U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Building Technologies Office

Buildings Interoperability Vision Technical Meeting

March 11-12, 2015

Buildings Interoperability Vision Technical Meeting

6 March 2015

Meeting Purpose

Review the landscape of automated buildings equipment integration today and stimulate thinking of a vision for interoperability of connected buildings 10 to 15 years from now. By articulating industry stakeholder alignment on a common vision and desired interoperability characteristics, context can be provided to discuss the challenges and gaps that must be overcome to realize this vision, and the sequence of steps necessary to make progress toward it. The results of this meeting will include comments on a report describing today's buildings interoperability landscape and an outline for a vision document and will provide input to future meetings for framing a buildings interoperability roadmap.

Summary

Buildings are an integral part of our nation's energy economy. The advancement in information and communications technology (ICT) has revolutionized energy management in industrial facilities and large commercial buildings. As ICT costs decrease and capabilities increase, buildings automation and energy management features are transforming the small-medium commercial and residential buildings sectors. A vision of a connected world in which equipment and systems within buildings coordinate with each other to efficiently meet their owners' and occupants' needs, and where buildings regularly transact business with other buildings and service providers (such as gas and electric service providers) is emerging. However, while the technology to support this collaboration has been demonstrated at various degrees of maturity, the integration frameworks and ecosystems of products that support the ability to easily install, maintain, and evolve building systems and their equipment components are struggling to nurture the fledging business propositions of their proponents. Through its Building Technologies Office, the United States Department of Energy's Office of Energy Efficiency and Renewable Energy (DOE) is sponsoring an effort to advance interoperability for the integration of intelligent buildings equipment and automation systems, understanding the importance of integration frameworks and product ecosystems to this cause.

For connected buildings ecosystems of products and services from various manufacturers to flourish, the ICT aspects of the equipment need to integrate and operate simply and reliably. Within the concepts of interoperability lie the specification, development, and certification of equipment with standards-based interfaces that connect and work. And beyond this, a healthy community of stakeholders that contribute to and use interoperability work products must be developed. A previous DOE technical meeting[1] has taken stock of the interoperability of connected equipment and systems in buildings today. In addition a Buildings Interoperability Landscape report has been drafted to describe an interoperability framework for buildings, including lists of relevant use cases, stakeholders, and interoperability goals. This document can be found at http://energy.gov/eere/buildings/downloads/buildings-interoperability-landscape-draft. To encourage vibrant

[1] Technical Meeting: Data/Communication Standards and Interoperability of Building Appliances, Equipment, and Systems, held at the National Renewable Energy Laboratory, Golden, Colorado, 1 May 2014. Summary notes and presentations can be found at, http://energy.gov/eere/buildings/downloads/technical-meeting-datacommunication-standards-and-interoperability-building

product ecosystems for connected buildings in the future, a series of technical meetings is proposed with the objectives of reviewing this landscape report and developing a roadmap of activities that advance connected buildings interoperability.

An initial step in the roadmap process is to develop a vision for the interoperability of small to medium commercial connected buildings products and services. Even though interoperability advances will also pertain to large facilities, they are critical to support the business propositions of smaller buildings automation deployments where allocations for integration and operations support are minimal. Similarly, these interoperability advances will pertain to homes, though the focus is not on homes initially due to their diversity and the different type of relationship with their owners. By imagining the expectations of equipment integration and operation in these buildings 10 or 15 years from now, stakeholders can temporarily suspend incrementally addressing today's integration issues and look toward common features of a desired future state. This meeting is designed to review the Buildings Interoperability Landscape report, and to stimulate thinking about the attributes of a future desired state, while setting aside how to build it. By engaging attendees representing a variety of stakeholder perspectives, we hope to find common characteristics that lead to directional alignment.

Outcomes

The result of this meeting will be an outline for drafting a buildings interoperability vision whitepaper. The content of the vision whitepaper is a discussion subject for the meeting; however, important aspects are expected to include the desired attributes or requirements of interoperability that can be shaped into goals and metrics so that advancements can be assessed. Subsequent meetings will review and refine the vision and begin the process of defining a roadmap of activities that moves to bridge today's connected buildings situation with the vision.

