PMU Error Impact on Measurement-Based Applications

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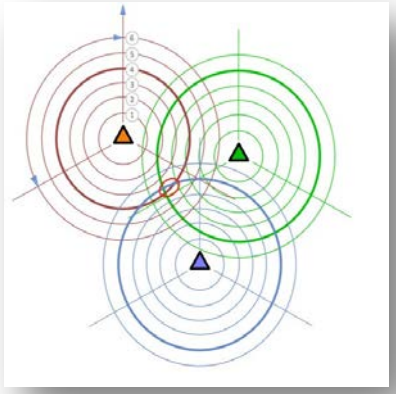
Outline

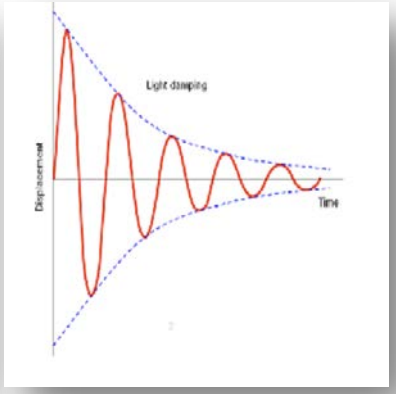
- Introduction
- Methodology
- Impact Analysis
- Conclusion

Introduction

- PMU applications for this study

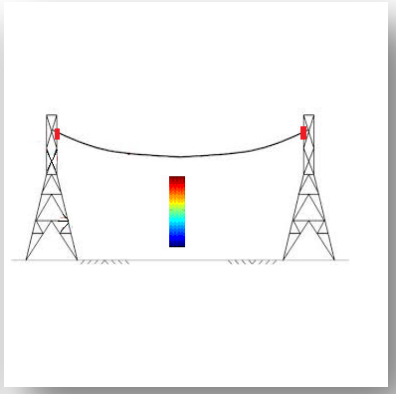


Event Location



Oscillation Detection

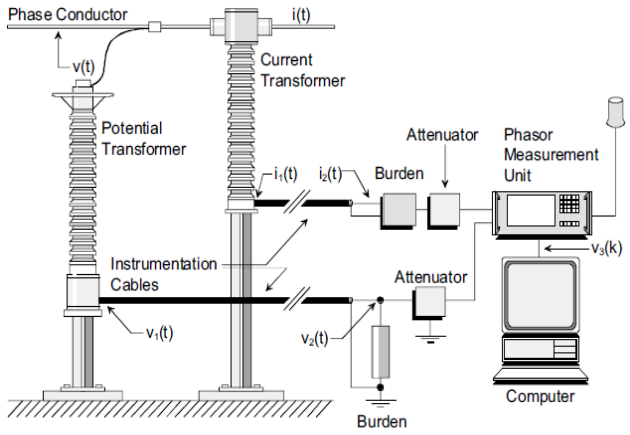
Islanding Detection



Dynamic Line Rating

PMU Measurement Error

- PMU Error
  - IEEE Std C37.118.1-2011, C37.118.1a-2014
  - Phase angle: 0.57° based on 1% TVE
  - Frequency error = 0.005 Hz
- Instrumental Channel Error
  - PT, CT , Cable combined error
  - -0.2° to -1.0° for most cases

