

# Power Grid Simulator

*GridSim*

**Mani V. Venkatasubramanian**

Washington State University

Pullman WA

# GridSim - Real Time Simulation of Power Grid Operation & Control

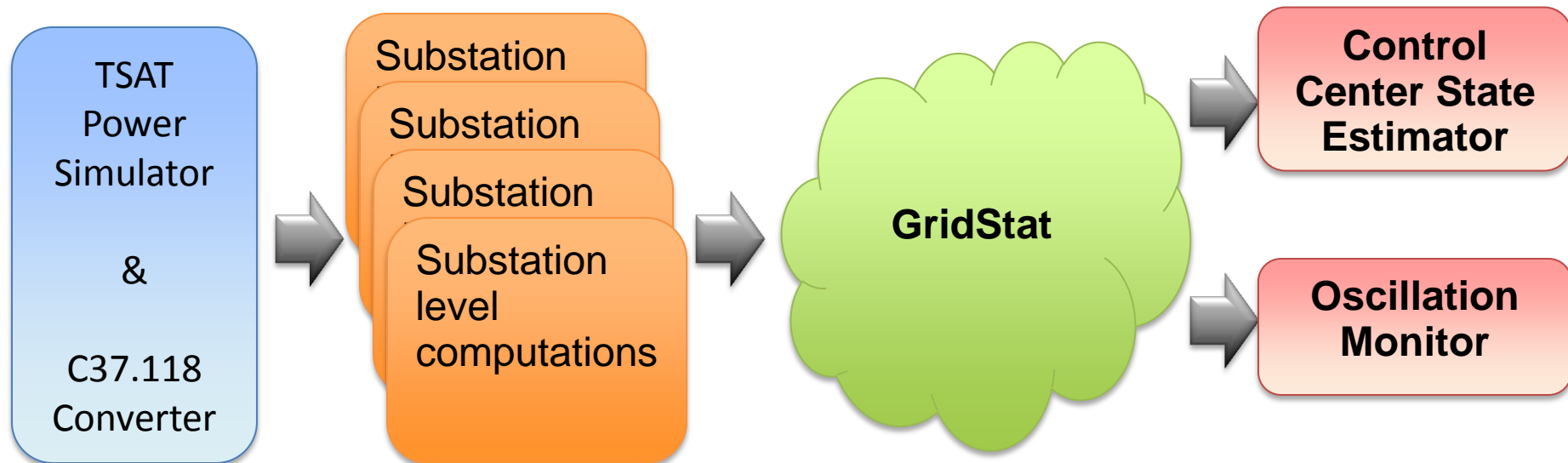
- Funded by USDOE
- Project team: Mani Venkatasubramanian (Project Lead), **Anjan Bose**, Dave Bakken, Carl Hauser, Chuanlin Zhao, Dave Anderson, Dong Liu, Alex Ning, Ming Meng, Lin Zhang, Zaid Tashman
- Simulate PMU like real-time responses of large-scale power system including **power grid dynamics** and **communication network**

# Project Objectives

Improve Reliability and Security of the Electric Power Grid by developing

- A real-time large-scale power system transient stability simulator, including detailed dynamic models and communication middleware
- A platform for studying interactions of automatic algorithms for instability detection and **wide-area controls with communication networks**
- New operator support tools, like next generation state estimators, for better human decision making

