Distribution Arcing Fault Detection & Signature Library

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Objective

- ORNL, LLNL are working with PG&E on the installation of a high-fidelity optical sensor cluster on an electric distribution feeder (substation outlet) to capture grid signatures that can be used as early indicators of arcing to *identify and mitigate fire risk.*
- To capture real signatures, the sensor cluster has been installed in an operational utility service area. The novelty of the project is in both the high-fidelity sensor technology and analytical methodology on custom purpose platform.
  - Higher sampling frequency than DFA may expose new signatures and inform on sensor requirements for economical deployment at scale
  - Additional measurement quantities (Acoustics/Vibration)

High-Fidelity Optical Sensor

- At the core of the technology is a passive optical sensing mechanism capable of monitoring AC voltage (10kV-115kV), current (5-2000A), acoustics, temperature, and vibration.
- The frequency range of the optical detection can be tuned to cover over 30kHz bandwidth.
- The variety of sensing parameters integrated into the cluster also includes temperature, vibration and acoustics.
    - Facilitates correlation between different parameters (voltage/current/vibration/etc.) for signature learning
- Nominal sampling rate is 20kHz but can be increased up to 2MHz

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Arcing Fault Detection

- Optical sensor recordings (captured by ORNL) are being compared against electrical disturbances captured by a micro-PMU (LLNL)
  - Direct comparisons between magnitude, phase, and event duration for event verification and optical sensor validation
  - “Oscillographic” nature of optical sensor combined with high sampling rate provides additional “color” to micro-PMU recordings
  - Verified event optical sensor recordings are ingested into the Signature Library
- Arcing events are relatively rare. Building a data set for analytics training/testing will require exploiting knowledge about arcing faults from existing public data repositories in addition to events captured by the optical sensor/micro-PMU.
  - Research question: *what “features” can the optical sensor detect in an arcing fault that traditional sensing mechanisms cannot?*
- LLNL maintains a shared document of new event metadata, such as time, event type, etc. micro-PMU data files provided to ORNL upon request.

