Connected Buildings Interoperability Future Integration Vision

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A Vision for Future Building Integration

- Charting a course toward a future integration vision
- System integration philosophy
- Interoperability requirements of a buildings vision
- A "**straw dog**" vision for buildings integration
- Four (4) buildings interoperability vision stories
- What should a buildings interoperability vision document contain?

Toward a Vision for Buildings Interoperability

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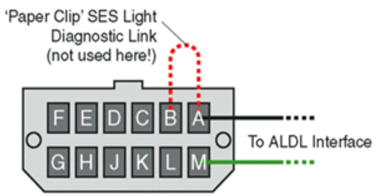
- Vision = A projection into a future we aspire to
- How might we develop a buildings interoperability vision for 10-15 years in the future?
  - Take the present into consideration when planning the future
  - Extrapolate key trends in interoperability
  - Identify some key enablers that may help drive future smart buildings
  - Learn from ease of integration successes in other domains
- Examples:
  - Internet and Smartphones - connectivity, entertainment
  - Industrial Automation – distributed control (fieldbuses, OPC)
  - Home Media Production - signal processing (VST, AU, AAX, TDM)
  - Automobiles - engine diagnostics (On Board Diagnostics II)

On-Board Engine Diagnostics



The Rise of Computer Engine Control and Sensors

Torque App

1980's
OBD1
Proprietary

1996
OBD2
5 Flavors

2003
Freedom of Customer Choice

2008
CAN bus
(One True Protocol for now)

2010's
Open Data Access
(Bluetooth)

Some Observations from OBD2

- It is possible for a **very large, diverse & competitive ecosystem** to have an interface for real-time information
- An **agreement between manufacturer's** was needed
- The importance of defining an **interface**
- **Agree on the interface but compete on both sides of the interface**
- Information is both **generic and manufacturer-specific**
  - Generic information is defined by ecosystem
  - Manufacturer-specific information is accessed via repository
- Interface **grows over time** with competition (extensible)
- Information is **decoupled** from the communications technology
  - No "one true way" of communicating
- **Longevity** of the interface – 20 years and counting (endurance)
- **Security** is physical, not cyber– an emerging issue
- And the story doesn't end! (electric and self-driving cars)

Importance of Ecosystems

- General customer needs
  - Cost vs benefits
  - Security and privacy
  - Ease of installation and commissioning
  - Ease of use
  - Ease of ongoing support
- General provider needs
  - Cost vs benefits
  - Security and privacy
  - Customization and flexibility
  - Adaption to customer capabilities
  - Market growth
  - Ease of installation, commissioning and support
  - Open technology standards

debian

open source hardware

ANSI
American National Standards Institute

Java

python

REST API

Google

android

Apache

RDF

W3C®

MySQL

hadoop

UNIFIED MODELING LANGUAGE
UML

IETF®

Emerging Industry Interoperability Standards

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- Open data initiative and standards
  - ANSI, IETF, W3C, Data.gov, Open Knowledge Foundation
- Community vocabularies and ontologies
  - ASHRAE Facility Smart Grid Information Model
- Secure and open messaging
  - MQTT (Message Queue Telemetry Transport)
  - AMQP (Advanced Message Queuing Protocol)
- Business Process Modeling
  - OMG BPMN
- Internet of Things
  - IETF, IEEE P2413, 1547
- Business to business interoperability
  - Construction Operations Building Information Exchange (COBie)

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.

System Integration Guidelines

- **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.

System Integration Guidelines (con't)

