

SDG&E EPIC Program Overview



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Presentation overview



- SDG&E overview
- Project lists for three EPIC cycles
- Overall status and selected project highlights
- Final reports that have been released
- Information available on public website at sdge.com/epic

SDG&E service area



- A population of 3.6 million people in a 4,100 square-mile service area spanning 2 counties and 25 communities.



EPIC-1



Five projects in advanced distribution automation

1. Smart grid architecture demonstrations
2. Visualization and situational awareness demonstrations
3. Distributed control for smart grids
4. Demonstration of grid support functions of distributed energy resources (DER)
5. Smart distribution circuit demonstrations

EPIC-2



1. Modernization of distribution system and integration of distributed generation and storage
2. Data analytics in support of advanced planning and system operations
3. Monitoring, communication, and control infrastructure for power system modernization
4. System operations development and advancement
5. Integration of customer systems into electric utility infrastructure
6. Collaborative programs in RD&D consortia:
 - Unmanned aerial systems data lifecycle management and deep learning
 - Methodology for predicting propensity for customer adoption of PV

EPIC-3 approval pending (Application May 1, 2017)



1. Integration of battery and photovoltaic systems into utility operations
2. Energy storage performance evaluation
3. Application of advanced metering infrastructure (AMI) data to advanced utility system operations
4. Safety training simulators with augmented visualization
5. Unmanned aircraft systems (UAS) with advanced image processing for electric utility inspection and operations
6. Repurposing post electric vehicle batteries for utility, commercial, and mass transit applications
7. Demonstration of multipurpose mobile battery for port of San Diego and/or other applications

Overall status



- One EPIC-1 project continuing to mid-2018
 - Visualization and situational awareness use cases
- All other EPIC-1 and EPIC-2 projects completed and comprehensive final reports filed with CPUC and posted on SDG&E website
 - Reports sufficiently comprehensive to enable others to use the results and thereby foster more adoption
- Awaiting CPUC decision on EPIC-3 application filed on May 1, 2017