Logistics Information

Date: 11-12 March 2015
Location: Seattle, WA
Venue: Grand Hyatt Seattle
721 Pine Street, Seattle, Washington, USA, 98101
Tel: +1 206 774 1234, Fax: +1 206 774 6120
Email: seattle.grand@hyatt.com
Reservations Link: https://resweb.passkey.com/go/DepartmentofEnergy
Room Block Name: Building Interoperability Vision Workshop
Transportation Information: http://www.grandseattle.hyatt.com/en/hotel/our-hotel/transportation.html
Light Rail - $2.75 one way – Drops off 1 ½ blocks from hotel (Westlake Station)
Seattle Shuttle/Downtown Airporter: http://shuttleexpress.com

Contact

Tamica Dickenson
Pacific Northwest National Laboratory
tamica.dickenson@pnnl.gov
(509) 372-6802

Steve Widergren
Pacific Northwest National Laboratory
steve.widergren@pnnl.gov
(509) 375-4556

U.S. DEPARTMENT OF ENERGY

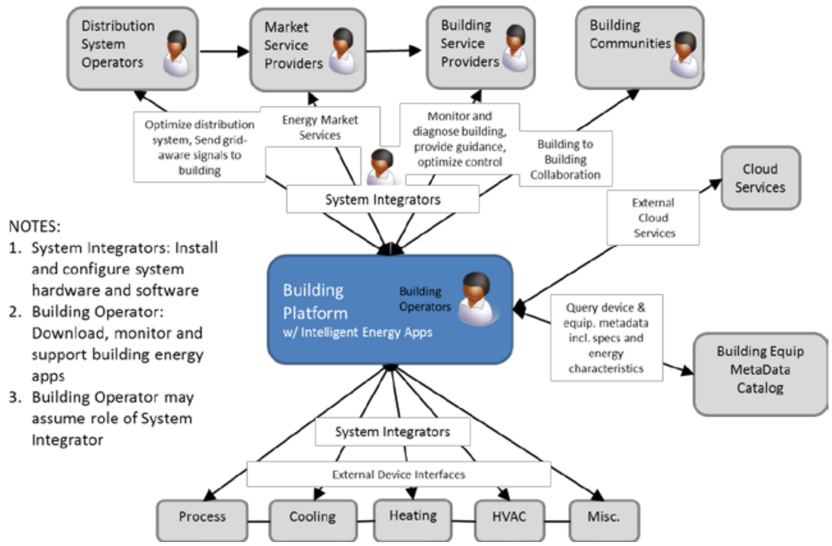
Pacific Northwest NATIONAL LABORATORY

Agenda

11 March 2015	
8:00 am	Welcome and Introductions
8:15 am	Overview: Sensors, Controls, and Transactional Network Program, Joe Hagerman, US Department of Energy (DOE), Building Technologies Office - BTO
8:30 am	Meeting Context • Purpose, goals, desired results and deliverables • Review Buildings Interoperability Landscape draft document
9:30 am	Vision Stories and Interoperability Requirements • Provocative ideas of what buildings automation integration may look like in the future • Interoperability characteristics • Selected scenarios that span buildings automation use case actor perspectives
10:30 am	Transformational ICT Directions – Internet of Things Ecosystems Presentations • Samsung: Alan Messer • Bosch: Charles Shelton, Adam Wynne • SmartCloud: Peter Hunt • Honeywell: Tariq Samad • The Allseen Alliance: Ivan Judson (Microsoft)
Noon	Working Lunch: Presentation from Kevin Lynn, DOE-EERE Grid Integration Initiative
1:00 pm	Breakout Session Topic 1: What does the future look like? • Orientation: interoperability scenarios from main actor perspectives • Facilitated discussion and results capture
2:45 pm	Breakout Session Topic 2: What are the interoperability attributes to consider? • Orientation: interoperability scenarios from main actor perspectives • Facilitated discussion and results capture
4:15 pm	Summary reports from breakouts
5:15 pm	Adjourn

12 March 2015	
7:45 am	Greeting and review of Topics 1 and 2 results
8:00 am	Buildings Automation Transformation - Industry Directions Presentations • Siemens: David Kopczynski • Iconics: Gary Kohrt • SkyFoundry – Project Haystack: John Petze • Energy Technology Savings (ETS): Jeff Hendler
10:00 am	Group Session Topic 3: What should a buildings interoperability vision include? • Orientation: example vision whitepaper outline • Facilitated discussion capturing a vision whitepaper outline
11:30 am	Closing comments – Joe Hagerman, DOE • Importance of a national strategy for the interoperability of connected equipment • Next steps and meeting adjournment
Noon	Adjourn

