



INCUBATENERGY LABS 2022 DEMO DAY

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Minneapolis
Minnesota



EPRI

Problem: GEB Needs a Solution For All Sensor Data



- GEB is the second largest energy transmission company in Colombia with over 1600 kilometers of lines and even more in construction.
- They manage a large fleet of sensors including DFRs, SCADA systems, and synchrophasor sensors.
- GEB does not have a tool to store or analyze the synchrophasor data generated by PMUs.
- There is a need for a solution to analyze this data as a whole to empower their response teams and analytic teams.



Solution: PingThings' PredictiveGrid Platform



The PredictiveGrid platform enables dozens of use cases including:

- improved system visibility
- monitoring
- alerting
- event analysis
- anomaly detection and classification
- and more.

PingThings

In order to provide the biggest impact on GEB's daily operations with synchrophasor data we deployed the PredictiveGrid in Amazon's AWS and developed two new prototype applications in about a month: rapid post-event analysis of potential lightning strikes and oscillation detection.



PingThings PredictiveGrid Platform Project

Supported/Hosted by: Grupo Energía Bogotá
EPRI Subject Matter Expert: Ed Beronet

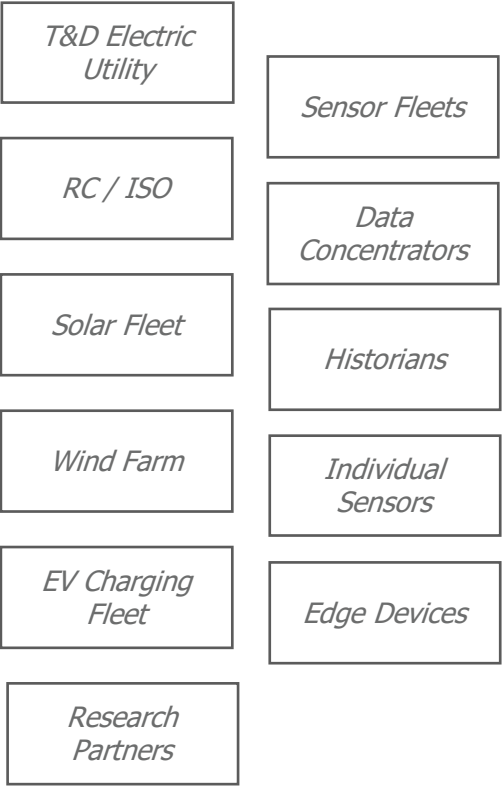
The PingThings PredictiveGrid platform is a time series data management, analytics, and application platform that can transform sensor data at any scale into a critical asset.

This project demonstrated the benefits that synchrophasor data can provide a utility using the PredictiveGrid platform.