Project highlights: Open communication standards



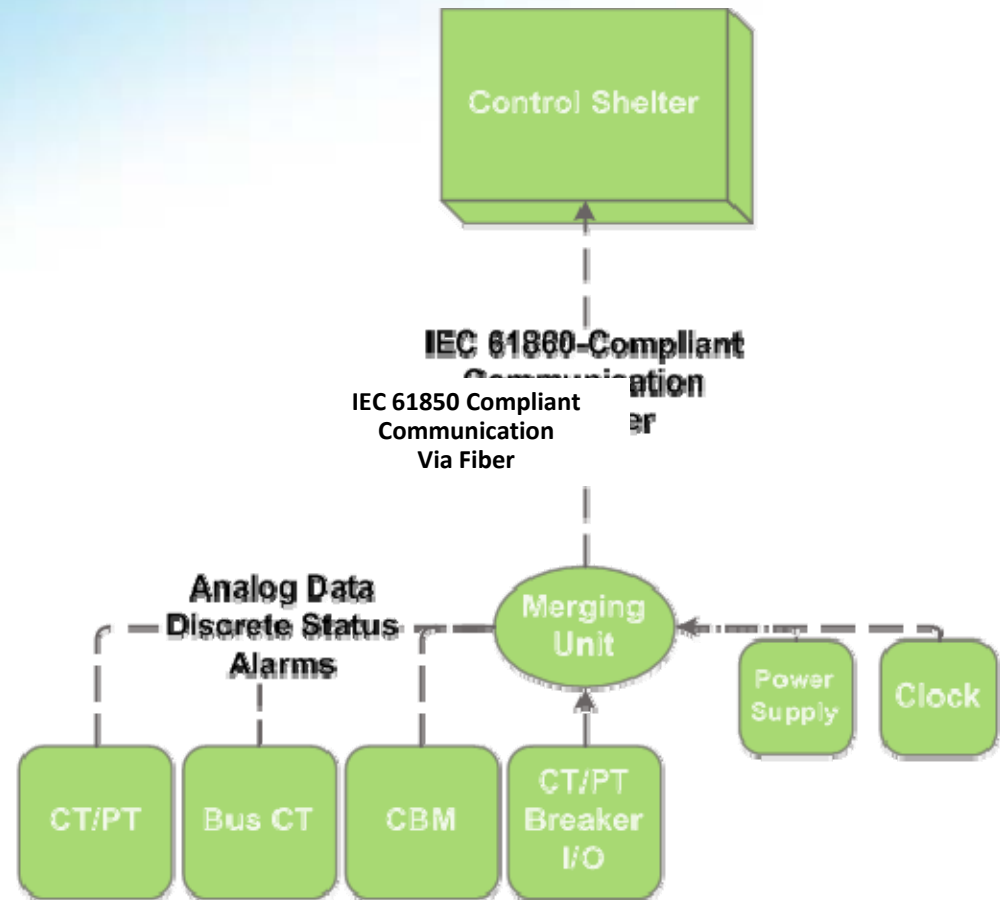
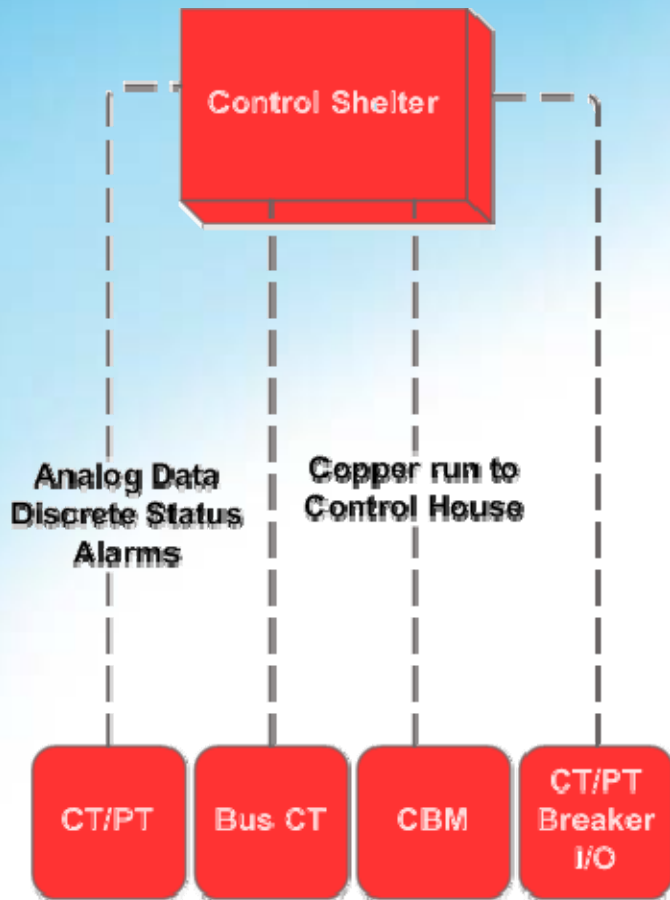
- Modernization of distribution system and integration of distributed generation and storage (EPIC-2)
 - Focus: IEC 61850 in substation network
- Smart grid architecture demonstrations (EPIC-1)
 - Focus: Communications standards for advanced distribution automation
- Monitoring, communication, and control infrastructure for power system modernization (EPIC-2)
 - Focus: Open field message bus

Substation project scope



- Demonstration of new substation protection and control
- Provide decision basis for SDG&E regarding commercial adoption of “digital substations” via IEC 61850
- Pilot IEC 61850 vendor interoperability within a substation

Comparison of legacy and IEC 61850 system



Demonstration system in laboratory



Conclusions



- Validated multi-vendor IEC 61850 process bus
- SDG&E substation protection concepts, settings, and schemes are compatible with an IEC 61850 process bus
- P&C with IEC 61850 process bus is an acceptable replacement for SDG&E's existing P&C
- While interoperability is not yet universal, significant progress has been made
- Many non-technical challenges remain
 - Training
 - Standards

