Pacific Northwest
NATIONAL LABORATORY

Building GridAPPS-D into a Platform for Advanced Distribution Operations R&D

October 12, 2022

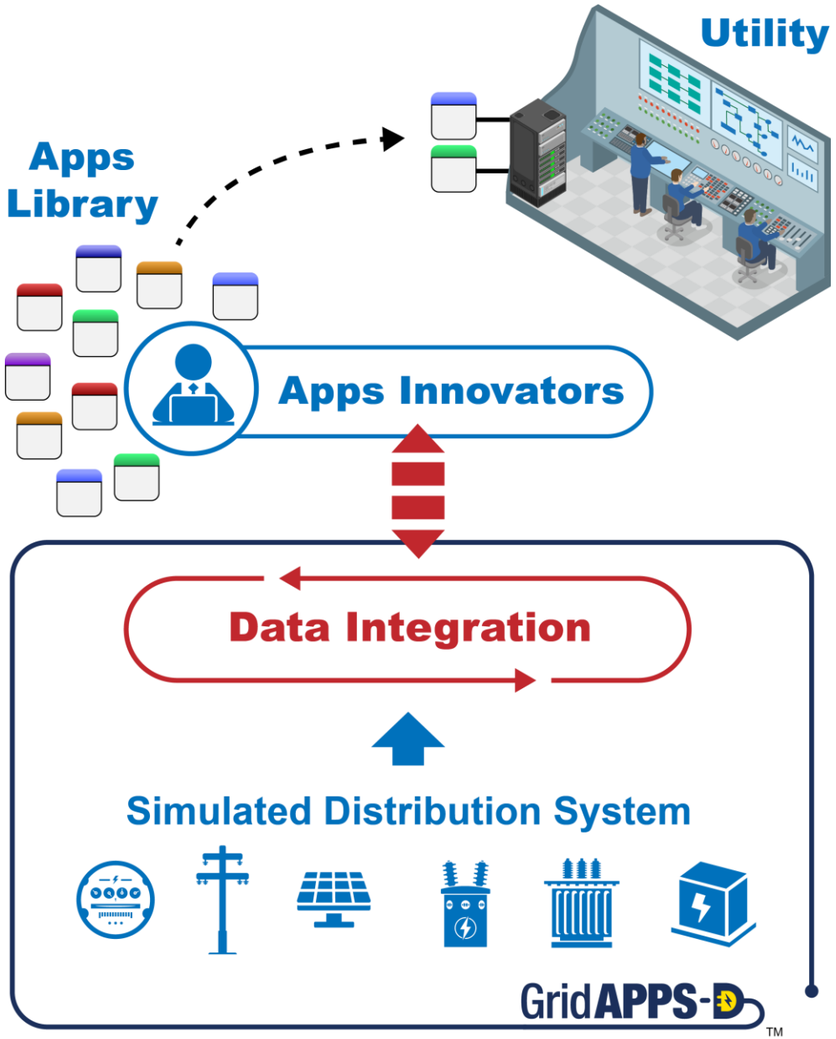
Andy Reiman
Power Systems Engineer
Co-PI for GridAPPS-D

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

GridAPPS-D: an Open-Source Data-Integration Platform for Distribution System Operations

- Response to key industry problem: *Reduce time and cost to integrate new systems*
- How: Platform architecture and standardization to separate data integration from functionality
- Benefits:
  - App innovators leverage the data rich environment in modernized distribution systems to provide new applications
  - Provides starting point for vendors to develop compliant data integration products
  - Enables utilities to access portable applications from multiple sources
  - Capabilities applicable to utilities of all sizes

