Real-Time Monitoring Oscillations and Dynamics

The Basics

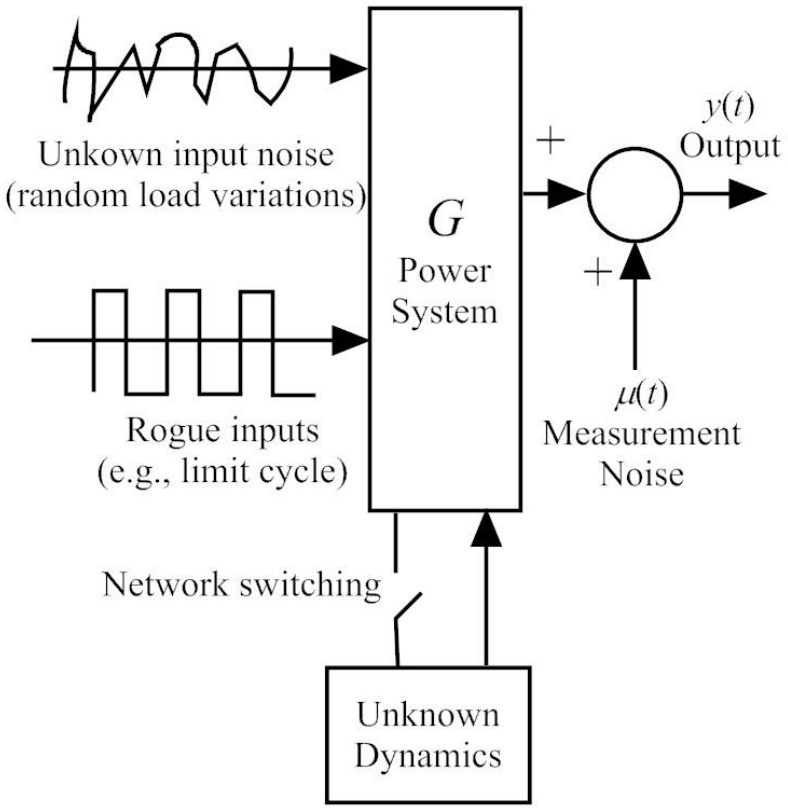
WECC Modes

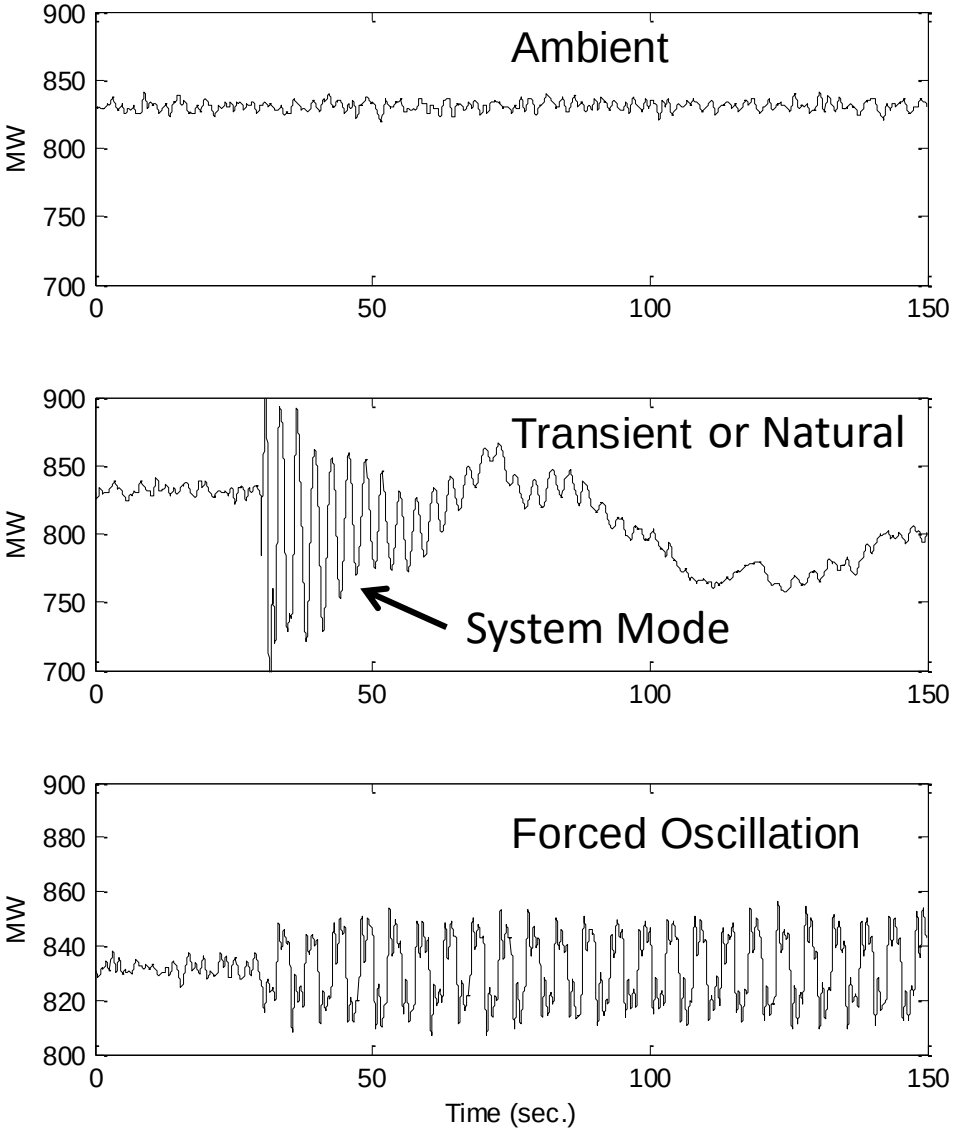
June 2020