# Simulation Test Bed for the Smart Grid



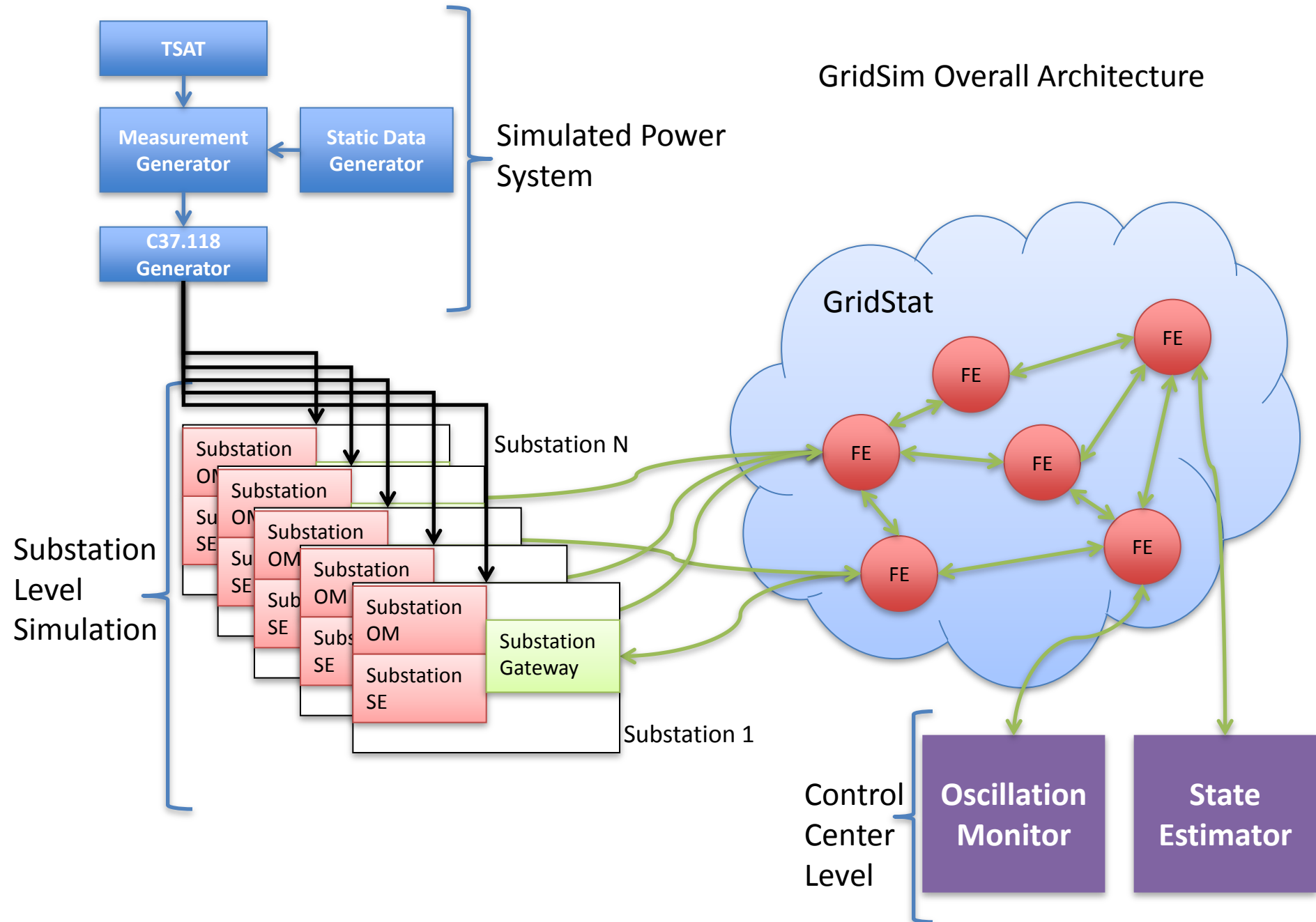
# Project Tasks

1. Real Time Power Grid Simulation
2. Streaming Measurement Data
3. Data Communications – Gridstat Middleware
4. Distributed Oscillation Monitoring
5. State Estimation – Two-level design

# Tasks 1 and 2

- **Real Time Power Grid Simulation**
  - Use commercial grade transient stability program – Powertech TSAT
  - Simulate a large real system in real time
  - Replace output file with streaming data
- **Streaming Measurement Data**
  - Streaming data needed at PMU locations
  - Measurement data in IEEE C37.118

