Testing the Smart Grid

Presentation to Lawrence Berkeley National Labs

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Agenda

- QualityLogic Introduction
- Pacific Northwest Smart Grid Demonstration Project
- QualityLogic's Role
- Other Smart Grid Projects
- Summary

QualityLogic

- Privately held, independent provider of testing products and services
- Started in Ventura County in 1986, now include test lab in Boise, ID and offices in Oregon and Colorado
- 4 primary industries served – printing, telecom, IT and Smart Energy

QualityLogic – Printing

- Company founded at the dawn of desktop printing to meet needs of printer companies to test:
  - Page Description Languages
  - Interface Protocols
  - Communications Protocols
- Competitive Analysis Testing performed for HP, Kodak, others

QualityLogic – Telecom

- QualityLogic fax testing tools used by carriers, network equipment providers, and device manufacturers to ensure interoperability

QualityLogic – Consumer Web Sites

- QualityLogic combines on-site management with offsite resources in our labs for some of the largest and advanced web-based consumer companies in the US
- As utility companies engage more actively with their customers via web sites and services, we expect to expand services into this sector

QualityLogic – Smart Energy

- Testing partner in the Pacific Northwest Smart Grid Demonstration Project
- Contributor to many standards efforts:
  - GWAC
  - UCA OpenSG/CIM
  - NIST SGIP Test & Certification Panel
  - ZigBee Alliance

The QualityLogic Way

- Analyze interop vulnerabilities in standards documents or proprietary specifications
- Get feedback from customers about interop problems with standards or products claiming to conform
- Analyze coverage gaps in existing test suites, tools, processes
- Develop solutions to enhance interoperability, complement existing test technologies

Definitions

Conformance Testing

- ISO/IEC 10641 defines Conformance Testing as a “test to evaluate the adherence or non-adherence of a candidate implementation to a standard.” This type of testing is normally accomplished by executing an implementation against a conformance test engine. However, since vendors can implement differing subsets of functions and the conformance engine itself may have bugs, conformance testing almost never insures interoperable products in the real world.

Interoperability Testing

- “The capability of two or more networks, systems, devices, applications, or components to exchange information between them and to use the information so exchanged.” In general, Interoperability Testing verifies that two or more implementations of a standard adhere to the standard (*i.e.*, are conformant to) ***as*** they intercommunicate, while conformance testing only tests that a single implementation is “conformant” to a standard. Without formal interoperability testing the likelihood is that products “claimed” to adhere to the same standard may well NOT interoperate as desired.

Definitions

Certification

- A trusted third party 'always' does Certification of an implementation of a standard. After a testing lab has deemed an implementation based on a standard (using a stated profile) as having met all the testing criteria, normally a trusted third party (the associated user organization who helped to create the profile) will certify the implementation as 'certified interoperable on the profile among product set X' or the implementation is 'certified conformant on the profile'.

Conformance and Interoperability Profiles

- Most standards define sets of functionality that may (optional functions) be implemented from the standard with the resulting software designated as conformant. However, different vendors may implement different subsets of functionality. Thus, it is usually necessary in conformance and interoperability testing to define a "Conformance Profile" or an "Interoperability Profile"; *i.e.*, a subset of the specification that all implementations must include if they wish to be interoperable.

Definitions

Security Testing

- Functional security testing analyzes whether an implementation correctly makes use of any security features from the standard or other security features specified in the device or computer system housing the implementation.   This is straight-forward functional or conformance testing
- However, a more important type of testing attempts to assess whether a "malicious" person can gain unauthorized access and compromise the system. This is the most difficult type of testing program because it must evaluate whether the system has vulnerabilities, which are not always obvious.

A Smarter Grid

Congress signs into law the Energy Independence and Security Act of 2007 to…

- “move the United States toward greater energy independence and security
- increase the production of clean renewable fuels
- protect consumers
- increase the efficiency of products, buildings, and vehicles
- promote research on and deploy greenhouse gas capture and storage options
- improve the energy performance of the Federal Government”

A Smarter Grid

EISA, Section 1305 – Smart Grid Interoperability Framework

- The Director of the **National Institute of Standards and Technology** shall have primary responsibility to coordinate the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems. Such protocols and standards shall further align policy, business, and technology approaches in a manner that would enable all electric resources, including demand-side resources, to contribute to an efficient, reliable electricity network. In developing such protocols and standards:
  (1) the Director shall seek input and cooperation from the Commission, OEDER and its Smart Grid Task Force, the Smart Grid Advisory Committee, other relevant Federal and State agencies; and
  (2) the Director shall also solicit input and cooperation from private entities interested in such protocols and standards, including but not limited to the GridWise Architecture Council, **the International Electrical and Electronics Engineers**, the National Electric Reliability Organization recognized by the Federal Energy Regulatory Commission, and National Electrical Manufacturer's Association.

