

PHASOR SIMULATION FOR OPERATOR TRAINING (PSOT)

Event Libraries and Integration with TSAT and RTDS for Real Time Simulations



DOE Grant Award DE-OE0000702

NASPI Presentation

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Prime Contractor – Jim Dyer, EPG

October 15, 2015

PSOT Project Participants

- **Southern California Edison (SCE)** – Cost Share Participant
 - Project Manager - Frank Ashrafi
- **Electric Reliability Council of Texas (ERCOT)** - Cost Share Participant
 - Project Manager - Bill Blevins
- **Electric Power Group, LLC** – Prime Contractor and Cost Share Participant
 - Project Manager - Jim Dyer
- **Dominion Virginia Power** (Dominion)
 - Adviser/Observer - Matt Gardner
- **Powertech Labs Inc.** – Added to Project for Real Time Simulations with TSAT/ePMU
 - Project Management - Lie Wang

What is PSOT?

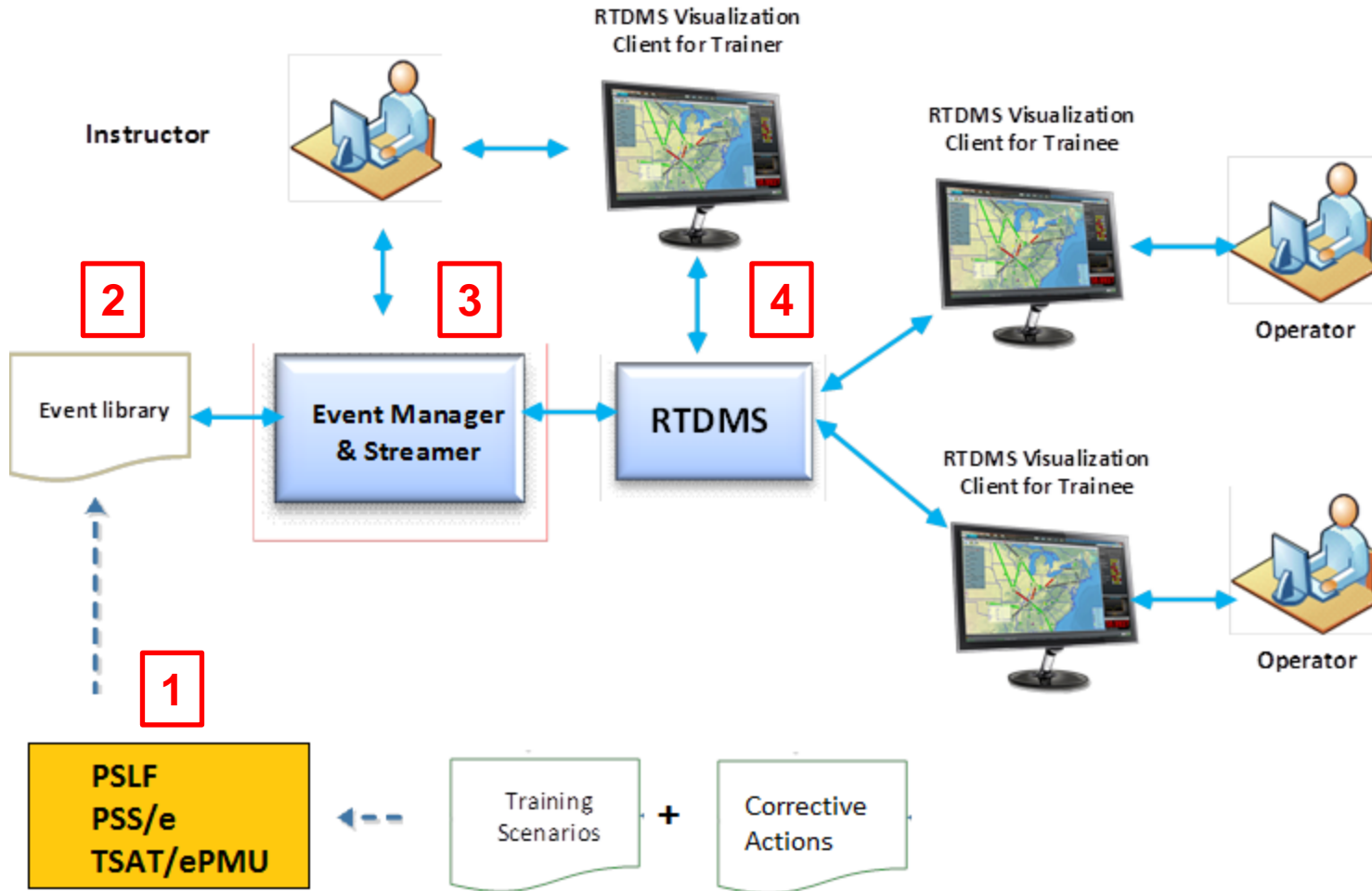
- A **Phasor-based training simulator** to train power system operators on the use of synchrophasor technology
- Training simulator utilizes
 1. Industry Standard **Power System Simulation Tools** to perform event simulations using dynamic models to build a library of system events
 - Off-line Simulation Tools including PSLF, PSS/E, TSAT/ePMU
 - On-the-fly Simulation Tools including TSAT/ePMU, RTDS
 2. **RTDMS** is used for Visualization

