Connected Buildings Interoperability Vision

Context

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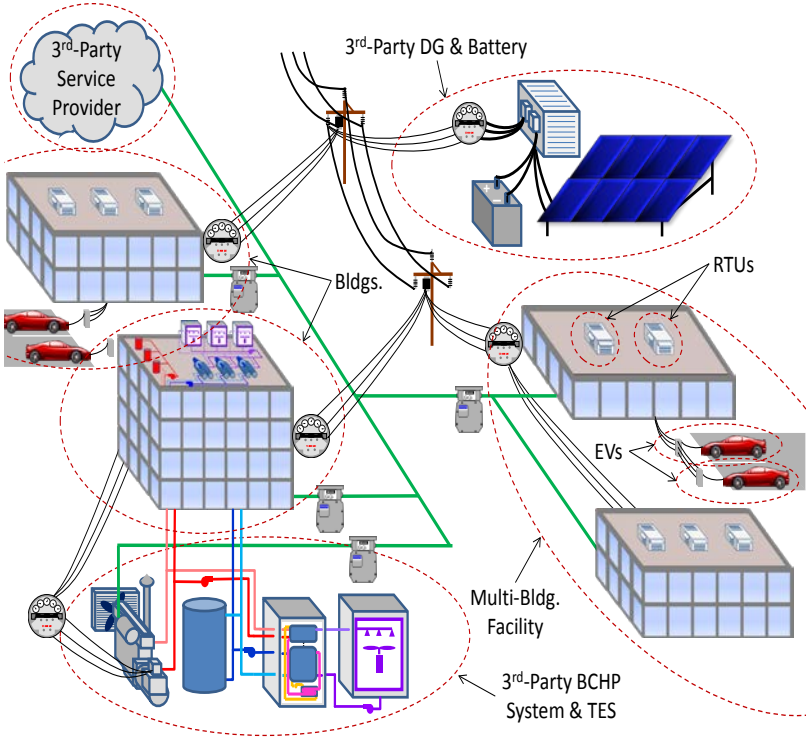
PNNL
11 March 2015

Topics

- Purpose of meeting
  - Buildings automation in the transformative time of connectivity
  - Interoperability – a connected buildings enabler
- Connected buildings interoperability landscape
  - Our point of departure
  - Review Buildings Interoperability Landscape draft document
- A national strategy for buildings interoperability
  - Our line of attack
  - Steps for aligning the buildings automation community on interoperability
- Design and outcomes for this meeting
  - Outline scope and contents of a buildings interoperability vision

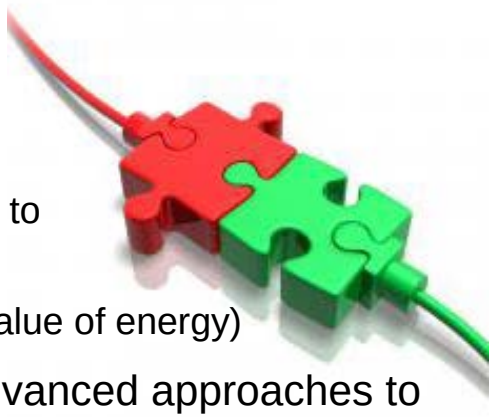
The Connected Building

- Negotiates and transacts energy services across the meter
- Integrates and coordinates connected equipment* (load/generator/storage) for energy efficiency and financial benefits
- Supports the scalable integration of clean and efficient technologies such as PV and EV chargers
- Provides awareness, visibility, and control to serve the preferences of its managers, operators, and occupants



* Connected equipment knows how it is performing, how it could perform, and is capable of communicating that to others.

Why We Need Connected Buildings



- Today's stock of buildings are noticeably "un-connected"
  - Limited by existing control and coordination technology
  - Advanced automation deployments constrained to large buildings due to automation equipment, installation, and maintenance costs
  - Value streams are often hidden and untapped (e.g., time dependent value of energy)
- Large-scale deployment of clean energy technologies requires advanced approaches to building equipment integration and electric grid coordination
- Improved integration approaches for deploying technology can enable new services
  - Examples include advanced power electronics, operations diagnostics, grid-responsive building technologies, vehicle charging coordination
- Greater energy and business efficiencies can be mined through co-optimization approaches that reach across the meter
  - Allow intelligent trade-offs between comfort/quality of service and consumption

Interoperability is essential for buildings information exchange (within buildings and with external parties)