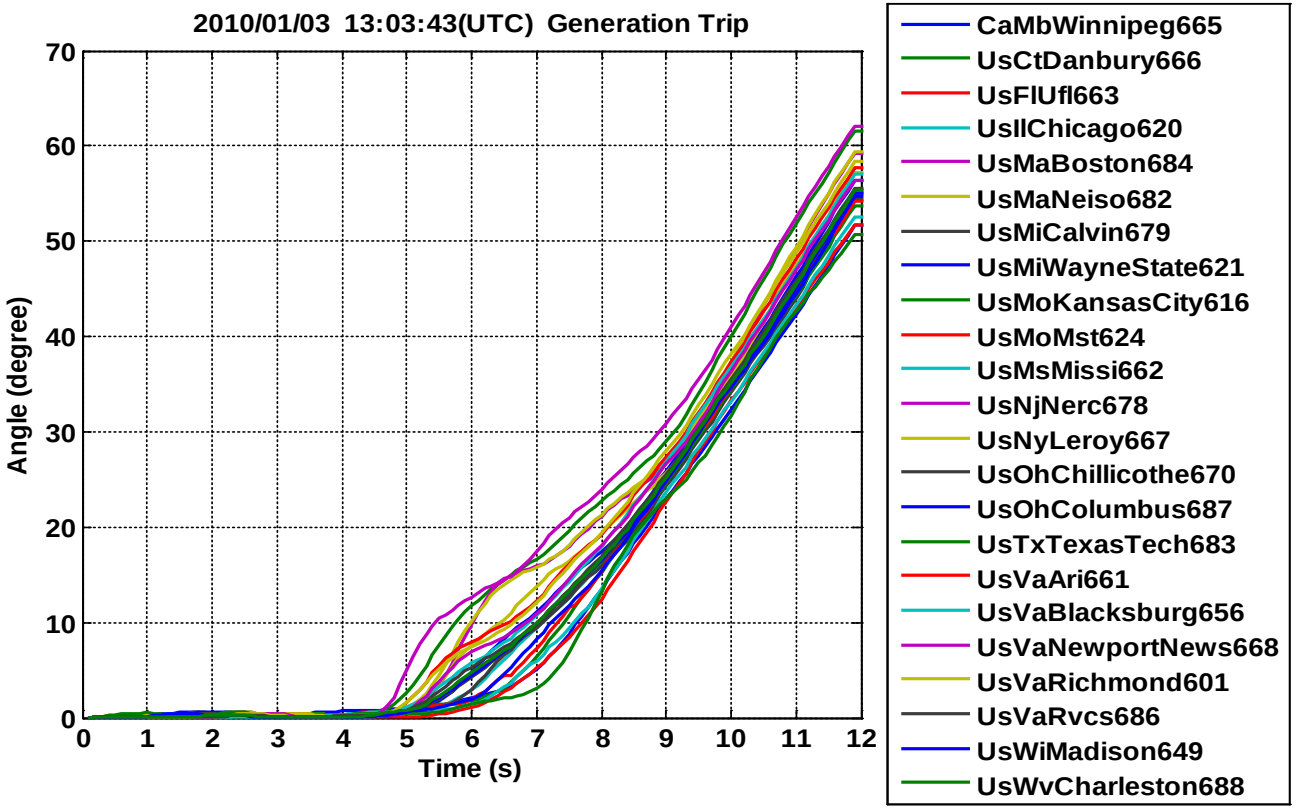


Methodology

- Assumption
  - Frequency error: ±0.005 Hz
  - Angle error
    - PMU part : ± 0.6°
    - Instrumental channels -1.0°(maximum)
- Approach
  - Assume the maximum error
  - Find the worst case

