Oscillations in Eastern Interconnection

- Ambient oscillations are normal
  - Constantly occurring
  - System “breathing”
- Long-know oscillation modes
  - 0.5 Hz family – New York oscillations – not sure against what
  - 0.25 Hz family – New England
- First major usage by NERC of PMUs began in mid-2007
  - 2008 South Florida event heavily analyzed
2007 Broad River Disturbance
• 0.52 Hz          Damping = ~4.2% (not too good!)

2007 MRO Disturbance
• 0.5 Hz family    Multiple times with variable damping

2008 Florida Disturbance
• 0.05 Hz          Damping = ~52% (really good damping)
• 0.25 Hz          Damping = ~17% (good damping)
• 0.51 Hz          Damping = ~4.5% (not too good!)
EI Oscillation Modes (work in progress)
Florida Disturbance – Non-Local Impacts

- Turkey Point (FPL)
- Callaway/Rush Island (Ameren)
- TVA
- 59.82 Hz High set Step A
- 59.7 Hz Step A
- Dorsey (MH)
April 2012 Oscillations

- FNet alarm indicated
  - 1,800 MW plant tripped
  - FDR triangulation location Minnesota / North Dakota
- Triggered FNet Oscillation Alarm
  - 0.25 Hz family between MRO and New England
- Signature was that of a Dorsey-Forbes 500 kV line trip with a Dorsey DC converter run-back

- Known unit trip – Plant Vogtle Unit 1 (Georgia) tripped
  - Net output ~1,100 MW
InterConnection: EI

Estimated Reliability Coordinator: MRO NPCC

Event Date: 2012-04-14

Event Time: 17:46:47 UTC

Event Type: Generation Trip

Estimated Amount: 1800.0 MW

Point A: 60.0110 Hz  Point B: 59.9393 Hz  Point C: 59.9352 Hz

Unit Detection Order (the first 6 units):
CaMbKelsey893, UsMnCrystal747, UsMnGre790, UsMnOtpc720, UsNdDevilslake740, UsSdBigstone739
FNet Frequency Response Plot
FNet Triangulation

(2012-04-14 17:46:47 UTC)

(53.7367, -93.5368)

EI Generator Trip: 1800 MW
• Triggered FNet Oscillation Alarm
  - 0.25 Hz family between Winnipeg, Manitoba and New England

• Oscillation triggering continued about 300 times per day for several days
FNet Oscillation Sample
0.25 Hz family mode shapes exist between

- Southeast and Northwest EI – determined in the South Florida EA
- Manitoba and New England – often observed and active damping done by Dorsey DC Bi-Pole converter (Winnipeg, Manitoba) and Forbes SVC

Both mode shapes share units in MRO that participate in the oscillatory behavior

- Common mode frequency
- Manitoba-New England shape more dominant
  - Reflective wave at edge of the interconnection
April 2012 Oscillations

Contributing factors

• Dorsey – Forbes 500 kV line out of service – weakened system

• Dorsey Oscillation damping effectively out of service

Analysis indicated

• Low energy oscillations

• Sufficient damping
MHEB Oscillation Analysis - 230 kV System

Damping around 10%
Questions?