# 2012 Smart Grid R&D Program
# Peer Review Meeting

## Wide Area Wireless Distribution Grid Sensor for Underground Assets

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# Wide Area Wireless Distribution Grid Sensor for Underground Assets

## Objective

Develop and demonstrate a wireless network solution for distribution automation, including fault circuit indicators and transformer monitoring, capable of secure and reliable communication with below ground and hard to reach utility assets at a TCO that is commercially viable for utilities to deploy at large scale. Enable utilities throughout the US to improve critical grid reliability metrics including SAIDI.

ONRAMP WIRELESS

SEL SCHWEITZER ENGINEERING LABORATORIES

GridSense™

SDGE® A Sempra Energy™ company

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## Life-cycle Funding Summary ($K)

| Prior to FY 12 | FY12, authorized | FY13, requested | Out-year(s) |
|---|---|---|---|
| $1,046 | $580 | $39 | $0 |

## Technical Scope

- Conceptual design and trade studies including sensor system interfaces, augmenting FCI with current measurement capabilities, RF studies
- Design, build and test sensors with secure, low power ULP communications
- System integration with ability to report, alarm, and geospatially analyze data, trends, and historical information
- Plan and deploy evaluation network at SDG&E and Southern California Edison, field wireless sensors and complete six (6) month field test

# Significance and Impact

- A significant reduction in SAIDI achievable in 2-3 years! SDG&E:
  - 65% of distribution circuit miles are underground
  - Most underground outages occur on branches – unjacketed cable faults and connector failures
  - 331 outages per year (2007-2011) on underground branches with >100 customers
  - Significant SAIDI time savings from below ground fault detection with annual crew time savings of >422 hours
- Achieve 2015 and 2016 DOE targets to reduce SAIDI by 5% and 10% respectively through distribution automation

TABLE 1
SDG&E RELIABILITY RESULTS 2005-2010

| | Without Major Events Excluded | | | With CPUC Major Events Excluded | | |
|---|---|---|---|---|---|---|
| Year | SAIDI | SAIFI | SAIDET * | SAIDI | SAIFI | SAIDET ** |
| 2005 | 61.99 | 0.637 | n/a | 58.46 | 0.567 | - |
| 2006 | 52.83 | 0.545 | n/a | 52.65 | 0.541 | - |
| 2007 | 182.17 | 0.590 | n/a | 52.00 | 0.481 | - |
| 2008 | 59.17 | 0.517 | n/a | 58.92 | 0.515 | 28.32 |
| 2009 | 67.06 | 0.542 | n/a | 66.01 | 0.538 | 34.17 |
| 2010 | 89.77 | 0.863 | n/a | 67.74 | 0.543 | 35.82 |

* No data available, SAIDET is only calculated with CPUC exclusions
** SAIDET reporting began in 2008

# Significance and Impact

- Lowest TCO with 10x less network infrastructure over alternative technologies – commercially viable solution
  - SDG&E 4100 sq mile service territory – urban, coastal, rural, desert, mountains – with 15,000 distribution circuit miles
  - 35 ULP Access Points cover distribution circuits at overhead height – additional 150 Access Points cover below ground circuits
    - **“Total reach”** – powered, battery operating, overhead, pad mount, below ground
  - <$9M of network infrastructure (hardware, software, IT and implementation) generating approximately $5.5M in annual savings (SAIDI incentives and crew time savings)
- Additional benefits – hard to quantify in ROI terms:
  - Hourly/15 minute peak load information on circuits provides new “set of eyes” on the distribution grid useful for planning and load balancing
  - Pumping less handholes and manholes reduces environmental impact
  - Crew safety – reduce heavy manhole lid lifts