Buildings Interoperability Vision Stories



Building Ecosystem Model

Building Story Context

The following building interaction stories depict first person scenarios, or stories, inspired from existing building use cases contained within the Transaction-Based Building Controls Framework, Volume 1: Reference Guide[2]. Settings for the stories are described by the Buildings Interoperability Vision section of the Buildings Interoperability Landscape Draft document[3]. This vision portrays key actors, such as building operators, interacting with intelligent software applications running on an ecosystem-supported hardware-software system platform. Intelligent applications, also referred to as intelligent agents, execute logic on behalf of the building operator. The stories represent hypothetical but realizable scenarios that could enable key visionary interoperability objectives such as ease-of-interaction, cost-effective integration, and deployment at scale.

Each use case from the reference guide has multiple paths of execution (i.e., threads). The stories that follow choose a specific use case thread, which is summarized in each story. The threads selected are not intended to be rigorous scenarios for product development. Their purpose is to provide a visionary context for extracting interoperability requirements that enable a variety of methods for enabling a range of services similar to the ones depicted. Details relating to specific interactions such as service messaging payload contents, message syntax and transport are important to the extent that the interoperability requirements extracted do not limit specific future interactions.

Certain philosophical assumptions were applied in developing the stories below. The next section introduces the importance of these assumptions to support interoperability goals.

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[2] "Transaction-Based Building Controls Framework, Volume 1: Reference Guide," prepared for the U.S. Department of Energy by Pacific Northwest National Laboratory, PNNL-23302, December 2014. Accessed March 2015 at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23302.pdf

[3] Buildings Interoperability Landscape – DRAFT, prepared for the U.S. Department of Energy by Pacific Northwest National Laboratory, PNNL-24089, February, 2015. Accessed March 2015 at http://energy.gov/eere/buildings/downloads/buildings-interoperability-landscape-draft

System Integration Philosophy

Interoperability makes the integration of buildings automation equipment and systems simpler and predictable. To manage the complexity of a large number of connected equipment and systems over a long time horizon, the philosophy of system integration must consider enduring qualities such as the ability to evolve the system and its equipment over time and the ability to scale up to integrate greater numbers of components. These considerations have led to focus on the interface where things connect and the boundary within which qualities such as authority, responsibility, security, and privacy can be clarified. The following philosophical considerations are borrowed from the GridWise® Interoperability Context-Setting Framework[4].

Agreement at the Interface: The interface agreement captures the interaction between parties, including any assumed actions. It is about the goods and services exchanged, price, scope, schedule, quality, and consequences for failure to perform. It is about what is delivered and the process to get it, not how the deliverable is generated.

Boundary of Authority: The agreement is situated in the transactive stream at the place where responsibilities are clearly defined. This forms a boundary of authority for addressing rights of privacy and security, and separates the way business is conducted on either side of the interface. Requirements between transacting parties for the way business, privacy, and security are dealt with need to be reflected in the interface agreement along with appropriate mechanisms for auditing.

Decision Making in Very Large Networks: For networks of things to scale, they need to delegate responsibility to the end points. One can draw a bubble around an end-point (equipment, subsystem, building?), but the hyper-network of end-points relies on these areas of automation acting in their own best interests while conforming to policies (rules) that support the health of the overall system. Hierarchical approaches have their place in complex systems as well and are helpful for defining lines of responsibility that are important to the above 2 points.

Role of Standards: Open standards have obvious interoperability benefits and should be encouraged, but they are not the full story. The use of standards should be a technical/design/business choice and not a hard policy. This is because technology and standards change over time and this evolution needs to be accommodated rather than stifled. Policy is best when it sticks to results-oriented performance requirements and ecosystem necessary conveniences, such as VIN numbers on vehicles.

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[4] GridWise Architecture Council, *GridWise Interoperability Context-Setting Framework v1.1*, 2008. Accessed March 2015 at http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf.

Building Internal Interaction Story

Use Case: Automated Building Energy Efficiency

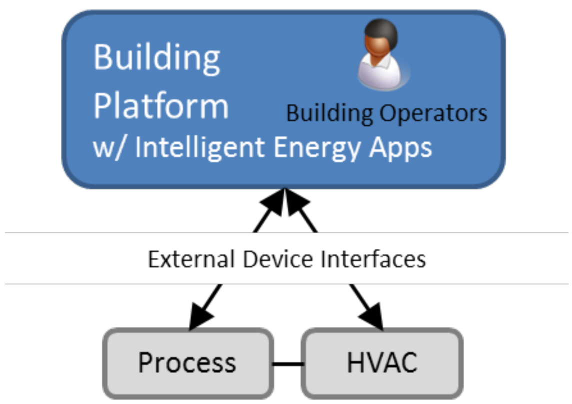
Actors: Building Operator (BO)

Description: A first person view of applying automation to a small building through the eyes of its operator. It focuses on technology integration but draws from familiar interaction patterns.

