An Integrated Topology Estimator for the OpenLSE

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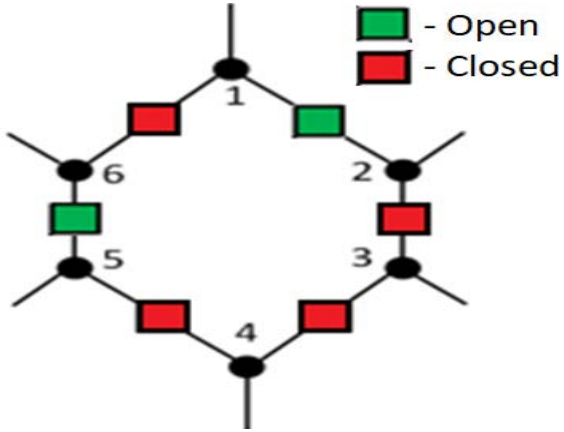
Andreas Schmitt

Introduction

- System topology impacts analytics
- Current topology processors make use of breaker status
- Availability of time-synchronized breaker status data is not common
- Breaker status data has errors

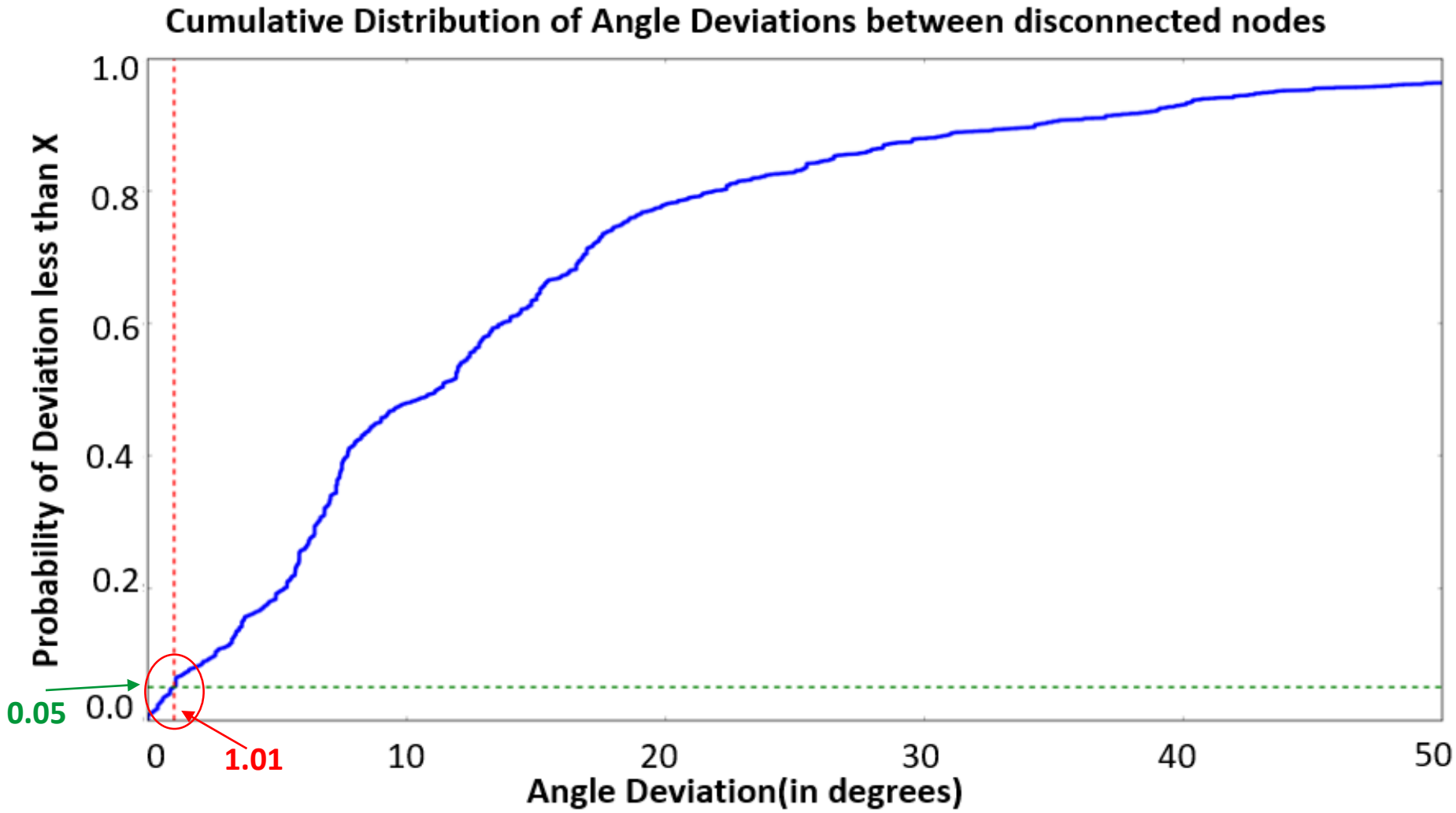
Topology Estimation

- Empirical Approach based on voltage coherency
- Nodes connected by breakers will have similar voltages
- Disconnected nodes *may* differ
  - System connectivity
  - Measurement errors