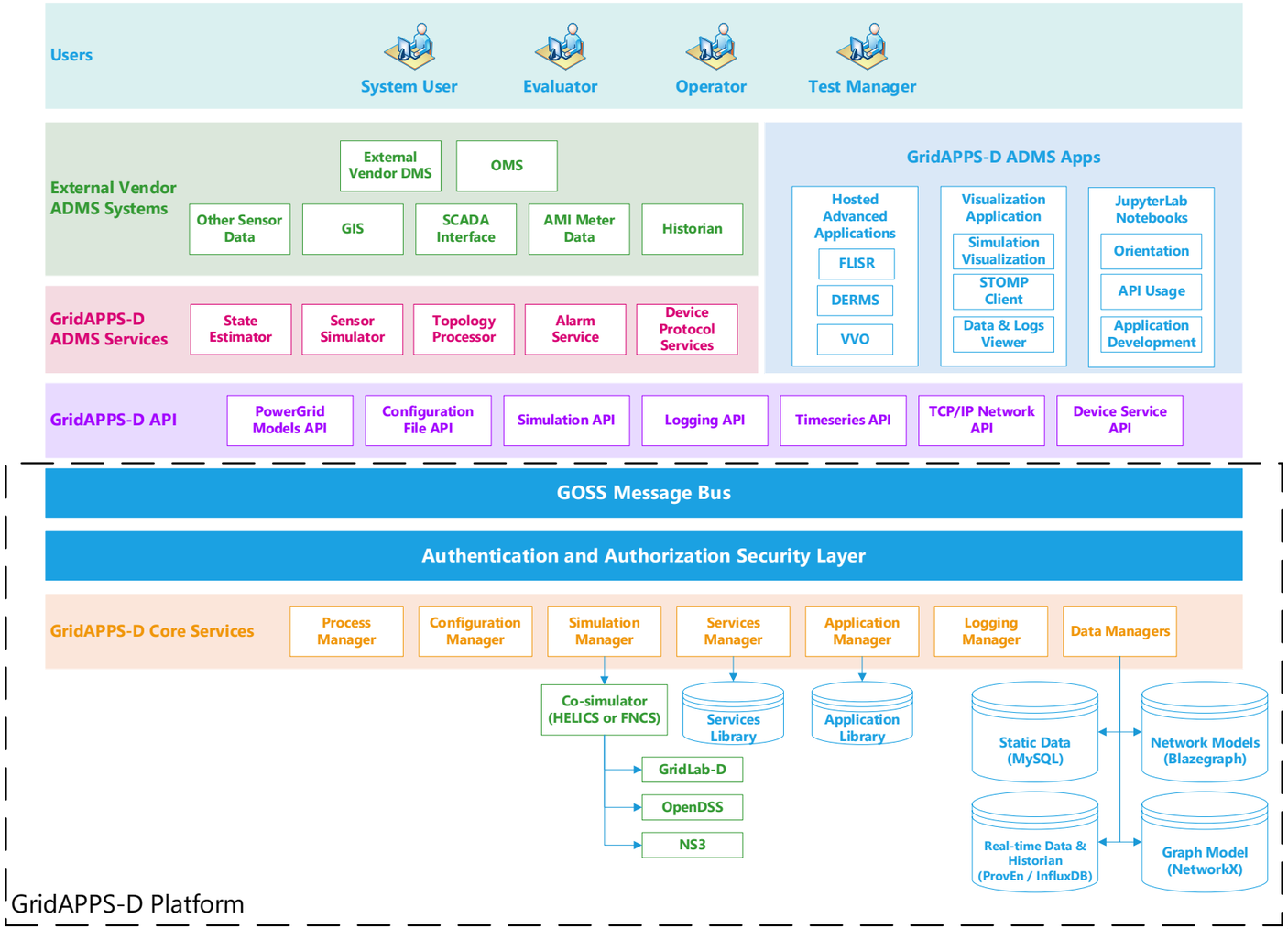


Driving Interoperability in Distribution Operations

Use Case	Target Audience	Notes
An **application incubator** for advanced distribution system operations functionality.	Researchers	Internal and external; core, coordinated, and uncoordinated.
	Application Vendors	Integrated solution providers are moving toward interoperability.
A **reference implementation** of a standards-based data-integration platform for distribution system operations.	Software Platform Vendors	GridAPPS-D does not compete with commercial vendors.
	Distribution Utilities	We have observed that utility demand drives market adoption.

