eMosaic: Electrification Mosaic Platform for Grid-Informed Smart Charging Management

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ABB Inc.

ELT274

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Overview

Timeline

- Project start date: 10/2020
- Project end date: 12/2024
- Percent complete: 10%

Barriers

- Determine methods to integrate with Utility signals and management
- Provide a combined view of multiple charging sites, levels, and types to form a full picture of EV charging
- High level of interoperability desired
- Provide pilot demonstrations with scalability assessment

Budget

- Total project funding
  - Total: $7.6 M
  - DOE share: $4.93 M
  - Cost share: $2.73 M (20%)

Partners

INL: EV charge and operation modeling scalability and power HIL tests for demonstration, Timothy Pennington (lead)

Utah State University: EV charging site and transportation system modeling, EV site deployment, Regan Zane (lead)

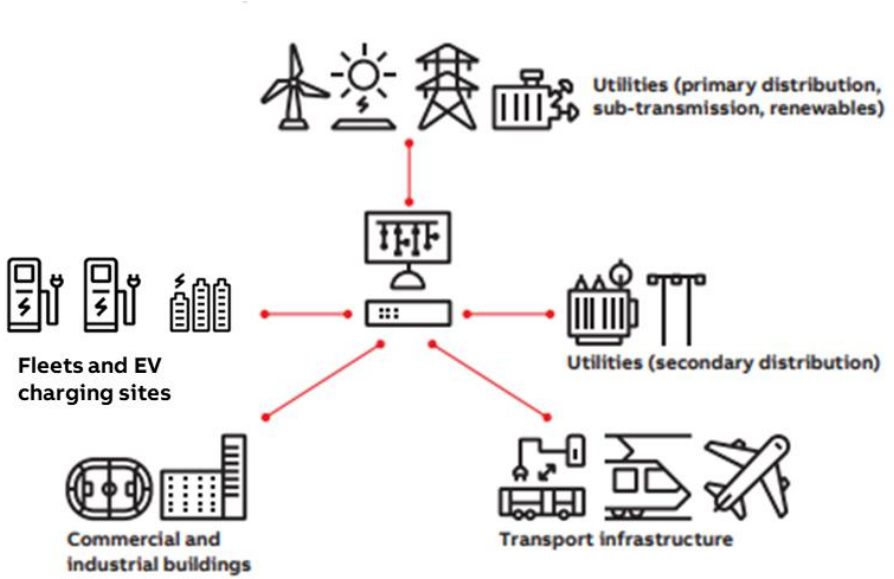
Rocky Mountain Power: Utility pilot planning and consulting, James Campbell (lead)

Proterra: EV transportation route planning consultation and telematics data for modeling and forecasting tasks, Alan Westenskow (lead)

Relevance

Provide a combined view of multiple charging sites, levels, and types to form a full picture of EV charging for Utility informed smart charging management:

- Explore site level control strategies to utilize utility planning, forecasting, and available resources to inform pricing and incentives
- Determine smart charging management needs for cloud aggregation and management features
- Enable larger scale grid services beyond individual sites informed by utility needs and input



Objectives:

- Develop a scalable, secure, and resilient eMosaic platform to provide localized and bulk grid services and smart charge management.
- Field deploy, validate and demonstrate the platform in the Rocky Mountain Power/PacifiCorp service territory
- Research, develop, and demonstrate a reference EV charging aggregation and control to provide novel features to utilities