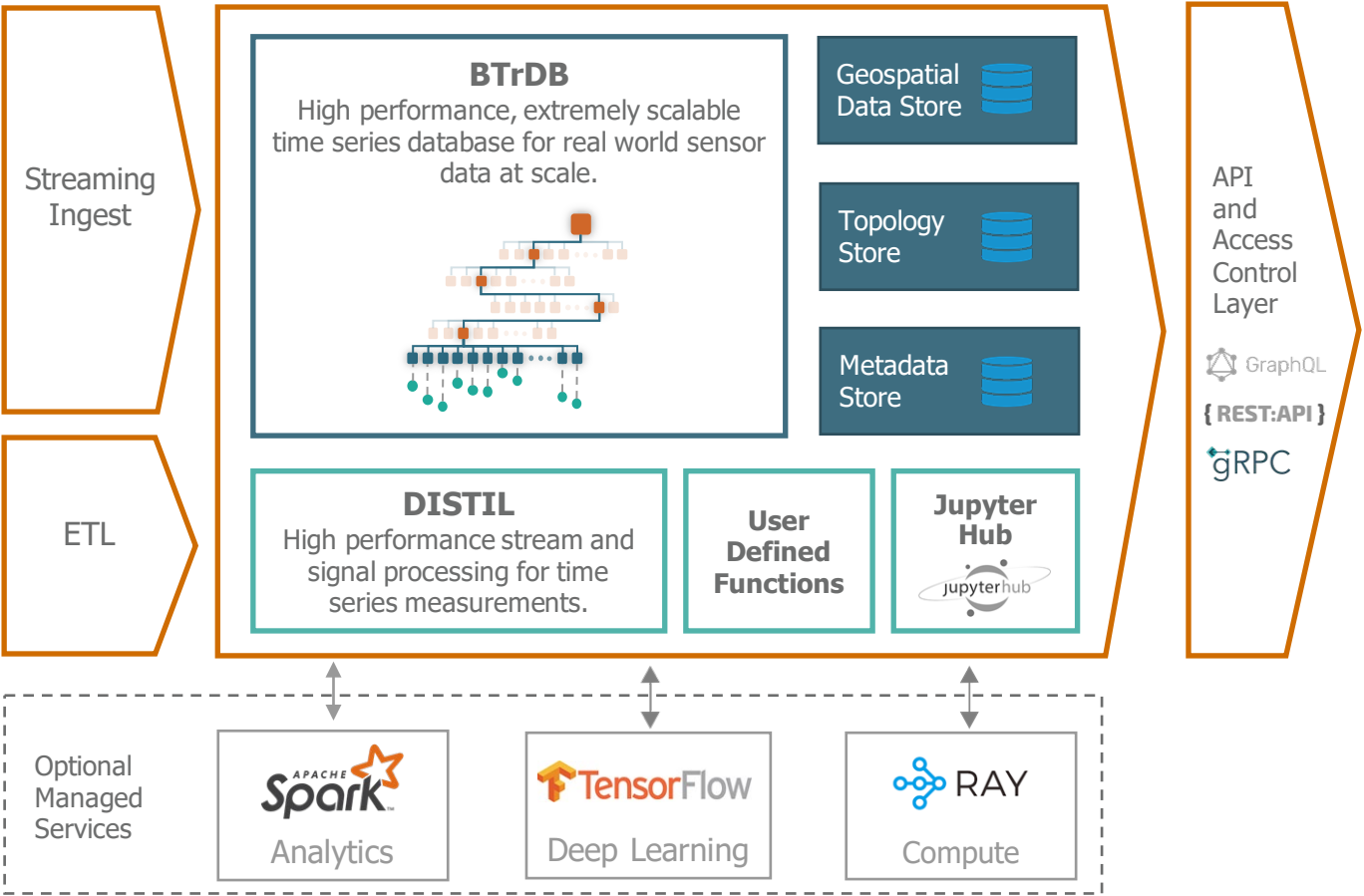
PingThings' PredictiveGrid Platform



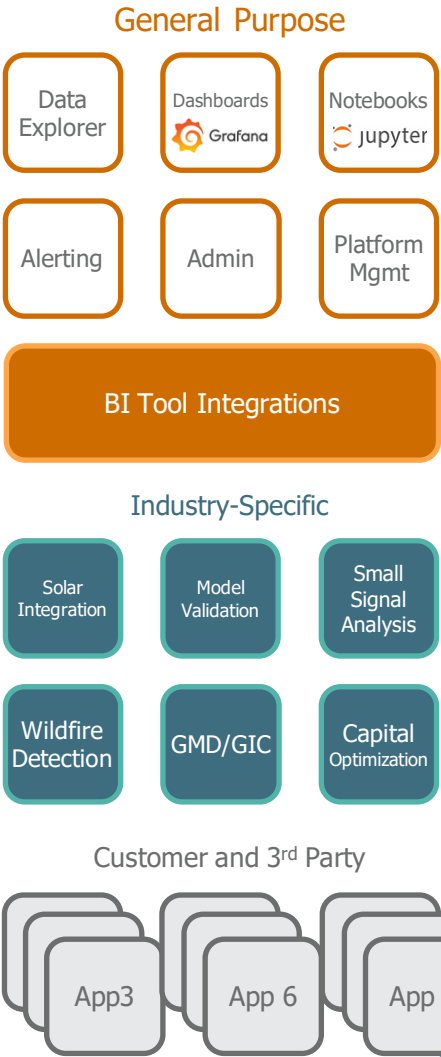
Data Sources



PredictiveGrid™