GridAPPS-D Platform Components and Apps

- Open-source platform and dev environment
- Pre-built Python and Java libraries for tasks / API calls
- Numerous shared services
- Simple app registration and containerization with Docker
- Ability to interface with multiple vendor ADMS
- CIM used for all network models and messages
- Protocol support for DNP3, IEEE 1547, IEEE 2030.5



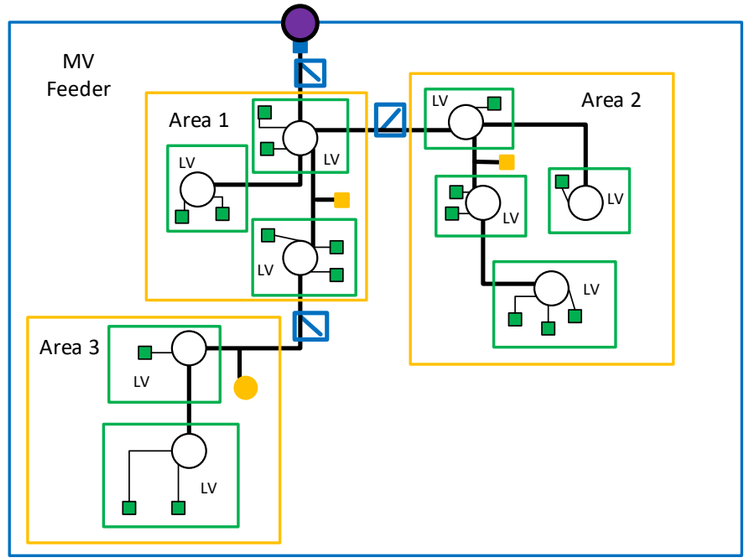
GridAPPS-D Distributed App API

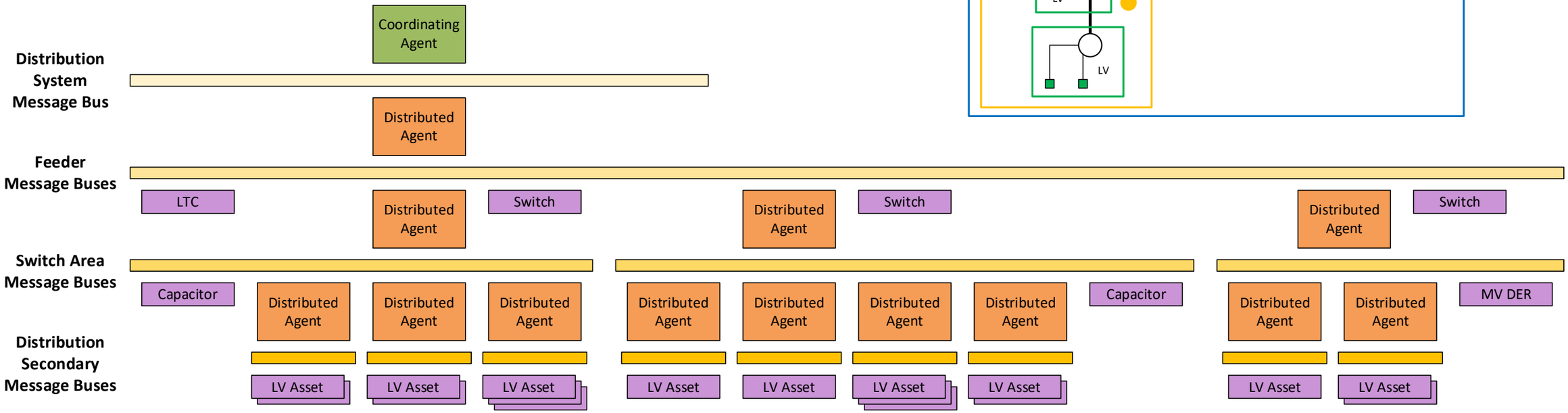