# GridSim Overall Architecture



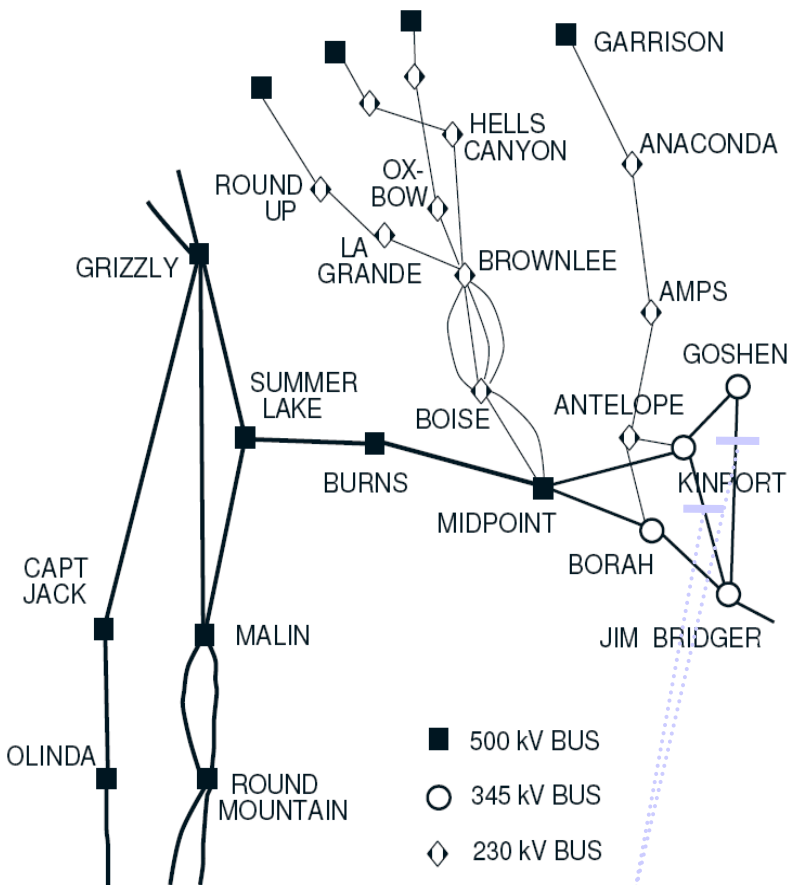
# Test Systems

- Kundur 11-bus test system
  - 4 generators
- 179-bus Western system model
  - 29 generators
- WECC July 2, 1996 blackout case
  - 6180 buses
  - 1005 generators
  - Idaho area monitored

