

# System Stability through technology

Basic capability



Advanced capabilities



Mechanical controls



Fly by wire



Stability through physics

Stability through technology

# Smart Grid Design Goals

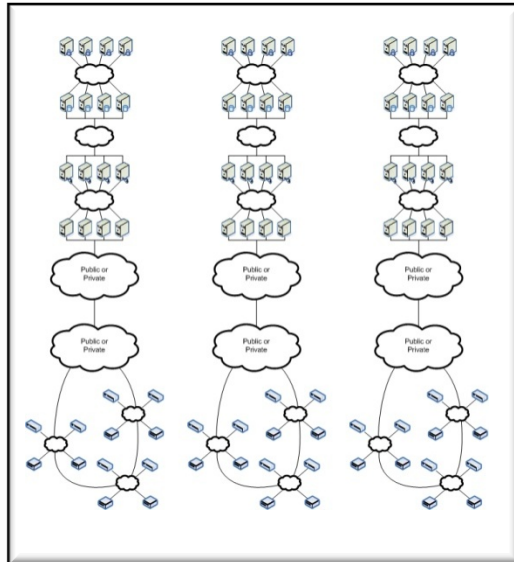


- **More** – increased capabilities
  - More capabilities at the edge and enterprise, pervasive automation
- **Better** – faster, more reliable & secure
  - The electric grid is more resilient
  - Dynamic control of all security elements allows the system to adapt to evolving threats
- **Easier** – usability (convergence, unified control, visualization, information on demand)
  - Tens of Millions of nodes are manageable
  - Situational awareness
  - Common Services allow for easier integration of new capabilities and technologies

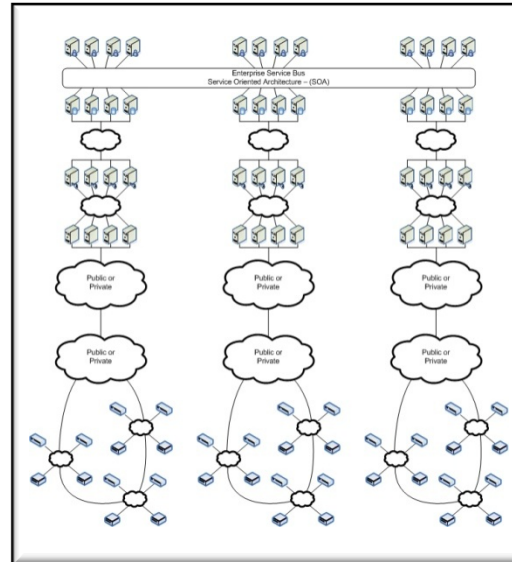
# Smart Grid System of Systems (SoS) Research

