

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Eastern Interconnection Oscillations

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RELIABILITY | ACCOUNTABILITY



- 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!)

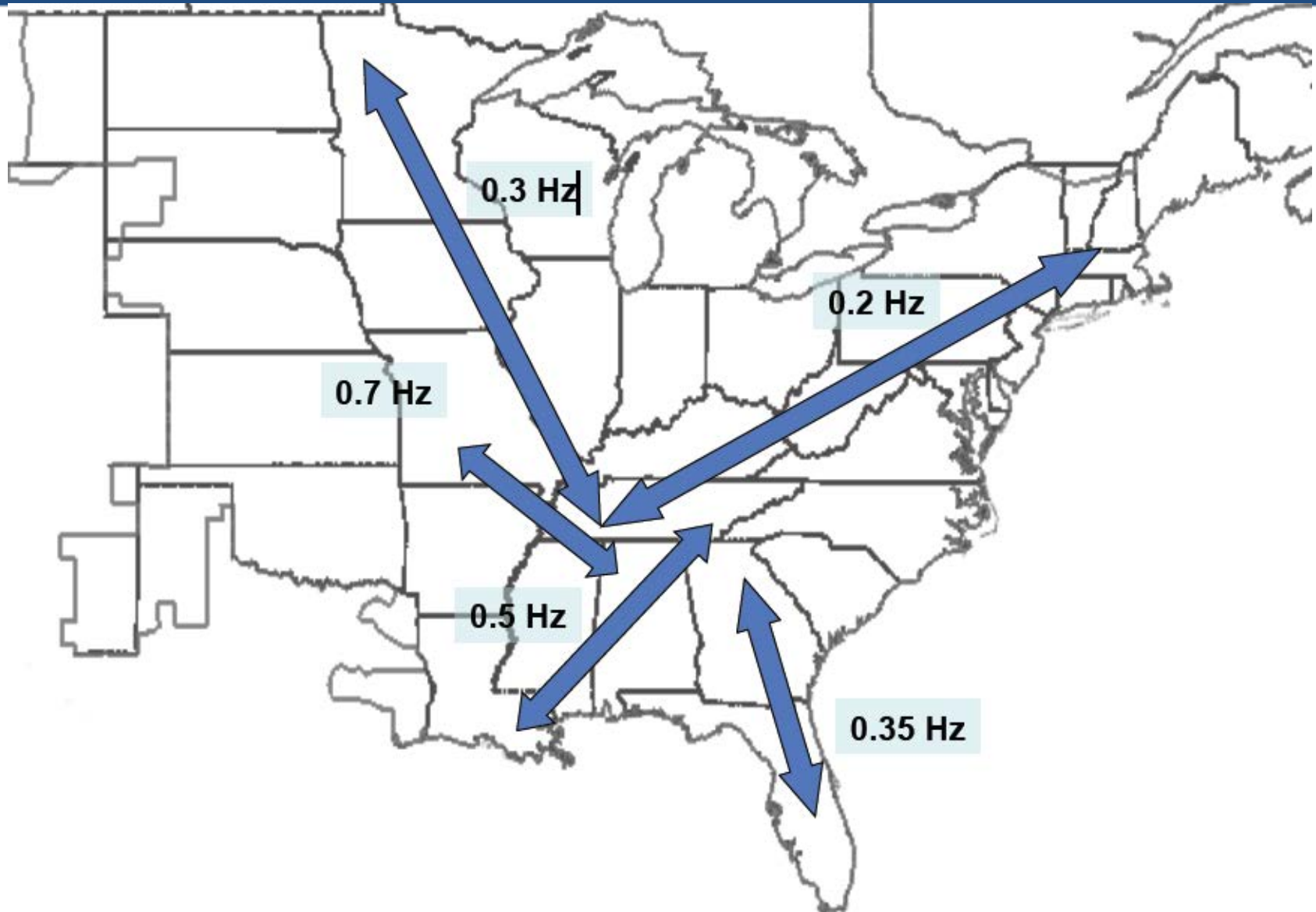
