



Point-on-Wave-Based Measurement Infrastructure Health Analytics

Identifying Issues: No Event Data

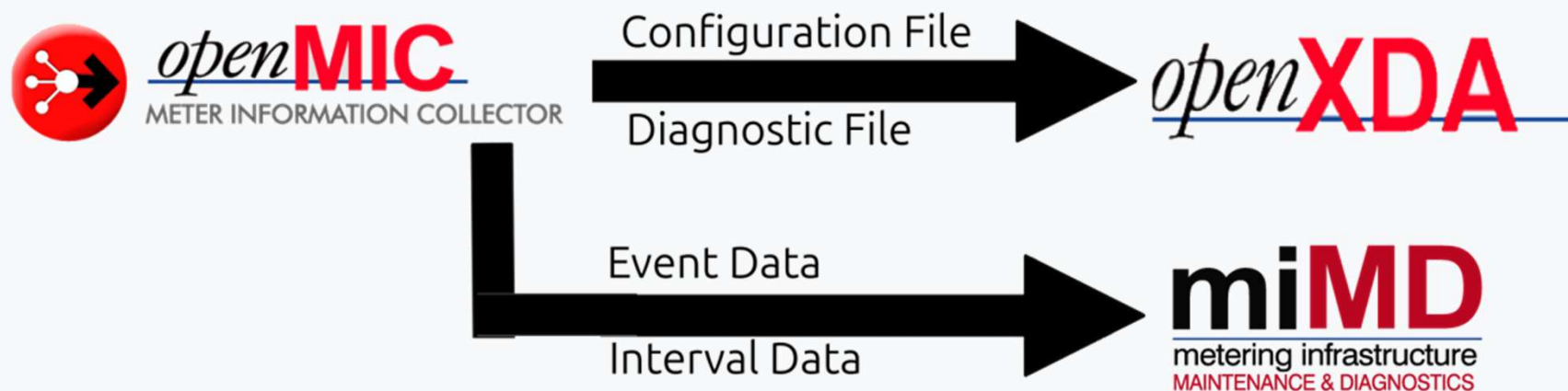
- Weakness with event trigger based approach
 - If no data is reported, it can be difficult to determine if an issue exists
- Need to find a way to know if there should be reported point on wave data.

404

Common Meter Health Issues

- Misconfiguration
 - Missing 0 somewhere
 - Left in Testing mode
- Synchronization Issues
 - No GPS data
 - Clock is off
- Communication Issues
 - Loss of connection
 - Missing event trigger

Data Pipeline



Diagnosing Misconfigurations

- Difference Engine
 - Report statistics on changes
 - Report alarms based on known misconfigurations
- Diagnostic Issues
 - Raise alarms for issues reported by the meter

Diagnosing Missing Data

- Important to diagnose missing data
 - Could be downed connection
- Examine interval data for statistics
 - Completeness
 - Based on configured sample rate
 - Correctness
 - Unreasonable
 - Incongruent
 - Latched
- Examine nearby meters

Possible Issues

- Lightning – No waveform analytics. Cause based on time, correlation with lightning strike data
- Conductor Break
- Tree -In-Line
- Conductor Slap / Debris Mid-Line
- Lightning Arrestor Failure
- Insulator Breakdown due to Contamination
- PT/CT Ratio Changes

