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Edge Computing Infrastructure using Application-specific Programmable System-on-chip to Process Large Data Sets

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Grid-interactive Controls Group

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Grid Transformation








Decentralization



Resilience











Diversification

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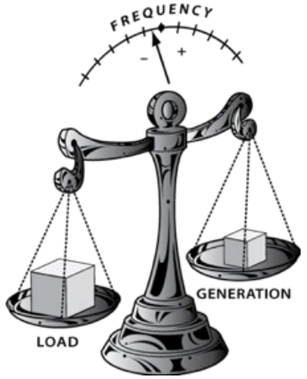
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Motivation

Application challenges	• Integrating variable distributed energy resources (DERs) • Integrating storage at multiple layers • Integrating electric vehicles (EV) • Managing demand – Residential, Commercial, Industrial – Enabling energy coordination and trading between buildings and trading between buildings and grid
Technology challenges	• **Diverse data sources – temporally and spatially** • **Scalable control and diagnostics algorithms that are driven by data** • **Actionable, real-time situational awareness**





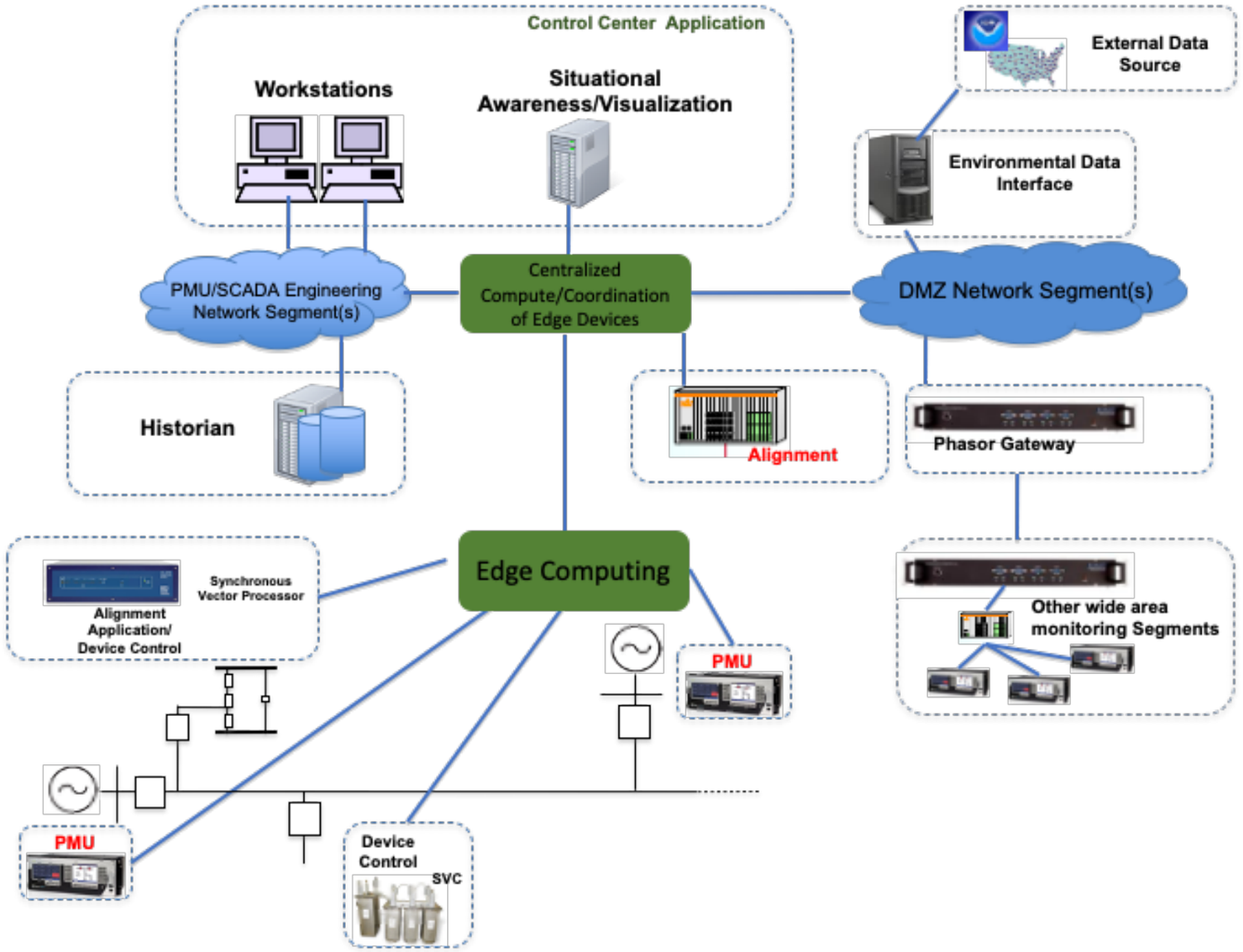


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Project Objectives

- Develop the workflow for deploying emerging distributed control/learning applications with edge computing platform to identify requirements and steps necessary for effective deployment
- Demonstrate prototyped edge computing platforms including both hardware and software for advanced grid control and analytics

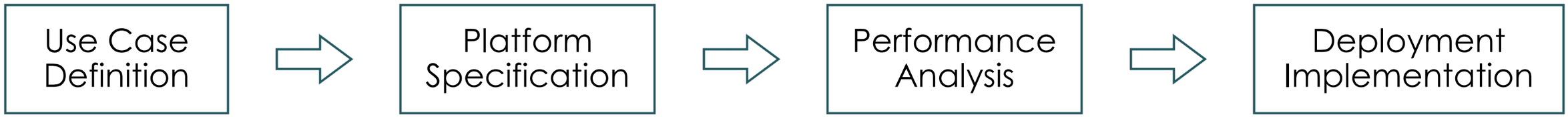


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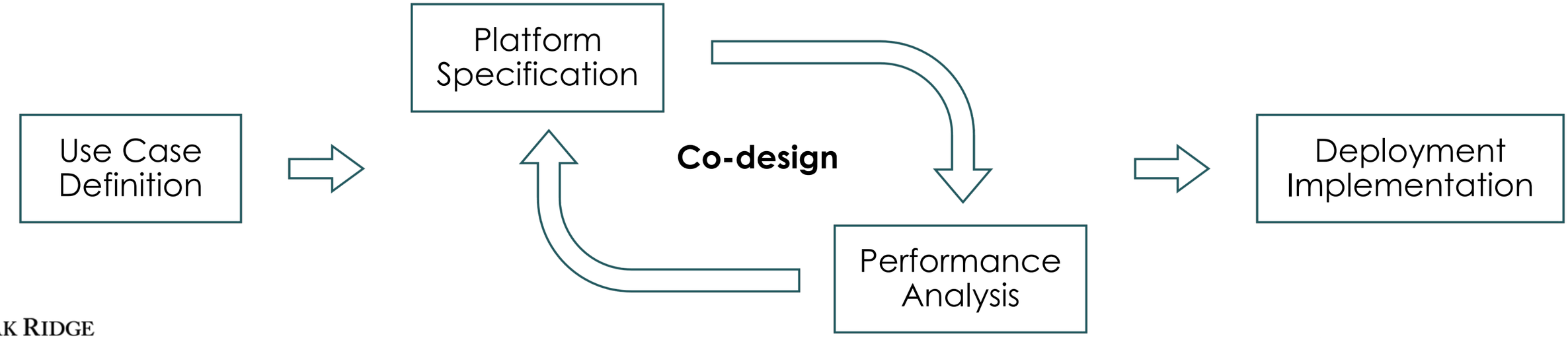
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Deployment Workflow

