

PPL Electric Utilities

We Deliver.

Real Time Operation Analysis

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PPL Electric Utilities - Relay Engineering

Agenda

- What is Real Time Operation Analysis (RTOA)
- PPL's process for RTOA
- Operation metrics and benefits of RTOA
- Future developments
- Q&A



What is Real Time Operation Analysis

- Real Time Operation Analysis (RTOA) is the process of recording and analyzing a Transmission Disturbance Event (69kV and above) to determine the fault type and location within 4 hours of the event.
- RTOA is achieved as a group effort of multiple engineering groups/roles
- Post-op analysis of all operations are reviewed for extent of condition



What are the RTOA roles

- Transmission System Operator (TCC)
 - RTOA Relay Engineer
 - System (Field) Engineer
 - Transmission Asset Planning
-
- These roles are assigned as an on-call assignment rotating on a weekly basis.

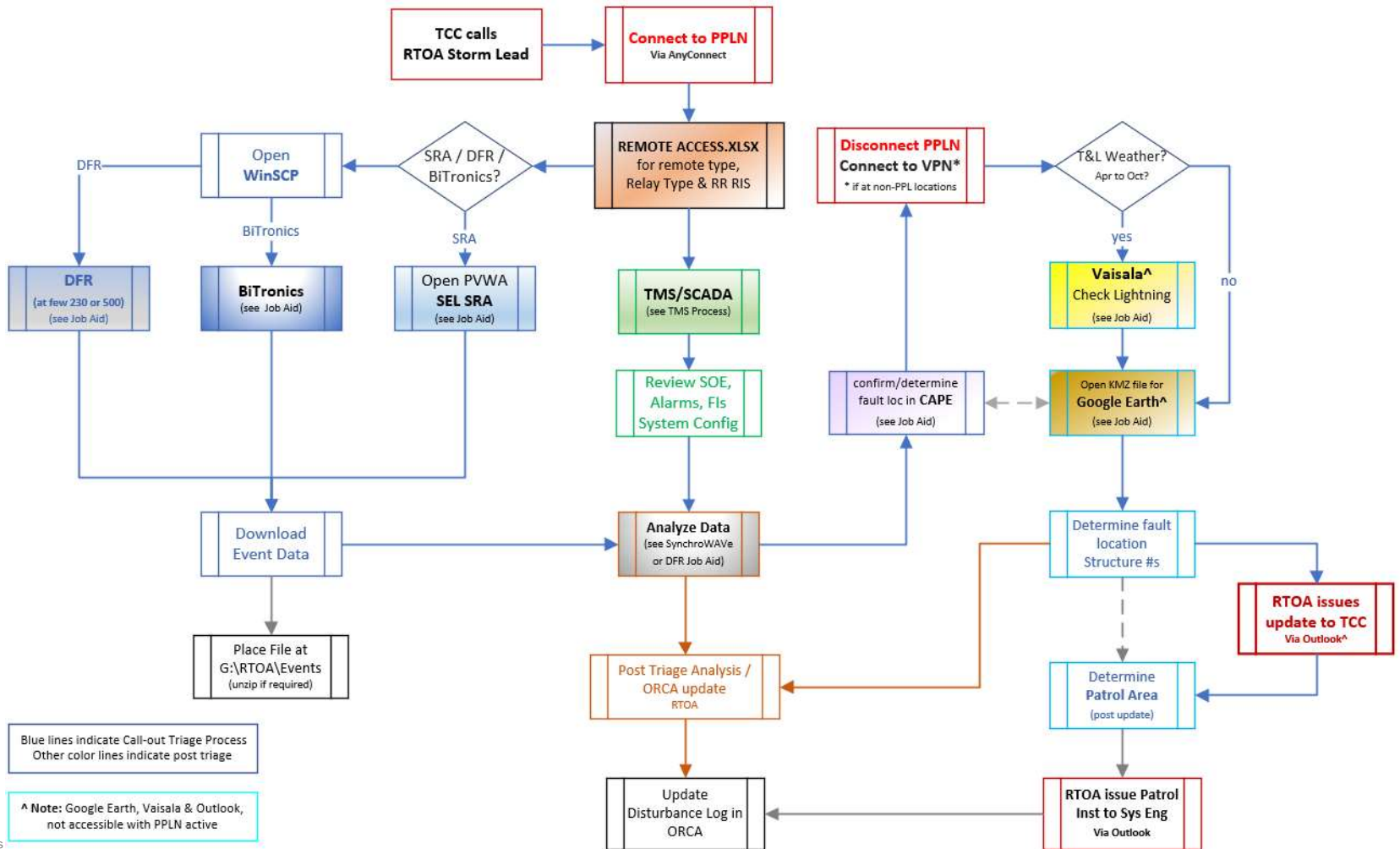


RTOA Operation Process Example

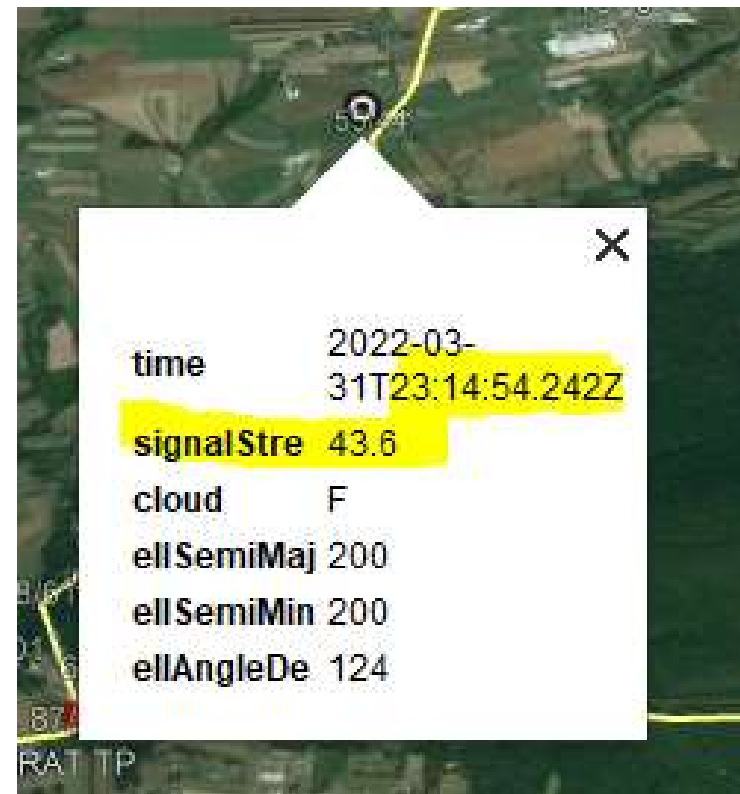
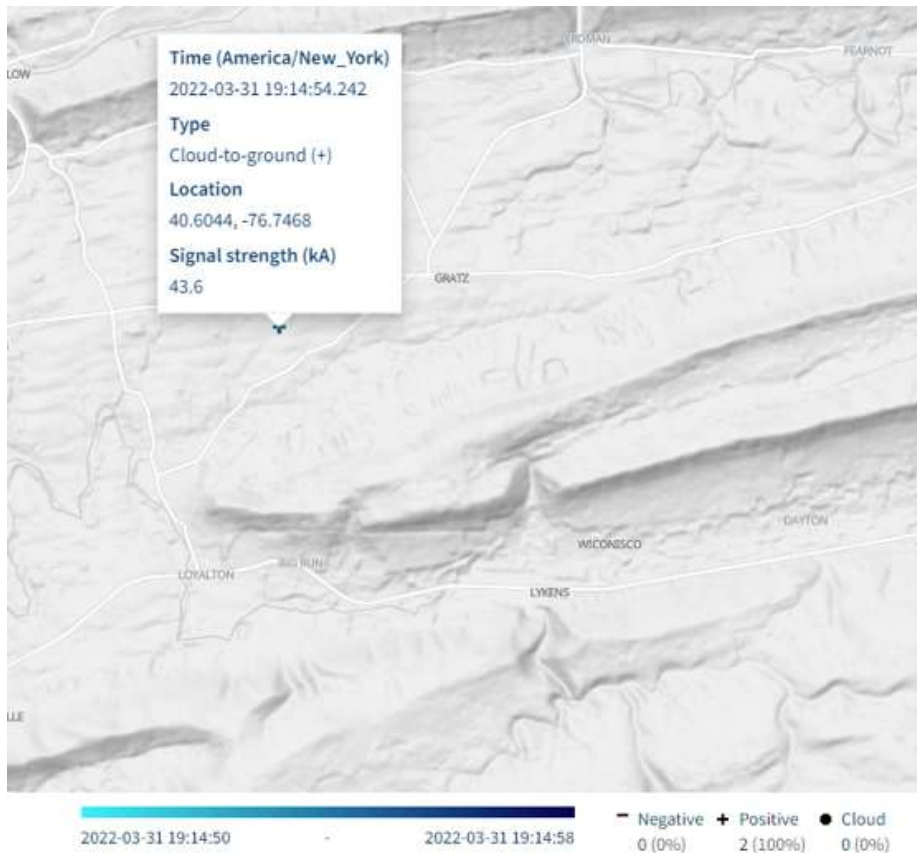
- 1) TCC engages the RTOA upon a transmission disturbance event
- 2) Remote retrieval of relay sequence of event records (SER) and fault recordings
- 3) Verify that protection elements operated correctly utilizing SER
- 4) Fault analysis using CAPE or Aspen
- 5) Targeted patrol instructions sent to System (Field) Engineering to find cause and/or damages to equipment
- 6) Post-op analysis for extent of condition/cause



