



# V&R Energy

The **POWER** to make a right decision!

[www.vrenergy.com](http://www.vrenergy.com)

## V&R Energy

### *Technology Partner Flash Talk*

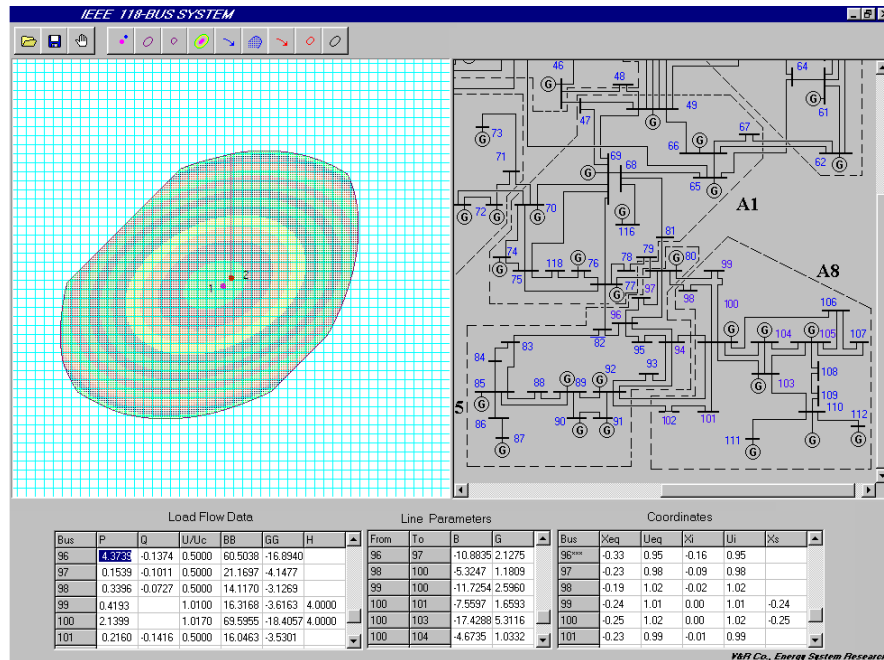
***Marianna Vaiman***  
***NASPI Work Group Meeting***  
***Salt Lake City, UT • April 16 – 17, 2024***

