

Figure 14- 1 Wide Area Measurement System (WAMS).

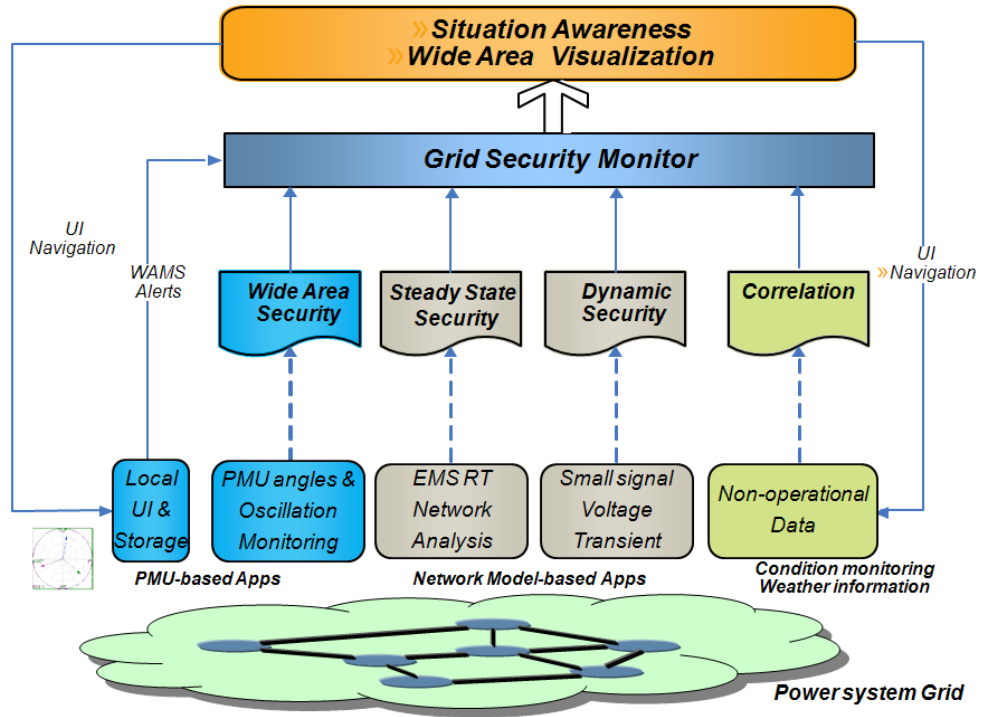


Figure 14- 2 Integration of WAMS within an Advanced Visualization Framework.

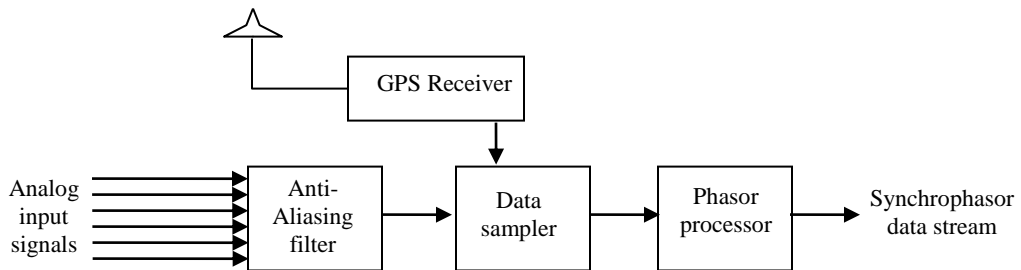


Figure 14- 3 Building Blocks of a Generic Phasor Measurement Unit (PMU).

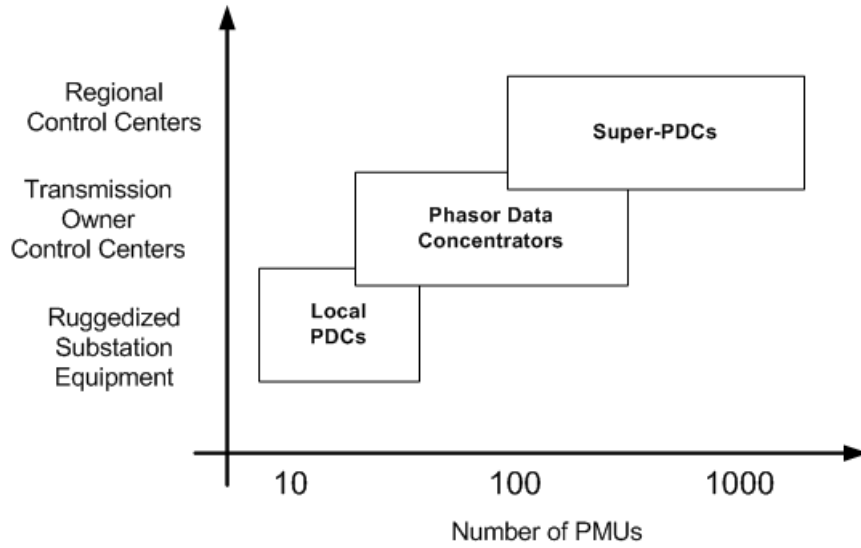


Figure 14- 4 The Three Levels of Phasor Data Concentrators: (1) Local or Substation PDCs, (2) Control Center PDCs, and Regional Substation PDCs.

	Number of PMUs			
Samples / Second	2	10	40	100
30	57	220	836	2085
60	114	440	1672	4170
120	229	881	3345	8340

Figure 14- 5 Data Produced by Different Numbers of PMUs and Sampling Rates (Kilobits/second).

