Integrated Grid Project (IGP)

EPIC Winter Symposium

Bob Yinger – Chief Engineer

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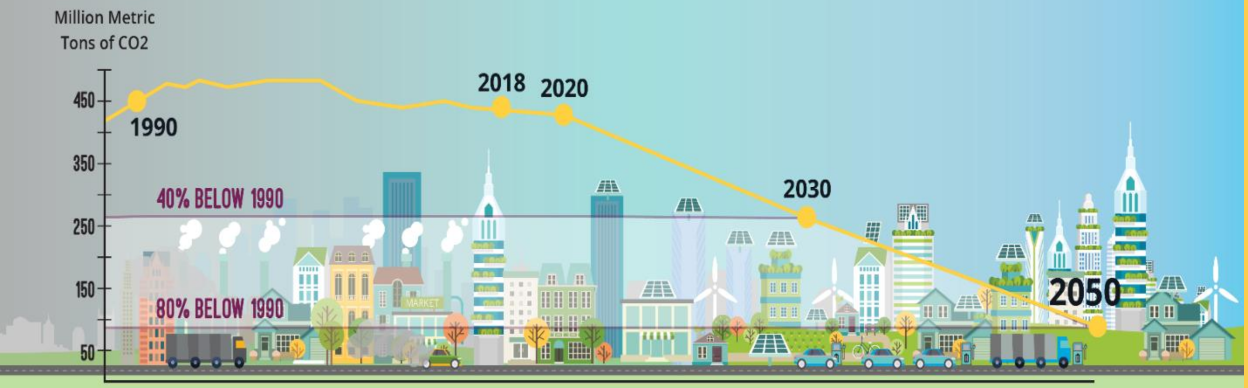
Southern California Edison in 2018

- 15 million residents in a 50,000 square mile area
- 40% energy from carbon-free sources
- Joined open letter to support Paris Climate Accord
- Utility Dive "2017 Utility of the Year" for our 2017 Clean Power and Electrification Pathway



Supporting California's 2030 greenhouse gas reduction goals

Objectives

- Demonstrate the next generation grid infrastructure (field and back office) to manage, operate, and optimize the grid with high penetrations of DER
- Provide a demonstration test bed for systems, equipment, and concepts for future modernization efforts
- Verify technology readiness and potential architectures

