PRSP Update: Building Grid Operator Monitoring and Control Assistant based on Synchrophasor Data

Jeanne Bullion, Peak Reliability
Marianna Vaiman, V&R Energy

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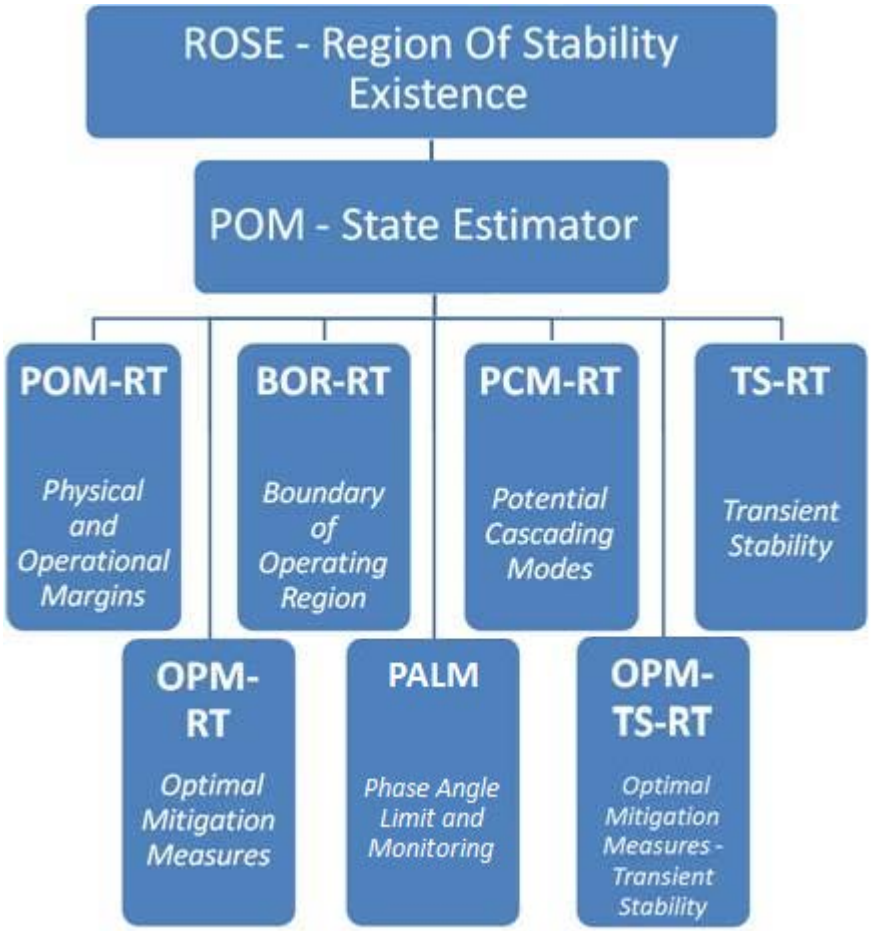
Project Team

- Grid Operator Monitoring and Control Assistant – GOMCA
  - V&R's Workstream under Peak Reliability Synchrophasor Program (PRSP)
- Project Participants - BPA, CAISO, IPC, Peak, SCE, SDGE
- Real-time monitoring and control based on the Region Of Stability Existence (ROSE) platform:
  - ROSE defines the range of phasor measurements or other system parameters for which the system may securely operate in terms of the accepted N-k security criteria

ROSE Software

- Model-based, measurement-based & hybrid State Estimator
  - Can use V&R's SE or export from any EMS vendor
- Model-based and measurement-based analysis
- Integrated voltage and transient stability analyses
- Real-Time Phase Angle Limit computation and monitoring
- Boundary-based solution
- Automatic analysis of cascading outages
- Automatic remedial actions