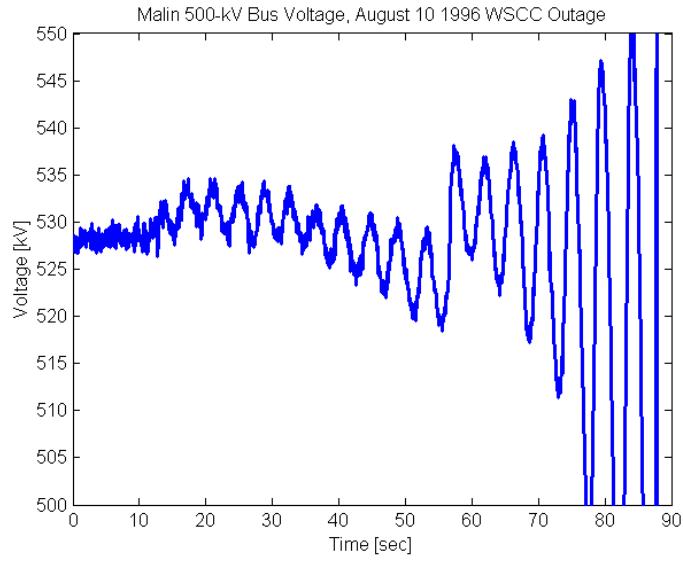


Figure 14- 6 Malin 500-kV Bus Voltage, Unstable Oscillation during August 10, 1996 Outage.

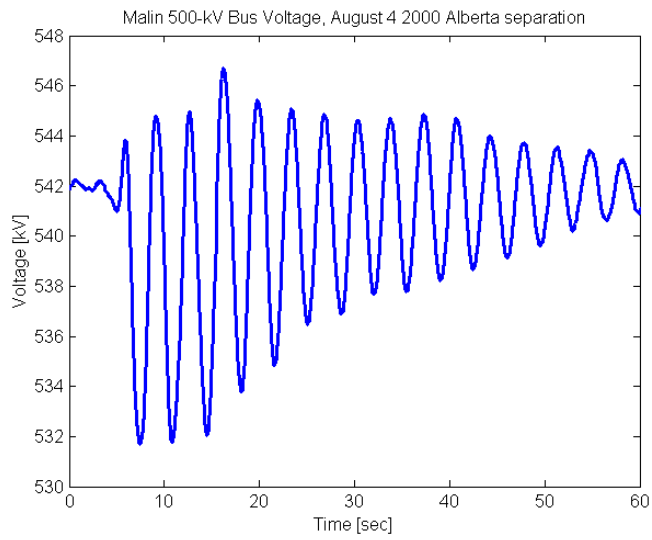


Figure 14- 7 Malin 500-kV Bus Voltage, August 4, 2000 Event.

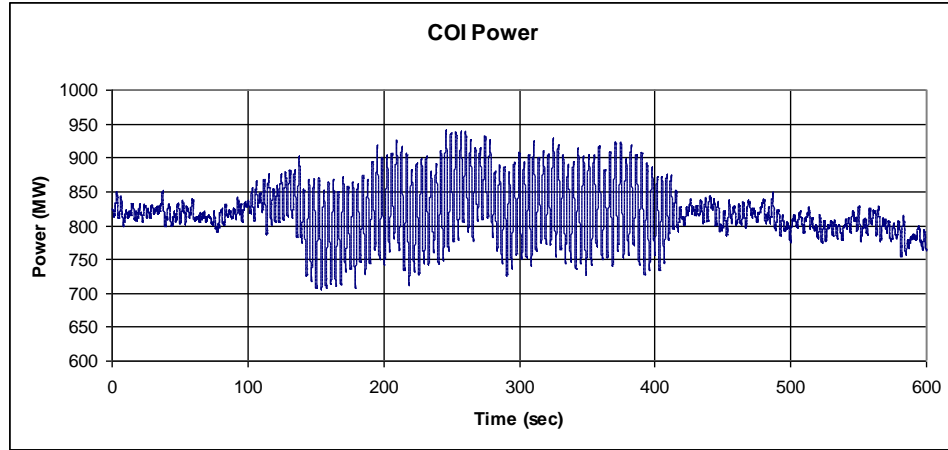


Figure 14- 8 Forced Oscillations on California – Oregon Intertie on November 29, 2005.

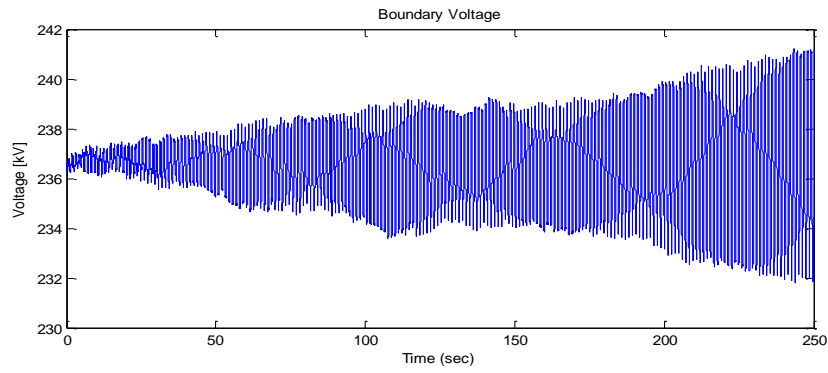


Figure 14- 9 Growing Oscillations at Boundary on September 29, 2004.