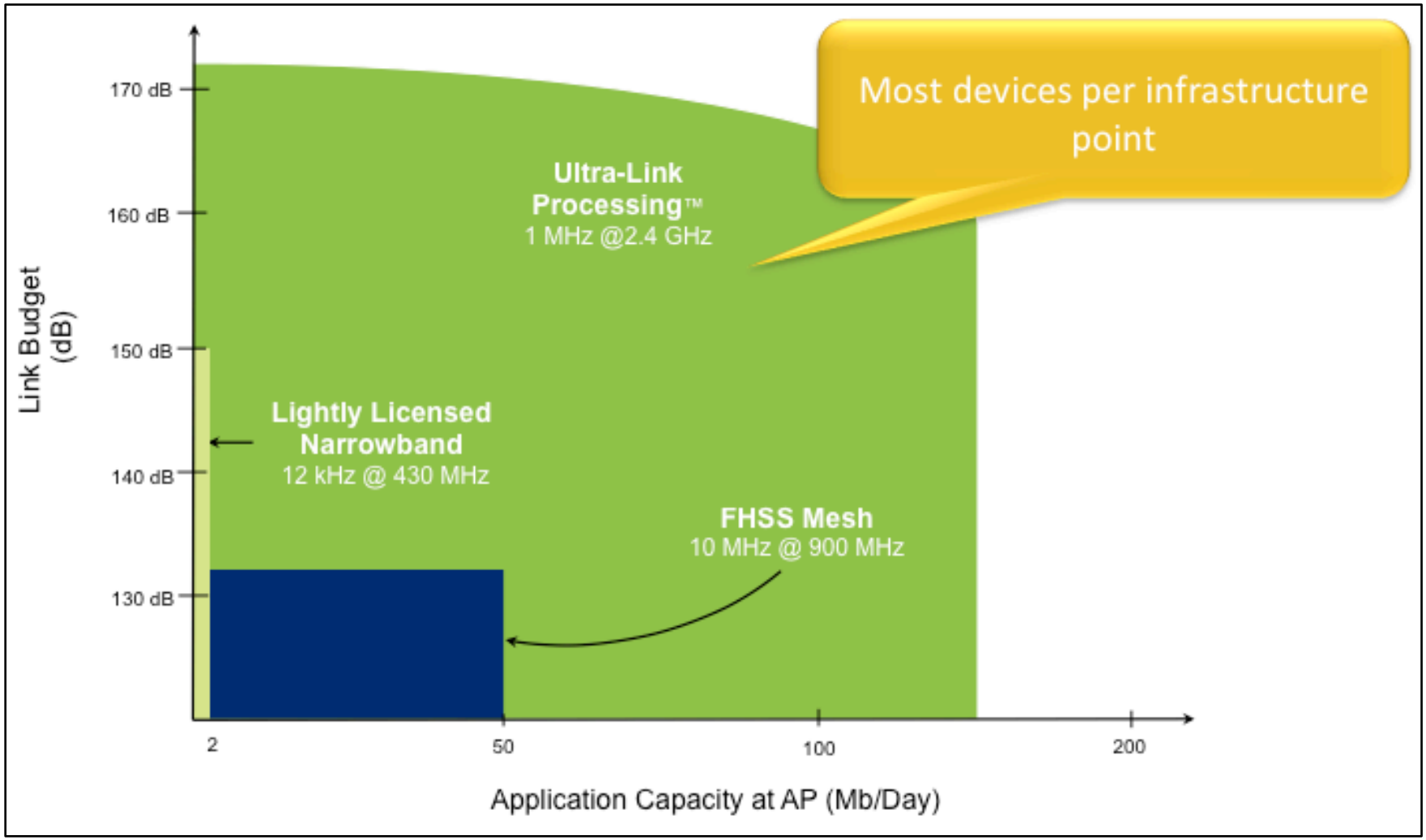
# Significance and Impact

- Solution has broad Smart Grid applicability and is adaptable and scalable for future applications – electric, water and gas
  - Purpose built to service unique needs of utility automation and Smart Grid sensors
  - High capacity wireless solution enables multi-application deployment for distribution automation, metering (hard-to-reach or new deployment) and critical infrastructure – capacity per Access Point
  - Simple, easy to deploy, star topology network is easy to deploy (50-350 sq. miles a day) enabling utility customers to start with critical applications and expand over time
  - Flexible to address requirements of IOUs and public power market including utilities with multi-service responsibility – deployable as utility owned or managed service

