



Hybrid WAMS & EMS Operator Training Simulator

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Key Drivers

Why Synchrophasors ?!

- Grids are operating at its stability limits

Aging infrastructure

Lack of investments in capacity building

Growing demand, etc.

- New system dynamics

Large penetration of renewables in the system

New age transportation(EVs), etc.

→ New age control rooms are forced to adopt advanced tools

Dynamics observability over a wide geography (WAMS)

Real-time dynamic security assessment

→ **Training** - Equally important is to train the operators to use these next-gen tools

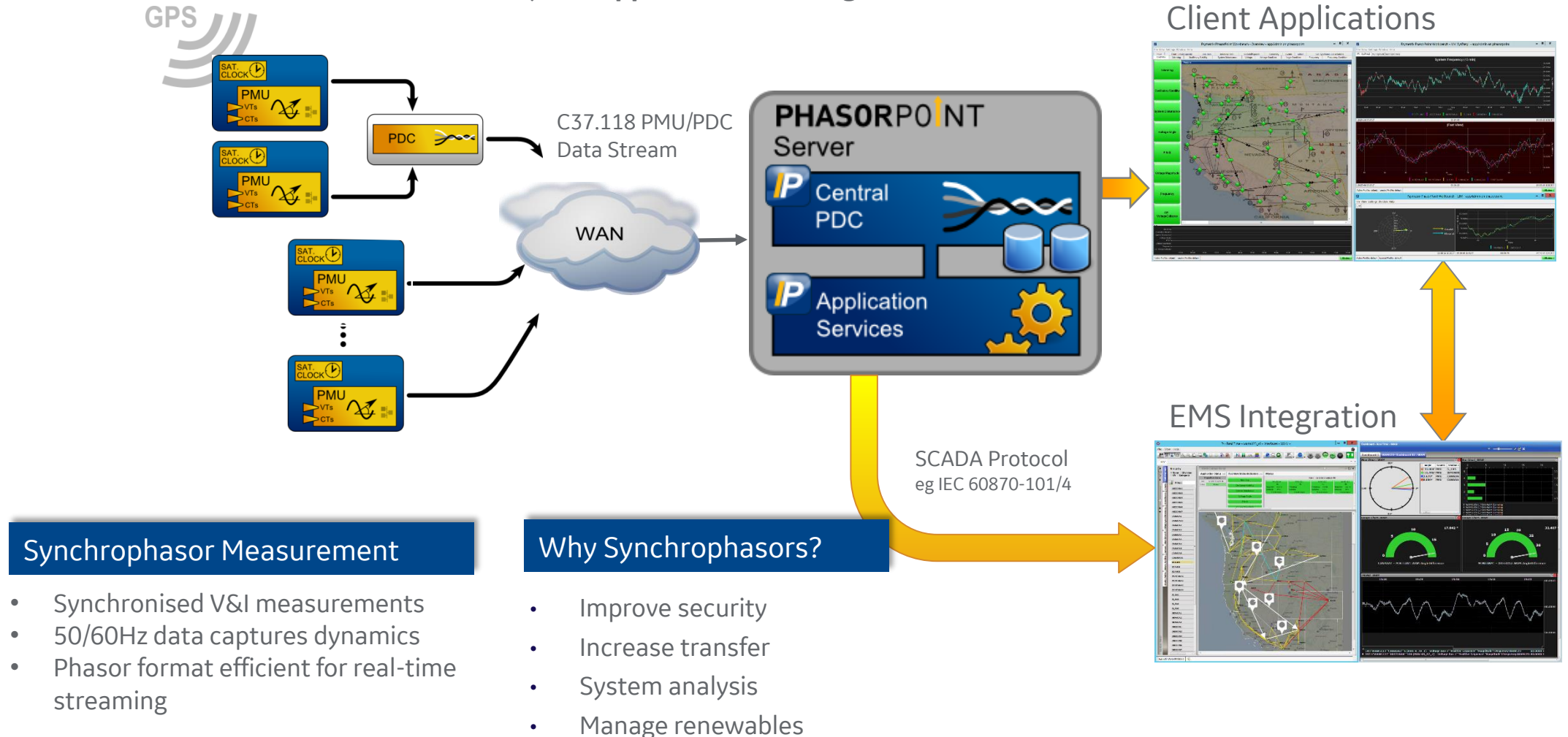


Wide Area Management System (WAMS)