NASPI Oscillation Workshop

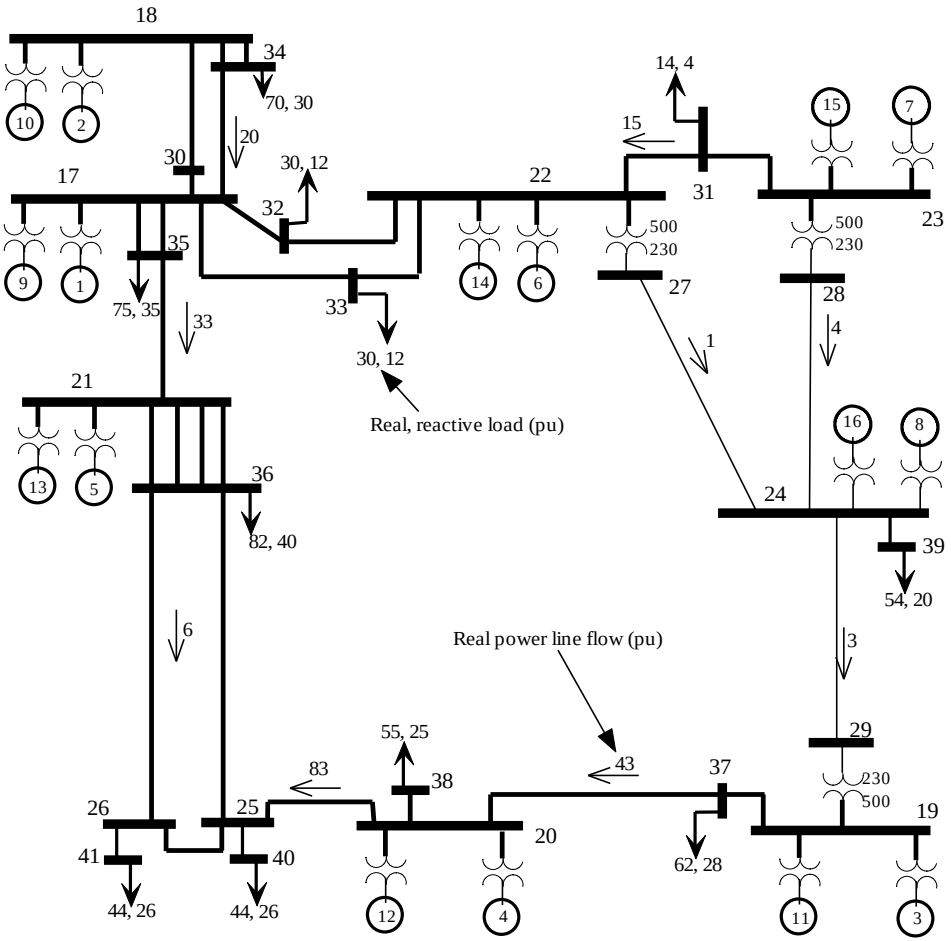
Dan Trudnowski and Evan Paull

Dynamic Response Types

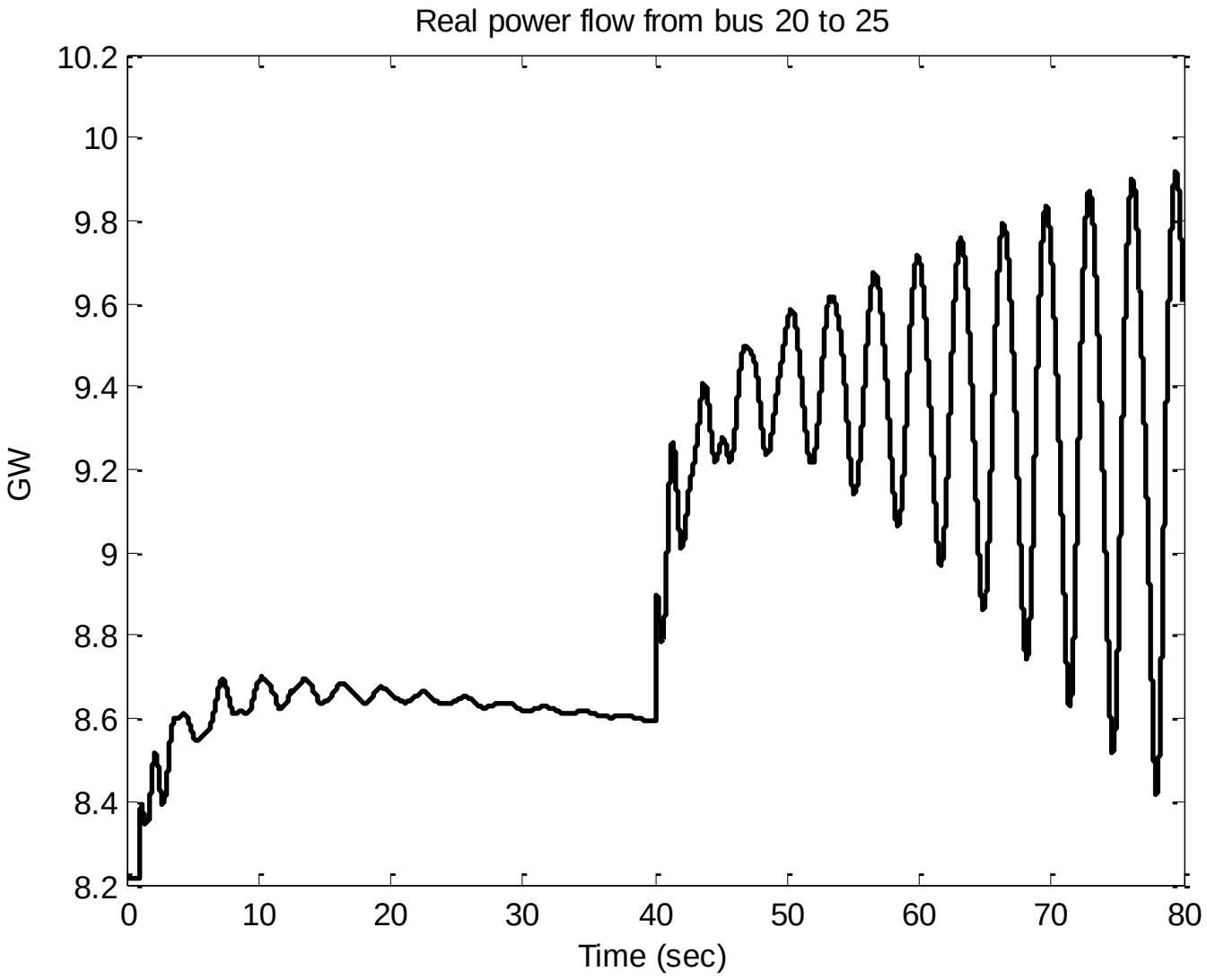


