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Solutions for Installations' Participation in Energy Markets

April 20, 2017

SERDP DOD • EPA • DOE | ESTCP

Welcome and Introductions

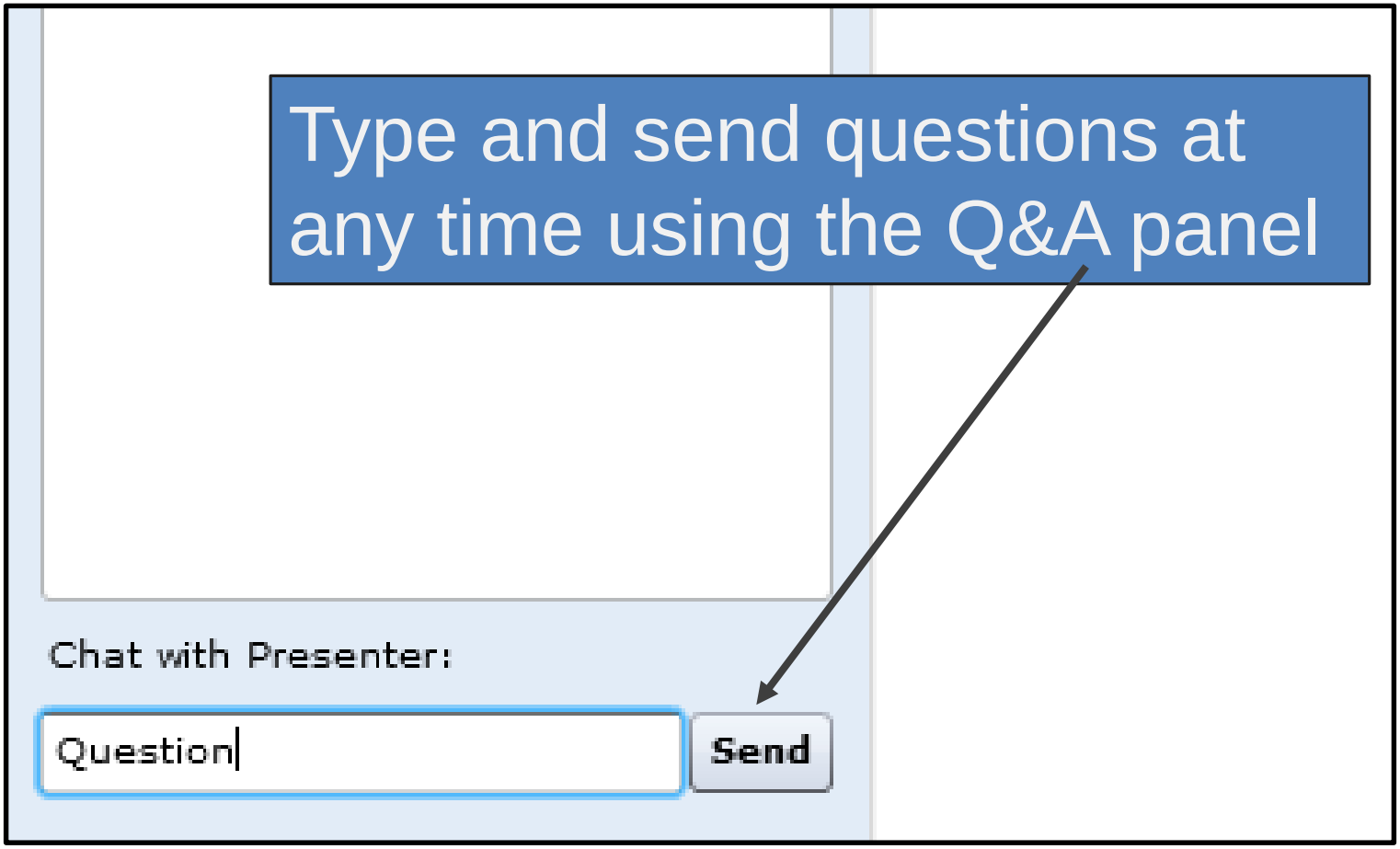
Jennifer Nyman, Ph.D., P.E.
Webinar Facilitator

SERDP DOD • EPA • DOE | ESTCP

Webinar Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Jennifer Nyman, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (5 minutes)
  Mr. Timothy Tetreault, SERDP and ESTCP
- **Secure Automated Microgrid Energy System** (25 minutes + Q&A)
  Mr. Kevin Meagher, Power Analytics
- **Market Aware High Performance Buildings Participating in Fast Load Response Utility Programs with a Single Open Standard Methodology** (25 minutes + Q&A)
  Mr. James Boch, IPKeys Technologies
- **Final Q&A Session**

How to Ask Questions



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SERDP and ESTCP Overview

Timothy Tetreault
SERDP and ESTCP

SERDP

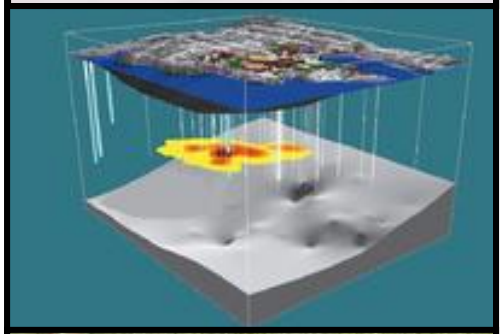
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

