OpenFIDO

2.3: Data Exchange Implementation and Validation Plan

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Presentation Overview

Review OpenFIDO status of the following:

1. **Detailed testing of operational software**
    a. Validation methods review
    b. Pipelines overview
    c. Platform functionality
2. **Data exchange implementation and validation plan**
    a. Import and export data formats
    b. Available open-source data exchange codes
    c. Data exchange implementation and validation plan

Validation methods overview

Three approaches to pipeline testing and validation

1. **Methodology validation (method "M")**
    - More complex or analytic pipelines
    - Typically implemented in a Jupyter notebook
2. **Autotest validation (method "A")**
    - Pipelines that do not require credentials and have good/open examples of inputs/outputs
    - Implemented in GitHub actions autotests
3. **User validation (method "U")**
    - Pipelines that implement use-cases of interest to users (e.g., SLAC, HAL, SCE, NG)
    - Users run tests using on-premise servers or local server and report issues on GitHub

OpenFIDO pipelines to be validated (1 of 2)

Pipeline name	**Description**
Address	Obtains addresses from locations, or locations from addresses
Loadshape	Performs loadshape cluster analysis based on AMI data
Weather	Obtains historical weather data
CYME extract	Converts CYME models to GLM models
Resilience	Performs system resilience analysis
Integration capacity	Performs integration capacity analysis
Electrification	Performs end-use electrification analysis

OpenFIDO pipelines to be validated (2 of 2)

Pipeline name	**Description**
Vegetation	Obtains vegetation data
Powerline	Performs powerline sag, sway, and contact analysis
Elevation	Obtains ground elevation data
Utility	Obtains data about utilities
Census	Obtains census data
Forecast	Performs load forecasting based on historical data
Tariff design	Performs tariff design analysis

Platform Functionality

Testing procedures/environments planned

1. **Server testing**
    a. Cloud server (AWS) - Active/ongoing
    b. On-premise server (SCE) - In deployment/training
    c. Standalone server (SLAC) - Active/ongoing
2. **Pipeline testing**
    a. Methodology validation (SLAC) - Active/ongoing
    b. Online autotests (SLAC) - Active/ongoing
    c. User testing (SLAC, HAL, SCE, NG) - Active/ongoing
3. **GridLAB-D/GLOW integration**
    a. GridLAB-D autotests (GitHub) - Active/ongoing
    b. GLOW integration test (HAL) - Pending

Import and Export Format (1 of 2)

Pipeline name	Inputs files	Output files
Address	CSV (geodata)	CSV (geodata)
Loadshape	CSV (amidata)	CSV (loadshapes and groups), GLM (models), PNG (loadshapes)
Weather	(none)	CSV (weather data), GLM (models)
CYME extract	MDB, CSV	CSV (CYME data), GLM (models)
Resilience	CSV, GLM	CSV (results), PNG (results)
Integration capacity	CSV, GLM	CSV (results), PNG (results)
Electrification	CSV, GLM	CSV (results), PNG (results)

Import and Export Format (2 of 2)

Pipeline name	**Inputs files**	**Output files**
Vegetation	CSV (geodata)	CSV (geodata)
Powerline	CSV (geodata)	CSV (geodata)
Elevation	CSV (geodata)	CSV (geodata)
Utility	CSV (geodata)	CSV (geodata)
Census	CSV (geodata)	CSV (geodata)
Forecast	CSV (amidata)	CSV (weather), GLM (model)
Tariff design	CSV, GLM	CSV (results), PNG (results)

Available Open Source Exchange Codes

Publicly released

- Loadshape
- Weather
- Address
- Census

Released utilities

- CLI
- Numpy & numpy-cli
- Clean

Private releases (pending validation)

- Cyme extract
- Resilience
- Integration capacity analysis
- Electrification
- Tariff design
- Vegetation
- Powerline
- Elevation
- Utility
- Forecast

Validation plan/status (1 of 2)