Value Proposition: Improving the ability of building devices and systems to interoperate will result in lower costs and other benefits including increased energy optimization and efficiency.

Story Sequence:

- BO purchases a "Building Platform" based on ability to integrate with existing equipment
- BO downloads an app that discovers the building and begins monitoring devices
- BO adds HVAC and kitchen appliances using "Black Boxes"
- BO downloads an app that monitors building energy and provides guidance and control
- BO interacts with the "Cyber Intrusion Agent" and has privacy concerns



I own and operate a decent-sized food restaurant. Some other building owners in the area have "Building Platforms" and I'm thinking about buying one. They rave about how easy they are to install and use, and the comfort, security and savings they get.

There are two that seem very popular. One, the "iBuilding", has the reputation of being very easy to use and has a bunch of cool features. Most new kitchen appliances, security systems and heating and lighting systems are compatible with it. The other, the "LightSaver", is very much like the iBuilding and seems to have the same features and functions. The one thing I did notice is that it has support for a bunch of older appliances and HVAC systems. This is important to me because my building is 20 years old and has older kitchen appliances and HVAC system. I can buy these little boxes called "Black Boxes" that plug into the freezer, frig and HVAC that let them work with the LightSaver. I decided that this feature was a "must-have".

I ordered the LightSaver and all I had to do was plug it in and download an app called "The Agent" into my phone. The Agent quickly walked me through the process of discovering my building after I got past the security and privacy screens. It found the electric and gas meters and the security and fire alarm system. Everything communicates by wireless so that makes installation easy. I can see my energy usage and my security cameras from anywhere, at any time from my phone, tablet or PC!

I ordered and plugged in Black Boxes for my HVAC and appliances. Bingo! My Agent found them and now I can see and change the temperature as well as check out how the appliances are operating. I can even change the temperature setting on my freezer and frig if I want to.

I go to the online Agent store and download an app called "The Breeze" that monitors my energy usage then shows me where I'm spending my money and how much I could save if I made some changes. It's important that my kitchen is fully functional during breakfast, lunch and dinner but I have flexibility between these times. I also don't mind if my lighting dims but it needs to be above a certain level during dinner. After walking through some screens where I tell it what my needs are, it responds by letting me know what information and resources it needs access to. It doesn't ask for everything, but for each capability, it lets me know what's needed to perform the job and asks for and obtains my permission beforehand. The access policies are established under pro forma language agreed to by the Smart Buildings Better Business Society, which works with state and federal legal groups on consumer rights and privacy issues.

Once the initial set up is complete, it begins monitoring the energy usage of my building and my appliances. If anything goes wrong, I get text and email messages with links to a website that provides more information on the problem and summarizes my building's operation.

I like the way the LightSaver is sensitive to the privacy aspects of my business, but I've been reading about major banks and businesses getting hacked. I started looking into this more deeply and found that the system is equipped with an cyber intrusion detection agent that allows me to configure my potential risk exposure while letting me know the trade-offs in performance and functionality of the apps I've deployed. I regularly get notices for security upgrades and occasionally an event occurs when an immediate patch is recommended. It also has the capability to move into degraded modes of operation changing its behavior if it detects an abnormal situation. Part of the operating agreement with each app is that they supply the fail-safe aspects of each building component so that devices can go to a default safe place while not necessarily shutting off.

Building Service Provider Story

Use Case: "Diagnostics and Automated Commissioning Services" (see Transaction-Based Building Controls Framework, Volume 1: Reference Guide)