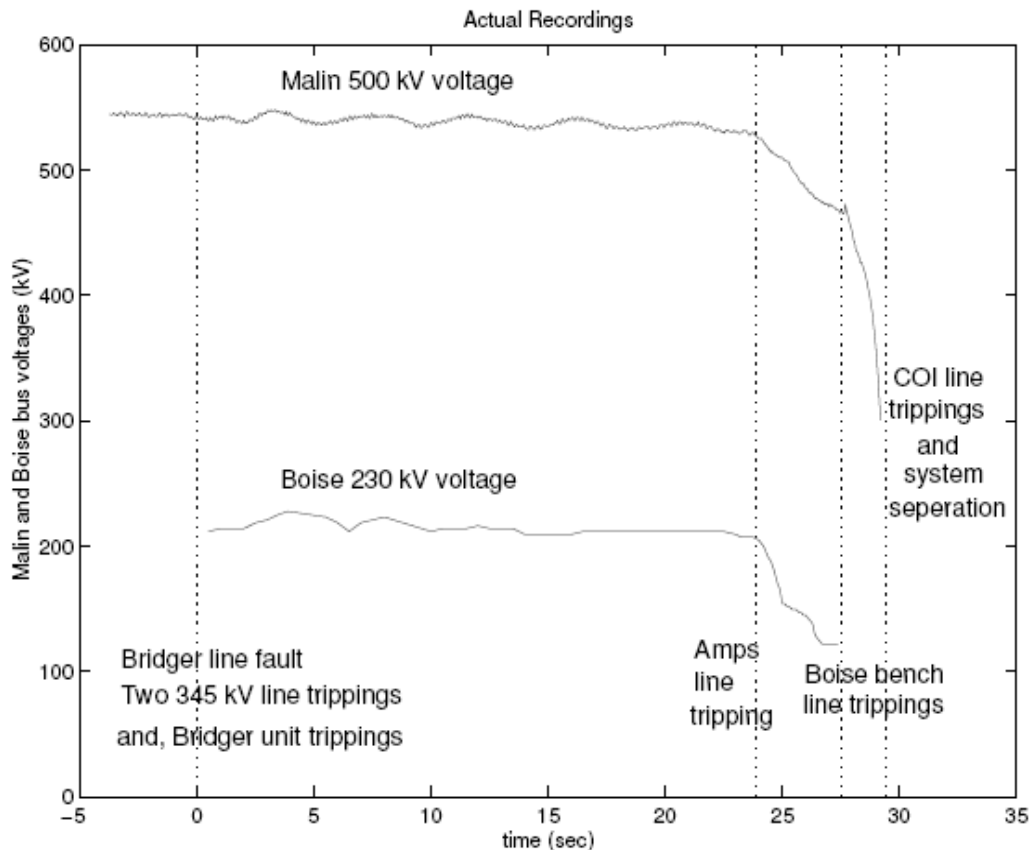


# July 2, 1996 WECC Blackout

- Heavy loads
- Double line outage near Bridger plants



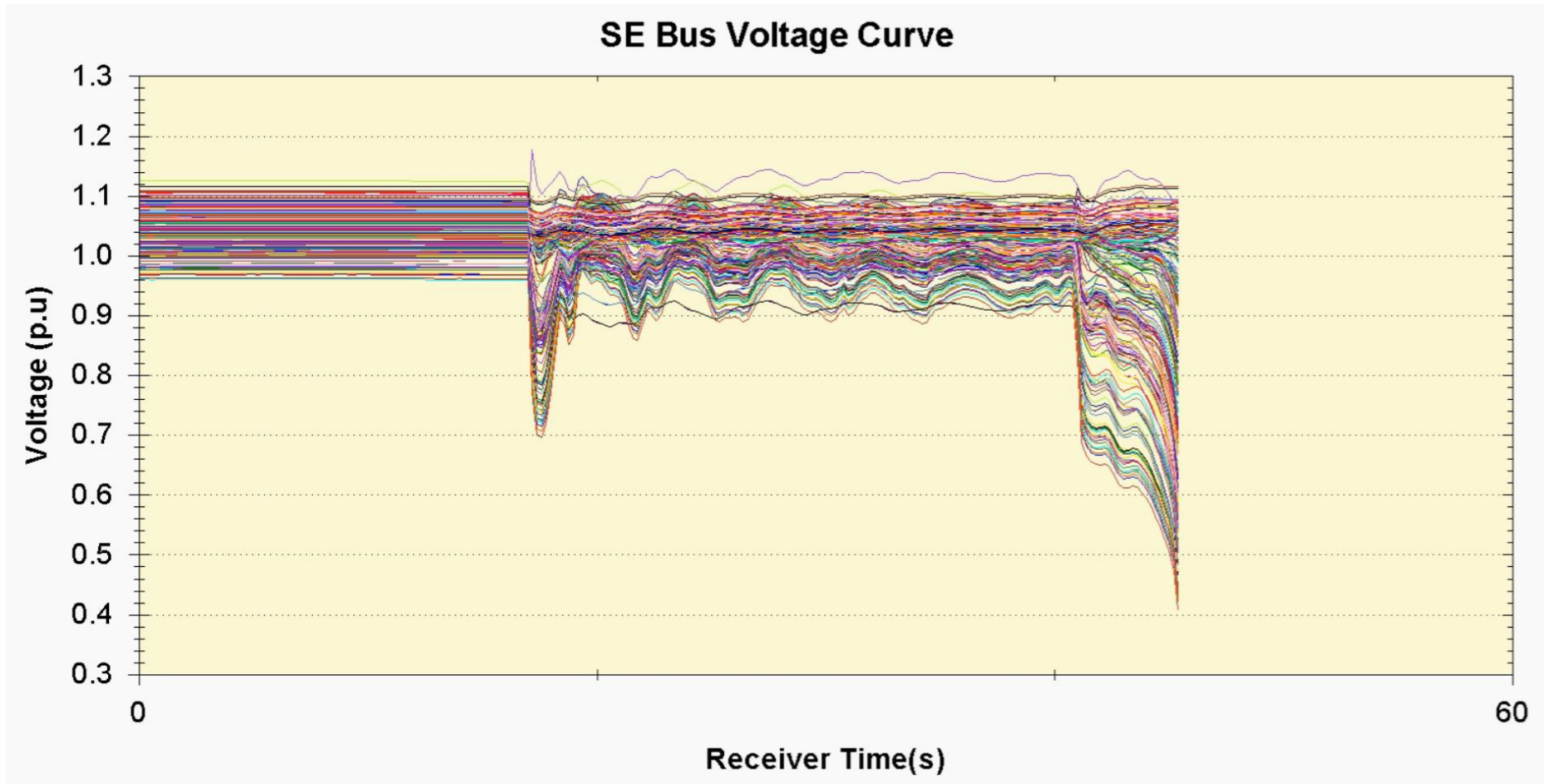
These Two Lines Tripped



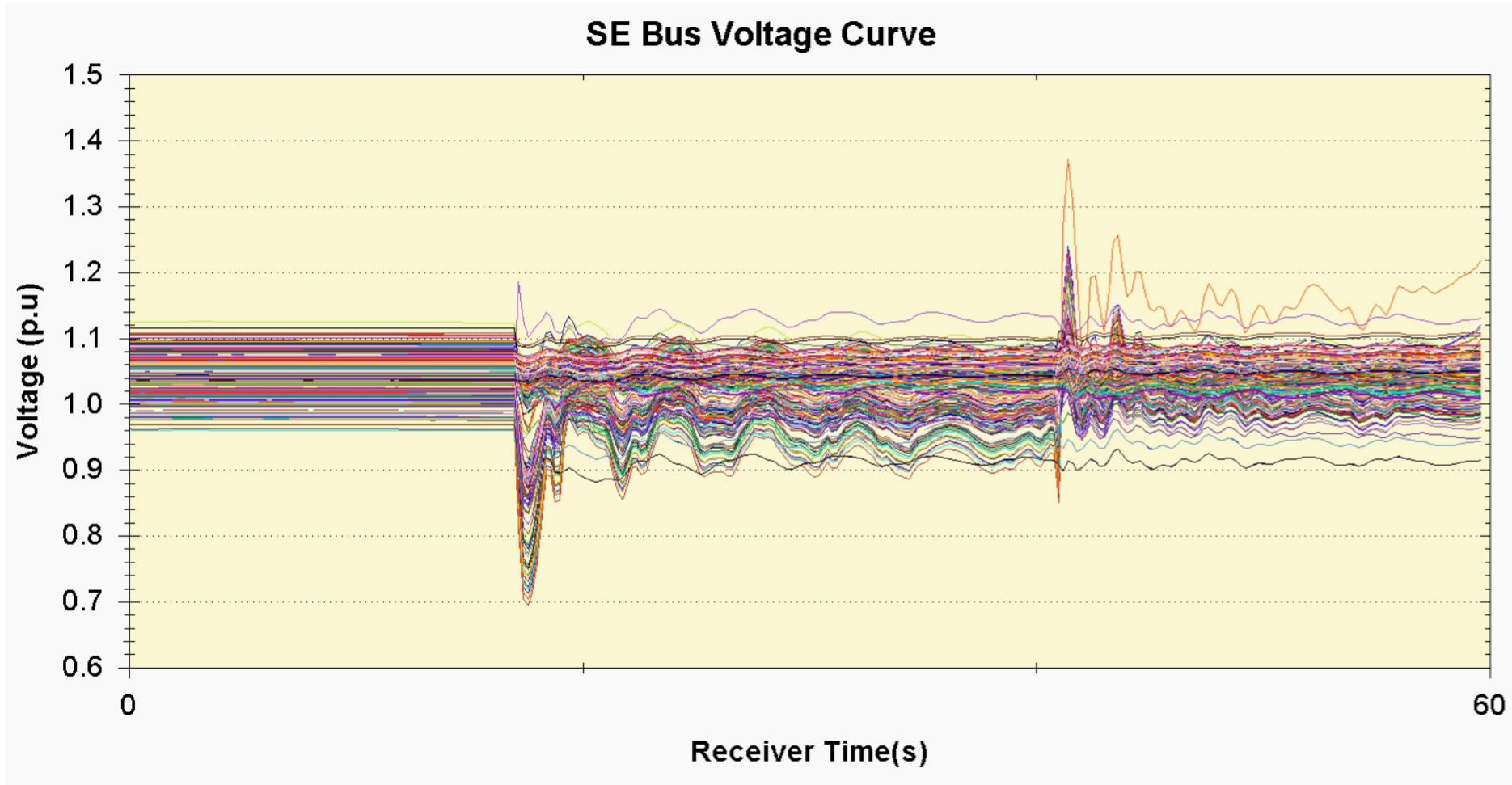
# WECC Test System

- WECC July 2, 1996 blackout case
  - 6180 buses
  - 1005 generators
  - 11982 branches
  - 300+ buses monitored by PMUs
  - 300+ voltage phasors and 900+ current phasors
  - 900+ PMUs streamed from simulator