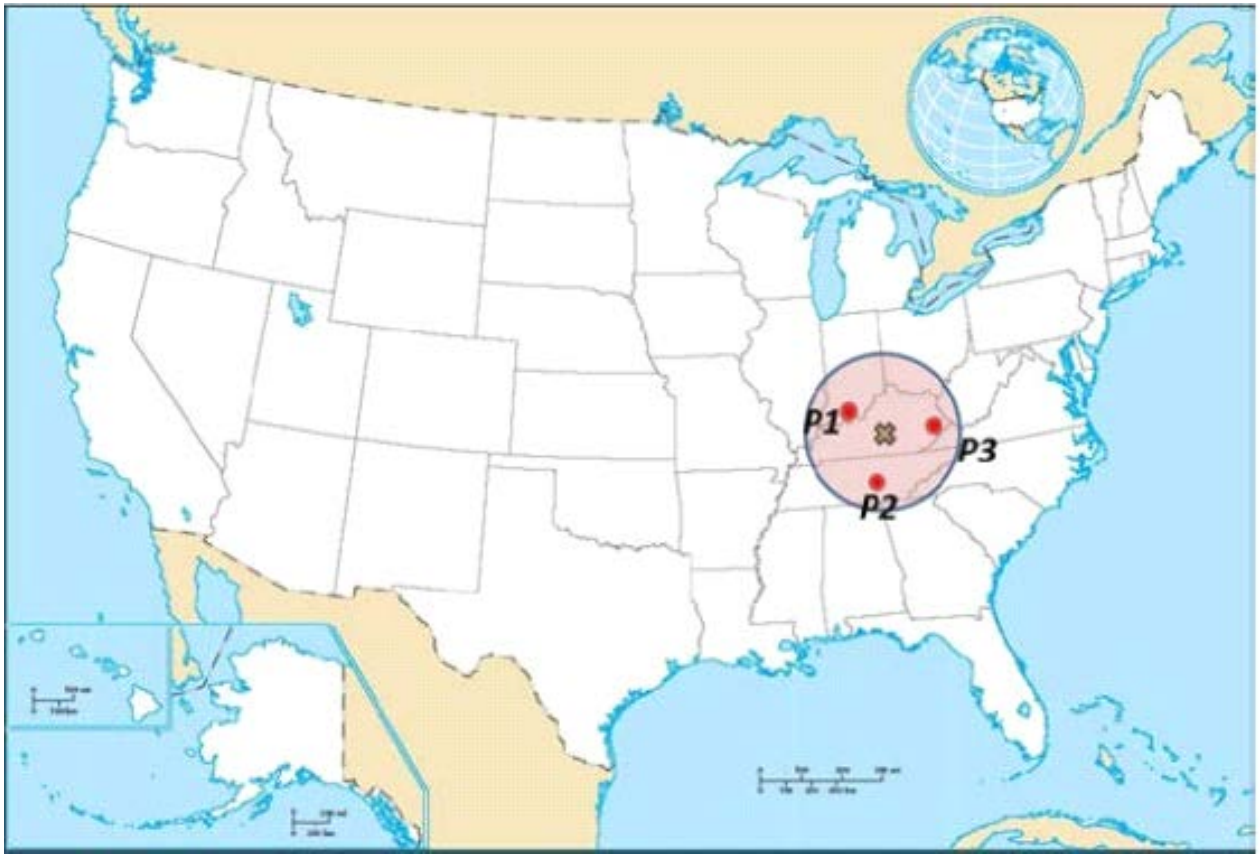
Event Location: A Brief Introduction

- Angle-Based Event Location



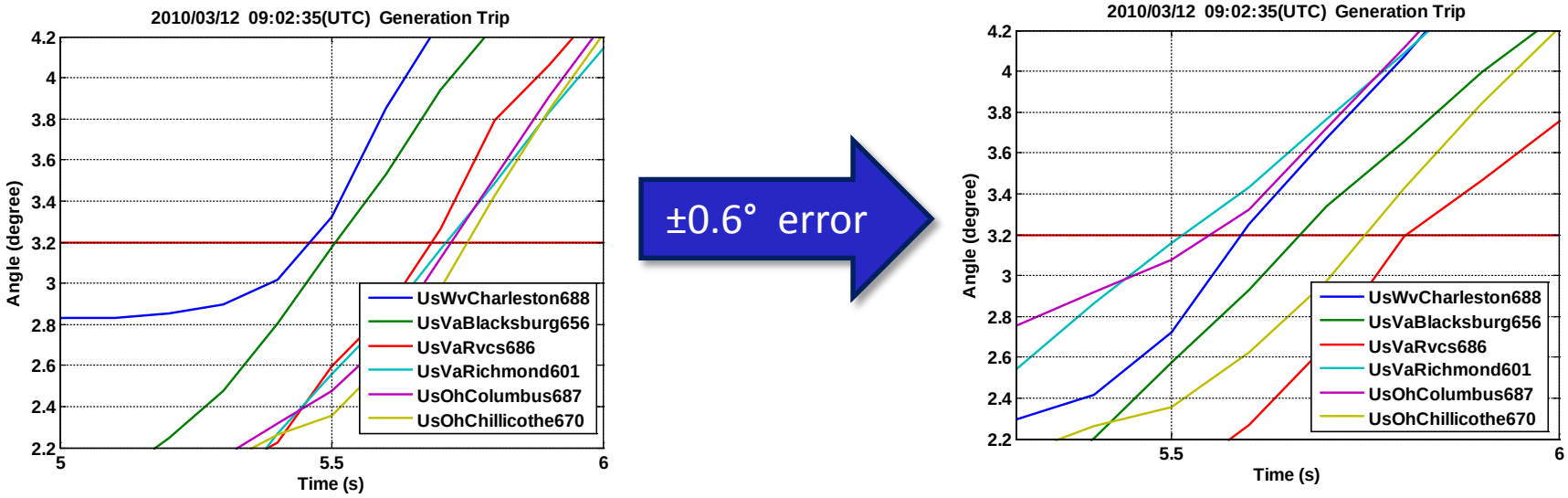
Event Location: A Brief Introduction

- Angle-Based Event Location



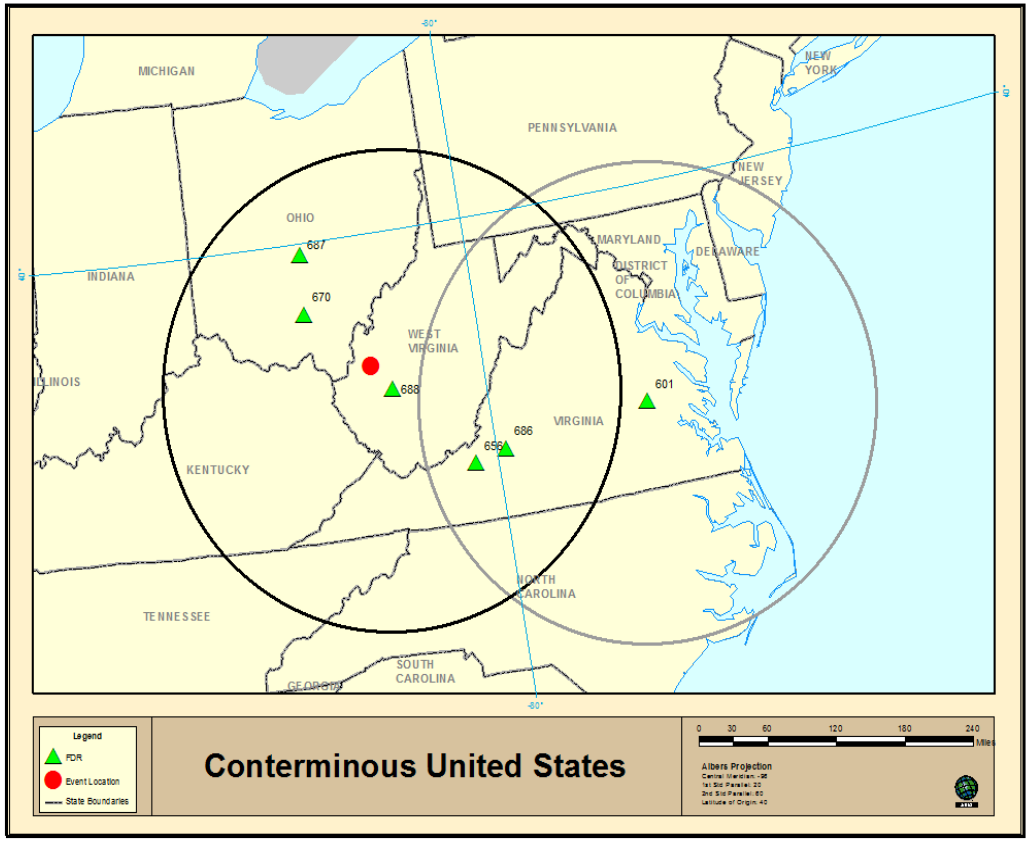