DOE Grants

QualityLogic
Putting Technology to the Test

- April 2009 – DOE pledges $4B in ARRA grants for Smart Grid
  - **$3.375 billion for Smart Grid Investment Grant Program** – DOE's Smart Grid Investment Grant Program will provide grants ranging from $500,000 to $20M for smart grid technology deployments. It will also provide grants of $100,000 to $5M for the deployment of grid monitoring devices.
  - **$615 million for Smart Grid Demonstration Projects**
  - **Smart Grid Regional Demonstrations** will quantify smart grid costs and benefits, verify technology viability, and examine new business models.
  - **Utility-Scale Energy Storage Demonstrations** can include technologies such as advanced battery systems, ultra-capacitors, flywheels and compressed air energy systems, and applications such as wind and photovoltaic integration and grid congestion relief.
  - **Grid Monitoring Demonstrations** will support the installation and networking of multiple high-resolution, time-synchronized grid monitoring devices, called phasor measurement units, that allow transmission system operators to see, and therefore influence, electric flows in real-time.

Pacific Northwest Smart Grid Demonstration Project

Excerpted from Presentation to West Coast Energy Management Congress by:

Battelle Smart Grid Deputy Director Tracy Yount

June 2010

PNWD-SA-8921

Demonstration Project Overview

- **Substantially increases smart grid asset installation in the region by purchasing and installing smart grid technology**
  - $178 Million project led by Battelle
  - Project participants include BPA ($10M), 11 utilities ($52M), 5 project-level vendors ($27M). DOE matched with $89M.
  - Over 60,000 metered customers directly affected
  - 112 MW of responsive resources (loads and generation) engaged

- **Demonstrates coordination of smart grid assets locally and across the region using innovative communication and control system**
  - Hierarchical communication—from generation through transmission and distribution, and then onward to the end users
  - Transactive control—innovative incentive signal that coordinates smart grid resources to support regional needs for transmission, reliability, renewables, etc.

Project Basics

Pacific Northwest SMART GRID DEMONSTRATION PROJECT

- Install and implement a unique distributed communication, control and incentive system
- Use a combination of devices, software and advanced analytical tools to enable consumers to manage their electric energy use
- Collect data over a 24-month consecutive period to provide insights into consumers' behavior while testing new technologies

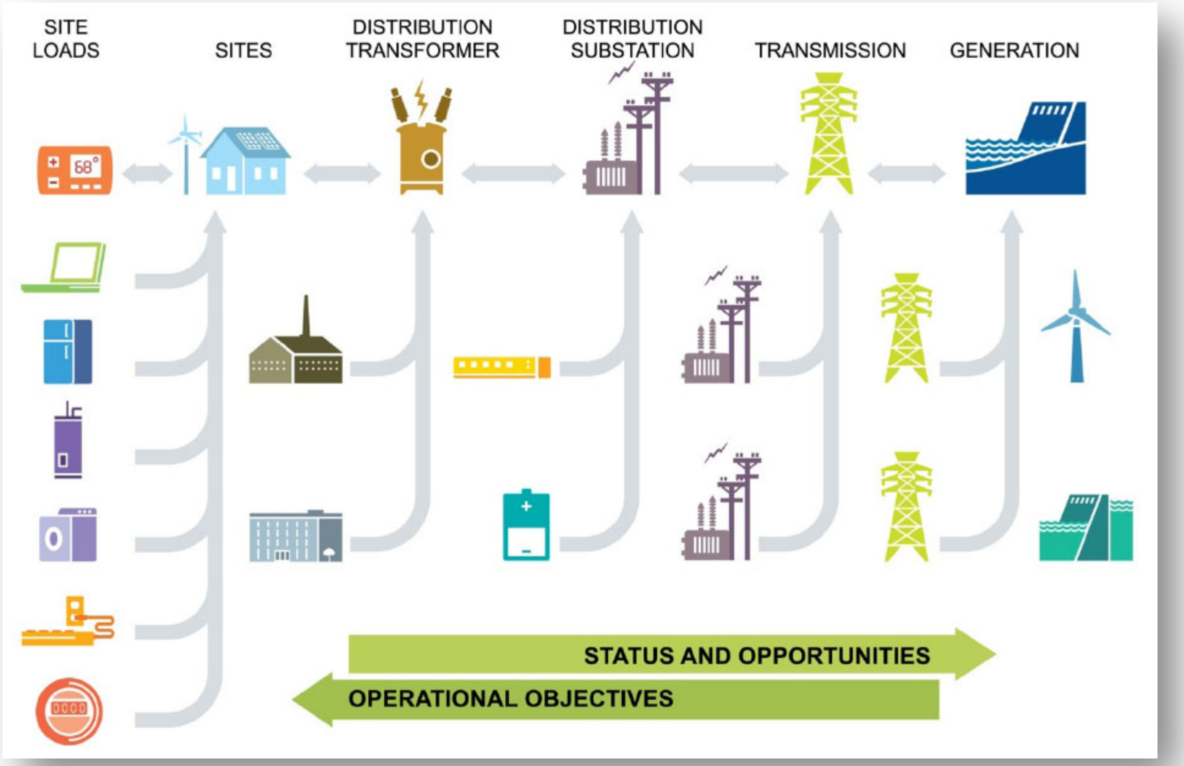
Key attributes:

