OAK RIDGE National Laboratory

April 16, 2025

Third-Party Sensor Data as a Service

Bruce Warmack, Ali Boyaci, & Aaron Wilson

Aaron Wilson

Electrification and Energy Infrastructures Division

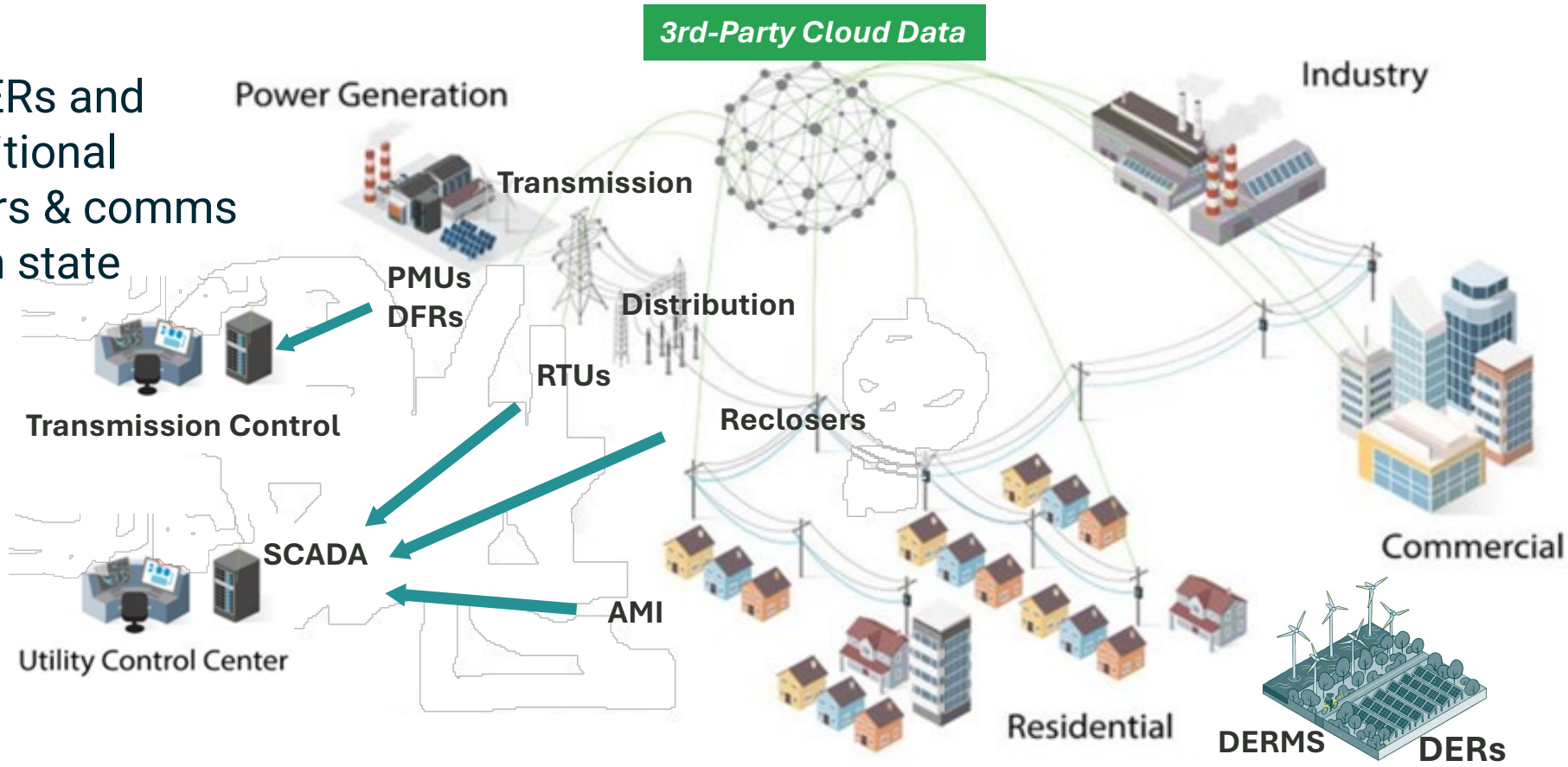
Funding by the Office of Electricity

U.S. DEPARTMENT OF ENERGY

ORNL IS MANAGED BY UT-BATTELLE LLC
FOR THE US DEPARTMENT OF ENERGY

Grid operations need more observability than ever.

The dynamics of DERs and IBRs challenge traditional utility-owned sensors & comms for accurate system state estimation.



Opportunity: Emerging BTM and other third-party sensors offer high time and spatial resolution, providing real-time grid visibility and disturbance detection.

SDaaS allows utilities to access critical grid data without owning sensors.

Third-Party Data

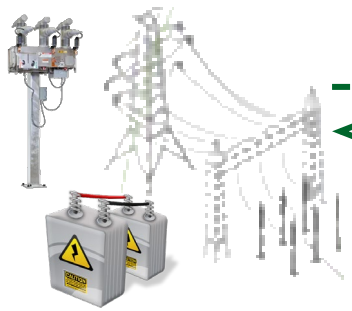
High Resolution:

- Voltage
- Frequency
- Harmonics
- Transients
- Waveforms
- Sag, Swell, Outage
- ROCOF
- Power Quality
- FLISR
- Event diagnostics

Lightning Data

Weather Data

Sensor Data as a Service (SDaaS)



Utility owned equipment

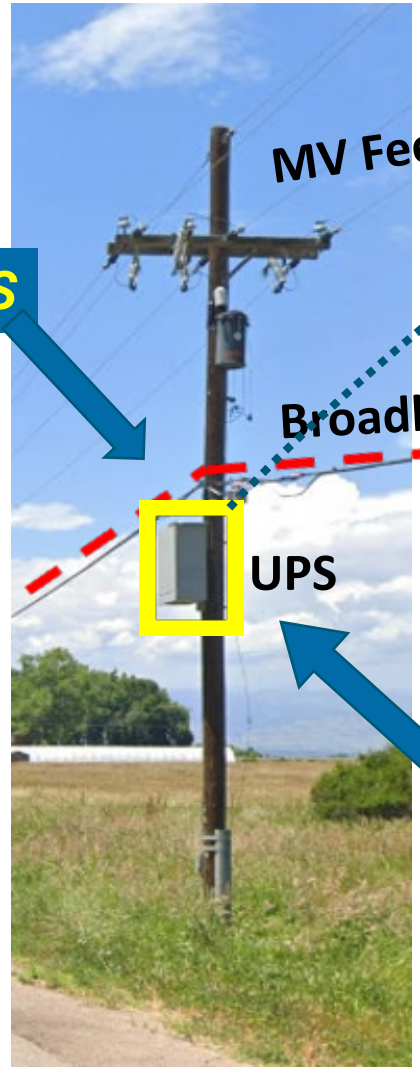
Utility Control Center

Bulk Electric Supplier

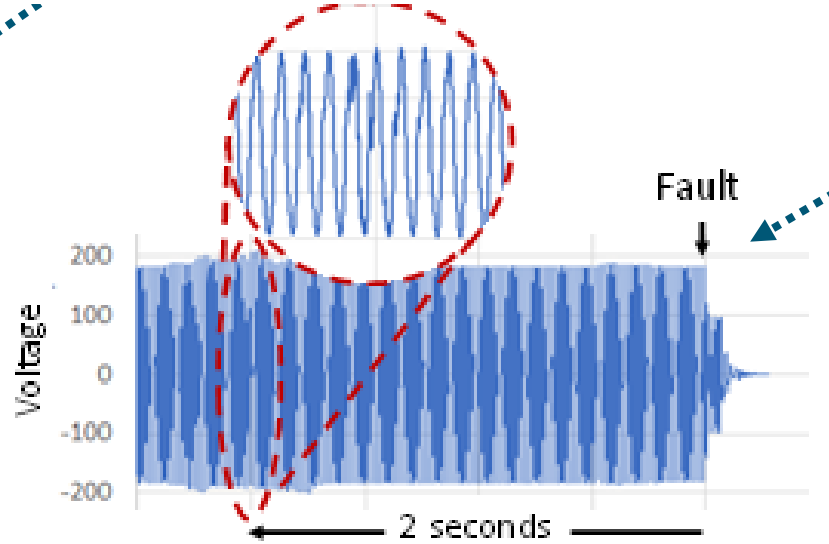
Data sources:

- Co-located infrastructure
- BTM
- Private sector

Broadband parallels distribution feeders and can be tapped for high-resolution data.



Presently 650,000 broadband UPS boxes connect to >90% of population.

