Modern Grid, Modern Capabilities

Essential utility and vendor collaboration to enable the future grid

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Welcome

Erich W. Gunther
Chairman and CTO, EnerNex
Member, GMS Architecture Team
Acknowledgment and Disclaimer Statement

This technical report was prepared by Southern California Edison Company (SCE) and is based on a project undertaken by SCE to address ways of modernizing SCE’s grid to meet emerging needs, including those associated with the use of distributed energy resources (hereafter, the “Project”). SCE acknowledges the contributions of a team of individuals as participants in this Project, including:

David Bass
John Bubb
Michael Garrison Stuber
Erich W. Gunther
Doug Houseman
Chris Knudsen
Jeremy McDonald

Ricardo Montano
Clint Powell
Peter Reed
Greg Robinson
Ron Sellemi
Steve Van Ausdall
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Housekeeping: Q&A

We will address questions at the end of the presentation.

• Write your questions on the cards provided at the door.
• One question per card.
• Hand them to outside aisle for collection.
Introduction

Caroline Choi
Vice President, Energy and Environmental Policy
Grid Evolution & Challenges

Heather Sanders
Principal Manager Integrated Grid Strategy & Engagement
This Panel will explore distribution grid transformation, required capabilities, and enabling architecture.

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Where we go from here
External factors drive transformative change

- Ambitious environmental and renewable energy mandates
- Federal and state incentives for alternative energy
- Expectations about 3rd-party capabilities and technologies

- Falling costs of distributed generation
- Advancement in demand-side technologies
- Possible emergence of effective energy storage
- Anticipated plug-in electric vehicle adoption rates

- Concerns about future costs and reliability
- Increasing self-generation
- Interest in getting off the grid

Emerging technologies enable new energy players:
- Consumer product and Internet companies
- New energy service companies
- Large integrators and defense contractors
- Traditional energy technology vendors
...resulting in fundamental changes

- Grid stability thru rotational inertia
- Dispatchable generation
- Passive/predictable loads
- Human-in-the-loop grid management
- Rigid and centralized system control

Drivers
- Policies
- Technologies
- Customers
- Competition

Emerging
- Reduced stability due to generation mix change
- Stochastic generation
- Transactive loads
- Faster system dynamics by orders of magnitude
- Flexible and resilient distributed systems

Current
- Rigid and centralized system control
- Passively predictable loads
- Human-in-the-loop grid management
- Dispatchable generation
- Grid stability thru rotational inertia
Guiding principles

- Promote customer choice and engagement
- Preserve grid safety, reliability, and affordability
- Use competitive processes
- Play a key role in carbon reduction
SCE requires new capabilities to support increasing DER penetration and their ability to provide grid services.

- Integrated Distribution Resource Planning
- Optimization across DER and Grid Assets
- Distribution Grid Operations
- Dynamic Supply – Demand Balancing
- Interconnect Process Improvements (DER – Generation, Storage, Demand Response)
- Integrated Work Management
- Integrated Asset Management
- Safety, Reliability, and Resiliency
SCE Architectural Perspective

Jeff Gooding
Principal Manager, IT Architecture and System Design
Goals of the modern electric grid

- Intelligent
- Renewable
- Reliable
- Resilient
- Customer-centric
- Efficient
- Secure
- Distributed

The Modern Electric Grid
Systems of systems characteristics

Grid characterized by increasingly complex systems that are network-centric, real-time, cyber-physical-social systems

- Thousands of platforms, operators, users supporting millions of sensors, decision nodes, actuators and customers
- Connected through heterogeneous wired and wireless networks
- Operating in a dynamic and ever evolving threat environment

Adapted from: SEI Ultra-Large Systems Study
Challenges

- **Increasingly fragile grid** reduces time to respond to events
- Regulatory **pace may not match** solution readiness
- Energy technology to **impact reliability** may not be under direct control
- Grid **must be hardened** against cyber threats and attacks
- Optimization and stability algorithms **must adapt** to changing customer and device behaviors
- Modern **grid must be affordable** and align economic interests of DER owners and infrastructure providers to infrastructure needs of society
Grid stability through technology

Basic capability

Mechanical controls

Advanced capabilities

Fly by wire

Stability through physics

Stability through technology
Modern grid architecture principles

• Ensure **public and workforce safety**, reliability and affordability

• Be **flexible** enough to accommodate future requirements through software-centric designs, common services and layered architecture patterns

• Adhere to **standards-based** connectivity (end-to-end IP), security, protocols and application specific profiles

• Use **common semantic models**, well-defined systems of record and modern integration practices

• Use common user interface frameworks for **all applications**

• Accommodate **legacy** grid equipment and protocols through gateways and virtualization

• Security is **end-to-end** and designed into the architecture from the start

• Shall use **distributed control and event-driven** architectures
Layered architecture principles ensure flexibility

- Operational capabilities supported by ubiquitous platforms and common services
- Services available at the edge of the network and event driven
- Communications design allows for connectivity across multiple network domains
- Security is end-to-end and supports defense-in-depth principles
- Hierarchical control allows for optimization algorithms at different levels in the system
Modern grid control considerations

Develop distributed control & optimization diversity capabilities in DER integration

• Scalability & Flexibility
  – Communications
  – Computation
  – Dynamic topology
  – Available measurements