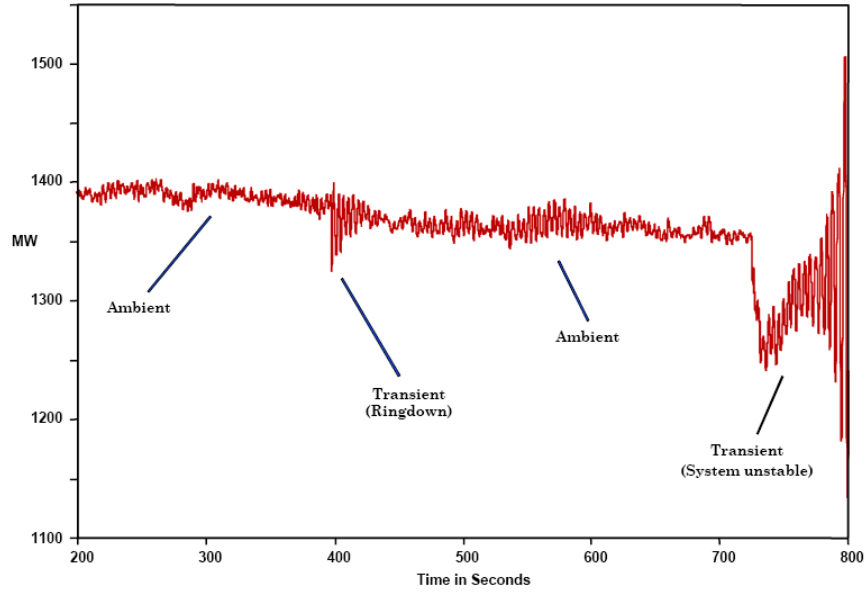


Figure 14- 10 Real Power Flowing on a Major Transmission Line During the Western North American Power System Breakup of 1996.

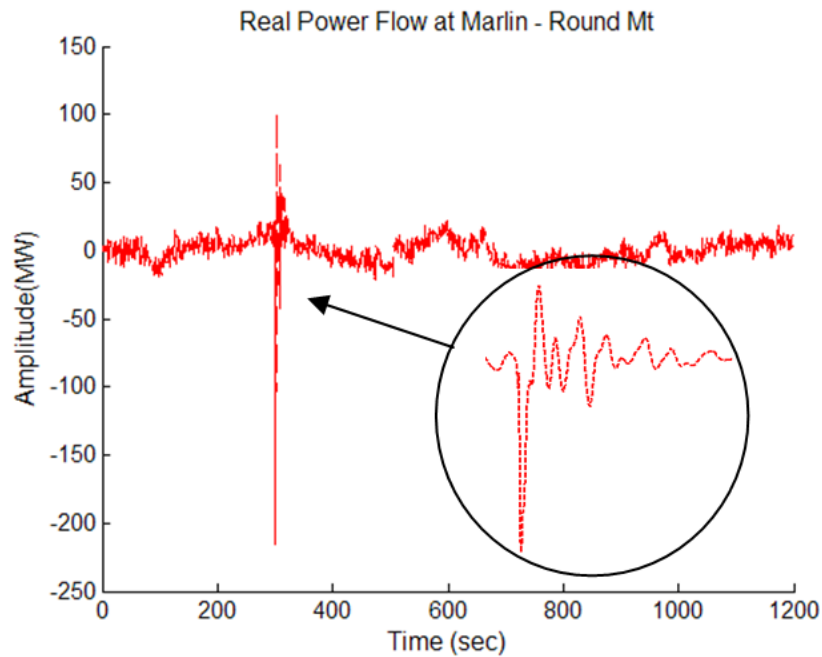


Figure 14- 11 Brake Response of US Western Interconnection. Brake Inserted at the 300 sec. Point. Combined Ambient and Ringdown data from field measurements. Detrended Power

Flowing on a Major Transmission Line.

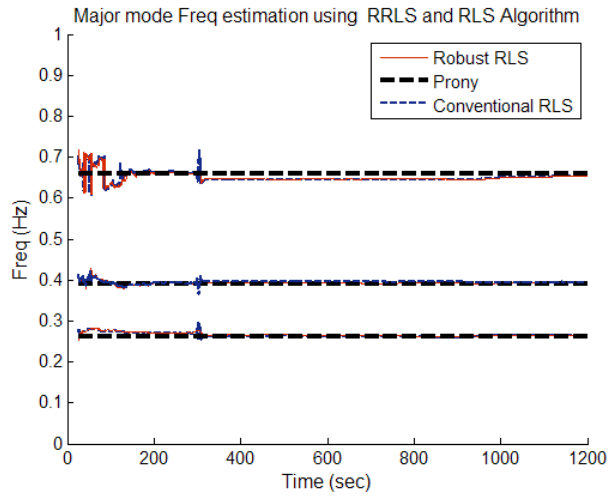


Figure 14- 12 Frequency Estimation of the Major Modes using the RRLS Algorithm.

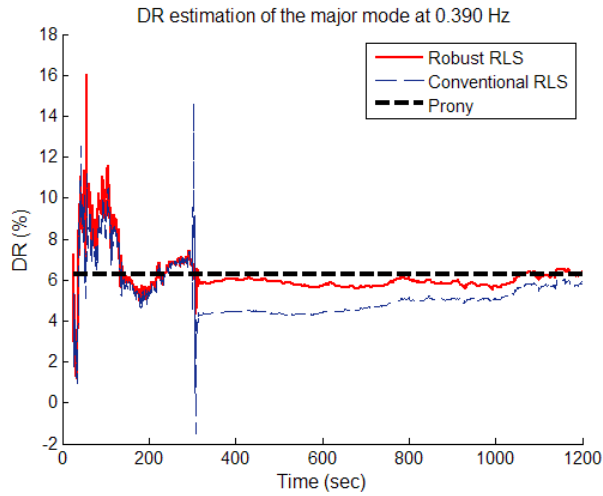


Figure 14- 13 Damping Ratio Estimation of the Major Mode around 0.39 Hz.

