Energy Systems Innovation Center

WASHINGTON STATE UNIVERSITY

Standards Based Data Integration for Utilities

John R. Theisen | Monish Mukherjee | Anjan Bose | Michael Diedesch | John Gibson

PESGM 2023
STP202

Introduction

Motivation

- Traditional distribution management systems are typically isolated from or loosely coupled with different enterprise applications.
- The Common Information Model (CIM) has emerged as a widely accepted solution for data exchange and system integration in distribution systems.

The motivation for the work was to develop a data integration framework to showcase various analysis and tools that can developed based on the comprehensive models by organizing data from various enterprise systems.

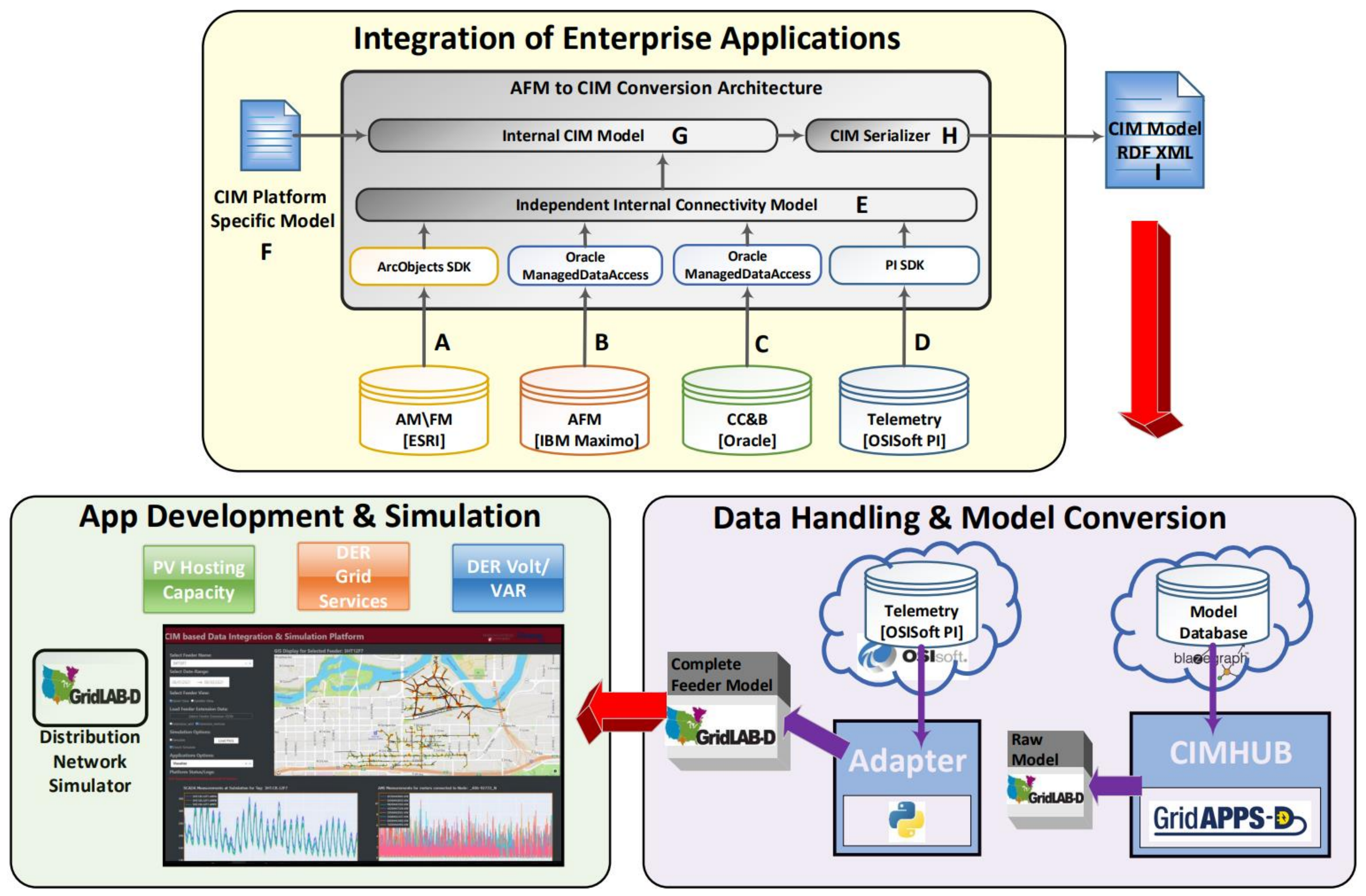
Challenges

The coordination of different enterprise systems can be difficult when utilizing different vendors. By using CIM, data processing can be streamlined when considering adding additional data systems to existing infrastructure.

Objective

The objective of this work was to validate the standards based information framework and to showcase some application use-cases to highlight some of the capabilities that can emerge from enabling interoperability among diverse enterprise systems.