Synchrophasor Solutions in Control Room

Measurement based, Model based and Hybrid Applications working in unison



WAMS applications in Control Room

Measurement based applications



Hybrid (Model + Measurement) Applications

Online Parameter Estimation

Online Linear State Estimator

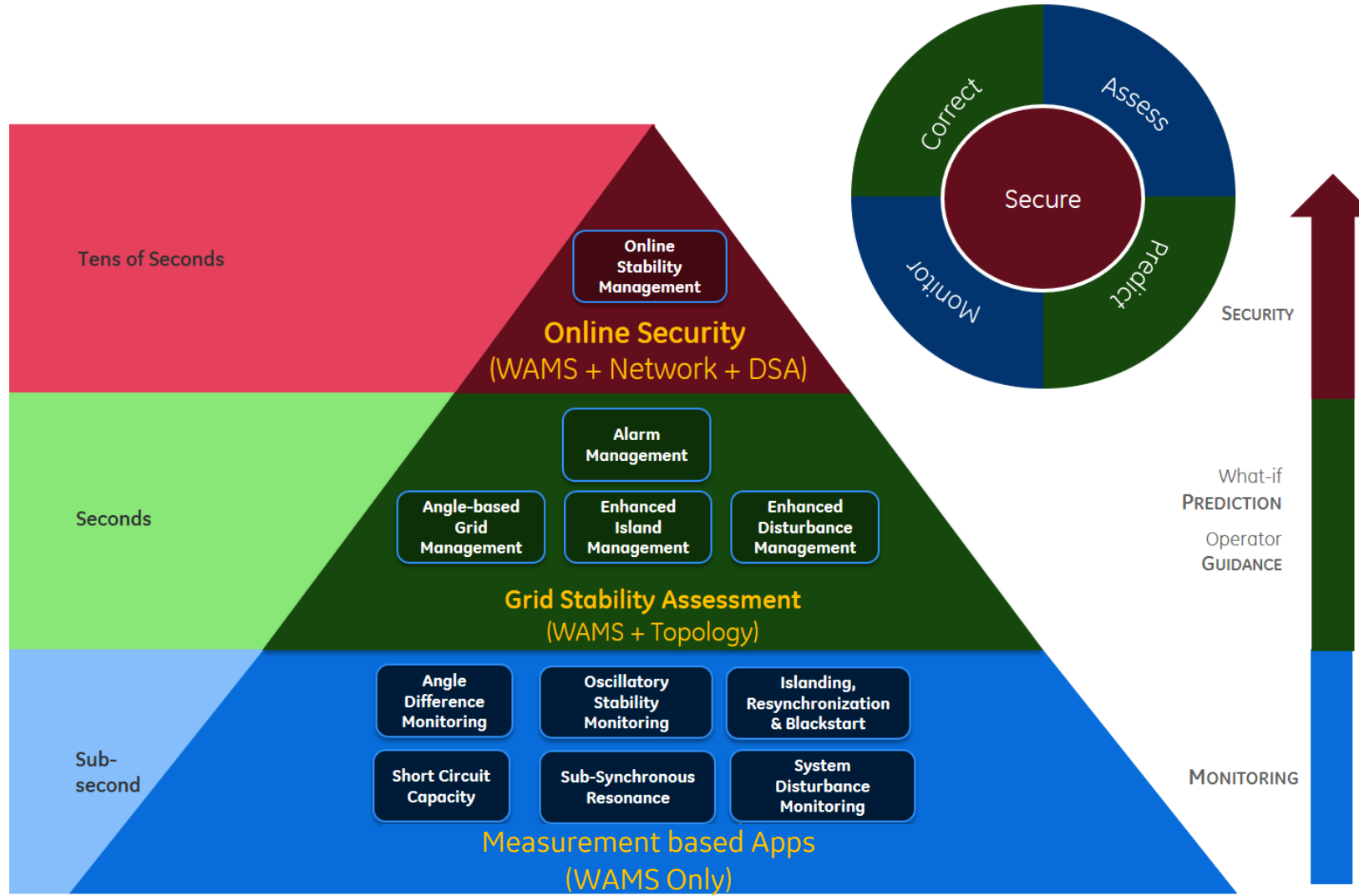
Enhanced Disturbance Management

Enhanced Island Management

Angle based Grid Management

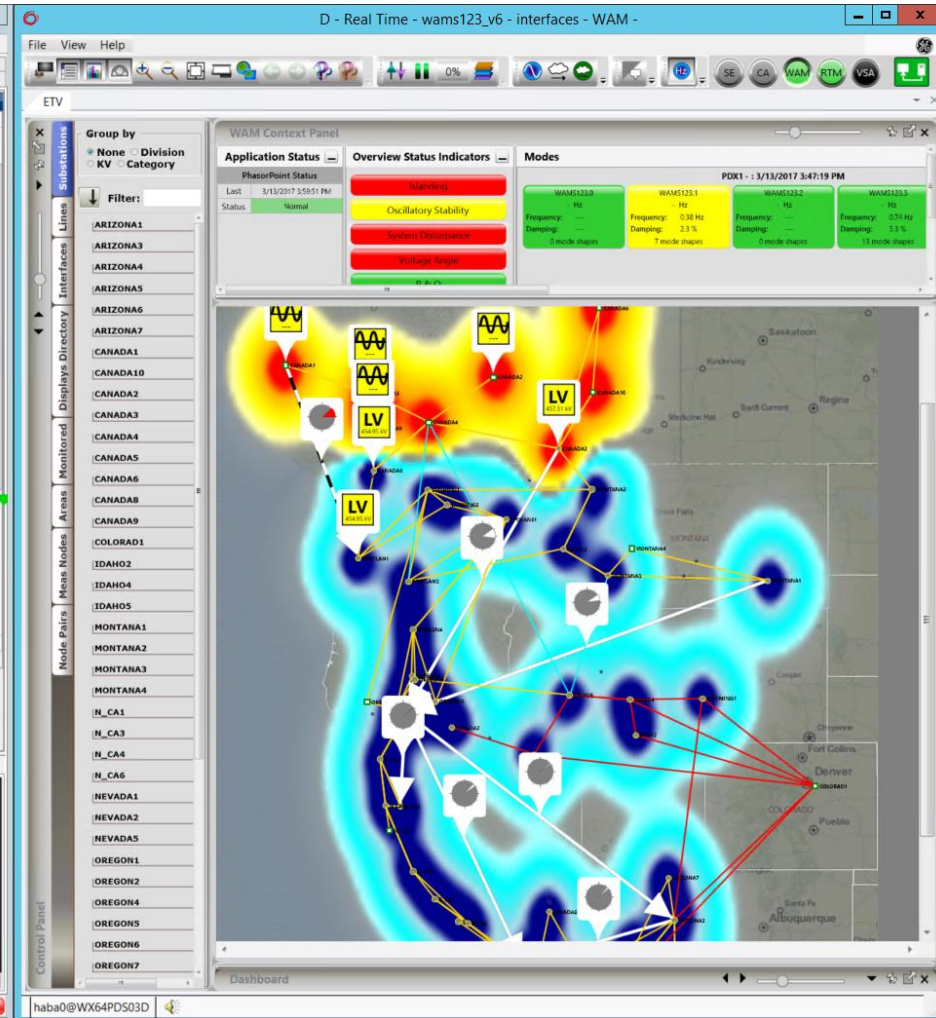
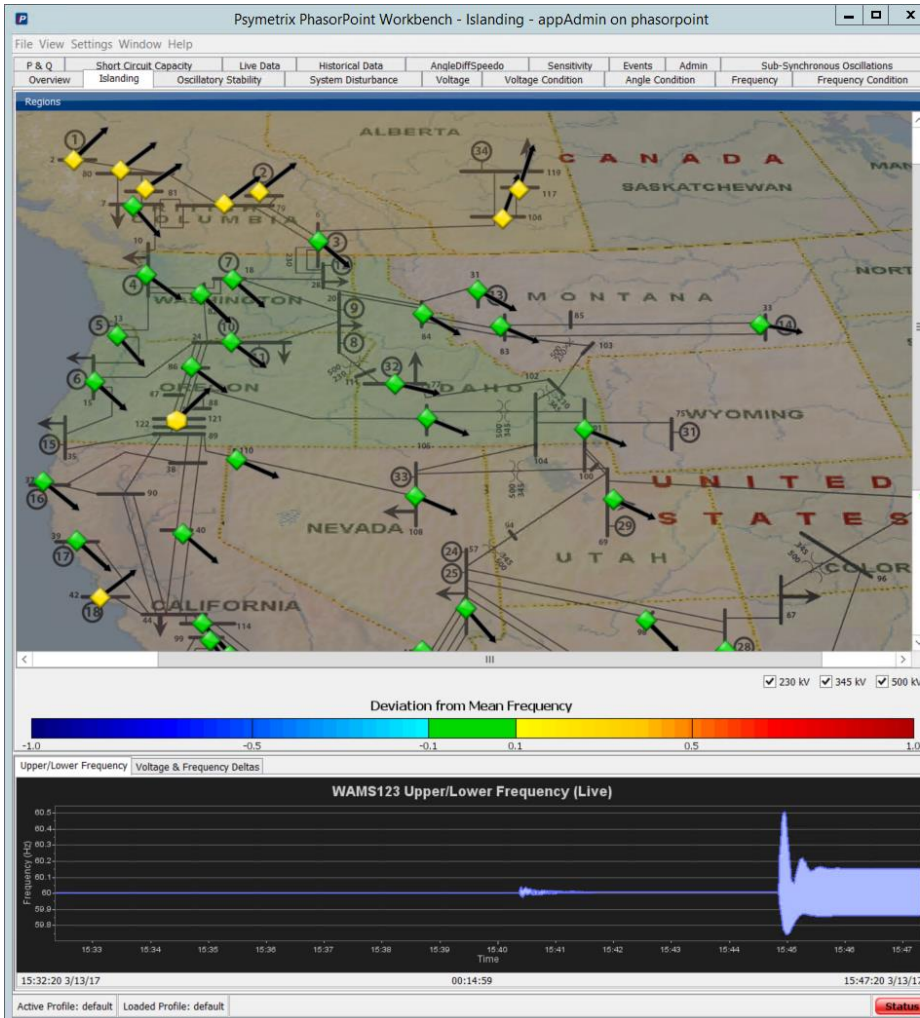