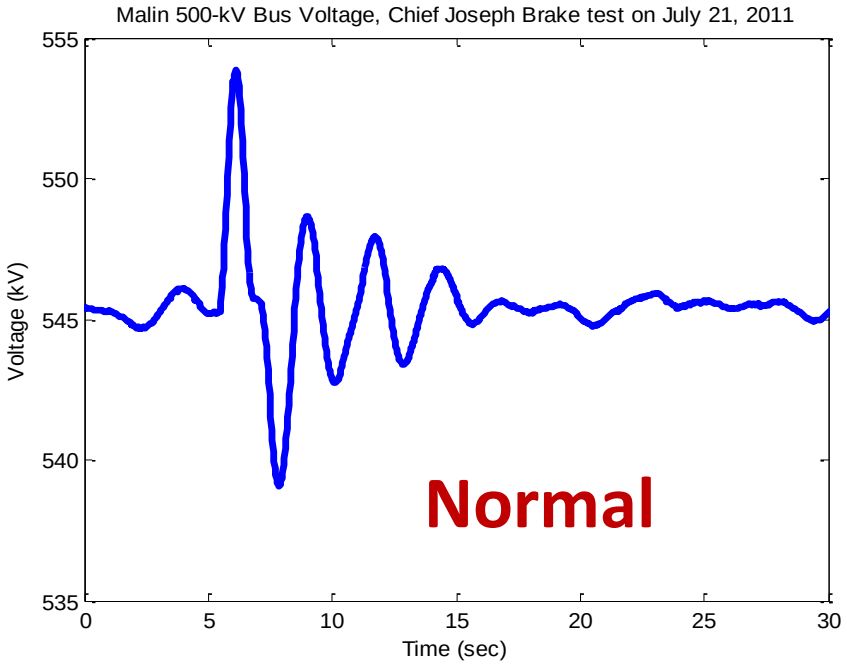


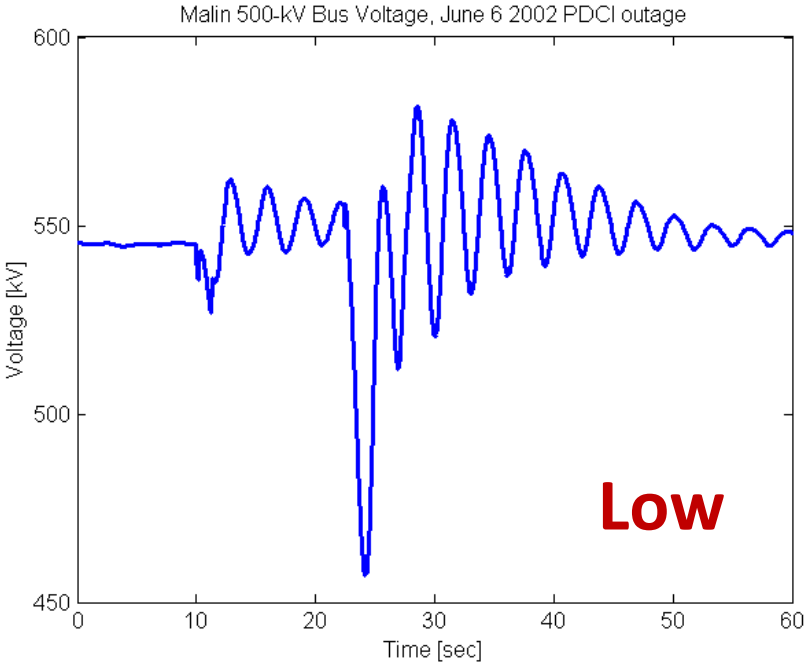
Damping vs Loading

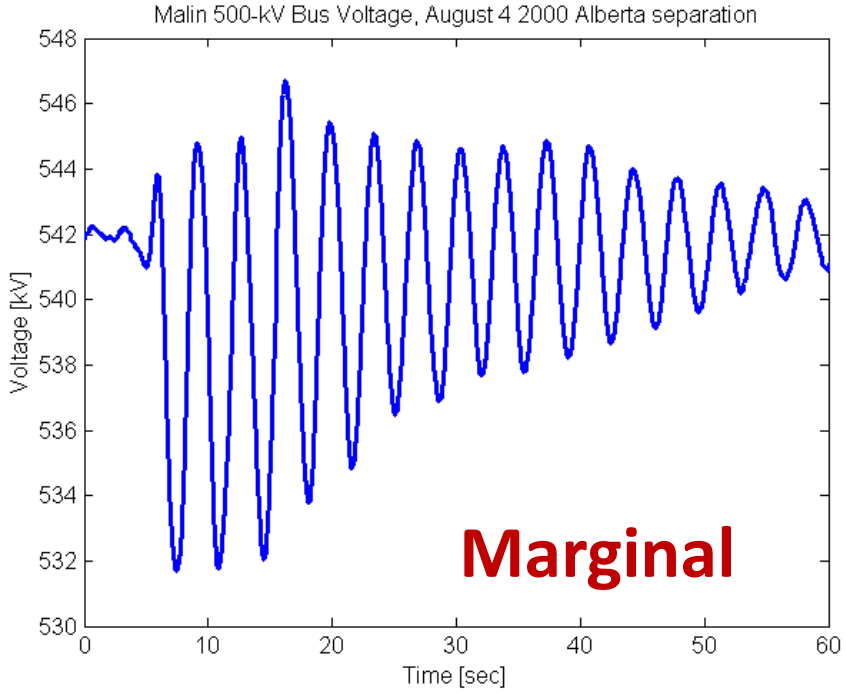