CIM Framework Architecture

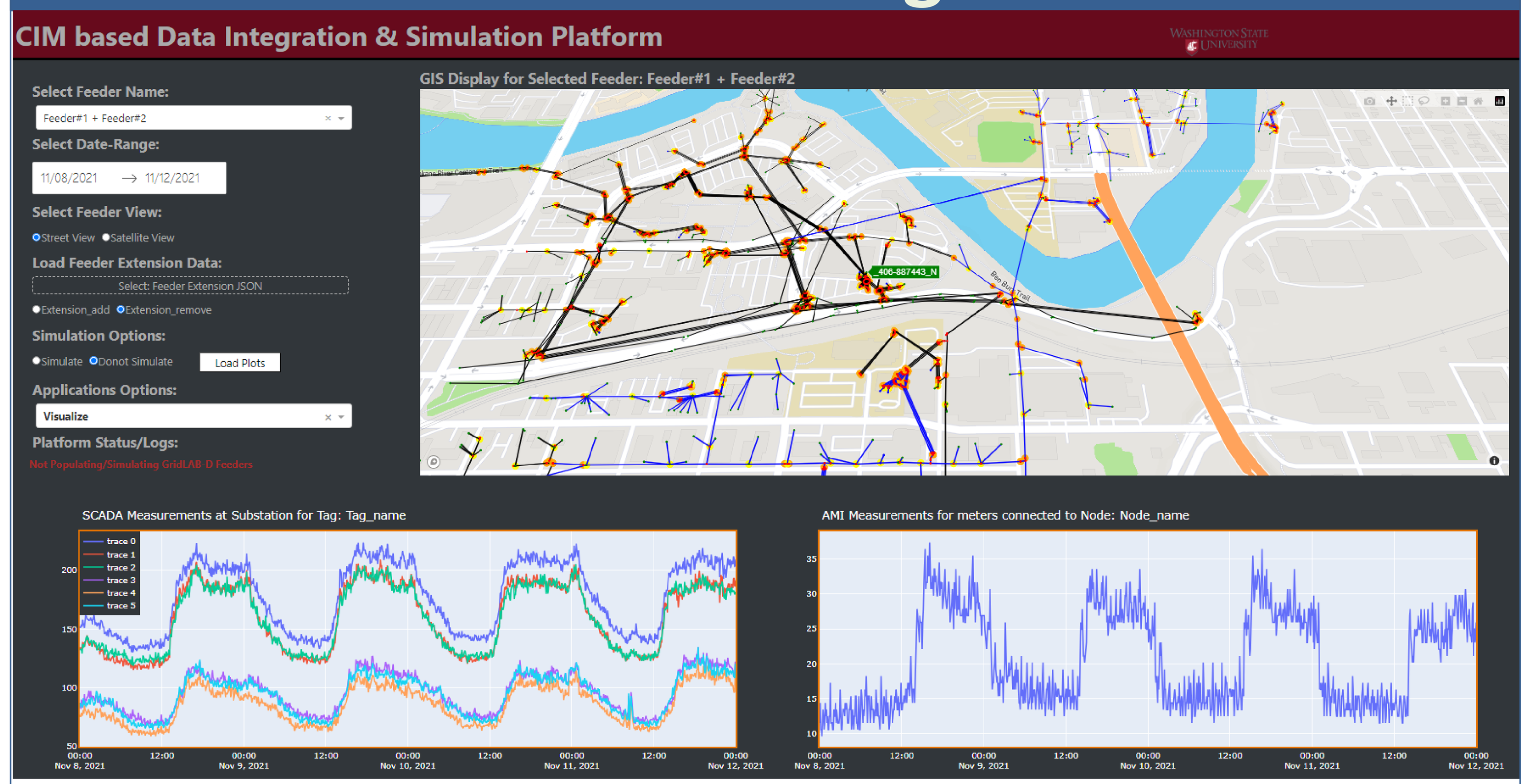


Conceptual architecture of the CIM based framework.

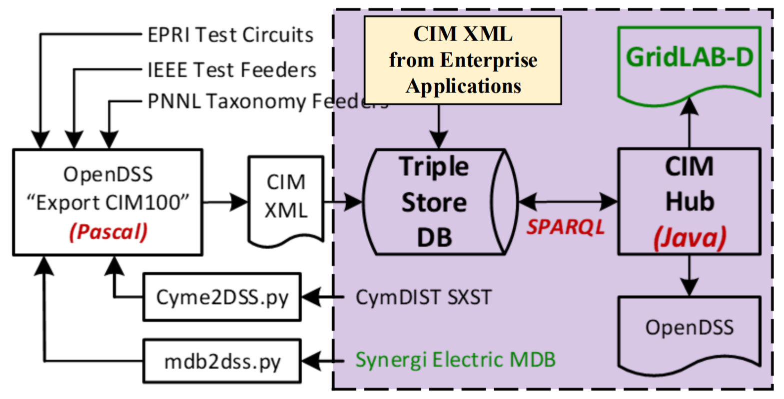
- **Integration of Enterprise Applications** combines DER management systems (DERMS), AM/FM systems, advanced metering infrastructure (AMI), outage management systems (OMS), and asset management systems (AMS) into a single readable format for data processing.
- **Data Handling & Model Conversion** via database queries can create models usable in other simulation software. Here, we use GridLAB-D.
- **App Development & Simulation** allows us to visualize and test different scenarios that can be simulated through GridLAB-D