Pipeline name	**Test case (M, A, or U)**	**Test host(s)**
Address	Forward and reverse resolution (A)	SLAC (done)
Loadshape	AMI data from SCE and NG (M)	SCE (done), NG (in progress)
Weather	NSRDB vs NOAA weather data (U)	SLAC (pending)
CYME extract	SCE and NG models (U)	SCE (done), NG (in progress)
Resilience	SCE extreme weather event (U)	SLAC (in progress), SCE (pending)
Integration capacity	IEEE 123 test case (U)	SLAC (in progress), HAL (pending)
Electrification	IEEE 123 test case (U)	SLAC (in progress)

Validation plan (2 of 2)

Pipeline name	Test cases (M, A, or U)	Test hosts
Vegetation	SLAC system (M, U)	SLAC (pending)
Powerline	SLAC system (A)	SLAC (pending)
Elevation	SLAC system (A)	SLAC (pending)
Utility	Random locations (A)	SLAC (pending)
Census	Random locations (A)	SLAC (done)
Forecast	SCE, PGE amidata (M)	SLAC (done)
Tariff design	IEEE 123 network (A)	SLAC (pending)

Contacts

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Validation Pipeline Dependencies and Data Sources

	Hosting Capacity	**Resilience**	**Electrification**	**Tariff Design**
Weather	NSRDB	NOAA	NSRDB	NSRDB
Load model	AMI loadshapes	AMI load data	AMI loadshapes	AMI loadshapes
Network	CYME	CYME	CYME	CYME
Equipment	CYME	CYME	CYME	CYME
Rates				HIFLD, OpenEI
Vegetation		SALO		
Poles		Spidacalc		
Elevation		USGS		
Powerlines		CYME		

OpenFIDO Pipeline Spec Sheet: Hosting capacity

Name: integration_capacity

Synopsis: Solar hosting capacity analysis for distribution feeders

Purpose: Determine the maximum solar capacity at load buses

Source: California ICA Working Group Methodology (modified)

Input: NSRDB weather, CYME network and equipment, AMI loadshapes

Output: Solar capacity (CSV, PNG)

Example: IEEE-123

Pipeline Spec Sheet

Name: resilience

Synopsis: DOE Grid Resilience Intelligence Platform (GRIP) anticipation analysis

Purpose: Perform distribution system resilience analysis prior to major weather events

Source: DOE GRIP project (GMLC)

Input: NOAA forecasts, AMI load data, CYME equipment and network, SALO vegetation data, SpidaCalc pole data, and USGS terrain data

Output: Line and pole failure metrics time series (CSV, PNG)

Example: SLAC system network analysis

Pipeline Spec Sheet

Name: electrification

Synopsis: End-use load electrification impacts analysis

Purpose: Determine distribution system impact of full electrification of end-uses

Source: SLAC methodology develop for Gridworks Electrification Study

Input: NSRDB weather, AMI loadshapes, CYME network and equipment, electric end-use fractions

Output: system upgrades (CSV, PNG) and electrification limits (CSV, PNG)

Example: IEEE-123

Pipeline Spec Sheet

Name: tariff_design

Synopsis: Tariff analysis

Purpose: Compute customer costs and utility revenues for multiple tariffs

Source: Tariff analysis methodology

Input: NREL OpenEI database

Output: Customer electricity costs, energy use, and utility revenues

Example:

Pipeline Spec Sheet

Name: weather

Synopsis: Obtain historical weather data

Purpose: Generate weather data for GridLAB-D simulations

Source: NREL NSRDB

Input: Latitude and longitude for weather data needed

Output: Weather files (CSV)

Example:

Pipeline Spec Sheet

Name: loadshape

Synopsis: Generate load data and models from AMI data

Purpose: Create load schedules and players for GridLAB-D simulations

Source: Load data analysis and ML methodologies

Input: AMI data

Output: GridLAB-D players (CSV) and schedules (GLM)

Example:

OpenFIDO Pipeline Spec Sheet

Name: address

Synopsis: Resolve mapping of utility premise addresses and geographic location

Purpose: Mapping customer data (e.g., AMICSV) to network node (CYME MDB)

Source: Nominatim API to Open Street Map dataset

Input: Latitude, Longitude (CSV) or Address (CSV)

Output: Latitude, Longitude, Address (CSV)