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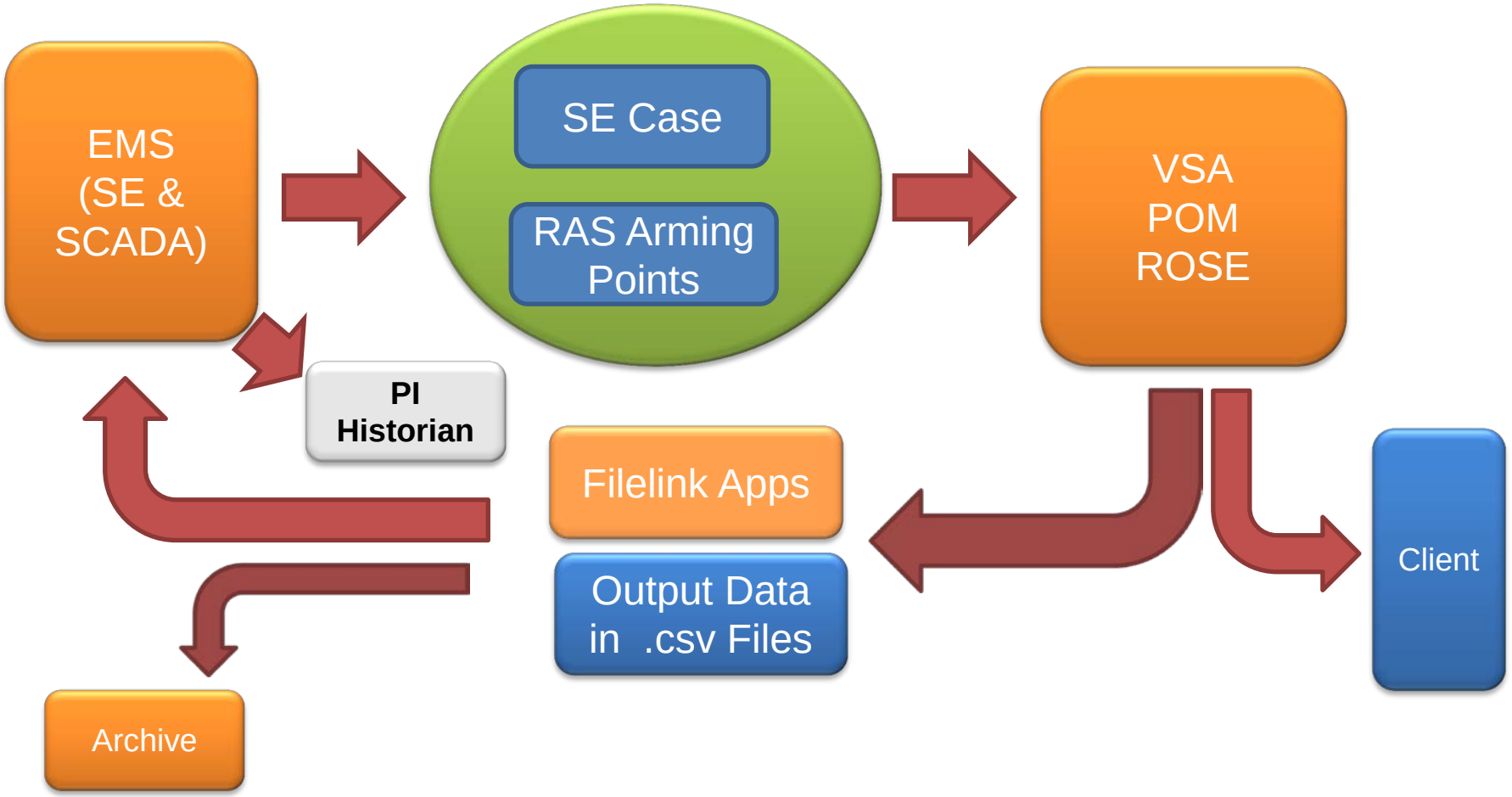
Peak-ROSE Application Architecture