- Leave an installed operational base of smart grid assets and successful operational strategies for the region
- Stimulate the regional and national economy by creating approximately 1,500 jobs and a vibrant smart grid industry

Project Basics (cont'd)

Operational objectives:

- Manage peak demand
- Facilitate renewable resources
- Address constrained resources
- Improve system reliability and efficiency
- Select economical resources (optimize the system)



Aggregation of Power and Signals Occurs Through a Hierarchy of Interfaces

Goals and Objectives

Goals:

- Provide two-way communication between distributed generation, storage, and demand assets and the existing grid infrastructure
- Validate new smart grid technologies and inform business cases. Quantify smart grid costs and benefits
- Advance interoperability standards and cyber security approaches for transactive control
- Integrate rapidly expanding portfolio of renewable resources

Objectives:

- Manage peak demand
- Facilitate integration of wind and other renewables
- Address constrained resources
- Select economical resources
- Improve system efficiency
- Improve system reliability
    - Load Management
    - Conservation Voltage Reduction
    - Distributed generation

Project Participants

Battelle
The Business of Innovation

BPA

Avista

Benton P·U·D

City of Ellensburg Washington

Your Co-op Flathead Electric

the city of Idaho Falls IDAHO

Lower Valley Energy

City of Milton-Freewater Oregon

NorthWestern Energy

Washington State University
World Class. Face to Face.

Peninsula Light Co.
a mutual corporation · since 1925
The power to be...