Recommendations



- Continue to explore commercial adoption of IEC 61850
- Develop a laboratory to support future work and training
- Initiate pilot projects to gain experience with IEC 61850
 - 12 kV capacitor automation using GOOSE
 - 138/69 kV bus protection
 - Transformer monitoring and control
 - SCADA interface to the digital substation

Architecture project scope



1

- Architecture baseline and development

2

- Pre-commercial demonstration of IEC 61850 for feeder and substation applications

3

- OpenFMB/IEC 61850

Architecture development



Domains

- Bulk Generation
- Transmission
- Distribution
- DER
- Customer premises

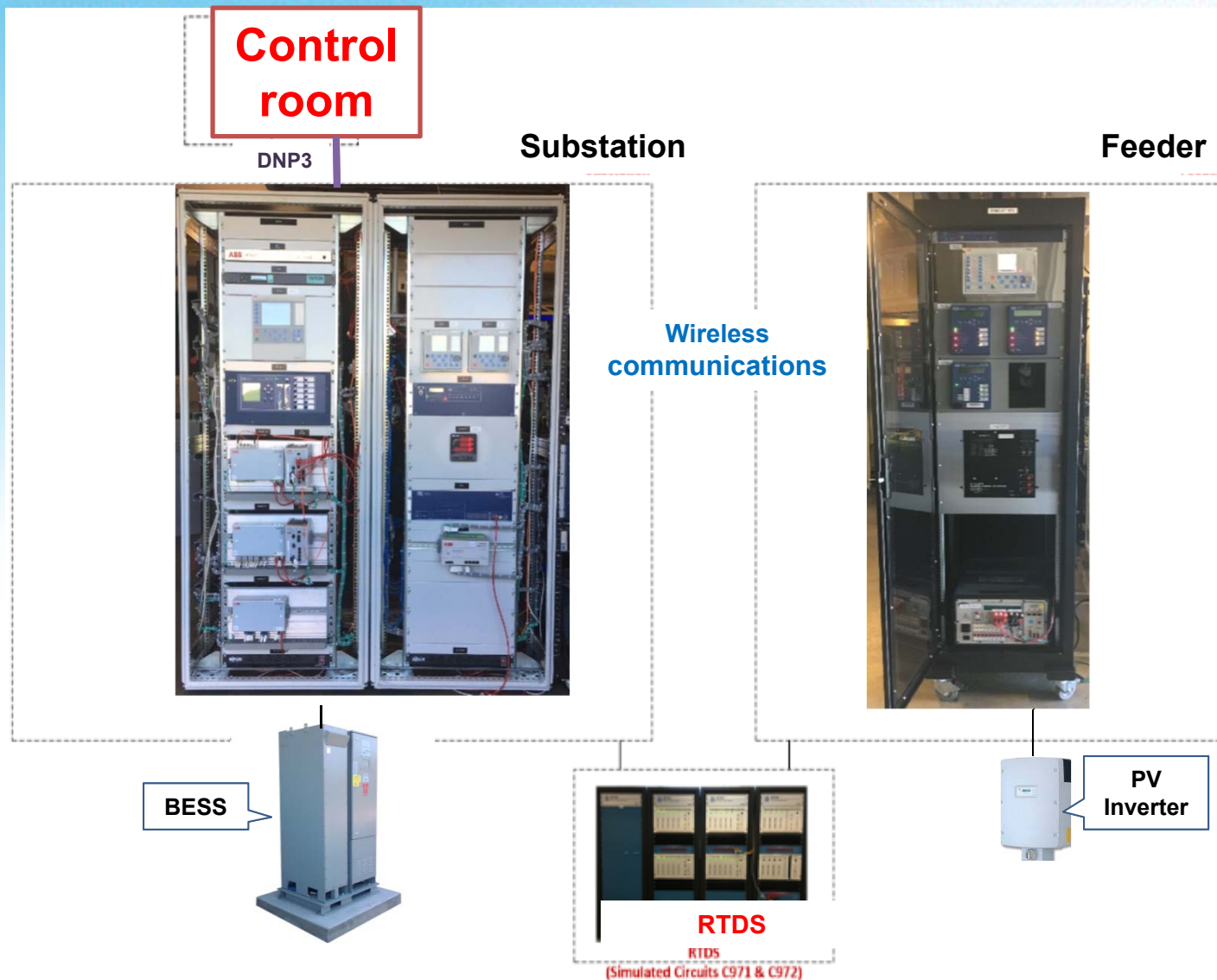
Zones

- Process
- Field
- Station