# Brief History of PMUs and V&R Energy

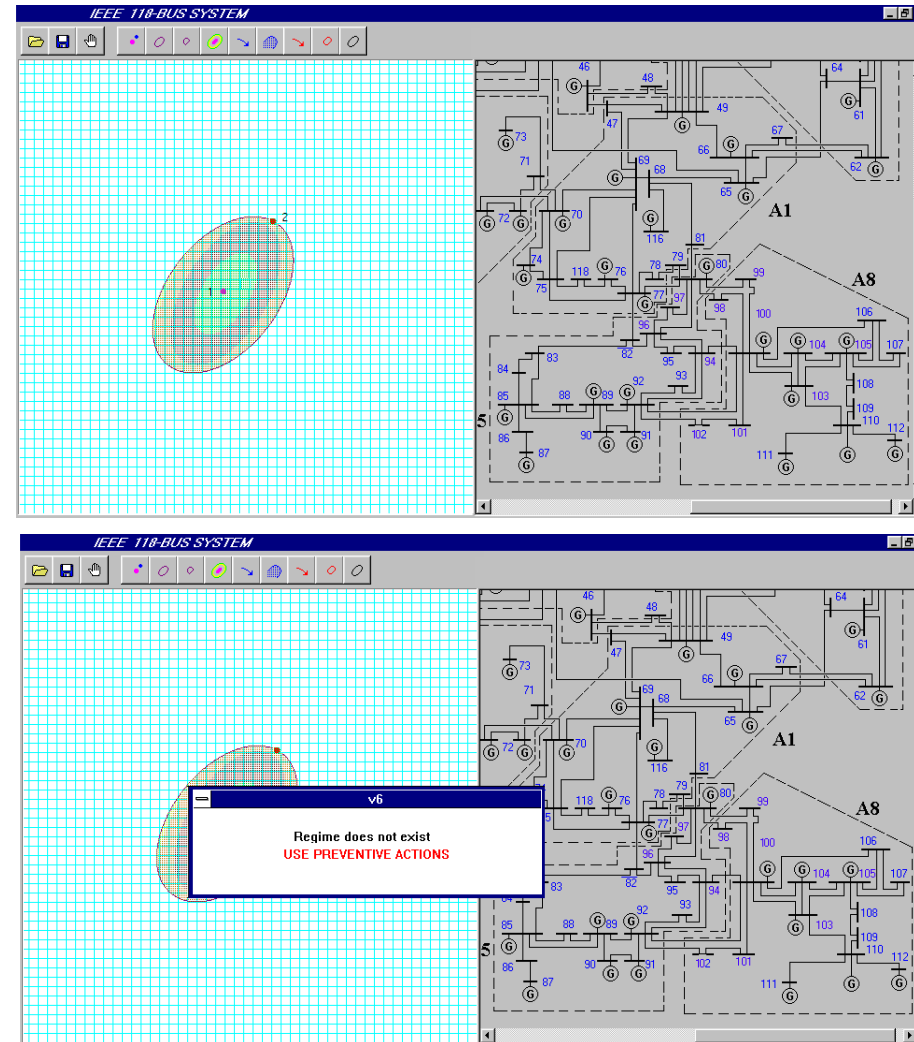
- 1988: Arun Phadke and Jim Thorpe invent PMUs
- 1992: Macrodyne builds the first PMU model; V&R Energy is founded
- 1996: First V&R Energy's R&D PMU-based app is developed
- 2014: During NASPI Voltage Stability Workshop, V&R Energy pioneers the concept and demonstrates the benefits of a PMU-based EMS system:
  - Invented PMU-based State Estimator Case or LSE Case (e.g., PMU-based power flow), which is the basis of the PMU-based EMS system
  - Prior to this, “standard” output of LSE was conditioned and expanded PMU stream
- 2023: First field deployment in US of Distribution Linear State Estimator at ComEd, supplied by V&R Energy (D-PMU ROSE/DLSE )
- Extensive experience using PMU data for advanced applications
- PMU-based and hybrid tools for transmission and distribution systems

# The Start: POM Suite/ROSE ver. 1996

- Boundary-based approach shown on the plane of two phase angles
- Determines the relationship between the region of stability existence and the maximum transfer capability for the specific interfaces



■ ROSE for the base case conditions



■ ROSE at the limit value of stressing  
 — The operating point is on the boundary