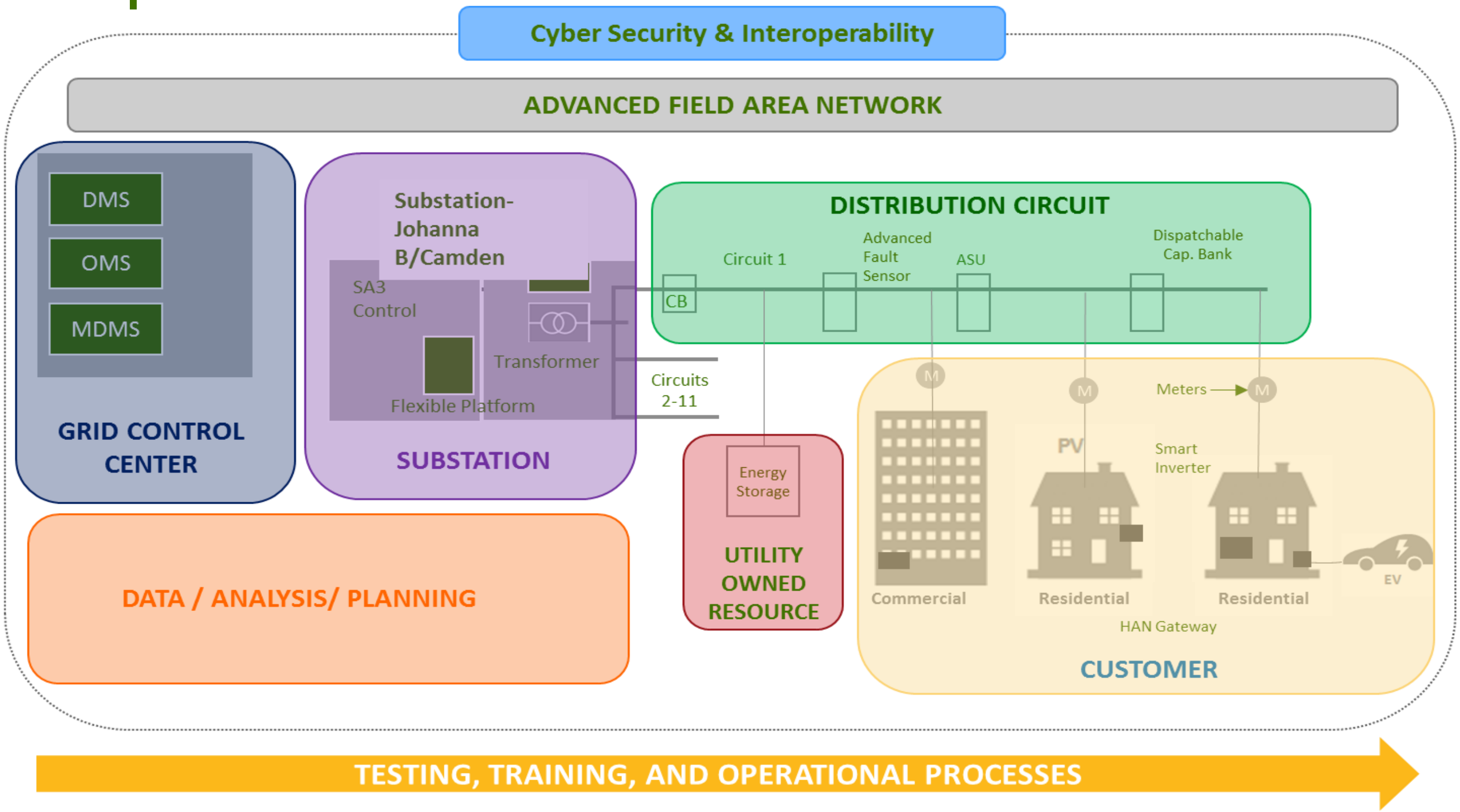
This testing of emerging technology components and back office systems will enable effective technology choices, reduce capital deployment risk, and accelerate SCE's ability to modernize the grid

Scope and Timeline

- IGP focuses on optimizing all DER assets, 3rd party- or utility-owned
- The project is organized into three major areas
  - DER control systems (voltage and power flow optimization)
  - Cross cutting functions (i.e. communications, cyber & integration)
  - DER resource contracting for tests (3rd party & aggregators)

Phase 1: Planning 2015 - 2016	Phase 2: Lab Test 2017-2018	Phase 3: M&V 2018—2019

Scope



As controls interact with back-office applications, field devices, and aggregators over the Internet, cybersecurity measures become more important