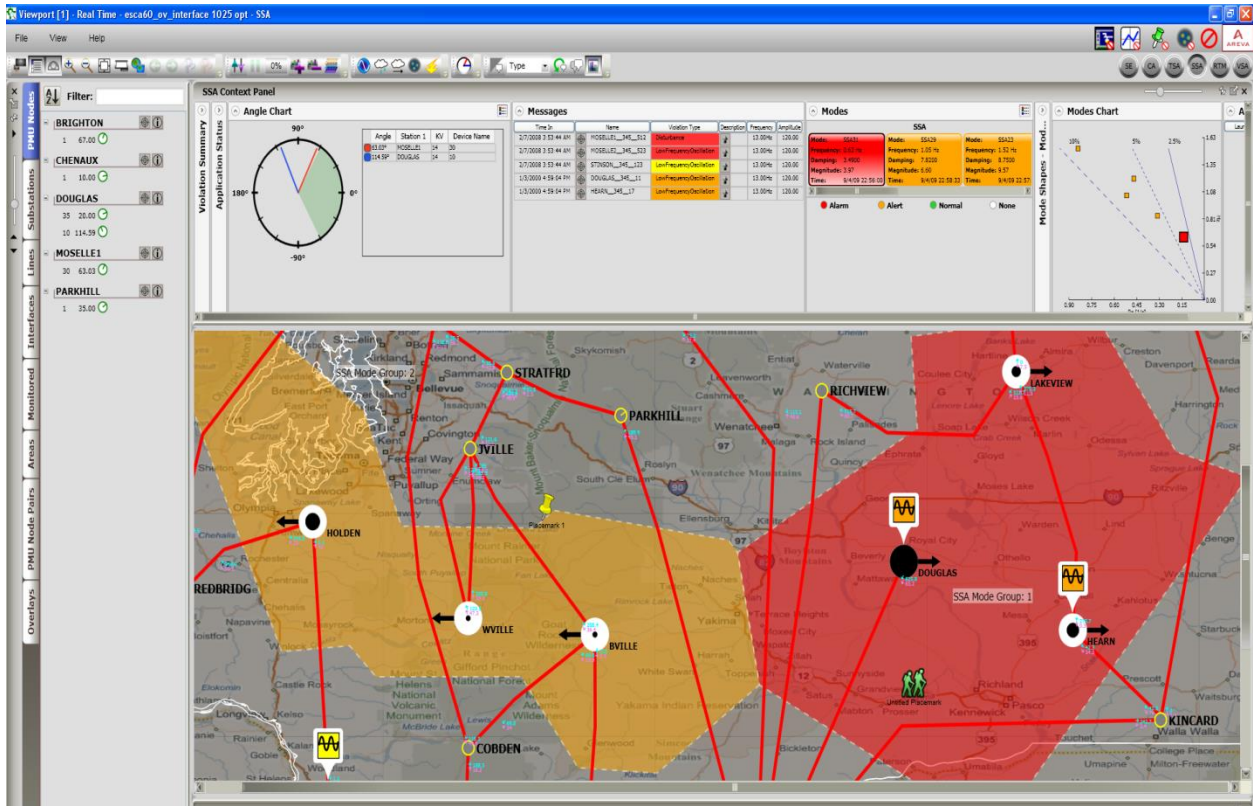


Figure 14- 14 SynchroPhasor based Small-Signal Stability Monitoring within e-terravision.

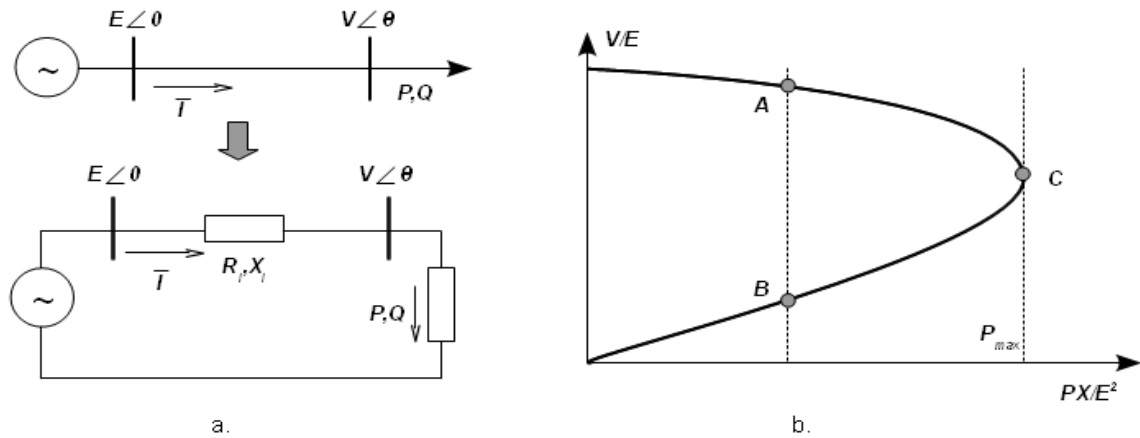


Figure 14- 15 (a) Simple Two Bus System and (b) Power-Voltage Characteristics.

