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Leveraging Synchro-Waveforms in a Multiresolution Timeseries Platform

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Outline

1. Intro
2. Contextualizing Power Grid Data
3. PredictiveGrid Platform's Multiresolution Approach
4. Key Capabilities and Features
5. Synchro-waveforms with Other Data Sources
6. Benefits and Challenges with Synchro-Waveform Data at Scale
7. Next Steps and Announcements

Terminology

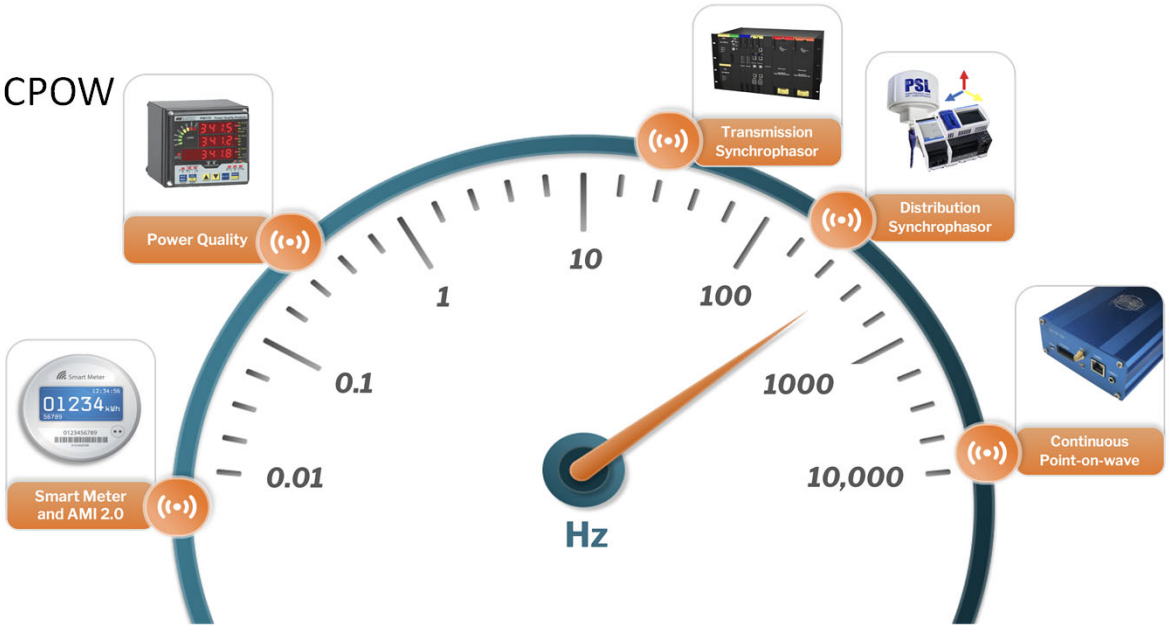
Contextualizing Grid Data

- Report Rate
  - Data sent from a device(s) send to a data historian/timeseries store
- Sample Rate
  - Measurement rate of a device (!= to report rate in all cases)
- Point
  - (Time, value) tuple of data
- Stream/Signal
  - Timeseries that are made up of Points

Power Grid Data Types

Contextualizing Grid Data

- Grid Timeseries Data
  - 0.001Hz <-> MHz
  - AMI <-> SCADA <-> PMU/DFR <-> CPOW
  - Events