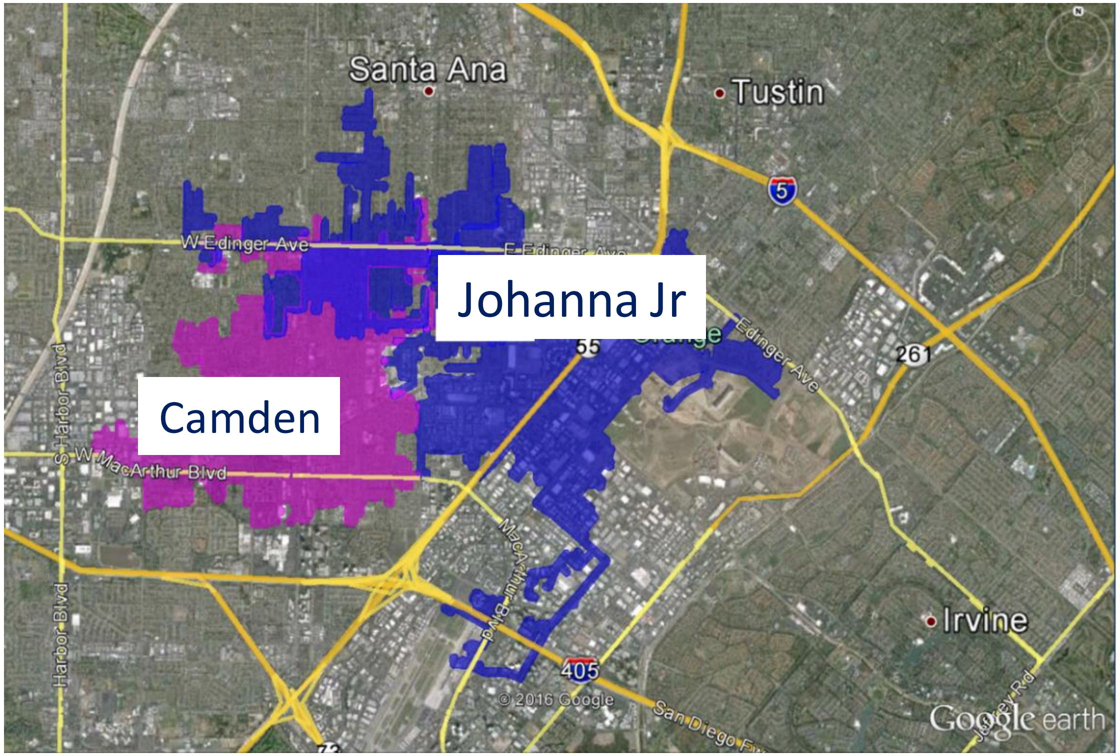
Technical Highlights

- DER Controls
  - Provides increased DER integration capacity by optimizing power flow and voltage control
- Operational Service Bus
  - Provides easier integration of multiple applications through standard data and services
- Field Area Network
  - Provides low latency communications for advanced field automation and DER controls
- IEEE 2030.5 Standard
  - Provides standard method to communicate with smart inverters and aggregators