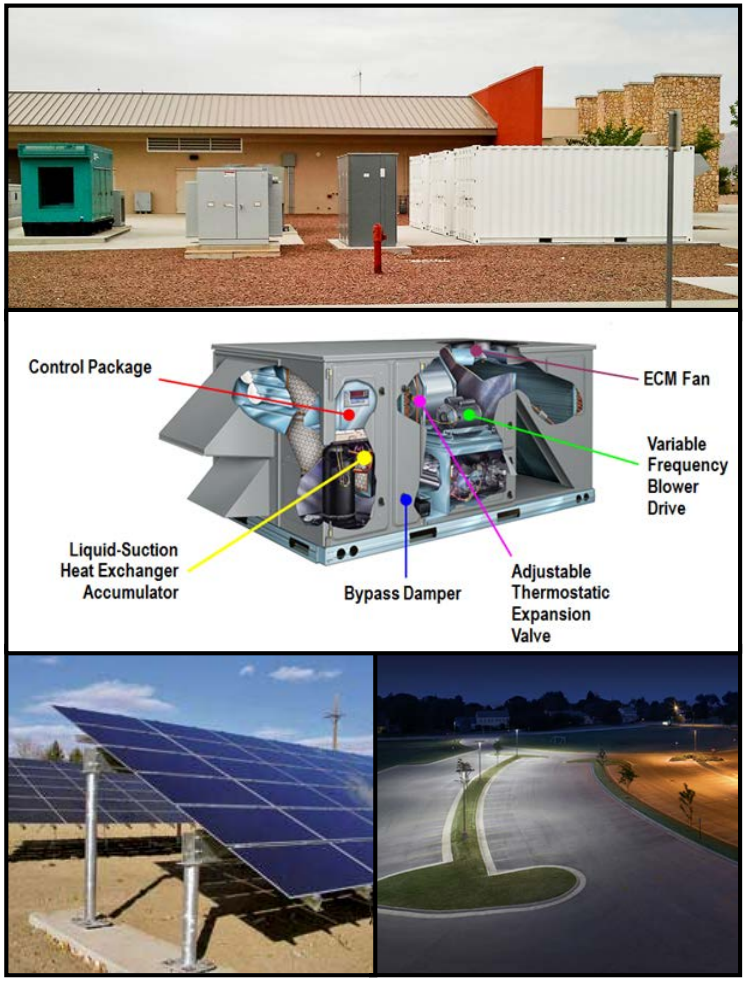
Program Areas

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Resiliency
5. Weapons Systems and Platforms



Energy and Water

- Smart and secure installation energy management
  - Microgrids
  - Energy storage
  - Ancillary service markets
- Efficient integrated buildings and components
  - Design, retrofit, operate
  - Enterprise optimized investment
  - Advanced components
  - Intelligent building management
  - Non-invasive energy audits
- Distributed generation
  - Cost effective
  - On-site
  - Emphasis on renewables



SERDP and ESTCP Webinar Series

Date	Topic
May 4, 2017	Novel Coatings Systems for Use as High Performance Chemical Resistant Power Topcoats
May 18, 2017	High-Resolution Site Characterization at Chlorinated Solvents Sites
June 1, 2017	Tools for Risk-Based Remediation of Unexploded Ordnance
June 15, 2017	Coupling Geothermal Heat Pumps with Underground Seasonal Thermal Energy Storage
July 20, 2017	Management of Energetic and Propellant Material Releases on Testing and Training Ranges

For upcoming webinars, please visit

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

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SERDP • ESTCP SYMPOSIUM

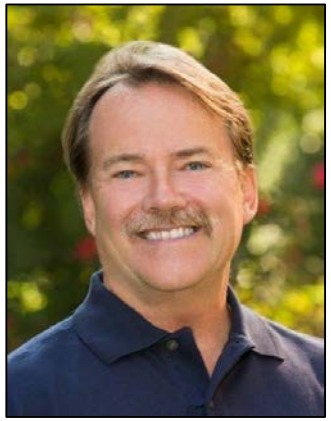
2017 | Enhancing DoD's Mission Effectiveness

A three-day symposium showcasing the latest technologies that enhance DoD's mission through improved environmental and energy performance

- November 28 - November 30, 2017
- Washington Hilton Hotel
  1919 Connecticut Avenue, NW
  Washington, DC 20009
- ***Registration is open***

Secure Automated Microgrid Energy System (SAMES)

Kevin Meagher
Power Analytics



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Agenda

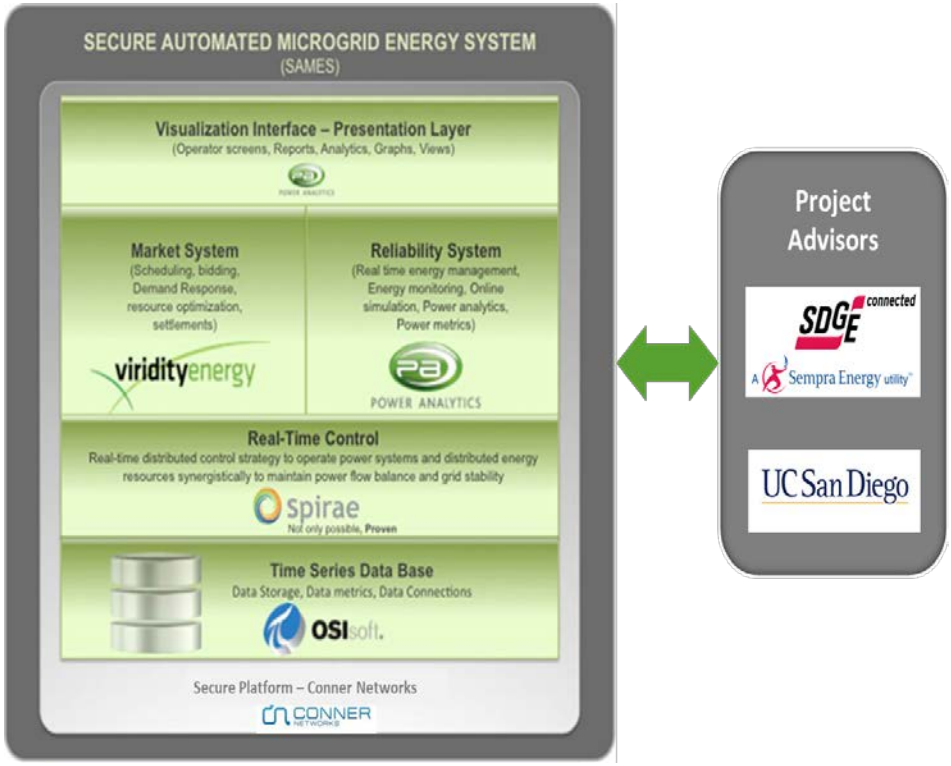
- Microgrids for energy surety
- Power model foundation
- San Diego SAMES cluster
- Colorado State University (CSU) Power House Integrid Lab
- Conclusions

Microgrids for Energy Surety

- A collection of loads and generation in a clearly defined electrical boundary
  - Can include emergency/backup generation
  - Can include renewable generation
  - Must maintain stability and reliability (utility grade)