2007 MRO Disturbance

- 0.5 Hz family Multiple times with variable damping

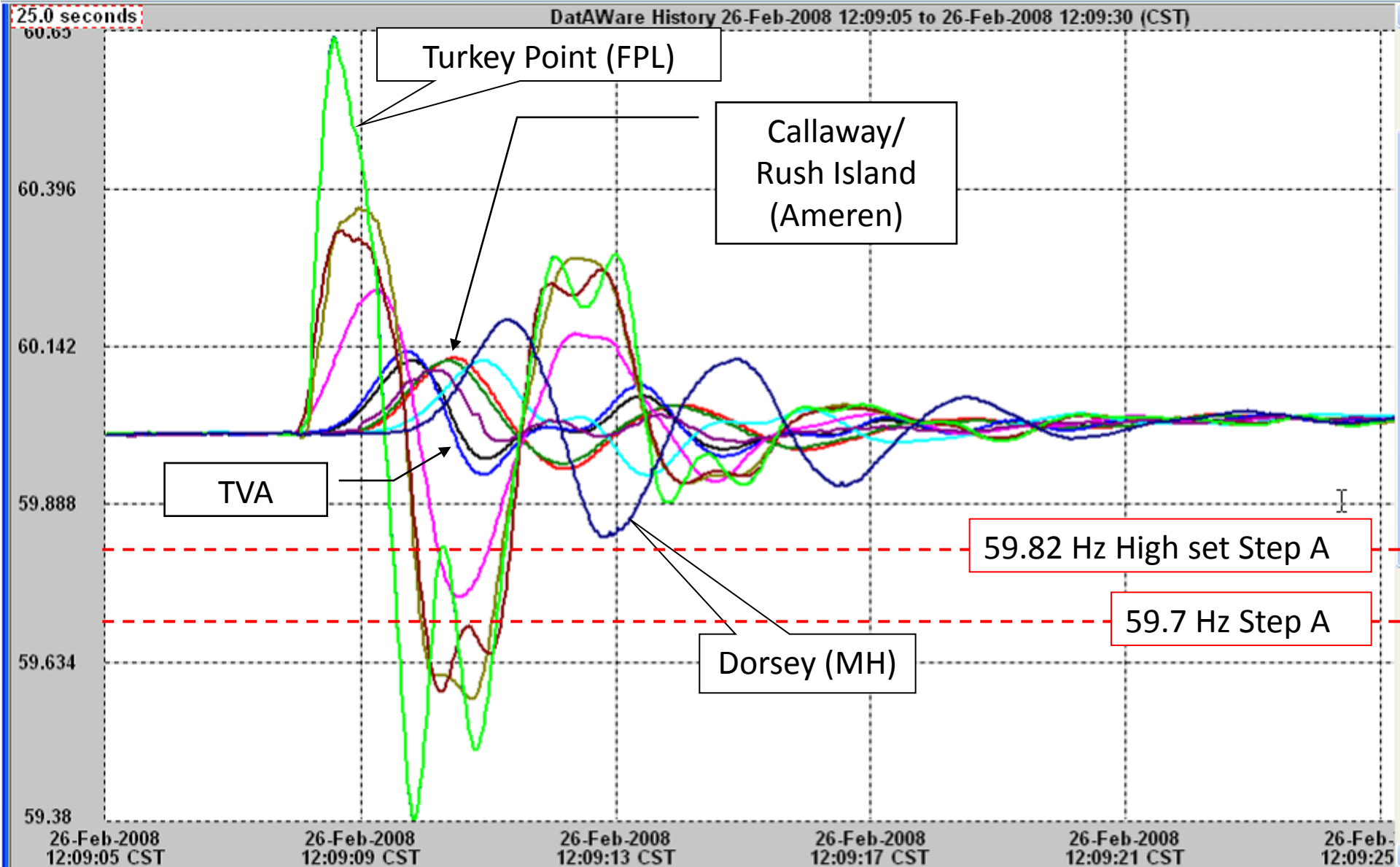
2008 Florida Disturbance

- 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



- 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