- Pre-defined Platform



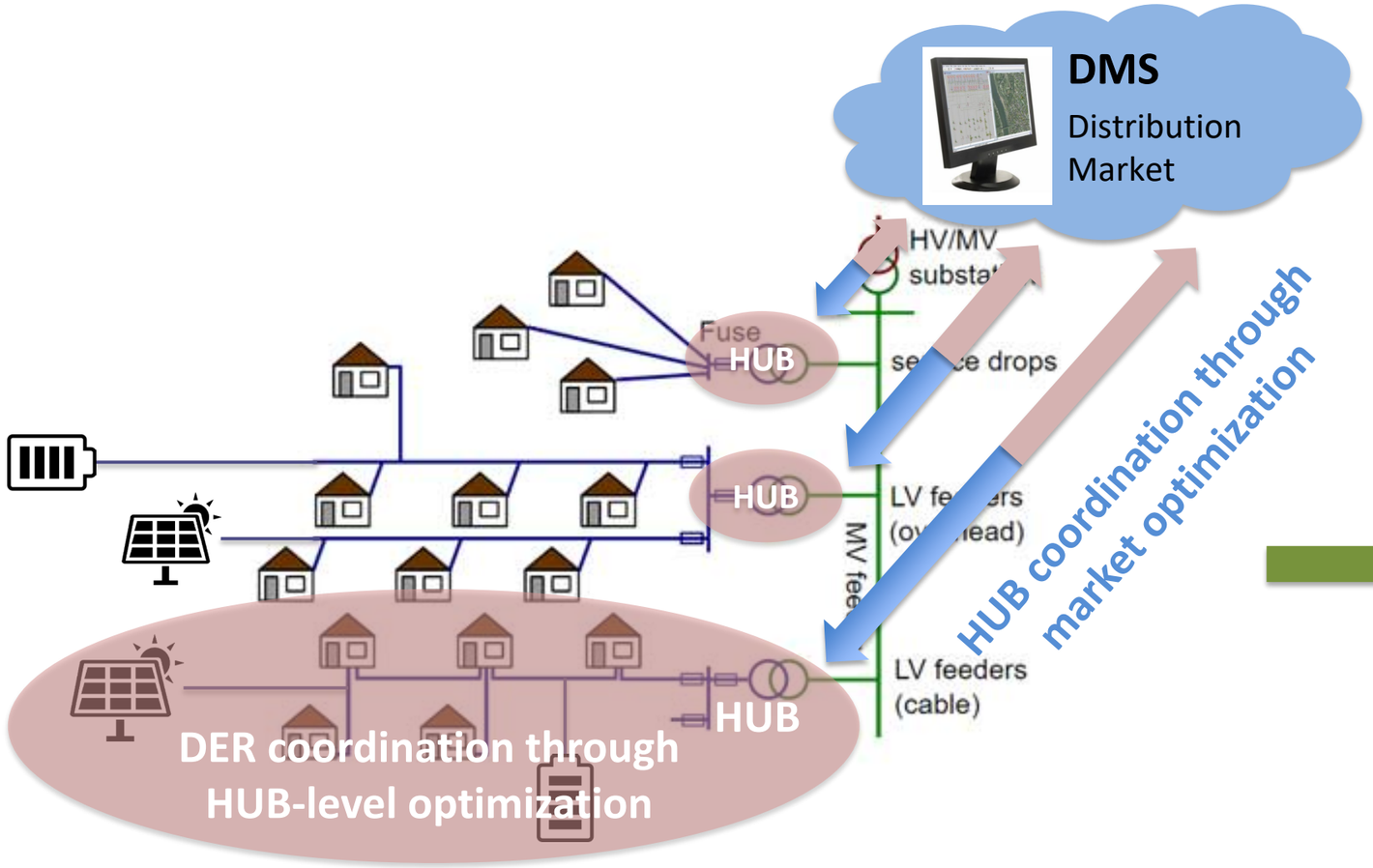
- Custom-designed Platform

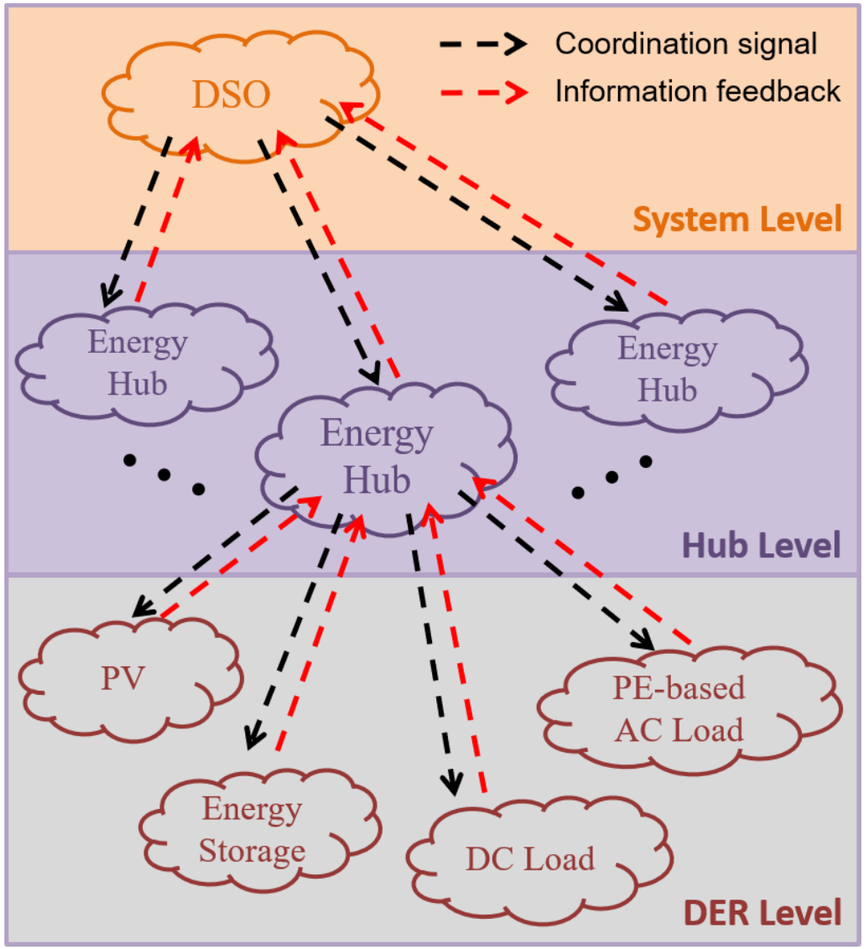


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Use Case Definition – Distributed Control

- Introduce HUB as the single point for control
- Enable new DMS for scalable DR integration and economic operation