How Error Impact

- An example

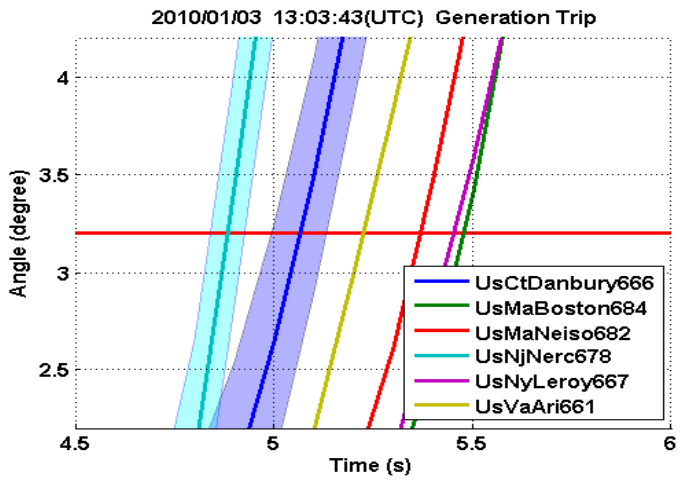


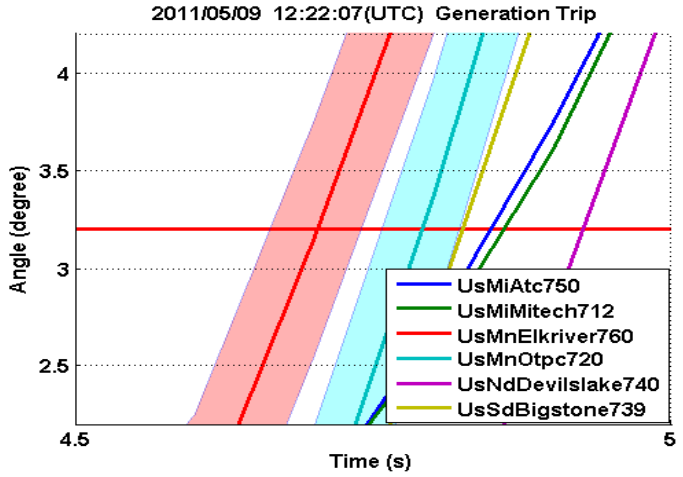
How Error Impact

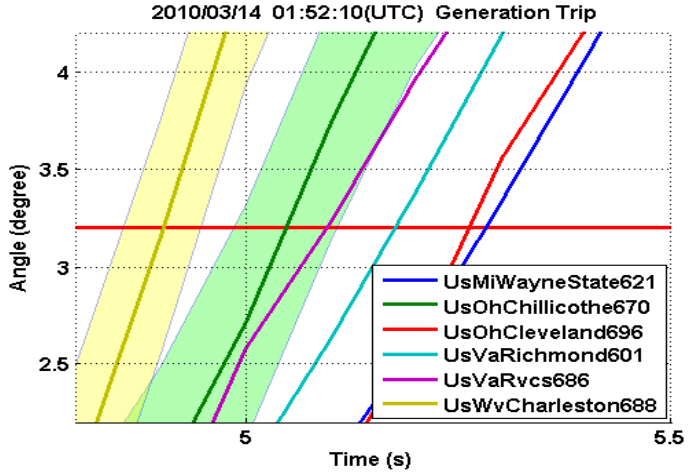
- An example

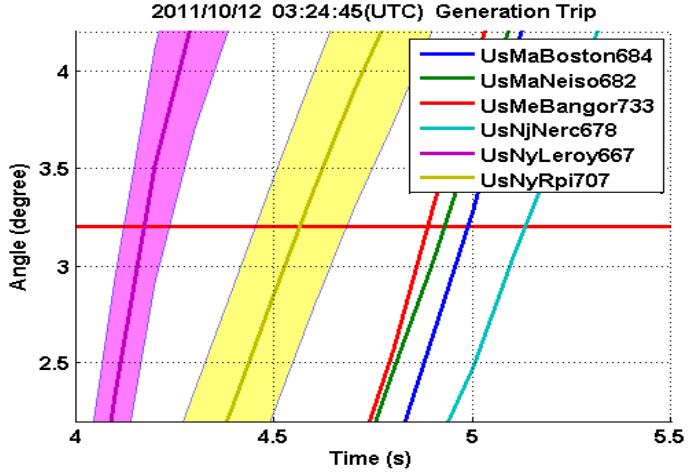