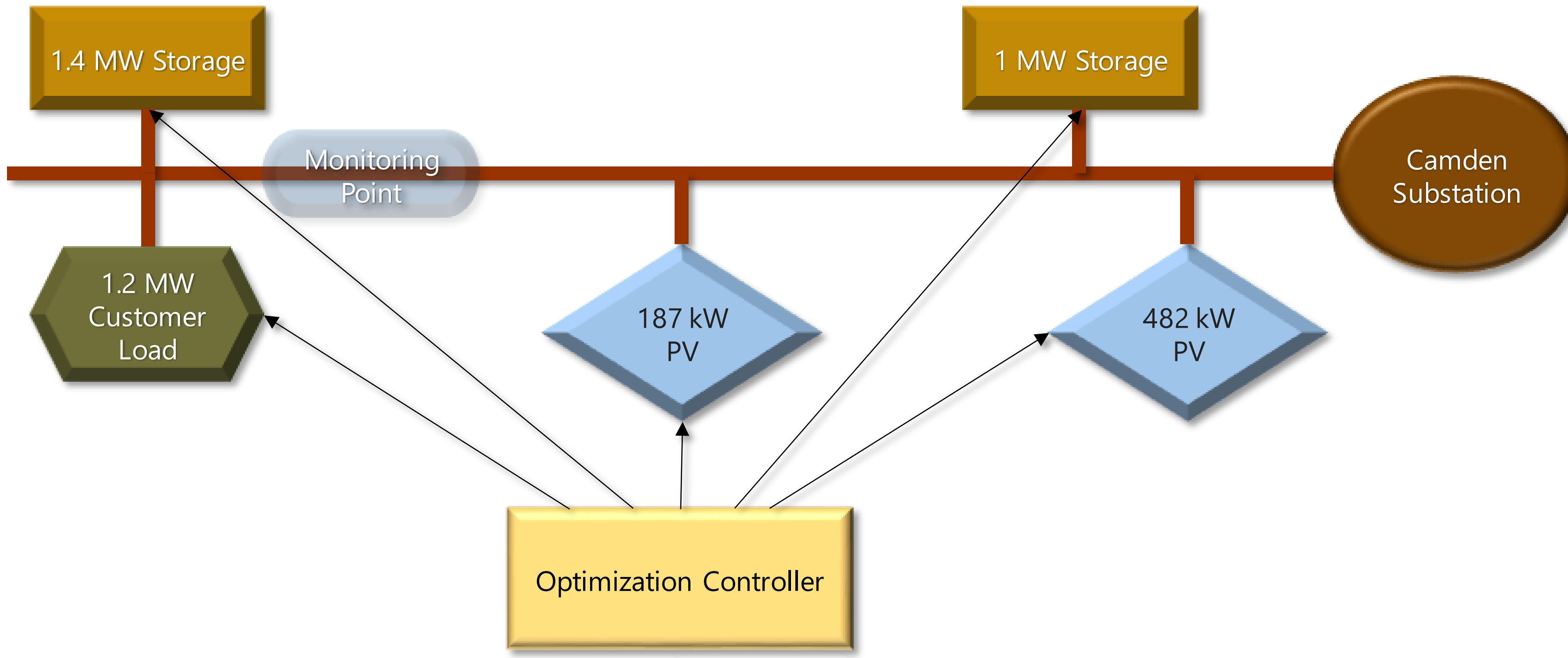
Site Selection

Camden and Johanna Jr substations

- Mix of overhead and underground circuits
- Both residential and commercial customers
- Several large PV installations already in place
- Located in the Preferred Resource Pilot (PRP) area