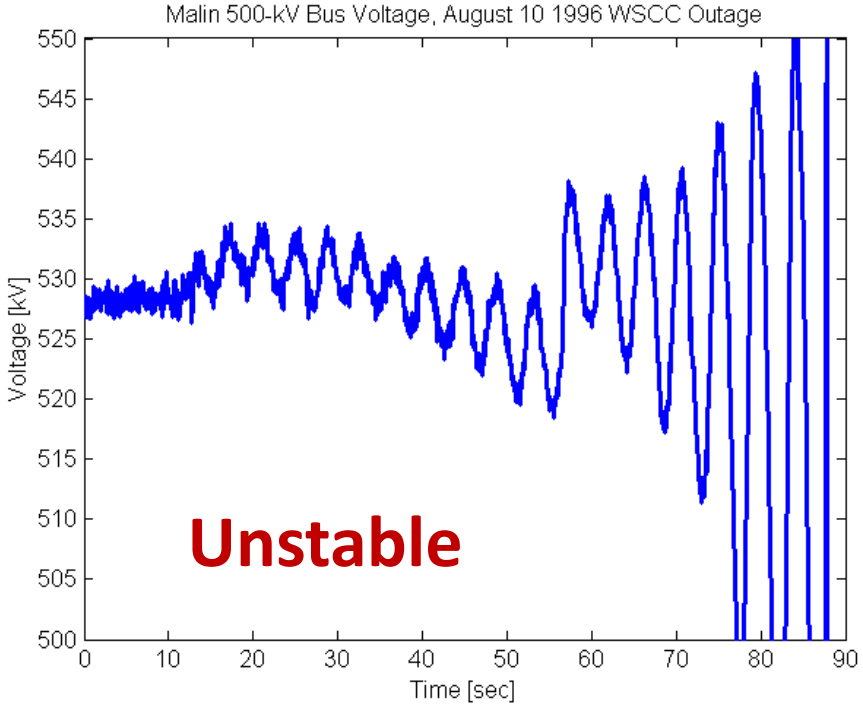
Damping vs Loading




Malin 500-kV Bus Voltage, Chief Joseph Brake test on July 21, 2011
Voltage (kV)
Time (sec)
Normal