Approach

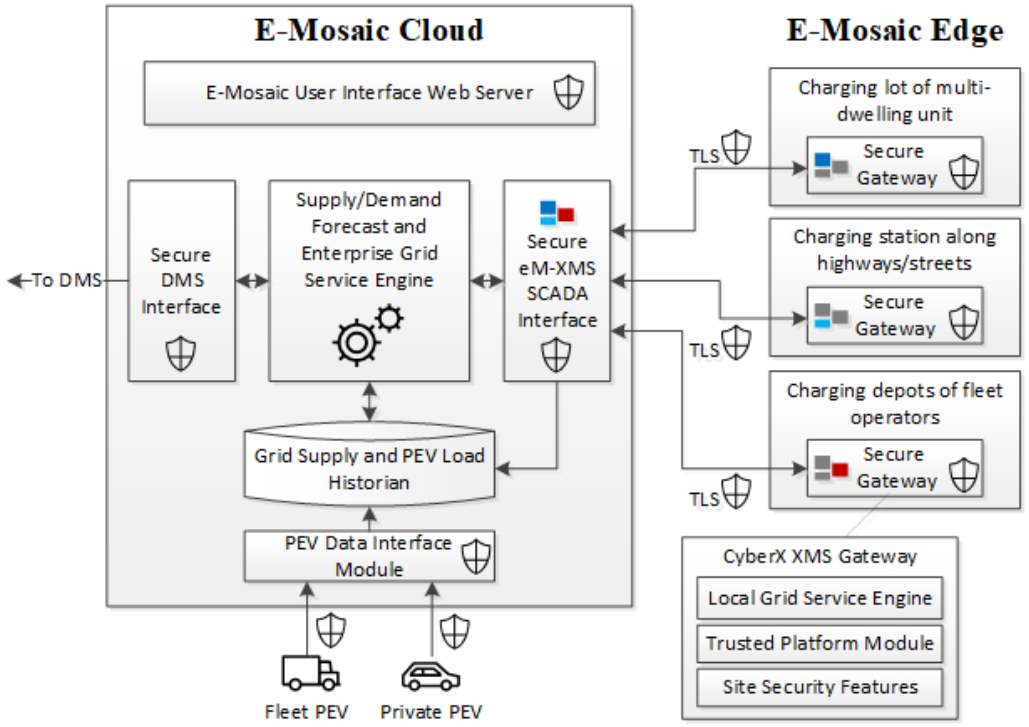
Milestones

No.	Milestone	Date	Type
M1	Complete Edge/cloud platform architecture design	6/30/2021	Quarterly Progress Measure
M2	Complete site requirement evaluation and initial data collection	6/30/2021	Quarterly Progress Measure
M3	Complete Caldera data simulation and model development	9/30/2021	Quarterly Progress Measure
M4	Complete data model and grid service algorithm design	9/30/2021	Quarterly Progress Measure
M5	Complete eMosaic SCM function development and prototype	11/30/2021	Annual Milestone
M6	Complete demonstration charging site control design	11/30/2021	Annual Milestone
M7		12/31/2021	Go/No Go
M8	Complete laboratory test design	3/31/2022	Quarterly Progress
M9	Preliminary laboratory tests for site integration	6/30/2022	Quarterly Progress
M10/11	Final laboratory test for site integration/Field deployment and demonstration plan	9/30/2022	Annual Milestone
M12		10/31/2022	Go/No Go

Approach

Detailed Tasks for eMosaic Project Budget Period (Year 1 - 2)

- **Task 1.1: eMosaic Architecture Design – In Progress**
  - Task 1.1.1: Edge and cloud platform selection
  - Task 1.1.2: Building base XFC station model & use cases
  - Task 1.1.3: Scalability design | Task 1.1.4: Data model & interoperability
  - Task 1.1.5: Prototype integration
- **Task 1.2: Grid Service Development – In Progress**
  - Task 1.2.1: Local grid services definition
  - Task 1.2.2: Cloud based FR and DR | Task 1.2.3: Charging site forecast
  - Task 1.2.4: Reinforcement learning site control
- **Task 1.3: Model and Control Design of Charging Sites – In Progress**
  - Task 1.3.1: Charging site model definition
  - Task 1.3.2: Model based charging site control validation
  - Task 1.3.3: Charging site load/ price forecast | Task 1.3.4: Model scalability
  - Task 1.3.5: Charging asset and energy needs gathering