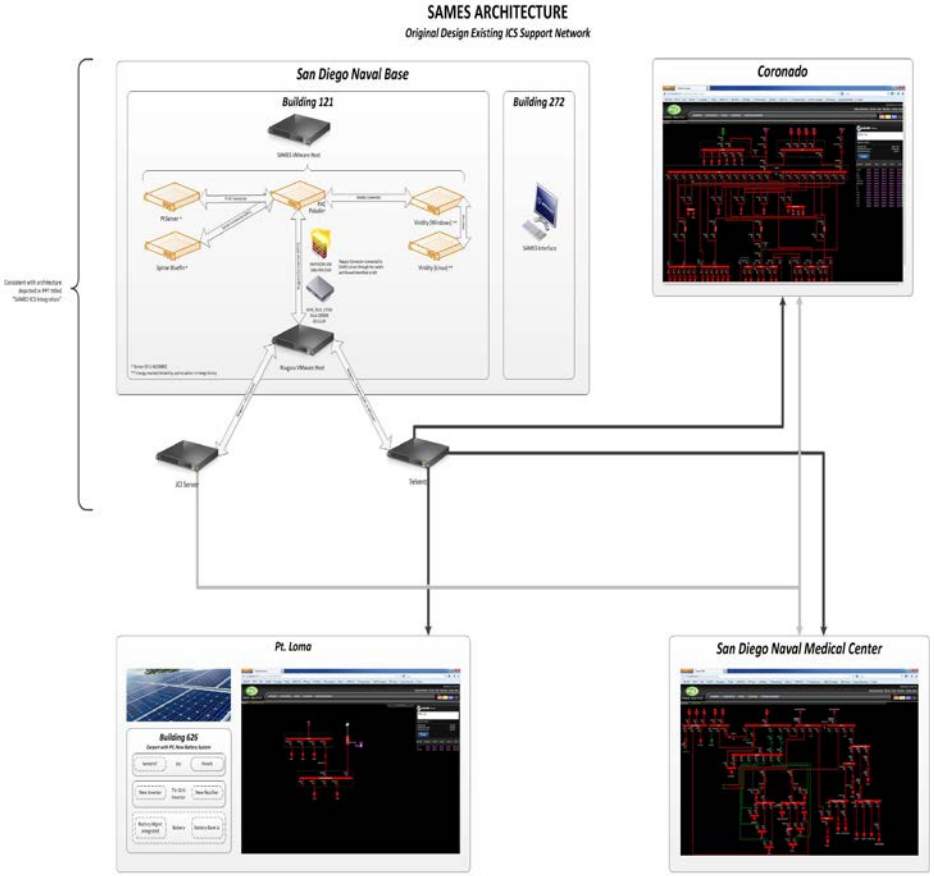
SAMES Team

- SAMES team and project advisors
- Integrated software and hardware into a secure network
- Spirae technology
  - Not integrated on San Diego cluster
  - Integrated at CSU Power House Lab



SAMES Servers

- Two servers located at Naval Base San Diego (NBSD) and connected (cluster) via secure fiber optic network to other locations
- Circuits chosen by NAVFAC as shown
- DIACAP strategy required integrated Niagara server for real time data

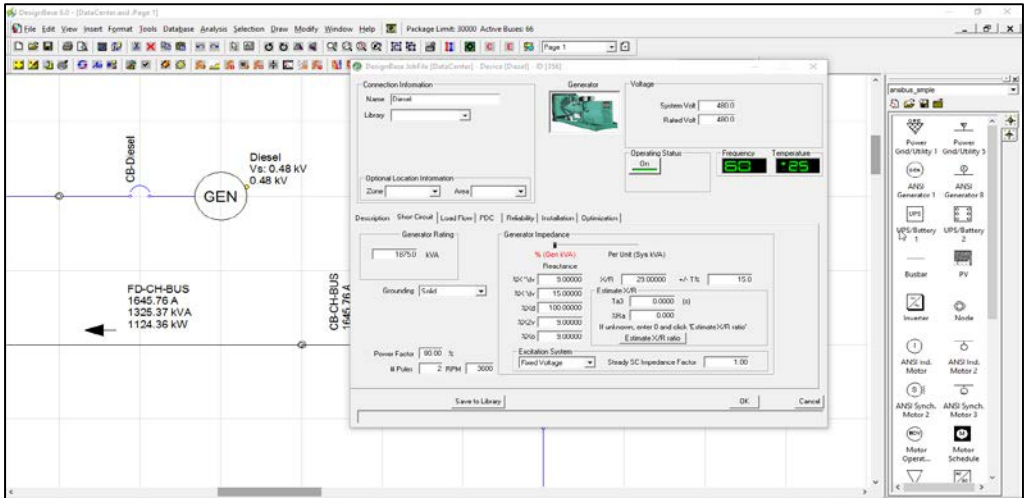


Power Model Foundation

- Develop a detailed power model of the site
  - Use previous power model work
  - Augment existing power model with any missing equipment/nameplate data
  - Iterate the power model with analysis, feedback and site visits