Malin 500-kV Bus Voltage, June 6 2002 PDCI outage
Voltage [kV]
Time [sec]
Low

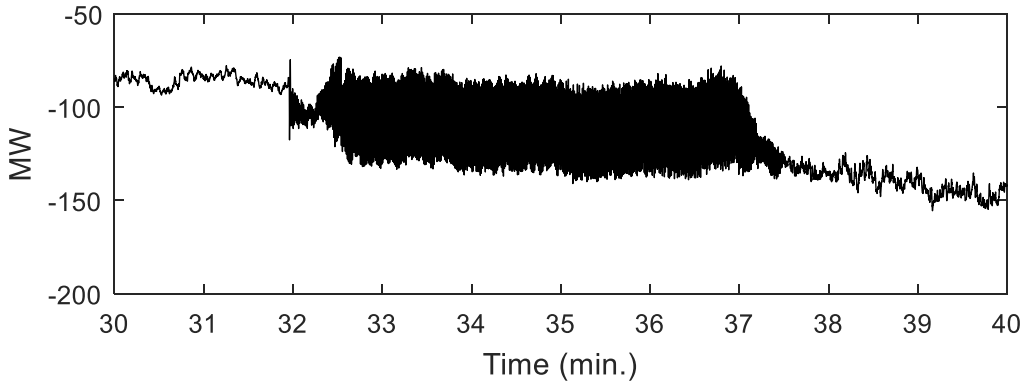

Malin 500-kV Bus Voltage, August 4 2000 Alberta separation
Voltage [kV]
Time [sec]
Marginal

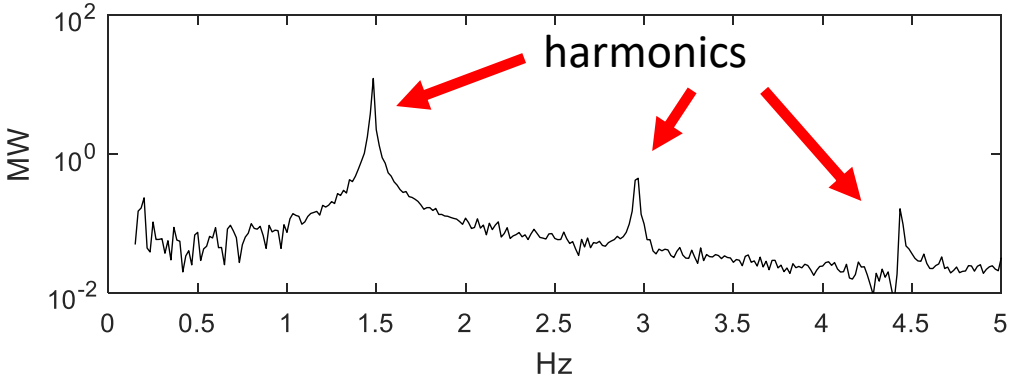

Malin 500-kV Bus Voltage, August 10 1996 WSCC Outage
Voltage [kV]
Time [sec]
Unstable

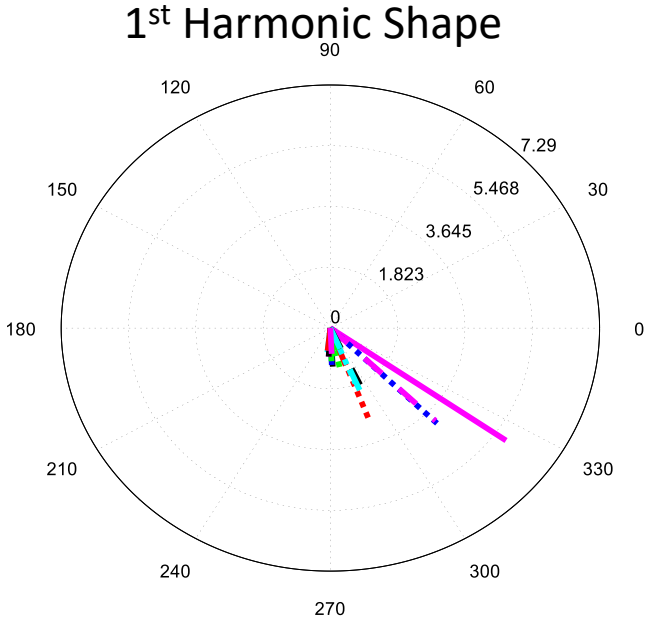
Forced Oscillations

- Response of system to an apparatus in a limit cycle
  - e.g. generator controller
- NOT A SYSTEM INSTABILITY
- Very common
  - WECC = 16 events in 2008/9 operating season in WECC.
- Can be very severe if near a natural mode (resonance):
  - WECC: November 30, 2005.