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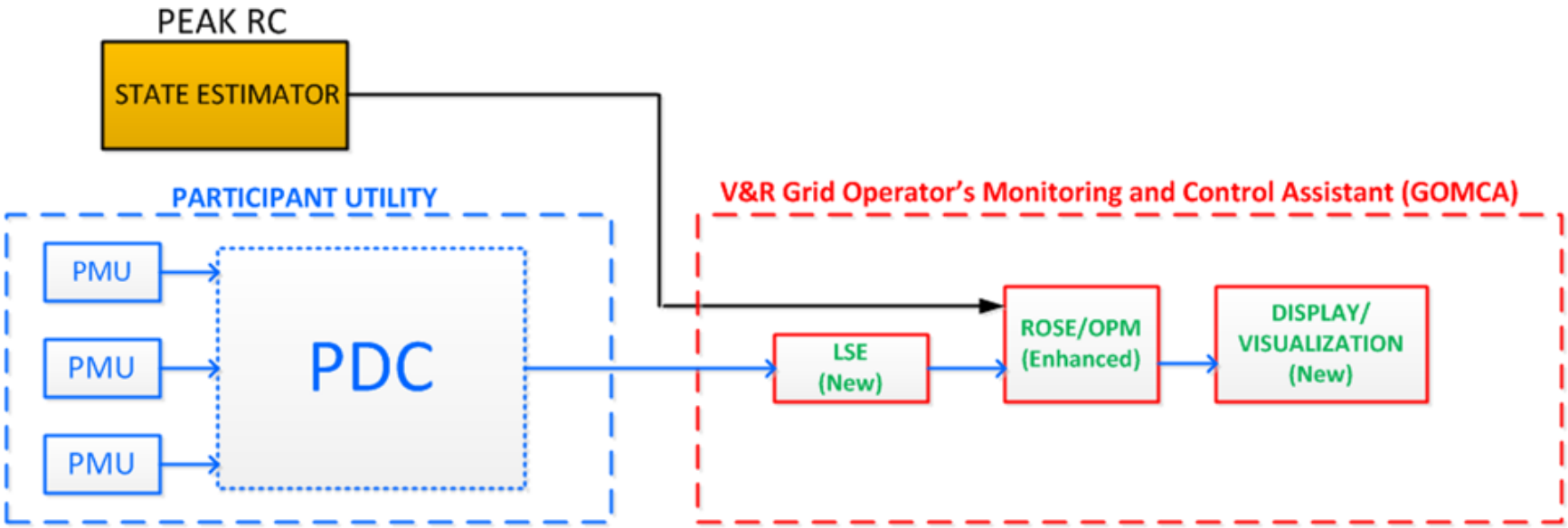
GOMCA Project Objectives

- Demonstration of V&R Energy's Liner State Estimator (LSE) on realistic WECC network, including:
  - Observability analysis;
  - Bad synchrophasor data detection and conditioning;
  - Validation of cases created by LSE and their applicability to voltage stability analysis;
  - Based on the methods and algorithms that V&R demonstrated during NASPI Voltage Stability Workshop.
- Measurement-based analysis:
  - Measurement-based voltage stability analysis;
  - Automatic determination of corrective remedial actions;
  - Situational awareness wall to visualize in an easy effective way synchrophasor data, and results of voltage stability analysis;
- ROSE integration with EMS/PDC systems of the project participants;
- ROSE Enhancements
- Technology transfer to project participants, training workshop.

High Level Architecture PRSP – GOMCA



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LSE – Related Tasks

- LSE at Idaho Power:
  - Prototype LSE study includes:
    - Observability study;
    - Methodology for identifying additional PMU locations;
    - Bad data analysis and detection using LSE;
  - LSE cases for IPC
- LSE at CAISO
- LSE at SDGE
- LSE at SCE
- LSE at Peak
- Measurement-based voltage stability analysis
- Measurement-based corrective actions
- Building situational awareness wall

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Peak-ROSE – Related Tasks

- Peak-ROSE VSA software integration at IPC
- Peak-ROSE VSA software integration at SDGE
- Peak-ROSE VSA software integration at SCE
- All project participants will use the same WSM model provided by Peak:
  - Cases are provided via an automated process
  - Available every 5 minutes
- Peak-ROSE (“hybrid” ROSE) enhancements
- Technology transfer

Linear State Estimator

- Working with each participant:
  - To perform observability study
    - MODEL WILL BE NEEDED
    - Involves use of the SE data
  - Validation of the results of LSE for participant's network/PMU installation;

Linear State Estimator (cont.)

- Incorporating algorithms for bad data detection and conditioning into LSE;
- Test the quality of the algorithms/data;
- Analyze the applicability of the cases created by LSE for voltage stability analysis;
- Do changes to LSE process, if needed, to create cases suitable for voltage stability analysis.