Benefits of WAMS-EMS Integration



WAMS Applications

Oscillation Monitoring & Island/Resync Management



Phasor Data in EMS

Alarms and Hybrid applications

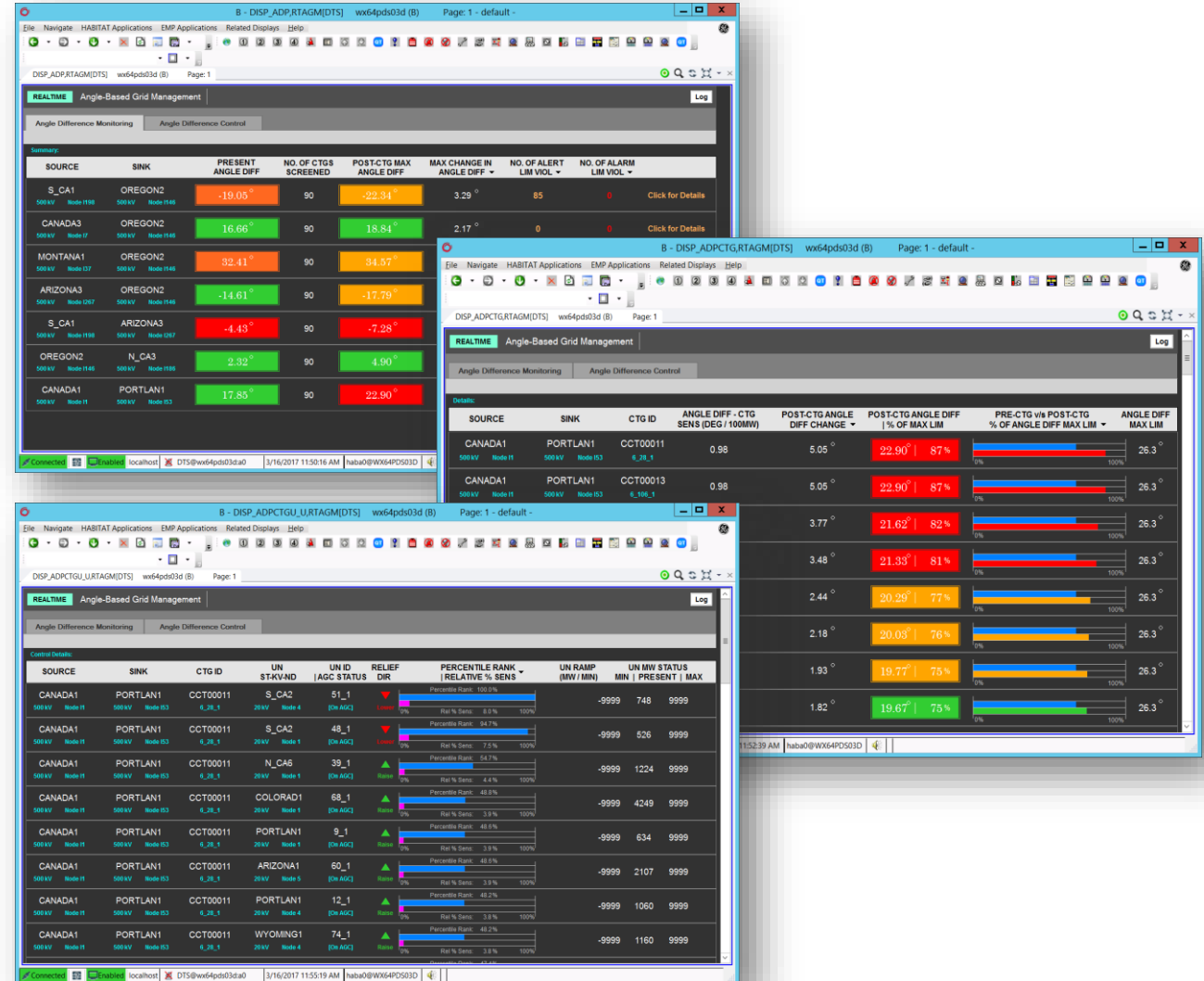
- Bring data from PhasorPoint at a down sampled rate of 1 frames/second
- Alarms and composite events are used by integrated alarms application – operators doesn't need to switch between screen
- Raw data is being used by hybrid applications where phasor measurements meets model



AGM

Angle-based Grid Management

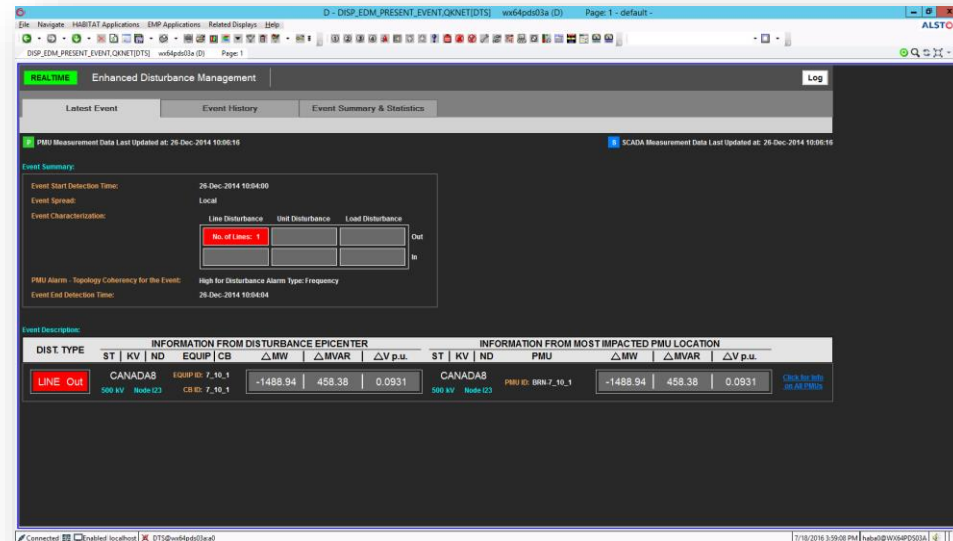
- Use angle difference as stress indicator
- Angle Difference Monitoring
- Predict angle difference for the all branch contingencies
- Recommend unit based control actions for each contingency –
The most sensitive unit for each node pair and contingency combination