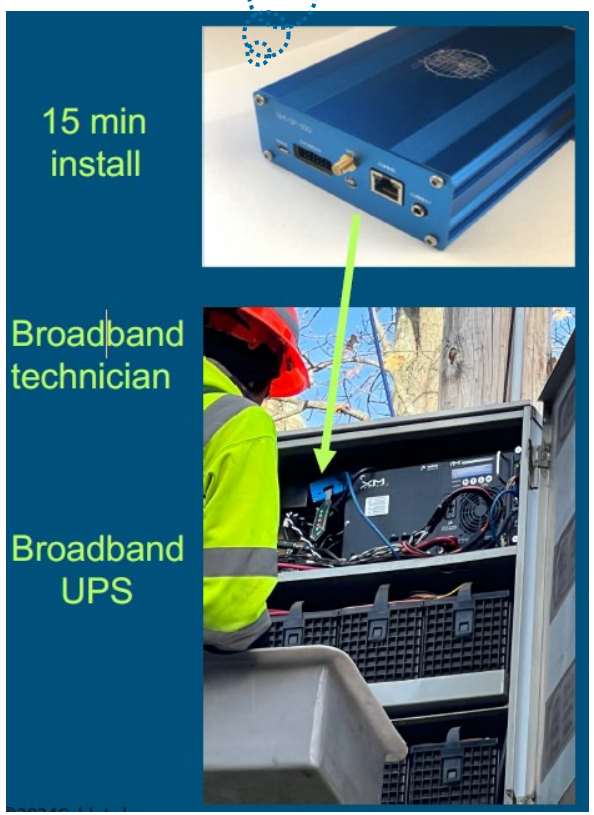


Actual recording capturing small arcing activity 2 seconds prior to outage.

DAQ box added to the UPS can stream 10kHz data – with power ride-through

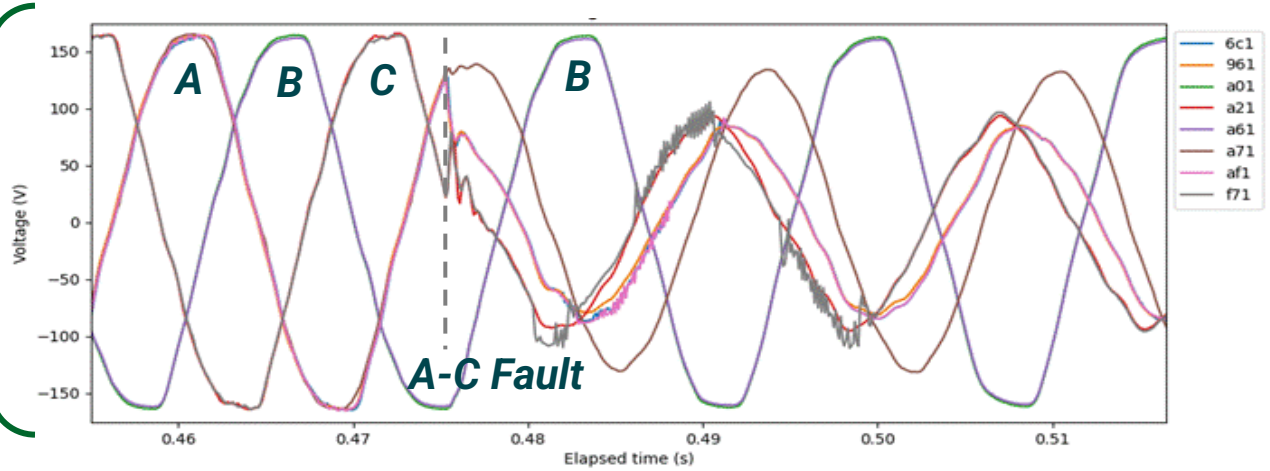
High Fidelity GridVisibility, inc.

Cloud Aggregation Server



Waveforms contain details of transient and steady state behaviors.

- *Phase ID*
- *Fault analysis*
- *Arcing*



Simple impedance loading

$Length_{Line} := 6mi$ $Power := 10MW$ $Voltage := 14kV$

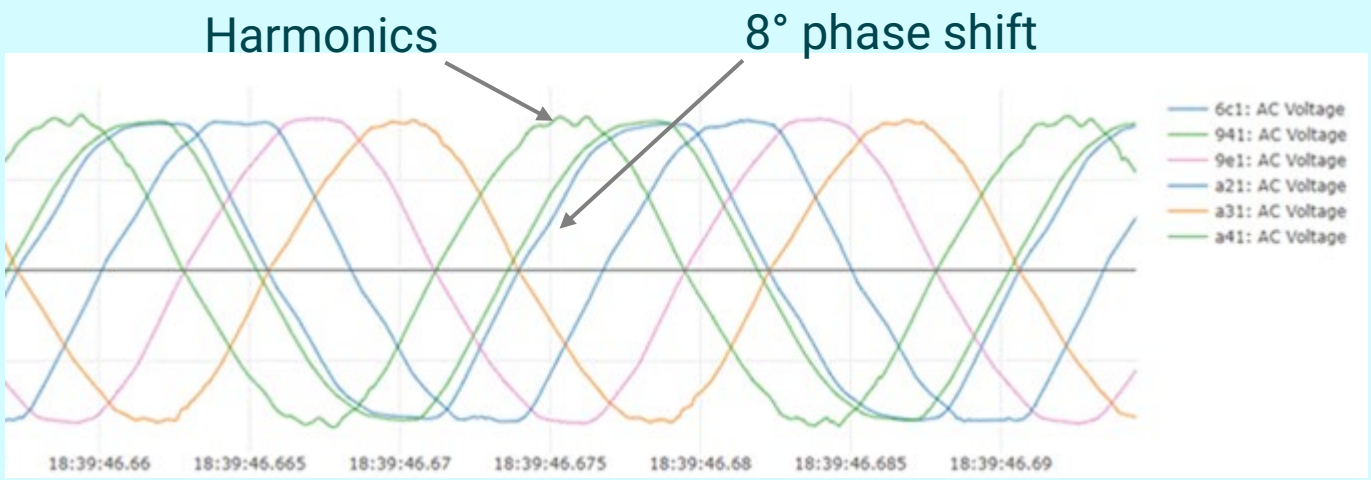
$R_{Line} := 0.0335 \frac{\Omega}{1000ft} \cdot Length_{Line} = 1.06\,\Omega$ 636MCM AAC

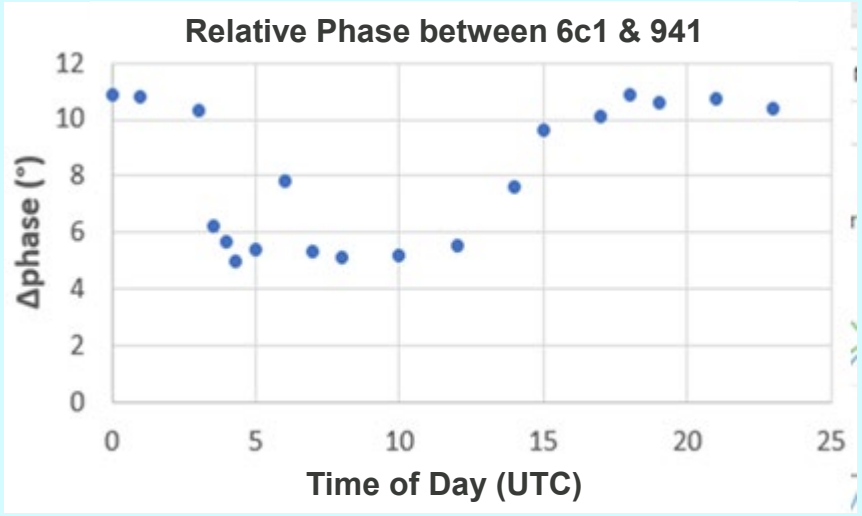
$X_{Line} := 2\pi \cdot 60Hz \cdot 1.3 \frac{mH}{mi} \cdot Length_{Line} = 2.94\,\Omega$

$R\_load := \frac{(14kV)^2}{Power} = 19.6\,\Omega$

$\operatorname{atan}\left(\frac{X_{Line}}{R\_load + R_{Line}}\right) = 8.1\,deg$

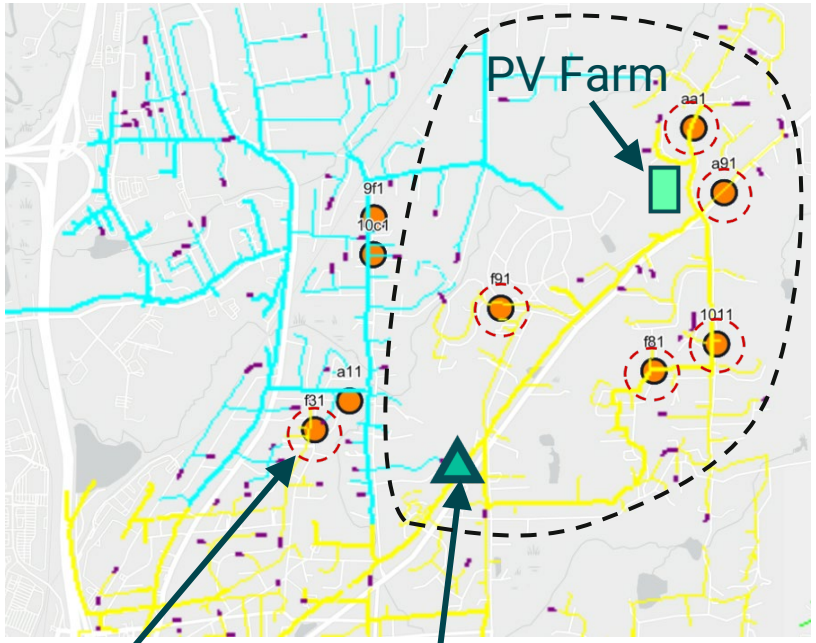
Phase shift shows power load and direction by line impedance.