- **Task 2.1: Initial eMosaic Platform Setup/Test**
- **Task 2.2: eMosaic Platform Demo Planning**

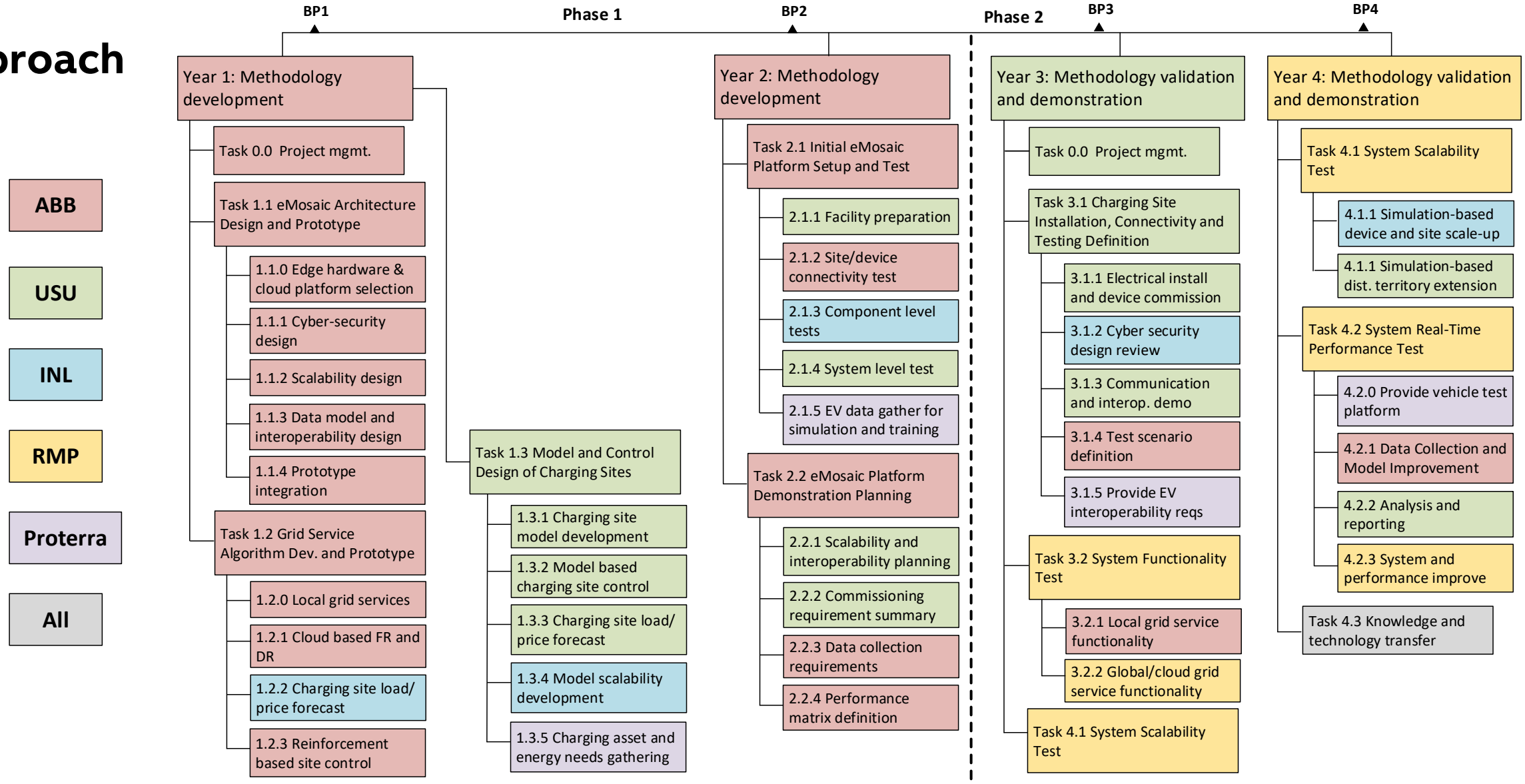
Approach

Detailed Tasks for eMosaic Project Budget Period (Year 3 - 4)