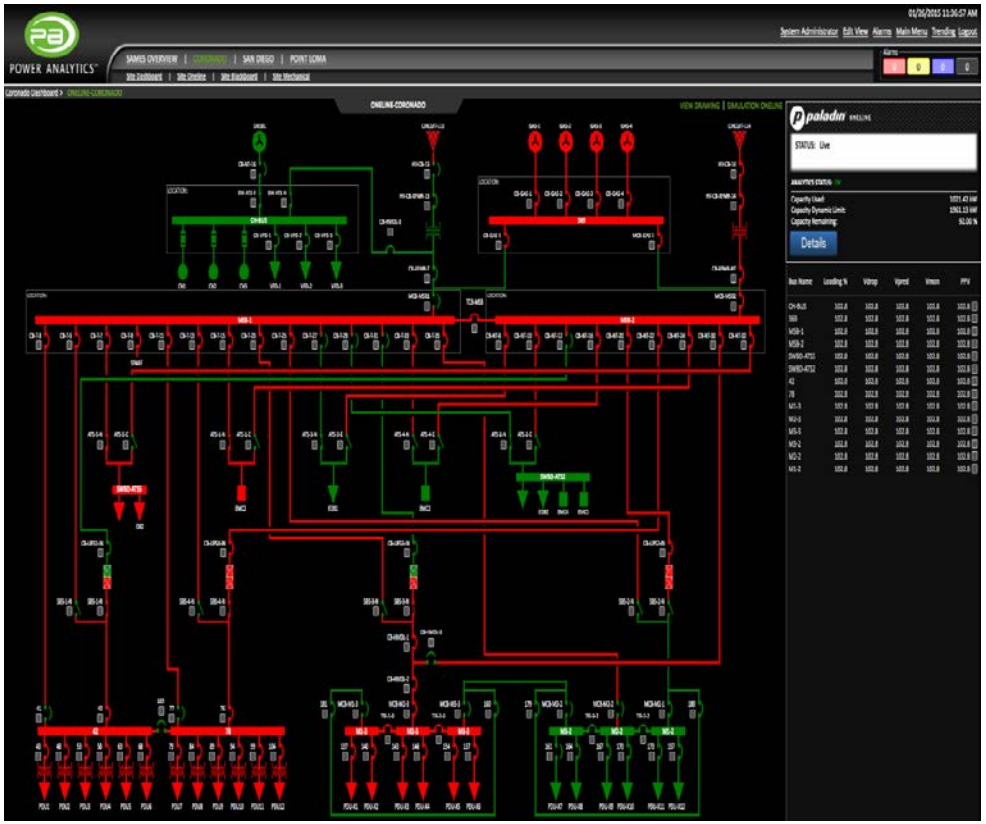
NBSD Medical Center

- Section of single line/one line model
- Circuit selected focused on the Medical Center for NBSD
- Created power model from existing models, updated and ultimately integrated with real time data to compare, calibrate and synchronize
- Power model becomes a living automatically updated record of the actual power network for planning, control, training and maintenance



NBSD Medical Center

- Real time one line at the duty desk
- Real time data is fed into the power model, power analysis is triggered based on thresholds and results displayed
- Real time single line is animated based on the power model, not directly from real time data
- Dashboard shows total capacity of the microgrid, and capacity remaining based on current operations



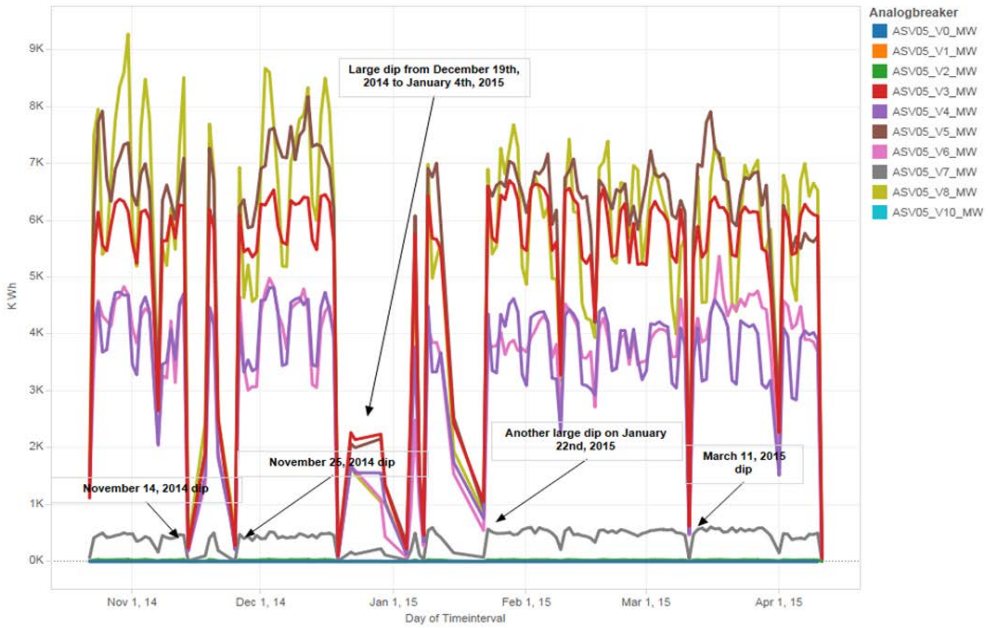
Power Model

Real Time Data

Analysis	Conclusion	Comments
Pt. Loma PV support Bldg 66	57.6 kW array is sufficient	Power network will support the PV
Medical Center reduction of 10%	Existing array cannot meet annual 10%	PV can support up 31% for periods
Medical Center can “island” from utility	Using standby generation, yes	Existing generation supports islanding
Increase power stability if required	Naval Medical center, yes. No for other circuits	Medical center has sufficient generation help stabilize
Medical center peak reduction of 10%	PV is not sufficient, requires existing gens	PV and Gens reduce peaks by 9.3%
Natural disaster capability	Medical center will survive essential loads	Only the Medical Center

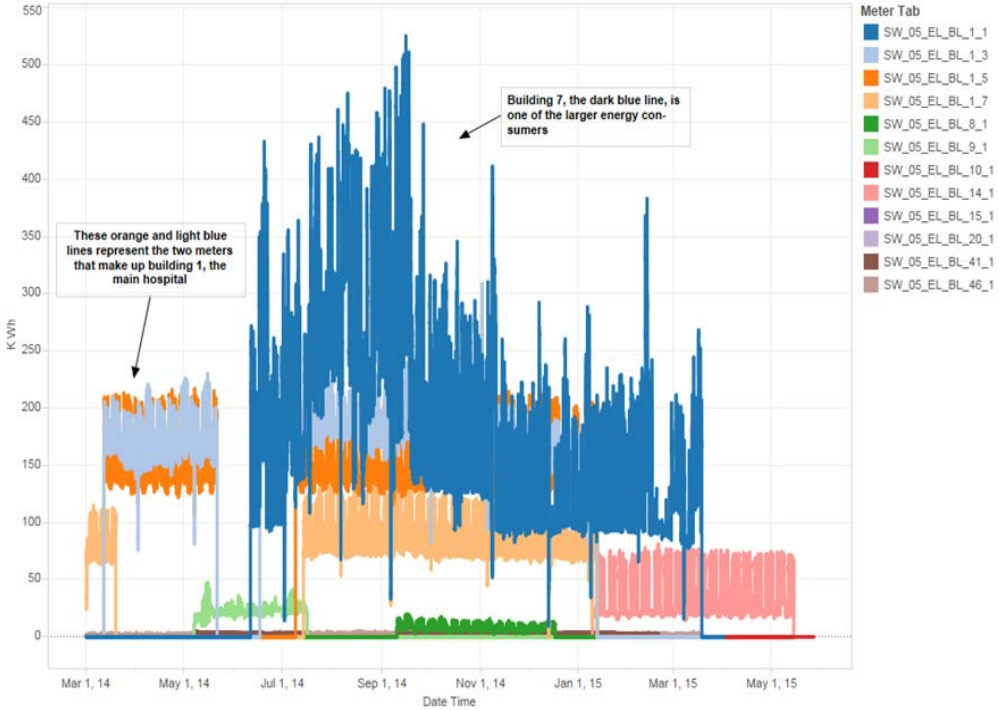
Point Loma

- Total energy consumption over the period of operation, October 2014 until April 2015
- Total energy consumed was 3,544,934 kWh over this period
- Maximum one-day energy was 32,946 kWh



