EPRI Roles in Support of NASPI Research and Training

NASPI, New Orleans
March 6, 2008

Stephen Lee
Senior Technical Executive

Kai Sun
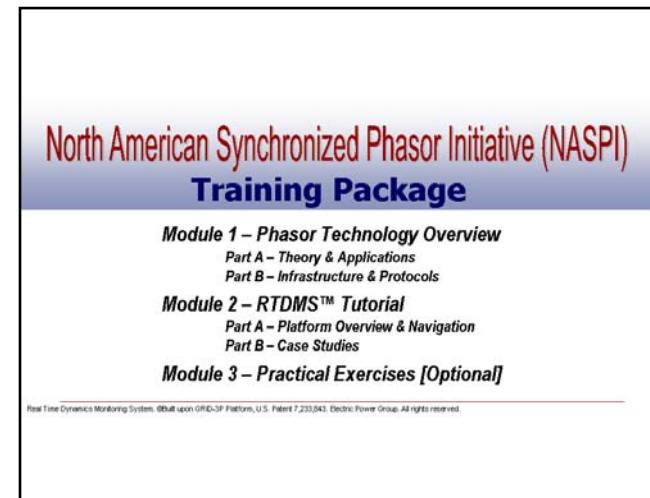Project Manager

Power Delivery and Utilization

Outline

- Education and Outreach
- Research Projects in Operation and Planning

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Education and Outreach

- Support NASPI Webcasts and Training
  - Convert ERLphase TESLA DMEs to PMUs (11/1/07)
    - Tony Weekes, Manitoba Hydro
    - Krish Narendra, ERLPhase
    - 21 organizations, 25 attendees
  - Phasor Technology and RTDMS Training (1/22/08)
    - Terry Bilke, MISO
    - Manu Parashar, Vivek Bhaman, EPG
    - 33 organizations, 59 attendees (several are roomfuls)

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

NASPI Training Resources Page & Industry Events Page

- http://www.naspi.org/resources/training/training.stm
- http://www.naspi.org/industry/industryevents.stm/

EPRI Research Task Forces Relevant to NASPI

- Situational Awareness Task Force
- Online Stability and Control Task Force
- Controlled Separation and System Restoration Task Force
- Modeling and Standardization Task Force
- Reliability Assessment Task Force
- Engineering Study & Economic Assessment Task Force

ELECTRIC POWER
RESEARCH INSTITUTE
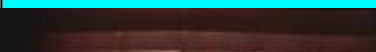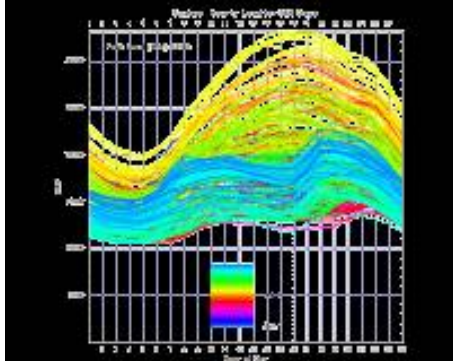
2008 Portfolio – Situational Awareness

- Base Projects
  - P39.001 Alarm Management and Situational Awareness
  - P39.002 Next Generation State Estimation
  - P127.003 Visualization and Prediction of Cascading Outages with Human Factors
- Supplemental Projects
  - Online Risk Monitor for Cascading Outages Incorporating PMUs (Prediction of Cascading Outages)
    - ConEd, NYPA, Entergy, ISONE, Exelon, AEP, FirstEnergy, TriState
  - Wide Area Power System Visualization Using EMS Data
    - CenterPoint
  - Wide Area Power System Visualization and Location of Disturbance Using Real-Time PMU Data
    - ConEd

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

P39.001 Alarm Management & Situational Awareness

- Scope
  - Alarm root cause diagnosis with MFM (GoalArt)
  - Situation Awareness in Power Systems Operations (SA Technologies)
- Deliverables
  - Technical Updates
  - Workshop(s) on Situational Awareness

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Situation Awareness in Power Systems Operations (SA Technologies)

- System Design Guidelines for Supporting Situation Awareness in Power T&D

  - **A. Color Usage Guidelines for Power T&D**

  - **B. Guidelines for Enhancing Situation Awareness of Automated Systems**

  - **C. Guidelines for Supporting Predictive SA**

- SA Technologies will work with 3-4 EPRI members

  - Interview, analyze and draft the initial guideline documents

- One or two EPRI workshops will present the findings, gather more input

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Calendar

- May **27**~29, PSAPO Technical Conference, Situational Awareness Task Force, Southern Co., Atlanta