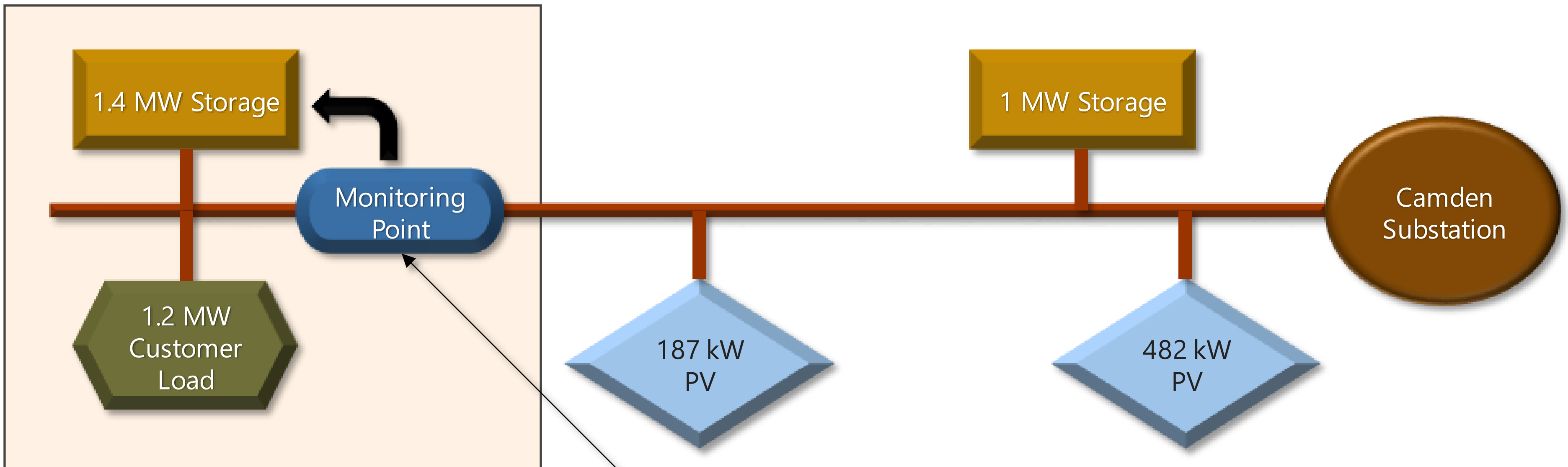


Use Case: Power Flow & Voltage Optimization



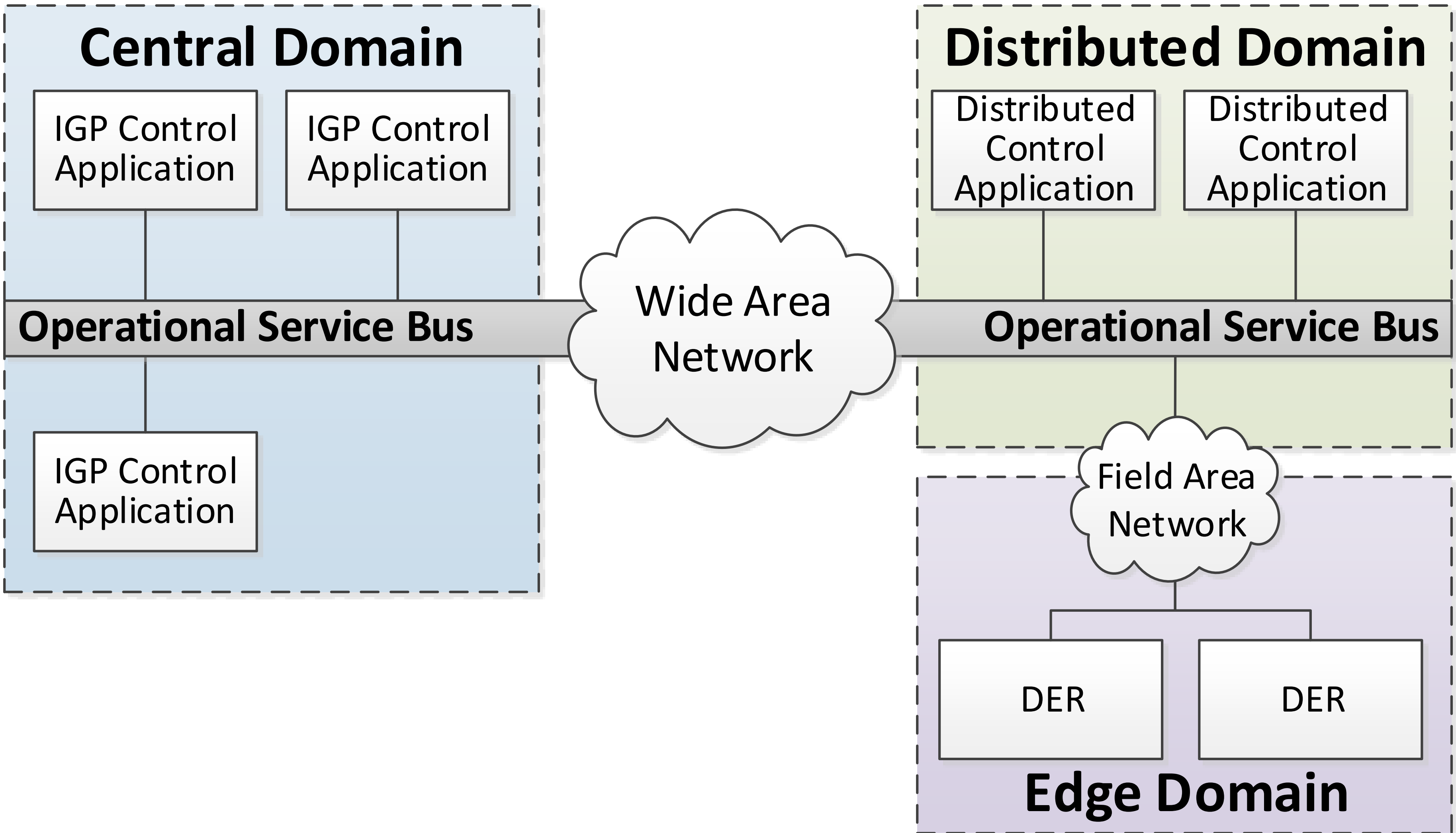
Optimization controller monitors all DER and sends commands to maintain the correct voltage levels and operate within grid power flow constraints