EDM

Enhanced Disturbance Management

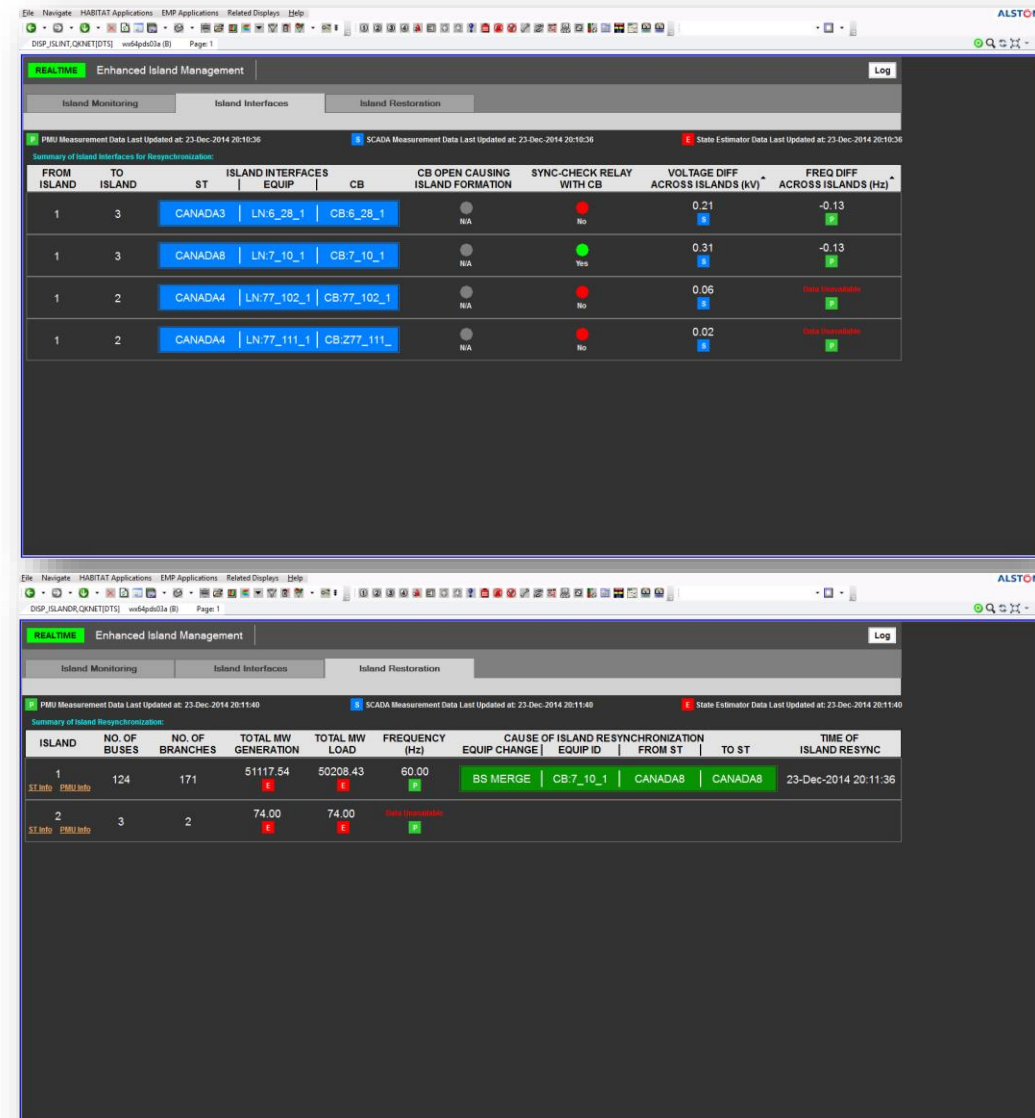
- Disturbance Detection
- Correlation between WAMS events and topology change in EMS. Associate it to the nearest PMU
- Disturbance classification
- History and statistical analysis of disturbance/events
- Automated CSV Report



EIM

Enhanced Island Management

- Island Detection
- Island interfaces
- Cause and location of island formation
- Realtime unit, load and its contribution to total generation and load in the island respectively
- Resynchronization paths
- Voltage, angle and frequency deltas across the islands



Hybrid Operator Training System



Training options

PHASORPOINT

1) Stand-alone WAMS Training Environment

Dynamic simulation capability driving synchrophasor applications in PhasorPoint.

Demonstrates the product's capabilities for WAMS real-time applications, enabling exercise the trainee's understanding of the solution.



2) Historical Event Capture Playback

Re-run of past system events within the WAMS environment, enabling configuration adjustments and operator response analysis.