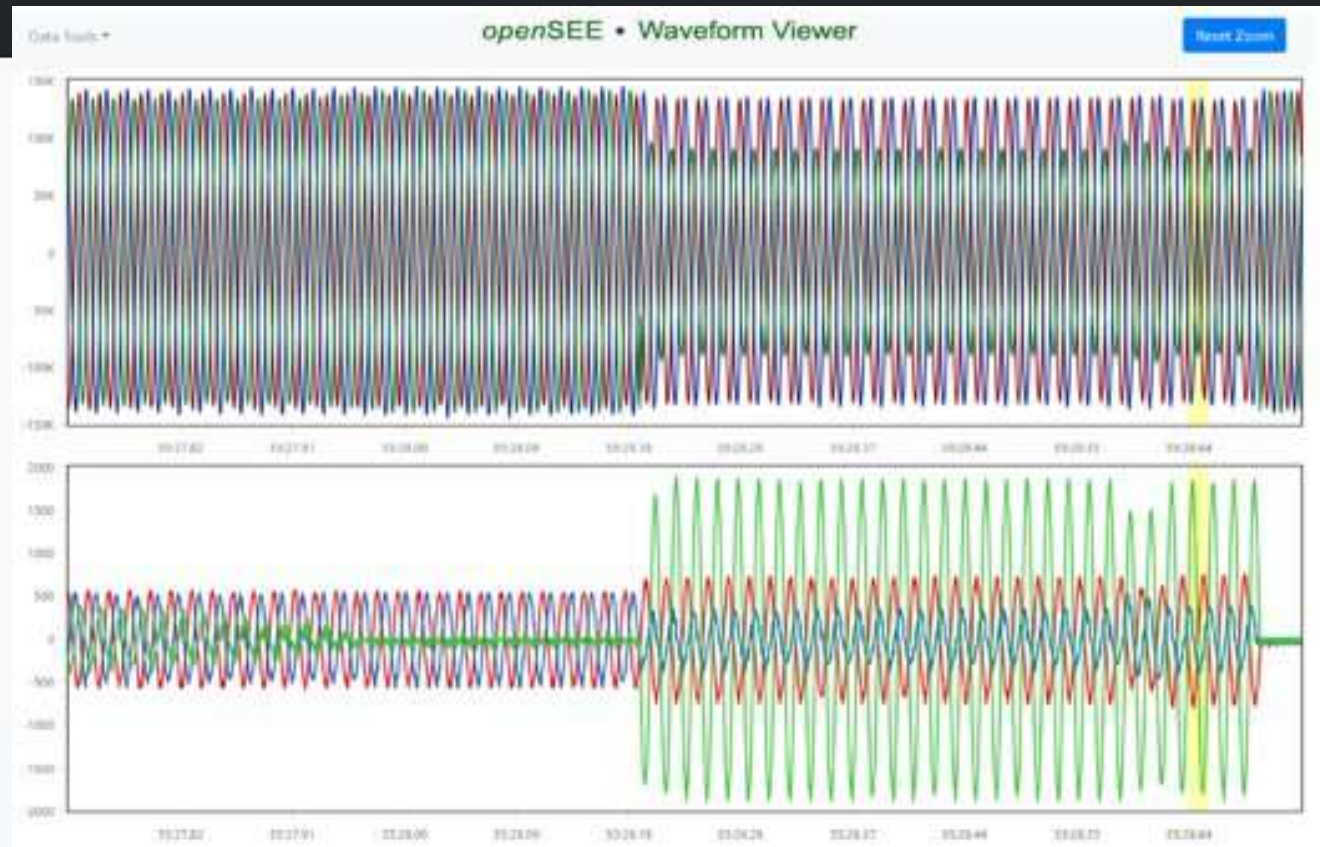
Lightning

- Query lightning database
- Check for proximity to event
- Lightning database is external



Conductor Break

- Phase-to-ground
- Look at the pre-fault currents.
 - Should disappear in exactly one phase.



Tree-in-Line

- Phase-to-ground faults
- Check for high fault resistance of tree
- Conflicts with lightning arrestor and insulation contamination

$$R_F = \sqrt{(X_S D_S)^2 - (X_S D_R)^2} - R_S D_R$$

where:

R_F = Fault Resistance of Tree (Ω)

R_S = Line Loop Resistance (Ω /mile)

X_S = Line Loop Reactance (Ω /mile)

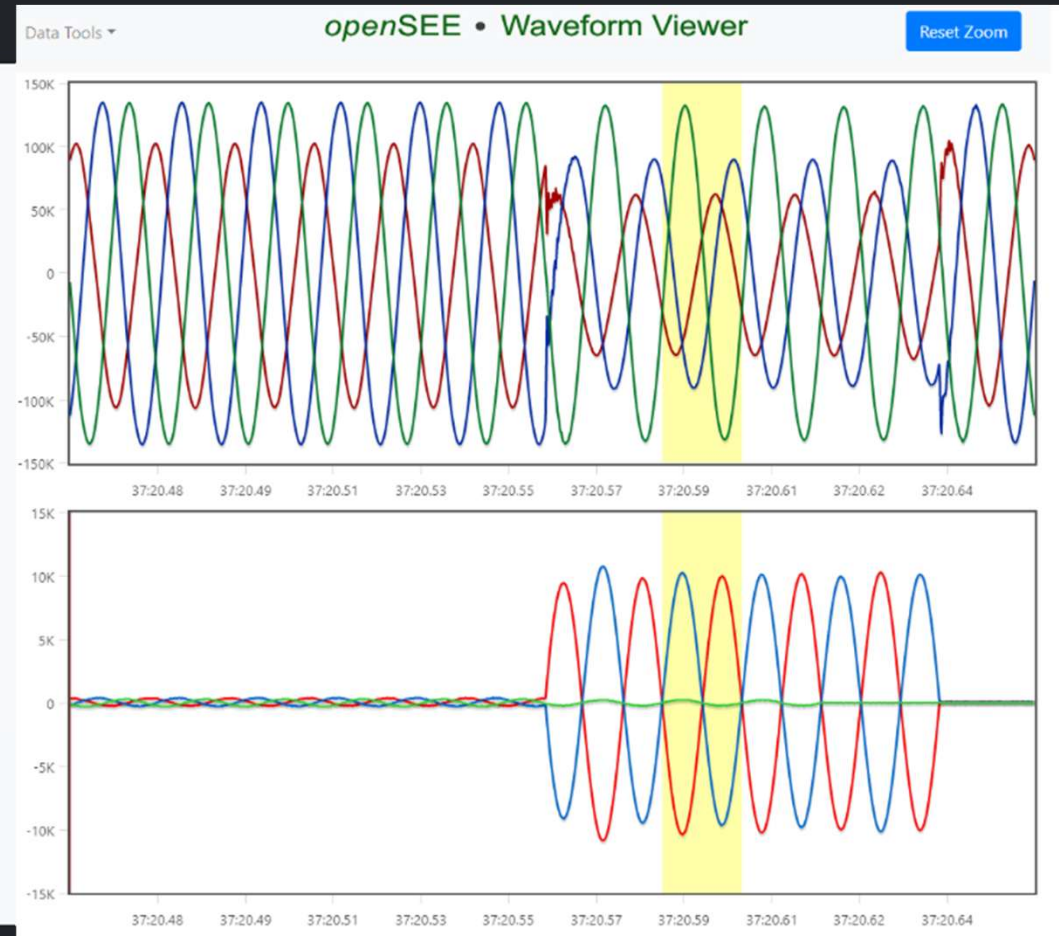
D_S = Calculated Fault Location using
Simple Method (miles)