- October 8th, Situational Awareness Task Force Conference, EPRI Charlotte, NC (followed by NASPI meeting, hosted by EPRI, Oct 9-10) – Guests are welcome

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Full Situational Awareness

- Geographical awareness (within and outside own footprint)
- Facilities awareness (loading conditions, etc.)
- Controllability awareness (how much safety margin or elbow room for maneuvering?)
- Predictive awareness (when will problems arise?)
  - Look for CEC (PIER/TRP) report on Critical Operating Constraints Forecasting
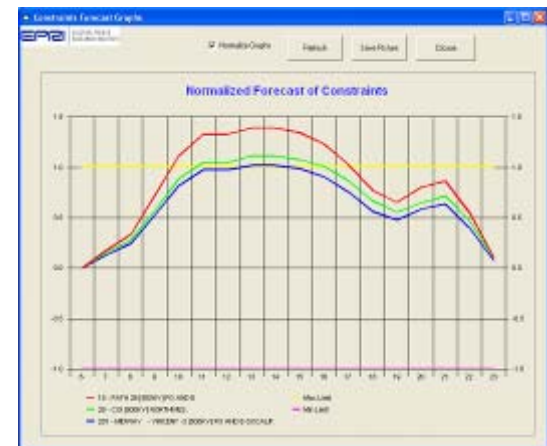
Prototype Visualization of Frequency
Location of Disturbance
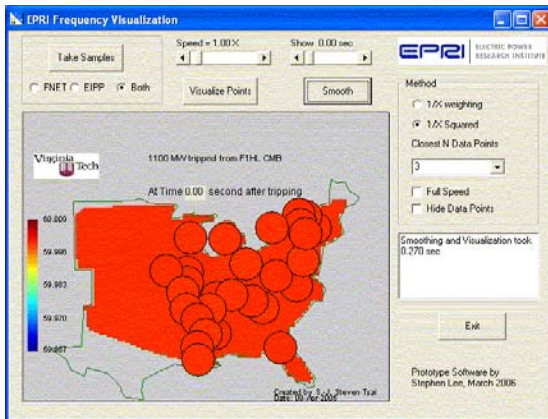
Community Activity Room
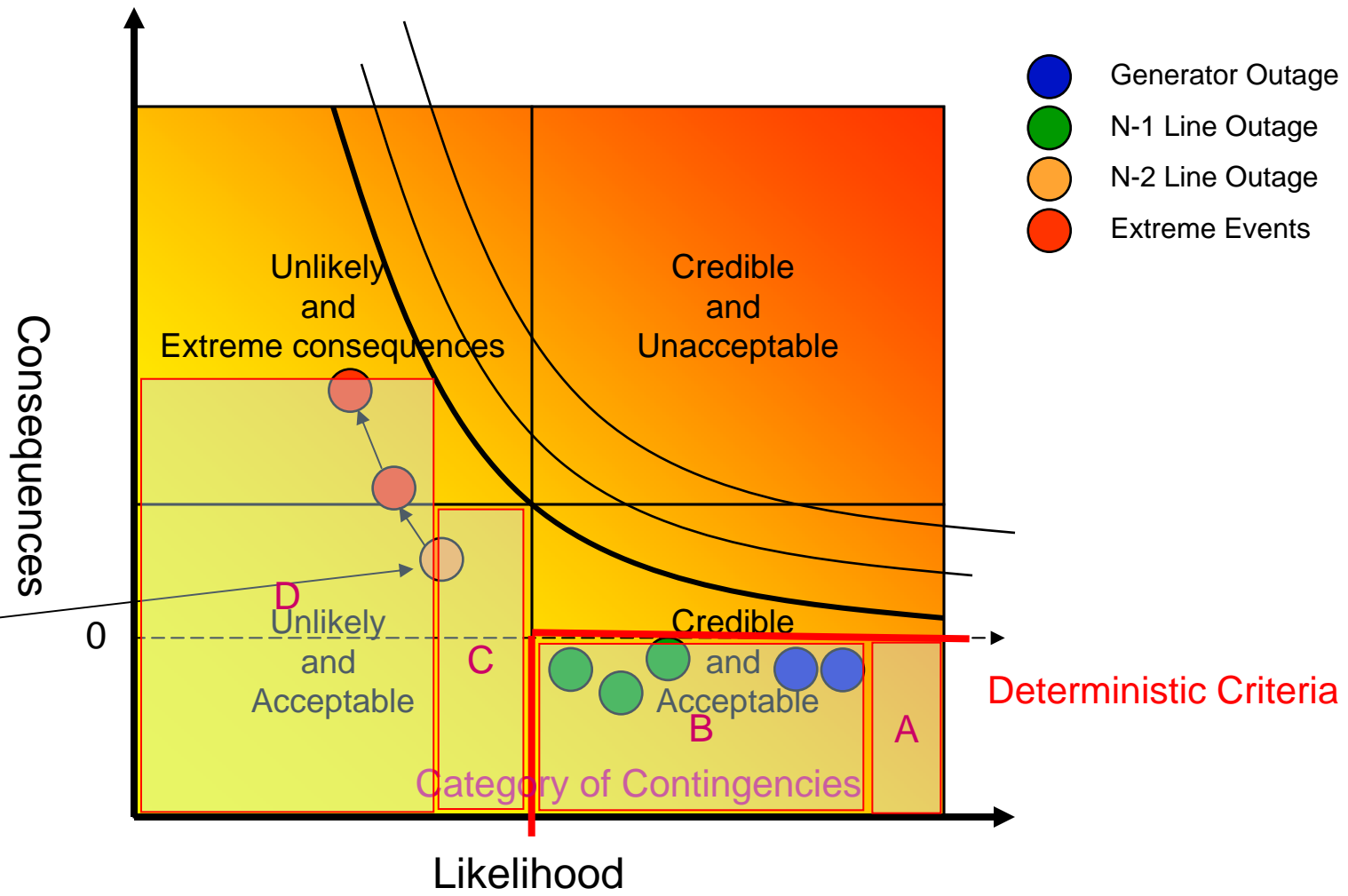Visualizing Transmission Bottleneck
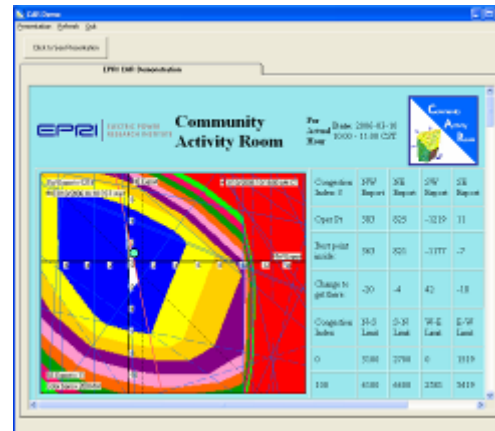
Critical Operating Constraint Forecast
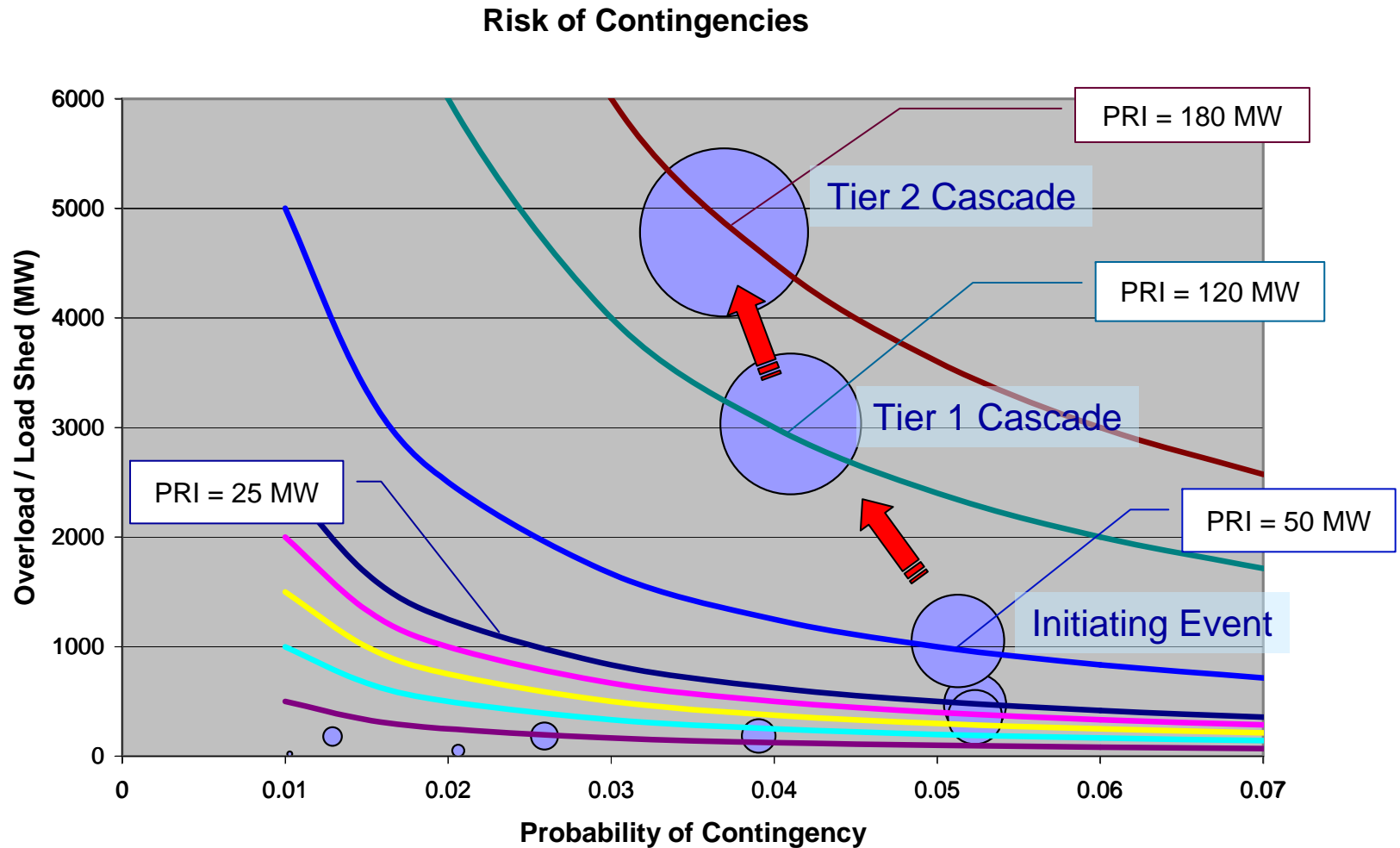Predictive Situational Awareness