RTOA Operation Callout Process



Lightning Data (Vaisala)



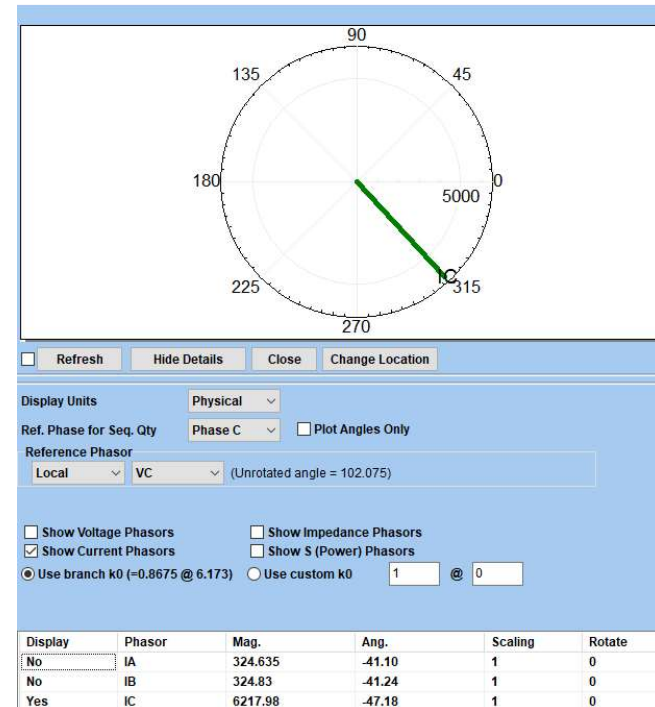
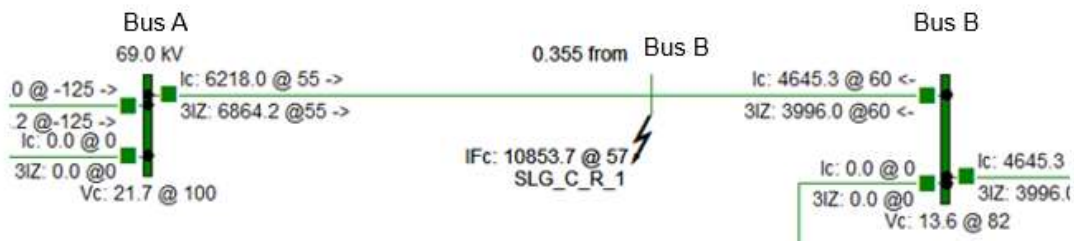
Synchrowave Event Analysis



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Fault Analysis

- Apply a sliding fault on the line location reported by the relay
 - Apply the same fault type reported by the relay. Make sure that was not an evolving fault and the fault type matches the trip trigger.
- Add fault resistance to align the simulated fault current angle with the measured current phasor.