# Technical Approach & Transformational R&D

- High performance wireless system, “Ultra-Link Processing” – securely and reliably communicate in hard to reach environments with the ability to plan and design networks
  - Industry break through in communications technology – purpose built “cellular-like” network for Smart Grid automation operates at -32 dB SNR, reliably in unlicensed 2.4 GHz ISM band
  - Performance hammer – provides wide area coverage or ability to penetrate hard to reach locations leveraging signal processing innovation
  - Antenna diversity further augments performance in challenging environments - another 10 dB of performance
  - Coverage is coupled with high capacity to service many devices per infrastructure point – relevant example application capacity (per AP):
    - 20K AMI meters
    - 960,000 FCIs
    - 8K Smart Transformers

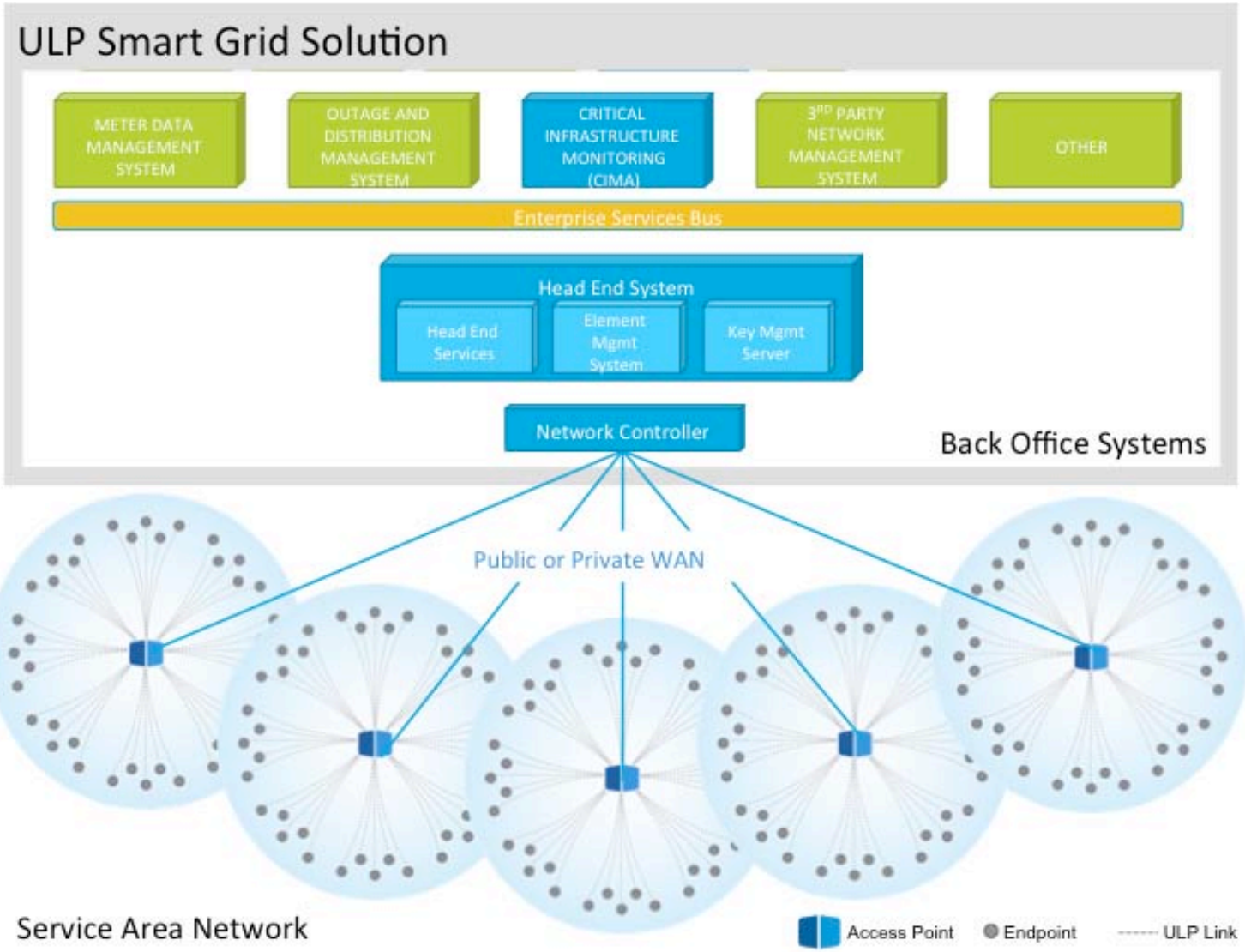
# Technical Approach & Transformational R&D