A comprehensive research framework addressing situational awareness to improve grid reliability

ELECTRIC POWER
RESEARCH INSTITUTE

Online Reliability Monitor of Standard Contingencies & Potential Cascading Modes

Legend:
- Generator Outage
- N-1 Line Outage
- N-2 Line Outage
- Extreme Events

Consequences (y-axis)

Likelihood (x-axis)

Unlikely and Extreme consequences

Credible and Unacceptable

Unlikely and Acceptable — D

Credible and Acceptable — B

C

A

Potential Cascading Mode With Storm Approaching

0

Deterministic Criteria

Category of Contingencies

11

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Risk Exposure to One Cascading Mode With 1 Line on Maintenance Outage

Risk of Contingencies

Chart showing Overload / Load Shed (MW) on the y-axis (0 to 6000) versus Probability of Contingency on the x-axis (0 to 0.07).

Labels on chart:
- PRI = 180 MW
- PRI = 120 MW
- PRI = 25 MW
- PRI = 50 MW
- Tier 2 Cascade
- Tier 1 Cascade
- Initiating Event

EPRI | ELECTRIC POWER RESEARCH INSTITUTE
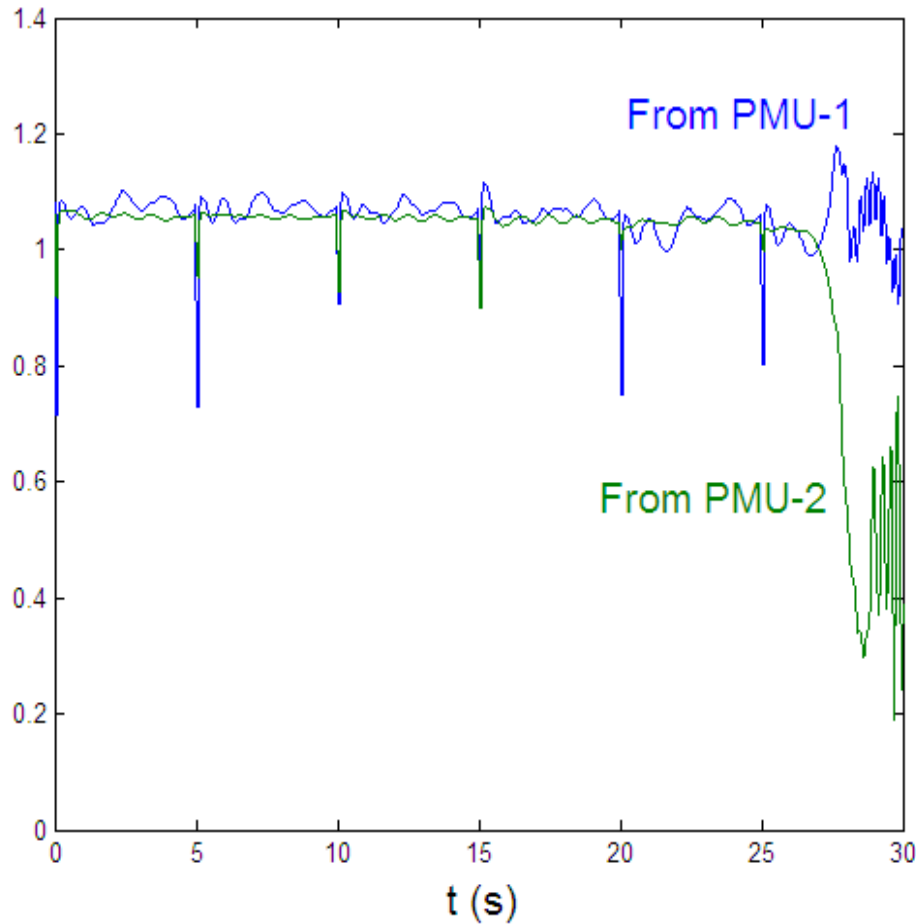
Remaining Storage or Synchronizing Capacity (RSC) of an Interface Computed from PMU