Most Scenarios Unaffected



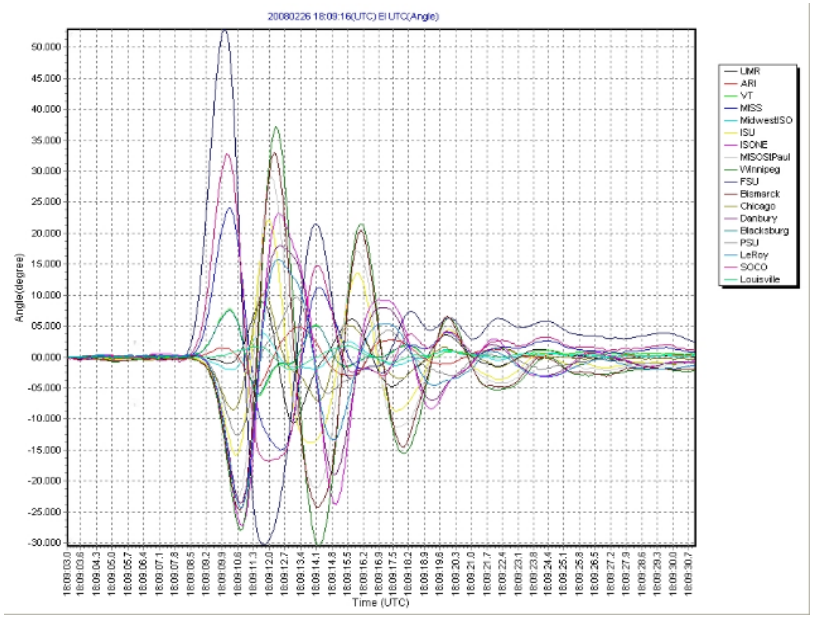


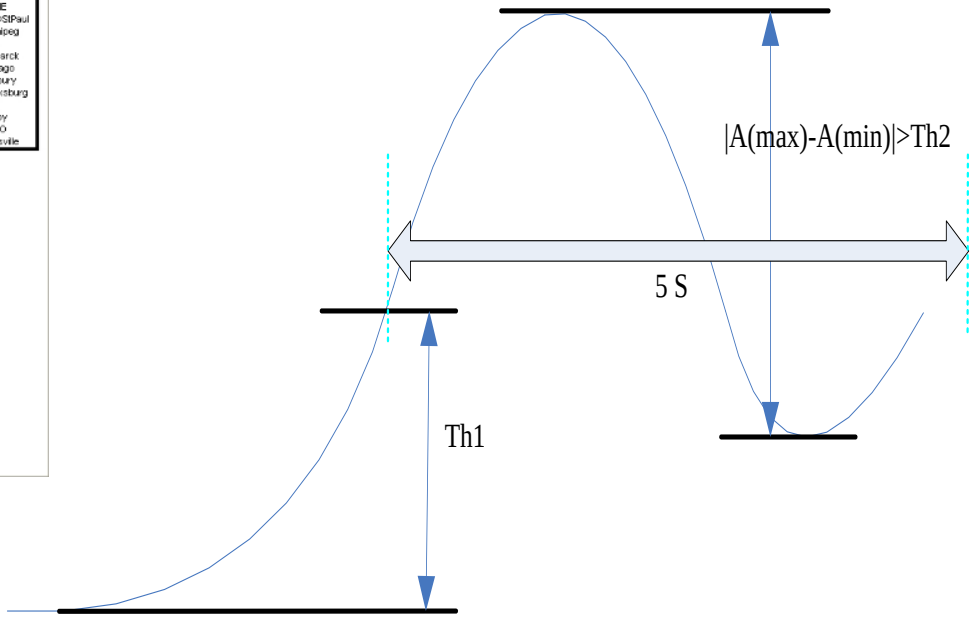




Oscillation Detection: Approach

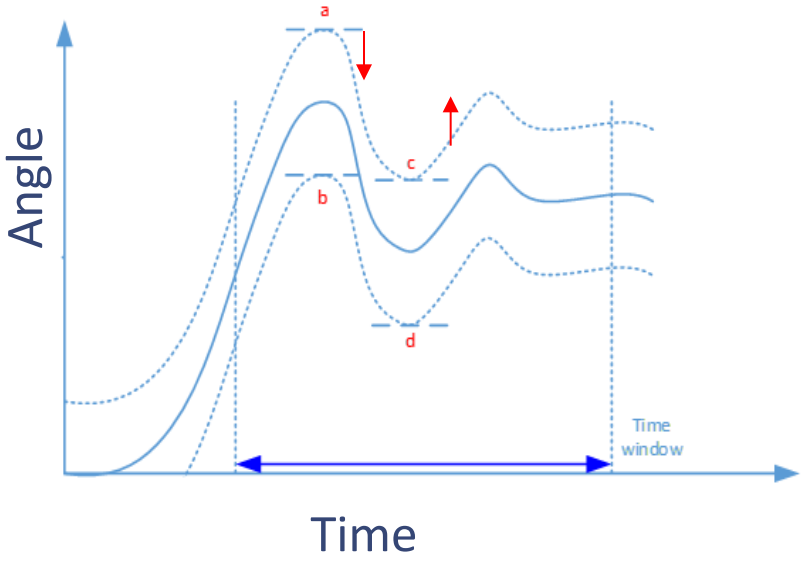
- Phasor angle based two-threshold method