Sample Scenario:
Diagnostic and Automated Commissioning Services

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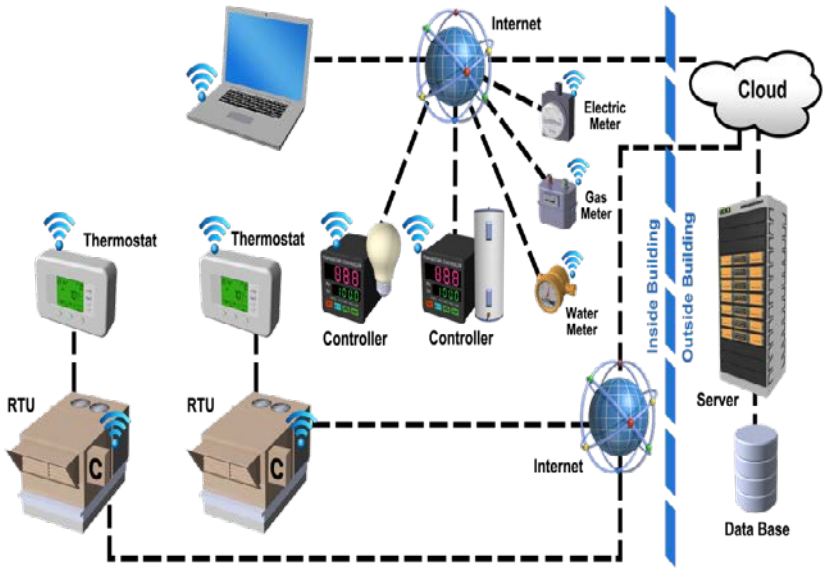
Approach

- Customer signs up with service provider (SP)
- Data streams sent from building automation system to SP
- Diagnostic/commissioning information delivered by SP to customer electronically
- Customer pays for services provided or optionally problems identified/fixed



Technology requirements

- Web applications
- Map data streams to diagnostic procedures

Expected outcomes

- Energy and operating cost savings
- Efficient buildings

From "Transaction-Based Building Controls Framework, Volume 1: Reference Guide"

Sample Scenario:
Tenant Contracts with Building Owner for Energy

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Approach

- Owner allocates tenants / divisions allowance on energy bill
- Tenants receive penalties if exceed allowance
- Owner broadcasts dynamic rate to buildings automation system
- Markets used for tenants to buy surplus allowance from others

Technology requirements

- Wide-area network (WAN) & local-area network (LAN)
- Buildings automation system
- Tenant-level sub-metering or non-intrusive load monitoring

Expected outcomes

- Cost savings for tenants / building owners
- Smart buildings

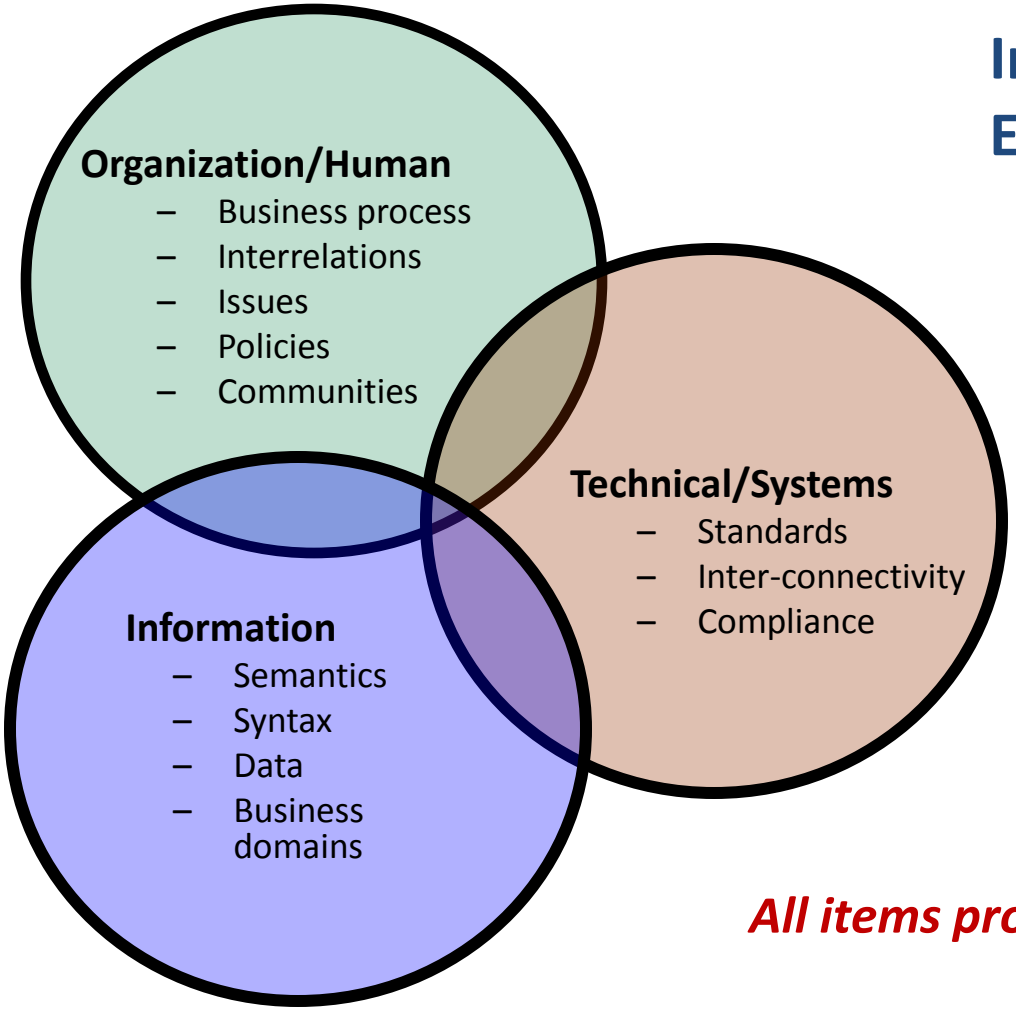
From “Transaction-Based Building Controls Framework, Volume 1: Reference Guide”