Power outage reveals aberrant PV farm disconnect behavior.

PV farm appears to sustain outage with over-voltage and oscillating 5-6 cycles at 84Hz before disconnect.



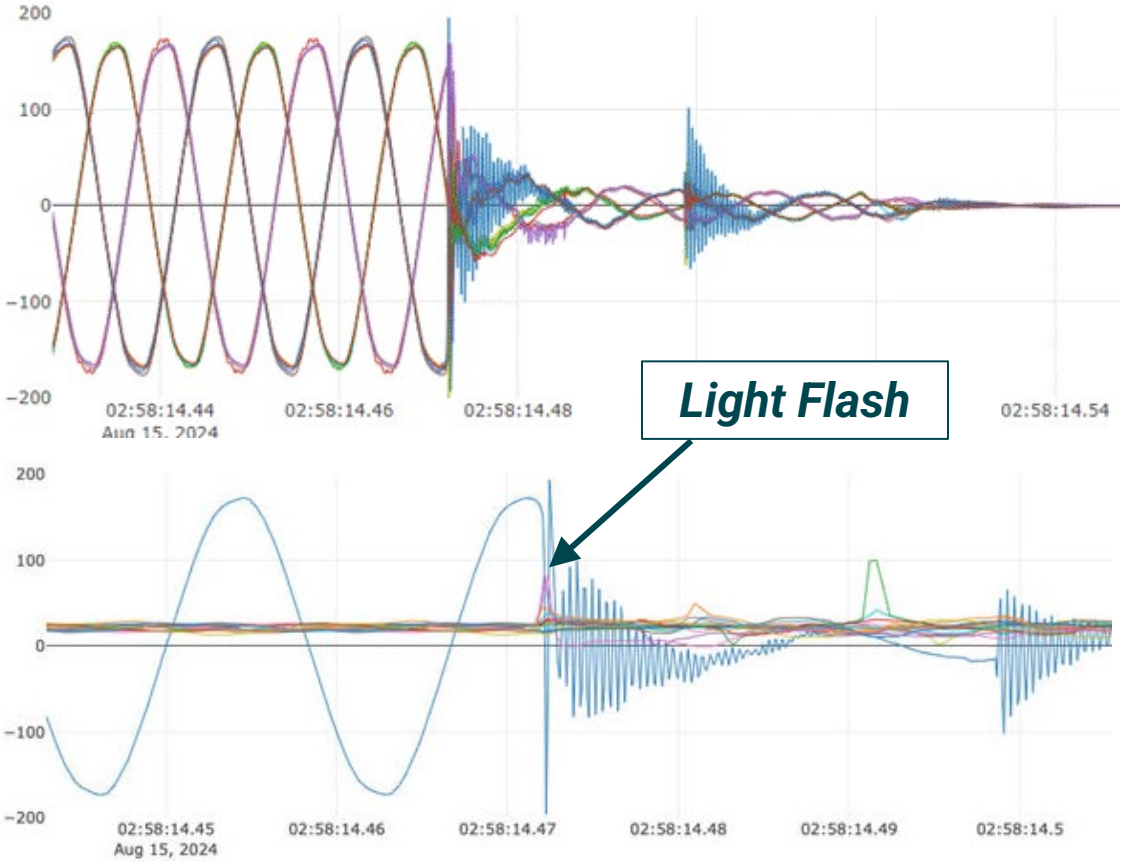
Upstream of Recloser

Recloser disconnected downstream sensors on all phases.

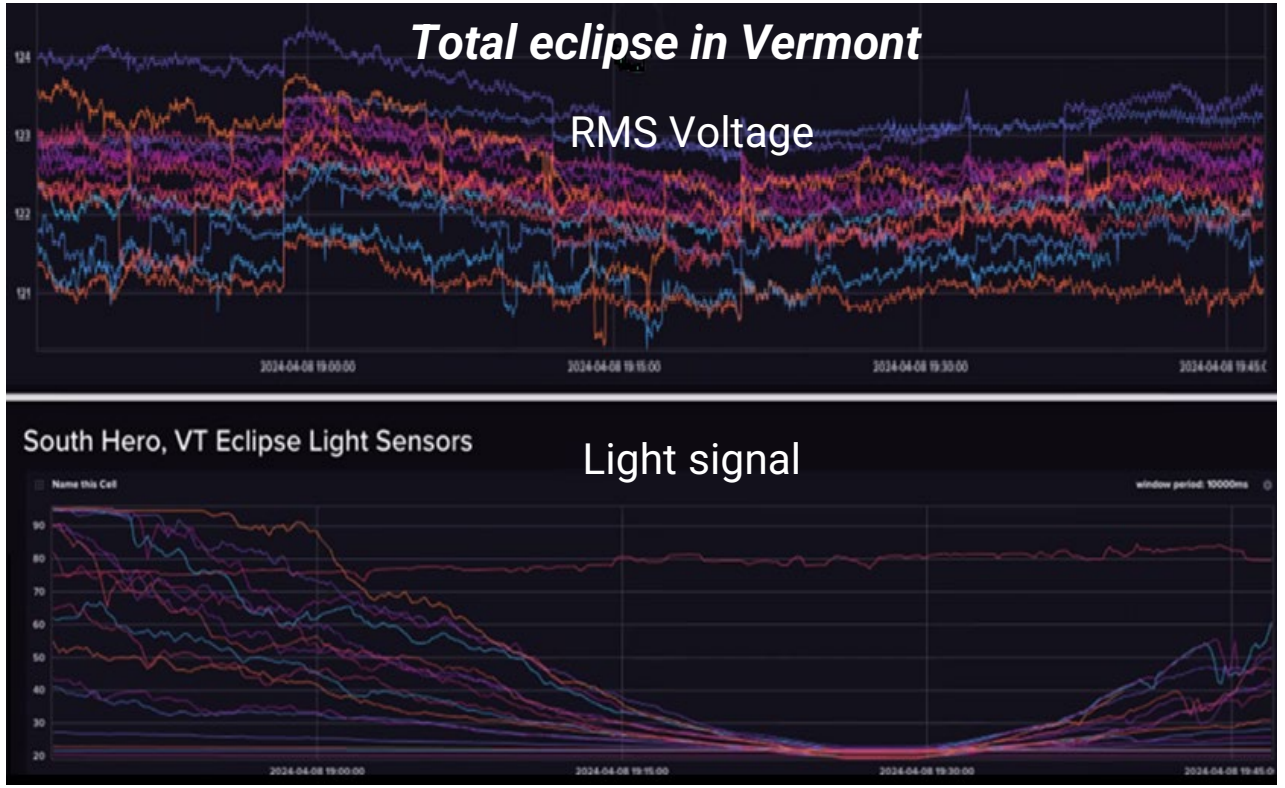
Multiple GPS-timestamped broadband sensors in New Haven, CT

Light sensors in GridVisibility DAQs detect ambient light, including lightning flashes in the area.

Lightning precipitated outage



Voltage depression caused by eclipse on DERs countered by tap changes.