Portland General Electric

Seattle City Light

University of Washington 1861

3TIER

ALSTOM

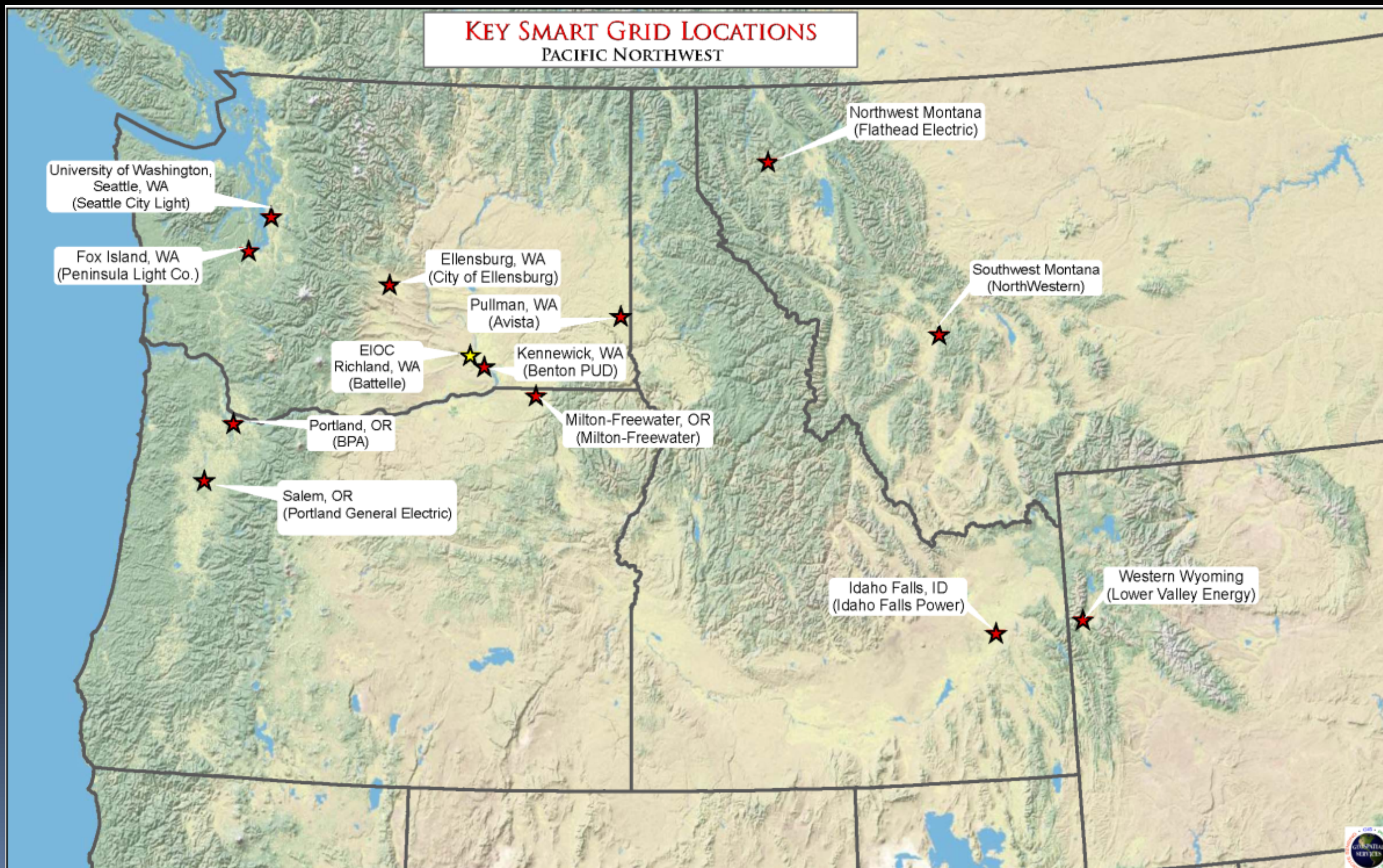
Drummond group

IBM

NETEZZA

QualityLogic

PNW SGDP Geography



Demonstration Project Timeline

	2010	2011	2012	2013	2014
Phase 1 - Concept Design	7 months				
Phase 2 - Build Out		24 months			
Phase 3 - Data Collection & Analysis				24 months	
Phase 4 - Cost Benefit Analysis & Reporting					6 months

- Complete contracts
- Design "system of systems" to connect subprojects to EIOC

- Install equipment at subproject
- Build 'system of systems'

- Sites up and running
- Gather two years of data
- Perform data analysis

- Finalize cost/ benefit
- Draft transition plan

Periodic progress reports are required:

- Monthly financial reports to DOE
- Semi-annual program review meetings
- Technical reports
- Up to five presentations / meetings to DOE on final reports

Subproject "Experiment" Summary

Pacific Northwest SMART GRID DEMONSTRATION PROJECT

	Transactive Control	Reliability	Conservation /Efficiency	Social	Totals
Avista Utilities	4	3	5	3	15
Benton PUD	1	1	1	0	3
City of Ellensburg	1	0	8	0	9
Flathead Electric	6	2	0	0	8
Idaho Falls Power	8	2	3	3	16
Lower Valley Energy	3	2	6	1	12
Milton-Freewater	3	0	0	0	3
Northwestern Energy	4	1	3	1	9
Peninsula Light	2	1	1	0	4
Portland General Electric	4	1	1	2	8
UW/Seattle City Light	5	0	3	0	8
Totals	41	13	31	10	95

Interoperability Standards and the PNW Demo Project

- Working Group evaluating Smart Grid standards for Project Transactive Control technology
  - NIST Smart Grid Standards Roadmap
  - SGIP PAPs
  - Functional Requirements from various user groups and SGIP
  - IRC (ISO/RTO Council) standards
- Potential matrix of standards and subprojects
- Ron Ambrosio, Chair SGIP Architecture Committee and Chair GWAC
- Rik Drummond, Chair SGIP Test and Certification Committee
- James Mater, Chair of SGIP TCC Work Group on assessing TCC program maturity
- Others TBD including Utility Members

Interoperability Standards and the PNW Demo Project

- ***From the Final DOE Regional Demonstration FOA***
- One of OE's top smart grid priorities is the work with NIST and FERC on a framework for interoperability standards. This effort is focused on an accelerated timetable for the development of a standards development roadmap and a process for getting standards for interoperability in place as rapidly as possible.