FNET Event Report

Recorded Event: 2012-04-14 17:46:47 EI

InterConnection: EI

Estimated Reliability Coordinator: MRO NPCC

Event Date: 2012-04-14

Event Time: 17:46:47 UTC

Event Type: Generation Trip

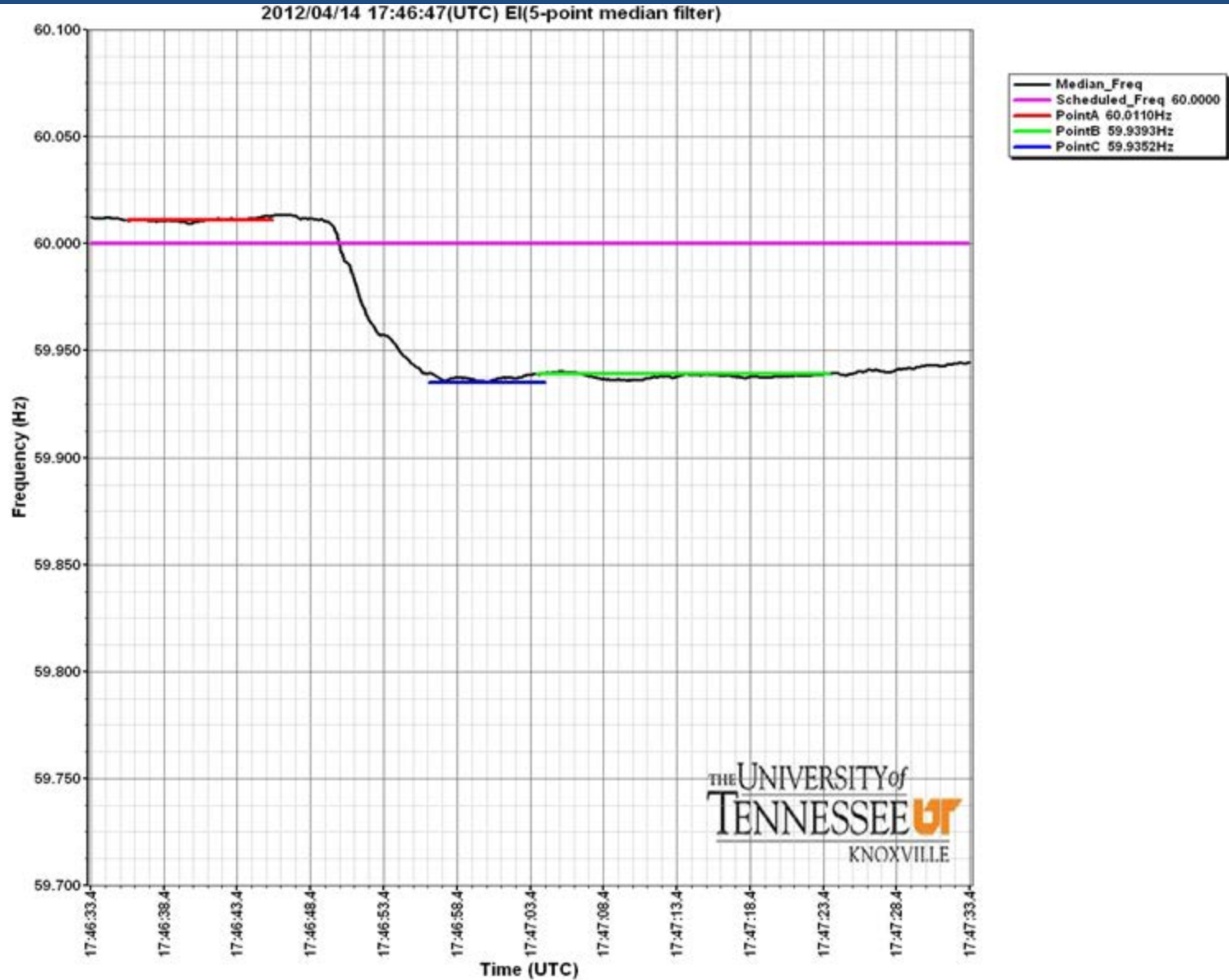