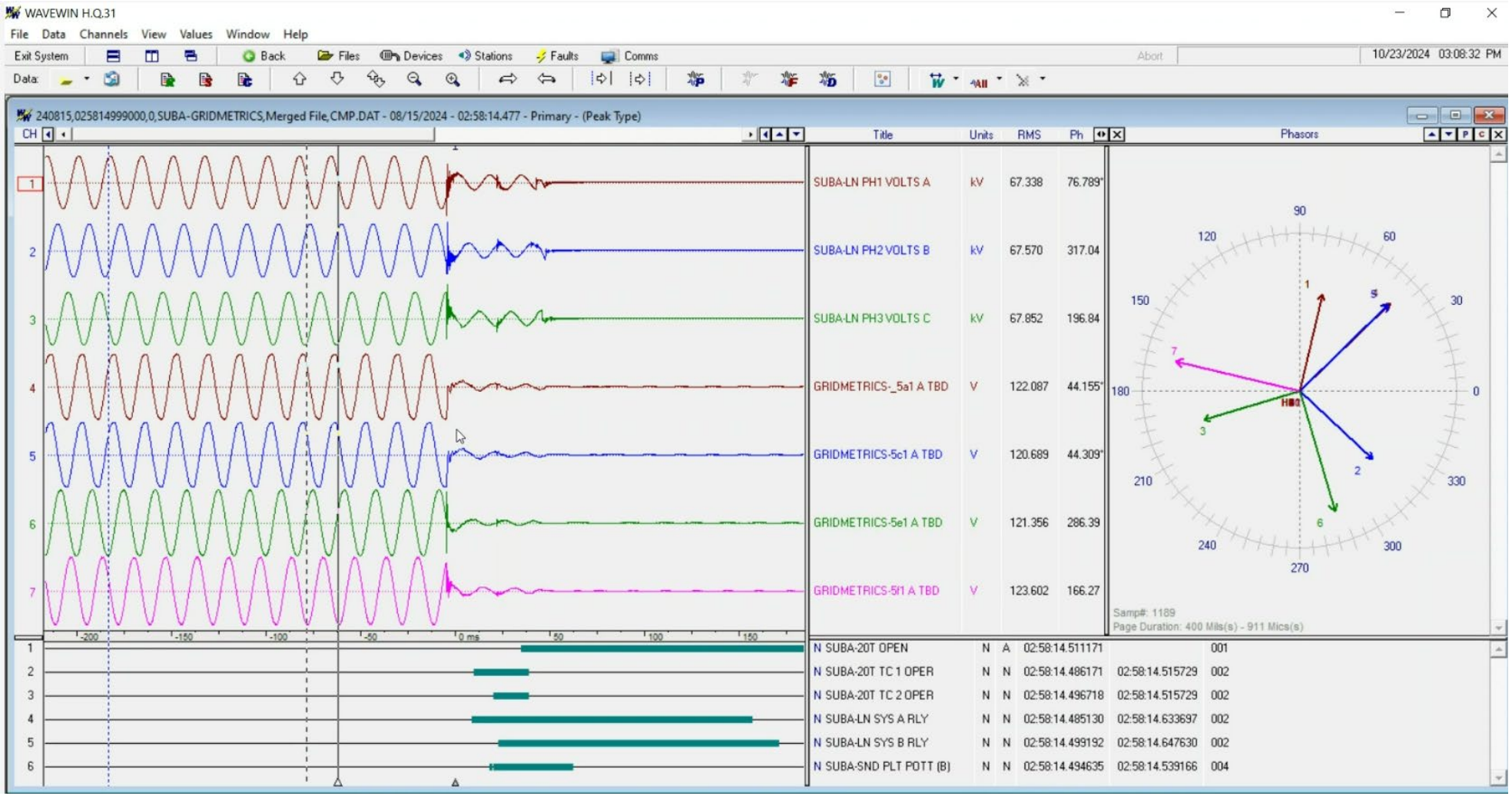


Compatibility of SDaaS with utility software eases adoption by utilities.

Utility PTs

GridVisibility sensors

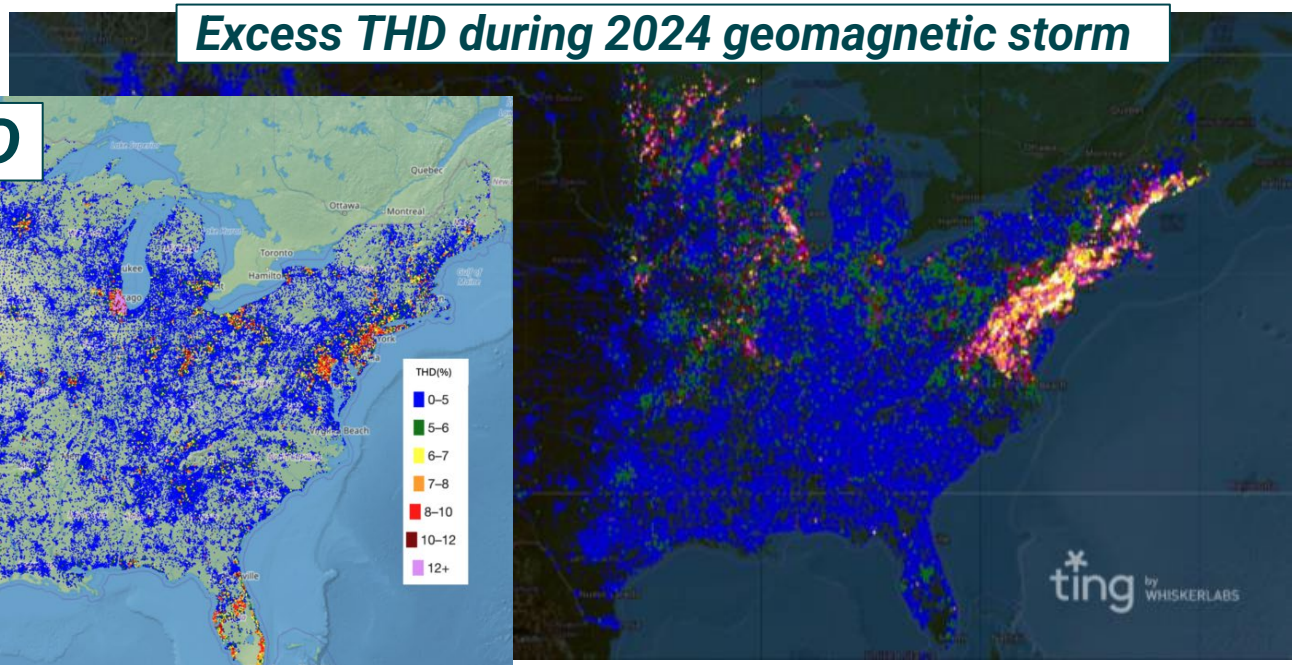
Utility digital data



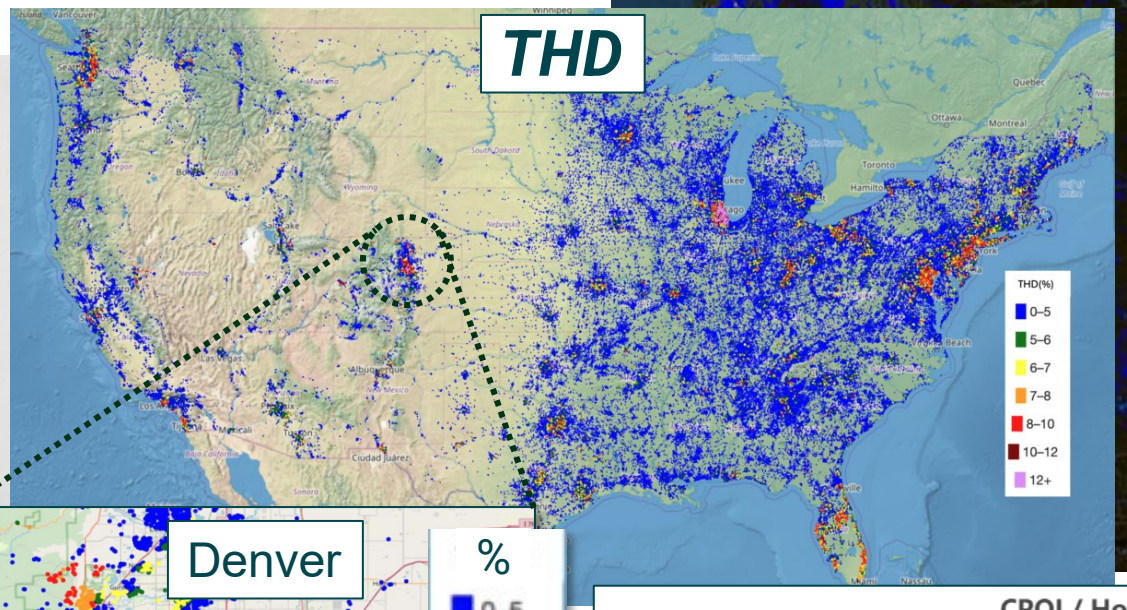
Whisker Labs Ting sensor monitors voltage and arcing in the home.

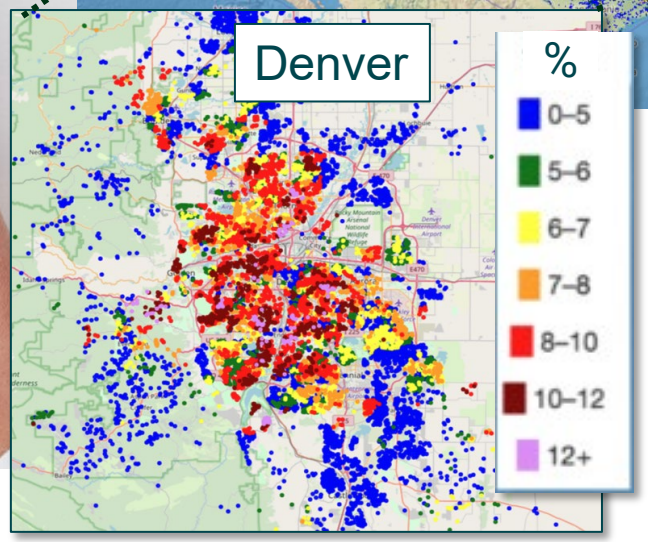
Installed by the homeowner, it connects with Wi-Fi.