Peak-ROSE Enhancements

- Peak prepared a list of enhancements
- Coordinated with V&R
- Peak/V&R work closely with WECC entities to incorporate current modeling practices into WSM file and Peak-ROSE VSA analysis

Peak-ROSE Integration

- The same computational functionalities as in Peak-ROSE
- Installed at project participants' sites
- Modeling of additional scenarios for voltage stability assessment with each participant

Measurement-Based Analysis and Visualization

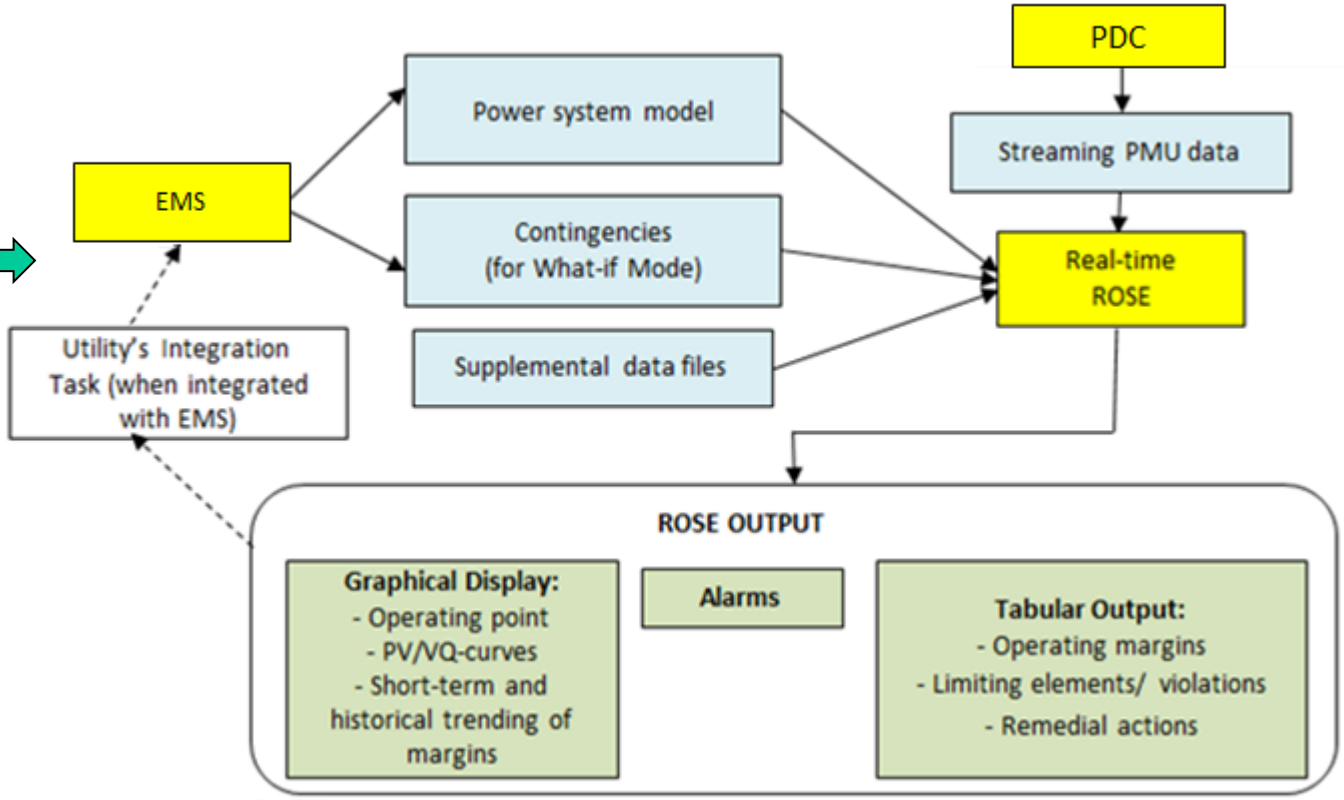
- Uses model created as a result of Linear State Estimation
- Voltage stability analysis
- Automated corrective actions:
  - Automatically determine corrective actions
  - Work with participants:
    - To implement remedial actions for their system;
    - Validate the results of automated computations.
- Building situational awareness wall:
  - Displaying the results of the analyses via easy-to-understand GUI;
  - Customization for each participant.