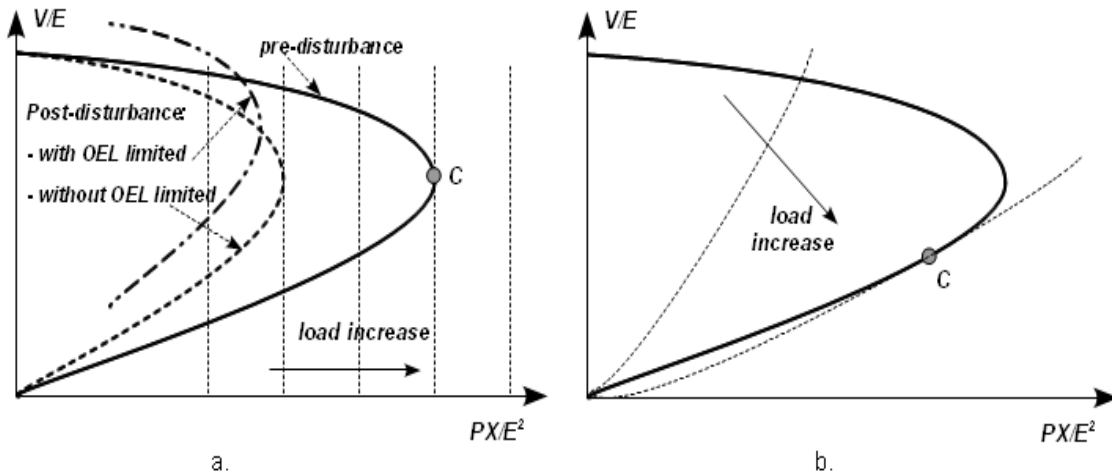


Figure 14- 16 Voltage Instability Mechanisms.

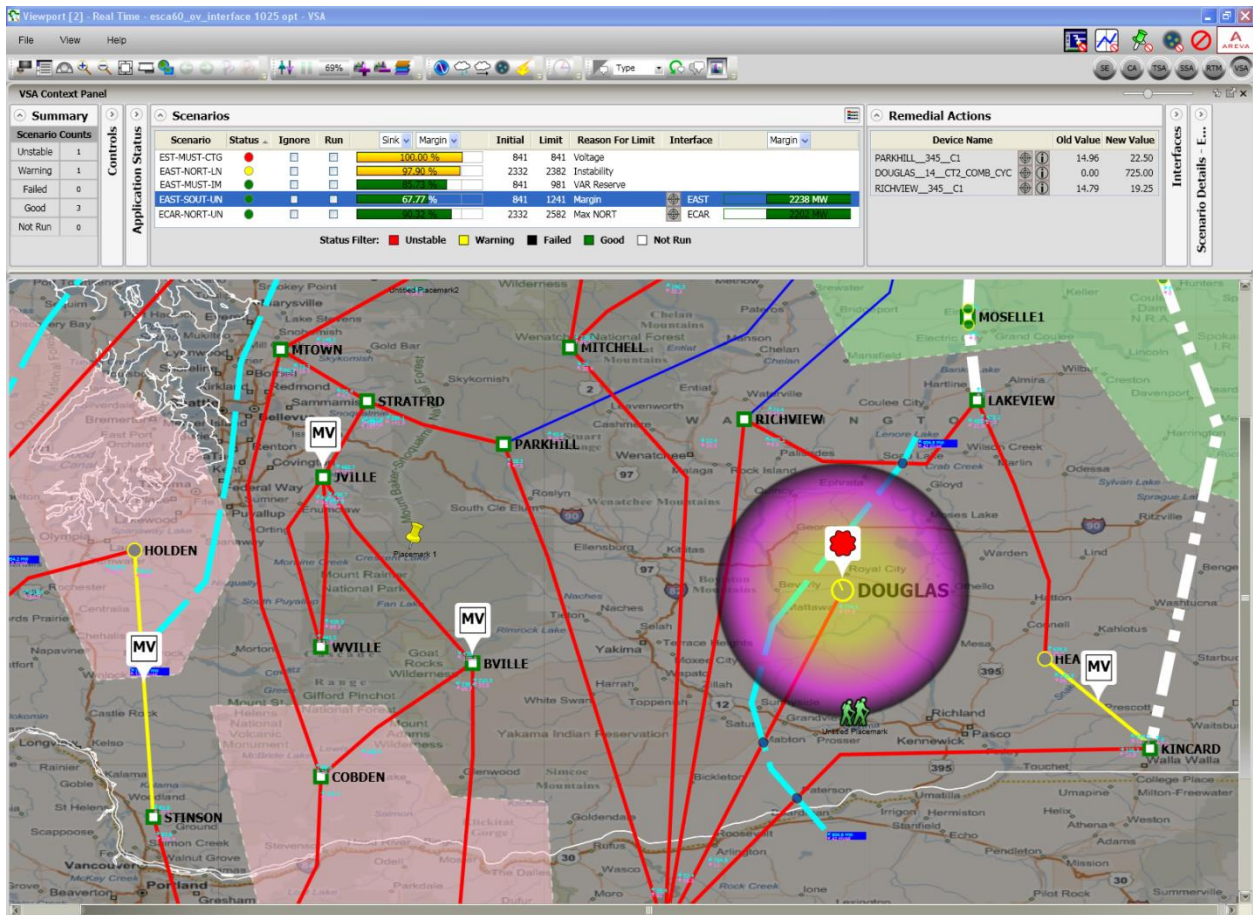


Figure 14- 17 Real-Time Voltage Stability Assessment within e-terravision.