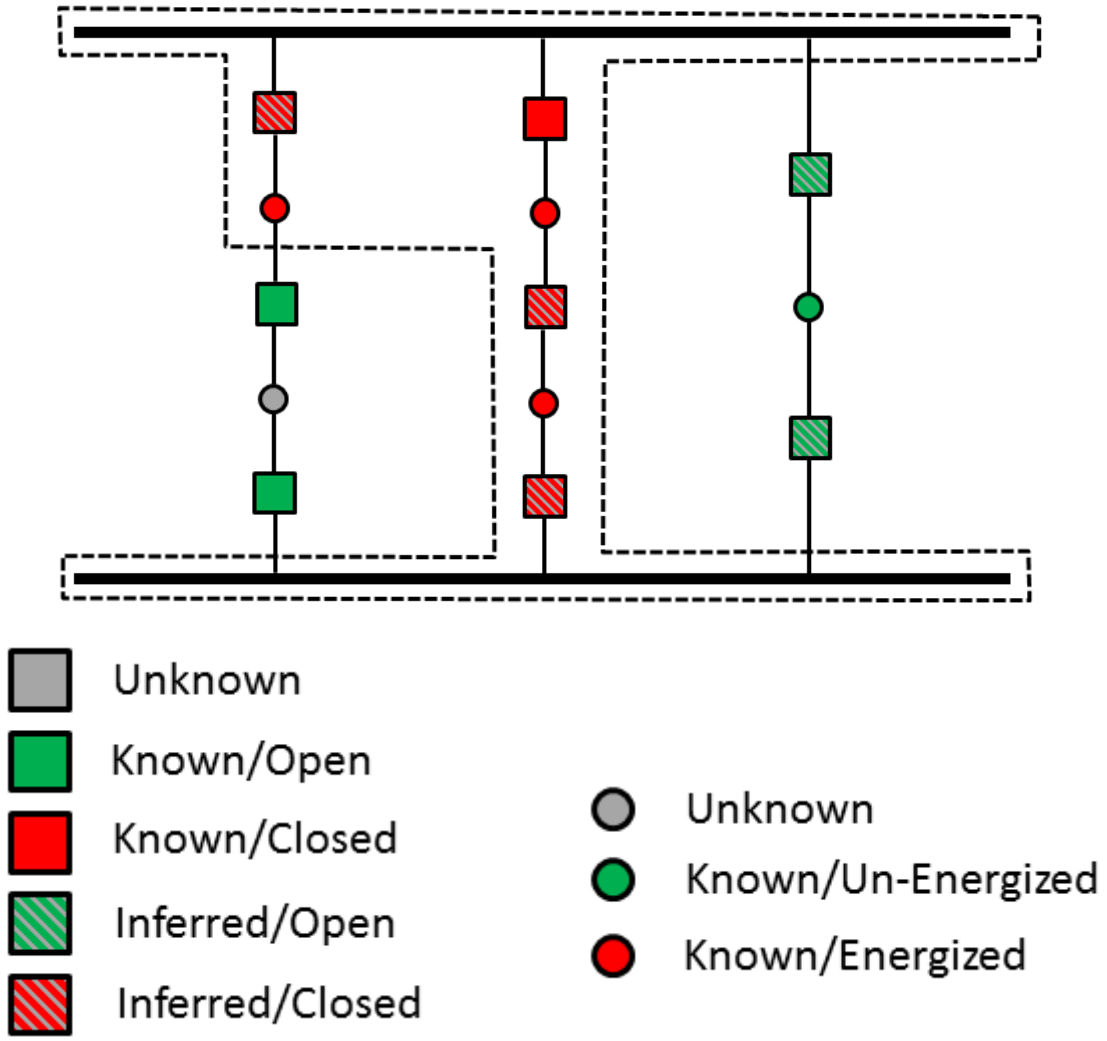
- Step 1: Calculate Voltage Deviation Threshold
- Step 2: Reconstruct bus/branch model

Results for Offline Methodology



Reconstruction Procedure

- **Level – 0 :** Initialization step, determine only if nodes are energized or not
- **Level – 1 :** Read breaker status telemetry where available and connect nodes as such
- **Level – 2 :** Compare the voltage angle deviation of adjacent nodes to infer and/or validate breaker telemetry
- **Level – 3 :** Provides state vectors representing groupings with each grouping containing equipotential nodes.
- **Level – 4 :** Uses sparse measurements and inherent topological information along with sparse time-stamped breaker telemetry to better group the observed and unobserved nodes.