Applications



Secure, Scalable, and Reliable Infrastructure



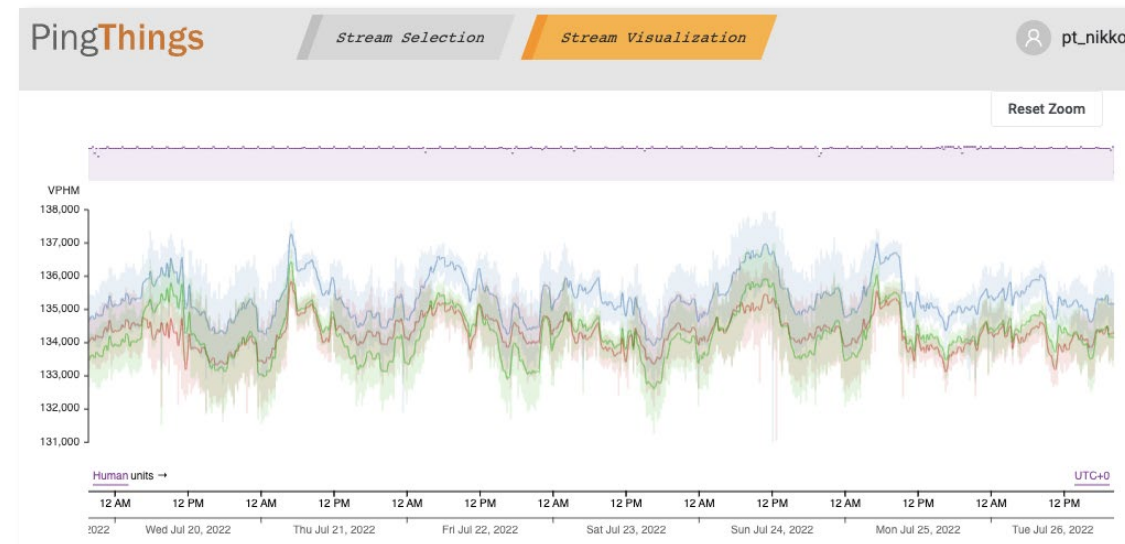
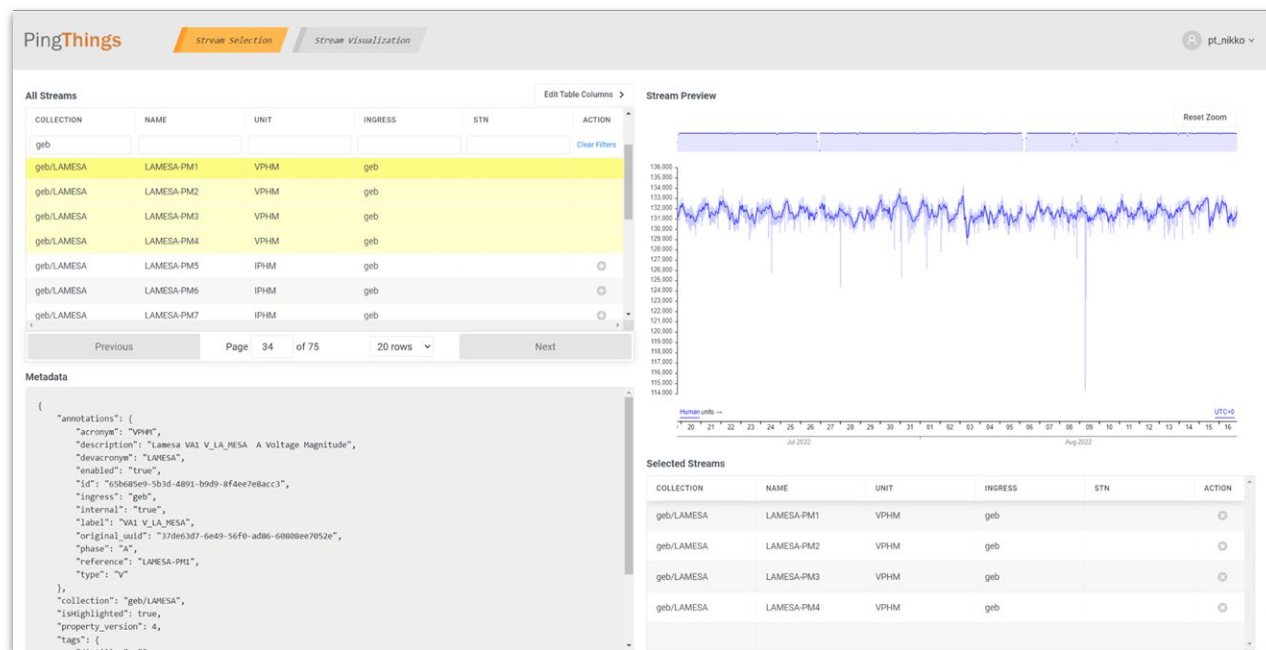
Key Objective:

Use the PingThings platform to ingest and manage synchrophasor and historical data sets provided by GEB, explore and analyze potential use cases, and ultimately allow GEB to advance the state of working with time series data for operating the grid in a safe, reliable, and sustainable way.

Key Milestones:

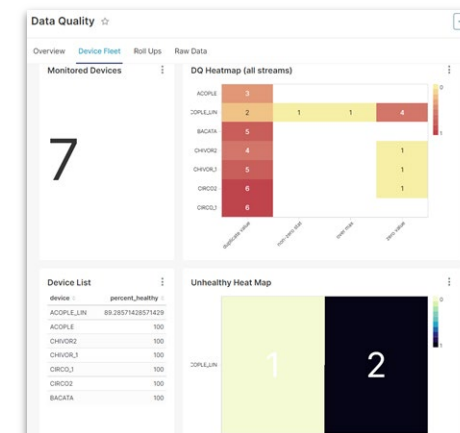
- Deploy the PredictiveGrid platform in Amazon's AWS
- Ingest of streaming and historical data supplied by GEB
- Assess data quality
- Develop two prototype use cases
 - Rapid post-event analysis of potential lightning strikes
 - Oscillation detection
- Test and evaluate analytic developed

Data Ingestion and Data Quality Assessment



Data Quality Issues Found:

- Data gaps
- Time configuration issues
- Low voltage streams
- Incorrect phase labels
- Missing voltage measurement streams
- and more



Prototype : Post-Event Analysis of Lightning Strikes



We used the platforms' speed to rapidly scan all available PMU voltage magnitudes for potential lightning strikes and correlate suspicious events. If any events stood out across enough streams, we flag it as a potential strike and record the duration, severity, and extent.

Using this information, we automatically generate a report that visualizes all voltage magnitudes and frequencies for all affected PMUs along with a severity table and map detailing which sensors were most affected. We also calculate reactive and active power calculations to provide insight on grid state.

The PredictiveGrid platform is able to scan two months of the entire system in less than 10 seconds to provide GEB's response and post-analysis teams actionable intelligence to make informed decisions.