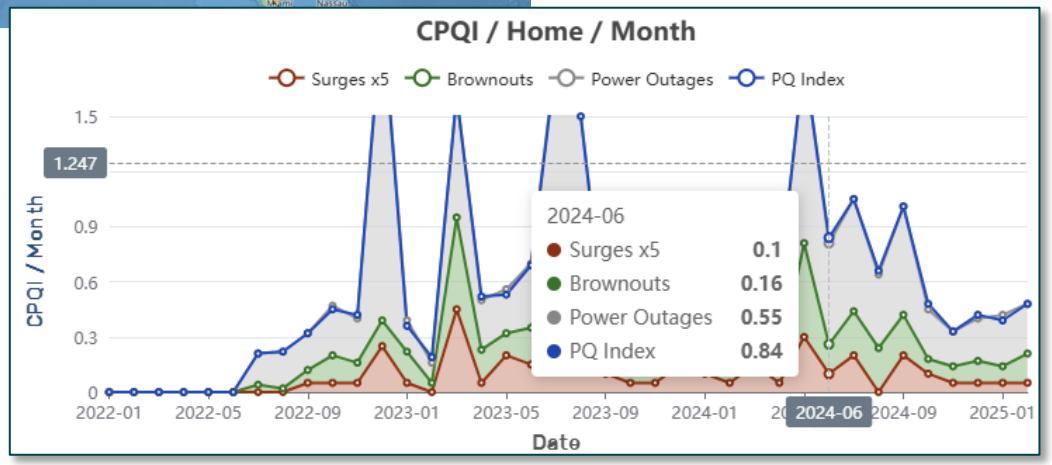
Excess THD during 2024 geomagnetic storm