# Technical Approach & Transformational R&D

- Single network supports both powered and battery operated devices
  - ULP network autonomously adapts to real time link conditions (interference levels can change) to reliably deliver application data at optimal energy levels
  - Ultra-low ULP power performance
    - Signal processing versus transmit power
    - Ultra-low deep sleep current consumption
    - System architecture and data model
- Technical approach and R&D are foundations for a commercially viable and proven network
  - Great technologies are of limited use unless they can be cost effectively deployed to meet key industry requirements
  - Integration of data into utility operational systems
  - Ability to cost effectively manage and support system over 10-20 year life – reduced ULP infrastructure is key to TCO advantage

# Technical Approach & Transformational R&D



# Technical Accomplishments

- FY11
  - Completed three sensor trade studies (interfaces, power, and analog measurement)
  - Completed substantial portion of field testing for RF coverage study
  - Design Verification and reliability testing of ULP uNode for low power, performance across extended operating envelope
  - Initiated sensor design and communication integration
- FY12
  - Completed application analytics software platform (completed April 2012)
  - Complete demonstration network deployment at SCE and SDG&E (completed May 2012)
  - Complete integration testing and initiate deployment of trial units (June 2012)
    - Smart Transformer and 8301D – just started
    - Release RF Trade Study (June 2012)
  - Deploy 8301A units (Sept 2012) – SDG&E only
  - Complete field trial and release final report (Dec 2012)

# Technical Accomplishments – Start of Pilot

# Project Team Capabilities & Funding Leverage

- Leveraging network automation and information technology to improve electricity distribution (efficiency, lower costs, reliability) is a recognized national need
  - Change and introduce new technologies and solutions to solve these challenges requires a catalyst
  - DOE funding brought together different businesses to develop a solution commercially viable for the US utility market. Utility partners (not directly funded) get the unique opportunity to evaluate solution at minimal cost
- Business Organizations
  - On-Ramp Wireless – global provider of wireless systems and services for energy and industrial customers
  - Schweitzer Engineering Labs (SEL) - designs, manufactures, and supports a complete line of products and services for the protection, monitoring, control, automation, and metering of electric power systems.
  - GridSense – applies world-class engineering, innovative technology, and unmatched customer support, and delivers practical solutions with high performance-to-cost ratios that help utilities worldwide optimize transmission and grid performance

# Project Team Capabilities & Funding Leverage

- Utility Partners
  - SDG&E is a regulated public utility that provides safe and reliable energy service to 3.4 million consumers through 1.4 million electric meters and more than 840,000 natural gas meters in San Diego and southern Orange counties. The utility's area spans 4,100 square miles. SDG&E is a subsidiary of Sempra Energy, a Fortune 500 energy services holding company based in San Diego, CA.
  - Southern California Edison is one of the largest electric utilities in California, serving more than 14 million people in a 50,000 square-mile area of central, coastal and Southern California, excluding the City of Los Angeles and certain other cities. SCE is based in Rosemead, CA and has approximately 17,000 employees.

# Contact Information

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