Estimated Amount: 1800.0 MW

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

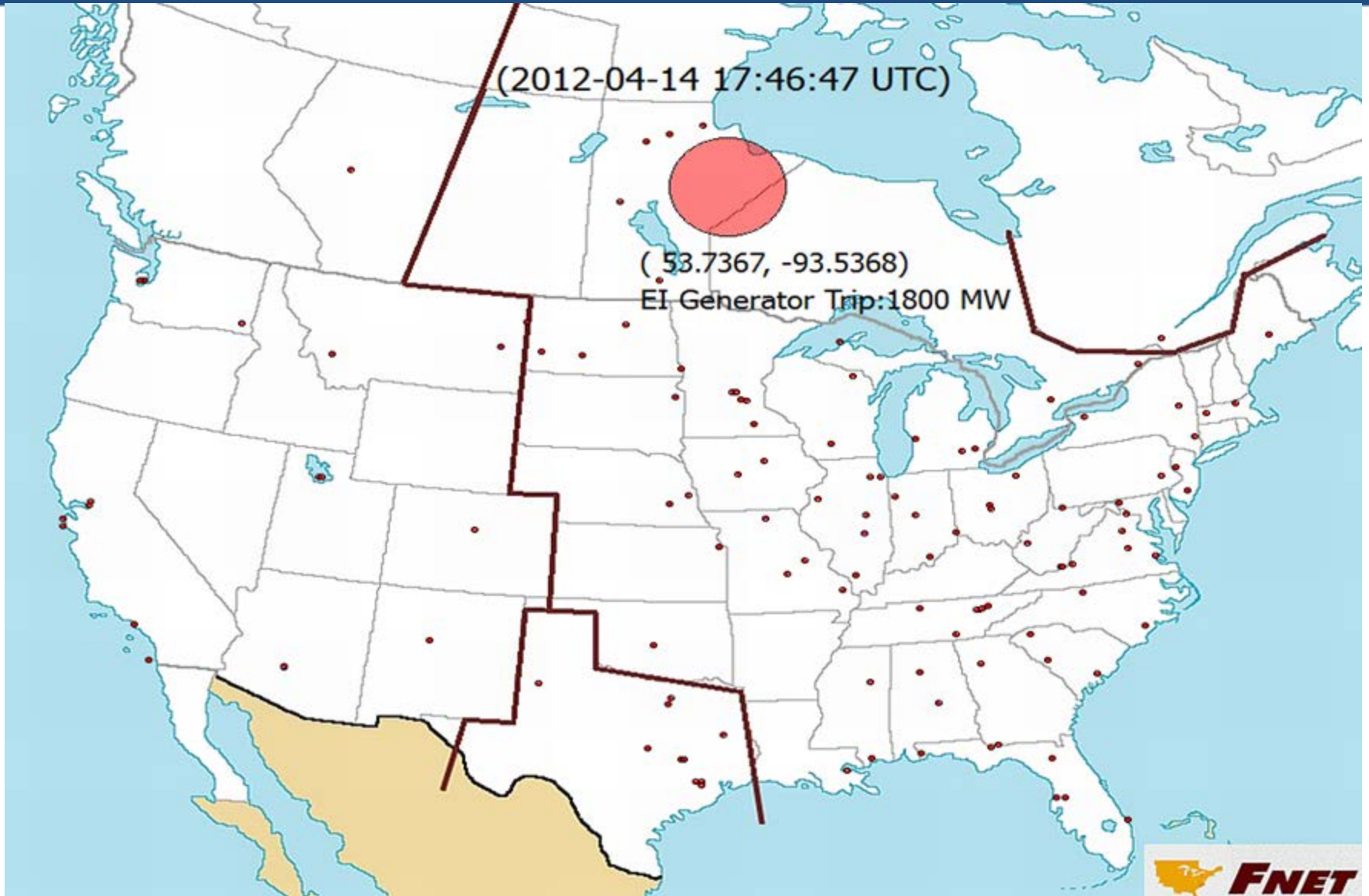
Unit Detection Order (the first 6 units):

CaMbKelsey893,UsMnCrystal747,UsMnGre790,UsMnOtpc720,UsNdDevilslake740,UsSdBigstone739