WECC FO, Mar. 2015





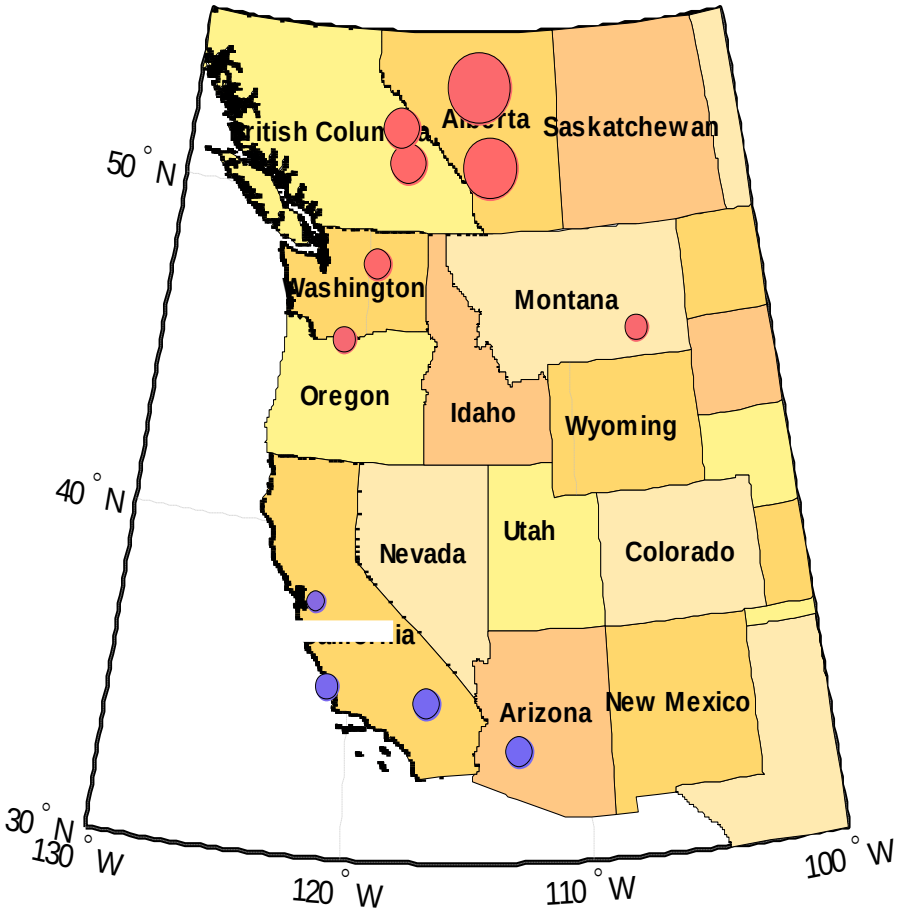


Real-Time Analysis Goals

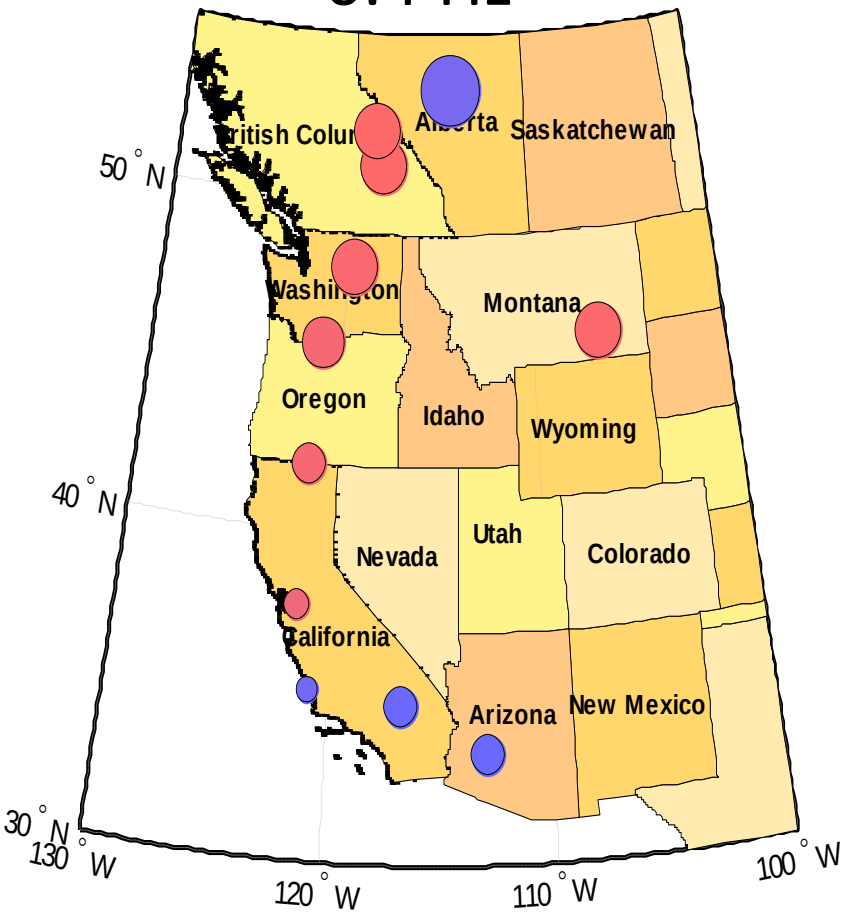
- Track System Modes
  - Modal frequency, damping, and shape
  - WECC currently tracking modes, FOs bias the estimates
- Detect any sustained oscillations
  - General frequency band
  - Amplitude and locations of oscillations
  - Distinguishing between natural and forced oscillations
  - Identify sustained forced oscillation source
  - All these done fairly successfully except distinguishing
- Control Actions
  - Forced oscillations
    - remove the driving source
    - been done many times
  - Low damped modes
    - Solutions require significant studies (e.g., reduced loading on key corridors, PSS unit adjustment, etc.)
    - Research required in solutions