Possible Emerging Standards for PNW Project

0 Meter Upgradeability Standard	1 Role of IP in the Smart Grid
2 Wireless Communications for the Smart Grid	**3 Common Price Communication Model**
4 Common Scheduling Mechanism	5 Standard Meter Data Profiles
6 Common Semantic Model for Meter Data Tables	7 Electric Storage Interconnection Guidelines
8 CIM for Distribution Grid Management	**9 Standard DR and DER Signals**
10 Standard Energy Usage Information	11 Interoperability Standards to Support Plug-in Electric Vehicles
12 Mapping IEEE 1815 (DNP3) to IEC 61850 Objects	13 Harmonization of IEEE C37.118 with IEC 61850 and Precision Time Synchronization
14 Transmission and Distribution Power Systems Model Mapping	15 Harmonize Power Line Carrier Standards for Appliance Communications in the Home
16 Wind Plant Communications	17 Facility Smart Grid Information Standard

SGIMM

Pacific Northwest SMART GRID DEMONSTRATION PROJECT

- SGIMM = Smart Grid Interoperability Maturity Model
- DOE FOA for Regional Smart Grid Demonstration Projects
  - D4.2: *Open architecture/standards: Interoperability Maturity Level – the weighted average maturity level of interoperability realized between electricity system stakeholders*
- Under development by the GridWise Architecture Council led by Steve Widergren, PNNL.
  - Committee members include Ron Melton, Terry Oliver (BPA), James Mater and Rik Drummond, Austin Montgomery (SEI) and Alex Levinson (Lockheed Martin)

More Information

- Battelle: www.battelle.org
- PNNL: www.pnl.gov
- BPA: www.bpa.gov/Energy/N/smart_grid/index.cfm
- DOE OE: www.oe.energy.gov
- Smart Grid: www.smartgrid.gov
- PNW-SGDP - http://www.pnwsmartgrid.org/
- QualityLogic – www.qualitylogic.com

QualityLogic's Responsibilities

- Testing responsibility of the Pacific Northwest Smart Grid demonstration project
  - Perform functional conformance and interoperability testing of the PNW's transactive control system
  - Provide interoperability guidelines to utilities to assist in purchasing and operating interoperable smart grid equipments
  - Develop training program to educate the participants in development of interoperable smart grid assets
  - Contribute to the development of smart grid related standards in support of the PNW's transactive control system