- Operation
- Enterprise
- Market

Interoperability layers

- Business
- Function
- Information
- Communication
- Component

Demonstration setup



Key findings



- **Architecture**

- Potential architecture changes are needed due to the ongoing proliferation of DER and other IEDs

- **IEC 61850 provides the following benefits**

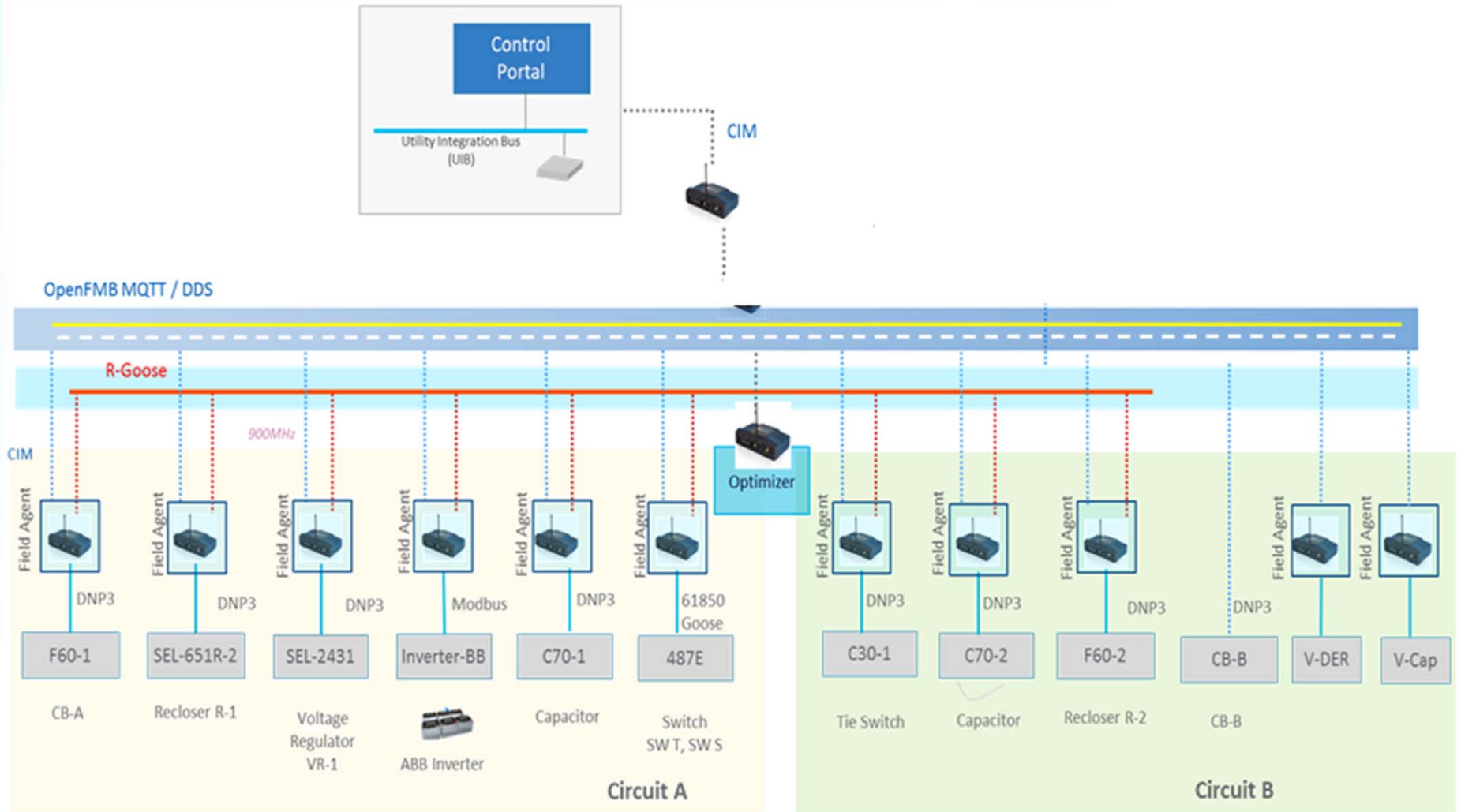
- Test/maintenance features are safer and faster than traditional approaches
- Reduces engineering and testing efforts
- GOOSE consistently out-performed the traditional hard-wired breaker-failure-initiation scheme
- Protection performance could be significantly improved
- Improves power system operations due to peer-to-peer capabilities