## Four evolutions of Smart Grid SoS Architectures

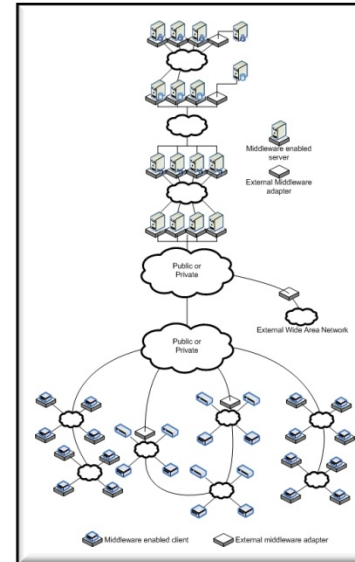
### Silos



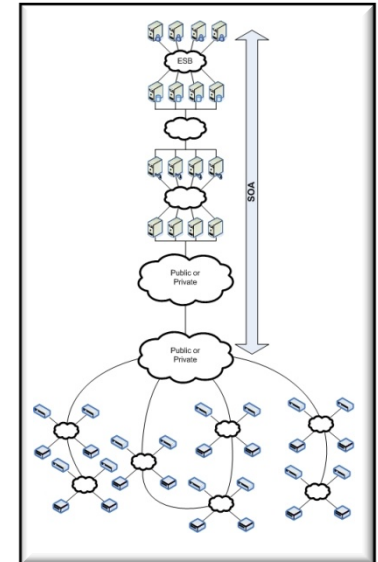
### ESB



### Adapter-based



### Common



1

Current-state

2

Typical SI Approach

3

DoD-style approach

4

Standards-based Internet-style

# CCS Introduction

- Changing Landscape
  - Increased attention from government, media, public
  - New class of adversary and malicious threats
  - Increase use of Communications and Automation on the grid
  - Customer and 3<sup>rd</sup> Party Interaction increasing
- Objectives
  - Security needs to keep pace with increasing pace of technology adoption
  - Security needs to be baked in to new procurements while addressing legacy environment (No device left behind)
  - Security needs to comply with all regulations and relevant standards
  - Adhere to common services architecture that reduces implementation and operational costs through reuse