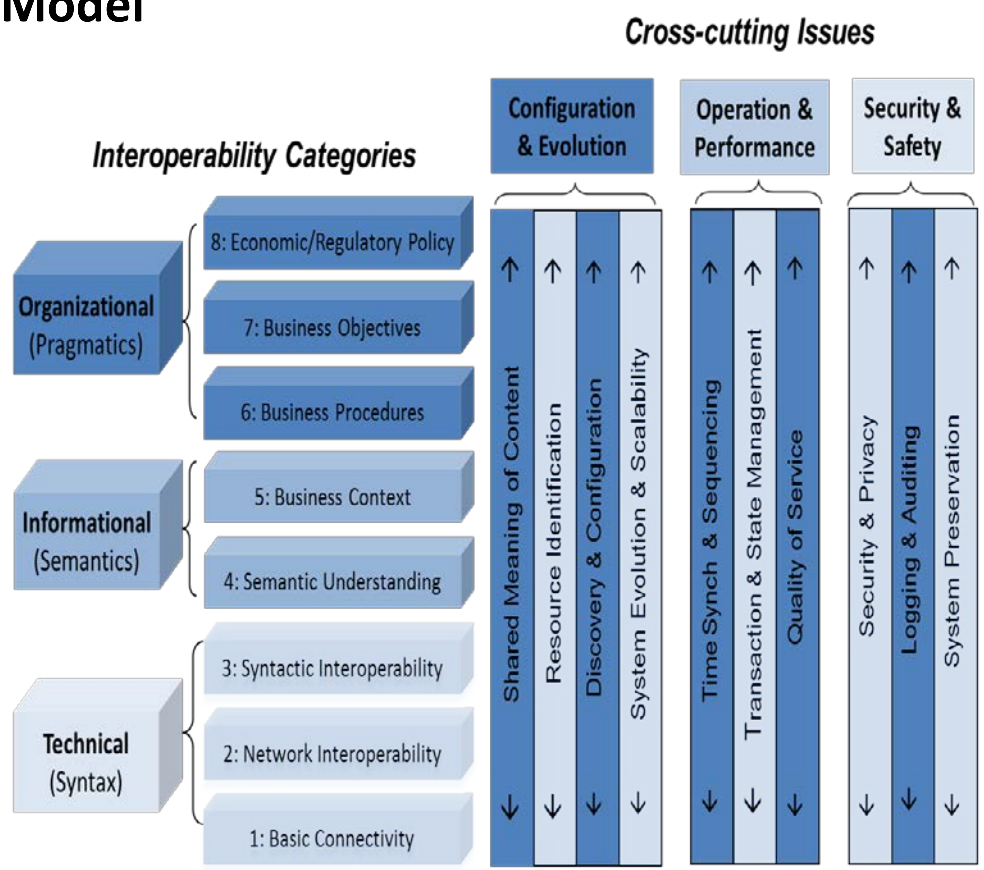
- **Decision Making in Very Large Networks**: For networks of things to **scale, they need to delegate responsibility** to the end points. This approach provides the basis for highly scalable systems.

- **Role of Standards**: 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**.

Interoperability Characteristics and Requirements

GWAC Interoperability Maturity Model

- ***General Interoperability Goals***
  - ***Organizational goals***
  - ***Informational goals***
  - ***Technical goals***
- ***General Cross-cutting Issue Goals***
  - ***Configuration and evolution (CE)***
  - ***Operation and performance (OP)***
  - ***Security and safety (SS)***



General Interoperability 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.

General Interoperability Goals

- **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 (application) 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 Goals

- **Configuration and evolution (CE) goals**
- CE1: Information models (vocabularies, concepts, and definitions) 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.

General Cross-Cutting Goals

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- **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 (loss of functionality) fail safe (health of system above individual components)**

Interoperability and Security

- Natural tensions
  - Interoperability enables systems to work together
  - Security limits only specific systems to work together
  - Privacy limits data to only specific systems for specific purposes
- BOTH must work together - balance
  - Impact of security on UPnP’s scope of use

Creating a Shared Vision for Future Buildings Interoperability

- Selected stories that evoke **DESIRED** user experiences for integration of connected equipment and systems to extract interoperability requirements
  - Inside Building Operations (BO)
  - Between BO and others
    - Building Communities (BC)**, Building Service Providers (BSP), Market Service Providers (MSP), Distribution Service Operations (DSO)
- Stories are **illustrative** to initial discussion **ONLY**
- **Inspired from existing building use cases** contained within the Transaction-Based Building Controls Framework, Volume 1: Reference Guide and NOT COMPREHENSIVE
- **Actors interact with intelligent software applications running on an ecosystem-supported hardware-software system platform.**
- 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.