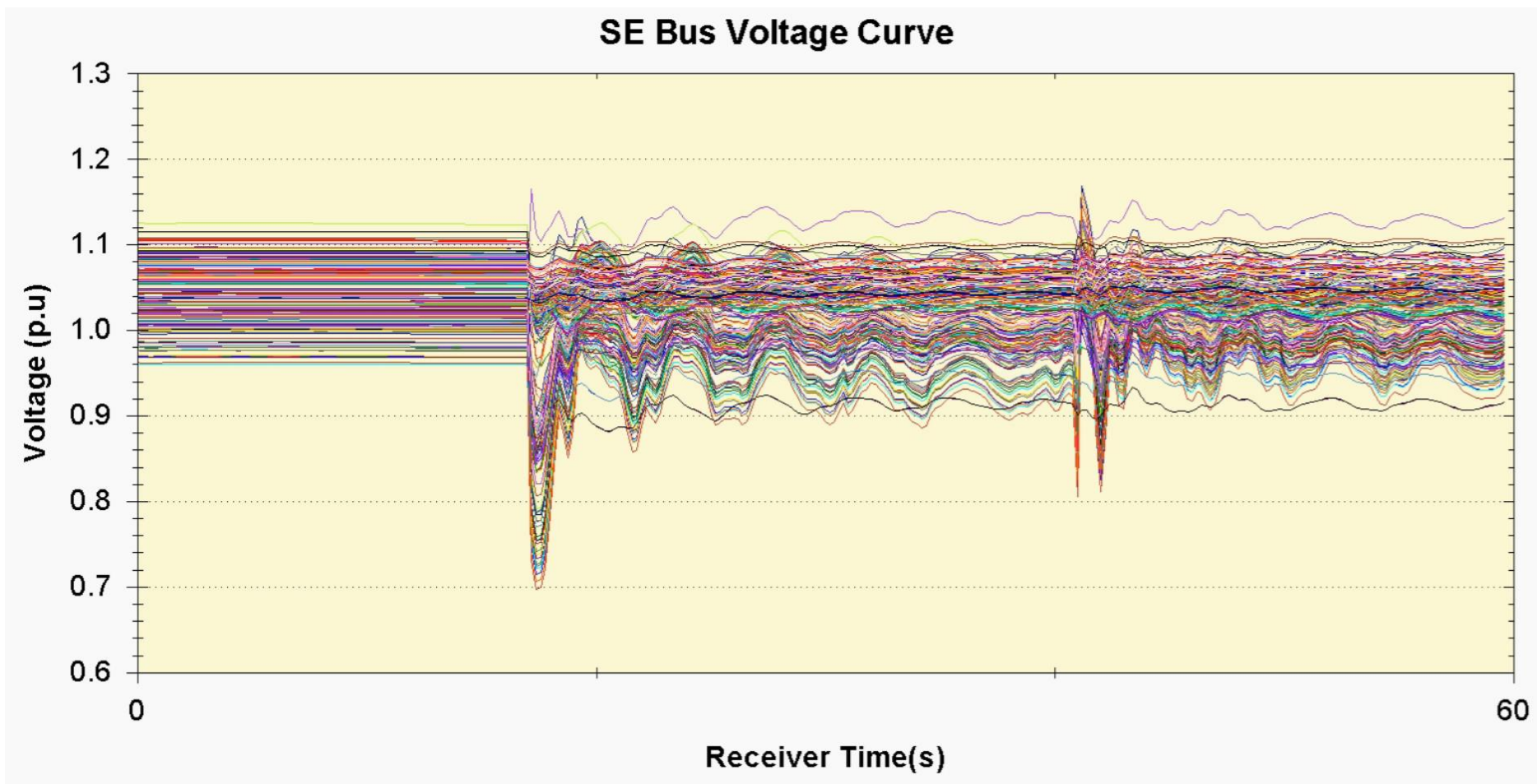
# Blackout event simulation