- Solution
  - CCS is a common service for securing applications and devices
  - CCS focuses on securing all critical energy delivery operations
  - CCS is the first open and standards based implementation which meets all objectives

# CCS Technology Highlights

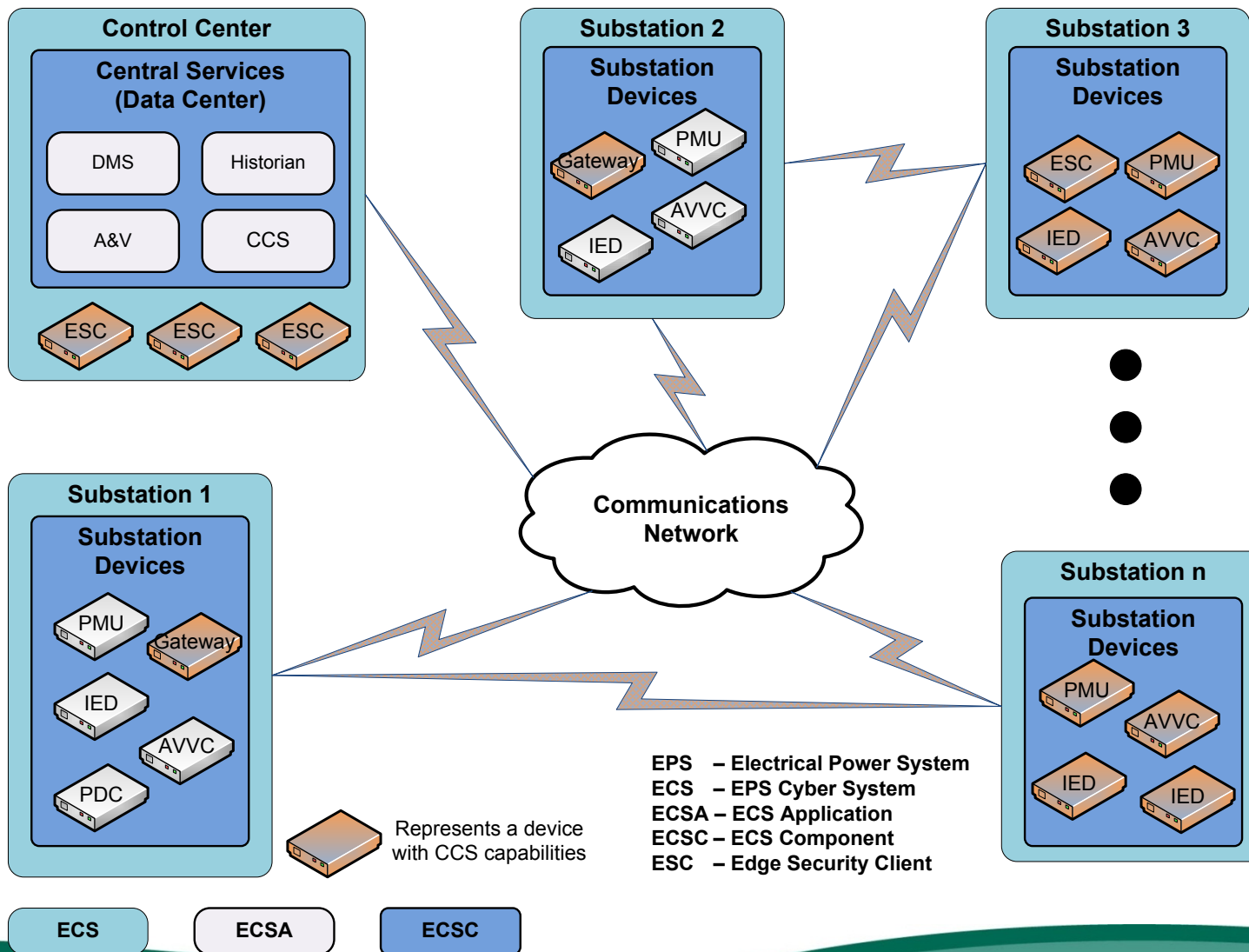
- The most advanced security system in the energy sector
  - Next generation utility technologies
  - DoD technology transfer
  - Best practices from many sectors
  - Modern SOA style architecture
- The most compliant security system
  - NERC CIP Version X
  - All Federal Processing Standards (DHS, FIPS)
  - NIST Compliant (NISTIR, SP)
- A robust, scalable and dynamic security system
  - Supports all Grid Applications
  - Supports current and next generation networking (MPLS)
  - Supports all major protocols used on the Grid
  - Modular Construction