Layer 1: Distribution System

Layer 2: Feeder

Layer 3: Switch Area

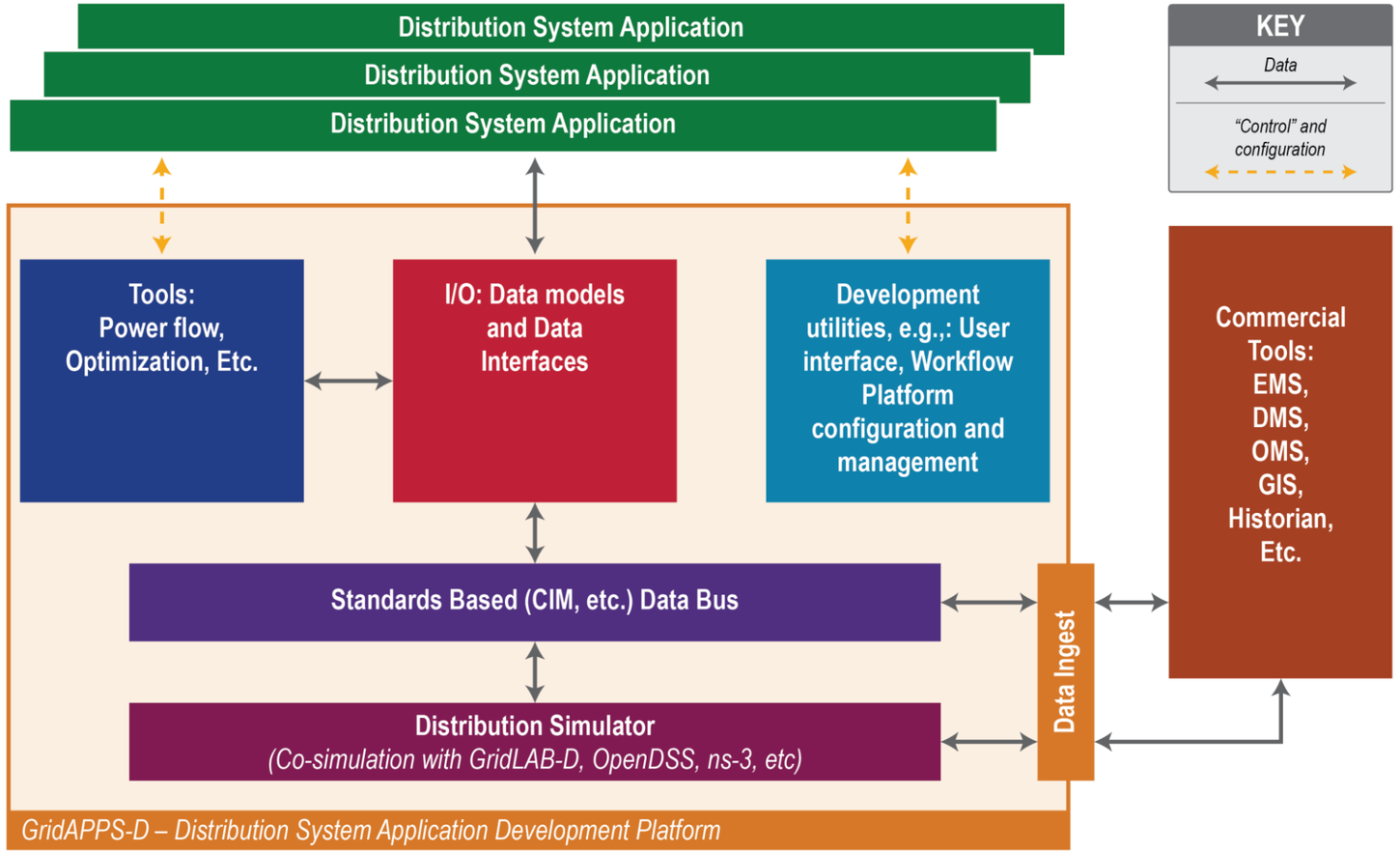
Layer 4: Distribution Secondary





GridAPPS-D Development Approach

- Lead Developer
  - Software Engineer
- Dev Team Specialists:
  - API
  - Co-Simulation
  - Front-End
  - Data Management
  - CIM Implementation
- App Developers
  - Domain Engineers



Development Approach

Partial Implementation of Agile Development

- Regular Stand-Ups