Use Case: Virtual Microgrid

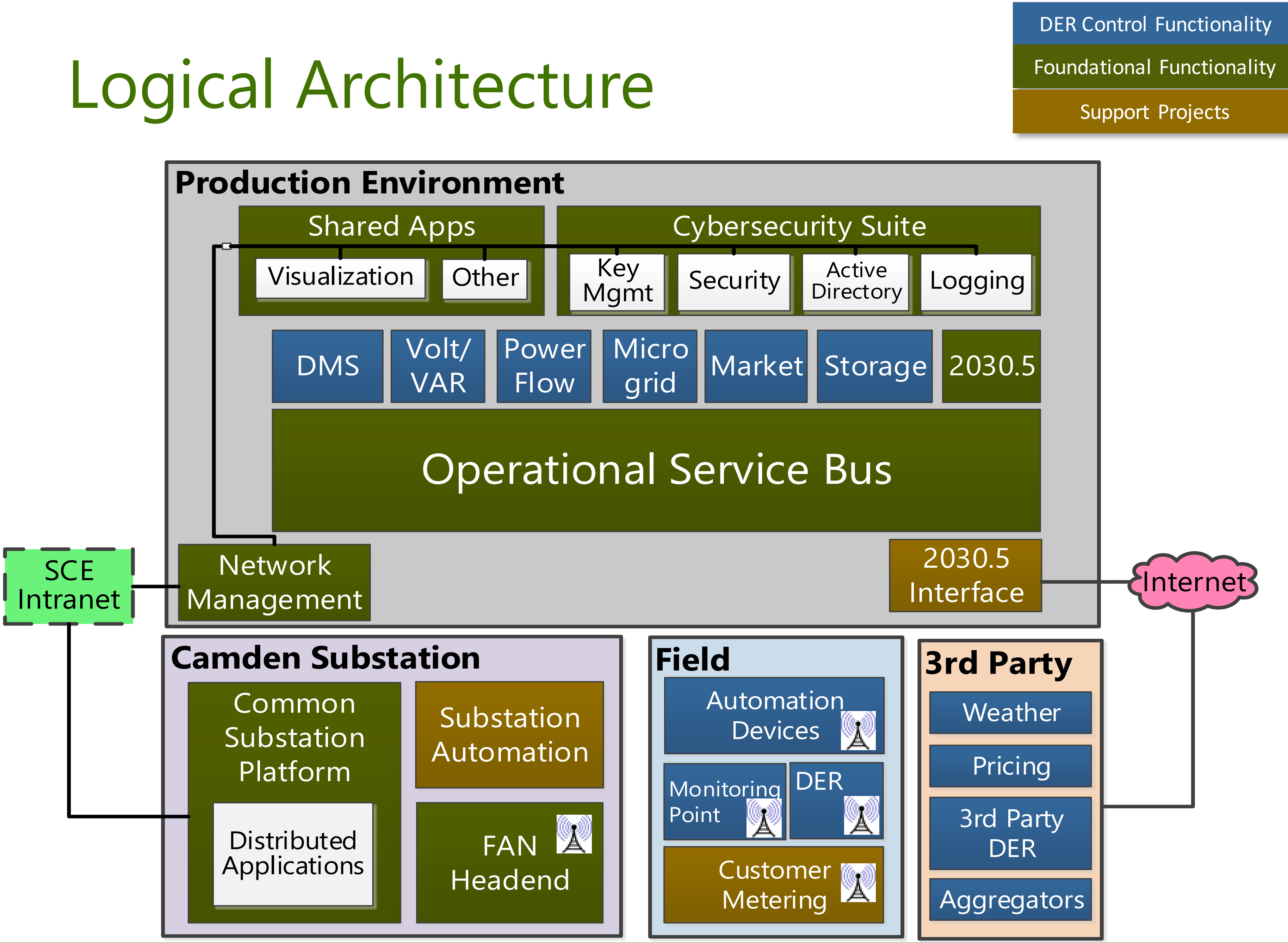


Monitoring point samples power flow and directs DER to reduce the power flow at the monitoring point to zero