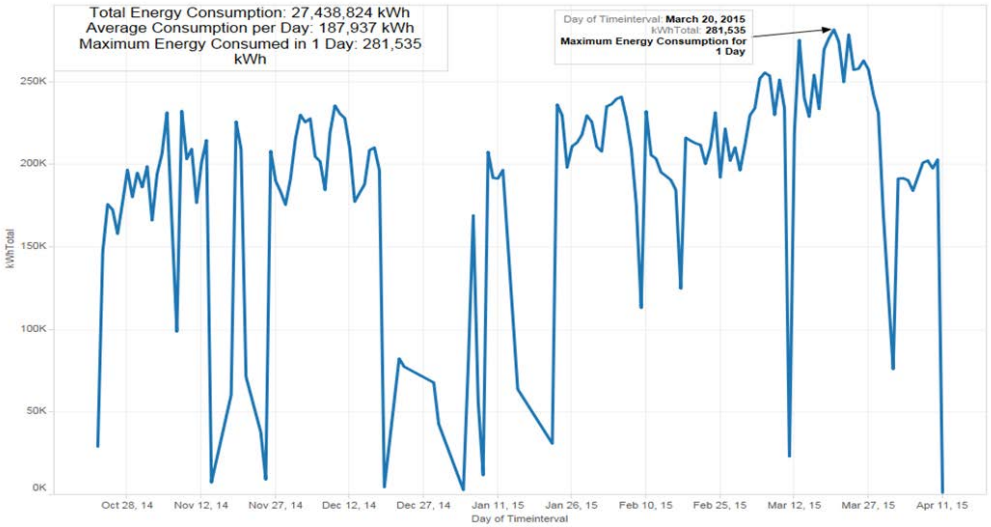
NBSD Medical Center

- Total energy consumption over the period of operation, March 2014 until May 2015
- Total energy consumed was 16,144,828 kWh
- Maximum one-day energy usage was 85,573 kWh



Coronado Naval Air

- Total energy consumption over the period of operation, October 2014 – April 2015
- Total energy consumed was 27,438,824 kWh during this period
- Maximum one-day energy consumed was 281,535 kWh



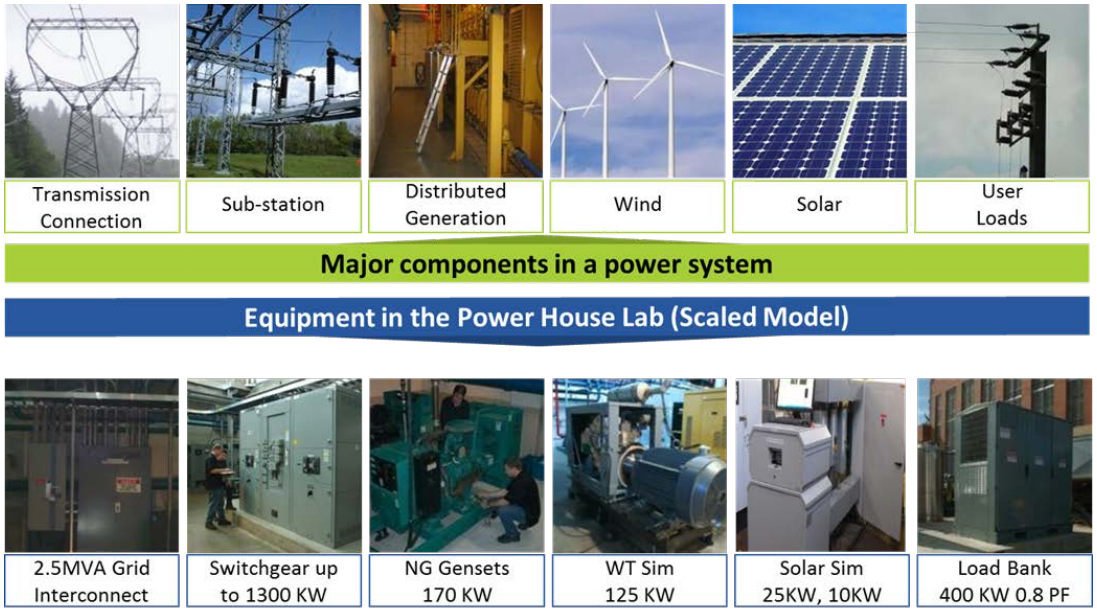
Mirrored Site CSU

- Pre-staging for SAMES
- Control demonstration and use case
- Identical process to San Diego
  - Power model
  - Use of existing infrastructure
  - Integrated real time

CSU Power House

Integrid Lab

- Former substation and large engine lab for CSU
- Utility switchgear @ 13.2 kV
- Transformer, 13.2/0.48 kV, 2 MVA
- 2 Nat Gas Generator Sets 2×125 kVA, 480 V
- Voltage Regulated, Active Power Dispatch Controllable algorithm to share power



- Wind Turbine (WT) Simulator, max 80 kW (4×20 kW)
- Synchronous Condenser, Solar PV emulator, 480 V, max 23 kW, Load Simulator, max 200 kW, min PF=80%, running load profile

CSU Power House

Main Dashboard Communicates Real Time Status

Thermal camera and regular cameras

Control connections

load shedding priority

Scenarios

Modeled and Controlled

Scenario	Description	Key Analytics
Utility connected	Utility connected, no distributed generation or synchronous generation	Power flow Contingency (N-1) Short circuit Arc Heat (arc flash)
Utility and Distributed Generation	Utility connected with renewable generation No synchronous generation	Power flow Contingency (N-1) Short circuit Arc Heat (arc flash)
Utility, Distributed Generation, Synchronous Generation	Utility connected along with renewable generation and synchronous generation	Power flow Contingency (N-1) Short circuit Arc Heat (arc flash)

Scenarios

Modeled and Controlled

Scenario	Description	Key Analytics
Loss of Utility (Islanding)	No Utility connection. Islanded mode using renewable generation and synchronous generation	Power flow Contingency (N-1) Transient Analysis Short circuit Optimal power flow
Loss of Utility, automatic load shedding	Islanded from the Utility, dynamic load shedding with loss of renewable generation	Power flow Contingency (N-1) Transient Analysis Short circuit Optimal power flow
Loss of Utility, renewable generation only	Islanded from Utility, stable operation with renewable generation only	Power flow Contingency (N-1) Transient Analysis Short circuit Optimal power flow