- Sprint Planning
- Continuous Integration
- Automatic Regression Testing

Parallel Development of Platform and Apps

- State Estimator
- Model Validator
- pyVVO
- Resilient Restoration
- Distributed Restoration
- Distributed Energy Coordinator

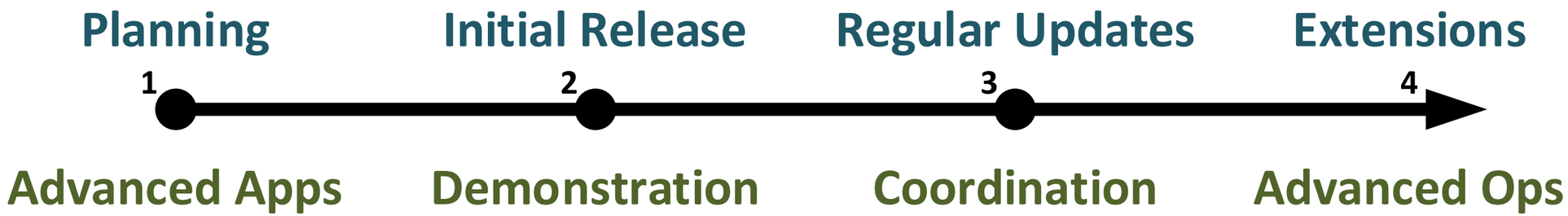
Cross-Cutting Activities

- Internal apps serve as
- Industry engagement
- Participation in standards development
- CIM interoperability tests
- Formal app evaluation by utility operators