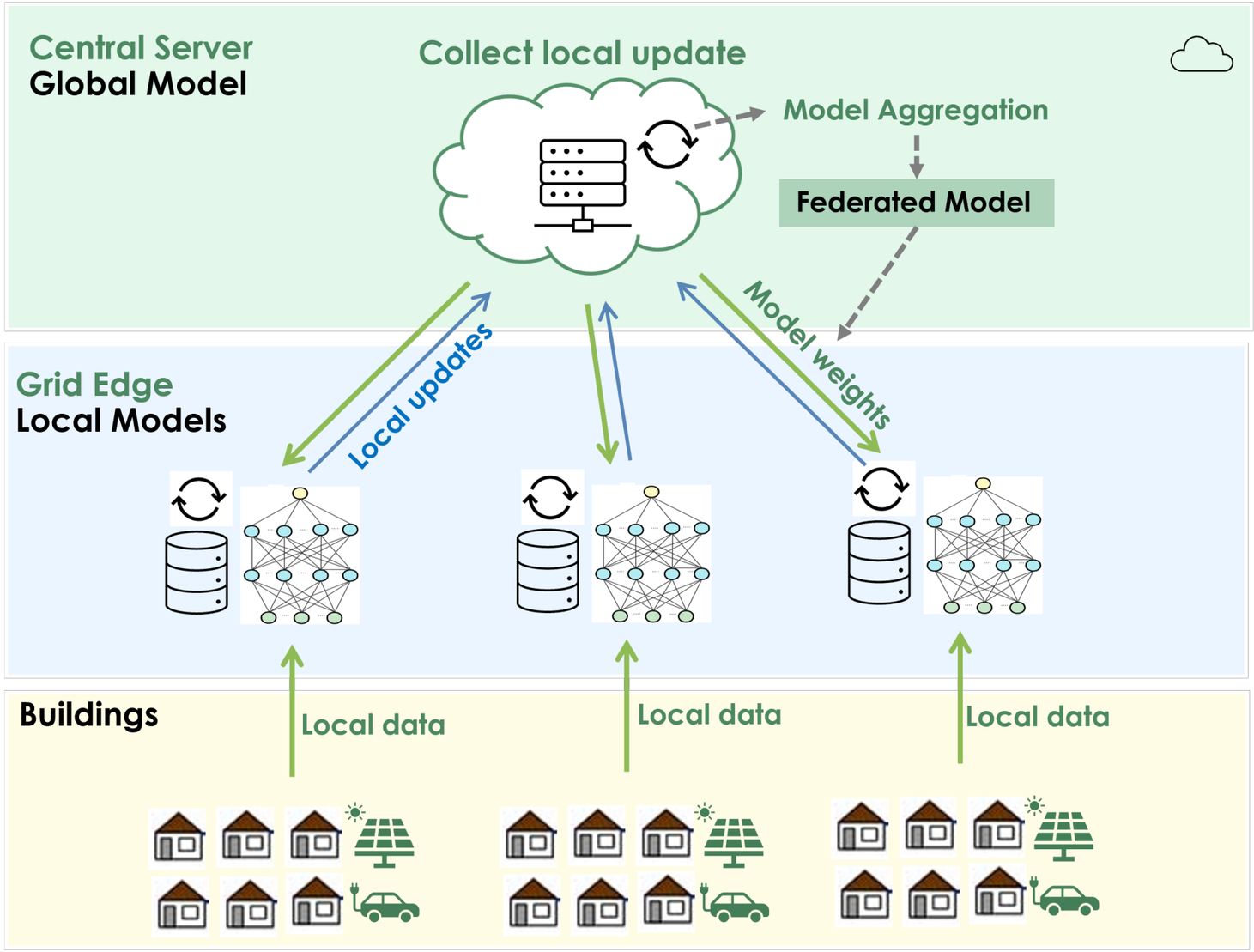


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Use Case Definition – Distributed Learning

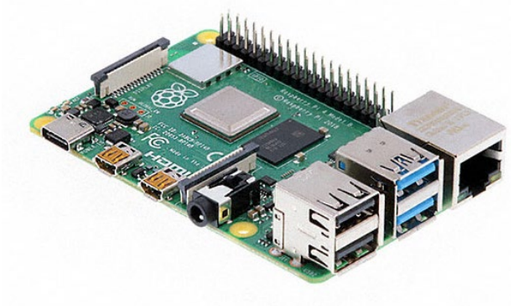
- Accurate DER and load forecasting becomes crucial for future distribution grid operations
- Centralized solution encounters significant barriers imposed by communication, computing and privacy constraints
- Federated learning allows local entity to train a shared model without sharing raw data



