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AMI Data Quality and Collection Method Considerations for Improving the Accuracy of Distribution System Mo

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Introduction

- Advanced Metering Infrastructure (AMI) provides new insights into the distribution system
- There are uncertainties in best practices for AMI collection intervals, meter precision, etc.
- This research seeks to create recommendations for AMI data collection strategies to facilitate emerging methodologies for correcting distribution system models
- Focus is identifying customer phases using a sliding window ensemble and spectral clustering to leverage the correlations between voltage profiles.

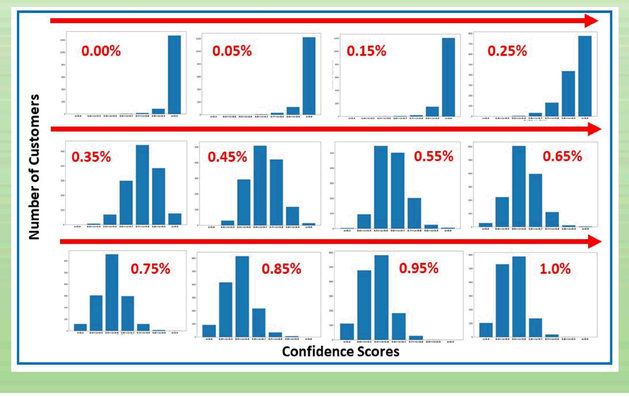
Confidence Score metric

- The confidence score metric allows a detailed analysis of the experimental results.
- The confidence score leverages the ensemble nature of the methodology.

$$\text{Confidence Score} = \frac{Number\ of\ instances\ of\ the\ majority\ prediction}{Total\ number\ of\ windows}$$

Measurement Noise

Max Noise Percentage	Base Case Accuracy	Test Case Accuracy
Original	100% (0)	100% (0)
0.05%	100% (0)	99.93% (1)
0.15%	100% (0)	100% (0)
0.25%	100% (0)	100% (0)
0.35%	100% (0)	100% (0)
0.45%	100% (0)	99.93% (1)
0.55%	100% (0)	99.71% (4)
0.65%	100% (0)	98.40% (22)
0.75%	99.93% (1)	96.37% (50)
0.85%	99.42% (8)	94.92% (70)
0.95%	99.13% (12)	91.88% (112)
1.0%	99.10% (13)	91.81% (113)



Results

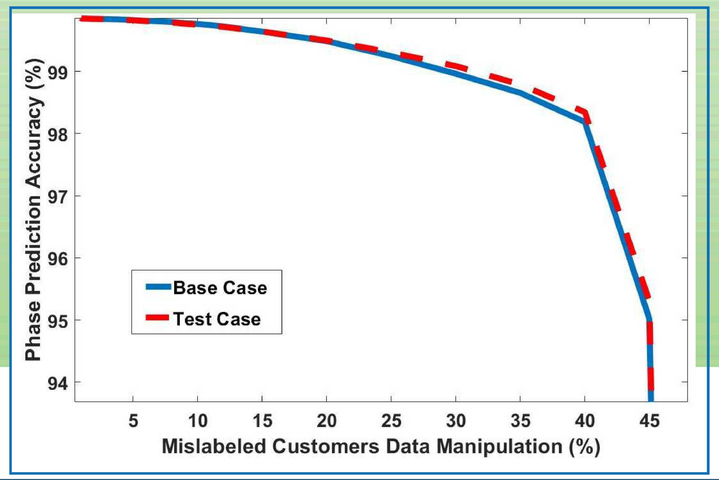
AMI Data Recommendations

Data Quality Manipulation	AMI Considerations Based on the Phase Identification Task
Measurement Interval	5 - 15-minute intervals are recommended
Meter Precision	At least 1 decimal on voltage measurements (240V) is required
Meter Bias	Bias does not impact phase identification results with this algorithm
Measurement Noise	< 0.25% maximum uniform random noise is recommended
Time Synchronization	> 1-min measurement intervals are required to account for the time synchronization errors
Missing Data	Sensitive to the *distribution* of missing data. Given uniformly distributed 4-hr missing data instances, with this algorithm, the percentage of missing data is required to be < ~4%
Data Availability	> 4 months of AMI voltage data are required

Experimental Cases

Data Quality Manipulation	Default Values Used in the Base Case	Default Value Used in the Test Case
Measurement Interval	15-minutes	15-minutes
Meter Resolution	2 decimals	1 decimal
Meter Bias	0% maximum bias	0.2% maximum bias
Measurement Noise (Meter Precision)	0% maximum noise	0.2% maximum noise
Time Synchronization	No time synch issues	No time synch issues
Missing Data	0% missing data	0.2% missing data.
Available Data	12 months	6 months
Mislabeled Phases	0% mislabeled	10% mislabeled

Impact on Mislabeled Phases



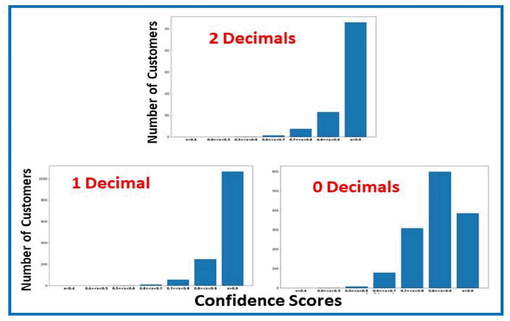
Conclusion

- These results inform AMI data collection strategies required for utilities to be able to use the data to validate and correct errors in their models of the distribution system.
- Note that the phase identification algorithm is correlation-based, so other types of algorithms may show other sensitivities. Work is ongoing in that area.

Dataset

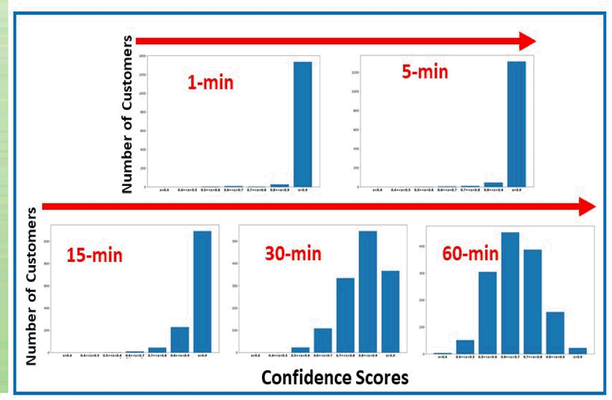
- A year-long AMI dataset from Pecan Street simulated in OpenDSS on EPRI's Test Circuit 5.
- 12.47 kV feeder with 1379 residential loads

Meter Resolution



Measurement Interval

Measurement Interval	Window Size – 4 days	Base Case Accuracy	Test Case Accuracy
1-min	5760	100% (0)	100% (0)
5-min	1152	100% (0)	100% (0)
15-min	384	100% (0)	100% (0)
30-min	192	100% (0)	100% (0)
60-min	96	100% (0)	99.93% (1)



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