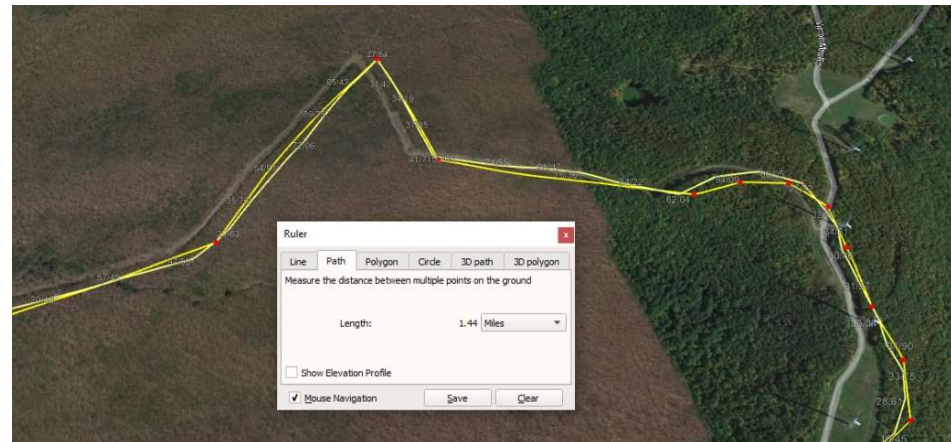


Fault Location

- Open the line KMZ file on Google Earth to trace the line grid numbers to the estimated distance from CAPE analysis.
- Open ArcGIS to trace the line grid numbers to the distance estimated from CAPE.
- Obtain the closest grid number from the estimated location.



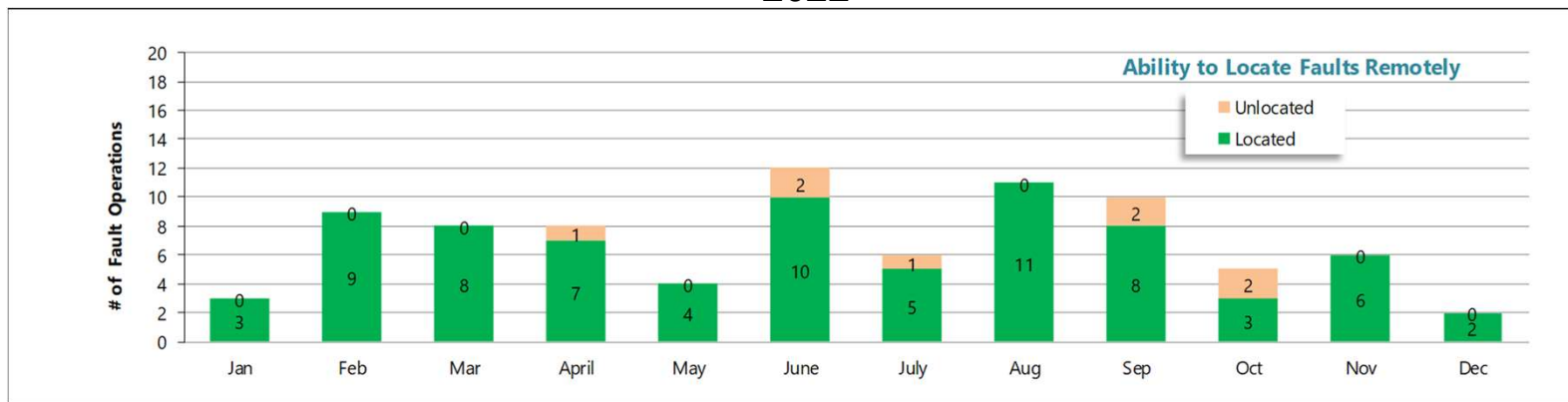
EFD



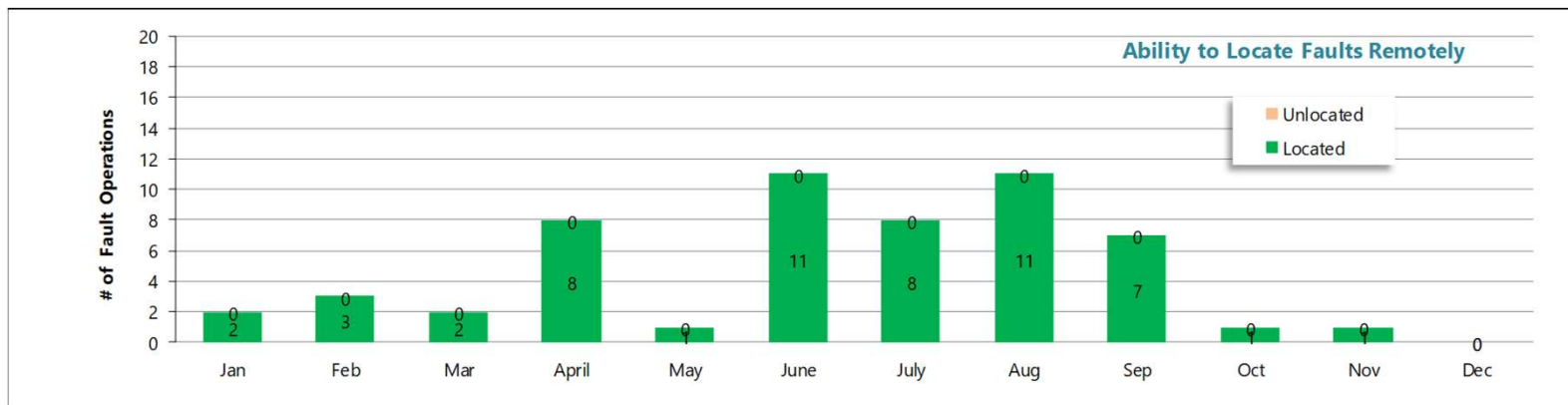
Lightning coordinates (Google Earth)