- **Task 3.1: Charging Site Installation, Connectivity Validation, and Test Scenario Definition**
  - Task 3.1.1: Installation & device commission
  - Task 3.1.2: Cybersecurity design review
  - Task 3.1.3: Communication connection and interoperability demonstration
  - Task 3.1.4: Test scenario definition
  - Task 3.1.5: Provide EV and supply interoperability requirements
- **Task 3.2: System Functionality Test**
  - Task 3.2.1 - .2: Local/Cloud Grid Service Functionality
- **Task 4.1: System Scalability Test**
  - Task 4.1.1 - .2: Simulation Scale-up for Individual Site and Service Territory
- **Task 4.2: System Real-Time Performance Test**
- **Task 4.3: Knowledge and Technology Transfer**

Unique aspects - *(1) Edge and cloud enabled features for smart aggregate and grid service (2) Reinforcement learning based charging site control (3) Location dependent multi-category demand/price forecast (4) Pilot using real hardware and scaled co-simulation*

Approach



Technical Accomplishments to Date

Milestone 1: Edge/cloud platform architecture design

- Selected initial hardware and cloud platforms for technology development
- Setup on-premise server/cloud for developing reinforcement learning, forecasting, and grid service algorithm development
- Designed initial plans for scalability of site solutions including multi-factored containerized applications running at individual sites or on higher performance server
- Determining data model requirements for key measurements and information required from individual sites, requirements for data update frequency to cloud aggregators
- Testing site control strategies using modeled data from INL's Caldera tools

Initial hardware and cloud platforms for technology development selected to enable aggregation and control

Technical Accomplishments to Date

Milestone 2: Site requirement evaluation and modeling

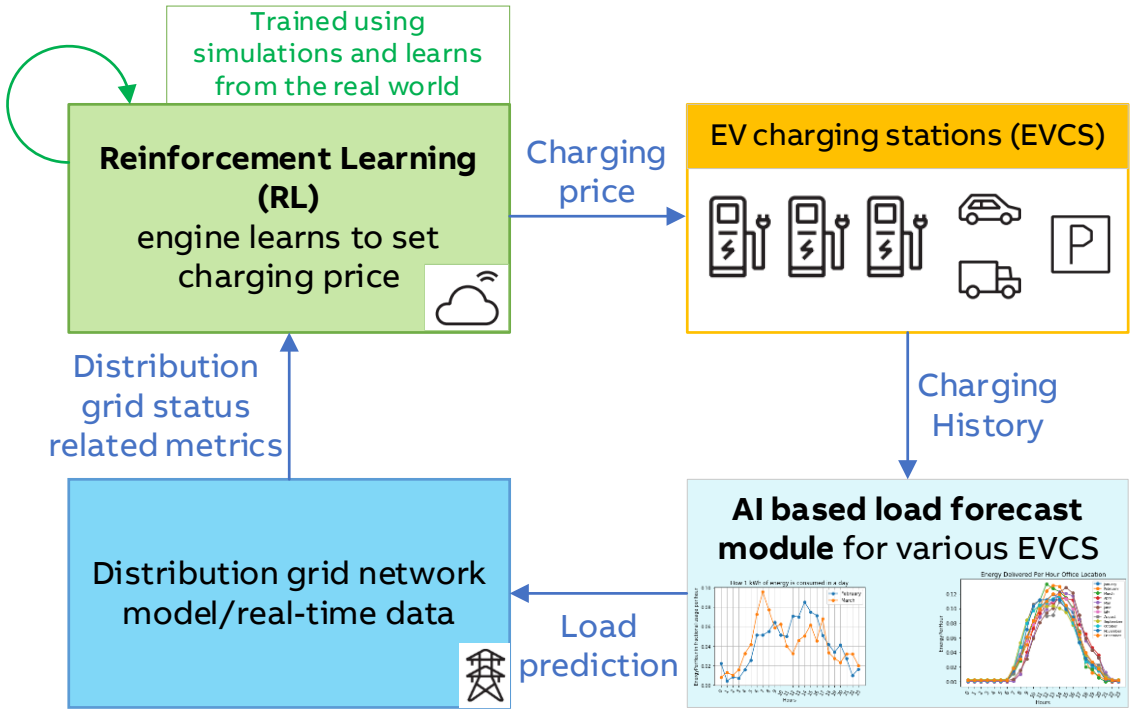
- USU has identified the Utah Transit Authority Central Station Intermodal Hub for the development of a charging site model
- Additional transit sites may be leveraged to further provide simulation possibilities and test results
- Collecting data for the site charging demands by obtaining real-time and historical information for the battery electric buses serviced at the hub.
- Required loads on the site have been identified (e.g. building utility, depot requirements, electric light rail) along with the respective data for model input.
- Developing model components for the site using Caldera models and will base future site modeling efforts on lessons learned in Intermodal Hub work