■ Remedial actions are invoked at the limit value

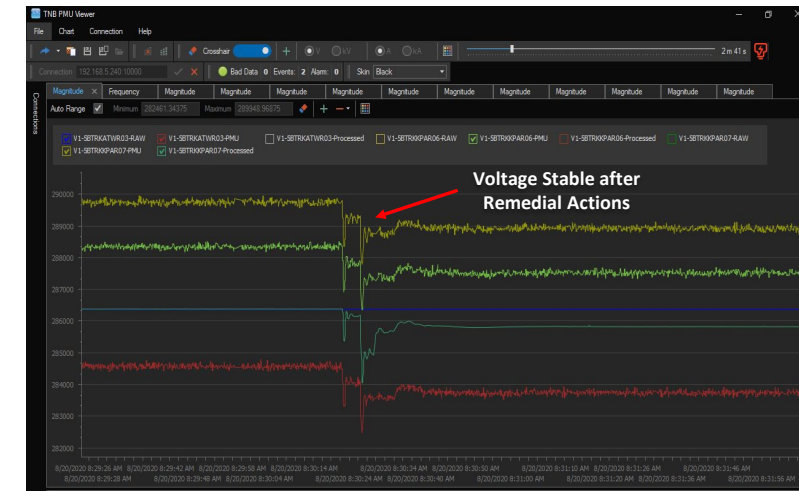
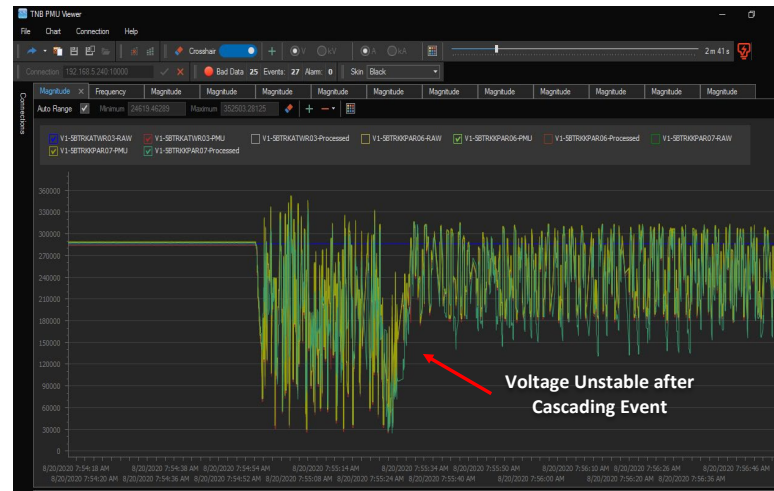
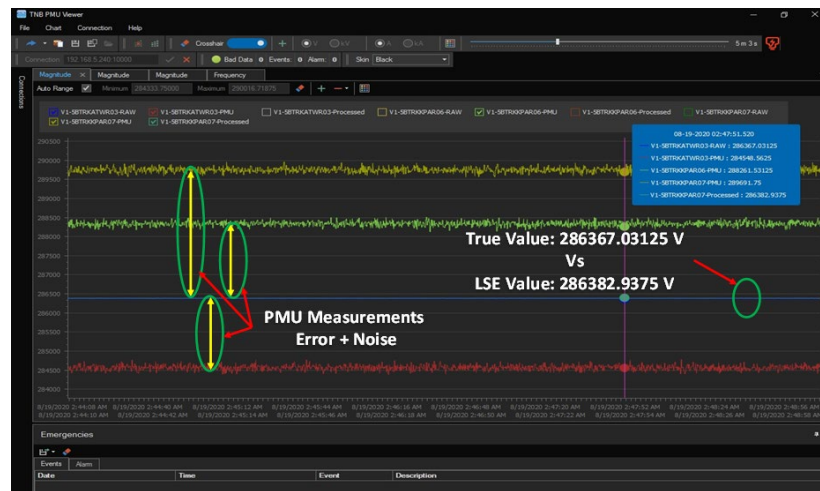
# PMU-Based EMS System at TNB - 2023