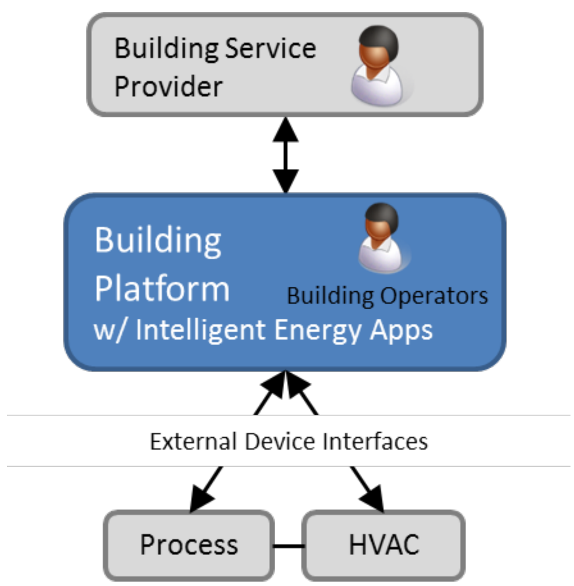
Actors: Building Operator (BO), Building Service Provider (BSP)

Description: A first person view of how a building operator might interact with a third-party that provides building commissioning services, energy guidance and diagnostics on behalf of the building operator.

Value Proposition: Minimizing the costs of supporting efficient operation of building systems and providing value-added services.

Story Sequence:

- BO already has "Building Platform" but needs help in maintaining the system
- BSP wants to provide energy services but needs access to building data
- BO downloads and configures a "Diagnostic Gateway" app and BSP app
- BSP interfaces with Gateway app to discover and monitor the devices connected to the building platform
- BSP updates app with energy information, diagnostics and guidance
- BO interfaces with BSP app



As the BO, I've been living with my Building Platform for a while now and have accumulated a collection of smart apps and devices. Using my smartphone, I can see if my devices are operating and turn them on and off manually. If an appliance doesn't seem to be working correctly, its app sends me a notification but it's now a pretty complex system. It sure would be nice if these parts were integrated together.

As a BSP, we've got the domain knowledge and expertise to help BO's manage their building energy costs but I need access to their building data. We work closely with customers to make sure they are comfortable working with us. The more data we have access to, the more services we can provide. We also need to keep our costs down so that our customers can afford to use our services. This is difficult because buildings differ and we need to scale to large numbers so we use a standard interface to integrate building data into our energy cloud. We also have a building platform app that accesses our cloud through standard interfaces and provides the BO with information and guidance. By using standard interfaces, we can help minimize app development costs. The BO can purchase the app outright or sign an agreement with us to split the energy savings and not have to pay upfront. This is a win-win.

As the BO, I download, install and run the BSP's app. As a prerequisite, I need to install another app called a "Building Diagnostics Gateway" from MicroFirm. This app acts as my agent to the outside world and lets me have control of what data I share and who I share it with. After registering with the BSP website, the BSP app guides me through a workflow to setup security, privacy and other basic app information. I allow it to store my data in the cloud so that I have access to historical reports and graphical trends from anywhere. It finds and interrogates my devices and appliances, asks permission to access each one of them, determines how to communicate with them and extracts metadata and energy data from the devices (or from somewhere) to build and initialize an energy model of my building. It shows me a diagram of my energy system. The app starts monitoring building sensors while it tunes the energy model. The app also allows me to configure my business workflow, schedule, priorities and constraints easily.

As the BSP, I've been collecting and analyzing the building's data and generating historical, current and forecast views of the BO's building energy system along with past and projected costs associated with each appliance. We're leveraging several indirect techniques such as using NOAA for weather data, detecting occupancy using manual entry and power consumption from product specs but after we've collected sufficient data, we'll show the BO a prioritized list of changes that would be worthwhile to improve system monitoring and energy performance. Using our app, the BO can understand where energy is being used and lost through a detailed (but easy-to-read) energy balance display.

As the BO, the apps have been running for a while now and have detected some abnormal conditions and sent operational status updates and events to my smartphone. They provide very clear error and warning messages when it finds something wrong with a device, or with the system as a whole, and tells me how to correct the error or who to contact for help. The energy guidance has been valuable and has lowered my bills.

As the BO, it sure is a good thing that the app has great security and privacy or I'd be turning it off about now. If I hear that the BSP has a security breech then I will. They stand behind a privacy agreement that spells out what information is accessed, who has access to it and how that information will be used. If I want someone else to have my data, I can securely give them appropriate approvals.