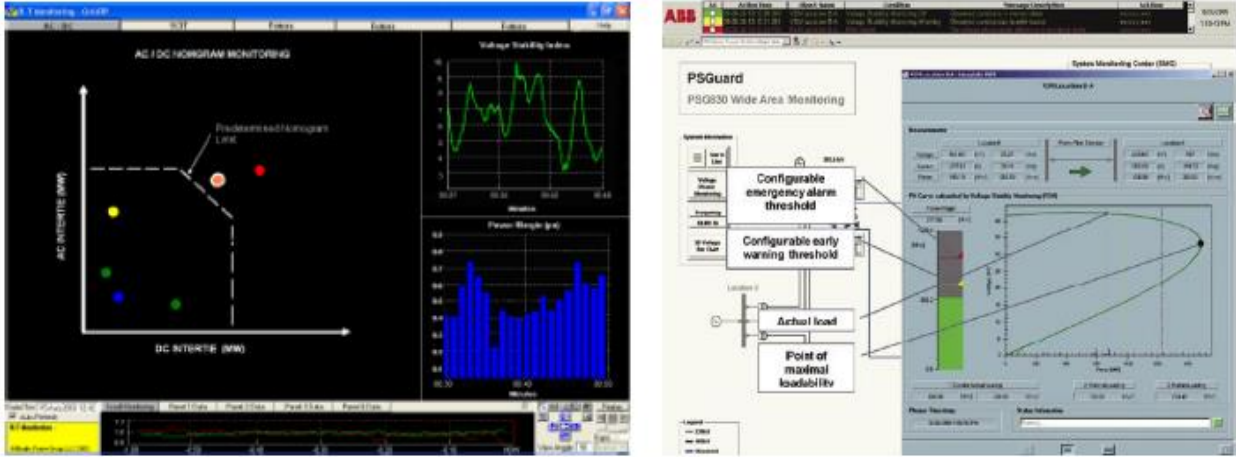


Figure 14- 18 Control Center Voltage Stability Monitoring Displays **Error! Reference source not found..Error! Reference source not found..**

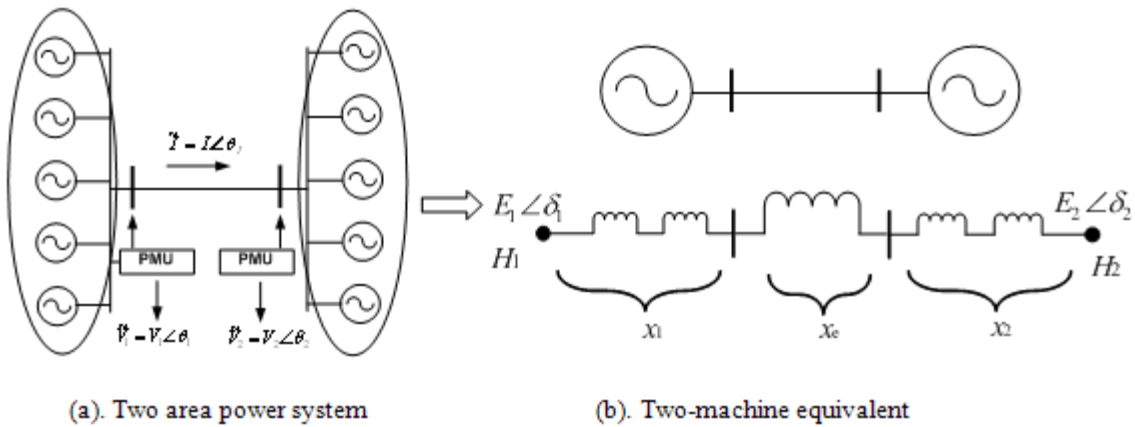


Figure 14- 19 Two-Machine Dynamic Equivalent of a Two-Area Power System.