## ■ LSE facts:

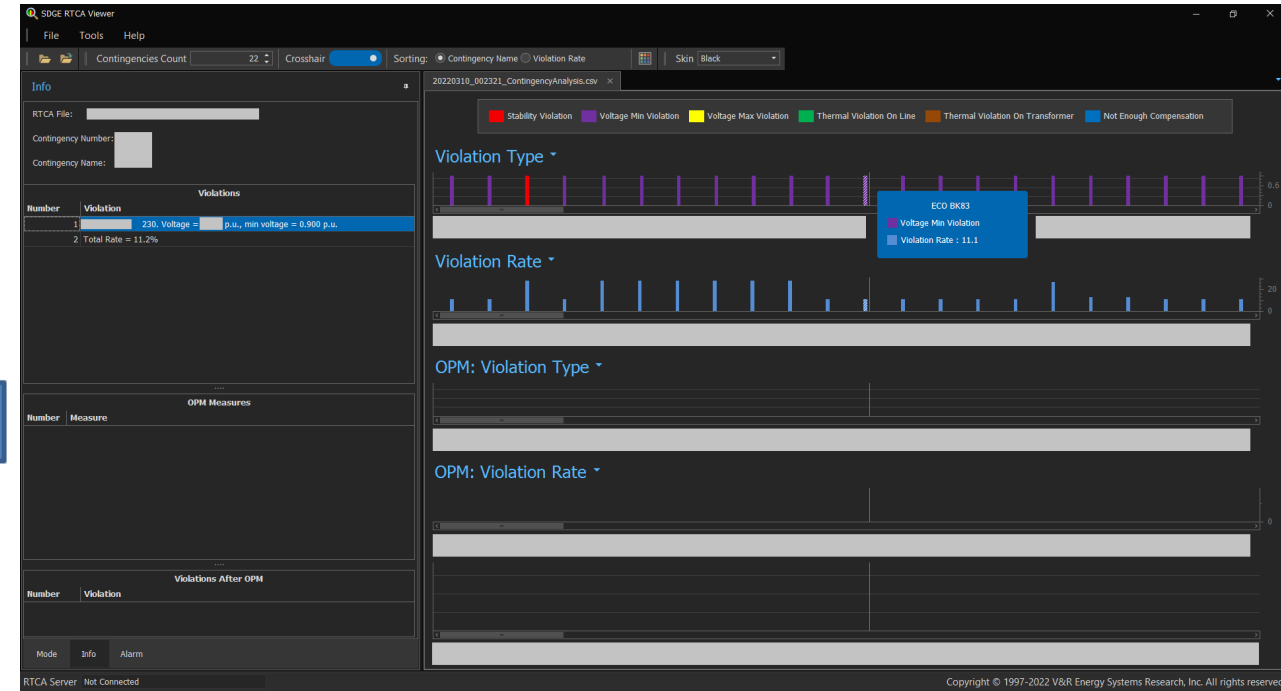
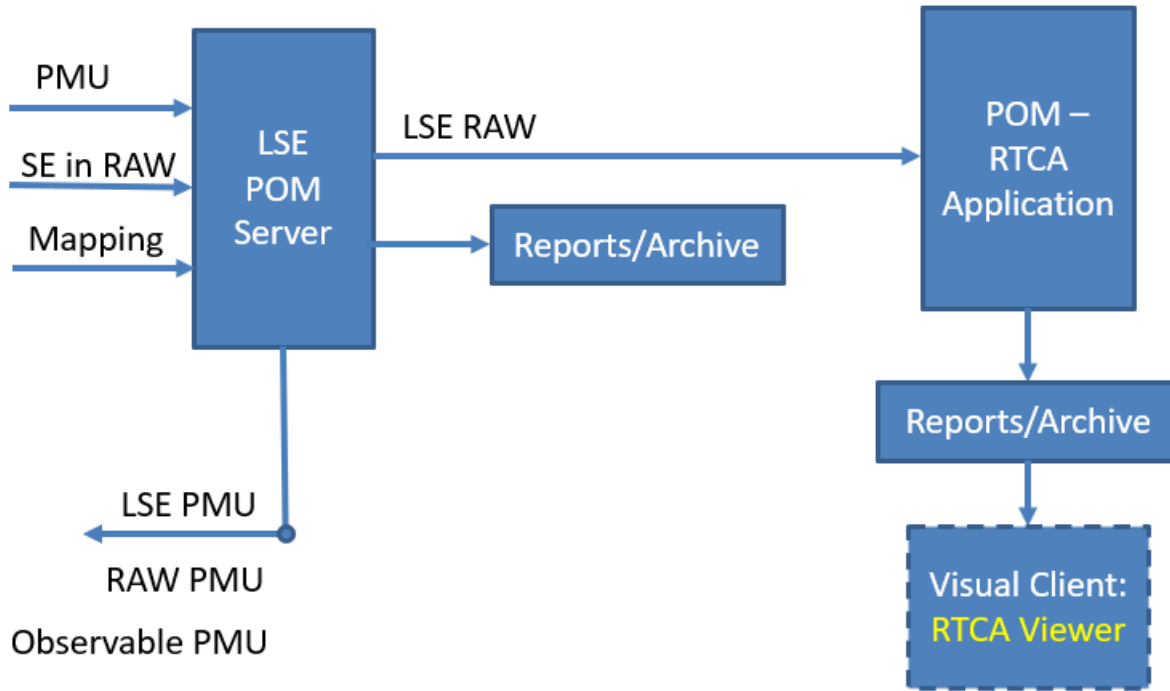
- LSE is performed 25 times/s
- 1218 PMUs / 7 PDCs are used
- LSE (dark green line) successfully suppresses the error and estimates voltage with a difference of less than 0.01% compared to the true value