# CCS Technology Highlights

- Easily Integrated into existing environment
  - Supports existing control and IT investments (Directory Services, Enterprise PKI)
  - 8 inflight advanced programs are relying on new services (e.g. ISGD, Phasor Measurement, SA3, C-RAS, etc.)
  - Supports gradual evolution to full compliance over time
- Ease of Use
  - AMI Security uses command line and requires vendor support
  - CCS has next generation web based graphical user interface
  - Enables a powerful and unified security operations center
- IEC has committed to align with CCS principles
  - Hosted IEC TC 57 Security Meetings
  - New Part to FERC reviewed/recommended 62351
- GE and Subnet are deploying CCS compatible devices and discussion are underway with other major vendors



# Operational View



# CCS Concepts: Advanced Visualization

## Easy to use, intuitive interface

The screenshot displays a web browser window with the URL `lb-ccs09-ubu:6001/csg/#csg`. The interface is divided into three main sections:

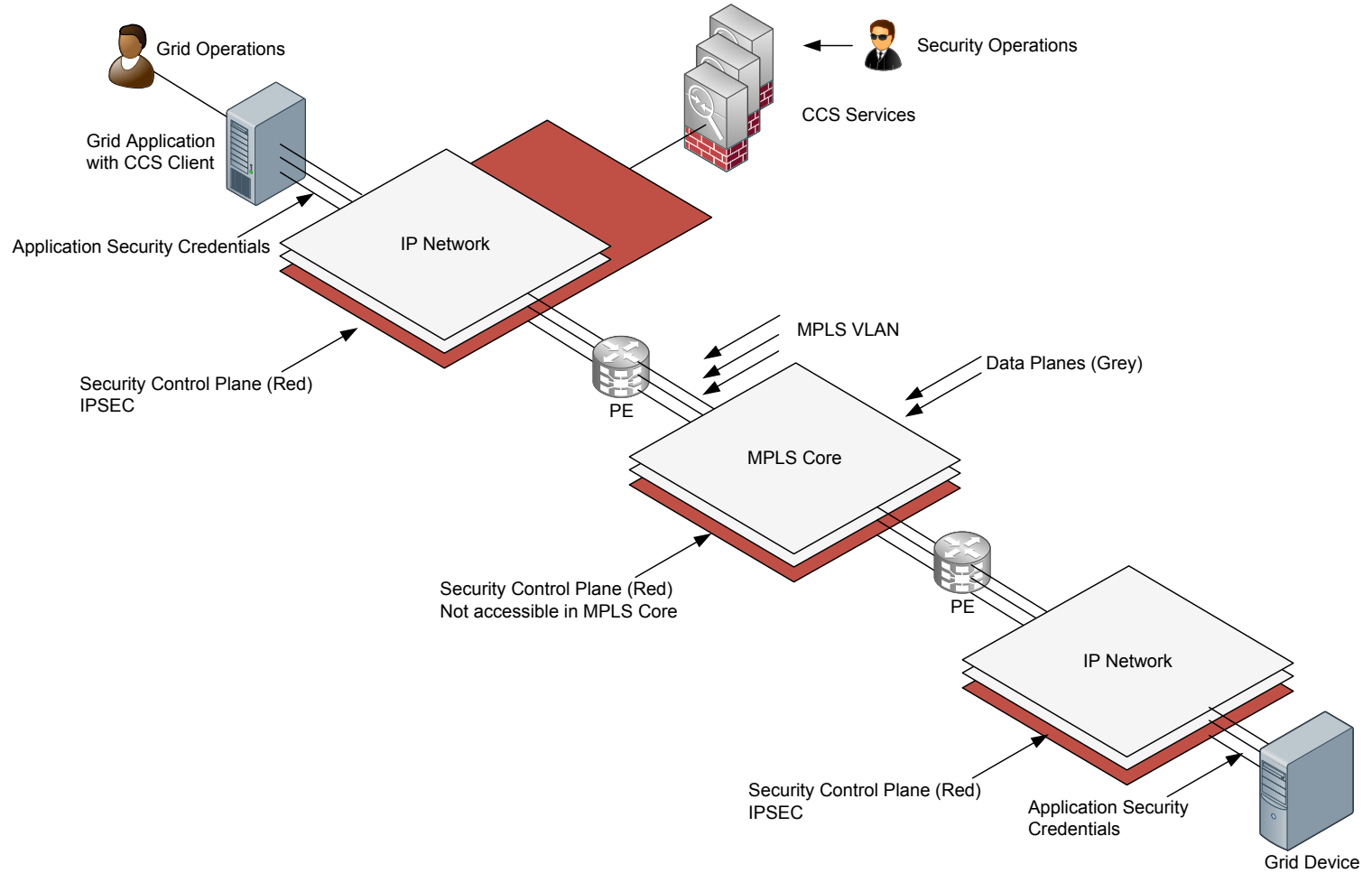
- Chart View Pane:** Located at the top, it features four vertical bar charts labeled "Identity Certificate", "BoH of Health", "Quality of Trust", and "Device Status". Each chart has a scale from 0 to 1.0. A large white text overlay "Chart View Pane" is centered over this section.
- Map - Geospatial View Pane:** The middle section shows a map of the Los Angeles area with green lines representing power lines. A specific location is marked as "Irwindale Substation 1". A large white text overlay "Map - Geospatial View Pane" is centered over the map.
- Table View Pane:** The bottom section contains a table with columns for "Description", "#", "Status", "ID", "BoH", and "QoT". The table lists various substations and their associated data. A large white text overlay "Table View Pane" is centered over the table.

At the bottom of the browser window, there is a status bar with the "ViaSat" logo, the date and time "Wednesday 8:13 PM", and the user name "engineer".