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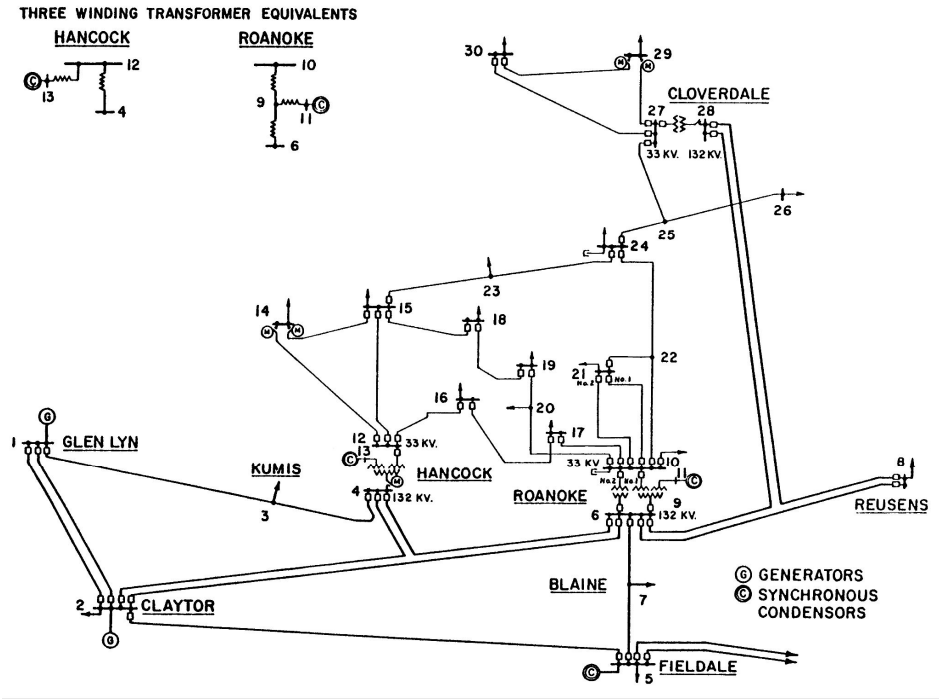
- Grid Metadata
  - Assets
  - Internal Metadata
  - Topology



http://www.ee.washington.edu/research/pstca/pf30/pg_tca30bus.htm

Power Grid Data Types

Contextualizing Grid Data

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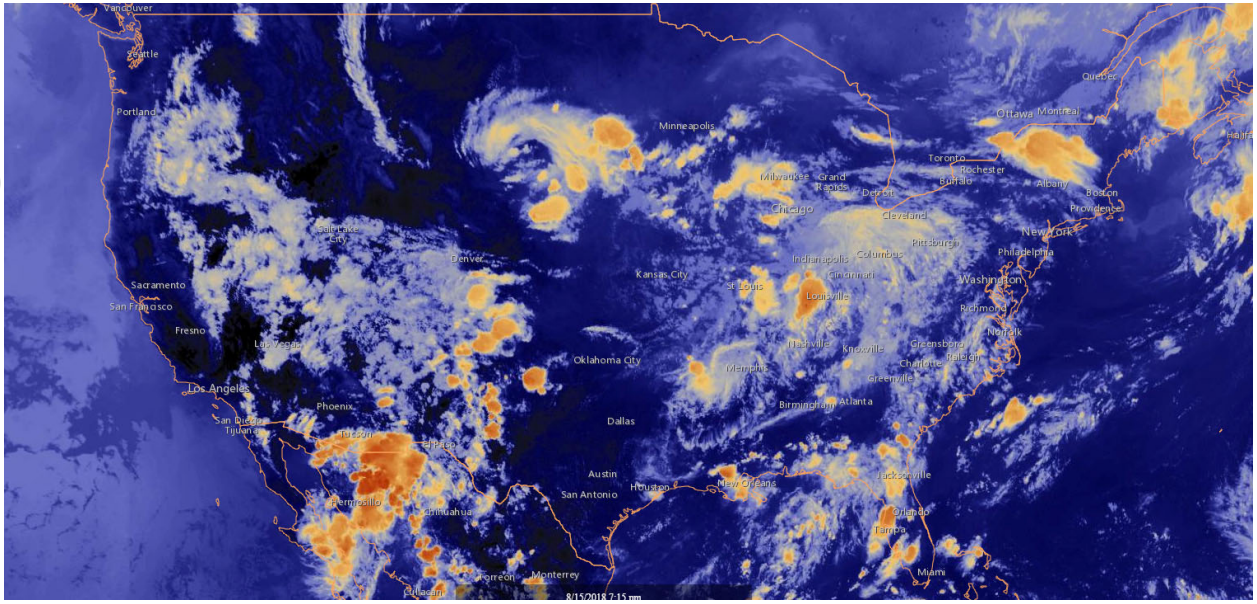
  - Assets
  - Internal metadata
  - Topology
- External Data
  - Weather
  - Space weather