Distribution System Operations Story

Use Case: "Transactive Acquisition of Ancillary Services" (see Transaction-Based Building Controls Framework, Volume 1: Reference Guide)

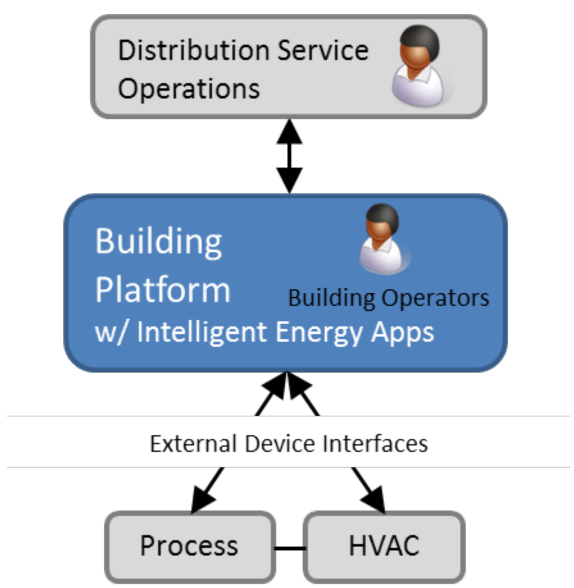
Actors: Building Operator (BO), Distribution Service Operator (DSO)

Description: A view of how a BO might supply spinning reserves to a DSO ancillary service market, and how the DSO may interact with the BO.

Value Proposition: Increased renewables are resulting in more grid fluctuations. Buildings can be a less expensive near-term alternative than distributed generation. Winning bidders are compensated for their ability to reduce load if called upon.

Story Sequence:

- DSO runs an hourly reserve program for spinning reserves
- BO connects to this interface using apps provided by the DSO or third parties
- BO configures his app and devices to respond to the DSO program and bid messages
- DSO clears the program's market hourly and the cleared price is broadcast to all BOs
- When needed, DSO broadcasts a reserve event and all BO's who won the bid curtail demand
- When expired, BO and DSO reconcile contract performance.



As the DSO, I monitor the system and run an hourly reserve market for feeder locational real-time pricing for BOs to participate in a spinning reserve ancillary services program. I define the pre-requisites for a building to qualify for the market. That includes the minimum amount of power and energy to bid, the range and speed of response that is acceptable for performance, and how the payment for the service will be reconciled (including measurement and validation requirements). This is reflected in the ICT interface to this DSO program.

As the BO, I can connect to this interface using apps provided by the DSO or third parties who use the same reserve market interface and may offer services to integrate with my buildings automation platform. I am able to discover the DSO offering from their website, fill out the qualification material, and once qualified obtain a secure sign-in code for interfacing with the DSO interface. I configure my automated equipment to be able to respond to the DSO reserve program. I use a third party app that the DSO website suggested as compatible with my Building Platform and the DSO program's interface to help do this. I give the app permission to discover my equipment and my system schedules and preferences for operation. It is smart enough to figure out where I have connected equipment that may have some flexibility and offers me options for setting my preferences on ranges of operation (e.g., space and refrigeration temperatures) that I'm willing to live within. Once set up, the app connects to the DSO program for real-time operation.

As the DSO, I confirm that the BO is signed up and available for the program. Reserve market messages periodically are sent to the BO indicating opening and closing of the market and market clearing results.

As the BO, my app monitors the building state and forecasted electricity needs within my preferences and sends the DSO Operator a bid curve of price and quantity of demand reduction.

The DSO reserve market clears hourly using the last bid from each BO. The cleared price is broadcast to all BOs. This indicates whether they are on-call to deliver demand reduction in the next hour.

As the DSO, I broadcast a reserve event and all BOs who won the bid automatically notify their building system to affect the demand reduction. Appropriate data is collected per the contract agreement to support their response. Once the crisis has finished, I remove the reserve event. BOs' systems respond with the appropriate information for reconciling the contract performance. My reserve program notifies the billing system of information, which reconciles the BO's bill for the service provided. In the case that no spinning reserve event is called, the bill is reconciled in accordance with the compensation for being on-call.

Market Service Provider Story

Use Case: "Transactive Energy Market Exchange" (Transaction-Based Building Controls Framework, Volume 1: Reference Guide)