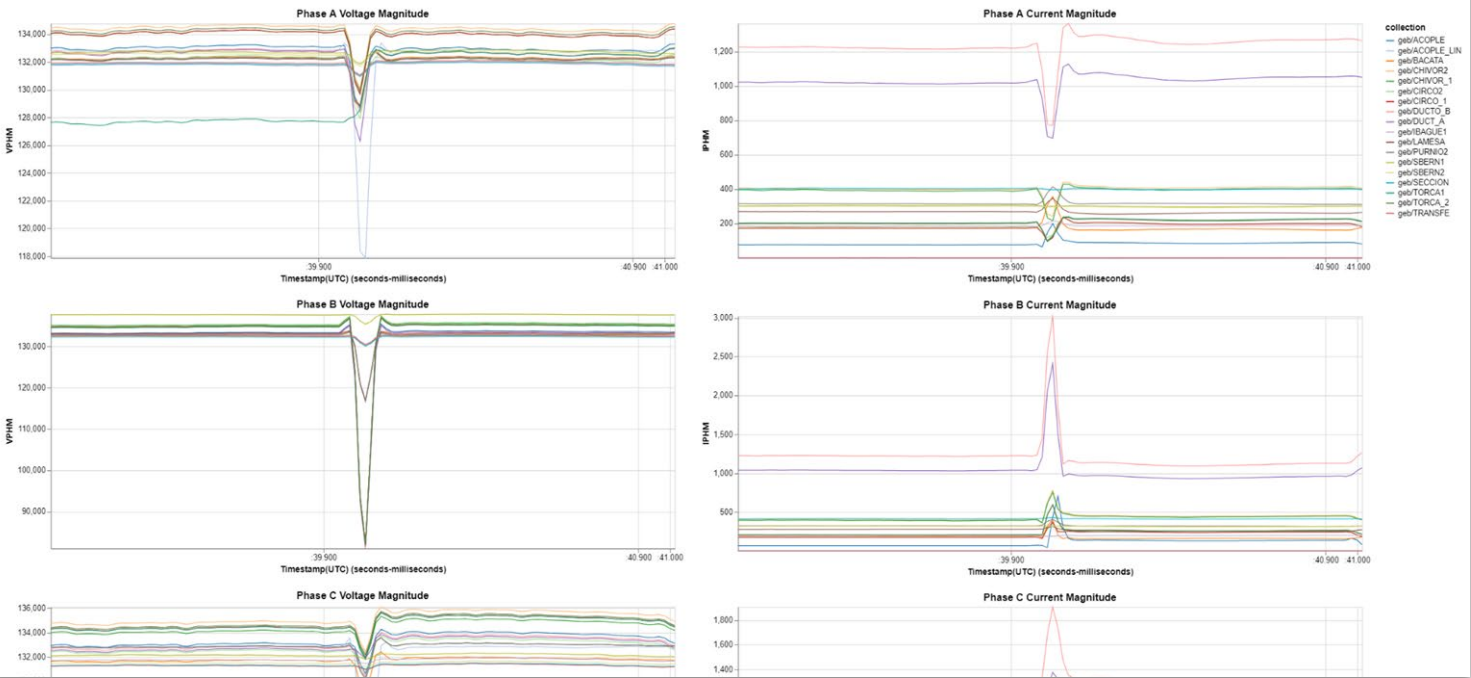
Prototype : Post-Event Analysis of Lightning Strikes



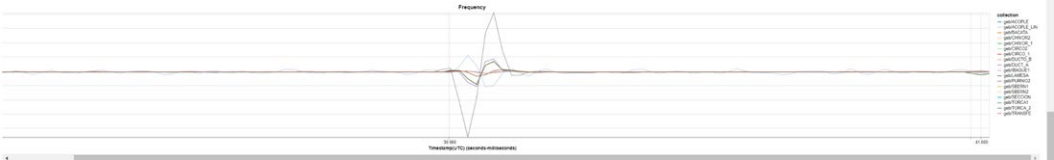
Event Report

Event ID: 16
Window Start Time(UTC): 2022-07-31 00:47:39.740000
Window End Time(UTC): 2022-07-31 00:47:40.813000
Window Duration(sec): 1.073741824
Sensor(s) that detected event: ['geb/TRANSFE', 'geb/CHIVOR2', 'geb/CHIVOR_1', 'geb/ACOPLE', 'geb/CIRCO2', 'geb/DUCTO_B', 'geb/SBERN1', 'geb/PURNIO2', 'geb/TORCA1', 'geb/DUCT_A', 'geb/CIRCO_1', 'geb/SBERN2', 'geb/SECCION', 'geb/IBAGUE1', 'geb/LAMESA', 'geb/TORCA2']
Phase(s) that detected event: ['A', 'B', 'C']
Most impacted sensor: geb/TORCA_2
Most impacted phase: B