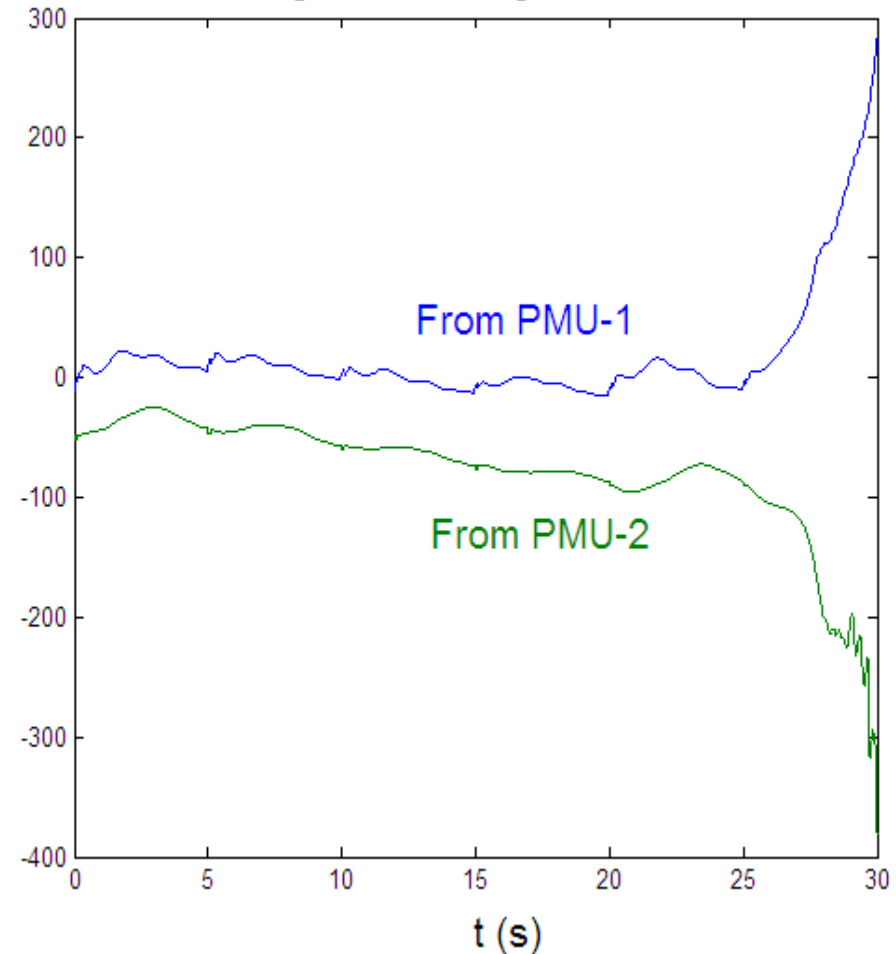$$RSC = (P_{12} / \sin \theta_{12})(1 + \cos \theta_{12})$$