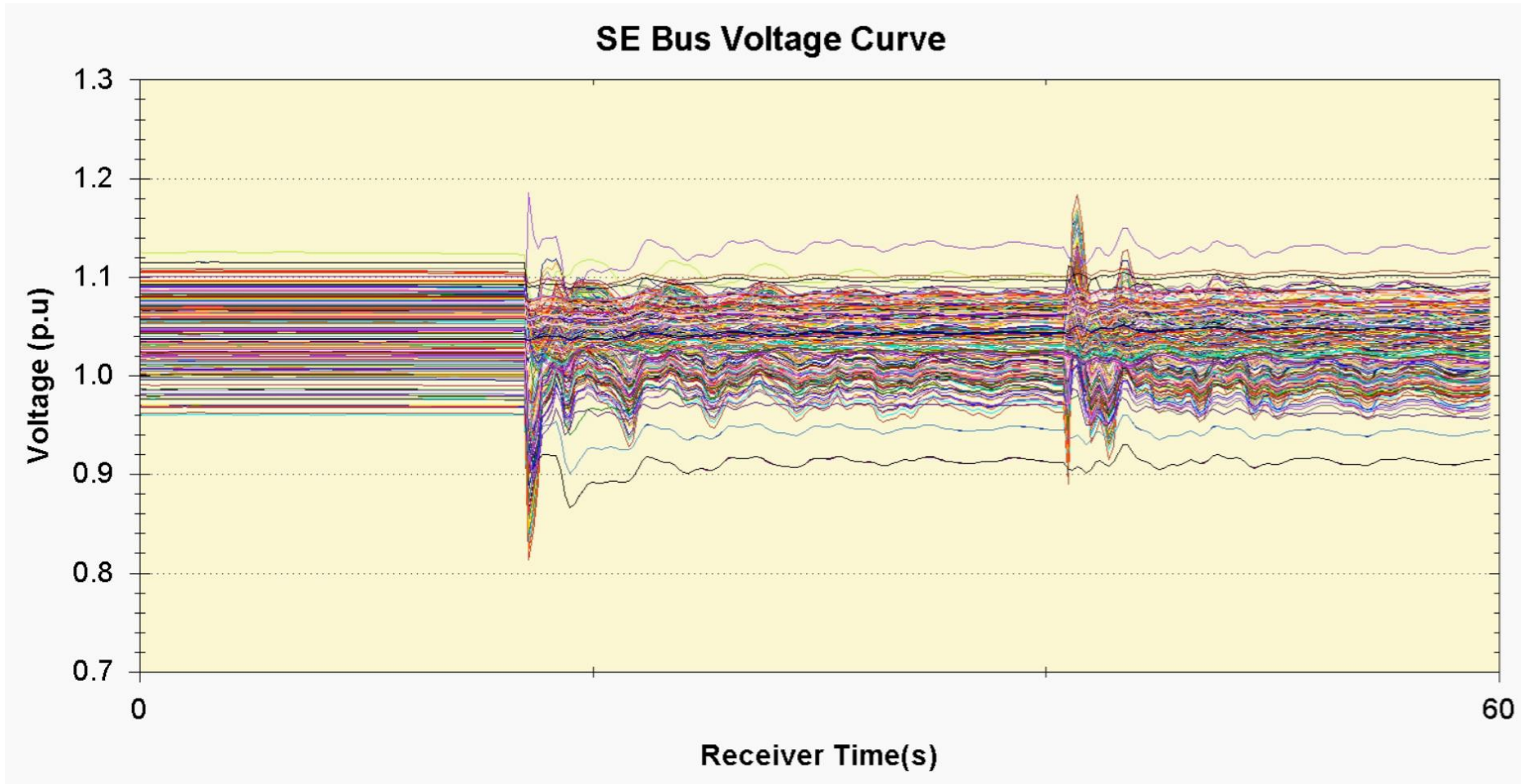
# Cap insertion at Boise from local trigger