Power Flow Analysis

- Base line model for the lab is integrated with real time data and analytics run as data changes for optimization, load shedding and control set points

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Utility	202.92 kW 162.92 kVar	111.30 kW 129.95 kVar	-86.35 kW 247.34 kVar	0	0	0
Synchronous Generators	0	0	200 kW -116.24 kVar	110.19 kW 119.44 kVar	101.62 kW 75.82 kVar	0
Solar Photovoltaic	0	23 kW	23 kW	23 kW	0	23 kW
Wind Turbines	0	80 kW -67.8 kVar	80 kW -67.8 kVar	80 kW -67.8 kVar	0	80 kW -67.8 kVar
Synchronous Condenser	0	-10.83 kW 99.8 kVar	-10.84 kW 99.8 kVar	-10.84 kW 99.8 kVar	0	-10.83 kW 99.8 kVar
Total Loads	200 kW 150 kVar	200 kW 150 kVar	200 kW 150 kVar	200 kW 150 kVar	100 kW 75 kVar	50 kW 37.5 kVar
Controllable Loads	0	0	0	0	0	41.47 kW -5.73 kVar
System Loss	2.92 kW 12.92 kVar	3.47 kW 11.95 kVar	5.81 kW 13.1 kVar	2.35 kW 1.44 kVar	1.62 kW 0.82 kVar	0.71 kW 0.23 kVar

Power System Optimization

- Baseline assumptions
  - Utility $0.2/kWh
  - Natural gas $0.075/kWh
  - Solar PV $0.125/kWh
  - Wind $0/kWh

- Optimal power flow for security constrained economic dispatch

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Total System Losses Before Optimization [kW]	2.93	4.3	4.54	3.21	1.62	N/A
Total System Losses After Optimization [kW]	N/A	N/A	2.47	3.24	N/A	N/A
System Loss Reduction [kW]	N/A	N/A	2.07	-0.03	N/A	N/A
Total Generation Cost before optimization[$/kWh]	40.6	22.2	11.7	8.25	7.65	N/A
Total Generation Cost after optimization[$/kWh]	N/A	N/A	11.33	8.23	N/A	N/A
Saving in Generation Cost [$/kWh]	N/A	N/A	0.37	0.02	N/A	N/A

Most Control, Most Savings

Conclusions

- Significant challenges of obtaining site data over the demonstration period
- Combining power modeling and existing infrastructure is essential
- Economic and base surety objectives can be achieved IF supported by leadership
- Lessons learned from SAMES directly impact Navy, Army, Marines and Air Force strategy

For additional information, please visit
https://www.serdp-estcp.org/Program-Areas/Energy-and-Water/Energy/Microgrids-and-Storage/EW-201340

Speaker Contact Information

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Q&A Session 1

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Market Aware High Performance Buildings Participating in Fast Load Response Utility Programs with a Single Open Standard Methodology

James S. Boch
IPKeys Technologies, LLC

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Agenda

- Project objectives
- Background on DoD and Internet of Things (IoT)
- Preparation
- Results
- Next steps
- Conclusion

Project Objectives

- Pave the way for DoD participation in automated demand response
- Provide DoD facilities with an accredited gateway to participate in automated demand response
- Provide an implementation roadmap for accrediting operation of load modifying automated demand response devices on DoD networks
- Provide guidelines and insights to other technology providers on how to get their devices accredited and obtain the coveted authorization to operate ATO
- Provide a reference guide for the value in participating in various demand response programs across the USA

Energy Market Information Value

- Machine to machine communication with energy markets yields the following benefits
  - Increases economic efficiency
  - Potentially enhances value of microgrids
  - Enables participation in short notice utility programs
  - Reduces the burden on personnel

IoT on the DoD Network

Key Issues

01 **Is it worth the risk?**

02 **Does it compromise the mission?**

03 **Does it meet a need?**
Whose? Facility? Post? Community? Utility?

