Reliability Compliance and Monitoring Tools

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Presentation Outline

Research for Reliability Compliance and Monitoring Tools

- Wide-Area Reliability Analysis and Monitoring Tools
- Approach and Project Management
- List and Description of Researched Projects
  - Summary and Relevance
  - Analysis and Results
- 2010 Technical Accomplishments
- Technology Transfer, Collaborations, and Partnerships
- Conclusion
**Research Transitioned from Development To Utilization for Reliability Monitoring and Standards Effectiveness**

**ENHANCE GRID RELIABILITY AND PROVIDE WIDE-AREA SITUATION AWARENESS**

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<th>FY2001-3</th>
<th>FY2004-9</th>
<th>FY2010</th>
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<td>WIDE-AREA RESOURCES ADEQUACY MONITORING</td>
<td>FREQUENCY RESPONSE STANDARD &amp; AUTOMATED RELIABILITY DAILY REPORTS</td>
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<td>INTELLIGENT ALARMS, SITUATIONAL AWARENESS, FMA</td>
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<td>1ST PROTOTYPE TOOL USING COMMON VISUALIZATION</td>
<td>7 APPLICATIONS DEVELOPED AND IN USE BY NERC/FERC/DOE</td>
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**RESEARCH FOCUS:**
- DEVELOPMENT
- PROTOTYPE
- IMPLEMENTATION

**RESEARCH FOCUS:**
- SYSTEM PERFORMANCE
- STANDARDS EFFECTIVENESS
- NEW STANDARDS VALIDATION

**FY2001-3**
- Wide-Area Monitoring Platform (GRID-3P)

**FY2004-9**
- 1st Prototype Tool Using Common Visualization
- 7 Applications Developed and in Use by NERC/FERC/DOE

**FY2010**
- Frequency Response Standard & Automated Reliability Daily Reports

**Inbox:**
- Q1 2012
- Q2 2012
- Q3 2012
- Q4 2012

**Dashboards:**
- Long Term Archiving Database
  - With PI-Type Tagging
  - Characteristics for Historical Data Analysis and Assessment
- Layer 4 – Wide-Area Visualization Solutions
  - Geo-Graphic
  - Multi-View
  - Multi-Layer
- Research for High Level Visual Solutions
## Seven NERC Applications in Use

<table>
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<th>NERC Applications</th>
<th>Current Users</th>
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<td>Resource Adequacy</td>
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<td>Frequency Monitoring and Analysis (FMA)</td>
<td>NERC Staff, FERC Staff, RS, BAs, RCs, Regions, TOPs, RSGs</td>
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<td>CPS1 and BAAL</td>
<td>BAs, NERC Staff</td>
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<td>Area Interchange Error (AIE)</td>
<td>NERC Staff, RS, BAs</td>
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<td>Automatic Reliability Reports (ARR)</td>
<td>NERC Staff, FERC Staff, RS, RCs</td>
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Typical Approach and Project Management

- Identify areas of research
- Define data requirements
- Define functional requirements

• Identify key partners
• Identify possible solutions
• Test assumptions
• Validate findings

CERTS Research Approach and Project Management

- Field test and identify variances
- Fix variances and deliver product to users

- Define functional specifications
- Develop prototype
- Factory test prototype

- Problems
- Identification
- Brainstorming
- Solutions
- Prototype
- Development
- Deliver
- Field Test
- Fix variances and deliver product to users
Three FY2010 Grid Reliability Research Projects:

1. Interconnections Reserve Adequacy and Frequency Response

2. Reliability Standards Analysis and Assessments

3. Automated Reliability Reports Research and Implementation – Transmission Metrics
Interconnections Reserve Adequacy and Frequency Response - Summary

- **Objective:** Analyze interconnections primary and secondary load-generation control response and impact on reserves, frequency response, AGC, and current control performance standards

- **Results:** Research collected and analyzed interconnection SCADA and phasor data; identified methods and processes to automatically collect significant interconnection frequency events and calculate frequency response; presented research results to NERC stakeholders.

- **Relevance:** Enhance interconnections reliability through research on Frequency Response and interaction between primary and secondary control

- **Partnership and Collaboration:** NERC stakeholders (FRSDT, Resource Subcommittee and FRI Group) were key partners and instrumental in guiding the research in terms of data and analysis methods for calculation and validation of event frequency response. The NERC Frequency Response Standards Drafting Team, Mark Inc. and Patterson Consultant were also key partners for this research project
Load-generation primary control based on inertia (1 to 2 sec), secondary control based on AGC (2 to 10 sec). Frequency Response is an indicator of control performance

Used 1 sec phasor and 1 min SCADA data for calculations

Frequency Response was researched to support NERC Frequency Response Standards Drafting Team with development of automatic methods for calculation of Frequency Response from events

Research starting point for Eastern frequency event definition suggested by RS was 40mHz and 20 sec excursion. This resulted in capturing less than 10 events/yr per interconnection – inadequate for standards development and new methods were researched

Research Findings:
- Use of 40mHz excursion for Eastern, 70 mHz for Western and 90 mHz for ERCOT Interconnections with 15 sec time window. This resulted in capturing approx 30 events for 2009 and was validated by RS - provides adequate number of events for Standards Drafting Team
- Recommended Frequency Response calculation using 15 sec window for selection of delta frequency and values of ACE for BA’s. This calculation method recommended for analysis and standards development - methodology under review by NERC FRSDT and RS
Interconnection Frequency Response
Analysis Methodology