****Building Community Story – Not in breakout sessions**

A Concept for Buildings Integration Stories

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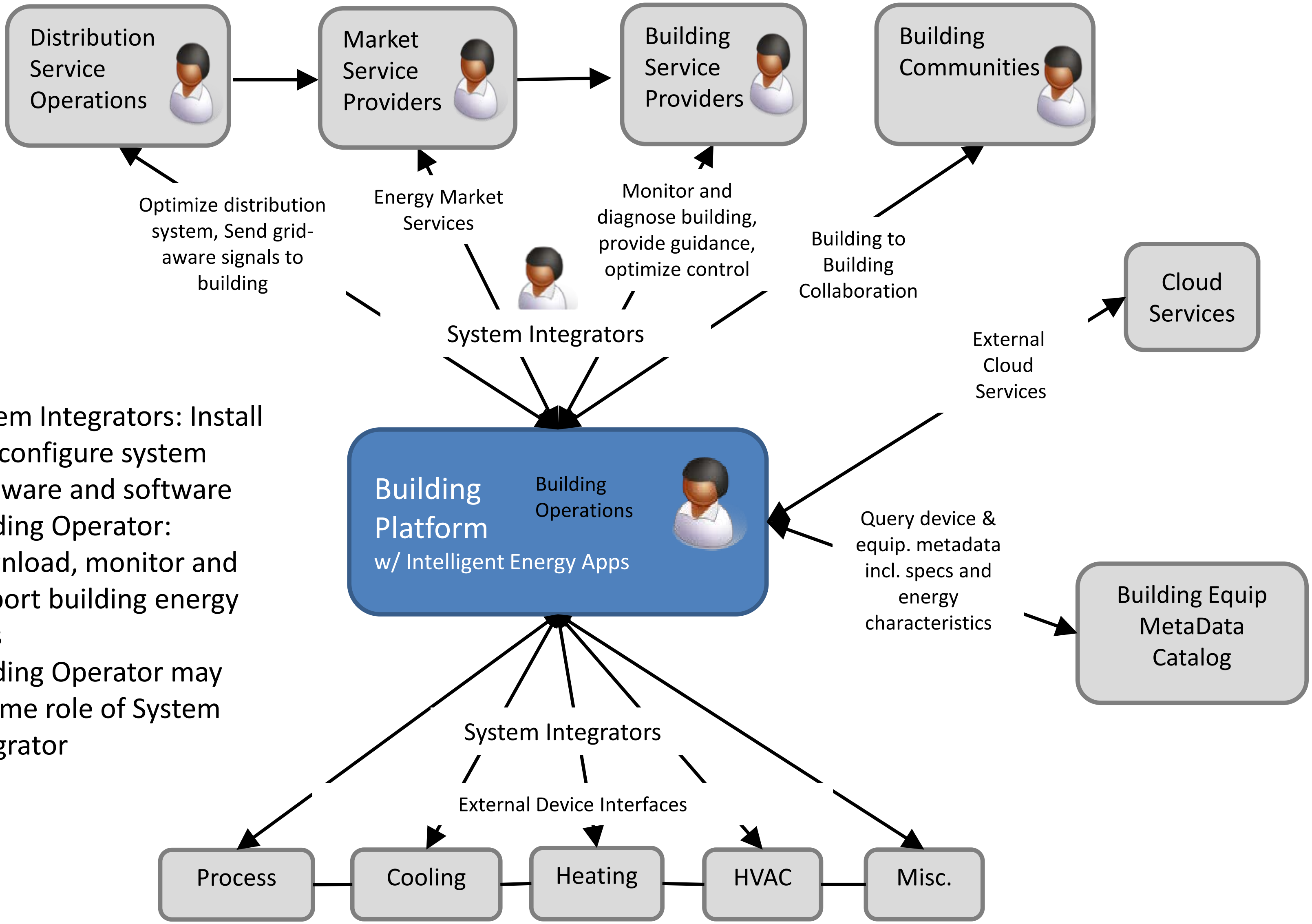


NOTES:

1. System Integrators: Install and configure system hardware and software
2. Building Operator: Download, monitor and support building energy apps
3. Building Operator may assume role of System Integrator

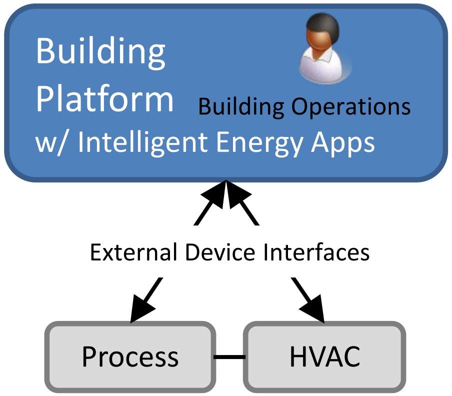
Building Internal Interaction Story

Use Case

- Automated Building Energy Efficiency

Actors

- Building Operations (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.