Evolution of GridAPPS-D

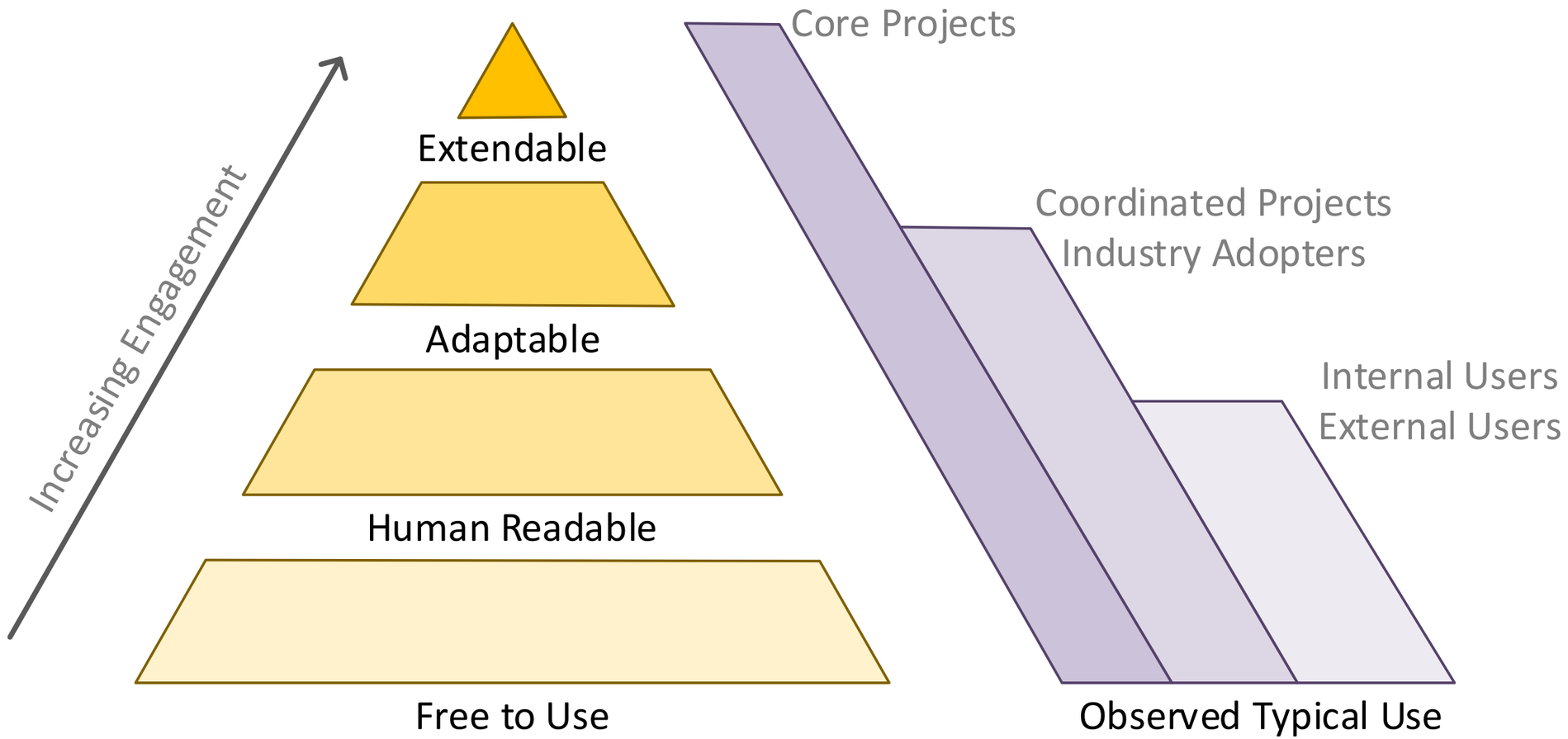
The GridAPPS-D platform has been co-developed alongside a synergistic research program.