Example: **gridlabd geodata merge -D address 37.22,-122.2**

```
id,latitude,longitude,address
0,37.42,-122.2,"Stanford Linear Accelerator Center National Accelerator Laboratory, LCLS X-Ray Transport Tunnel, Stanford Hills, San Mateo County, California, 94028, United States"
```

Pipeline Spec Sheet

Name: cyme_extract

Synopsis: Extract CYME models to CSV and generate GLM models

Purpose: Produce models for ICA, resilience, electrification, and tariff design

Source: Original converter from PNNL, upgraded by SLAC

Input: CYME MDB file

Output: CSV data tables and GLM models

Example: IEEE-13 and IEEE-123 CYME models

Pipeline Spec Sheet

Name: vegetation

Synopsis: Download vegetation data

Purpose: Object vegetation horizontal and vertical development as geodata

Source: Salo Sciences

Input: geodata (at least latitudes and longitudes)

Output: geodata (with canopy cover, canopy height, and base height)

Example: `gridlabd geodata merge -D vegetation 37.22,-122.4 --year=2020 --units=feet`

```
id,latitude,longitude,base,cover,height
0,37.22,-122.4,10.0,0.82,52.0
```

Pipeline Spec Sheet

Name: powerline

Synopsis: Calculation powerline characteristics

Purpose: Obtain line sag data

Source: Engineering calculations

Input: Cable data, weather data, and line geodata

Output: Line sag

Example: `gridlabd geodata merge -D powerline path_example.csv --cable_type="TACSR/AC 610mm^2" -r 50`

```
position,latitude,longitude,configuration,pole_height,id,distance,heading,linesag,linesway,linegallop
0,37.41505,-122.20565,flat3,54.0,0.0,0.0,0.0,54.0,0.0,0.0
50,37.41498,-122.20621,,,,50.0,263.0,49.0,0.0,0.0
```

Pipeline Spec Sheet

Name: elevation

Synopsis: Obtain ground elevation data

Purpose: Support calculation of line sag ground clearance and vegetation contact

Source: USGS

Input: Geodata (latitude and longitude)

Output: Elevation geodata

Example: `gridlabd geodata merge -D elevation 37.410,-122.20 37.420,-122.20 37.420,-122.21`

```
id,latitude,longitude,elevation
0,37.41,-122.2,58.0
1,37.42,-122.2,76.0
2,37.42,-122.21,105.0
```

Pipeline Spec Sheet

Name: utility

Synopsis: Obtain information about utility serving a location

Purpose: Gather mapping and company data

Source: Homeland Infrastructure Foundation-Level Data (HIFLD)

Input: Geodata (latitude and longitude)

Output: See https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-retail-service-territories

Example: **`gridlabd geodata merge -D utility 37.420,-122.20 --fields=NAME,WINTR_PEAK,SUMMR_PEAK,CUSTOMERS,YEAR`**

```
id,latitude,longitude,NAME,WINTR_PEAK,SUMMR_PEAK,CUSTOMERS,YEAR
0,37.42,-122.2,PACIFIC GAS & ELECTRIC CO.,12624.0,17263.0,5471786.0,2018.0
```

Pipeline Spec Sheet

Name: census

Synopsis: Census zipcode and state data

Purpose: Obtain zipcode and state census geographic data

Source: US Census Bureau

Input: Location latitude and longitude

Output: census TIGER data and mapping geodata for GridLAB-D html output

Example: **gridlabd geodata merge -D census 37.4,-122.2**

id,latitude,longitude,STUSPS,ZCTA5CE10
0,37.4,-122.2,CA,94028

Pipeline Spec Sheet

Name: weather_forecast

Synopsis: Weather forecast

Purpose: Obtain weather forecast for the next 2 weeks

Source: NOAA

Input: Latitude and longitude

Output: Temperature and wind forecast (CSV)

Example: `gridlabd noaa_forecast -p=37.4,-122.2`

```
datetime,temperature[degF],wind_speed[m/s],wind_dir[deg]
2022-02-24 09:00:00,39.0,0.9,180.0
2022-02-24 10:00:00,42.9,0.5,143.6
2022-02-24 11:00:00,46.0,0.4,112.5
```