Voltage Stability Assessment at the EMS

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EMS Overview – DSA Integration

- Load Forecast
- SCADA
  - Load (area) meas.
  - Status & Analog Data
  - Network Loss
  - Unit base point & transaction schedules
- AGC
- DSA Integration
  - Basecase
  - Original or Rescheduled Basecase
  - Harmful Contingencies
- Volt-Var Dispatch
- State Estimation
  - Basecase
- Contingency Analysis
  - Basecase
- Short Circuit
- DSATools
  - CTG & RAS
- Security Enhancement
  - Constrained Dispatch
  - Contingency Planning
  - Preventive Action
- e-terravision UI

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• Fully automatic
  – Auto-run in real time network sequence
  – One-click to run in the study mode

• Display the computation results on EMS side
  – Brings up VSAT result viewer from the EMS displays
  – Processes results to issue alarms, update statistics

• Archiving
  – Auto-archiving insecure cases for further investigation
  – Periodic Archiving
DSATools VSAT installations worldwide

Total: 36+

North America: 20+

Plus at utilities in:

Australia, China, Egypt, Ireland, South Africa,
Korea, UK, Saudi, Malaysia, Norway, NZ, Vietnam,
Colombia, etc
DOE and NERC are working together closely with industry to enable wide area time-synchronized measurements that will enhance the reliability of the electric power grid through improved situational awareness and other applications.

“Better information supports better - and faster - decisions.”
Emerging era of Holistic Grid Security Analysis

**EMS**

- **Traditional Model-Based Analysis**
- SCADA & Alarms
- State Estimator
- Small Signal Stability
- Transient & Voltage Stability
- Island Management

- Other EMS Applications

**PhasorPoint**

- PMU Measurement-Based Analysis
- WAMS Alarms
- State Measurement
- Oscillation Monitoring
- Stability Monitoring & Control
- Island Detection, Resync, & Blackstart

**Control Center - PDC**
Hybrid Approach to Voltage Stability Assessment

“Measurement-based” Voltage Stability identify potential problems:
- Voltage Profile & Sensitivities
- Reactive Reserves
- Real-Time Voltage Instability Indicator (RVII):
  Advanced indicators based on key properties associated with voltage collapse phenomenon

- “Model-based” Voltage Stability to evaluate:
  - MW/MVAR Margins
  - Weak network elements
  - Critical contingencies
  - Corrective Actions

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A Hybrid Approach to Voltage Stability Assessment
An integrated “measurement-based” and “model-based” approach

Real-Time Voltage Instability Indicator (RVII)

Detect WHEN in danger!

- Bus Voltage (V)
- Equivalent Impedance (Z_{eq})
- Reactive Margin (Q_{margin})

Estimate equivalent parameters in real-time

PMU measurements

Determine HOW to respond!

- Predict Q_{margin} changes under “worst case” contingency.
- Provide recommendations on corrective actions.
On-Line Voltage Stability Assessment

Integrated “measurement-based” and “model-based” analysis

Real-time P-V locus (and voltage sensitivities) based on PMU measurements.

⇒ monitor current operating condition

MW Margins are computed in real-time using “model-based” Voltage Stability Assessment Tools (VSAT).

⇒ identify proximity to voltage stability violation
San Ramon - Proof of Concept Facility

Strategic Team: PG&E, ALSTOM, GE, Mississippi State University, Quanta
Academic & Testing: Georgia Tech, OMICRON / RTDS / Virginia Tech., Washington State Univ.

EMS Visualization and Alarming Platform

- Interfaces
- Substation State Estimator
- Fault Locator
- Data Archival

PMU Apps
- RVII
- VSAT

Grid Stability Apps
- Islanding / Restoration
- SSAT
- Disturbance Locator
- Mode Compare
- TSAT

EMS Apps
- Fast Grid Topology Processor
- Fast Grid State Estimator
- Enhanced SE
- Security Apps

Simulation
- DTS

PMU and SCADA Data

SynchroPhasor Applications for the Control Center

Multi-host Redundancy (ISD Link)
DSA-EMS Integration with e-terra vision
Regional Reactive Reserves

Where are the Vars?

Select region of interest to identify available VAR resources

Detailed summary of existing resources within chosen region
Measurement-based voltage stability monitoring:
- Bus
- Corridor
- Load Center
RVII Engineering User Interface (UI)

- Real-Time Trends
- P-Q-V Curves
- Alarm messages

Monitored ‘Corridors’ & ‘Buses’.
Comprehensive Voltage Stability Alarms
Linking WAMS “Wide-Area” Low Voltage Alarms to Operator Guides in EMS

WAMS Composite Alarms

WAMS indicate the simultaneous occurrence of Low Voltage over a broad region.

Operator Guides in EMS

Detect WHEN to Take Action... and HOW to Respond!

Reactive Reserve Monitoring in EMS

Reactive Reserve (MVAR) monitoring for user-defined areas in EMS.

Decision making:
Operator Guides (e.g. “Switch On Capacitor Banks”).
Arm Special Protection Schemes
WAMS: “Wide Area Monitoring System”
The new heartbeat of the grid!
Thank you!