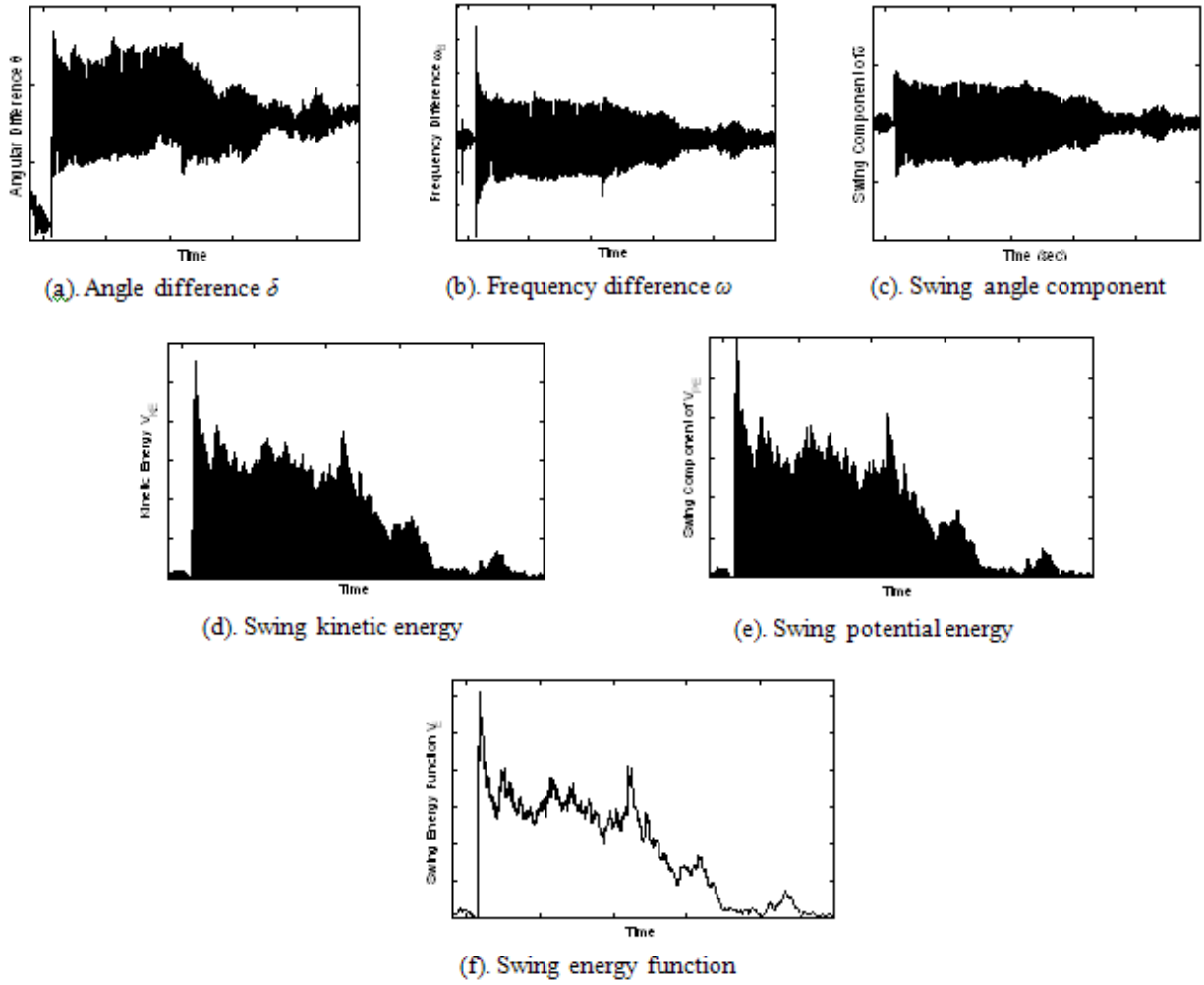


Figure 14- 20 Synchronphasor based Transient Energy Functions for a Western Interconnection Disturbance Event Swing.

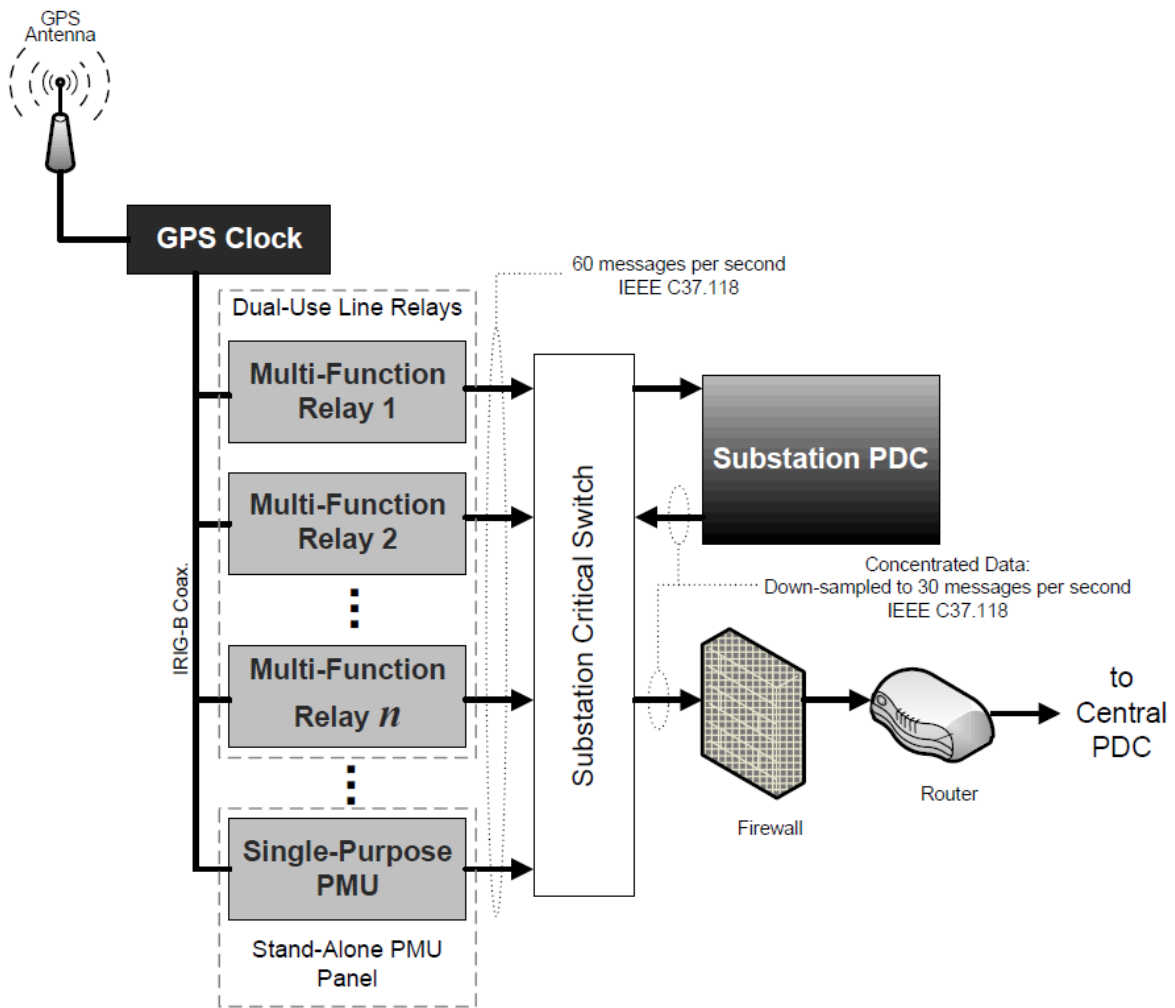


Figure 14- 21 Substation Architecture for a PMU based EHV State Estimator.