D_R = Calculated Fault Location using
Reactance Method (miles)



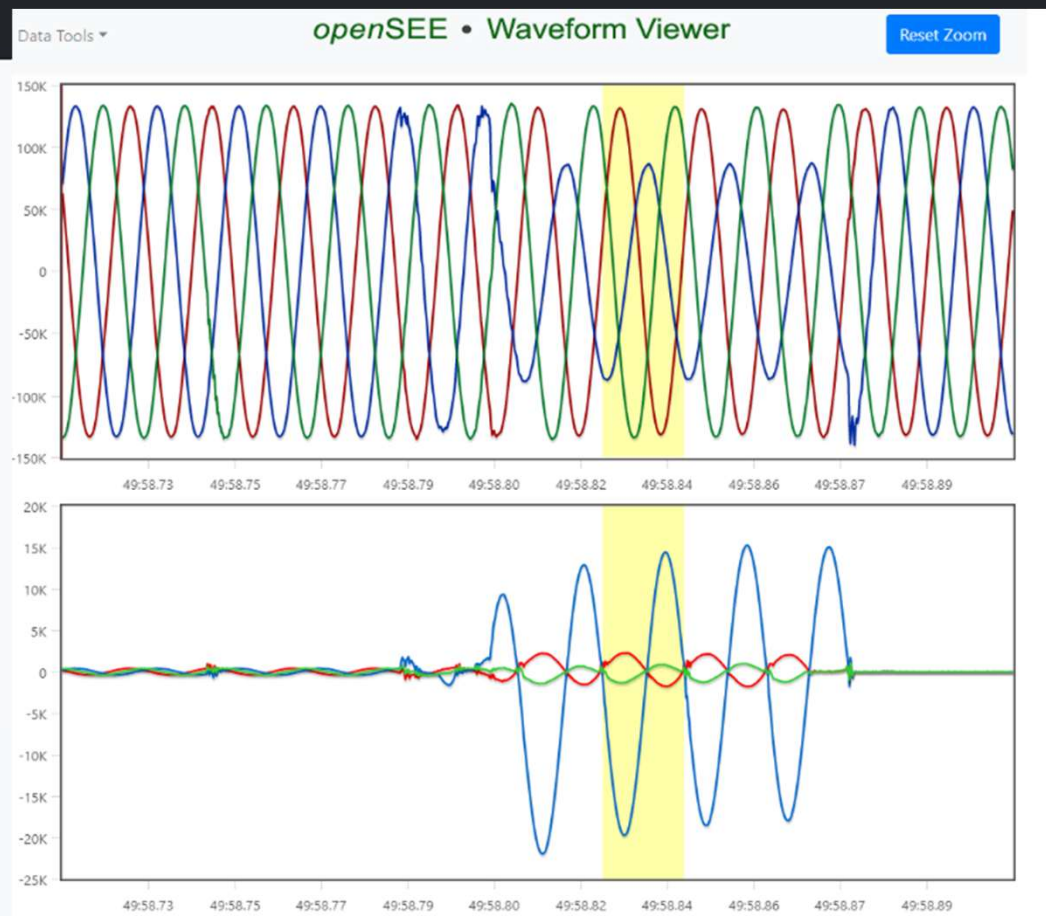
Conductor Slap / Debris Midline

- Phase-to-phase faults
- Check for the absence of ground current during the fault



Lightning Arrestor Failure

- Phase-to-ground faults
- Pre-fault load current
- Check for significant magnitude in third harmonic on current waveform of faulted phase



Insulator Breakdown due to Contamination

- Phase-to-ground faults
- Check if fault inception is close in proximity to the peak of the voltage waveform
- Prone to false positives



Additional Health Statistics

- Additional analytics ran on event trigger.
 - Developed by UTC
 - Monitors for CT/PT changes and characteristics.
- Health of Overall Monitoring System Tracked
 - Latency
 - Processing Start
 - End
 - File Download
 - Email Notification
 - Failure to Process Files
 - Number of Files Processed
- Days of bad data