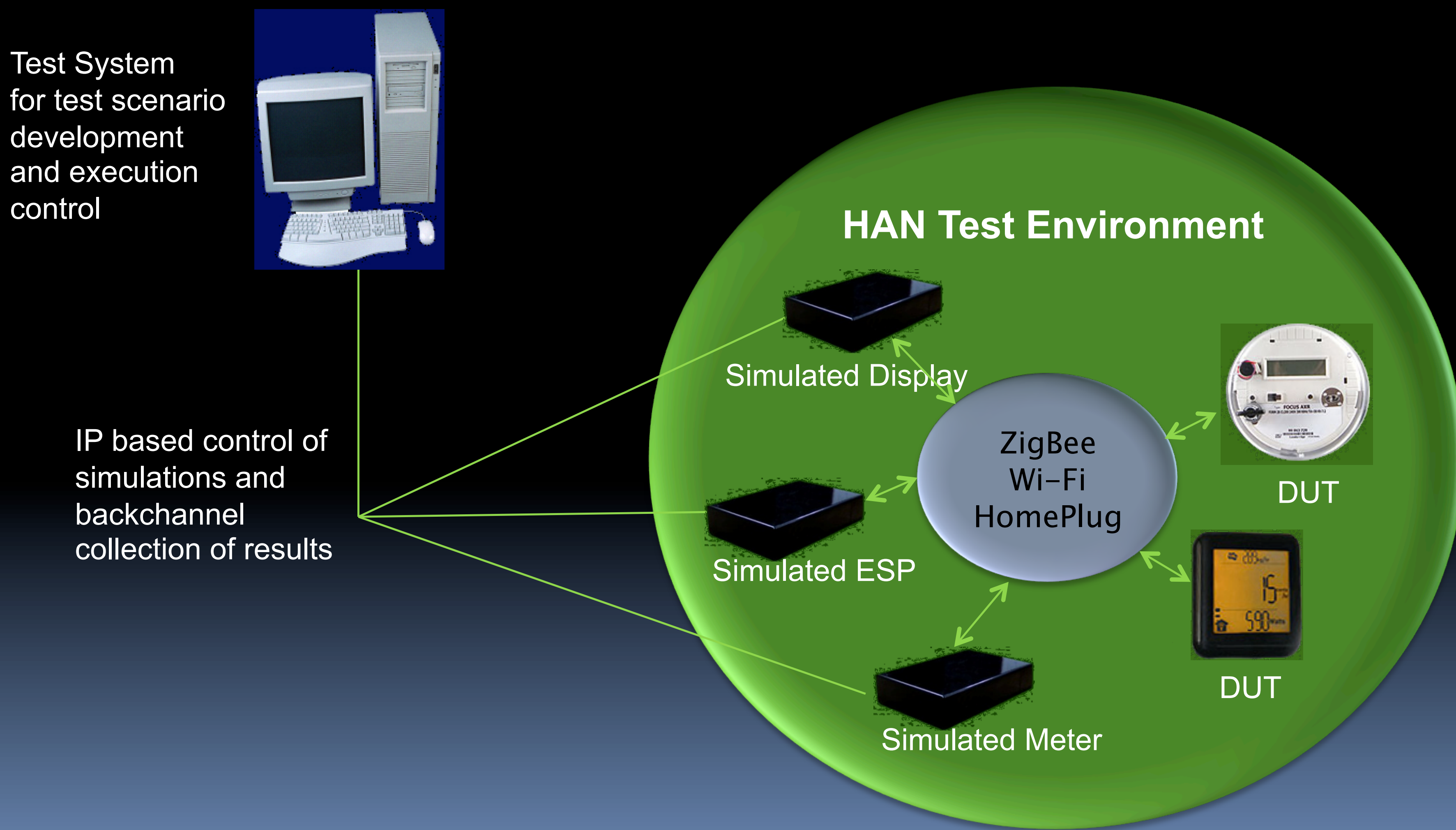
Testing Coverage

- EIOC contains the main transactive control system that will coordinate incentive and feedback signals from utilities
- Utilities will develop transactive control nodes that interoperate with the EIOC center
- QualityLogic will be responsible for ensuring a functionally conformant and interoperable transactive control system that will enable this integration

Other Projects

- Currently developing an Energy Management Test System to validate interoperability between devices sharing energy data
- First test suite will be for ZigBee Smart Energy Profile 2.0 enabled meters and residential energy management devices
- Currently developing a certification program for Itron so licensees of their technology can be assured of interoperability
- More to come…

Energy Management Test System Overview



Smart Energy Management Test System

QualityLogic
Putting Technology to the Test

- Test System Benefits
  - Quickly set up test environment with devices of varying capabilities, behaviors
  - Rapidly develop simulation scenarios for expected usage models
  - Identify interoperability problems without obtaining real devices
  - Simple integration into end-to-end test systems
  - Regression testing with latest device releases via a simple software update to the test system

Itron ERT Certification

- Itron RF technology "ERT" automates meter reading systems
- Manufacturers are licensing this technology to develop devices to collect and process this data
- QualityLogic has developed a certification program to assure interoperability between these devices and water, gas, and electric meters

Summary

- QualityLogic is a key partner in the largest smart grid demonstration project in the US
- We are actively pursuing interoperability issues in other smart energy technologies
- Visit us at www.qualitylogic.com, follow us on Twitter or become a fan on Facebook to stay current with these projects

What is a smarter grid?

- "Turbines to Toasters" – GE
- "Laying modern IT and communications technologies atop the world's aging electricity generation, transmission, and distribution systems" – Cisco
- "Distributed intelligence throughout the electric power system" – Battelle
- A platform to enable consumers to make more informed energy usage decisions

7 Key Characteristics

1. Enable active consumer participation
2. Accommodate new generation and storage
3. Enable new products, services, markets
4. Increase power quality for the digital economy
5. Optimize asset utilization and efficiency
6. Self-heal
7. Operate resiliently against attack and natural disaster

Smart Grid News – 4-17-09