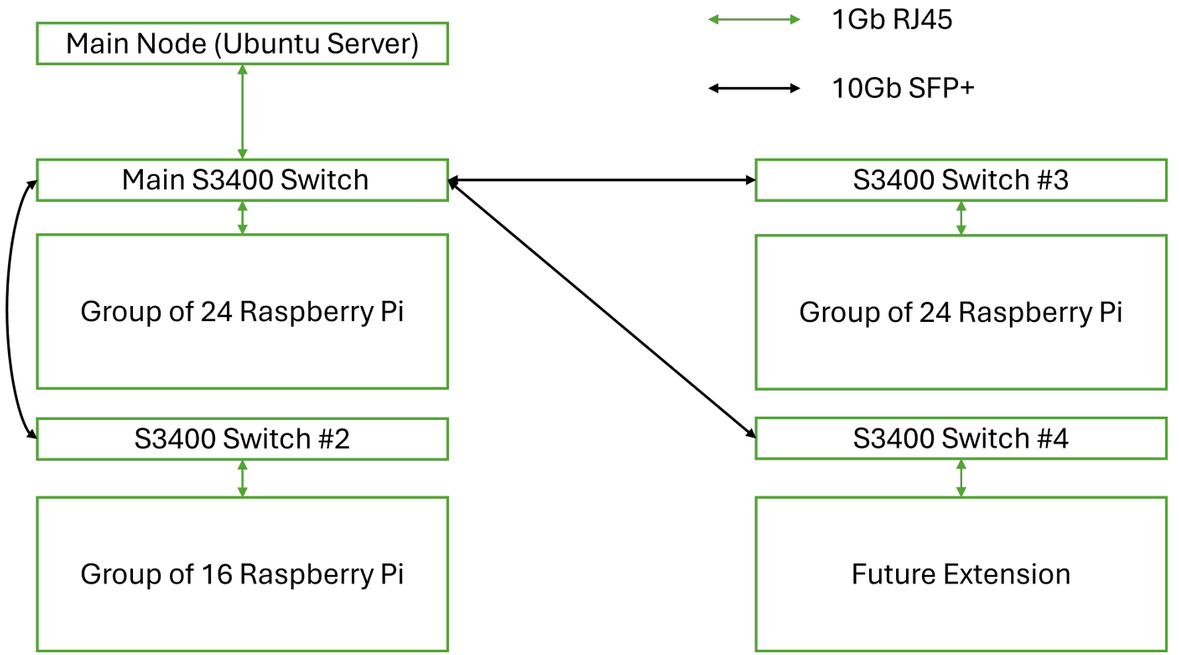
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Platform Specification

- Hardware Setup
  - 1 Main blade
    - Running Ubuntu Server 22.04 LTS
  - 64 Raspberry Pi (RPI) 4 B
    - 32 4 GB RAM and 32 2 GB RAM
    - Running Raspbian Lite OS
  - 64 PoE+ HAT (Power over ethernet)
    - Sits on top of Raspberry Pi to provide power
  - 4 SF S3400-24T4SP PoE+ switches
    - 10Gb SFP+ connections between switches
    - 1Gb RJ45 connections to RPI cluster
    - Includes DHCP server for IP assignment