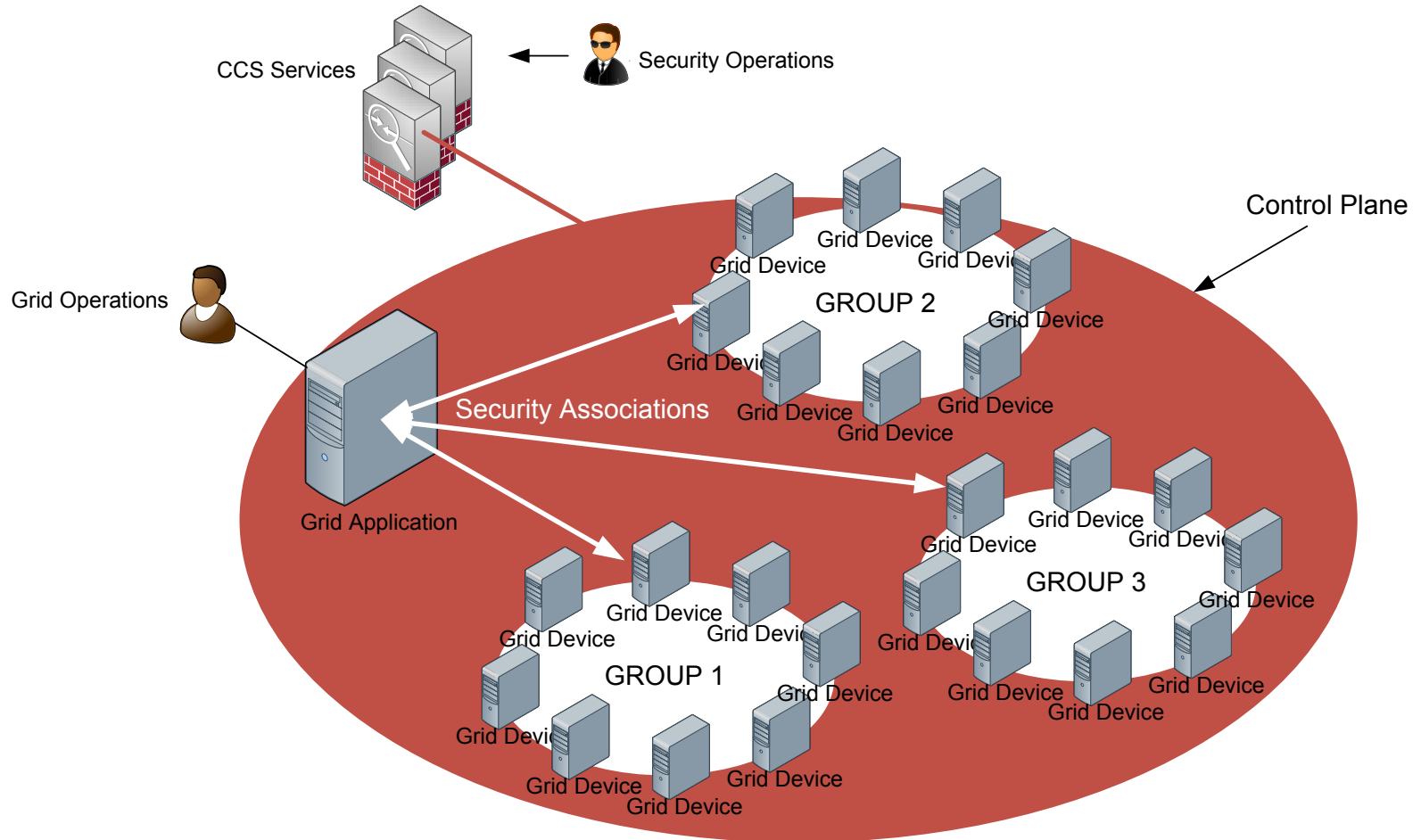
# CCS Concepts: Control Plane

## All Devices are centrally controlled



# CCS Concepts: Groups

## Management of communities and groups



# Initial CCS Capabilities

## Authentication

- Public Key Infrastructure (PKI), Identity Management, Attribute Certificates (BoH)

## Authorization

- Centrally Managed and Configured Security Associations (SAs)

## Accounting

- Audit & Reporting (Alert, Syslog)
- Security Information and Event Management (SIEM)

## Integrity

- Integrity Management Authority (IMA)
- Trusted Network Connect
- Bill-of-Health

## Quality-of-Trust

- Source-based Data Labeling : Trusted, Questionable, Untrusted

## Peer-to-Peer Communication

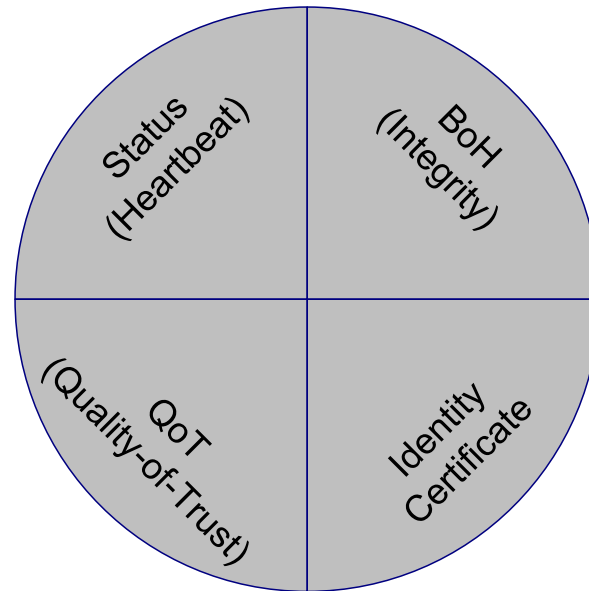
- Peer-to-peer middleware using Data Distribution System (DDS)
- Use only for control plane
- Several vendors available including open source