ROSE Implementations

- *Model - based ROSE:*
  - State Estimator data is required at the rate available at the entity using the application, usually 3 to 5 minutes.
- *"Hybrid"- based ROSE:*
  - Phasor and State Estimator data sets are required:
    - Phasor data at the rate available at the entity using the application, usually 30 samples/second.
    - State Estimator data at the rate available at the entity using the application, usually 3 to 5 minutes.
    - **Implemented at Peak**
- *Measurement - based ROSE:*
  - Phasor data is required the rate available at the entity using the application, usually 30 samples/second.
  - **Will be demonstrated using the DOE project**

“Hybrid”- ROSE Architecture

- Two analysis modes: Real-Time and Off-Line
- Inputs are:
  - State Estimator (SE) data, synchrophasor data, and additional files to perform voltage stability analysis (VSA)
- Real-Time Mode



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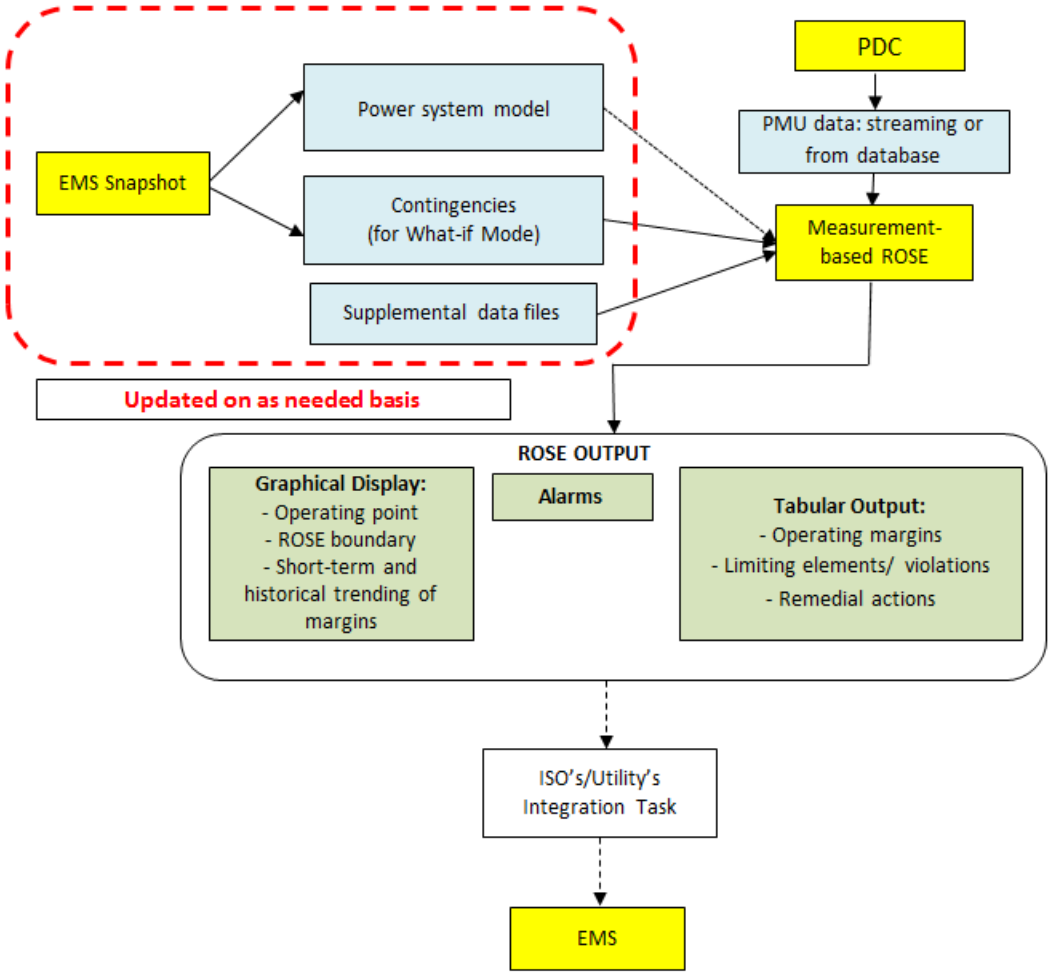
Measurement – Based ROSE Architecture

- One main input is synchrophasor data
- Additionally, we will need a power flow case to obtain model parameters, locations of PMUs, and additional files to perform voltage stability analysis (VSA)