Through the utilization of GIS data, the physical infrastructure can be visualized on a GUI. It can also display the network operational states from powerflow solutions and the historical load profiles.

Modelling



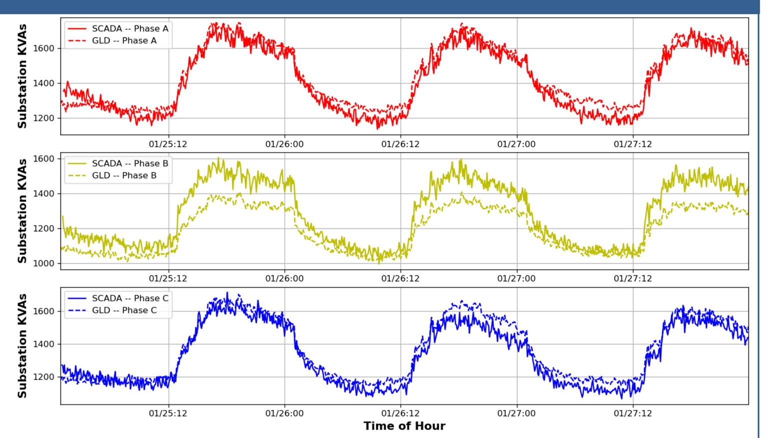
- This project utilized open source CIM models developed by Pacific Northwest National Labs (PNNL) through their GridAPPS-D project as a concrete reference when building the conversion process.
- The proposed platform loads dynamically developed CIM XML models from the utility's enterprise systems into a triple-store database for convenient use with the SPARQL query language.



CIM storage and Model Conversion Toolkit [GridAPPS-D].