# Cap insertion at Brownlee from remote trigger through GridStat



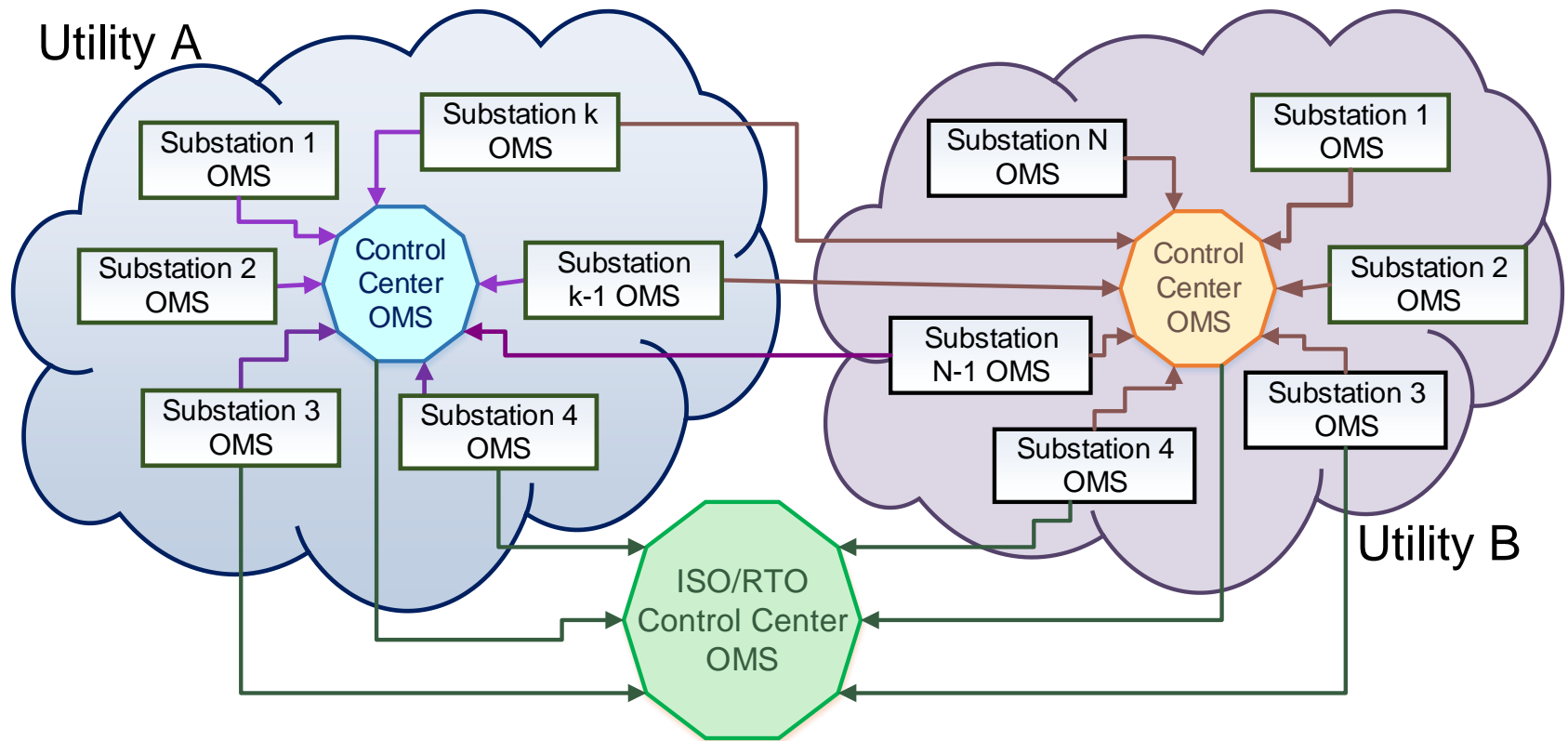
# Two Cap insertions at Brownlee from remote trigger through GridStat



# GridSim

- Enables real-time simulation of large scale power system transient stability models, communication and applications
- Platform for testing PMU applications
- Platform for testing wide-area controls
- Test bed for communication architectures and protocols
- Operator training of PMU responses and wide-area controls

# Two-level Oscillation Monitoring





# GridStat

- Data delivery middleware for Smart Grid
- Data plane components provide pub-sub model for data sources and applications
  - Multi-cast to use resources efficiently
  - Per-subscriber rate and latency management
  - Conserves network resources and simplifies applications
- Management plane handles resource allocation and subscription setup
  - Reserve multiple paths per-subscription
  - Provides authentication and authorization for access to published data streams