Magnitude Streams



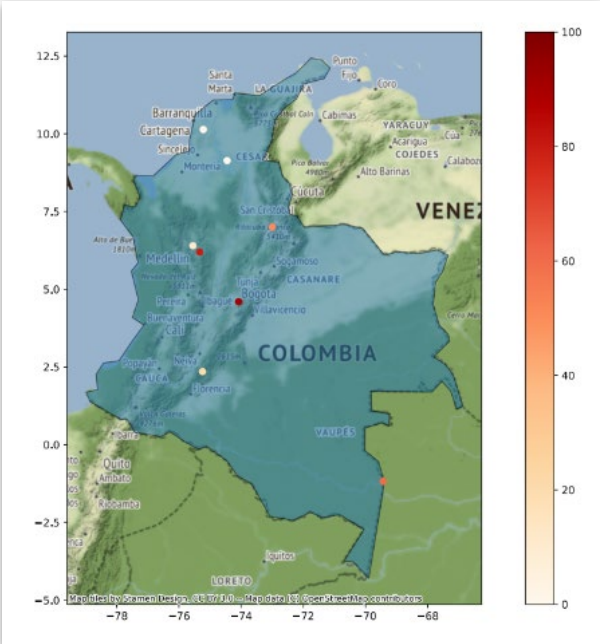
Frequency Stream



Sensors Severity

Severity is defined as the percentage of the sag value below threshold. It is calculated using the minimum voltage value divided by the threshold of each voltage magnitude stream (10% below base voltage magnitude value) within the start and end time in the plots above. If the severity is too high (above 90% vsc), it is very likely that the cause of the voltage drop is from data quality issue. Hence, they are not taken into consideration when finding voltage sags for lightning event detection. Also, if the severity is negative, this means the minimum value of a stream within the time window is above the threshold. Hence, no voltage sags below threshold are found for this stream. The highlighted fields below indicates sensors that have voltage sags below threshold that are potential lightning events. Note that the color of the highlighted field in the table is using the same scale as shown in the severity colorbar for the map below.

collection	Phase A	Phase B	Phase C	Substation	Latitude	Longitude
geb/CHIVOR_1	-7.399385	32.434752	-9.096234	GUAYVO	4.755310	-73.352285
geb/CHIVOR2	-7.407776	32.332960	-8.991248	GUAYVO	4.755310	-73.352285
geb/TORCA_2	-7.468026	32.473902	-9.073242	GUAYVO	4.755310	-73.352285
geb/ACOPLE	-7.410936	32.388934	-9.007866	GUAYVO	4.755310	-73.352285
geb/TORCA1	-11.052425	32.256180	-8.965077	GUAYVO	4.755310	-73.352285
geb/CIRCO_1	-9.174168	31.237694	-10.758444	GUAYVO	4.755310	-73.352285
geb/CIRCO2	-9.174448	31.227365	-10.767450	GUAYVO	4.755310	-73.352285
geb/ACOPLE_LIN	1.025982	2.000055	1.869594	NORKESTE	4.770171	-74.186007
geb/BACATA	-6.735869	2.028362	-9.364223	NORKESTE	4.770171	-74.186007



Prototype : Oscillation Detection



The second prototyped app detected oscillations by generating spectrogram reports for all sensors in GEB's fleet through all possible frequencies.