Typical Interconnection Frequency Pattern (V-Shape) During Significant Events

Frequency Response Estimation Methodology from Research

\[
\text{Freq Response} = \frac{\text{MW Loss}}{10 \times \Delta \text{Freq}}
\]

Recent Eastern Interconnection Frequency Pattern (L-Shape) During Significant Events

L-Shape Pattern presents challenges to Define a FR Estimation Methodology (Research in Progress)
Reliability Standards Analysis and Assessment - Summary

- **Objective:** Utilize data and information from current portfolio of CERTS developed NERC applications to research, analyze and assess the adequacy of the current reliability standards and improve application portfolio.

- **Results:** 1) Identified inadvertent performance reporting issues - schedule mismatches and incomplete data submission. Recommended new procedures to reduce large accumulation of inadvertent. 2) A new short term alarm and its thresholds were researched to define new Intelligent Alarm for alerting interconnection low Frequency Response. 3) Assessed and found correlation between active TEC and occurrence of Frequency Trigger Limit (FTL) alarms in Eastern Interconnection.

- **Relevance:** Continue research and assessment of current reliability standards adequacy. Develop new standards to improve reliability of electric grid.

- **Partnership and Collaboration:** The NERC RS, RCWG, NERC and FERC technical staffs and CERTS are key partners for this research project.
Automated Reliability Reports (ARR) Research and Implementation - Summary

- **Objective:** Research transmission grid metrics at the interconnection level for incorporation in existing CERTS developed Resource Adequacy ARR in use by NERC and FERC

- **Results:** Three transmission grid metrics for pre-contingency conditions identified for use in ARR: phase angle stability, voltage stability and thermal limits. These metrics were defined, estimated and validated using model-less approaches and phasor measurements

- **Relevance:** Expand ARR to provide visibility on interconnection transmission performance with the new metrics

- **Partnership and Collaboration:** PSERC (University of Illinois) was the key partner for this research project. FERC and NERC technical staffs reviewed research scope to define needs and functional requirements
Transmission Pre-Contingency Metrics – Calculated without Network Models

- Research method using Phasor measurements to calculate Grid Reliability Metrics
- Methodology researched and developed by University of Illinois and will be presented by them
- Three metrics defined that can be computed using Phasor measurements without network models. These metrics are:
  - Phase Angle stability
  - Voltage stability
  - Thermal limits
- EPG focus was to assess data availability, feasibility of implementing methodology in ARR and define tables, charts and format to present in reports
2010 Major Accomplishments

- Concluded that it is feasible to automatically identify interconnection events representative of Frequency Response (FR) performance. FR can also be automatically calculated for the three interconnections using frequency phasor data and ACE SCADA data.

- Recommended changes in inadvertent performance reporting to reduce large accumulation of inadvertent at the interconnection level.

- Identified new Short Term Intelligent alarm and its thresholds to alarm abnormal interconnections frequency disturbances.

- Validated that FTL alarms are impacted by Eastern interconnection TEC. Elimination of Eastern TEC is being considered.

- Transmission grid performance metrics research conclusions:
  - Metrics should be evaluated for two operating conditions: Pre-Contingency and Post-Contingency.
  - For Pre-Contingency - three metrics researched and validated; prototype specifications for automated Grid Reliability Report developed.
  - Post Contingency metrics research planned.
Automated Reliability Reports (ARR) 
Research Overview and Plan

**COMPLETED** - Research Results on Transmission Metrics will be Presented By University of Illinois

**CONTROLS/METRICS**
- Primary Control Performance (Frequency Response)
- Secondary Control Performance (AGC)
- Tertiary Control Performance (Reserves Mgmt.)
- Phase-Angle Stability Power Transfer Limit
- Voltage Stability Power Transfer Limit
- Thermal Power Transfer Limit
- Data Confidence Bands for Each Metric

**REPORTS**
- ARR Reports
  - Daily
  - Monthly
  - Seasonal
  - Annual
- TAPMR
  - Daily
  - Monthly
  - Seasonal
  - Annual

**USERS**
- In production since 2009
- Currently 37 users including NERC, FERC, DOE Staff, Subcommittees and Management

**CERTS**
Consortium for Electric Reliability Technology Solutions

**PROPOSED**
Targeted for Prototype Deployment in 4Q 2011
Technology Transfer and Dissemination

CERTS Research and Prototyping

NERC Integrates and Include in Support Maintenance Budget

NERC Board of Trustees Approves Tool as NERC Mission Critical

Field Trials NERC-ISOs-Utilities

NERC-FERC ADOPTION AND INTEGRATION OF ARR

NERC-FERC Application Users – Feedback, Enhancements, Priorities

NERC Acceptance By – Reliability Coordinators, Resources Subcommittee

CERTS Research and Prototyping
Conclusion

Results and findings of the three reliability researched projects will be used for definition and validation of new grid reliability standards and implemented, in the current and proposed portfolio of real time monitoring applications, to enhance the effectiveness of wide-area situation awareness reliability monitoring in consultation with NERC and FERC as appropriate.