ERCOT’s Experience in Identifying Parameter and Topology Errors using State Estimator

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ERCOT

2010 IEEE PES General Meeting, Minneapolis
29th July 2010
ERCOT Capacity and Demand

- **One of the largest single control areas in US**
  - 40,327 miles of transmission (345kV & 138kV)
  - 85% of Texas load

- **Capacity**
  - 75,755 MW active generation (84,237 MW installed)
  - Current reserve margin ~21.4%
  - Wind capacity: 9,117MW – most in nation

- **All-time Peak Demand**
  - 63,400 MW peak load (July, 2009)

- **Market Size**
  - 6 Million Customer with right to choose
  - $ 34 Billion Market
• Role of the operator is to know the status of the system and make sure that it is always very secure (N-1 Secure)

• Real-Time Network Security Analysis
• AREVA’s EMS is used in ERCOT
  - Some functions were developed internally in ERCOT

• Application Functions
  - State Estimation (RTNET) –WLS Method
  - Real-time Contingency Analysis (RTCA)
  - Dynamic Ratings (developed internally)
  - Study Network Analysis (STNET)
  - Voltage Stability Analysis (VSAT)
  - Transient Stability Analysis (TSAT)
SE Statistics (SESTATS)

SESTATS is a tool developed in-house at ERCOT. It monitors SE performance and metrics, and aids in identifying possible topology errors. The metrics captured by SESTATS include:

- Topology changes in the power system as seen by SE
- Availability of real-time telemetry to SE
- Quality of the real-time telemetry based on the estimates computed by SE
- Convergence quality of the SE solution and an SE execution summary
- Detected measurement residuals (categorized based on equipment types)
- Measurement redundancy and observability information
- Statistics data derived from the above information compiled to analyze long term trends

### State Estimator Overall Monitoring

**Application:** Realtime Network

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Coherency Check Using SESTATS

- Dead Equipment with Active Measurements

SESTATS tracks discrepancies between the equipment status and the analog telemetry values.
Coherency Check Using SESTATS

• Branch Status Error

A branch in the SE model can be a transmission line, transformers or zero-impedance branch (ZBR)
Coherency Check Using SESTATS

• Injection Status Error

An injection could be a generator or load
Coherency Check Using SESTATS

• CB Status Error

SESTATS also detects a discrepancy between CB status and existing analog measurements assigned to the CB
Detecting Topology Errors via SE Results

• Limitation of SESTATS
  - Requires available measurements on the elements
  - Cannot identify the complicate errors

• Topology errors lead to measurement residuals
  - Topology errors, like bad telemetry values, usually cause large measurement residuals around the locations of errors in SE results.
  - Bus mismatch is also a good indicator for the existence for topology error.
• Detecting and identifying the wrong branch status using SE results
Detecting Topology Errors via SE Results

• Detecting and identifying the bus splitting/merging issue via SE result
Detecting Topology Errors via SE Results

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- Detecting and identifying the bus splitting/merging issue via SE result
Detecting Parameter Errors via SE Results

- Detecting and identifying the bus the line/transformer impedance

- Detecting and identifying the shunt device parameter
Conclusions

• Cooperation among groups inside ERCOT and between ERCOT and TDSPs is very important to identify and correct the topology and parameter errors.

• Measurement redundancy is important to detect and identify errors. Errors in areas with high measurement redundancy are much easier to detect compared to those with low measurement redundancy.

• By applying KCL rules as pseudo-measurements in SE, the bus mismatches are used as another indicator for possible errors around a specific bus.

• SE monitoring tools can greatly help operations engineers to monitor the SE performance, and check for discrepancies between analog measurements and element status to provide a simple way to detect potential topology errors.
Thank U !!

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