Building Internal Interaction Story Summary

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- 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

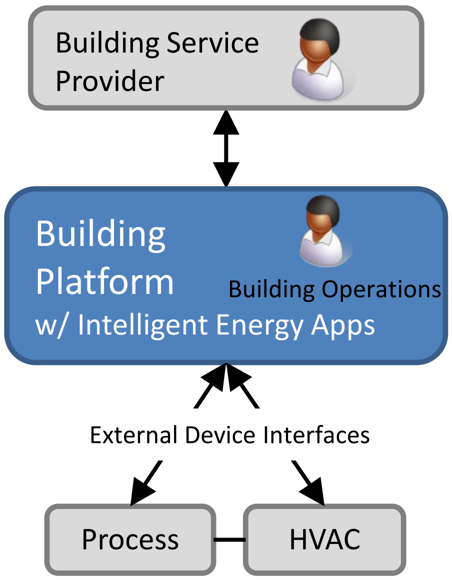
Building Service Provider Story

Use Case

- "Diagnostics and Automated Commissioning Services" (PNNL TE Ref)

Actors

- Building Operations (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.

Building Service Provider Story Summary

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- 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

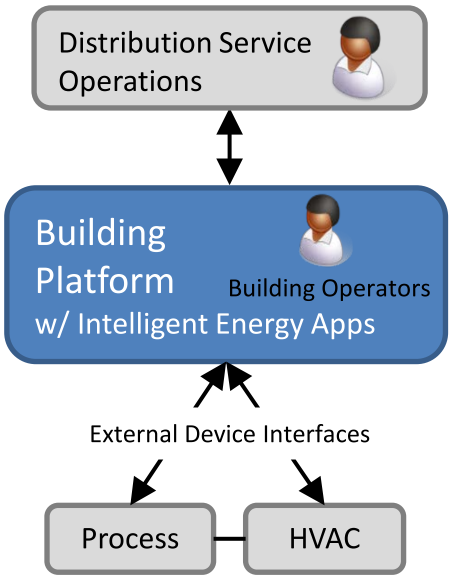
Distribution Service Operations Story

Use Case

- "Transactive Acquisition of Ancillary Services" (PNNL TE Ref)

Actors

- Building Operations (BO)
- Distribution Service Operations (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.

Distribution Service Operations Story Summary

- DSO runs an **hourly reserve program** for spinning reserves that **exposes an interface**
- 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.

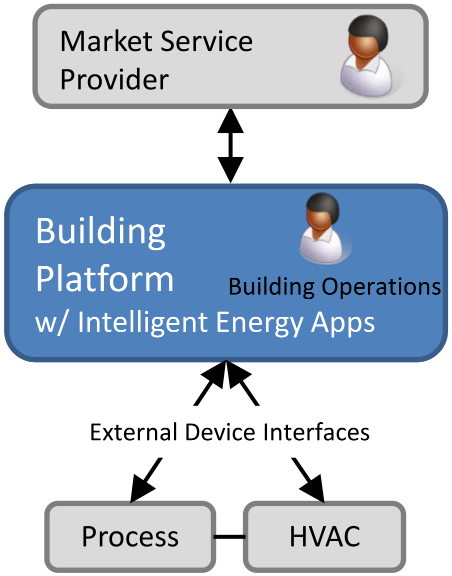
Market Service Provider Story

Use Case

- "Transactive Energy Market Exchange" (PNNL TE Ref)

Actors

- Building Operations (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 building 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.

Market Service Provider Story Summary

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- 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.

Q: What Belongs in a Buildings Interoperability Vision Document?

- Goal: To define how automation systems and components can work together in the future
  - NOT how to design an automation system
- Integration stories?
- Integration use cases (rigorous)?
- Reference Frameworks/Architectures/Models?
- Interoperability Characteristics and Requirements?
  - How can systems be evaluated relative to requirements?

Thank you!

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Questions/Discussion