FNet Frequency Response Plot



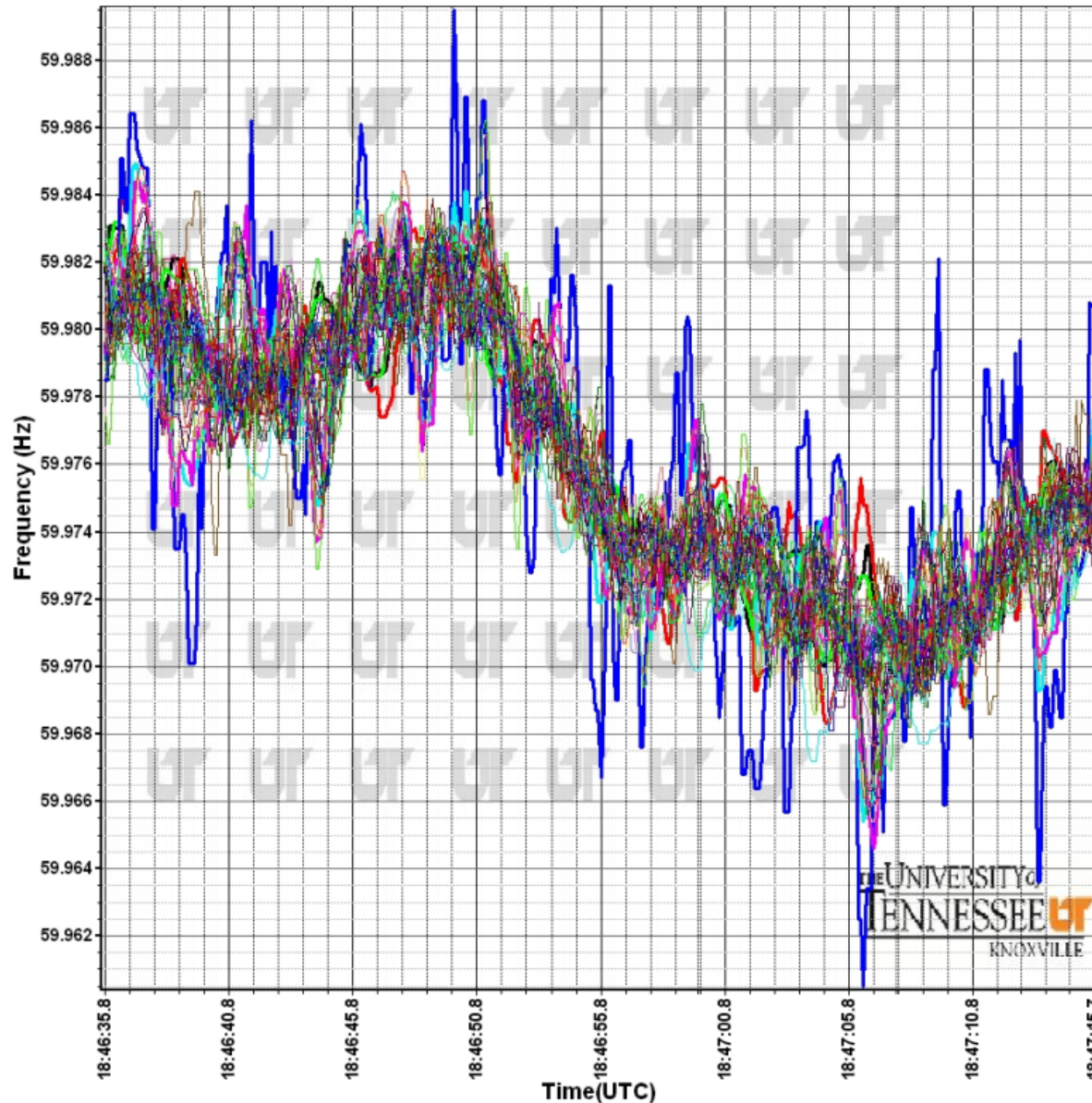
FNet Triangulation



- 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

Osci041412_184640(Ref:UsInImpa710)



- UsMaBoston684
- UsMeBangor733
- UsMaNeiso682
- CaMbWinnipeg685
- UsNdDevilslake740
- UsNdMduwilliston726
- UsNjAtlanticcity862
- UsMoKirksville781
- UsScFarris669
- UsIlMarion767
- UsMiWayneState621
- UsFIFsu786
- UsMoFranklin756
- UsVaRichmond601
- UsNyRpi707
- UsFlPensacola674
- UsInNipsc0797
- UsFiufl663
- UsOhAep803
- UsNeLes777
- UsIlMatton778
- UsMiAtc750
- UsMiCalvin679
- UsMnDodgeCenter877
- UsNdMduglendive730
- UsWvCharleston688
- UsInNipsc713
- UsTnKnoxsolar770
- UsOhDuke830
- UsSCCharleston762
- UsMnGre790
- UsTnGallatin868
- UsVaDoe728
- UsOkNorman759
- UsMDFrederick861
- UsMiMitech712
- UsIlChicago620
- UsSdBigstone739
- UsNdMdudickinson729
- UsVaBlacksburg785
- UsAlMontgomery673
- UsNcHampstead753
- UsVaRvcs686
- UsFlPlantcity623
- UsMsGolfport672
- UsMnCrystal747
- UsMnOtpc720
- UsIlUiuc755
- UsOhChillicothe670
- UsMoGape749
- UsWvWvu744