Signature Library

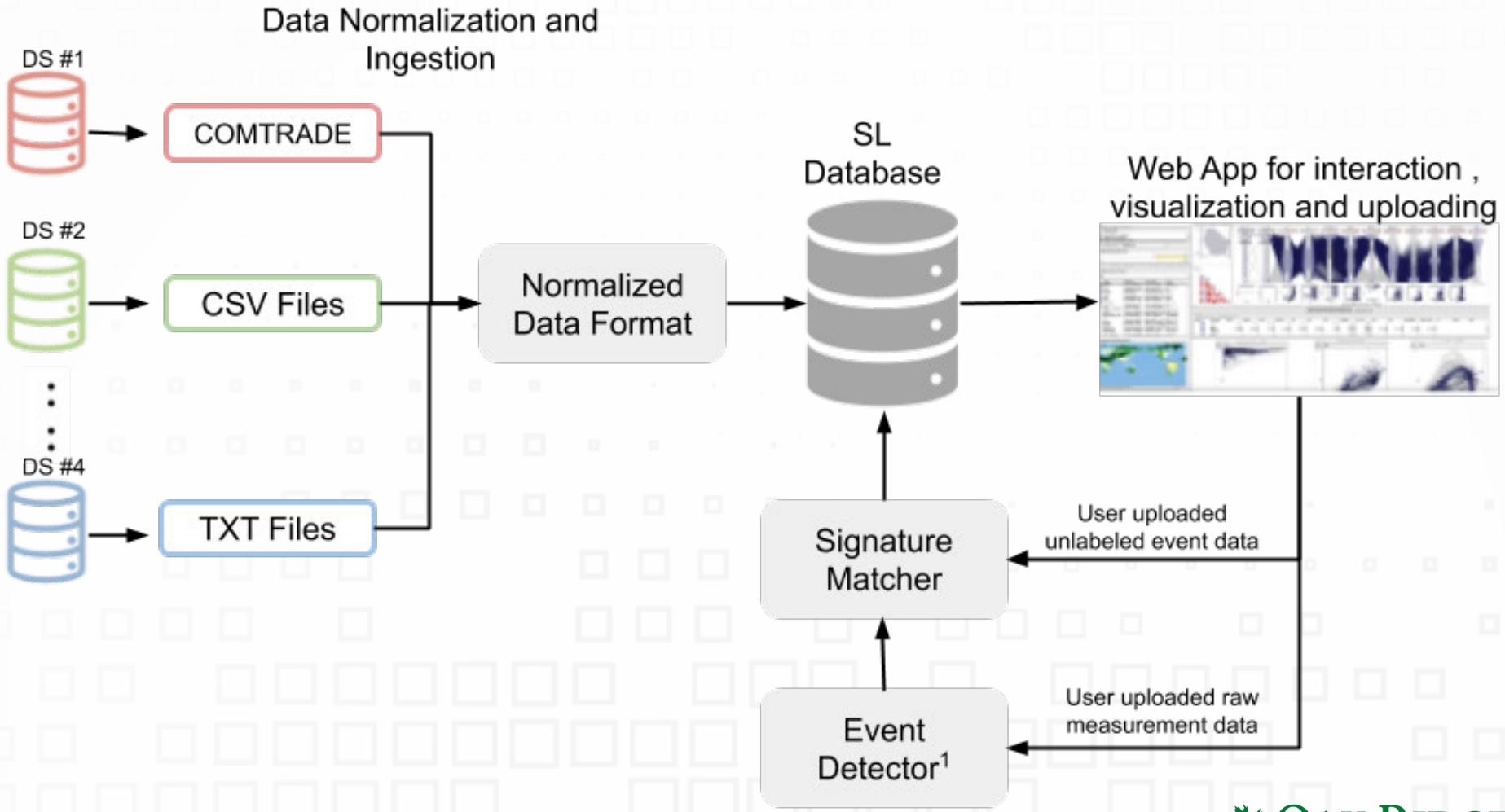
Objective

- Build a Signature Library Framework
  - The signature library (SL)
    - is a collection of labeled events or anomalies
    - will enable machine learning and traditional analytics research to predict and monitor power grid health.
  - A signature is a set of measurements (voltage, current, frequency, etc.) that characterize an event which could be an anomaly.

Framework allows us to

- Ingest, store and access event signature from disparate sources

Signature Library Framework



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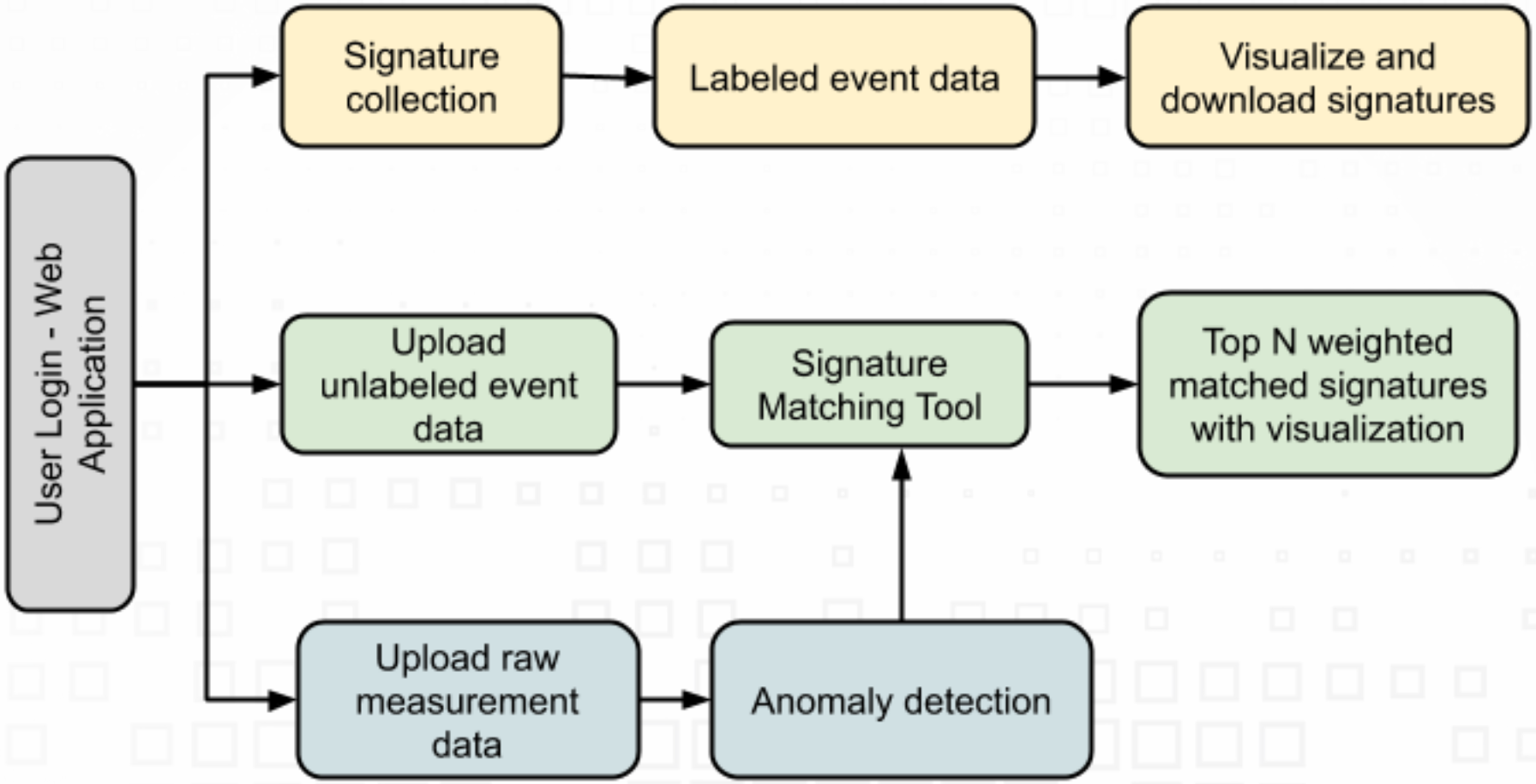
Signature Library Framework



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