DTS
INTEGRATION

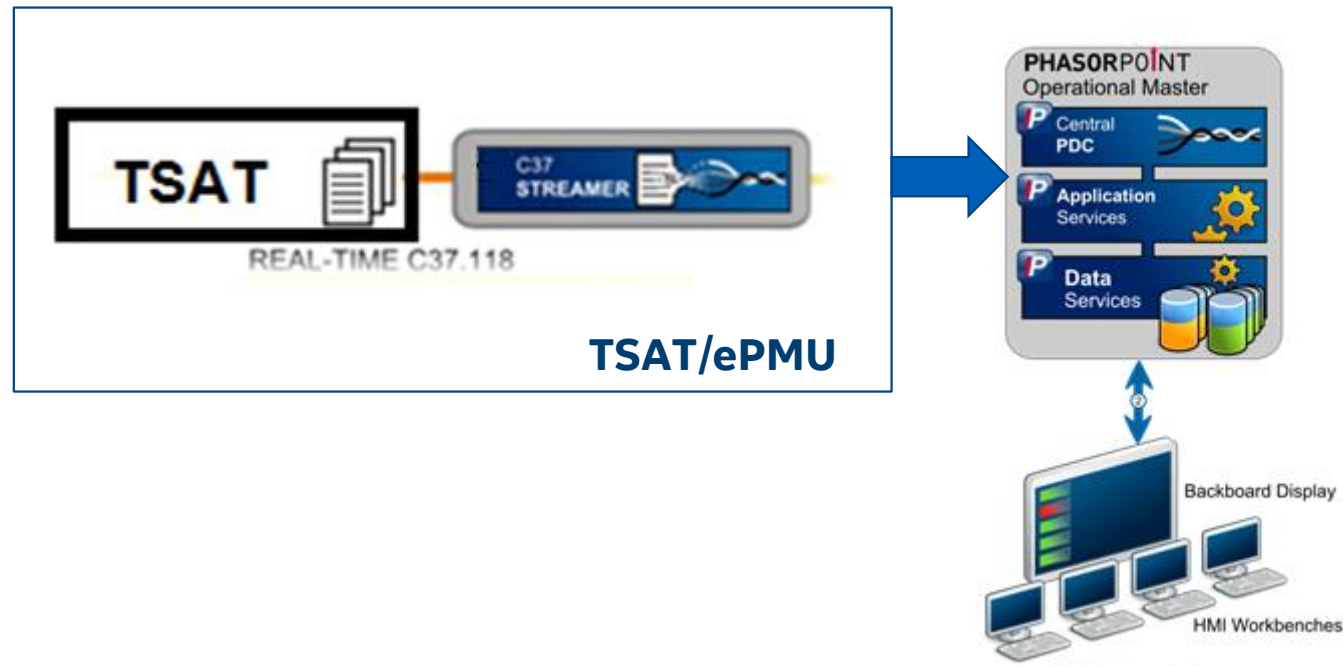
3) Hybrid (WAMS & EMS) Training Simulator (DTS/OTS)

Fully mimics the operational environment in a control-room, allowing the trainee to change the course of the system's response in real-time.



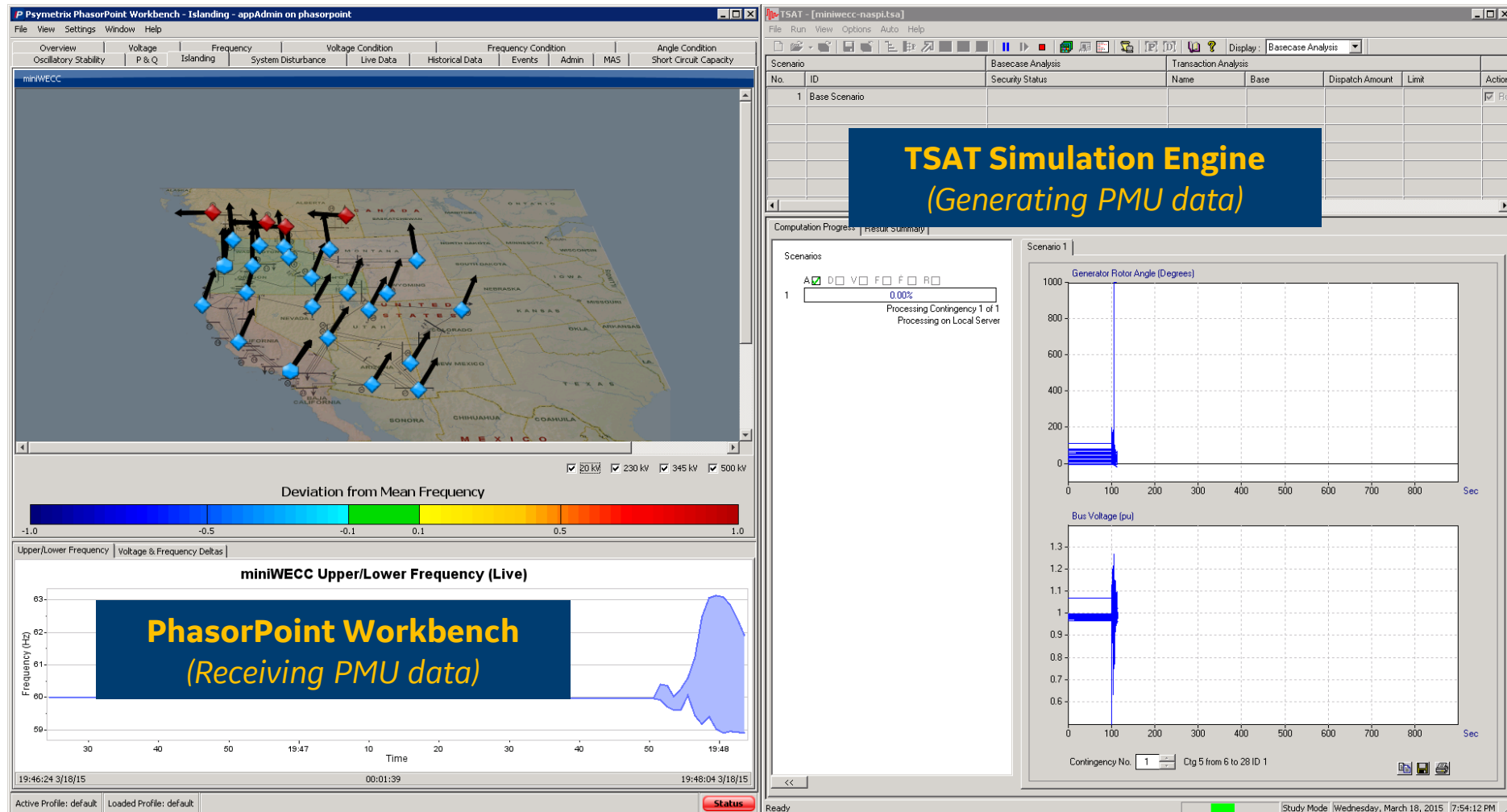
Option 1: Standalone WAMS Training Environment