A screenshot of GOES East Infrared Satellite Image - Latest 24 Hours Western Hemisphere over North America from 8/16/18. (Image credit: NOAA National Environmental Satellite, Data, and Information Service)

Data Storage and Analysis Challenges

Contextualizing Grid Data

- PMUs and event triggered POW are already data dense
  - Synchro-wave (WMUs) will increase this 100-1000x
- Many historians are great at storing one or a subset of these data
  - Data silos
- Holistic analyses of grid events are non-trivial
- Need for a unified/centralized data store and platform that is timeseries agnostic

A Report Rate Agnostic Platform

The PredictiveGrid's Multi-Resolution Approach

- Report rate is key to this challenge
- Need a solution that:
  - Agnostic to report rate of data
  - Quick traversal of timeseries through time (historical and real time)
  - Precomputed statistical summaries
  - Full access to the raw data at any time
  - Combines other data sources to the timeseries data
  - Useful interfaces for day-to-day users
  - High performance API access for data pipelines, SMEs, etc.
- PredictiveGrid Platform does this

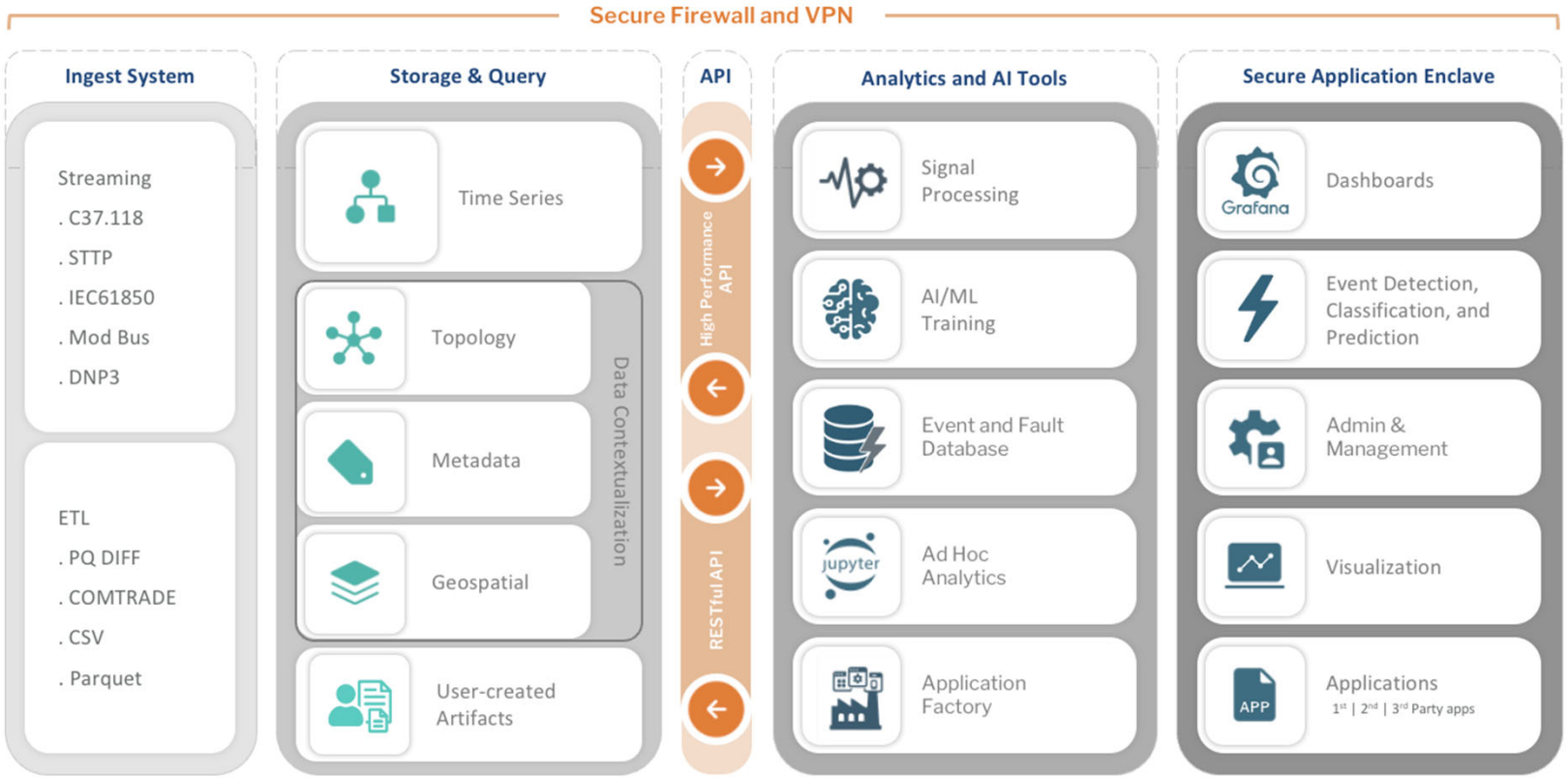
A Report Rate Agnostic Platform

Utility Data Sources

- Data Concentrator(s)
- Historians
- IOT/Devices
- Grid Sensors
  - . PMU
  - . AMI
  - . SCADA
  - . Power Quality
  - . IEDs
  - . DFR
  - . Continuous Point on Wave
  - . Proprietary 3rd Party