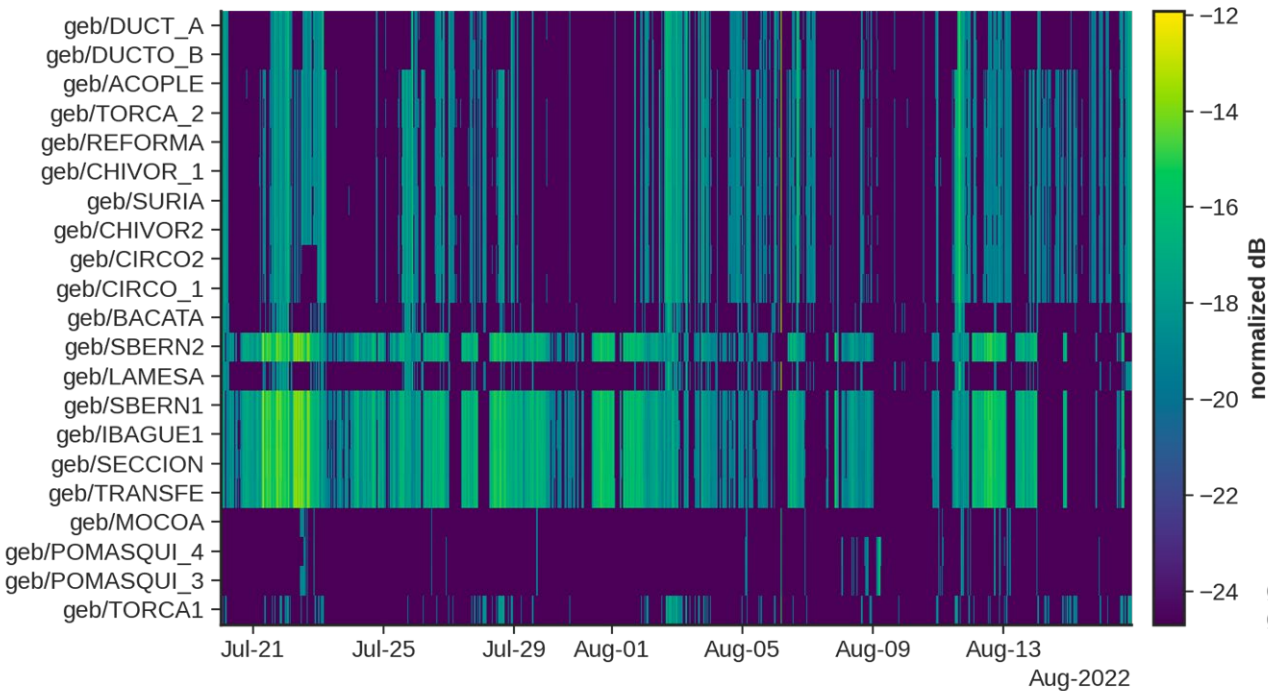
The PredictiveGrid platform allowed us to not just look at oscillations in real time but to look at all oscillations that have occurred historically throughout the system so that causal patterns emerge, informing mitigation efforts.

We also developed an interactive notebook to allow GEB to really dig into specific oscillations to get to their root cause.