THD

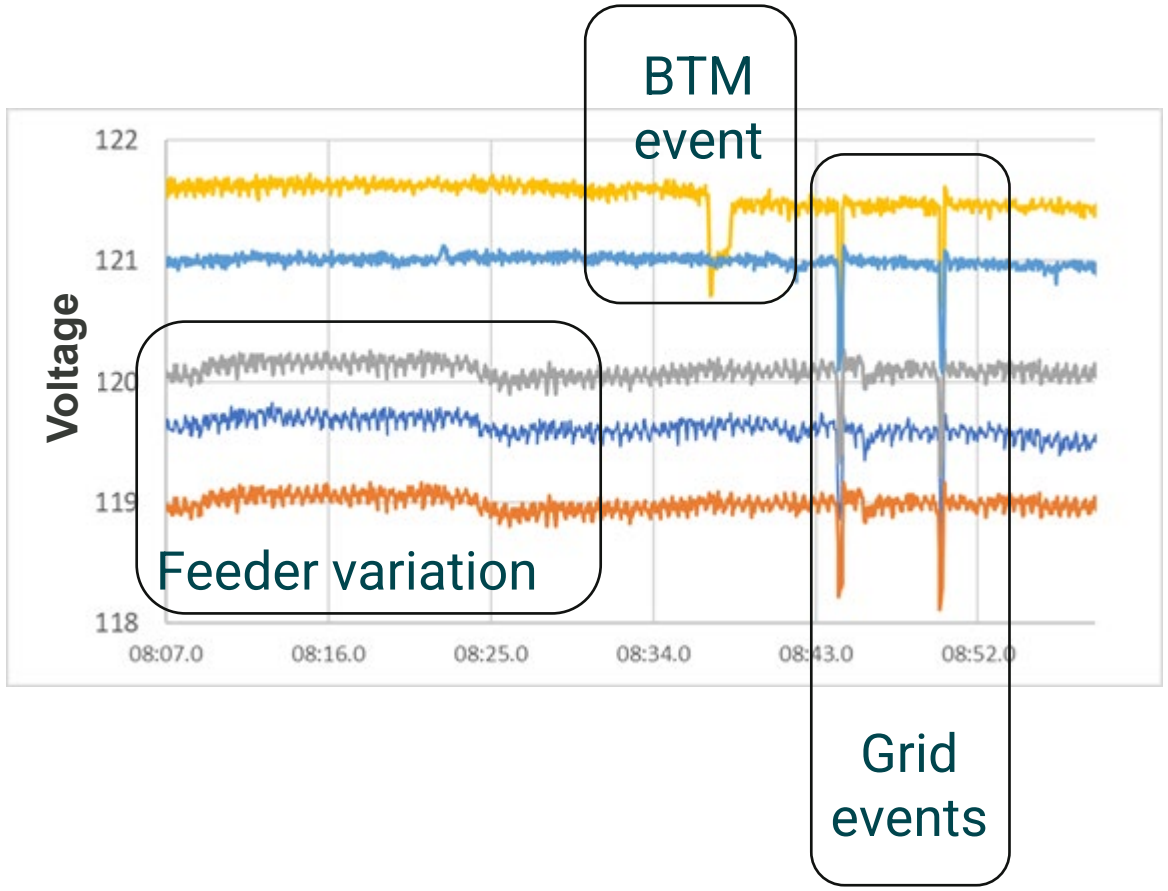


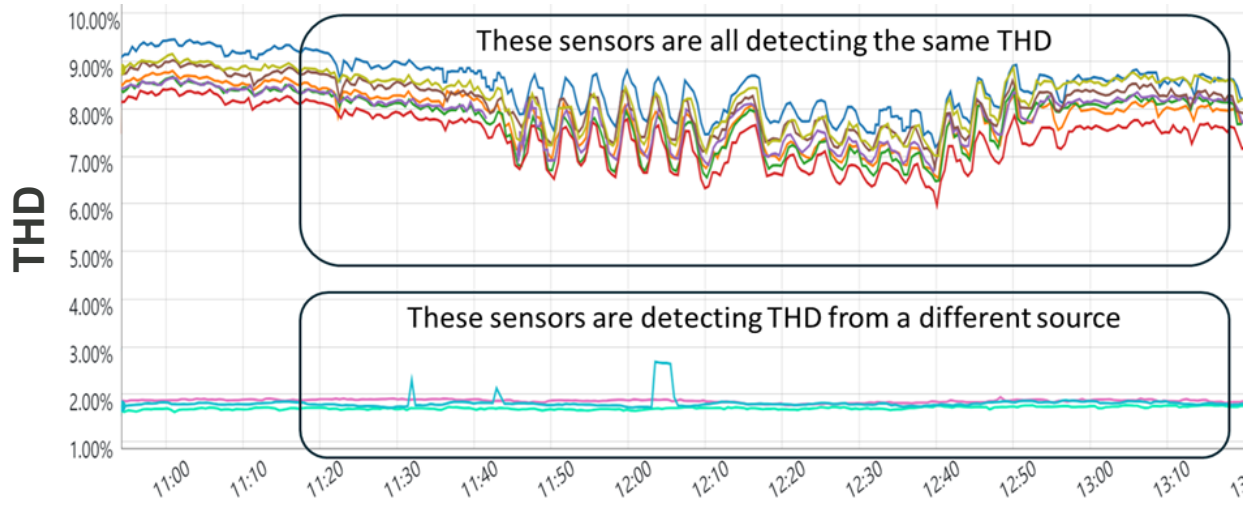




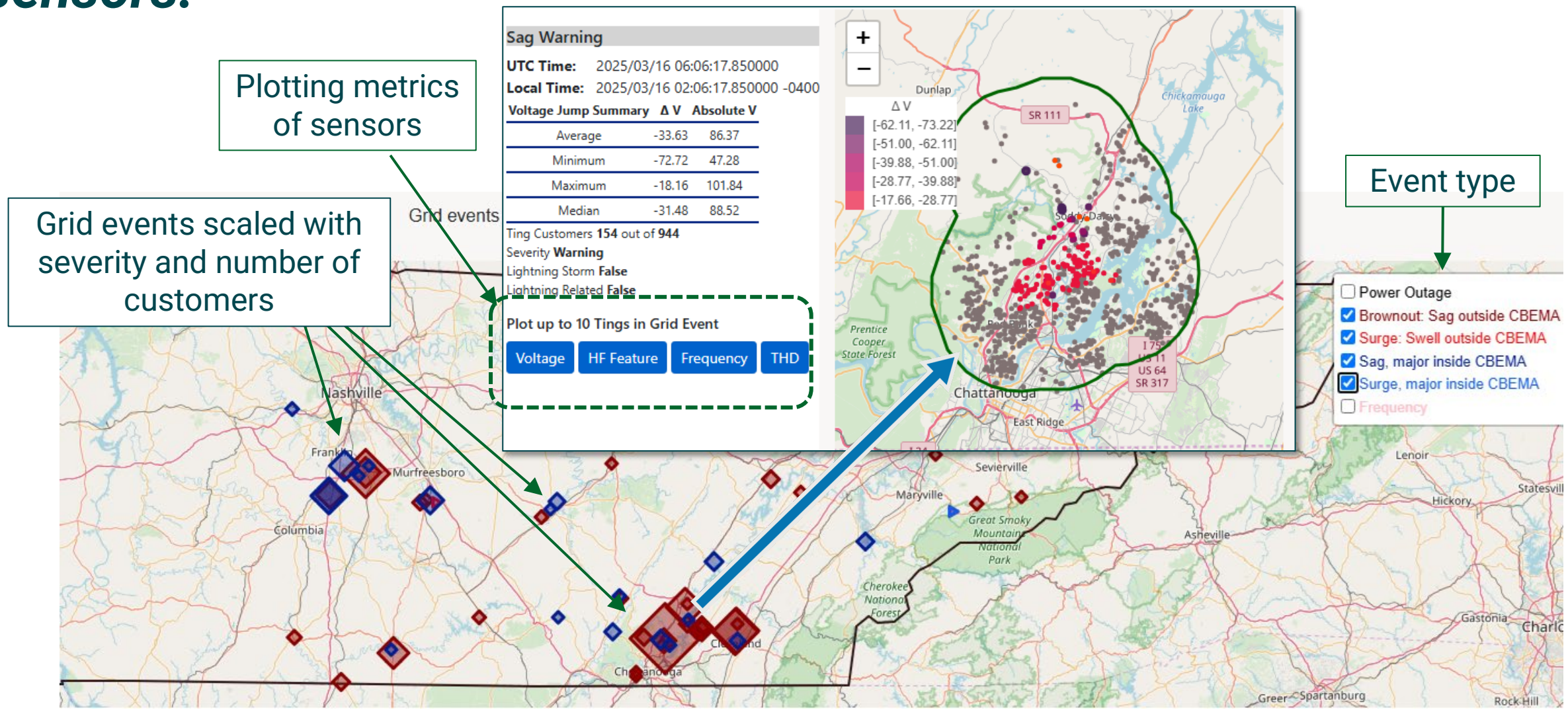
OAK RIDGE National Laboratory

Data correlation can readily distinguish BTM noise and grid variances and events.

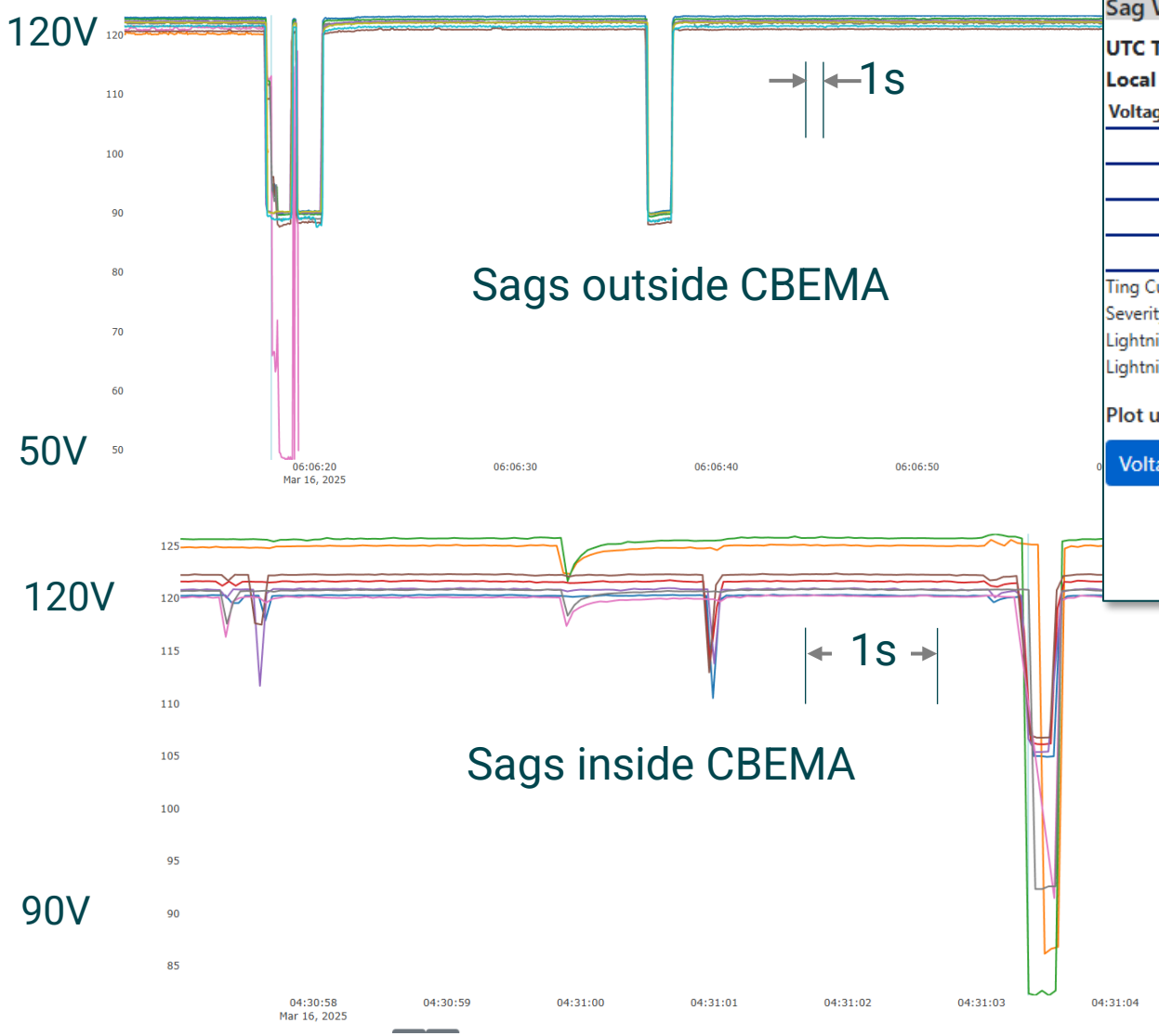




Selectable grid events show locations and number of affected sensors.



Events not seen by utilities are selectable.



Sag Watch

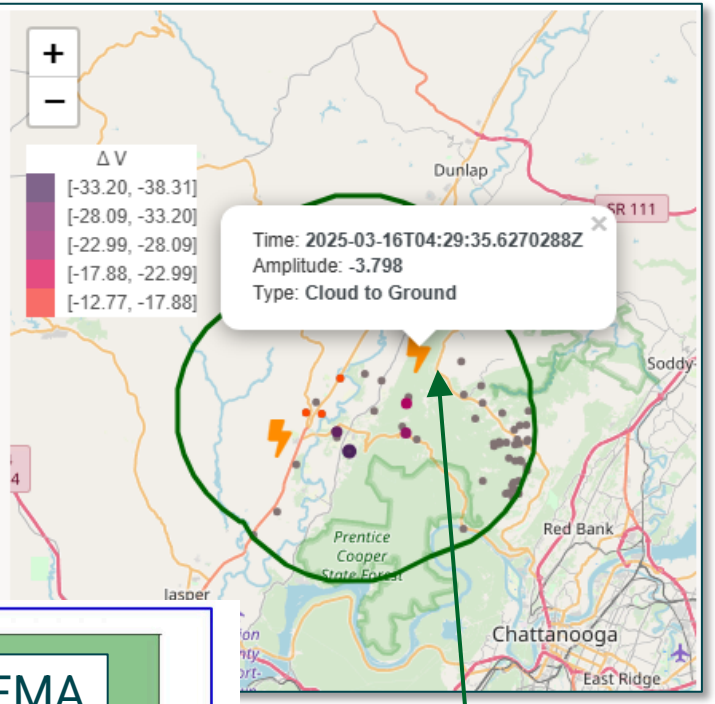
UTC Time: 2025/03/16 04:31:03.350000
Local Time: 2025/03/15 23:31:03.350000 -0500

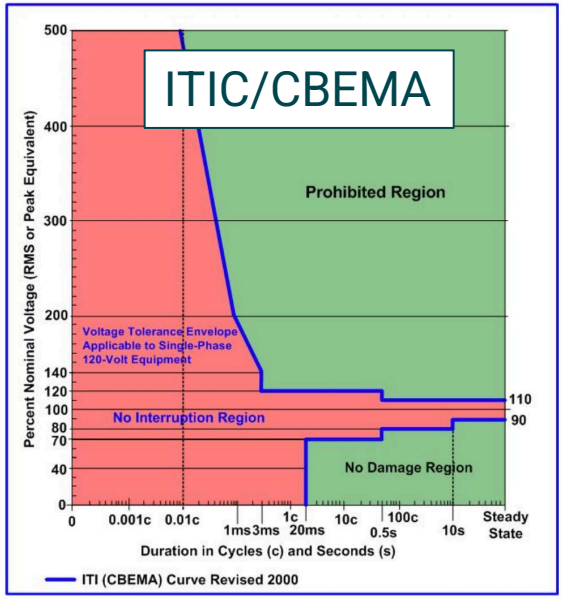
Voltage Jump Summary	Δ V	Absolute V
Average	-23.17	96.83
Minimum	-37.81	82.19
Maximum	-13.27	106.73
Median	-21.40	98.60