*Inter*operability – Integration at Arm's Length

What do we mean by interoperability?

- Exchange of actionable information
  - between two or more systems
  - across component or organizational boundaries
- Shared meaning of the exchanged information
- Agreed expectation, with consequences, for the response to the information exchange
- Requisite quality of service in information exchange
  - reliability, fidelity, security

Interoperability Benefits

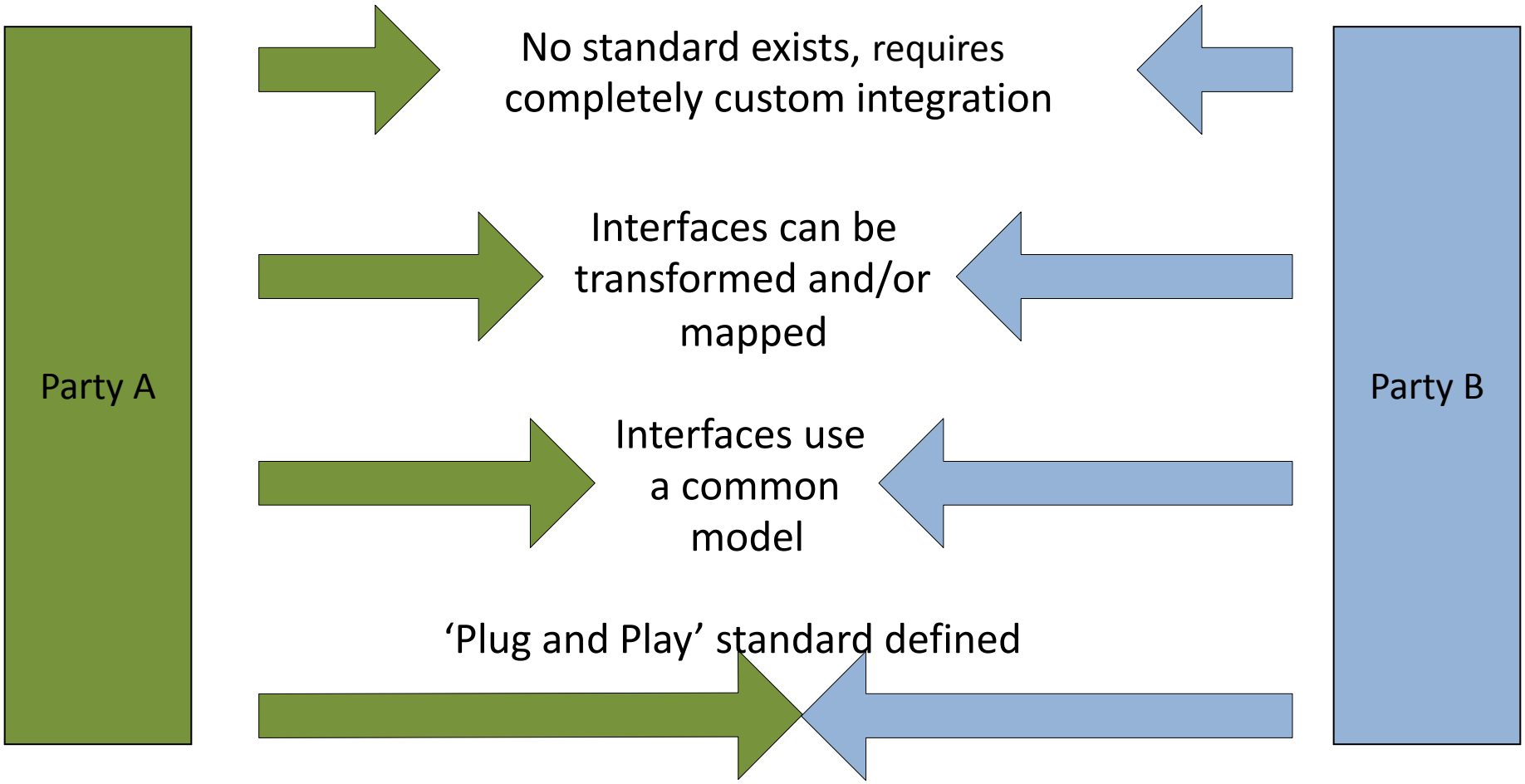


Interoperability - Expected Impact:

- **Reduces integration cost**
- **Reduces cost to operate**
- **Reduces capital IT cost**
- **Reduces installation cost**
- **Reduces upgrade cost**
- **Better security management**
- **More choice in products**
- **More price points & features**

All items provide compounding benefits

Reducing Distance to Integrate



Credit: Scott Neumann, UISol GWAC position paper

Some Interoperability Dimensions

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Market Ecosystem

Acquire interoperable products and supporting services

Testing and Certification

Trust interoperability before going to market

Interoperable Interfaces

Simple to install, update, and manage products

- Discover building automation products, their services, and how to interact with them
- Access the physical and energy characteristics and behaviors of connected equipment and systems
- Discover and interact with other buildings, energy markets, 3rd party service providers, and distribution system operators

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* http://energy.gov/eere/buildings/downloads/buildings-interoperability-landscape-draft

Technical Meeting on Data/Communications Standards and Interoperability of Building Appliances, Equipment, and Systems

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Held 1 May 2014, at NREL, Golden, CO

Presentations and participation from included…