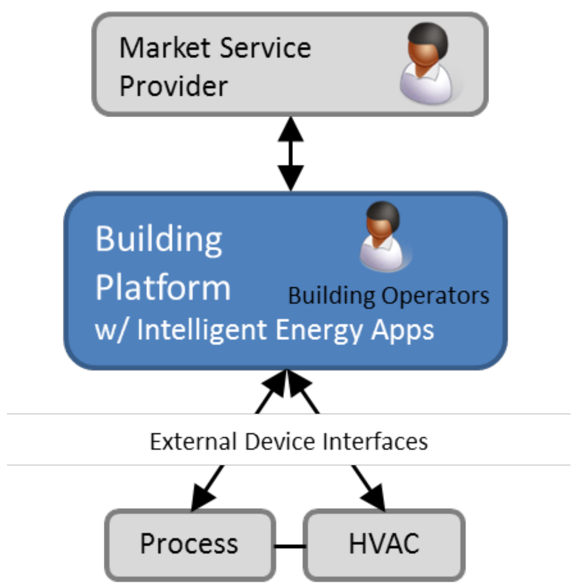
Actors: Building Operator (BO), Market Service Providers (MSP)

Description: A view of how a building operator might purchase energy from an energy market and how a market operator may interact with the owner/operator.

Value Proposition: Forward contracts may result in reduced peak demand and congestion, increased operational efficiency, better capacity planning, and increased integration of renewable resources. Energy consumers will have a broad range of purchasing options to better manage their energy costs with their demand flexibility.

Story Sequence:

- MSP works with wholesale energy providers to create buy/sell forward products
- MSP runs a forward contracts market for energy that exposes an interface
- BO connects to this interface using apps provided by the MSP or third parties
- BO configures his app and devices to select contracts automatically
- As agent for BO, app buys/sells contracts according to anticipated and historical consumption
- In monthly billing period, BO and MSP reconcile contract performance. BO's app uses this information to improve future contract selection.



As a MSP, I work with electricity generation, transmission and distribution providers to develop products that allow individual building owners to participate in a retail market. The products I develop are electricity contracts that can vary by contract duration and energy quantity. These contracts are bought and sold by electricity producers and consumers alike in an "energy stock market".

As a BO, I would like to shop for electricity in the same way I shop for other commodities. I need a mechanism for buying/selling forward contracts in the market operated by the regional MSP. The Building Platform I've purchased allows me to participate through apps designed to interface with the market.

As a MSP, I want to grow my market, so I expose a standardized market interface to enable a variety of 3rd party building platform apps. I also supply a free app called MyEnergyMarket app. This app is capable of integrating historical information from a building platform, using a standard software interface, to enable smarter electricity purchasing decisions automatically.

As a BO, I install the MyEnergyMarket app and it walks me through a set of contractual, security and privacy forms, and registers me as a participant in the forward energy market. The app recognizes my energy assets and appliances through an interface exposed by the Building Platform and can access my historical energy usage. I also have the option use the MyMarketOptimizer app that is available from MicroFirm. This app will evaluate the cost of operation under a contract and either; a) selects different contract duration, and/or b) adjusts operation to reduce energy cost.

As a MSP, I offer forward contracts ranging from 5 minutes to one year in duration by the various energy suppliers in our network. These contracts help my network of energy providers manage the operation of their assets and address system constraints through the pricing of their contracts. For example, Electricity Provider Inc. may increase the cost of 5-minute contracts to reflect congestion in their distribution system.

As a BO, I am offered recommendations by the app for purchasing energy based upon how I have used energy in the past. The app shows me a list of providers in my area and the types of energy contracts for which the app can bid. Some of these are short-term contracts on the order or minutes and others are longer term on the order of months. The app can dynamically buy and sell these contracts in order to minimize my energy cost. I review the options MyEnergyMarket app suggests based on my historical usage and configure the app to automatically buy and sell contracts on my behalf based on my energy use.

As a MSP, I maintain a highly secure, automated system that tracks and verifies the transactions between supplier and consumer using advanced metering and the openly available standardized, but very secure, software service interfaces that apps use to interact with the market. This system allows me to accurately reconcile contracts with BOs on a monthly basis.

Topic 1: What does the future look like?

Please refer to the handouts that provide a summary of the connected buildings integration story for your group. Reflecting on that story, please address the following questions. Keep the discussion at a higher level as the second topic is more narrowly focuses on interoperability attributes. Feel free to use ideas from this morning's panel discussion.

Does this story evoke a desired vision of a user interaction experience?

- Are there key steps or player interactions missing from the story?
- Are there major concerns or unreasonable assumptions depicted in the story?
- What other techniques can help portray a vision for buildings interoperability?

What types of user interactions do you foresee in the future?

0. What is level of user interaction do you envision for the steps in the story?
1. What is being exchanged in an interaction?
2. How much of the interaction would you expect to be automated?

What is needed in a vision for successful technology deployment?