Validation

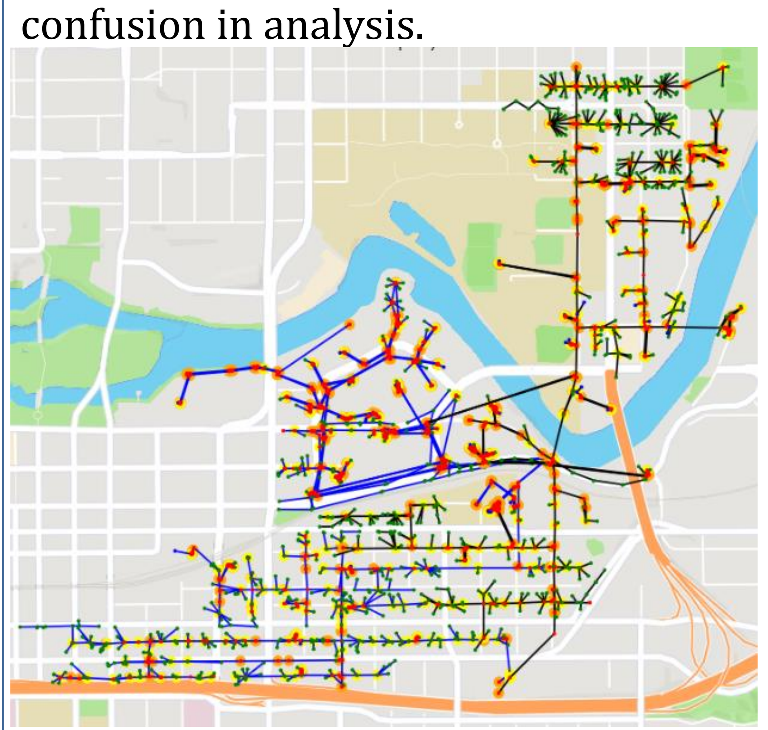
Validation of the model conversion from the utility system's feeder data to CIM was simulated with GridLAB-D. The intervals of inconsistency in the AMI data correspond to the mismatched intervals of the simulation.



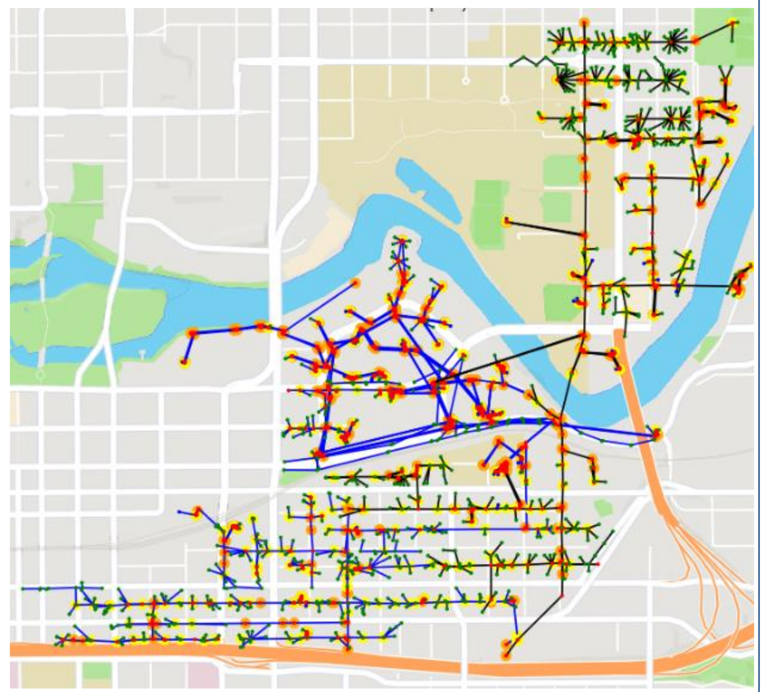
Substation Power of a feeder from Simulation and SCADA measurements

Network Topology

Network changes are common on a distribution feeder. CIM allows for accurately dated models and can display changes in network topology to avoid confusion in analysis.