External Data Sources

- Weather
- Environmental
- Satellite (time series)
- 3rd Party Sensors



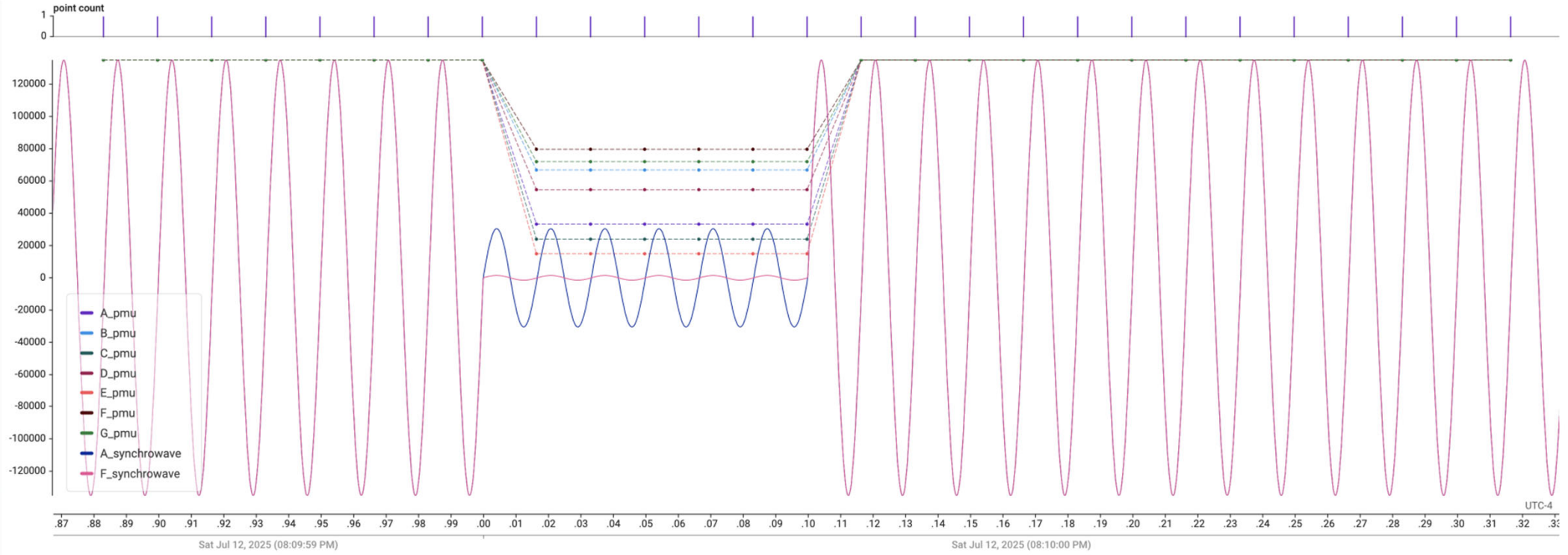
Key Characteristics

Key Capabilities and Features

- Report rate agnostic
- Fast data lookup and retrieval (millions of points per second per stream)
- Historical and real-time computations
- Cloud-backed, store as much data as needed
- Linearly scalable for data ingestion
  - Working with the GridProtectionAlliance (GPA), ingested **120M Points per second sustained**
    - **~160_000 PMUs, ~4k WMUs**
- No data silos
  - AMI, PMU, SCADA, CPOW, DFR, Space Weather, events, etc. all co-exist