Ting Customers **8** out of **75**
Severity **Watch**
Lightning Storm **True**
Lightning Related **False**

Plot up to 10 Tings in Grid Event

Voltage | HF Feature | Frequency | THD

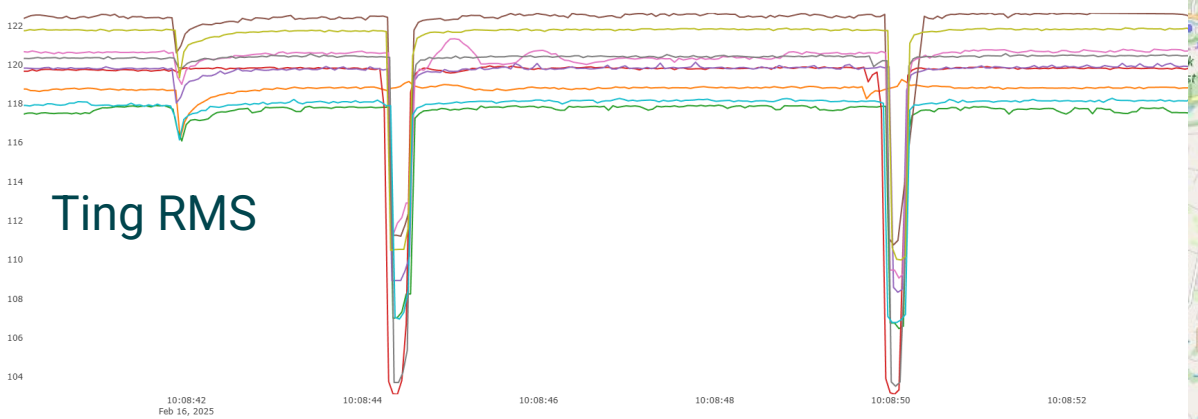


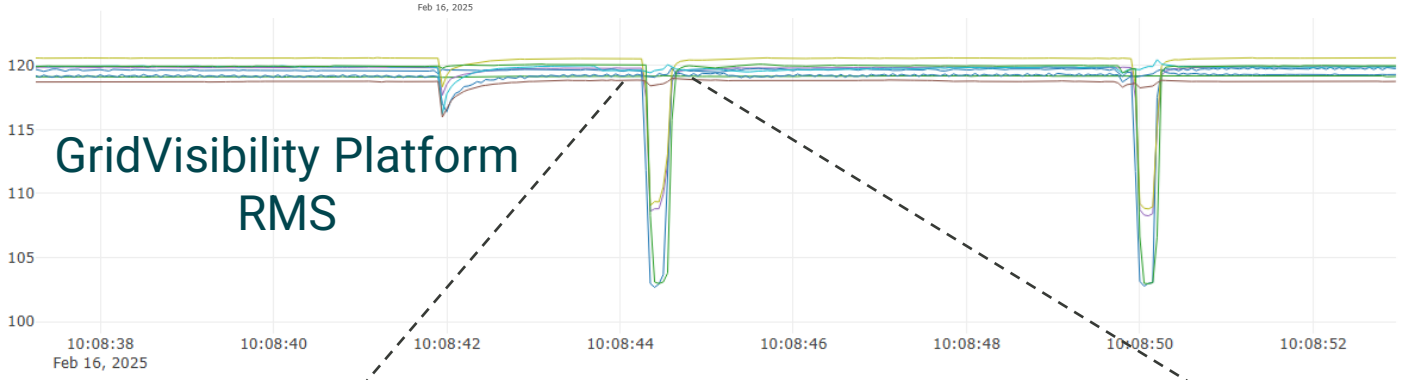


Lightning awareness

Comparing the same event with two independent SDaaS platforms

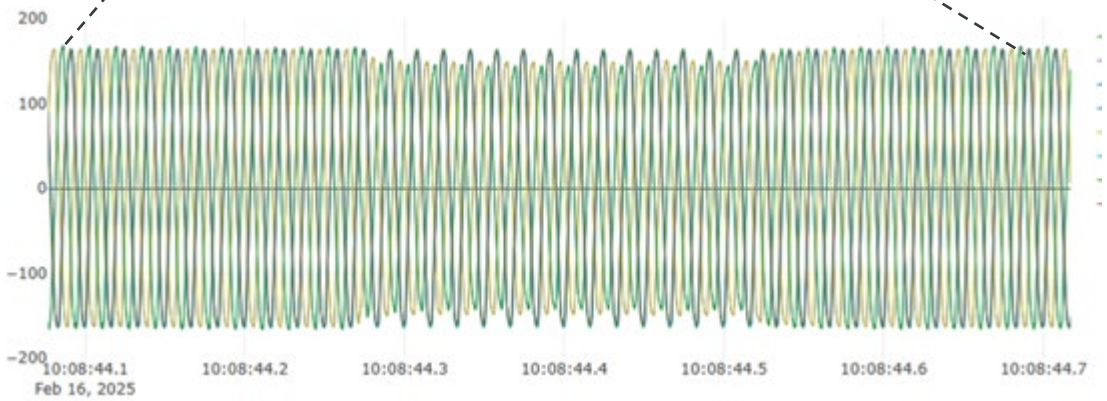
Sag events in New Haven, CT, 2/16/2025

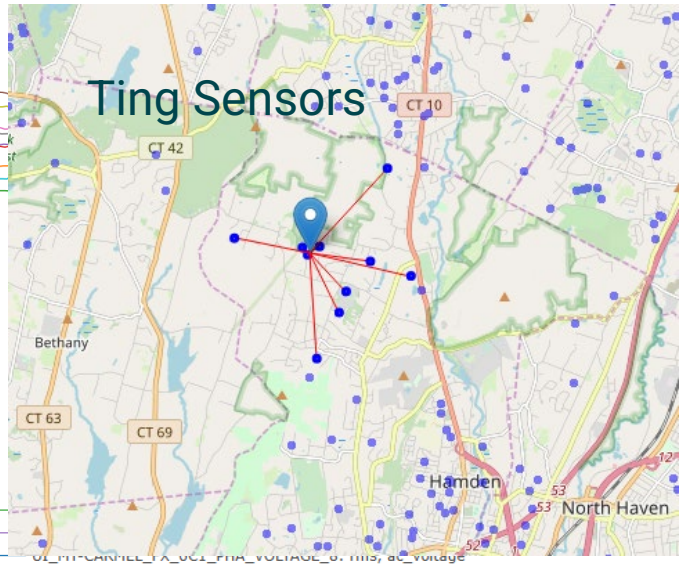




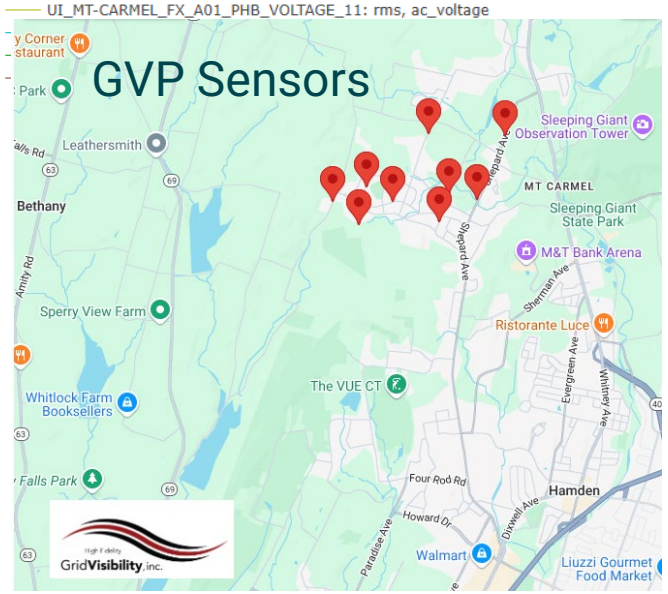
GVP Waveforms

(10kHz points)