Interoperability Gaps and Challenges (e.g.)

- **Interoperability is lacking at the organizational level**
  - Business/government policies do not encourage interoperability
  - Interoperability can be seen as a commoditization threat
  - Not aligned within stakeholder group or nationally
  - State of standards making has not encompassed business processes or aligned business objectives
- **Interoperability entering informational level**
  - Energy information models are emerging
  - Most models generic: point name/data value w/o rich equipment model
  - Too many point name/data value naming conventions to choose from
  - Time to enter/map generic model data is time consuming & error prone
- **Interoperability choices confusing at technology level**
  - Wide variety of communication and syntactic technology choices
  - Communications layers are often not cleanly separated from information
  - A unifying approach, such as Internet Protocol, has performance and policy challenges

Interoperability Gaps and Challenges (cont.)

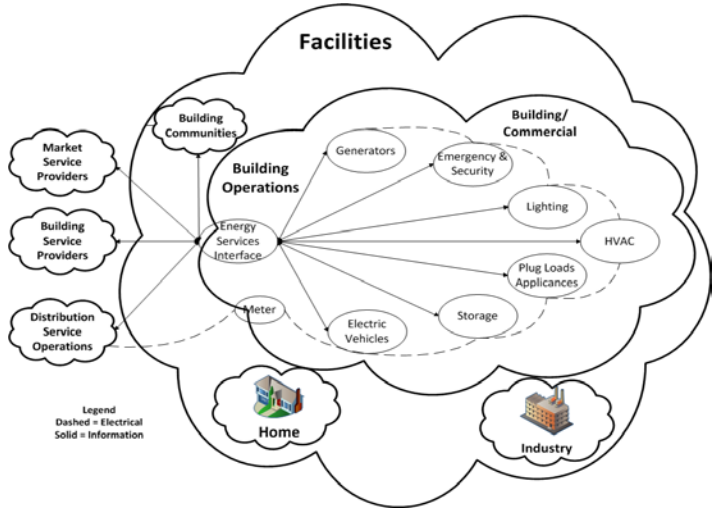
- **Interoperable configuration and evolution capabilities lacking**
  - Resource discovery is not supported, rely on manual setup
  - Equipment identity management is not standardized
  - Physical connectivity models between devices is done manually and is error prone
- **Operation and performance often not scalable**
  - Centralized control paradigm requires greater information exchange and is prone to central component failure
  - Unclear separation between communications medium and messages standards, means that performance options can be limited
- **Security, privacy, and safety concerns often an afterthought**
  - Older standards do not have security or integrate fully
  - Security and sensitive data policies only emerging
  - Safety and systemic fail-safe requirements often not addressed