PSOT Architecture - Two Approaches to Operator Training

- Event library Approach
 - Events are stored in an event library prior to training session

- Real Time Approach
 - During training session, instructor runs an on-the-fly event simulation and students get to observe the system impact of events and event mitigation

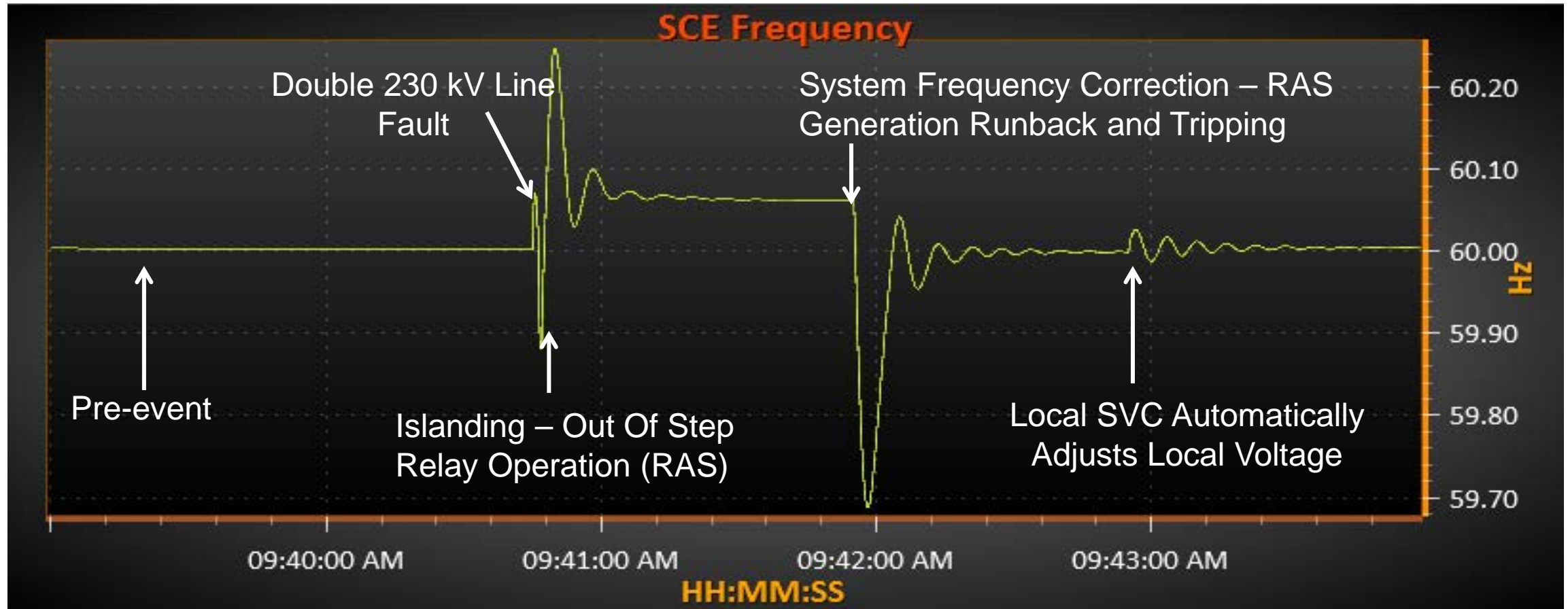
Event Library Approach



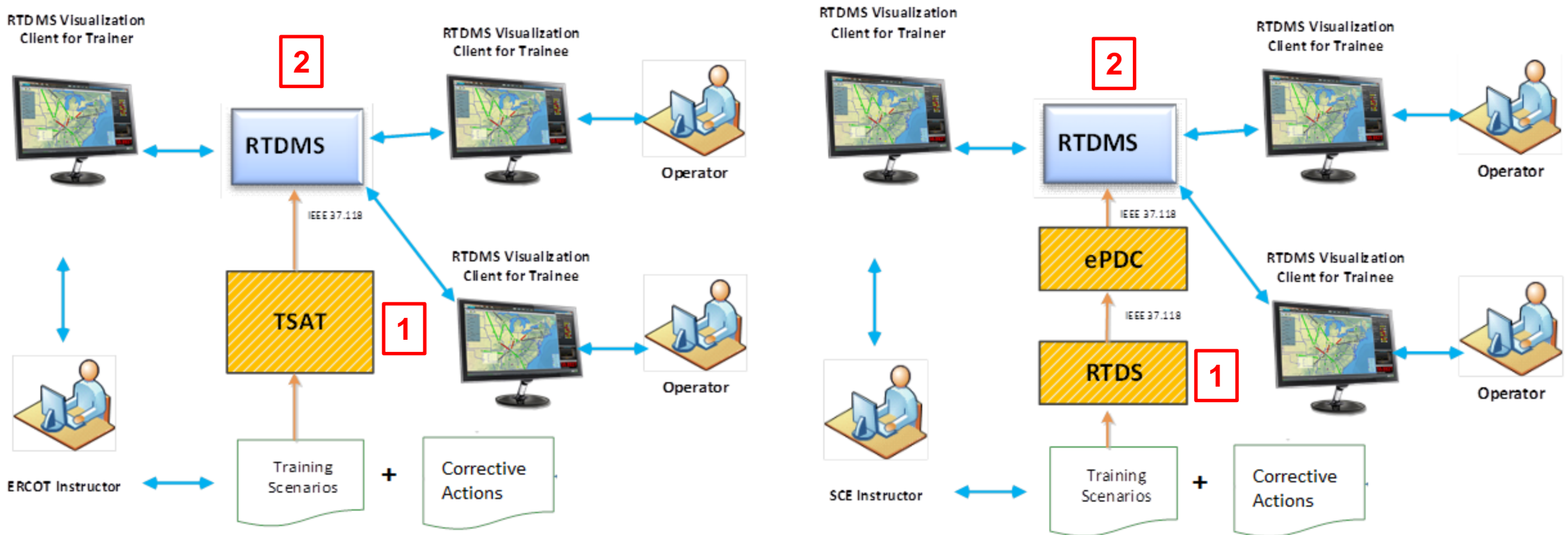
1. Using Off-line Simulations Tools
2. Event Library consists of Simulated + Actual Recorded events
3. Event Streamer & Manager is used to replay events from library to RTDMS
4. Visualization Tool – RTDMS