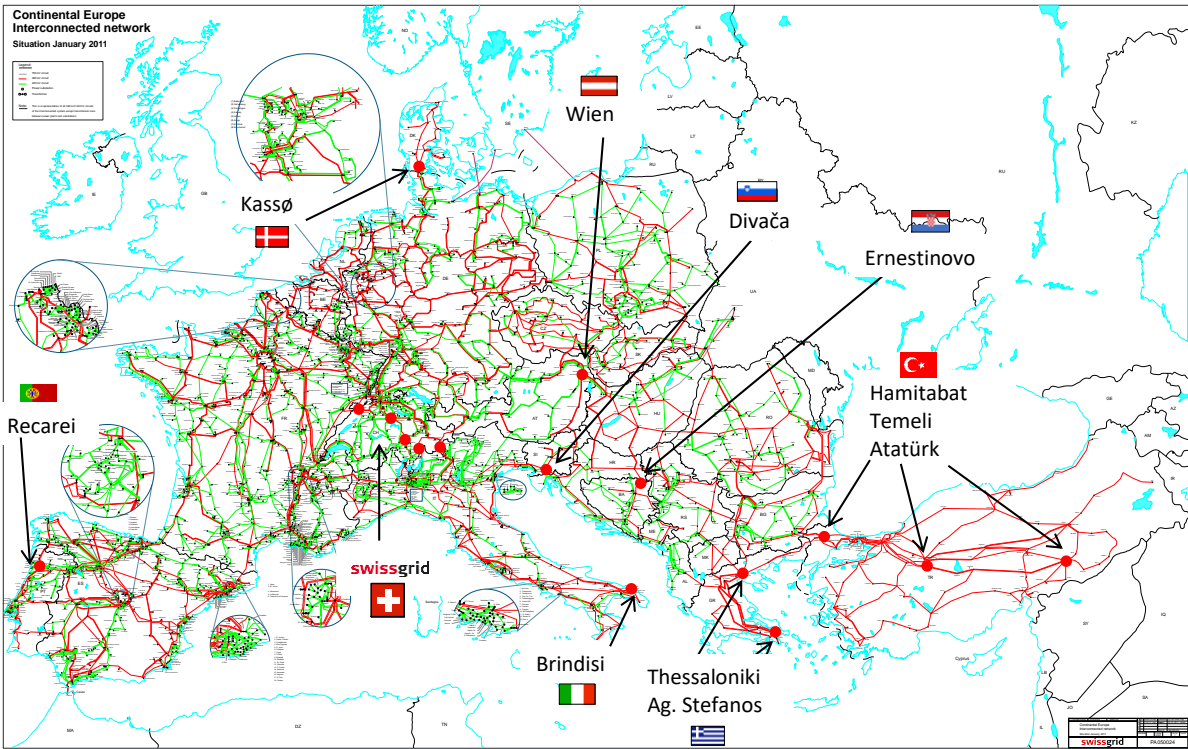


Figure 14- 22 Current Swissgrid WAMS Links.

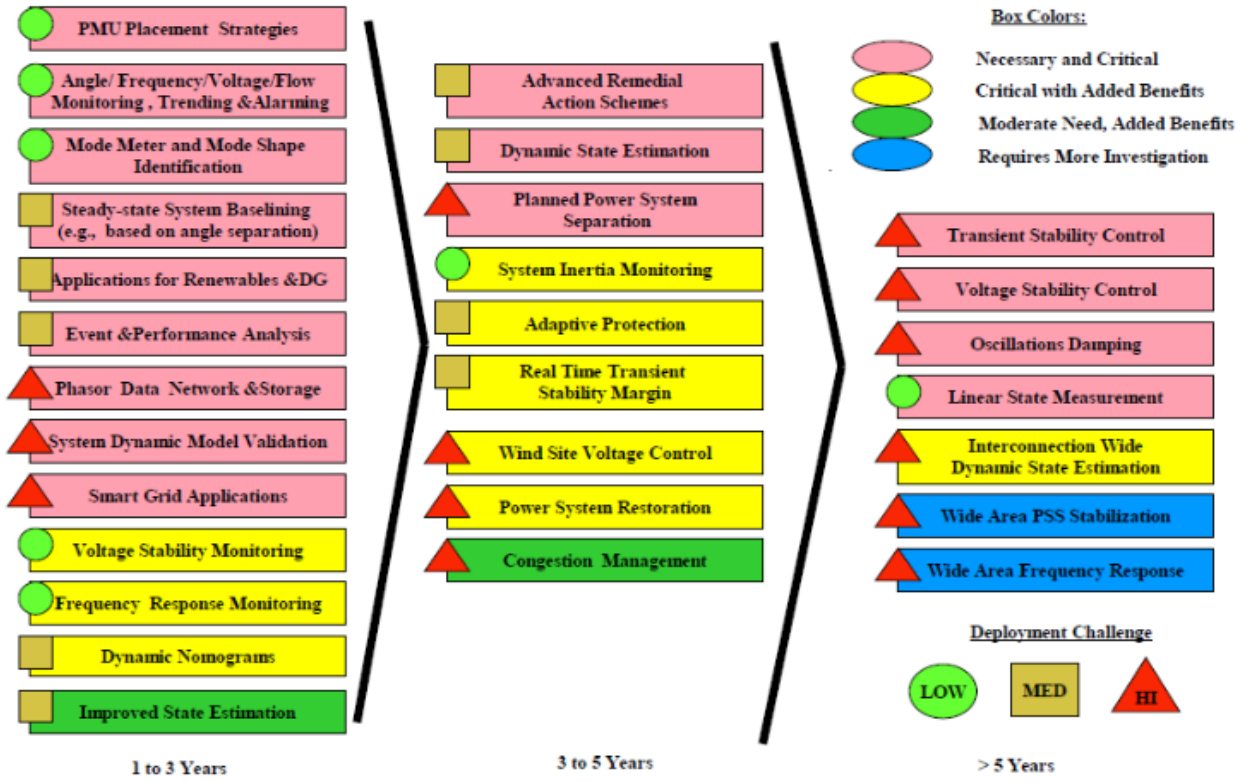


Figure 14- 23 NASPI Roadmap for Synchrophasor Applications.