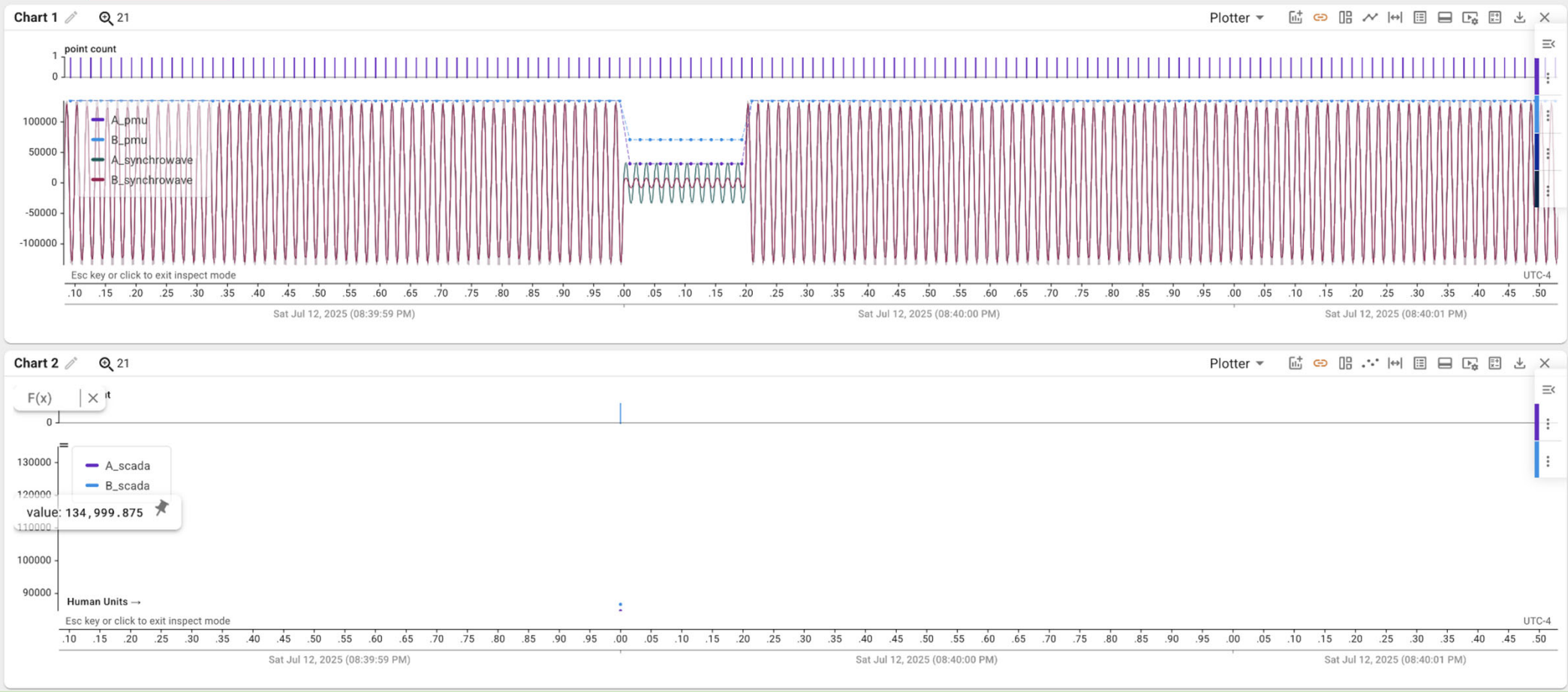
PMU and POW

Synchro-Waveforms with Other Data Sources



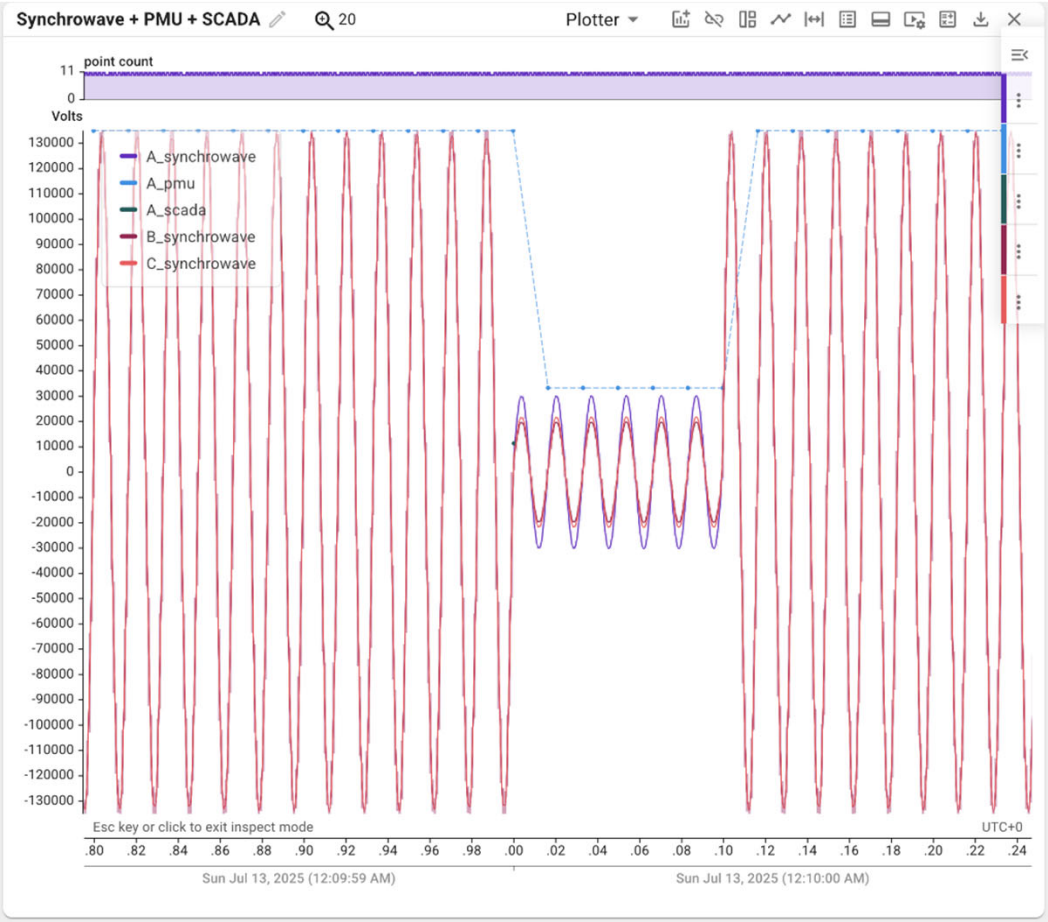
POW and SCADA

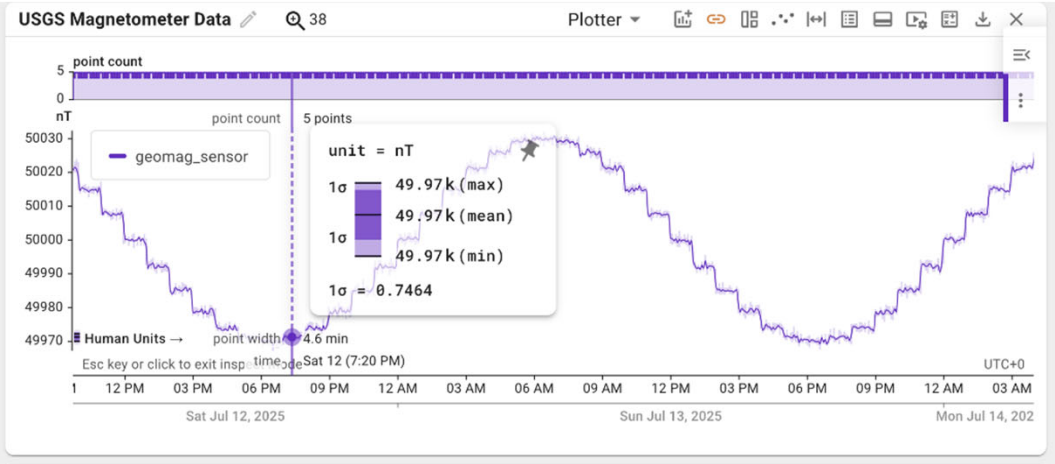
Synchro-Waveforms with Other Data Sources

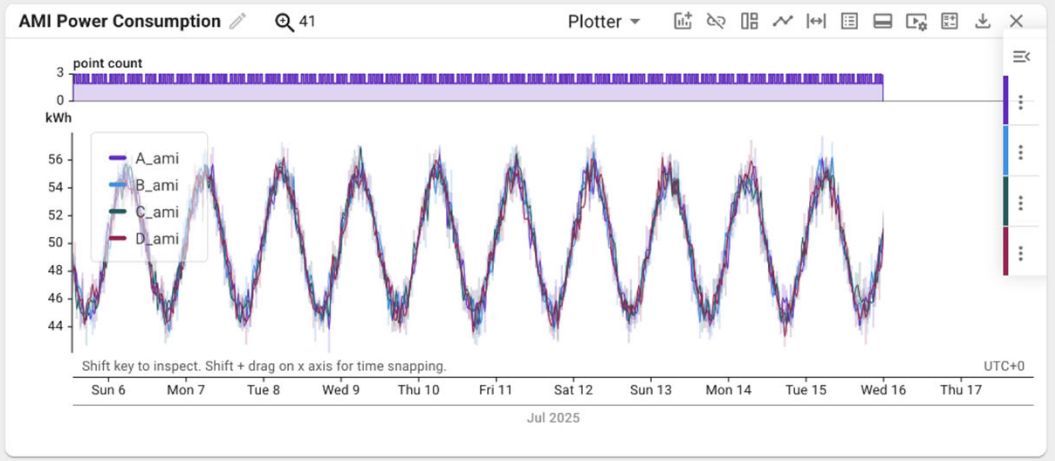


PMU, POW, AMI, Space Weather

Synchro-Waveforms with Other Data Sources







Our Experience

Benefits and Challenges of Synchro-Wave at Scale

- Benefits
  - Not limited to fundamental frequency of the grid for analysis
  - New, rich dataset for potential ML techniques, and new features/analyses
  - IBR dynamics have critical timescales that synchro-wave can measure!
  - Sub synchronous oscillation detection
- Challenges
  - Data density
  - Data quality
  - Large scale deployment and bandwidth needs
  - Lack of data standards

Where Are We Going?

Next Steps and Announcements

- Effective integration of multiple data sources and resolution will be necessary as grid becomes more dynamic
- Dataset fusion will be necessary for a holistic understanding of events
- Synchro-waveforms will be a part of this toolkit, deployed in key locations in the grid, supplemented by PMUs, DFRs, etc
- Challenge
  - PMUs are not in the control room for decision making, where does synchro-waveforms fit in the day-to-day grid operations?

Announcement

Next Steps and Announcements

- PingThings previously had an ARPA-E grant called NI4AI
  - National Infrastructure for AI on the Grid
- Curated open source timeseries available to the academic and industrial community hosted on the PredictiveGrid platform
  - Distribution uPMU, POW, events, AMI, generation timeseries
- Could only host US-based data
- We are starting a similar initiative internally!
  - The PredictiveGrid Grid Data Commons Project
    - Supporting world-wide data sets!
    - Synchro-waveform can be hosted as well
  - More info to come in the fall at NASPI
  - Email: commons@pingthings.io

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Thank you!