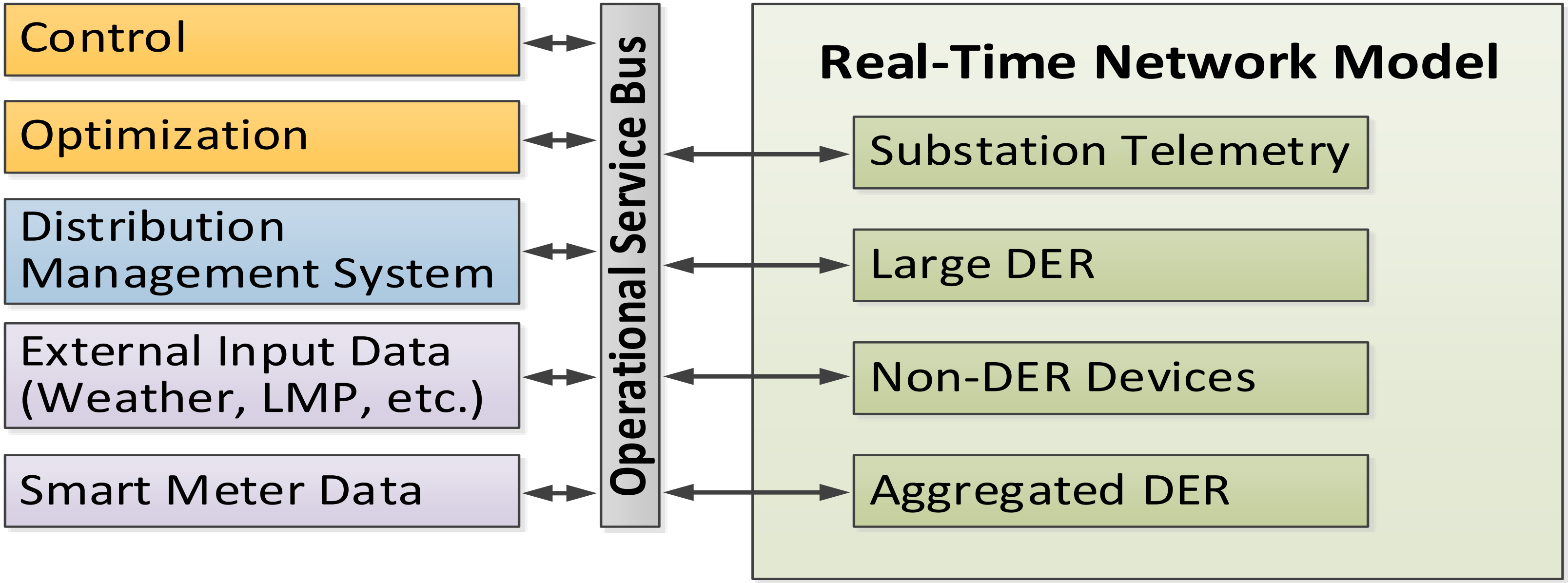
High Level Logical Architecture



Logical Architecture



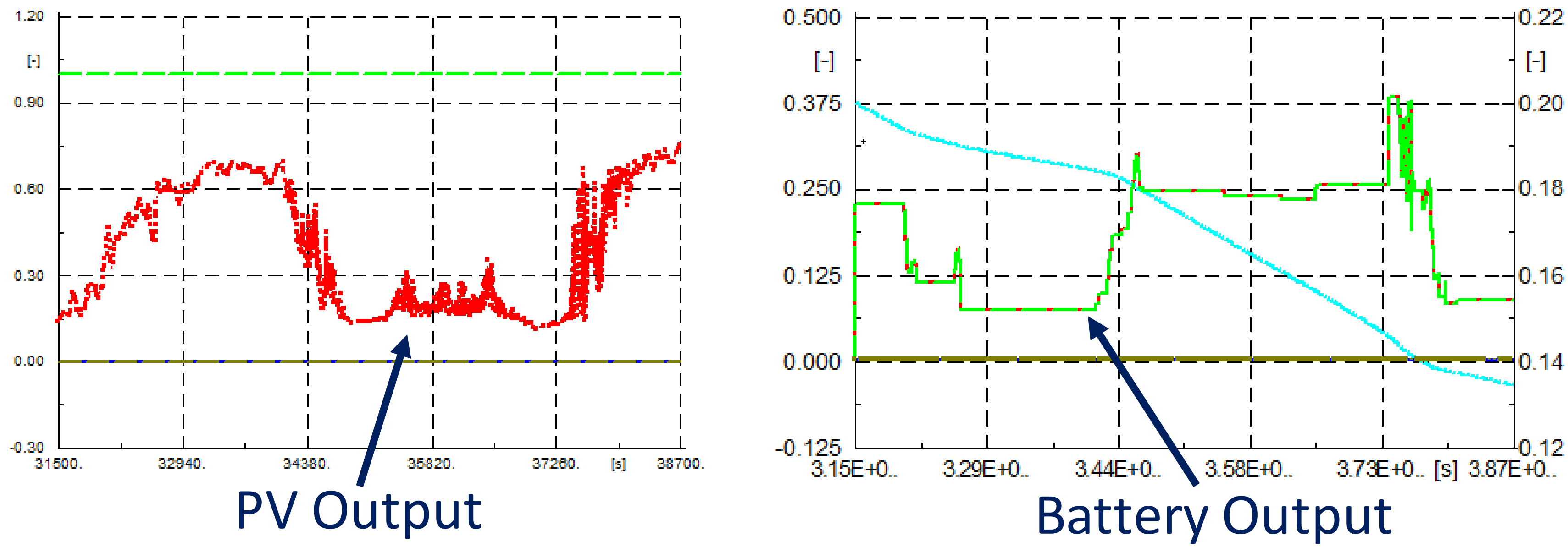
Closed-Loop Testing Approach



Benefits to the approach

- Test multiple applications, hardware configurations and communications infrastructure
- Testing both centralized and distributed controls as well as optimization routines
- Simulating hypothetical DER adoption or load growth scenarios

Example Test Results



- Battery is used to offset change in PV output as well as reduce the higher frequency PV output variations

Connecting to 3rd Party DER

- Most new DER resources connected to the utility grid are owned by customers or third-party developers
- For DERs to provide grid support, the utility may want to reduce output or produce reactive power limiting the DER's real power output
  - How do utilities compensate owners of DERs for the services they provide?
  - Will the incentives being considered lead to higher levels of penetration?

Key Accomplishments

- Identified site for utility-owned storage system
- Developed system requirements and completed system design for high penetration DER control systems
- Developed a high-level integration path for aggregators of DERs using IEEE 2030.5
- Integrated the distributed control systems with the production DMS through the operational service bus
- Assembled laboratory test environment based on the DigSILENT PowerFactory simulation system
- Completed first series of factory acceptance testing (FAT) of the control systems and the operational service bus