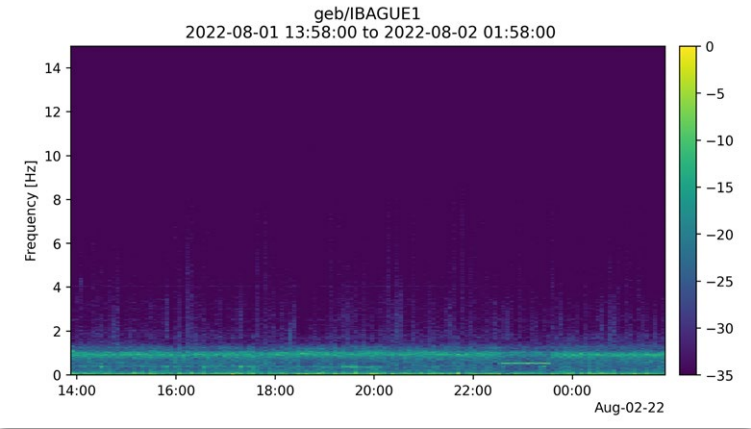
Prototype : Oscillation Detection



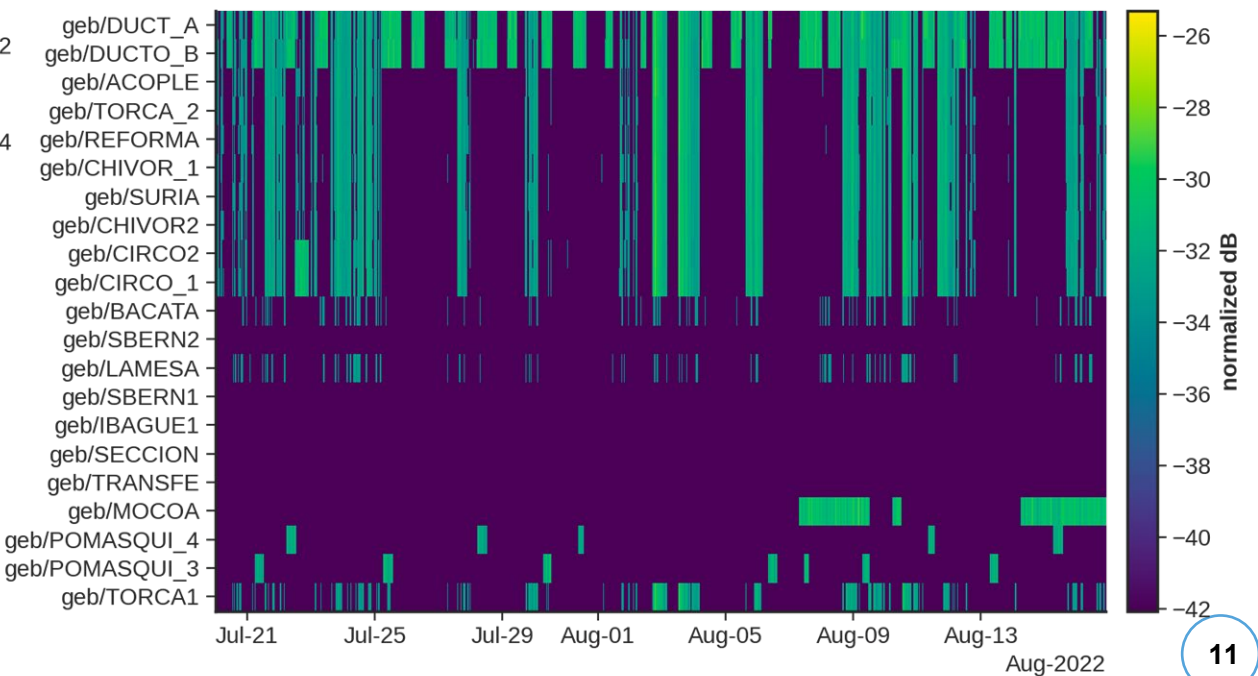
Oscillation Events from 1.0Hz



Collection: IBAGUE1
Start Date: 08/01/2022, 01:58 PM
Duration (hours): 12
Filter spectral noise:
Raw PSD Normalized PSD
Resample Timebins (minutes): 5
Zoom Frequencies: 0 - 15
PSD [db] color-scale: -35 - 0
Plot Spectrogram



Oscillation Events from 7.5Hz





Results and Learnings

GEB explored the benefits of synchrophasor data by making it available and being able to visualize it using the platform.

Immediate use cases were learned such as phase (ABC) identification, profiling voltage magnitude, and more.

The two deployed use case prototypes provide benefits such as reducing the time it takes to perform a post event analysis and exploring oscillation events at different frequencies.



After witnessing the benefits of combining synchrophasor data with the PredictiveGrid platform, GEB is eager to explore more use cases outside of the two included in the Incubatenergy Labs project.

Goals:

- Enhance user interface of existing applications
- Add more predictive functions
- Include data from other types of sensors
- Use case exploration

Thank You

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