## ■ Cascading results:

- 1877 N-1 initiating events are analyzed in one run
- 41 critical cascading events were identified and ranked based on severity measured using the Performance Index
- Optimal mitigation measures are identified to alleviate this stability violation



# PMU-Based Power Network Analysis System at SDG&E



- The system consists of **LSE POM Server** application, **POM-RTCA** application, and **SDGE RTCA Viewer** Visual Client

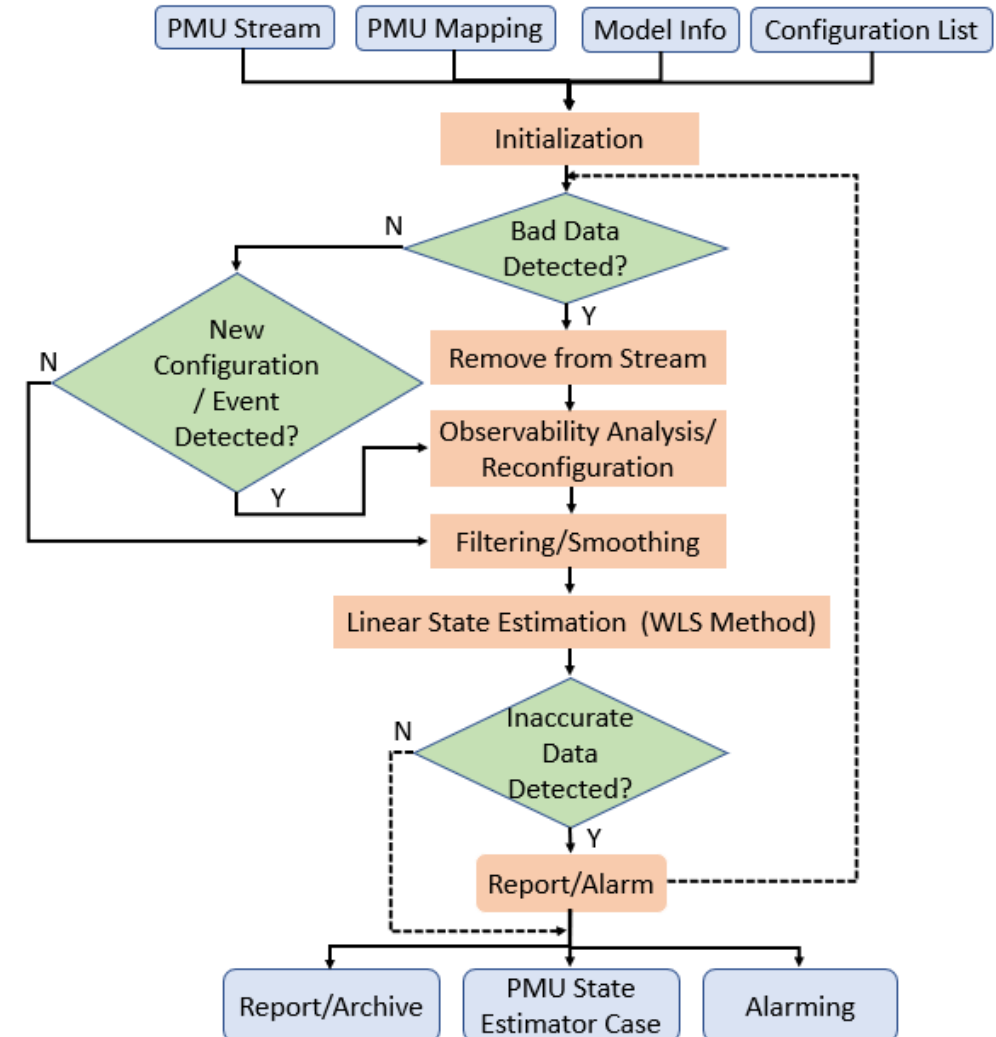
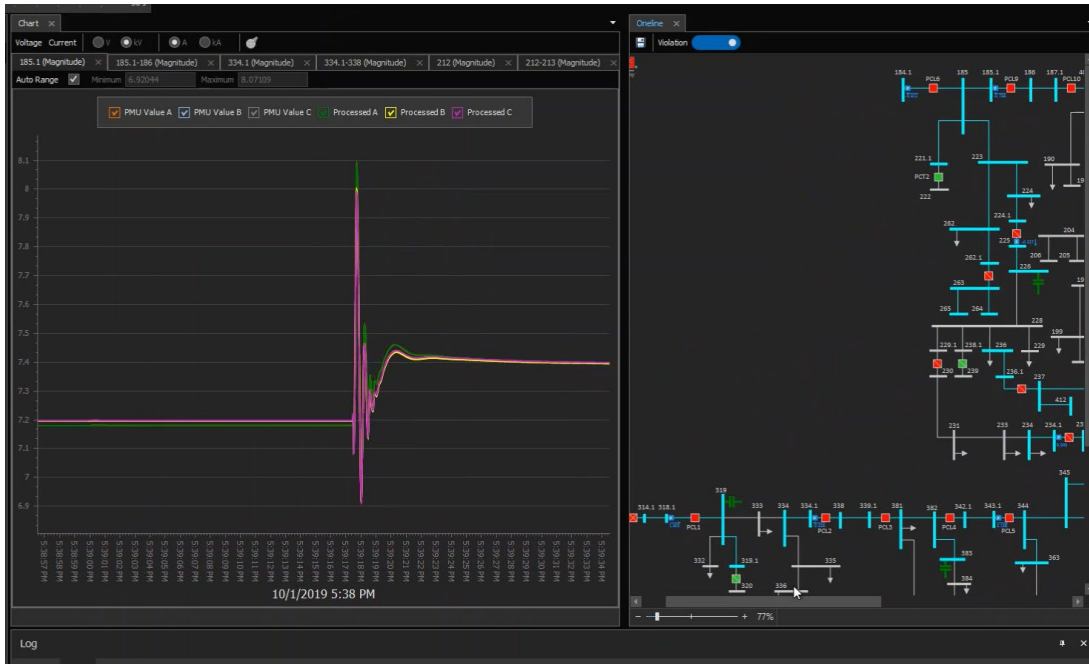


■ **Field deployment**



# Distribution Linear State Estimator for Increased Situational Awareness and Resilience at ComEd

- The software solves 3 phase unbalanced DLSE
- Bad data detection, correction, alarming and reporting
- Observability analysis
- Detection of switching events (only based on PMU data)
- Real-time system monitoring (voltage and thermal)



# Distribution Hybrid State Estimator as a Foundation for Grid Modernization Applications

- Enables integration of small DER through DER gateway and their monitoring using hybrid DSE
- Three use cases: fault location, isolation, and service restoration (FLISR); Volt - Var optimization (VVO), and DER dispatch
- NYSERDA demo project with Central Hudson and Quanta Technology