• Economic incentive variations
• Reliability (hierarchal system design)
• Security & trust engineering
Modern grid information management

Goals:

- Make data visible
- Make data accessible
- Enable data to be understandable
- Enable data to be trusted
- Enable data interoperability

Actions:

- **Make Data Assets Available to the Enterprise:**
  - Use metadata to describe and advertise data assets
  - Create data asset catalogs and organize by community-defined structure
  - Post data assets to shared space for Enterprise users

- **Make System Data / Processes Available to the Enterprise:**
  - Define and register format and semantics of system data and processes
  - Provide reusable/easy-to-call access services to make system data and processes available to the Enterprise

To make the right decisions at the right time

Courtesy DOD office of CIO
Grid Modernization Architecture & Principles

John Bubb
Principal Advisor, IT Architecture & System Design
Need for a Unified Platform
Grid Management System Overview

- Unified platform
- Service-based architecture
- Integrated set of operational functions
- Distributed intelligence / edge computing
- Multi-objective control: reliability, optimization, economic
- Well defined interfaces to promote interoperability
- Single source of truth (Systems of record & interaction)
Reliability System

Facilitates the consistent, reliable, and safe flow of electricity across the distribution network

- Adaptive relaying and protection
- Outage and restoration
- Tag-outs and crew safety
- Supervision of the distribution grid
- Management of the Mode of Operation in each area of the grid
Optimization System

Facilitates the optimal generation, consumption, and efficient exchange of electricity across the distribution network.

- Multi-objective optimization of Power Flow and Distributed Energy Resources (DER)

- Automation of, and communications to DER, DA, SA, BEMS, and HEMS

- Distribution and Sub-transmission State Estimation and equipment status management
Planning System

Provides guidance regarding updates and changes to the distribution network including all phases of traditional grid planning.

- Maintaining a dynamic topologically correct, temporally correct, electrically correct grid model
- Planning scenario management from planning to operations (What If?)
- Monitored condition based asset management and maintenance
- Forecasting and load profiling to the individual premise
- Electrical simulations support
- Management of micro-climate weather information and forecasts
Economic System

Interacts with markets and contracts to ensure that the economic implications of the distribution network are appropriately realized.

- Maintaining the actionable portions of contracts with customers
- Maintaining tariff and program enrollment by premise
- Pre-calculating the least cost options for grid operations based on forecast conditions
- Verification of customer system performance based on requested actions
Infrastructure Management System

Manages both the information technology (IT) and the operations technology (OT) that comprise the GMS.

- Grid device status
- Communications network status
- Sensor status
- Trust of devices
- Cyber-Security
- Device firmware and software
- IT and OT health
Data Repository System

Provides comprehensive archiving and organizing for all relevant grid data and ensures data availability to fulfill real-time grid functions and long-term needs

• Data Management

• Interactions with external systems (e.g. weather, ISO/RTO, etc.)

• Archiving

• Historical re-creation
**Integration System**

Enables managed interaction between disparate GMS entities and services through protocol translation and seamless messaging.

- Queuing
- Data and protocol translation and transformation
- Streaming event processing
- Orchestration and coordination of the GMS components
- Scheduling
Communication System

Facilitates connectivity and transport of information across all systems of the GMS.

- Manages communication to the field devices
- Prioritizes traffic where bandwidth or latency is an issue
- Works with all types of communications networks
- Allows the flow of information from Edge to Distributed to Central domains
Operational Capabilities and Field Technologies

Brenden Russell
Senior Manager, Power System Controls – Grid Services
Required Grid Management Capabilities

Monitor
- Real Time Situational Awareness
- Power Quality Awareness
- Distribution Load Flow Analysis

Control
- Auto Circuit Reconfiguration
- DER Dispatch
- Micro-grid Management

Predict
- Short term DER Forecasting
- Long Term DER Forecasting
- Contingency Analysis

Optimize
- Voltage Optimization
- Power Flow Optimizations
- Adaptable Protection
Enabling an Integrated and Flexible Distribution Grid
Transforming Substations into Intelligent Hubs

**Common Substation Platform:**
- Server-grade redundancy in the substation
- High availability, high capacity computing platform
- Centralized management of software/firmware
- Provides cyber-security / network segmentations
- Supports de-centralized control applications
- IT & OT device access and mgmt

**Next Generation Substation Automation:**
- Open, non-proprietary communications standard - IEC61850
- Process bus
- Remote management and diagnostics of equipment
- Data beyond SCADA: predictive maintenance
Distributing Controls to Support DER Future

**Proof of Concept:**

- Field message bus
- Machine to machine automated dispatch
- Distributed DER control coordination
- End to end centralized model – integration
- 3rd party DER aggregator integration
Objectives:

- Demonstrate next-generation grid infrastructure to manage, operate, and optimize preferred resources
- Determine controls and protocols for effective preferred resources interconnection
- Demonstrate ability to optimally provide safe, reliable, affordable service
- Develop framework to determine locational value of DERs and impacts to future utility investments
- Learn about uncertainties and be better positioned for change
Panel Discussion and Audience Q&A

Please put your questions on a card - 1 question per card

Please hand your cards to the outside aisle
Utility and vendor collaboration is essential to enable the future grid.

We look forward to continued collaboration.

Thank you.

For more information, please visit:
www.edison.com/home/innovation/smart-grids.html