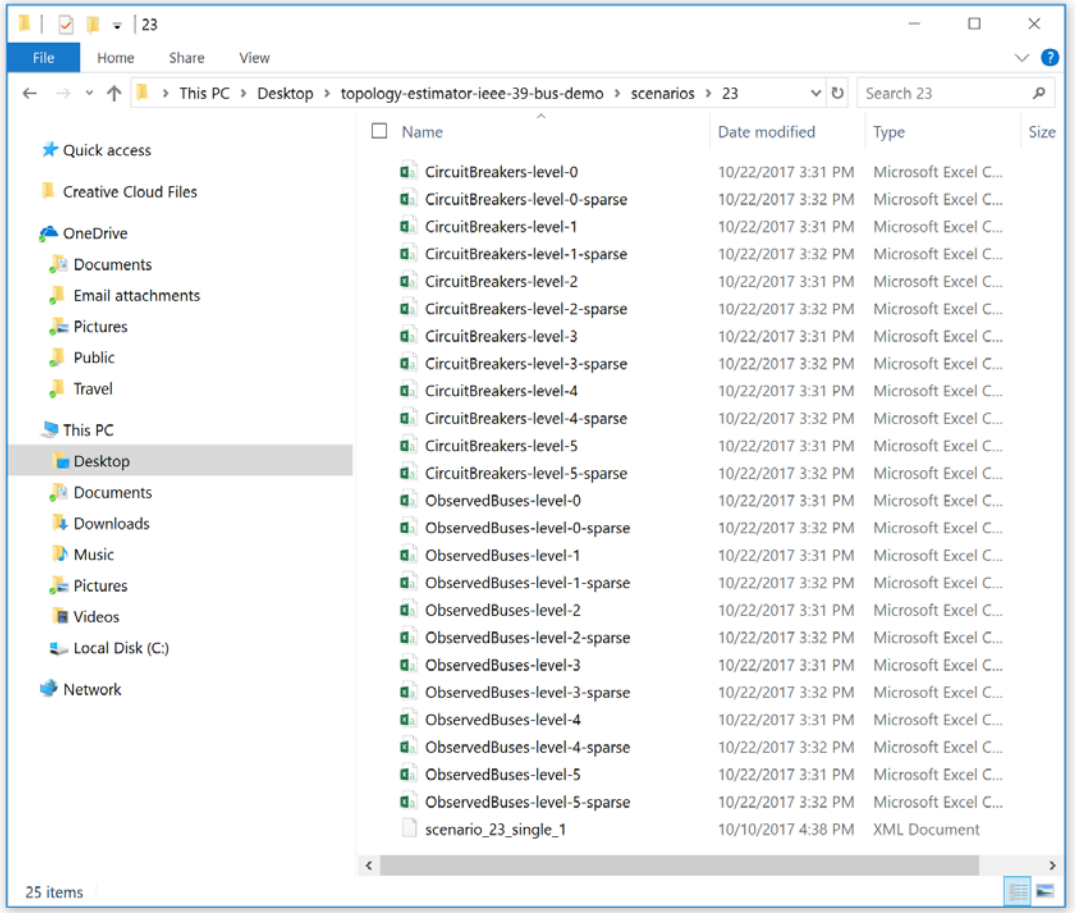
Topology Reconstruction Accuracy

- Simulations run for random substation breaker configuration under varying system conditions
- Correct bus/branch model defined as success
- Threshold=1.01°
- 1% Error=.517°

	Reconstruction Accuracy	Jenks Accuracy
No Measurement Error	.928	.866
1% Measurement Error	.918	.851
3% Measurement Error	.573	.682

Offline Testing of the Topology Estimator with IEEE39 Bus Demo

- Topology Estimation completed for several chosen scenarios for each level in algorithm
- The resulting reports were manually reviewed for consistency and accuracy
- The results of the testing verify that the Topology Estimator works as designed



Topology Conclusions

- Accurate even under noisy conditions
- Accounts for vast majority of system cases
- Provides alternative/redundancy with breaker status topology estimation
- Open Source: Available at
  - *Core Libraries, Offline Analysis & Modeling Tool*
    - https://github.com/kdjones/lse
  - *openLSE:*
    - https://github.com/kdjones/openlse