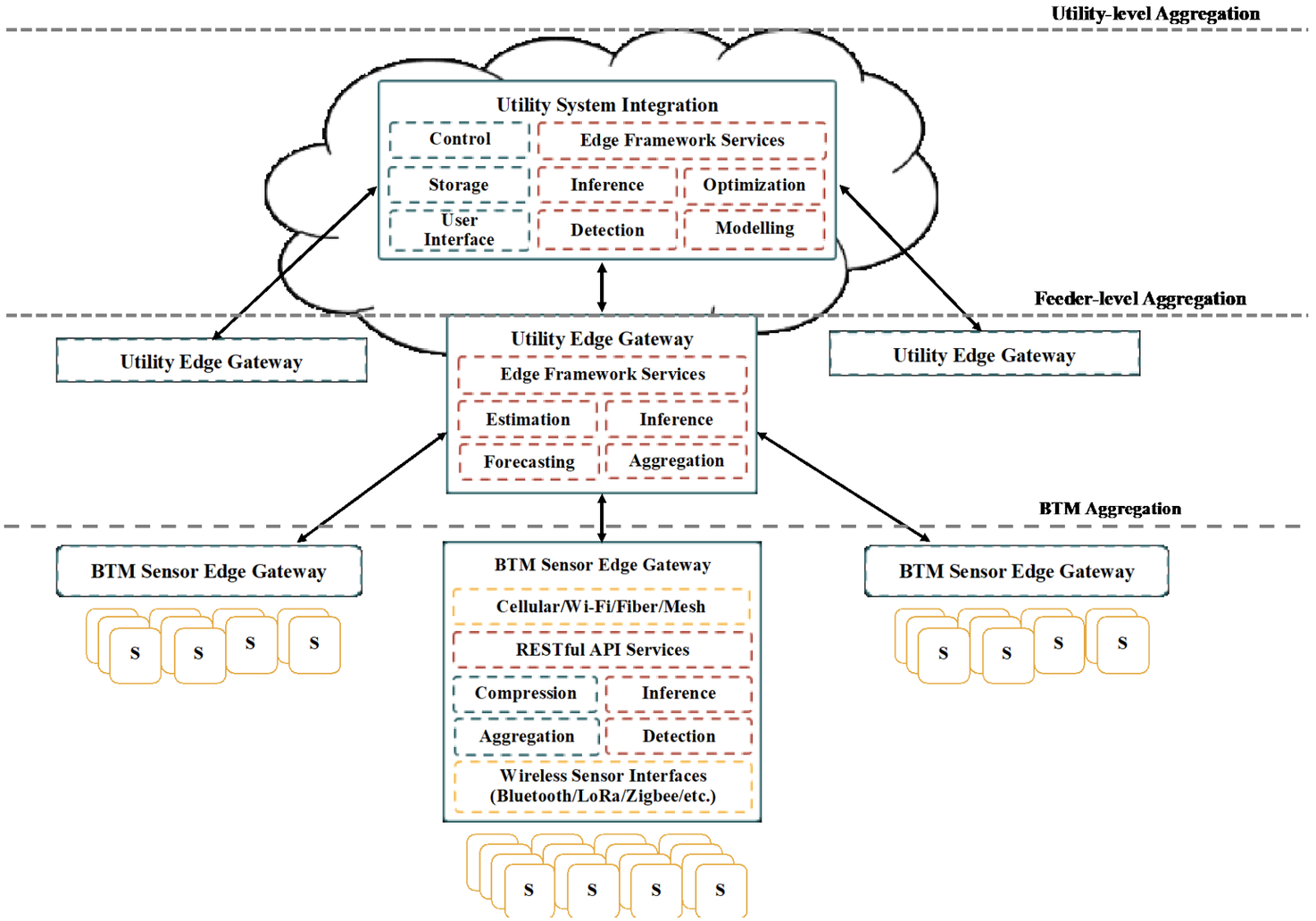


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Platform Specification (cont.)