EPRI | ELECTRIC POWER RESEARCH INSTITUTE
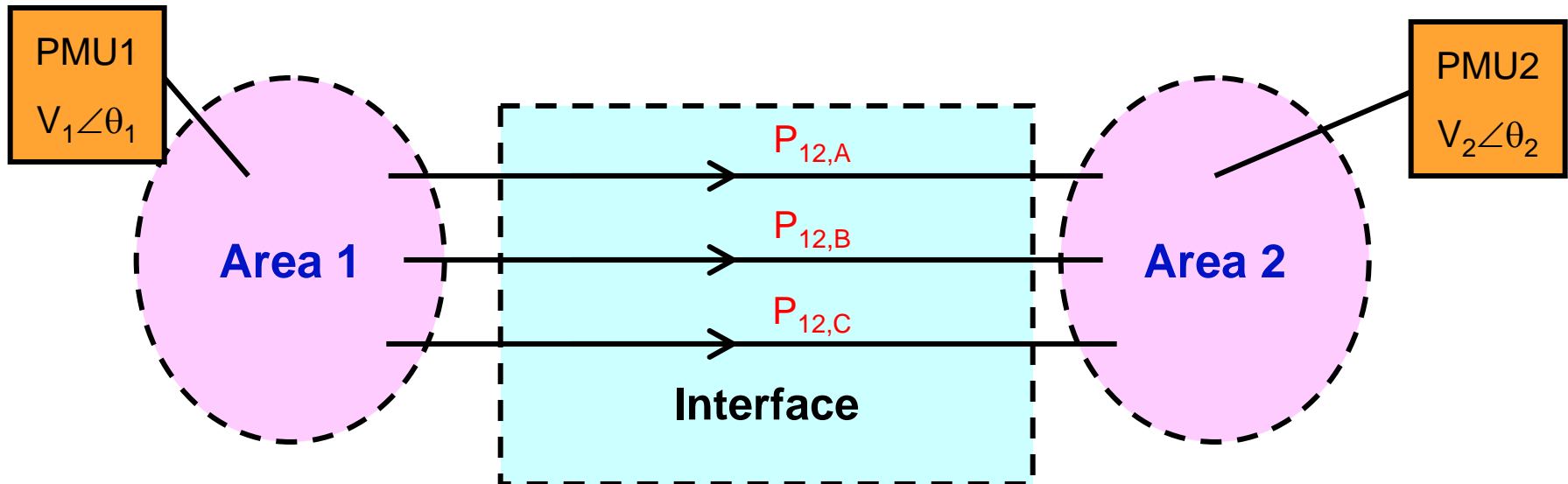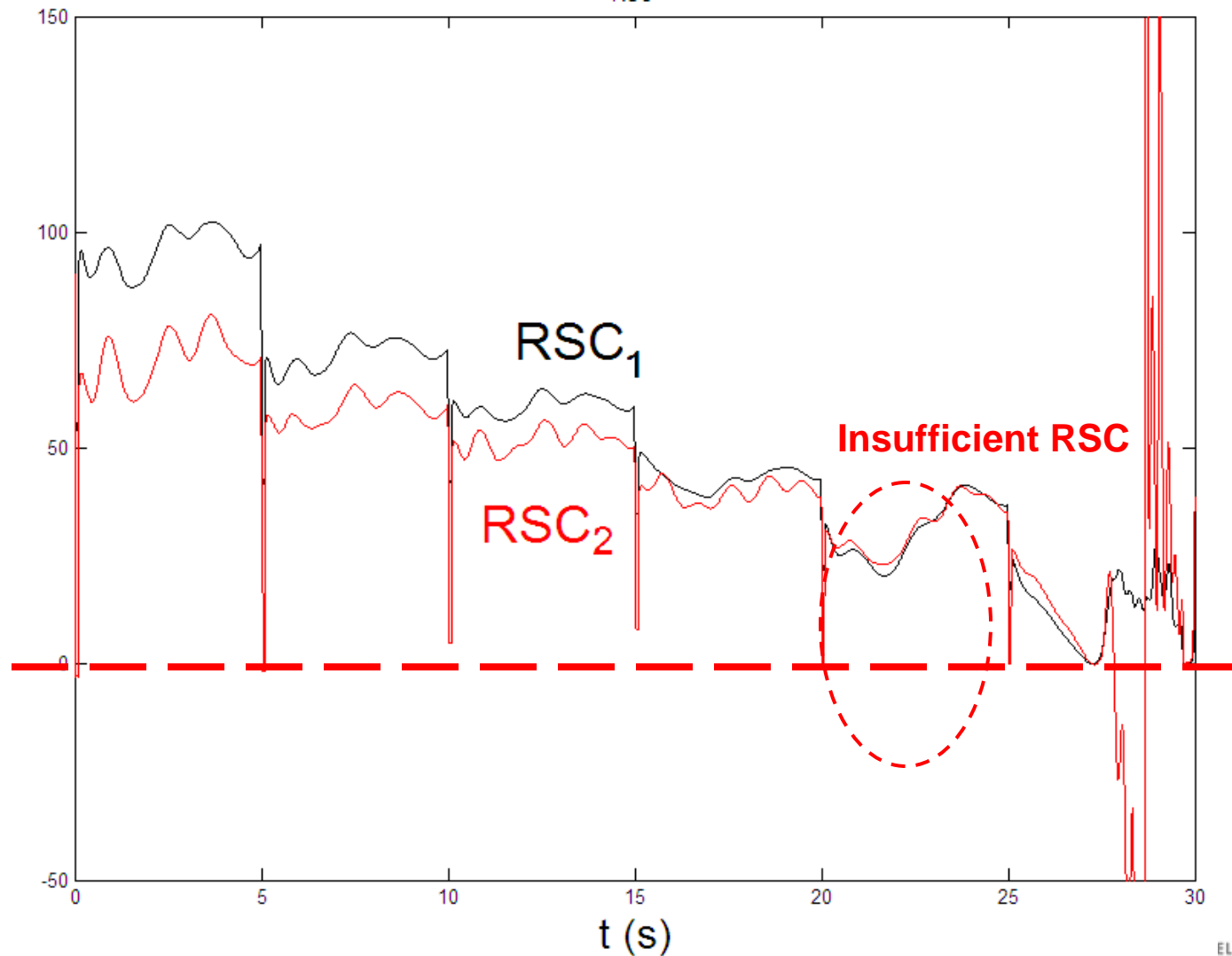
Sequence of Faults with Line Outages