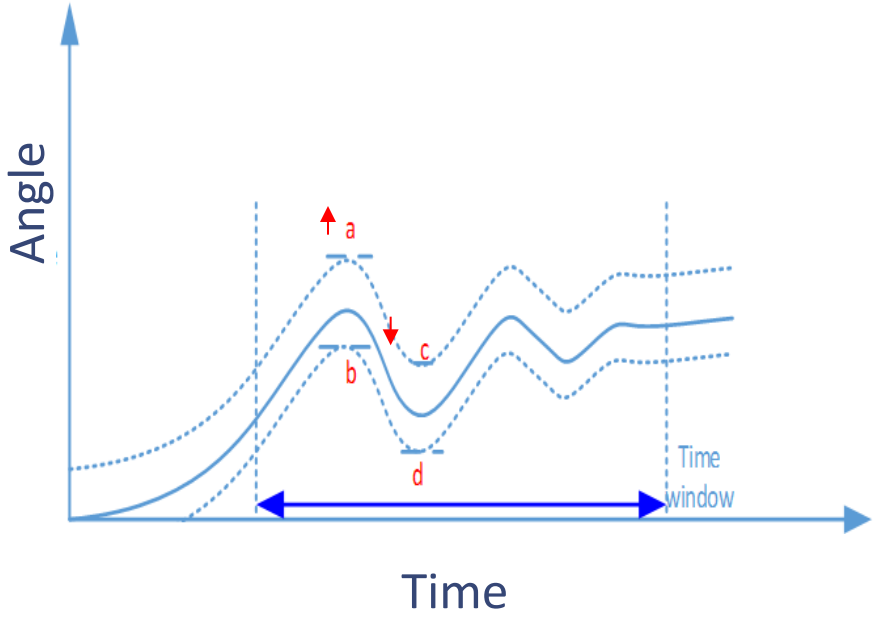




Impact of Error depends on thresholds

- Angle based method

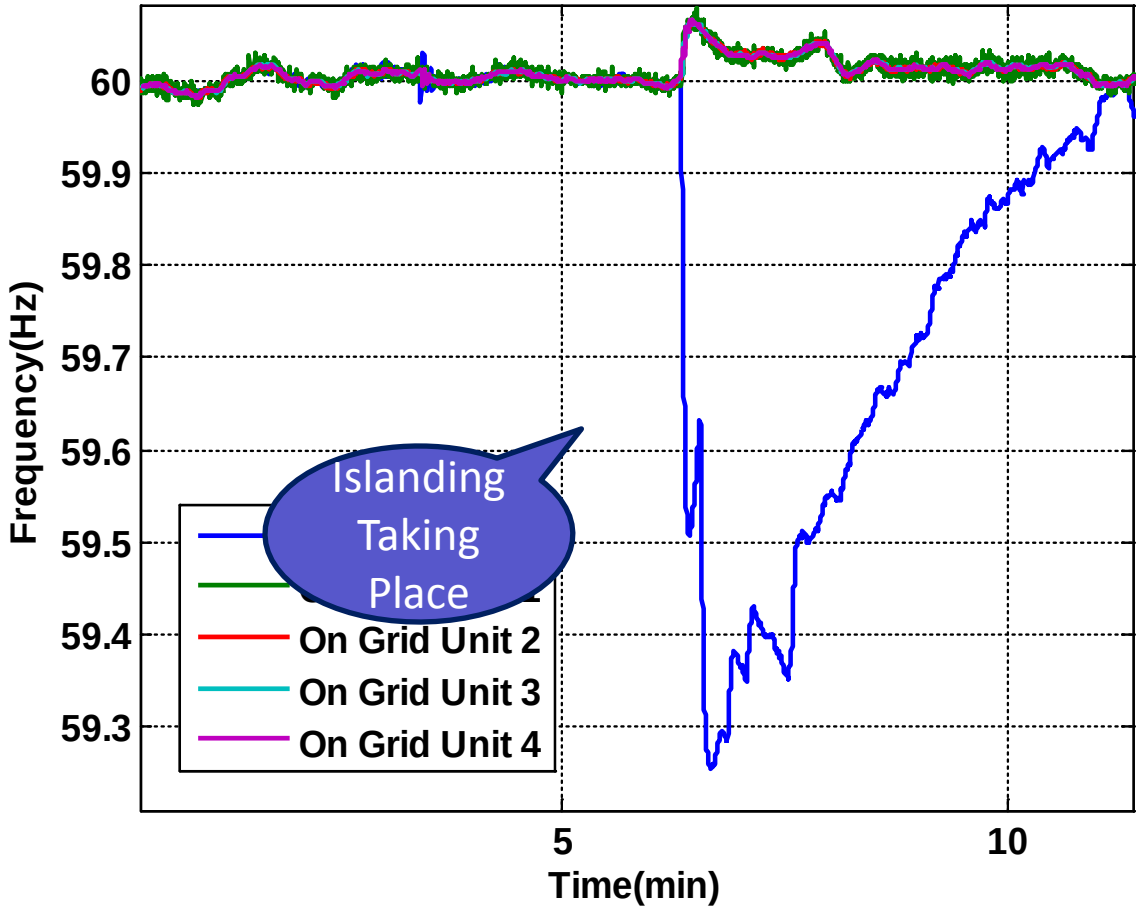




Failed Detection

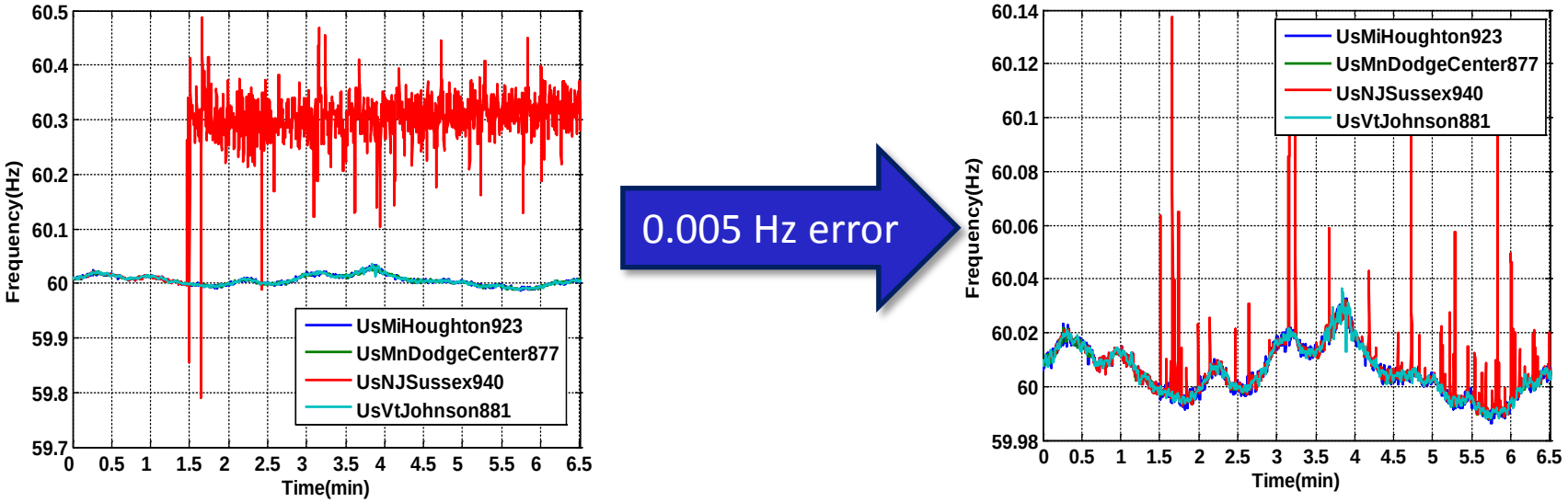
False Alarm

Islanding Detection: Frequency based



Impact of Error

- Error may decrease the frequency difference



Impact of Error

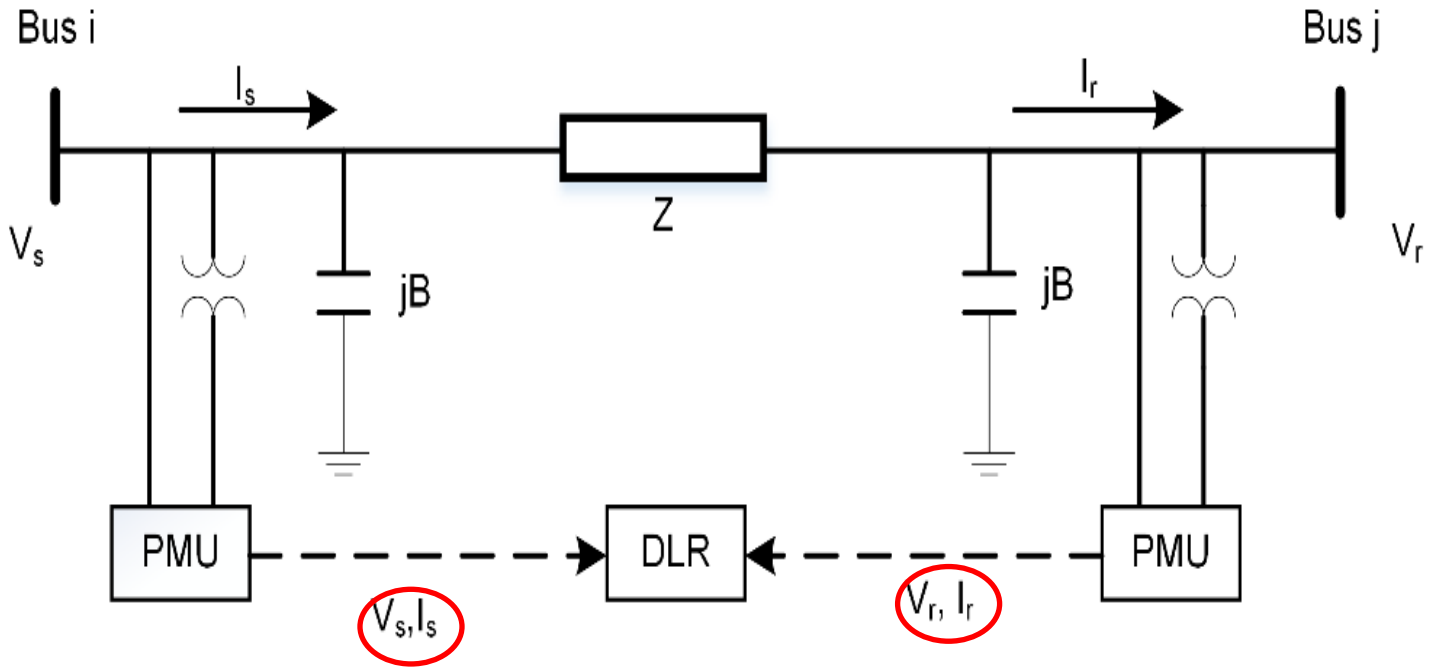