Event Library Approach - Project Example

- Islanding in SCE's Northern Region



Real Time Approach - ERCOT & SCE

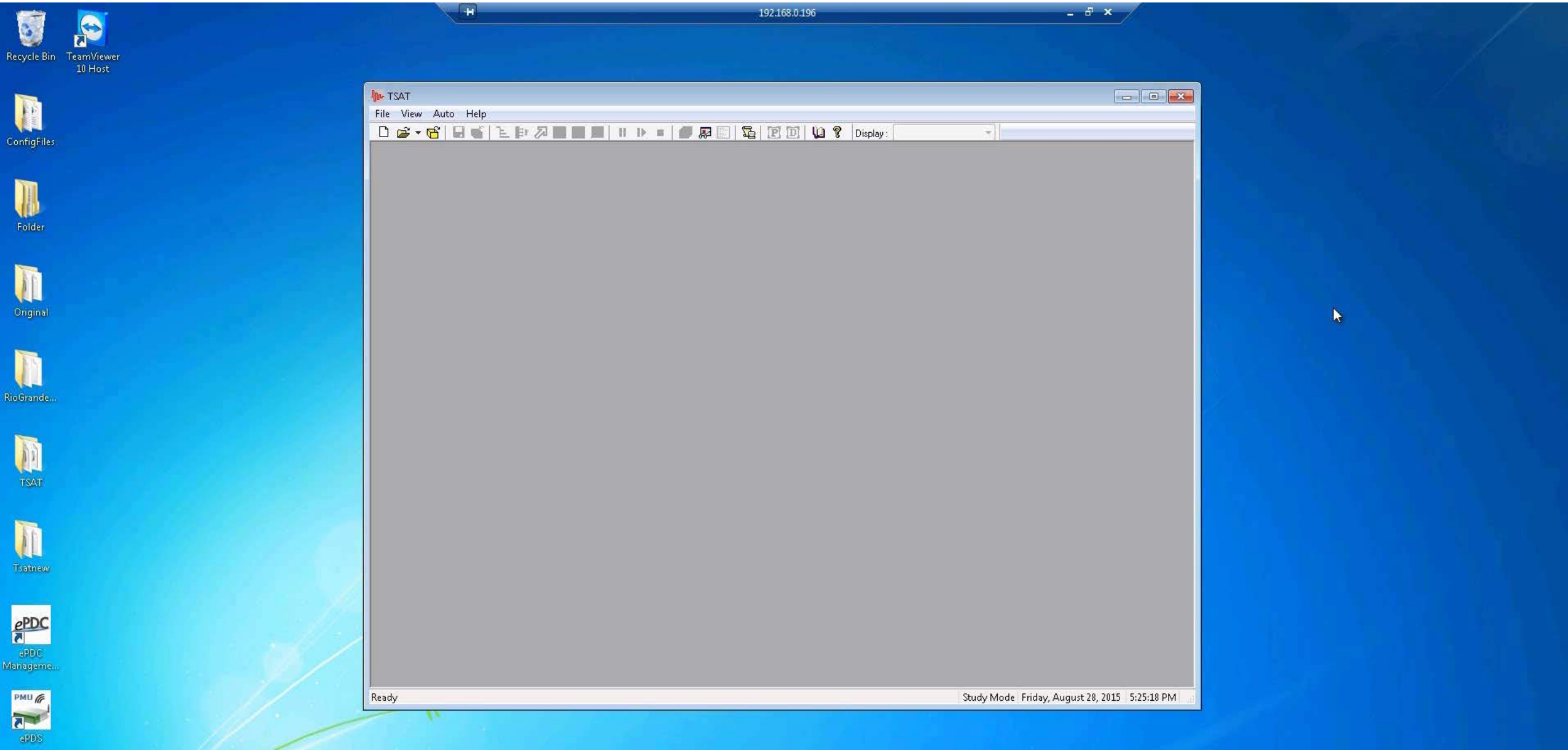


1. Using On-the-fly Simulations Tools
2. Visualization Tool – RTDMS

N-5 Event Simulation

1. **N-3 Units Trip** - Loss of 650 MW of Generation
2. **N- 4 and 5** – Loss of two 345kV lines

PSOT Demo Using Real Time Approach (TSAT/ePMU-RTDMS)



Event Summary

Loss of 3 units (650 MW)

- Frequency declines to **59.91 Hz**
- Angle Difference - increases from **12 to 21 degrees**
- Voltage – **3% voltage drop** in the Region

Loss of 2 - 345 kV lines

- Angle Difference increased from **21 to 45 deg**
- **10% drop in Voltage – Approaching Stability Limit.**

Corrective Action & Restoration: Prepare for the next contingency

- **Drop 700 MW of Load** in the Valley Region and angle difference decreased from **45 to 25 deg**
- **Reclose Relayed Lines** after checking Phase Angles and angle difference decreased from **25 to 12 deg**
- **Restore the 700 MW of Load**, angle difference increased from **12 to 20 deg**
- The **system is back to normal** conditions and operating within safe operating limits

PSOT - Status & Looking Ahead

- ✓ PSOT Event Library installed at ERCOT and SCE
- ✓ PSOT Event Library Demonstrated to ERCOT and SCE
- ✓ Real Time PSOT demonstrated to ERCOT – Deployment in Process
- ✓ At SCE, evaluating the capability of performing on-the-fly simulations with RTDS – In Progress
- ✓ PSOT Event Library with Generic Model – 4Q15
- ❑ Project Documentation - 4Q15
- ❑ Training for project participants - 4Q15
- ❑ Commercialization plan - 4Q15
- ❑ Final Report - 1Q16

Thank You!

Jim Dyer

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