Utilize Transient Simulation engine (TSAT) to generate simulated PMU data, driving PhasorPoint applications



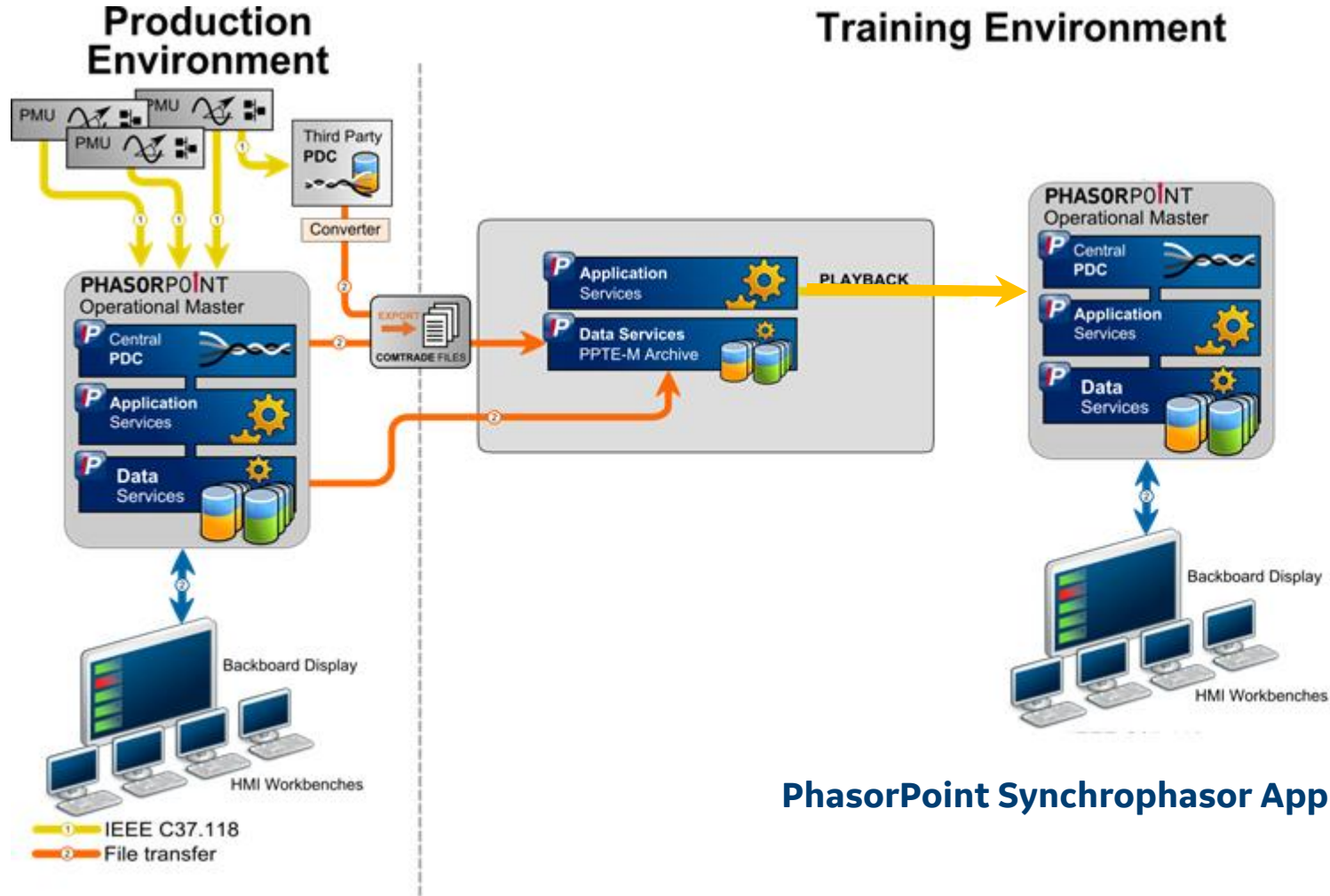
PhasorPoint Synchrophasor Applications

Sample Screenshot



Option 2: Historical Event Playback

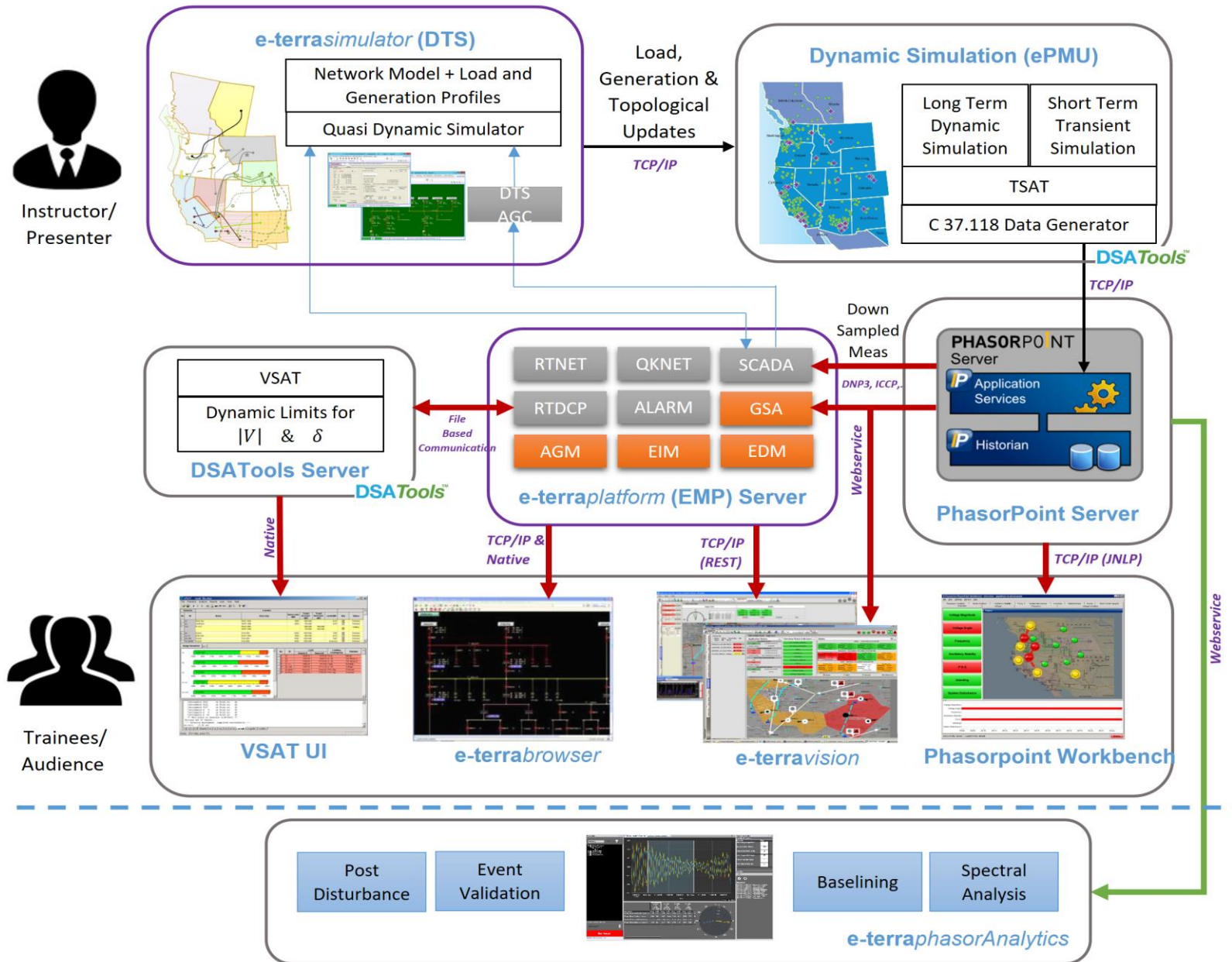
Ability to retrieve key event captures of interest and replay through PhasorPoint to reconstruct operator displays.



PhasorPoint Synchrophasor Applications



Closer Look at the Integration



Key Outputs

- Output to SCADA

- Bus Frequencies Sent from TSAT to DTS on a 1 second dynamic cycle, and are processed to determine DTS Frequency Relay Trips.
- Voltage/Angles Sent From TSAT to DTS on a 1 second cycle.
 - Voltage/Angles processed to determine other DTS relays (Voltage/Current).
 - Network STATE calculation is performed to determine branch flows which is then sent to SCADA.

- Output to PhasorPoint

- Bus Voltage Phasors, Current Phasors, Frequency, df/dt sent to PMU applications at sub-second rate (IEEE C37.118 format).



Demo Model – WAMS123/minniWECC



WAMS123 Demo Model

Miniature, Academic Simulation Model of US Western Interconnection Developed by BPA

System:

- 60 Hz
- 123 buses
- 34 generators
- 171 lines

Regions:

- Canada
- Montana
- North West (NW)
- California
- Utah



Demo Sequence

- Two tie lines connecting US and Canada regions
- AGM predicting angle difference violation between CANADA1 and PORTLAND1 for the worst contingency case; which happened to be one of the tie lines (6_28_1)
- Open Tie 1 (6_28_1), validate AGMs Prediction
- Look EDM for disturbance classification
- Open Tie 2 (7_10_1) to separate CANADA from US – Two Island
- Look at EIM for island interfaces, voltage and frequency deltas and resync paths
- Re-dispatch, match and manual resync



Demo



Summary

As we introduce WAMS and real-time dynamic stability analysis capabilities into the control room, it is **imperative** to provide a training environment for operators/dispatchers have a training environment to:

- Gain familiarity with the new stability metrics (such as angular separation and oscillatory damping), and how they are impacted with increased stresses on the grid.
- Playback past events of interest to analyze operator responses during those conditions.
- Provide unified view across traditional (steady-state) EMS tools (such as State Estimation, Contingency Analysis) alongside the new dynamic stability related information.

GE has been collaborating with Pacific Gas & Electric (US) to develop this **next-generation e-terra***simulator* with full WAMS integration and dynamic simulation capabilities to meet the needs of the future control room.



Questions