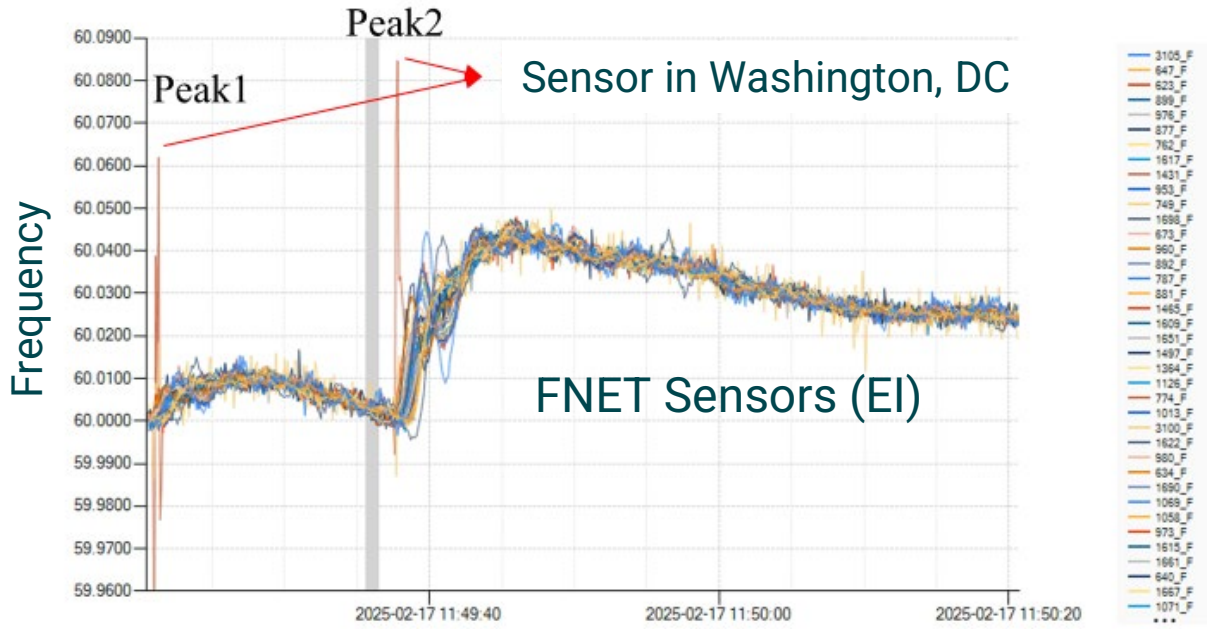


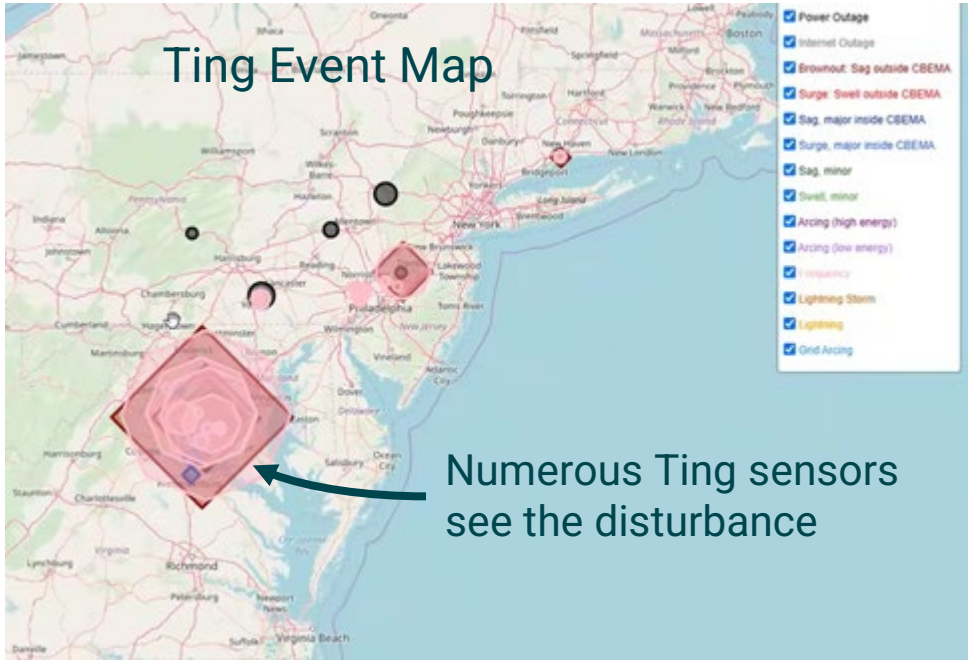


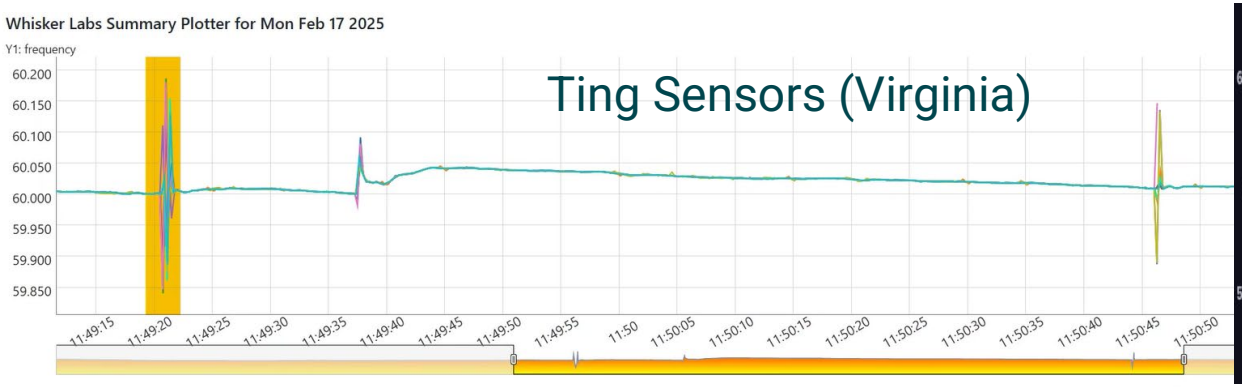
UI_MT-CARMEL_FX_A21_PHC_VOLTAGE_10: rms, ac_voltage
UI_MT-CARMEL_FX_A01_PHB_VOLTAGE_11: rms, ac_voltage

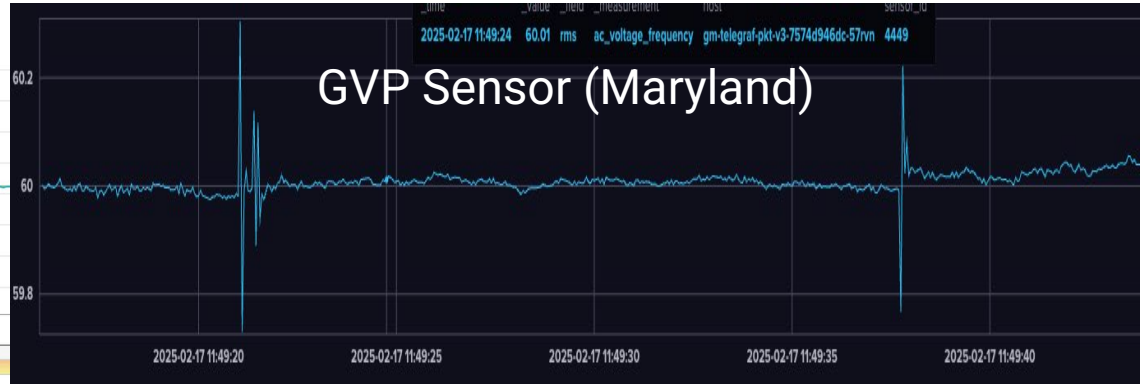


Sudden loss of load caused an Eastern Interconnect incident that was observed by three third parties: FNET, Ting & GridVisibility.

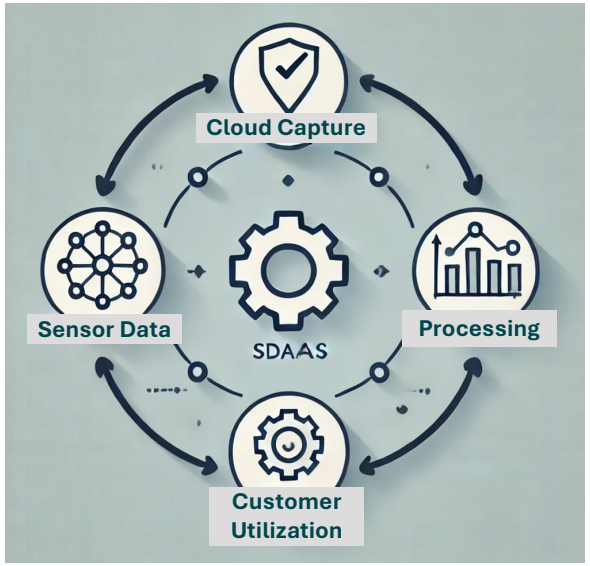








Offering SDaaS must ensure data reliability, accuracy, security, and customer value.



Data Value

- Comprehensive, detailed coverage
- Customizable, actionable data streams
- Intelligent filtering for event detection
- Historical event time sequencing and playback

Data Integrity and Curation

- Reliable, continuous, time-stamped data capture
- Automated validation, redundancy and retention

Security

- Encryption, access controls, regulatory compliance
- Clear data ownership and usage rights

Standardization & Compliance

- Seamless utility integration with utility apps
- Exchange with industry-standard protocols (e.g., IEC 61850, DNP3, OPC UA, CIM, IEEE C37.118 for synchrophasors, P2030.5 for DER.

Business Model

- Defined data ownership and IP rights
- Tiered licensing and flexible pricing
- Continuous updates, support 24/7
- Scalability for future technology needs

Thank you!

Contacts:

Aaron Wilson: wilsonaj@ornl.gov

Bruce Warmack: warmackrj@ornl.gov