Metrics and Benefits

2022



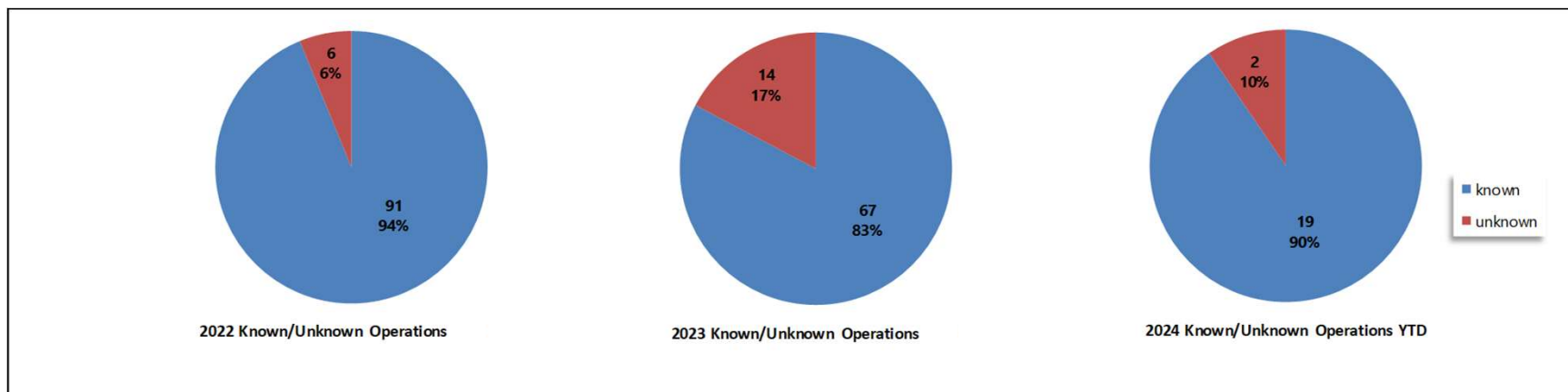
2023



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Metrics and Benefits

| | Jan | Feb | Mar | April | May | June | July | Aug | Sep | Oct | Nov | Dec | totals |
|---------------------------------------|------|------|------|-------|------|------|------|------|------|------|------|------|-------------|
| 12 Mo. Average Accuracy 2020 | 0.63 | 0.58 | 0.58 | 0.45 | 1.00 | 0.67 | 0.35 | 0.26 | 0.67 | 0.15 | 0.60 | 0.20 | 0.47 |
| from pivot sheet, use Col G for Month | | | | | | | | | | | | | |
| 12 Mo. Average Accuracy 2021 | 0.00 | 0.50 | 0.38 | 0.10 | 0.68 | 0.20 | 0.19 | 0.21 | 0.37 | 0.00 | 0.10 | 0.20 | 0.29 |
| from pivot sheet, use Col G for Month | | | | | | | | | | | | | |
| 12 Mo. Average Accuracy 2022 | 0.60 | 0.20 | 0.39 | 0.18 | 0.25 | 0.31 | 0.26 | 0.27 | 0.54 | 0.40 | 0.43 | 0.25 | 0.32 |
| from pivot sheet, use Col G for Month | | | | | | | | | | | | | |
| 12 Mo. Average Accuracy 2023 | 0.65 | 0.03 | 0.1 | 1.24 | 0.4 | 1.39 | 0 | 0.19 | 0.19 | 0.58 | 2.49 | 0.25 | 0.63 |
| from pivot sheet, use Col G for Month | | | | | | | | | | | | | |



Future

- Automatic remote file retrieval
- Distance to fault application integrating Google Earth KML files
- Tracking of SEL T-401L/TWFL Traveling Wave data
 - Line Monitoring – Ex. Detecting failed insulators