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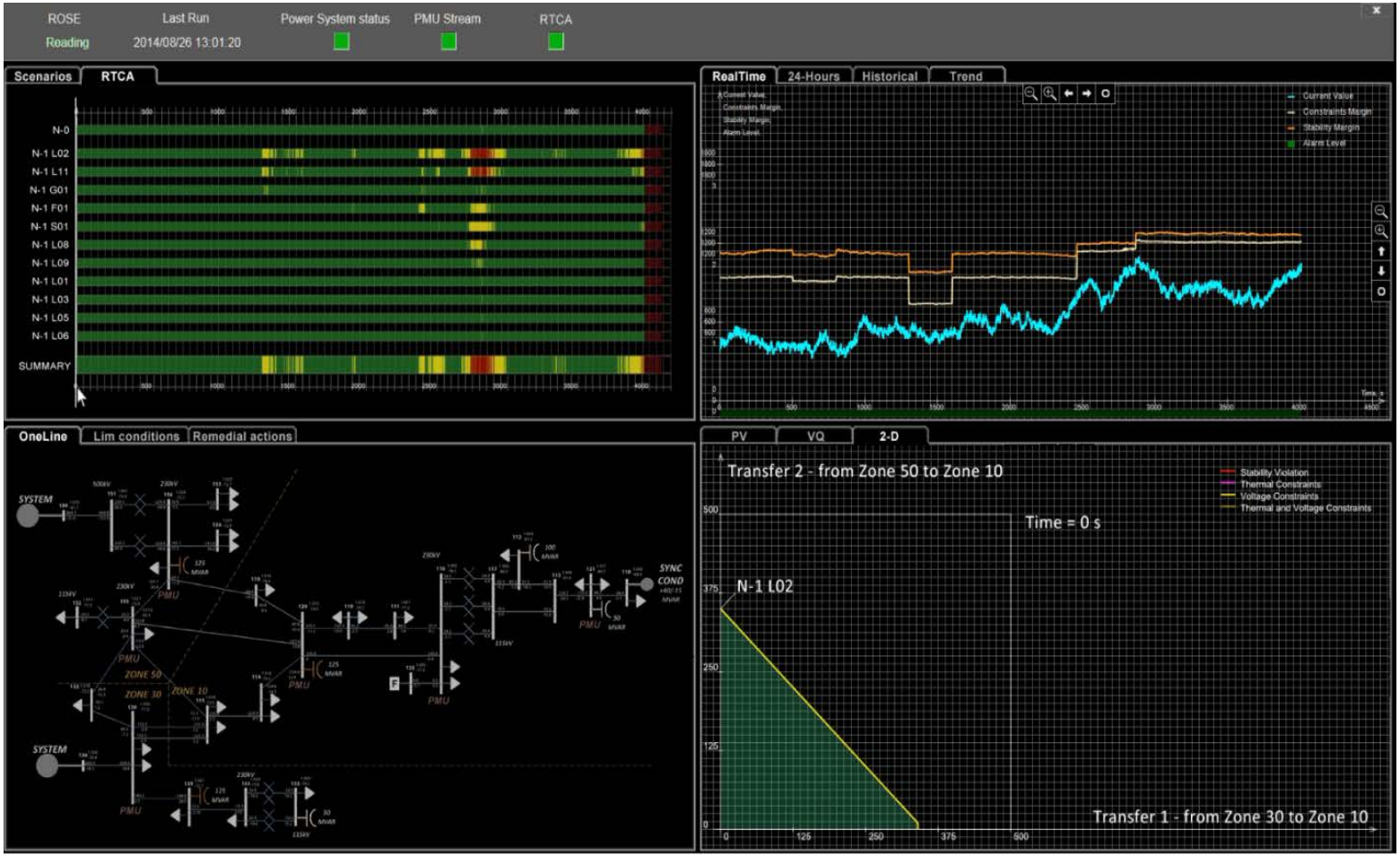
Measurement – Based ROSE

- Based on cases created by Linear State Estimator
- Demonstrated at 2014 NASPI Voltage Stability Workshop



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Conclusions

- DOE Grant
  - Peak is the grant recipient;
  - V&R is sub recipient.
- V&R's workstream is utilizing synchrophasor data in Grid Operator Monitoring and Control Assistant (GOMCA)
  - Linear State Estimation;
  - Measurement-based voltage stability analysis;
  - Measurement-based corrective actions;
  - Visualization;
  - Integration of Peak-ROSE with project participants.