Buildings Interop Landscape

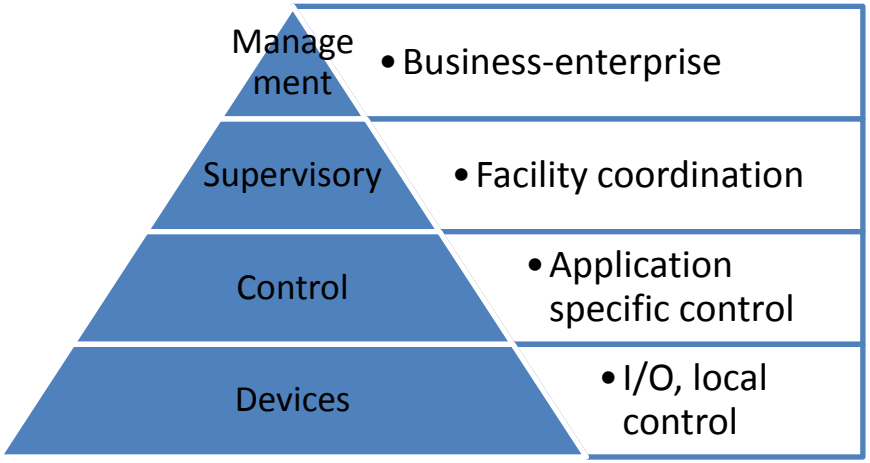
A point of departure to describe today's situation as we look to the future

- **Buildings interoperability framework**: Provide organizational structure by adopting and adapting existing interoperability architecture material to buildings
- Use the framework to present and relate the following
  - **Classes of use cases:** presents previously identified use cases for interoperability purposes with the help of the framework
  - **Relevant standards:** presents the relevant standards used in buildings connectivity deployments using the framework
  - **Taxonomy of stakeholders:** presents classes of stakeholders involved in buildings connectivity using the framework including **significant organizations** for involvement
- **Interop goals**: articulate attributes to evaluate for interoperability
- **Challenges and gaps:** describe interoperability issues derived from stakeholder engagement using the context of standards & interop goals
- **Emerging interoperability standards**: potential to align buildings with mainstream directions of ICT

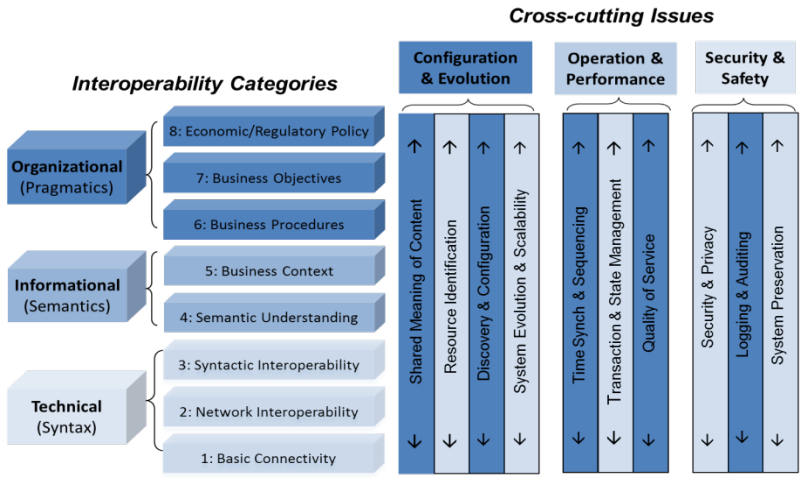
Inspirations for a Buildings Interop Framework



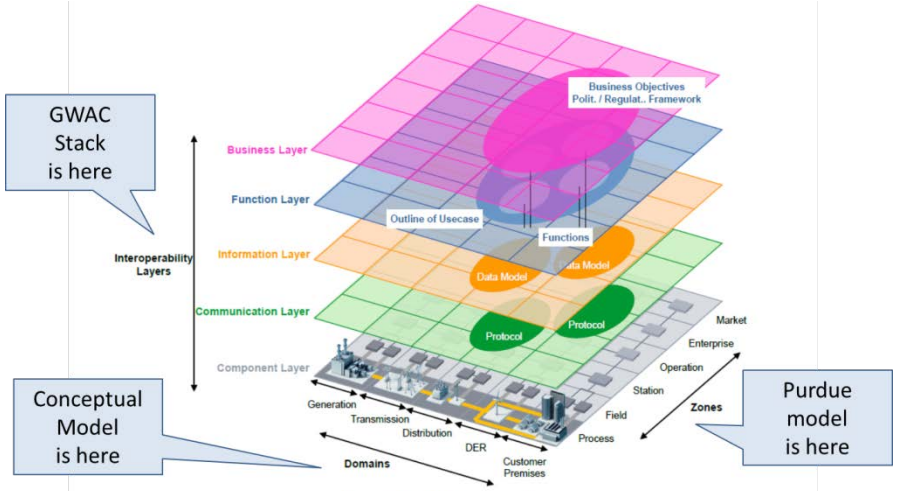
Derived from the SGIP conceptual model for the customer domain



