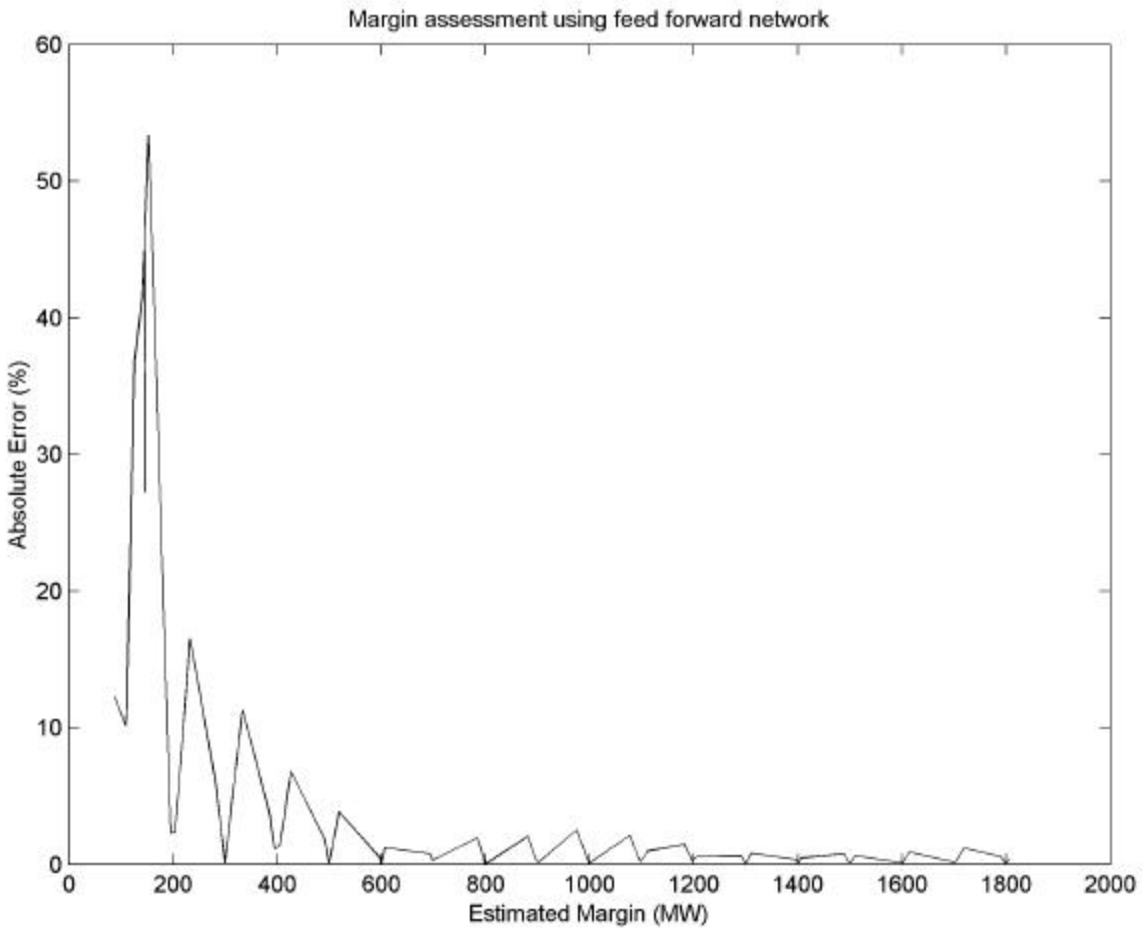
A new approach

- Training sets
  - IPFLOW – interactive power flow
  - VSTAB – voltage stability assessment
  - ETMSP – power system dynamics
- Feature selection
  - Active power flow in all lines
  - Reactive power flows in all lines
- ANN margin estimators
  - Levenberg-Marquardt
  - Bayesian Regularization

Voltage security margin results (WECC)



Dynamic security margin results (WECC)



Significance of the results

- The survey results are consistent among responders
- The results mirror many of the causes indicated in the investigation findings of August 14
- The results indicate needs in technical, procedural and administrative arenas
- The results define a roadmap for future security analysis
- The ANN approach to security margin estimation works well for voltage security assessment, but not as well for dynamic security assessment

Deliverables

- Integrated security analysis tools survey data synthesis report (final version currently being completed).
- Results of prototype utilization of commercial security analysis software in an integrated form (completed in June, 2002).
- A. Sittithumwat and K. Tomsovic, "Dynamic Security Margin Estimation using Artificial Neural Networks," *Proceedings of the 2002 IEEE PES Summer Meeting*, July 2002, Chicago.
- Final project report (currently being completed).

Next steps

- Prioritize needs
- Reflect priorities into RTGRM roadmap
- Collaborate with industry/NERC to consider a complete update of local and inter-area communication and computing architectures
- Continue to address hard issues of model accuracy
- Continue to address hard issues of computation