Defining EV charging site modeling requirements based on first identified Intermodal Hub Site

Technical Accomplishments to Date

Milestone 4: Initial data collection and forecasting

- Market driven approach to controlling the charging station load through price
- Train the RL agent using simulations allowing it to explore thousands of operational situations
- RL agent sets a time-varying price for charging.
- The solution is designed to help reduce the cost of delivering power to the customer, while also assisting the grid/utility.



Defining algorithms and required models and data to develop proposed features

Collaboration and Coordination

- **Project collaborators**
  - ABB (prime), industry vendor
  - INL (sub), national lab
  - Utah State University (sub), academic
  - Rocky Mountain Power (sub), utility
  - Proterra (sub), transportation sector

- **Communications**
  - Weekly meeting, ABB internal
  - Monthly to Bi-Monthly meeting, Project partners
  - As needed meeting with DOE and partners

- **ABB: EV site and cloud platforms for EV charging hardware integration and**
  - Integration of EV supply equipment, modeling and simulation for control feature
- **INL: EV modeling, EV Cybersecurity, and Power hardware-in-the-loop simulator for demonstration**
  - EV/EVSE modeling, HIL testbed and power systems
- **USU: Electric distribution system site control modeling and forecasting, EV equipment deployment**
  - EV/EVSE site modeling and forecast algorithms for control
- **RMP: EV pilot planning and deployment support**
  - EV engineering and demonstration support
- **Proterra: EV transportation route planning consultation and fleet scheduling interface support**

Remaining Challenges and Barriers

- Determining best way to integrate fleet or transportation dispatch management APIs
- Providing a security by design approach to embedded edge and remote cloud infrastructure for real-time aggregation and effective forecasting
- Validating feasibility of developed algorithms for reinforcement of price trends and user behavior incentives on price and other EV charging benefits to affect grid stability and planning
- Commissioning and coordinating pilot sites with additional controllers and data aggregations platforms
- Validating approach of scalability using Caldera modeling co-simulation and integrating with pilot sites to provide value

Proposed Future Works

- **Ongoing FY-21**
  - Create integrated eMosaic architecture prototype with EV charging equipment and
  - Continued development of model components in Caldera and identification of additional features to develop in Caldera
  - Establish communication with charging equipment at site.
  - Develop HIL simulation and site control strategy to enable grid services

- **FY-22***
  - Set up an eMosaic platform at USU and INL lab facilities for aggregation and feature testing
  - Plan a lab scale demonstration incorporating multiple sites and assess the eMosaic platform
  - Define interconnections for providing grid informed charging (protocols, models needed)
  - Define requirements for data gathering to support forecasting and other proposed control features

*Any proposed future work is subject to change based on funding levels.