WECC Modes

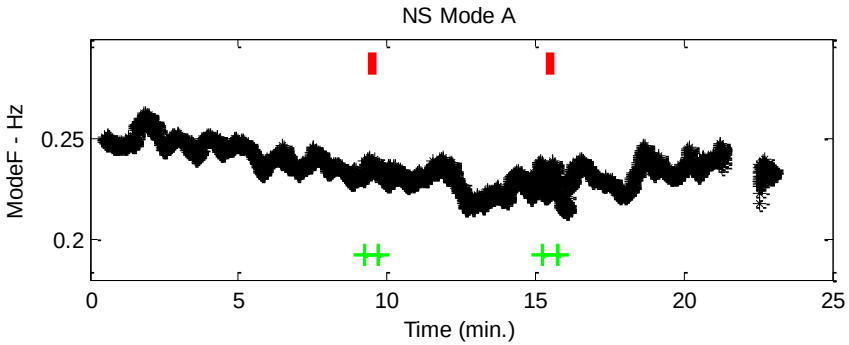
NSA Mode
0.25 Hz

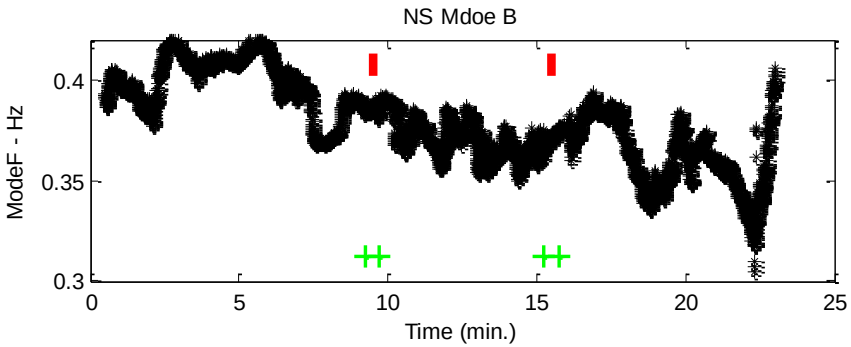


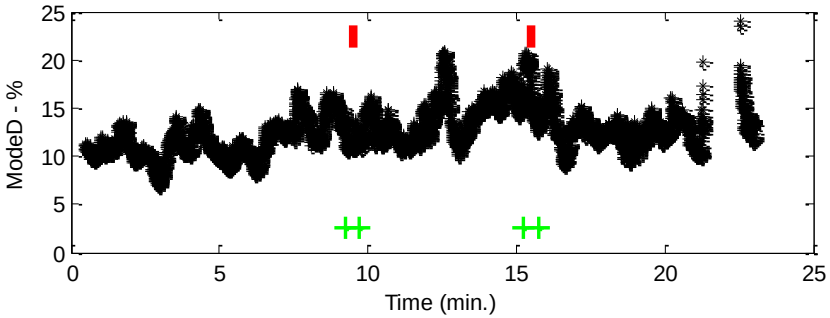
NSB Mode
0.4 Hz

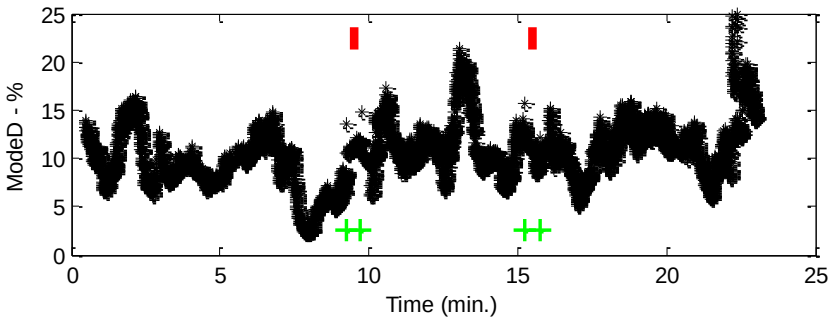


Mode Meter
June 19, 2013

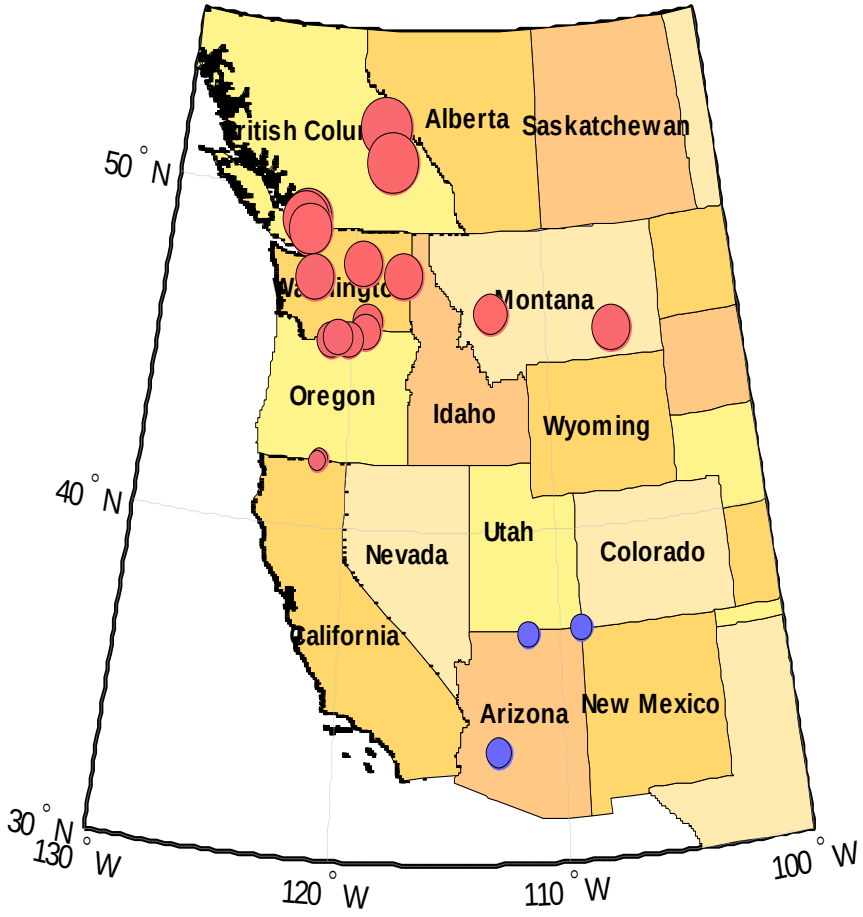




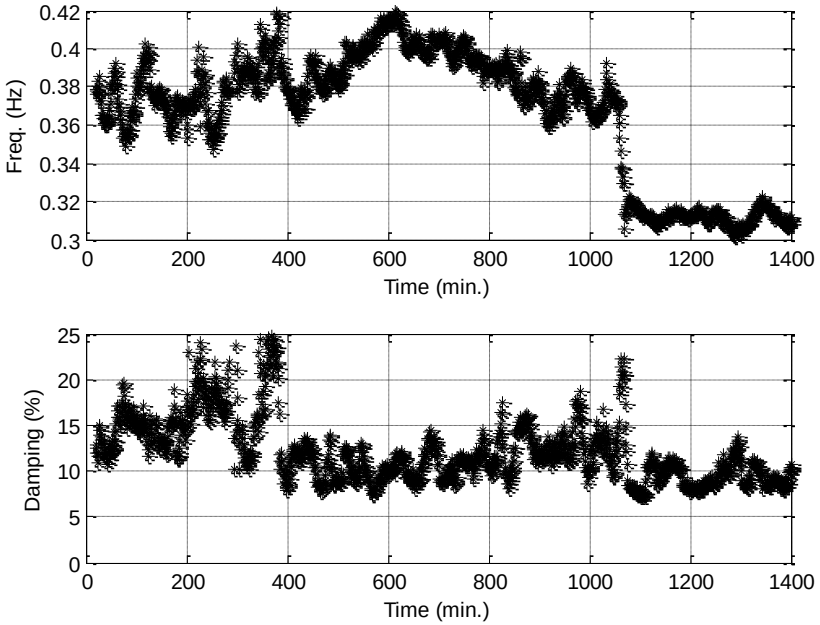




NSB Mode
0.3 Hz
Alberta Disconnected



Mode Meter, NSB Mode
June 18, 2012
Alberta Disconnects near 1100 min.



WECC WIMRG

- *Western Interconnect Modes Review Group* (WIMRG) aimed at updating and expanding WECC's knowledge of system interarea modes
- Goals:
  - Modal analysis of actual-system PMU Data sets after 2013. The goals are:
    - Modal frequency and damping properties of key interarea modes.
    - Mode shape properties of key interarea modes.
    - Identification of key interaction paths
  - Update WECC transient simulation cases to accurately reflect system modes
  - Study the impact of possible future system configuration on the system modes

Questions?