Open field message bus project scope



- Objective: Demonstrate and evaluate the use of OpenFMB for monitoring & control
 - Demonstrate interoperability
 - Demonstrate peer to peer communication
 - Demonstrate multiple protocol conversion
- Motivation: Explore migration strategy from legacy to new standards
 - Enable distributed intelligence
 - Enable integration with multiple systems
 - Determine whether traditional and new devices coexist

Demonstration setup



Contents of SDG&E EPIC website at sdge.com/epic



- Comprehensive project final reports
 - Sufficient detail to enable tech transfer to other users
 - Task descriptions and use cases
 - Demonstration results
 - Test set-up
 - Analysis, findings, recommendations
- Conference presentations
- Triennial project applications
- Other EPIC documents

Findings, gaps, and next steps



- Finding: OpenFMB is, at this point, more of a framework for integration (not yet a standard)
- Gaps: Many aspects of OpenFMB are yet to be defined:
 - Provisioning, management services, data profiles, security
 - Configuration, testing and certification
 - Dynamic subscription
- Next steps: Industry should consider:
 - Multicast traffic volume may be too high
 - Definition of optimally efficient payload formats
 - IEC 61850 using R-GOOSE as an option for OpenFMB framework

Comprehensive project final reports available: EPIC-1



- Project 1. Smart Grid Architecture Demonstrations Program
- Project 2. Visualization and Situational Awareness Demonstration
- Project 3. Distributed Control for Smart Grids
- Project 4. Demonstration of Grid Support Functions of Distributed Energy Resources (DER)
 - Module 1, Pre-Commercial Demonstration and Value Assessment
 - Module 2, Pre-Commercial Demonstration of Communication Standards for DER
 - Module 3, Pre-Commercial Demonstration of the EPRI DRIVE Tool
- Project 5. Smart Distribution Circuit Demonstrations
 - Module 1, Demonstrations of Advanced Circuit Concepts and Devices
 - Module 2, Pre-Commercial Demonstration of Methodologies and Tools for Energy Storage Integration into Smart Distribution Circuits

Comprehensive project final reports available: EPIC-2



- Project 1 Modernization of Distribution System and Integration of Distributed Generation and Storage
- Project 2 Data Analytics in Support of Advanced Planning and System Operations
- Project 3 Monitoring, Communication and Control Infrastructure for Power System Modernization
- Project 4 System Operations Development and Advancement
- Project 5 Integration of Customer Systems into Electric Utility Infrastructure
- Project 6 Collaborative Programs in RD&D Consortia
 - Module 1, Demonstration of Methodology and Tools for Estimating Propensity for Customer Adoption of Photovoltaics
 - Module 2, Unmanned Aerial Systems Data Lifecycle Management and Deep Learning Demonstration

Questions and discussion



SDG&E EPIC public website: www.sdge.com/epic



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