Summary

Designing eMosaic platform to provide a combined view of multiple charging sites, levels, and types to form a full picture of EV charging for Utility informed smart charging management

Four milestones in progress:

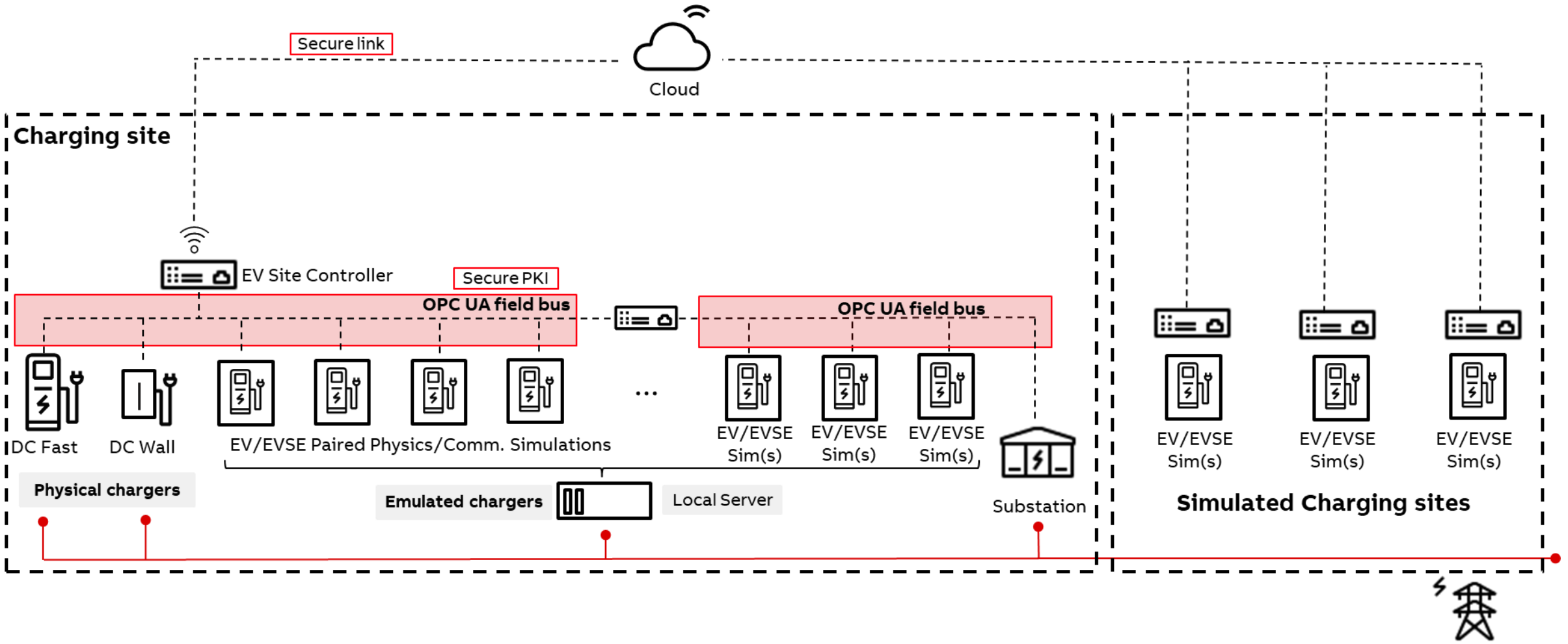
- Setup initial embedded hardware platform, designed software architecture, and setup high performance server for emulating cloud platform
- Defining EV charging site modeling requirements based on first identified Intermodal Hub Site
- Defining algorithms and required models and data to develop proposed features
- Partner teams incorporating Caldera models and determining feature to requests

Pilot demonstration phase will follow initial technology development* with utility and transportation partners