TOPOLOGY 1



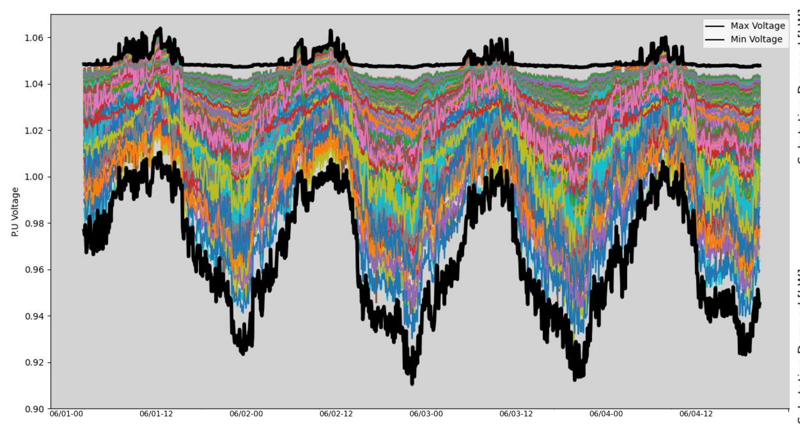
TOPOLOGY 2

Application: DER Optimization

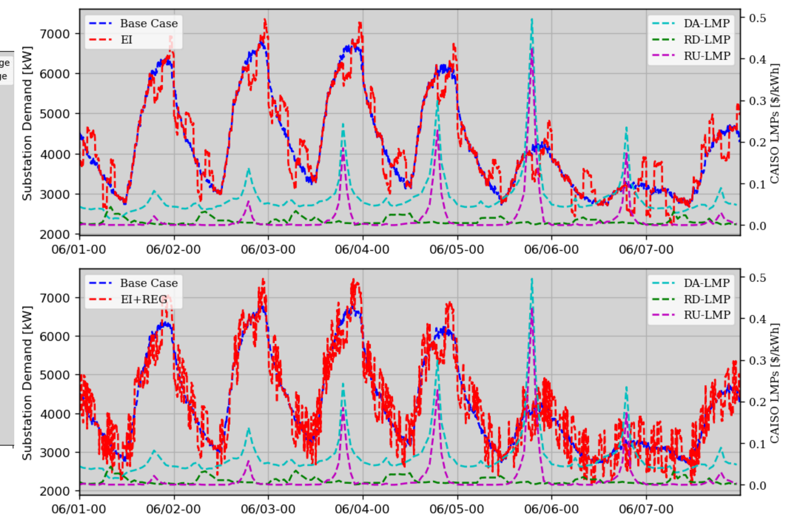
Objective: Maximize Economic Benefits

$$\underset{p_t, r_t^+, r_t^-}{Max} \sum_{t=1}^{T} \lambda_t p_t + \beta_t^+ r_t^+ + \beta_t^- r_t^-$$

- The BESS scheduling problem is formulated as an optimization for maximizing the economic benefit with respect to participation in Day-Ahead energy imbalance (EI) market as well as the Regulation Up and Regulation Down markets, which correspond to the Up and Down Real Time Markets (RTM) used by CAISO.
- Over a one-week period of time, battery schedules were dispatched that charged when prices were low, and discharged when prices were high, while ensuring the batteries remained within charging limits of [0.1, 0.9].



Maximum and Minimum voltages over all nodes.



Net substation demand from EI (top) and EI+RTM (bottom) BESS contribution.