04 **Is it cyber secure?**

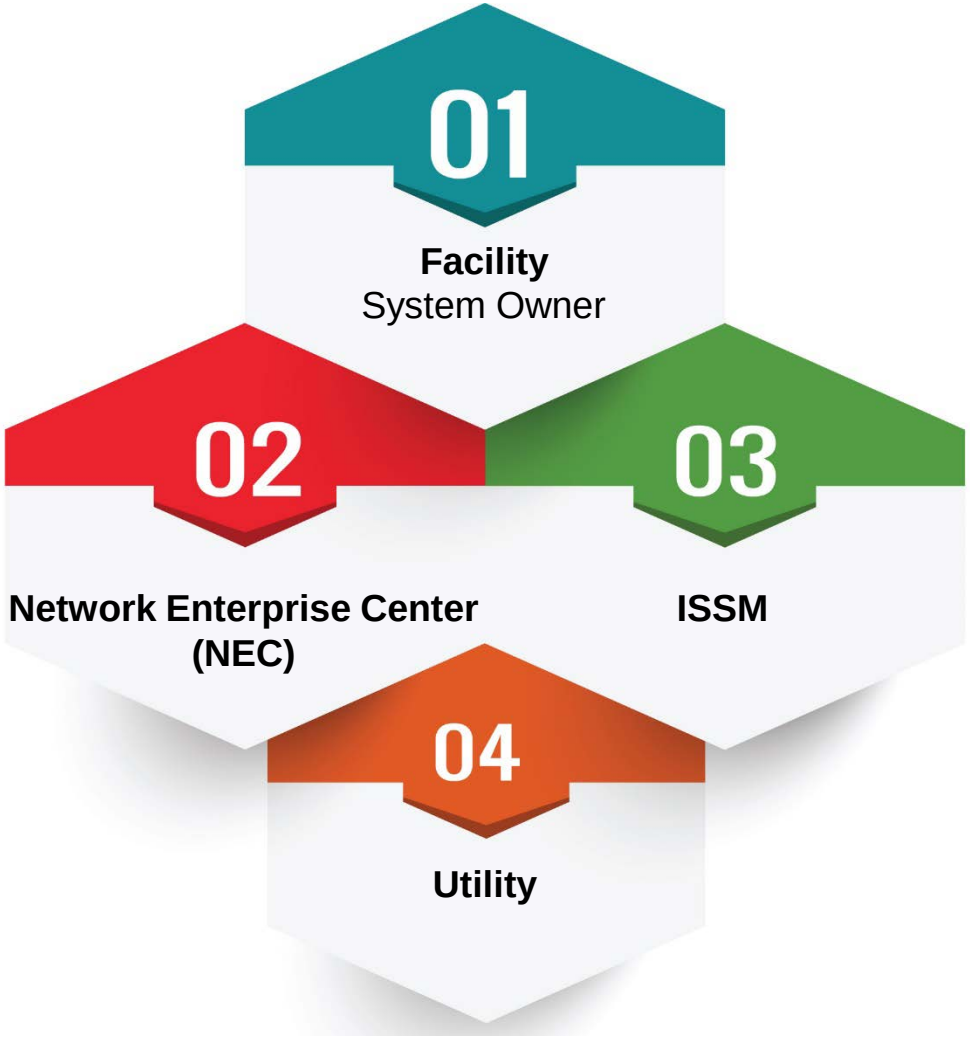
Title 10 Responsibilities

- Remember the mission to defend the United States always comes first

ATO / ATC

- To operate a system in a DoD facility an Authorization to Operate (ATO) is needed
  - ATO. Authorization granted by a DAA for a DoD IS to process, store, or transmit information. An ATO indicates a DoD IS has adequately implemented all assigned IA controls to the point where residual risk is acceptable to the DAA. ATOs may be issued for up to 3 years. (DOD 8510.01)
- To connect to the Global Information Grid (which includes the NIPRNet/SIPRNet) an Approval To Connect (ATC) is needed
  - ATC. The ATC defines the customer's connection boundaries as accepted by the DISN SIPRNET Management and reflects the completion of a successful network vulnerability assessment by the DISA SCAO. CJCSI 6211.02B 31 July 2003

Buy-In is Key


01
Facility
System Owner
02
Network Enterprise Center (NEC)
03
ISSM
04
Utility

Roles

- System owner
  - Typically the facilities manager
  - In charge of long term maintenance and use of the system
- Network enterprise center
  - This group manages devices that connect to the network
  - They can deny connection even to accredited devices
- Information system security manager
  - This person determines if the system is secure and issues the ATO/ATC
- Utility
  - Do they have an automated demand response program
  - Do they support the needs of the DoD, i.e., submetering, Opt out

Preparation

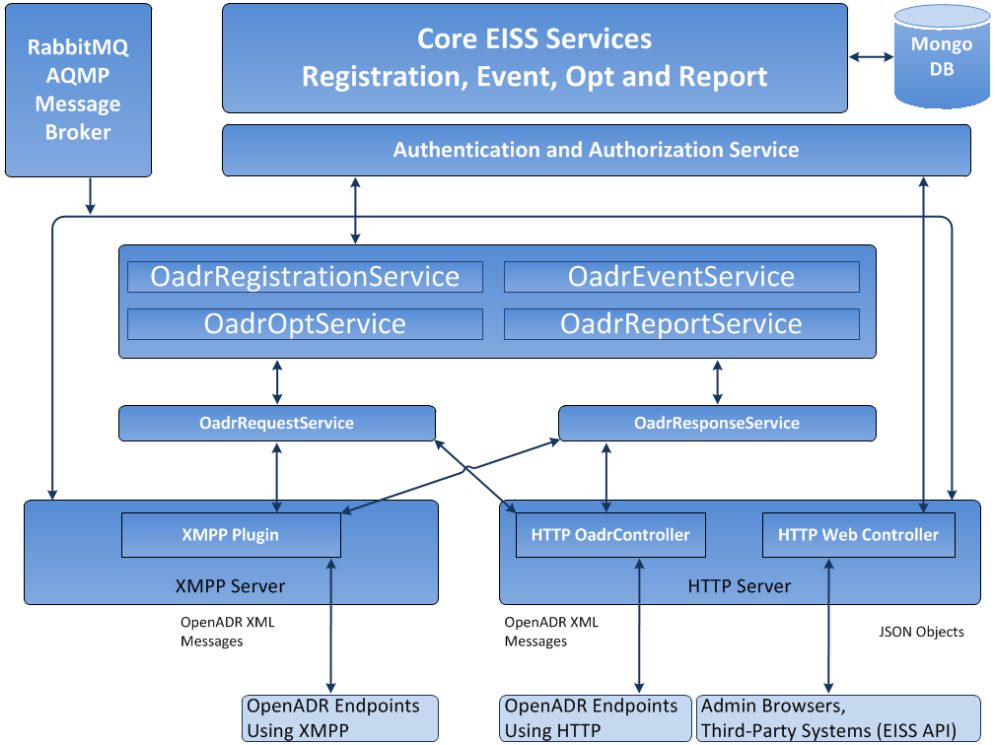
- Remember, we are certifying a device!
- Hardware
- Software
- Operating system (OS) and infrastructure
- Vulnerability scanning
- Port exceptions
- Encryption/authentication

Hardware

- Residential and light commercial devices can be problematic
- The more like an already accredited device, the better