ASHRAE automation model, from Purdue Enterprise ref model

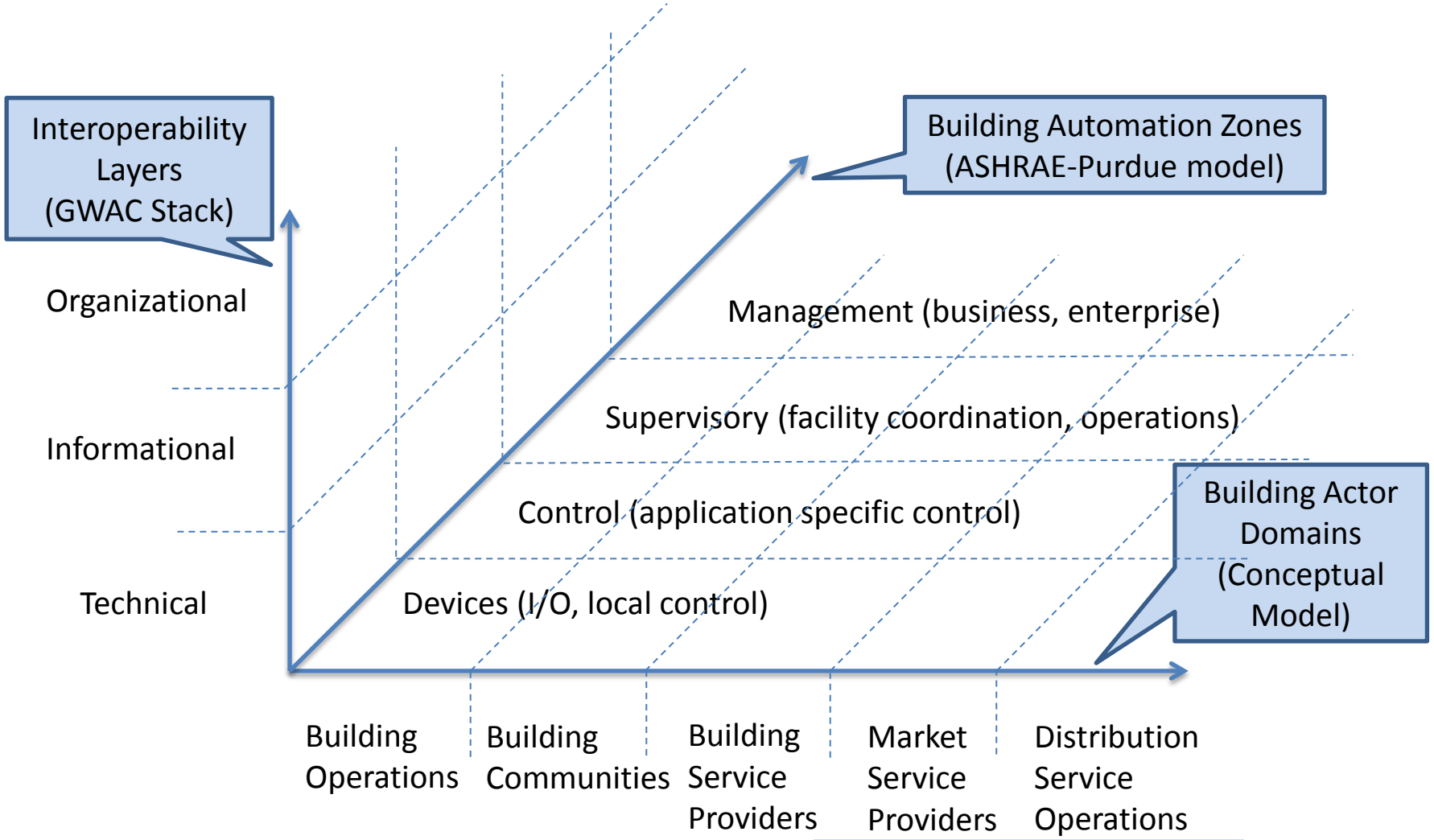


GWAC interoperability context-setting framework



EU-SGAM (smart grid architecture model) combines 3 previous models

Result: Buildings Interoperability Framework



Use Case Landscape

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Sources for identifying relevant use cases include,