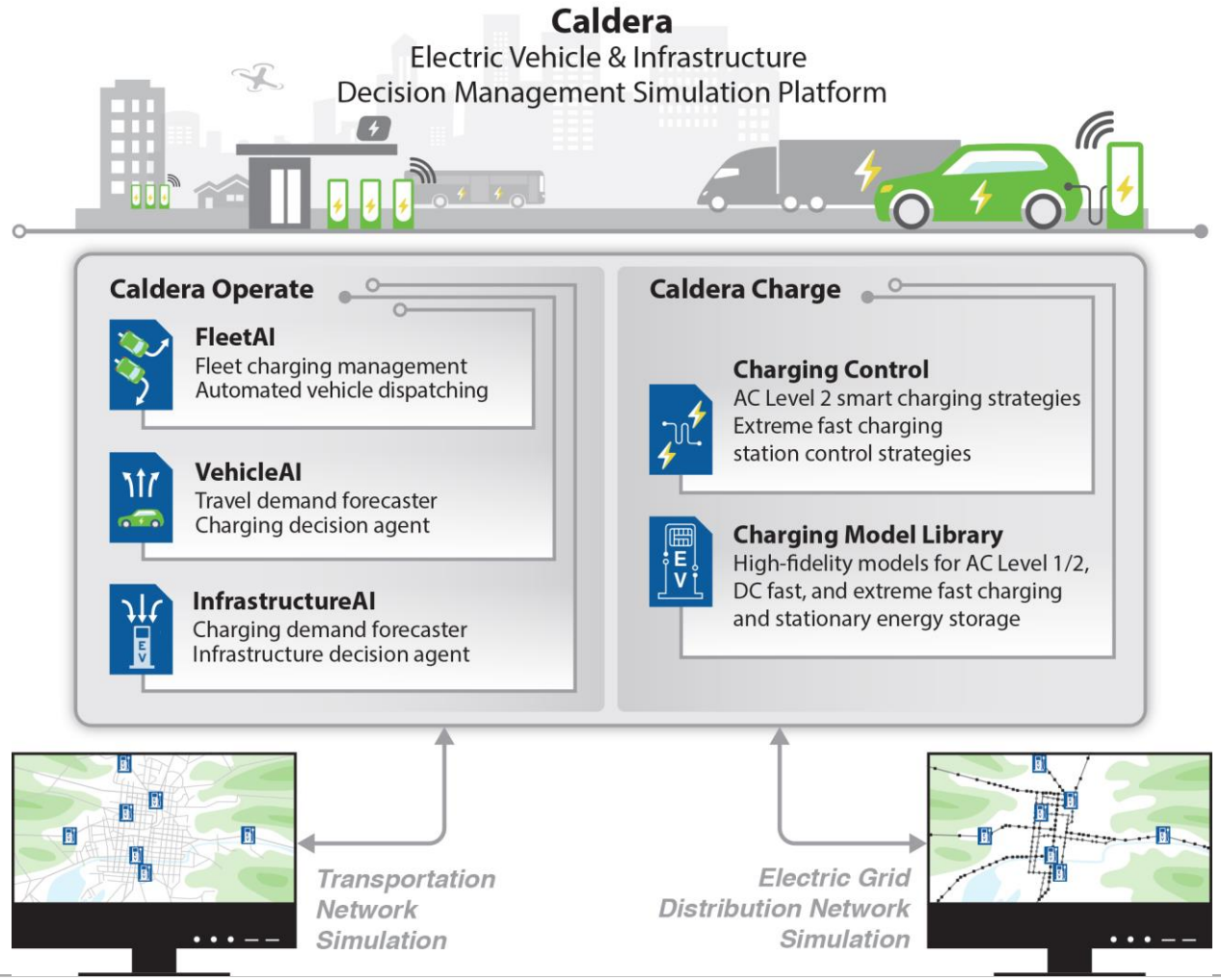
*Any proposed future work is subject to change based on funding levels.

Technical Back-Up Slides

SCM Communication and HIL Testbed



INL - EV Modeling for Operations and Charging



https://docs.helics.org/en/latest/user-guide/helics_key_concepts.html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