- Do you foresee ecosystems of products and services?
- Do you foresee buildings platforms for successful deployment?
- What deployment approaches and promising trends deserve representation in a vision?

Topic 2: What are the interoperability attributes to consider?

Please refer to this morning's presentation on "Measuring Interoperability". Consider the key characteristics of interoperability that arise in the scenario. How would we recognize interoperability desires were satisfied? While deficiencies in these characteristics may currently be challenges to realizing the vision, try to focus on what would be required to succeed, rather than what is a barrier to success. Please answer as many of the following questions as time allows:

What attributes are desired to support an ecosystem of interoperable products and services?

- For apps and services to flourish?
- For interoperability testing, certification, branding?

What attributes are desired to establish the interaction agreements between parties?

- To define the information exchanged? Information models?
- To establish business processes (flow of interaction)?

What attributes are desired to simplify configuration and enable technology evolution?

- For discovering services/apps/resources/information models?
- To ensure scalability and migration to newer versions or technology?
- To identify, configure, and manage resources?

What attributes are desired to support security, privacy, and safety requirements?

0. To identify and assess security risk?
1. To establish and support privacy policies?
2. To ensure safety under failure scenarios?

What attributes are desired to support reliable operation and performance?

0. To define quality of service, time, and scheduling agreements?
1. To define order, dependency, sequencing, and synchronization of time?

General Interoperability Category Goals

Organizational goals

- O1: Economic and regulatory interoperability policies are defined for the community
- O2: Regulatory alignment exists across the community
- O3: Policy provides incentives and removes impediments to enable interoperability
- O4: Policy is current and maintained
- O5: Business objectives of community participants are complementary and compatible
- O6: Compatible business processes and procedures exist across interface boundaries
- O7: Business interfaces are consistent with the business objectives

Informational goals

- I1: There is an information model relevant to the business context
- I2: The information model that supports the business context is derived from one or more general information models relevant to the functional domain

Technical goals

- T1: Structure and format of information exchange are defined
- T2: Information transported on a communication network is independent from the network protocols
- T3: Management of a network between interacting parties is aligned
- T4: Transport protocols used in specific exchanges are consistent
- T5: A communications path exists for transparent and reliable exchange between interacting parties

General Cross-cutting Issue Goals

Configuration and evolution (CE) goals

- CE1: Information models (vocabularies, concepts, and definition) are agreed to by all parties
- CE2: Where multiple-source information models exist, there are bridges between them
- CE3: Semantics (information model) are captured independent of the technical interoperability categories
- CE4: Resources can be unambiguously identified by all interacting parties
- CE5: Resource identification management is defined
- CE6: Discovery methods exist for interacting parties
- CE7: Configuration methods exist to negotiate options or modes of operation
- CE8: Parties can enter or leave without disrupting overall system operation and quality of service
- CE9: Interface contracts between parties allow freedom of implementation
- CE10: A migration path from older to newer versions exists
- CE11: Capability to scale over time without disrupting overall system operation

Operation and performance (OP) goals

- OP1: Common understanding of quality of service, time, and scheduling exists
- OP2: Time order dependency and sequencing are defined
- OP3: Time synchronization requirements are defined
- OP4: Transactions and state management capability (atomicity, consistency, integrity, and durability) are defined
- OP5: Performance and reliability expectations are defined

Security and safety (SS) goals

- SS1: Security policies (e.g., confidentiality, integrity, availability, and accountability) are defined, maintained, and aligned among parties
- SS2: Privacy policies are defined, maintained, and aligned among parties
- SS3: Risk is assessed and managed
- SS4: Logging and auditing processes are defined among parties
- SS5: Failures fail safe (health of system above individual components)

General areas to advance interoperability – *needs to be tailored for buildings situation*

From GWAC Smart Grid Interoperability Maturity Model

Topic 3: What should a building interoperability vision include?

Reflect back on what you have heard over the last two days about the current status and future directions in buildings interoperability. What should a vision document include?

What major elements should the document include?

- Vision statement?
- Strategic Goals?
- Integration stories and use cases?
- Interoperability attributes and metrics?

What topics should be included for realizing this vision?

- Is this a pure technology play?
- Are there legal or regulatory policy barriers?
- What roadmap efforts/actions are needed to move towards the vision?

Who can help realize this future and what are their roles?

- What is government (DOE's and others) role?
- Industry/standards/testing associations?
- Other stakeholders?

Who else should be involved in the development of this vision/document?

- What organization or market player is not currently represented?