Platform Development

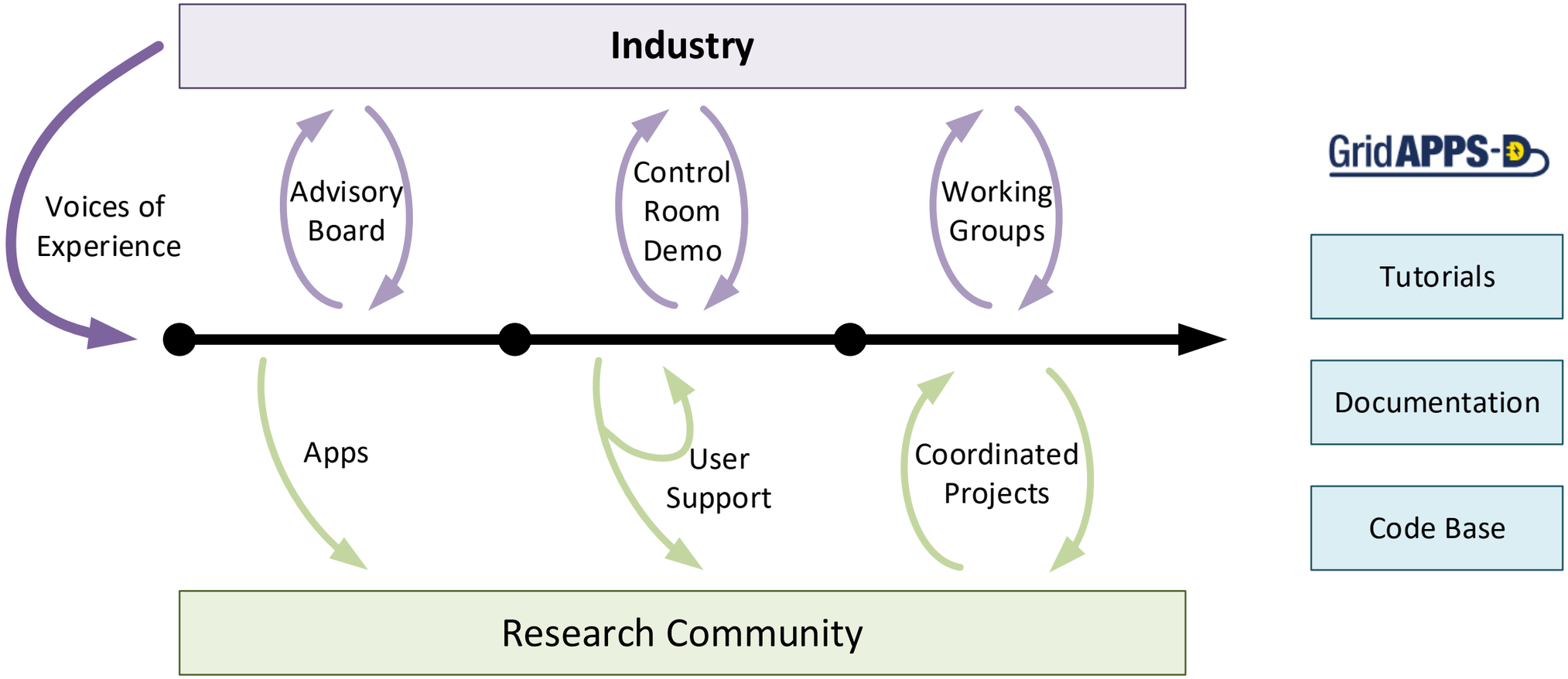


Synergistic Research

Community Benefits of Open-Source Software



Industry and Research Community Engagement



GridAPPS-D

- Tutorials
- Documentation
- Code Base

A standards-oriented approach enables adoption of concepts without adaptation of code.

Reach of GridAPPS-D

DOE Projects using GridAPPS-D

- OE: Electric Grid of Things
- OE: Sensor Technologies & Analytics
- OE: Grid Data Transport Analysis
- GMLC: FAST-DERMS
- SETO: Open Energy Data Initiative (CIM Hub)

PNNL Leads for GridAPPS-D

Jim Ogle *(PI)*

Andy Reiman *(Co-PI & App Lead)*

Poorva Sharma *(Lead Developer)*

Jon Barr *(Industry Point of Contact)*

Ron Melton *(Originating PI)*

Kevin Schneider *(Originating Co-PI)*

Pacific Northwest
NATIONAL LABORATORY

Thank you

Existing and Planned Applications

- GridAPPS-D Apps:
  - State Estimator (PNNL)
  - Py-VVO (AI-enhanced, PNNL)
  - CIM Model Validator (PNNL)
  - Transactive Market Pricing (PNNL)
  - DER Dispatch (NREL)
  - Solar Forecasting (NREL)
  - Battery Storage Coordinator (NREL)
  - Volt-var Optimization (WSU)
  - Resilient Restoration FLISR (WSU)
  - Data Consistency & Security (WSU)
  - Resilience for Fault Tolerant Systems (UAF)
  - Distributed State Estimator (alpha, PNNL)
  - Distributed Energy Coordinator (alpha, PNNL)
- Apps in Coordinated Projects:
  - Observable Islands Tool
  - Model Discovery Tool
  - VRN3P Net Load Forecasting
  - Harmonic Enhanced Load Modeling (HELM)
  - FRS (FAST-DERMS)
  - PMU Analysis (SENTIENT)