- Tested on different detection time:

  30s, 4s, and 2s and error does not influence the detection accuracy
- Error may affect accuracy if shorter detection time is required

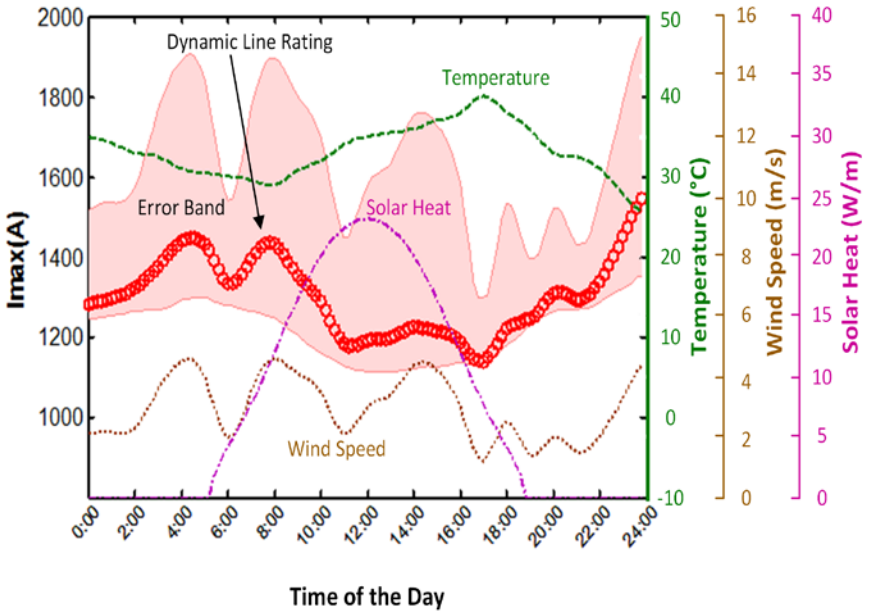
Dynamic Line Rating

- Find the highest current a line can transfer safely dynamically
- PMUs provide V and I on both ends
- Consider only angle error in V, I