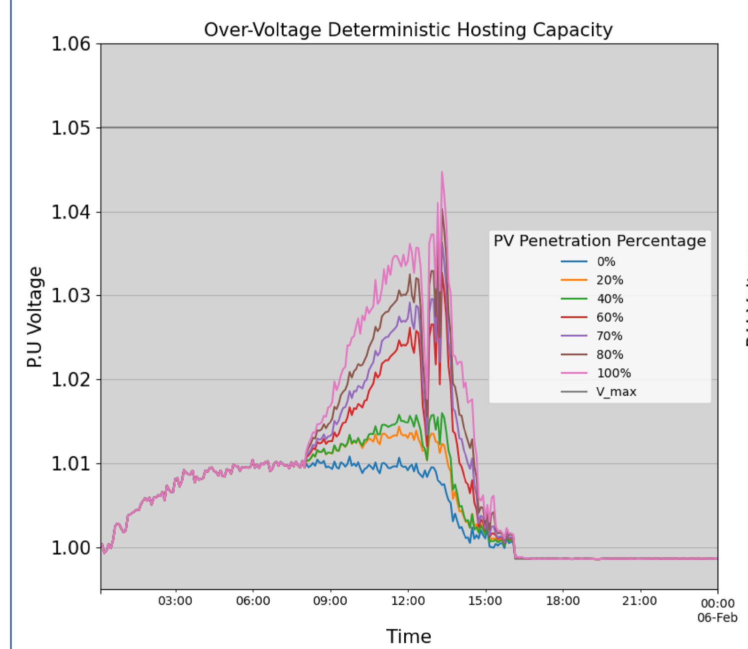
Value stacking potential over a summer week

	BESS Cycles per day	Value
EI only	1.57	\$1,133.39
EI+Reg	2.35	\$2,523.26

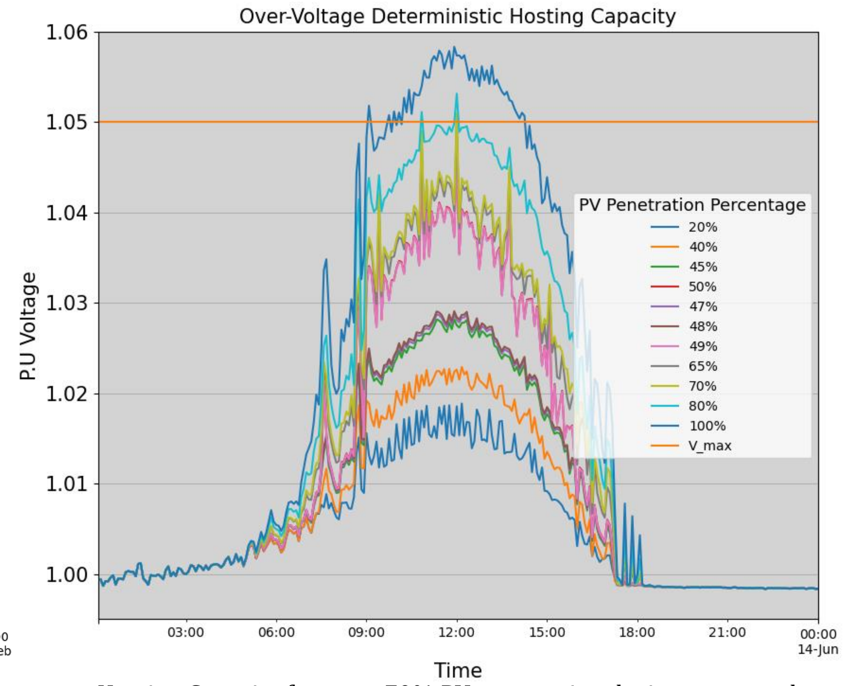
- The BESS Providing multiple services to the grid shows potential of Value Stacking.

Application: PV Hosting Capacity

The maximum amount of solar PV power generation that a distribution grid can accommodate without causing adverse effects on the system's performance was tested by virtually adding solar panels to the GridLAB-D Model. The penetration percentage is with respect to PV-supported loads greater than 10kV.



Hosting Capacity testing during Winter (low sun) day.



Hosting Capacity for up to 70% PV penetration during summer day.

By observing the system's per-unitized maximum voltage throughout the day, we can see when the system is over-voltage.

Acknowledgments

This material is based on work supported by Avista Corporation under the Micro-Grid Agreement funded through the Clean Energy Fund - II.