- Tested and evaluated four FAN communications systems and down-selected to two systems

Key Lessons Learned

- IEEE 2030.5 standard is in early stages of deployment and few aggregators have it
- Lab testing with a real-time simulation approach allows examination of a broad range of conditions before field deployment
- Edge computing capability in the FAN field device is vital to allowing network adaptability
- When integrating cybersecurity measures, examine all systems for continued proper operation
- Recruiting customers for the demo requires establishing value for their efforts/equipment use

Value for Future Modernization Efforts

- Design and demo IEEE 2030.5 architecture acceptable to SCE cybersecurity group
- Demo volt/VAR and power flow optimization techniques using DERs
- Show integration of multiple applications through operational service bus
- Develop detailed interface service definitions that can be reused
- Assess field message bus technologies
- Host first test of FAN technologies in the field

IGP Status

- EPIC I Activities Completed
  - Completed requirements, design and architecture
  - Completed control system RFP and vendor selection
  - Demonstrated core functionality and system integration in the lab
- EPIC II 2018 Activities
  - Begin field demonstration of the IGP controls with distribution circuit resources (e.g. capacitor controllers, remote control switches with monitoring, DER resources)

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Energy for What's Ahead℠

Bob Yinger
Consulting Engineer
Grid Technology & Modernization
Southern California Edison
Robert.Yinger@SCE.com