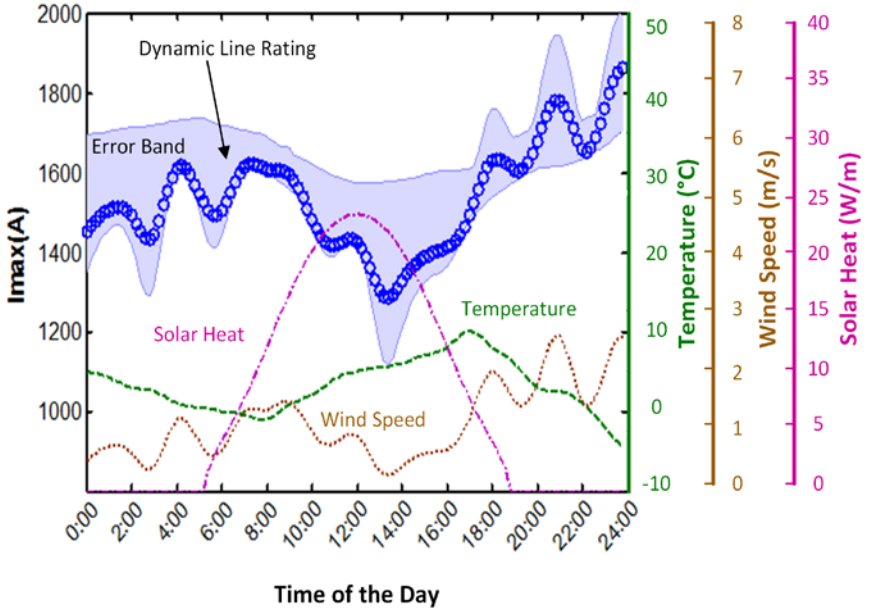
Error Impact



Weather Dependence



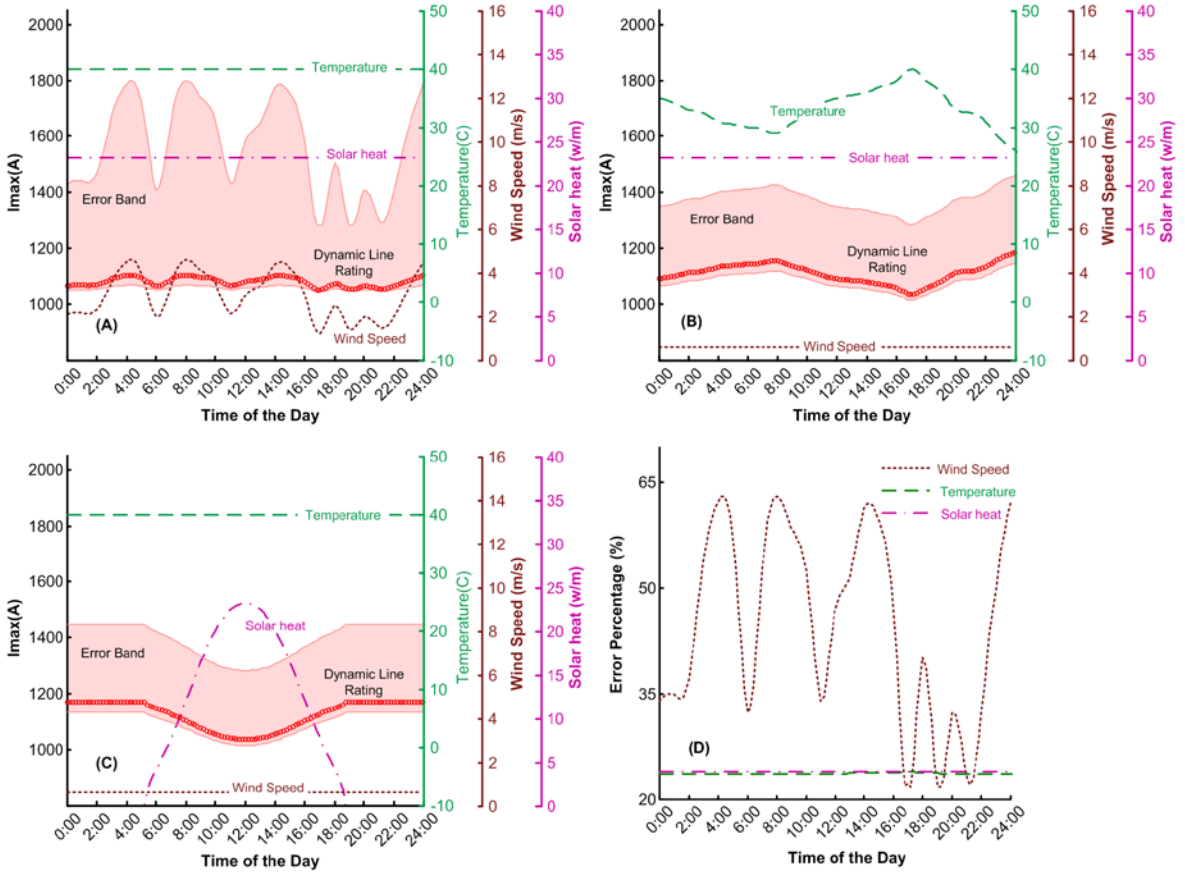
Summer
Errmax:45.87%



Winter
Errmax:22.87%

Different Factors

- Wind speed
- Temperature
- Solar heat



Conclusion

Application	Effect	Extent of Significance
Event location	Most cases there is no impact, but for some it is sensitive to the error	Minor
Oscillation detection	Possible to cause failed detection or false alarm	Threshold dependent
Islanding detection	Not likely to be influenced by error above 2 seconds	Detection time dependent
Dynamic line rating	Able to cause large errors	Major

Thank You!

Questions/Comments?