Bus Voltage Magnitude(pu)

From PMU-1

From PMU-2

t (s)

Voltage Phase Angles (Deg.)

From PMU-1

From PMU-2

t (s)

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Remaining Storage Capacity

ELECTRIC POWER
RESEARCH INSTITUTE
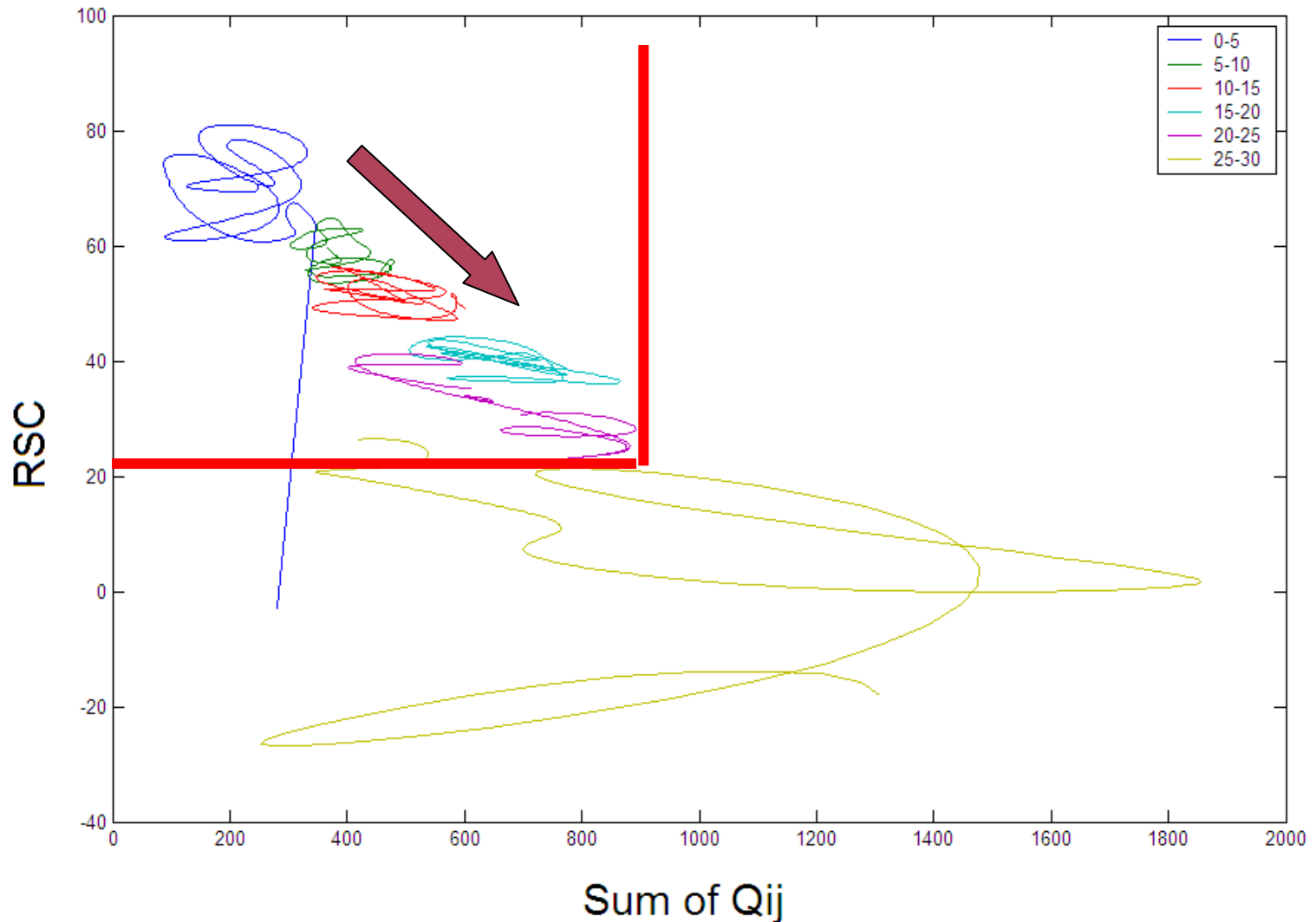
RSC in Phase Space
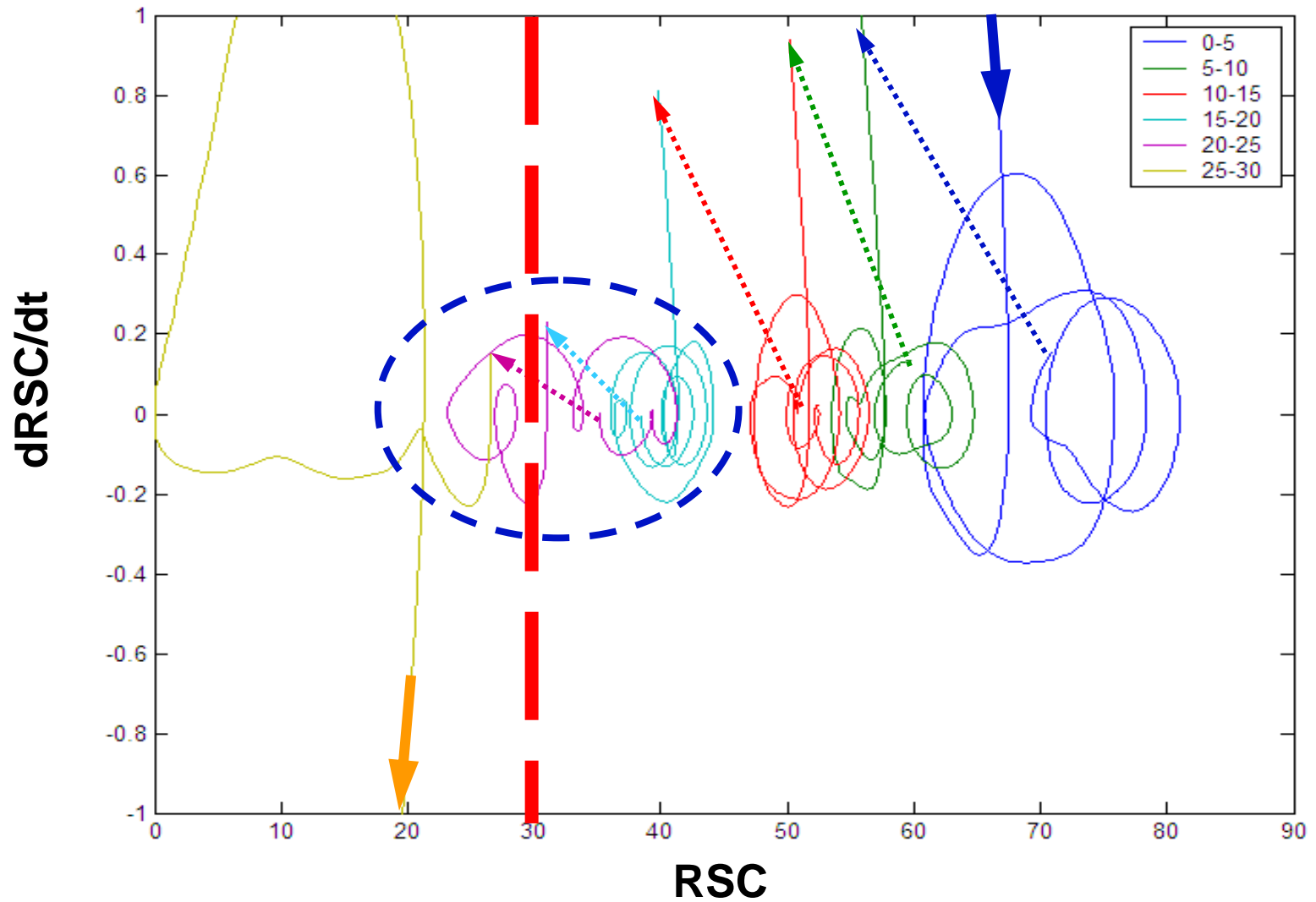
Combining Reactive Power Flows with RSC

Summary

- Continue to support NASPI training, education and outreach

- October 8th, Situational Awareness Task Force Conference, EPRI Charlotte, NC (the day before NASPI meeting, hosted by EPRI, Oct 9-10) – Guests are welcome

- System Design Guidelines for Supporting Situation Awareness – Workshops in Q4 2008

- Research in Cascading Outages

EPRI | ELECTRIC POWER RESEARCH INSTITUTE