- 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

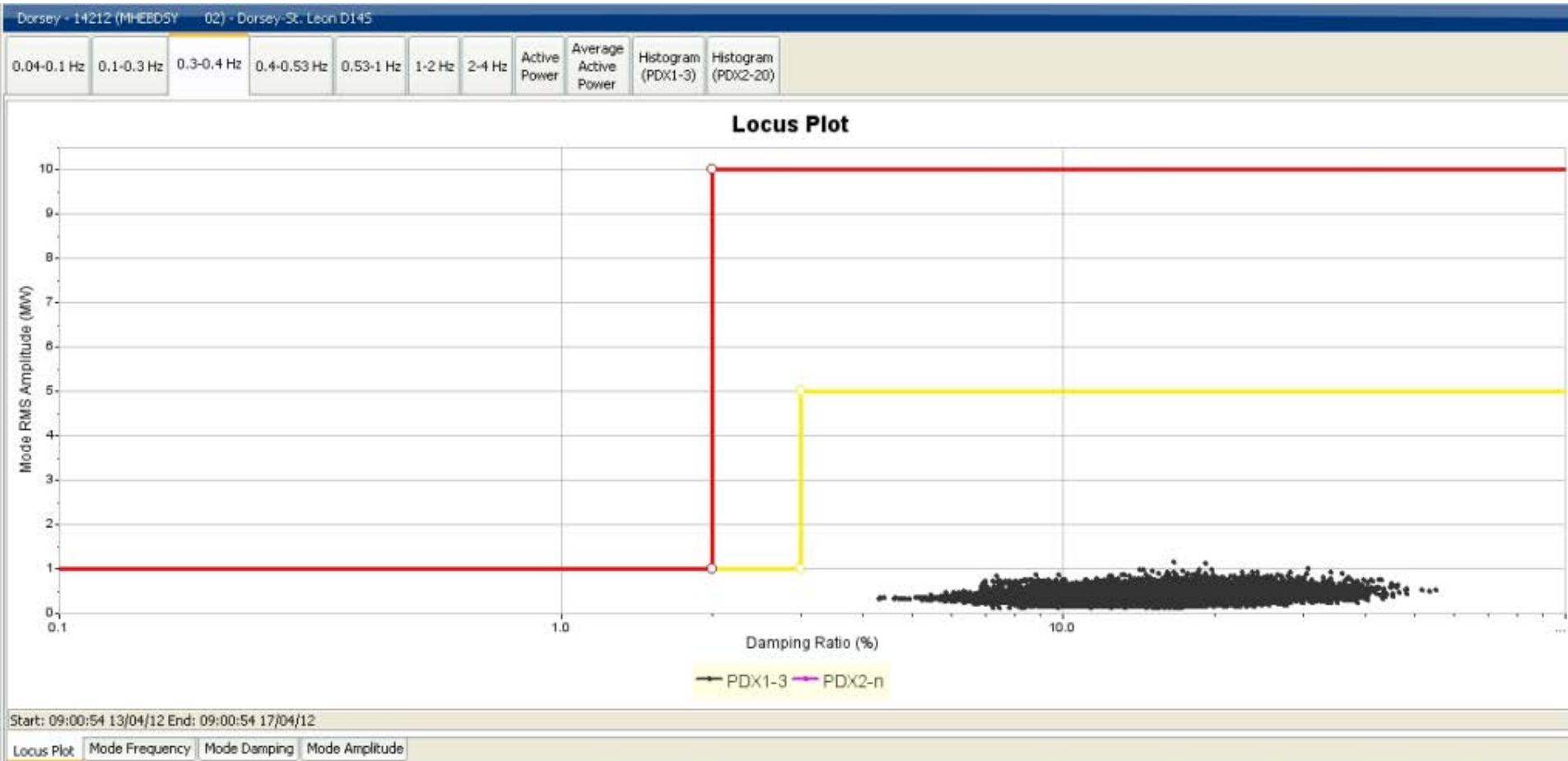
Contributing factors

- Dorsey – Forbes 500 kV line out of service – weakened system
- Dorsey Oscillation damping effectively out of service

Analysis indicated

- Low energy oscillations
- Sufficient damping

Damping around 10%





Questions?