- Software Framework

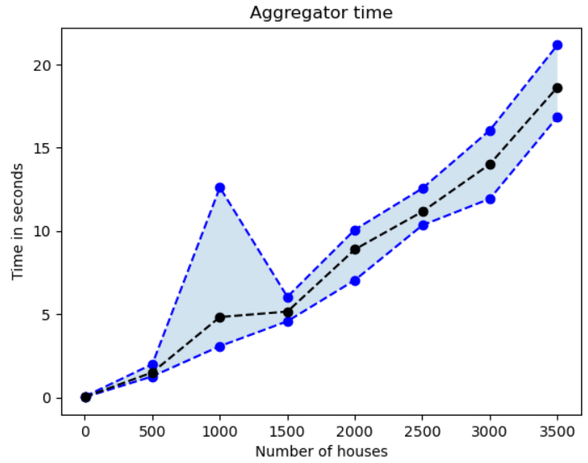


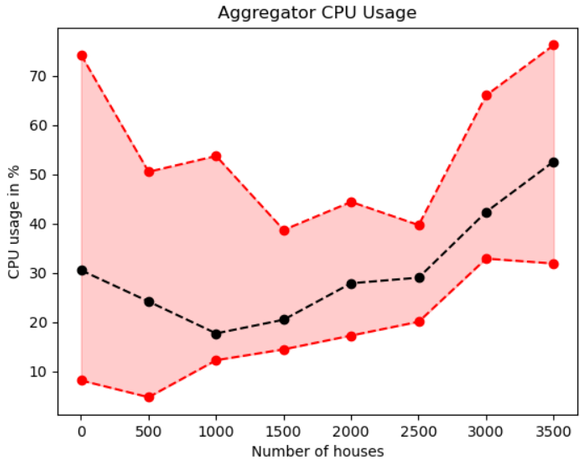
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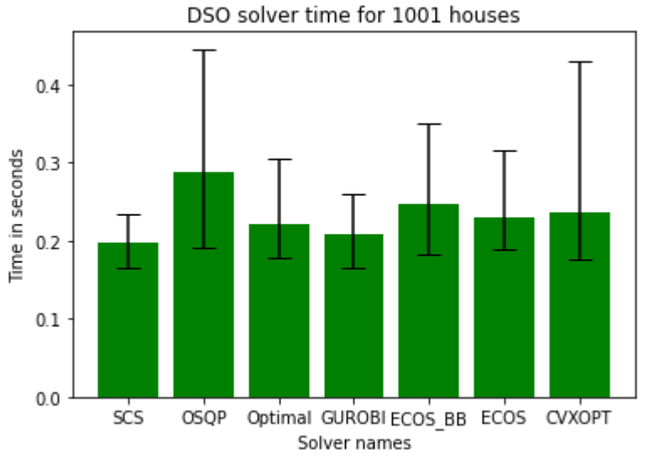
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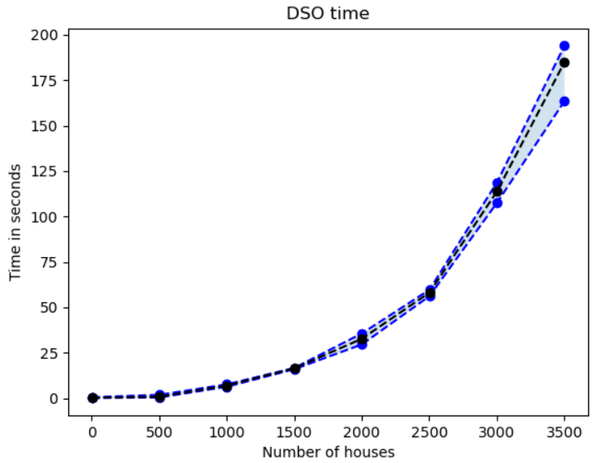
Performance analysis

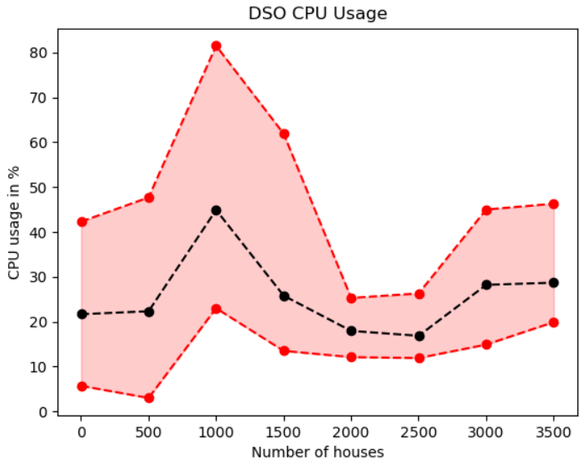
- Preliminary results for distributed Control

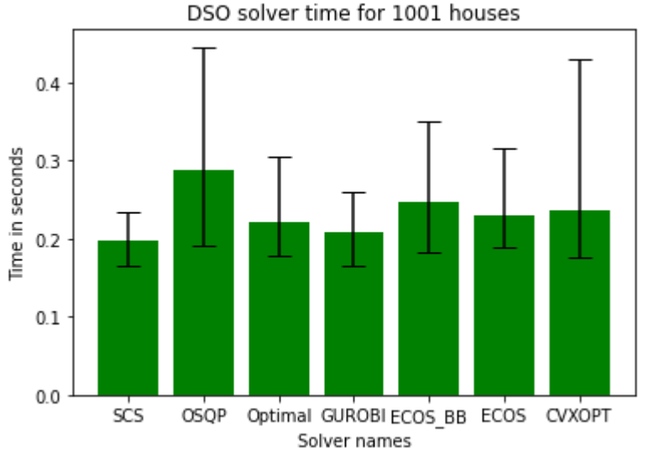












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Next Steps

- Complete the development of laboratory-scale edge computing platform with RPI 4
- Complete the performance analysis of selected use cases on distributed control & learning
- Complete the laboratory demonstration of edge computing hardware and software platform
- Investigate the interplay between the edge computing and communication system architectures

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Thank you

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