## Dynamic Interactive GUI

- Accessed via Web Browser (Chrome 14, FireFox 7 and IE 10 in the future)
- Built-in Test and Peek-Poke Capabilities

# GUI Icon Legend

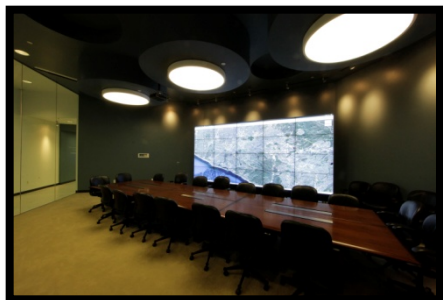
- All Nodes in the security network are displayed as circles and quadrants represent quality of security attributes



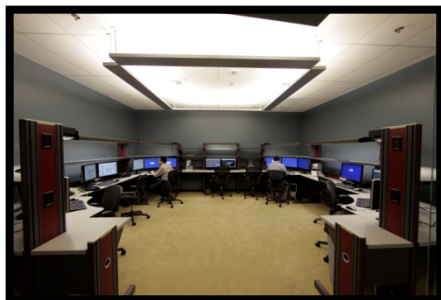
Status	BoH	Identity	QoT
<span style="color: green;">■</span> Alive	<span style="color: green;">■</span> Healthy	<span style="color: green;">■</span> Valid	<span style="color: green;">■</span> Trusted
<span style="color: yellow;">■</span> N/A	<span style="color: yellow;">■</span> Expired	<span style="color: yellow;">■</span> Expired	<span style="color: yellow;">■</span> Questionable
<span style="color: red;">■</span> No Heartbeat	<span style="color: red;">■</span> Unhealthy	<span style="color: red;">■</span> Revoked	<span style="color: red;">■</span> Untrusted
<span style="color: white;">■</span> Provisioned	<span style="color: white;">■</span> Provisioned	<span style="color: white;">■</span> Provisioned	<span style="color: white;">■</span> Provisioned

**To ensure proper operation, rigorous technology evaluation must take place in a controlled environment before smart grid technologies are deployed on the grid**

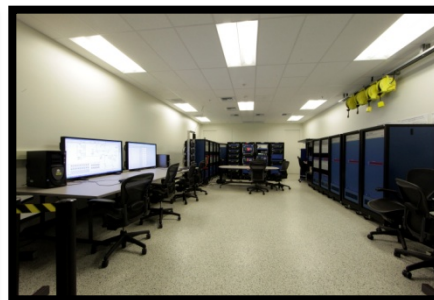
**Situational Awareness Lab**



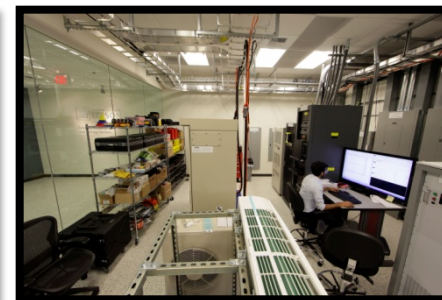
**Communications & Computing Lab**



**Power Systems Lab**



**Distributed Energy Resources Lab**



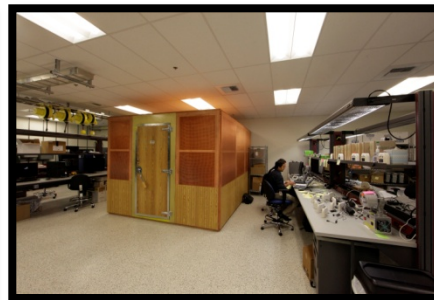
**Substation Automation Lab**



**Distribution Automation Lab**



**Home Area Network Lab**



**Garage of the Future Lab**