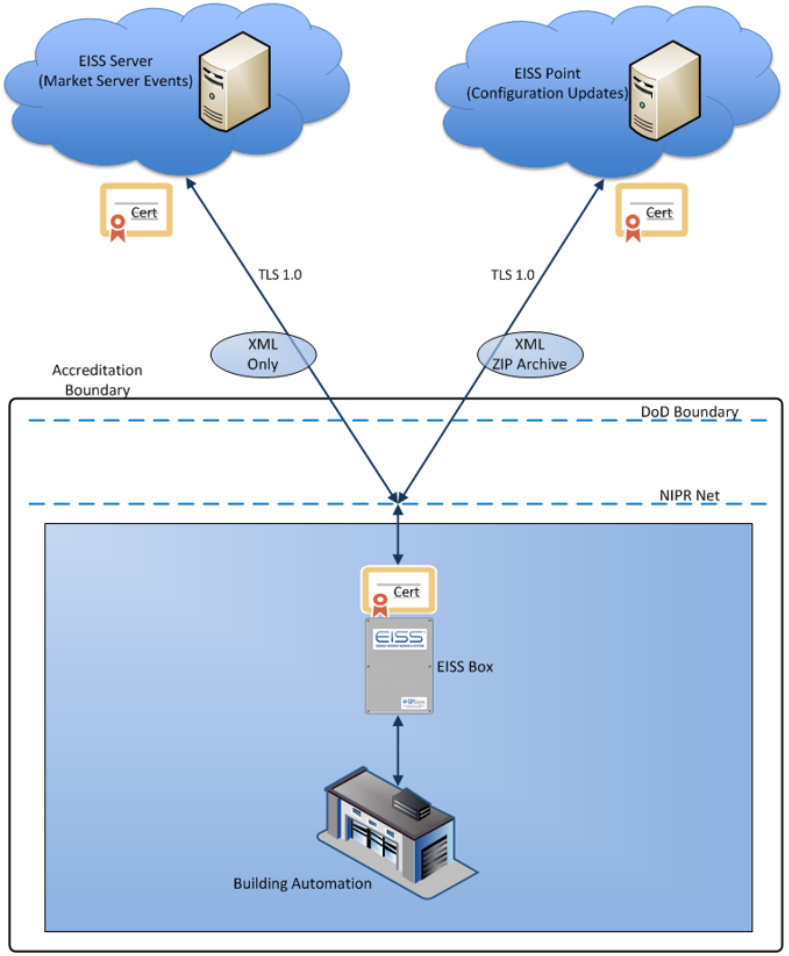
Software

- Application must be able to be updated to deal with emerging threats
- Messages should follow a request/response methodology
- Inbound communications are typically rejected by firewalls



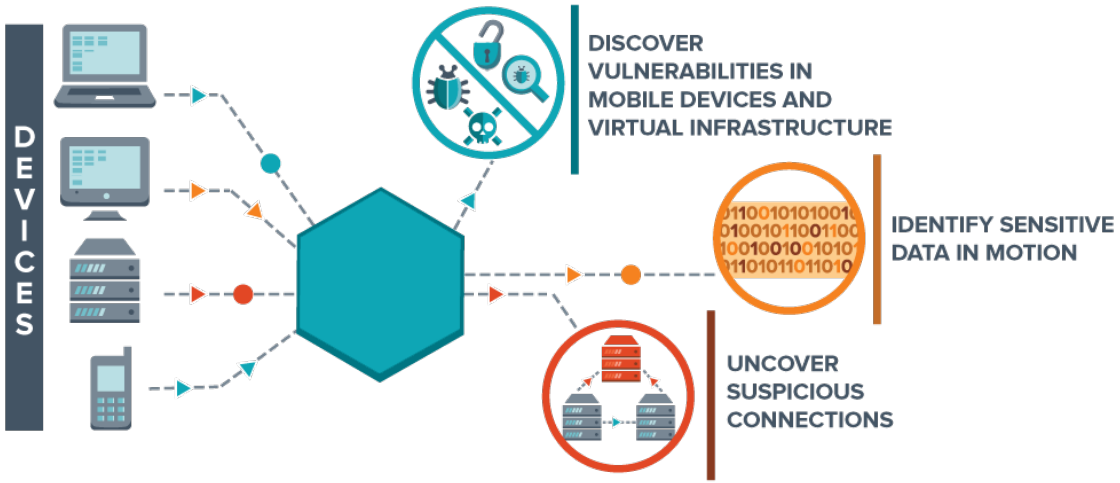
OS and Infrastructure

- Use of already approved operating systems reduces difficulty
  - Windows
  - Solaris
  - Red Hat Linux
- Not recognized OS require the vendor to support the OS as part of the accreditation
  - Debian Linux
  - Angstrom
  - Raspbian



Vulnerability Scanning

- Nessus is the current tool of choice to scan devices for vulnerabilities
- Security Technical Implementation Guides (STIG) are the approved methodology to modify the system for security controls and support

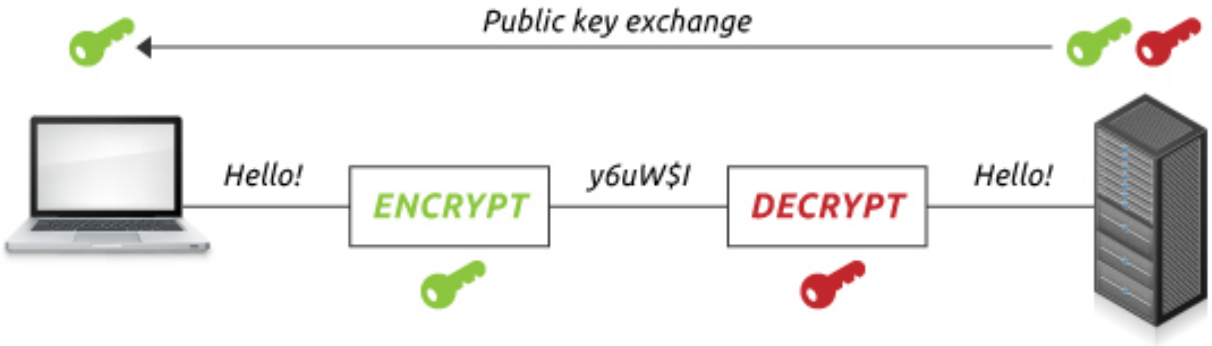


Port Exceptions

- DoD restricts the ports used as much as possible
  - Port 443 outbound
  - NTP outbound
  - Modbus 502

Encryption / Authentication

- Usage information and cyber threats require special treatment
  - The use of certificate authentication is a best practice
  - The consumption of energy is considered Personally Identifiable Information (PII) and needs to be safeguarded
  - Encryption of data at rest and in transit may be required



Results

- After 2 years we are about to receive our accreditation
- In order to make it through the accreditation process we
  - Changed to a windows operating system
  - Changed to a previously accredited hardware platform

Next Steps

- Camp Pendleton will deploy the DoD EISSBox system this summer
- Camp Pendleton believes it can shed 1MW without difficulty
- Participation in the Southern California Edison's Capacity Bidding Program will yield $67,000 per year at 1MW
- This system is also eligible for a $200/KW automation incentive

Conclusions

- Project paves the way for DoD participation in automated demand response markets
  - Accredited gateway for DoD facilities
  - Guidelines and insights for technology providers to get devices accredited
- Participation in energy markets produces value for the community and the DoD
- Accredited “adapter” facilitates rapid adoption by allowing existing building automation equipment to participate in automated programs without affecting their current accreditation

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Energy-and-Water/Energy/Conservation-and-Efficiency/EW-201401

Speaker Contact Information

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Q&A Session 2

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The next webinar is on May 4, 2017

Novel Coatings Systems for Use as High Performance Chemical Resistant Power Topcoats

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Survey Reminder

Please take a moment to complete the survey that will pop up on your screen when the webinar ends

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