- "Reference Guide for a Transaction-Based Building Controls Framework, Vol 1," DOE-BTO, PNNL-23302
  - End-user services, energy market services, grid services, societal services
- IEC PC118 Use Case Classes Technical Report
  - Market interactions, price information, ancillary services, energy usage data, etc.
- Energy Information Standards Alliance
  - Demand response & forecasts, trading power, system health monitoring, etc.
- IEC TC 57 WG21, 57/1492/DTR Draft Technical Specification – a collection of use cases from across the world
  - Flex start washing machine & EV charging, manage simple devices, customer sells generation, etc.
- Other use case sources are emerging

Standards Landscape

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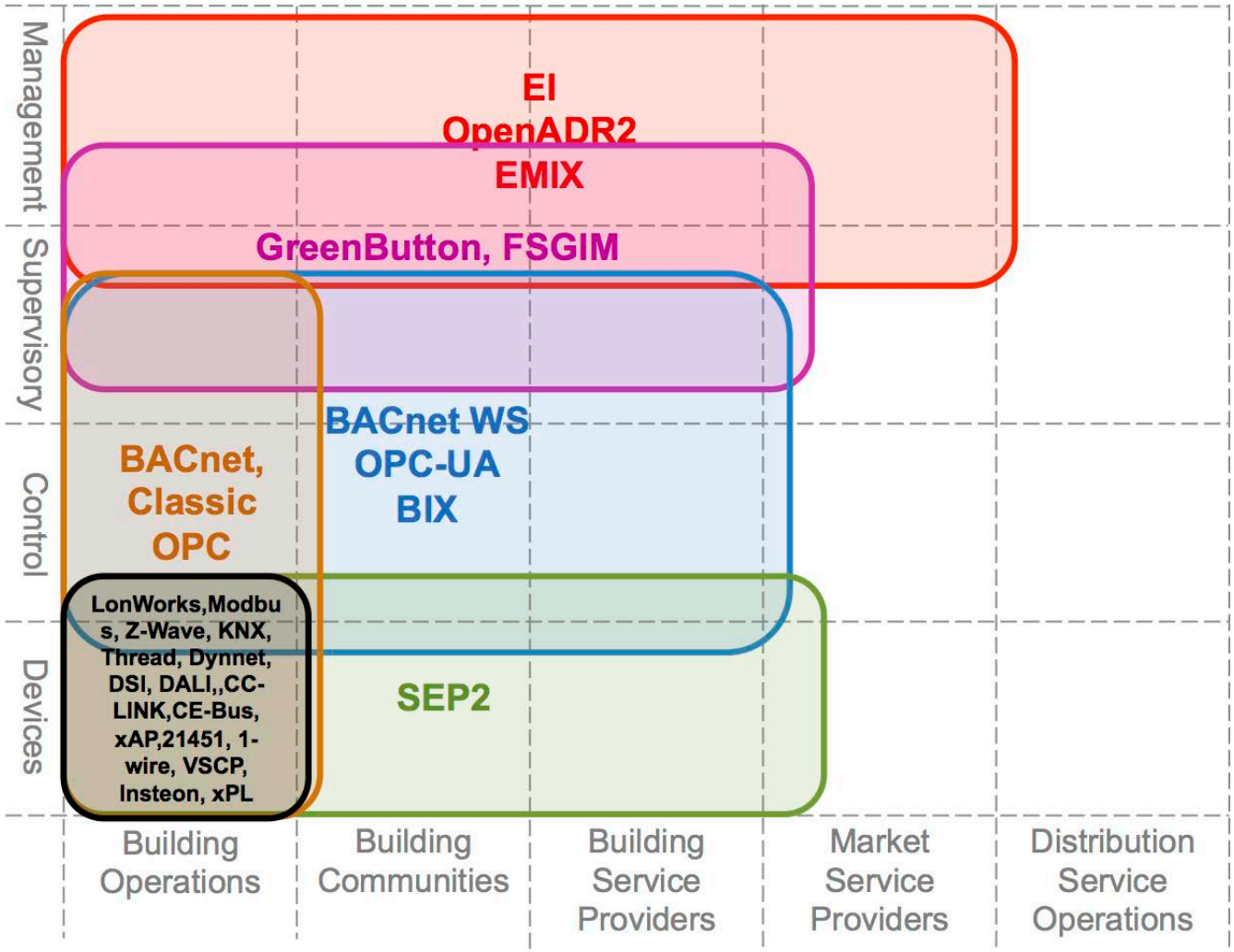
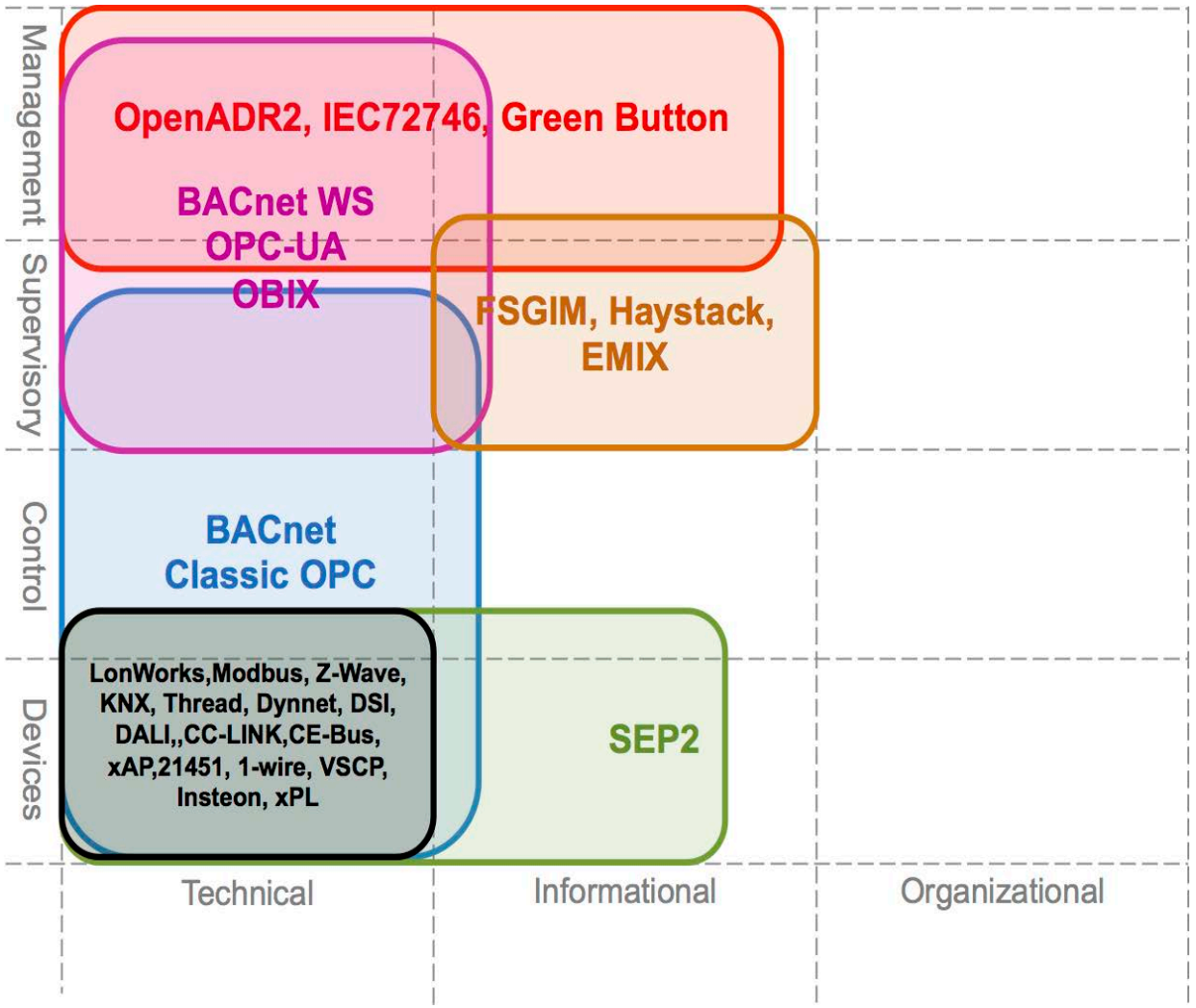
Sources for identifying relevant standards include,

- ANSI EESCC report
- IEC PC118
- NIST Framework and Roadmap for Smart Grid Interoperability Standards
- SGIP B2G, I2G, and H2G Domain Expert Working Groups

Standards Landscape – Zones & Actors



Standards Landscape – Zones & Interop Levels



Stakeholder Categories

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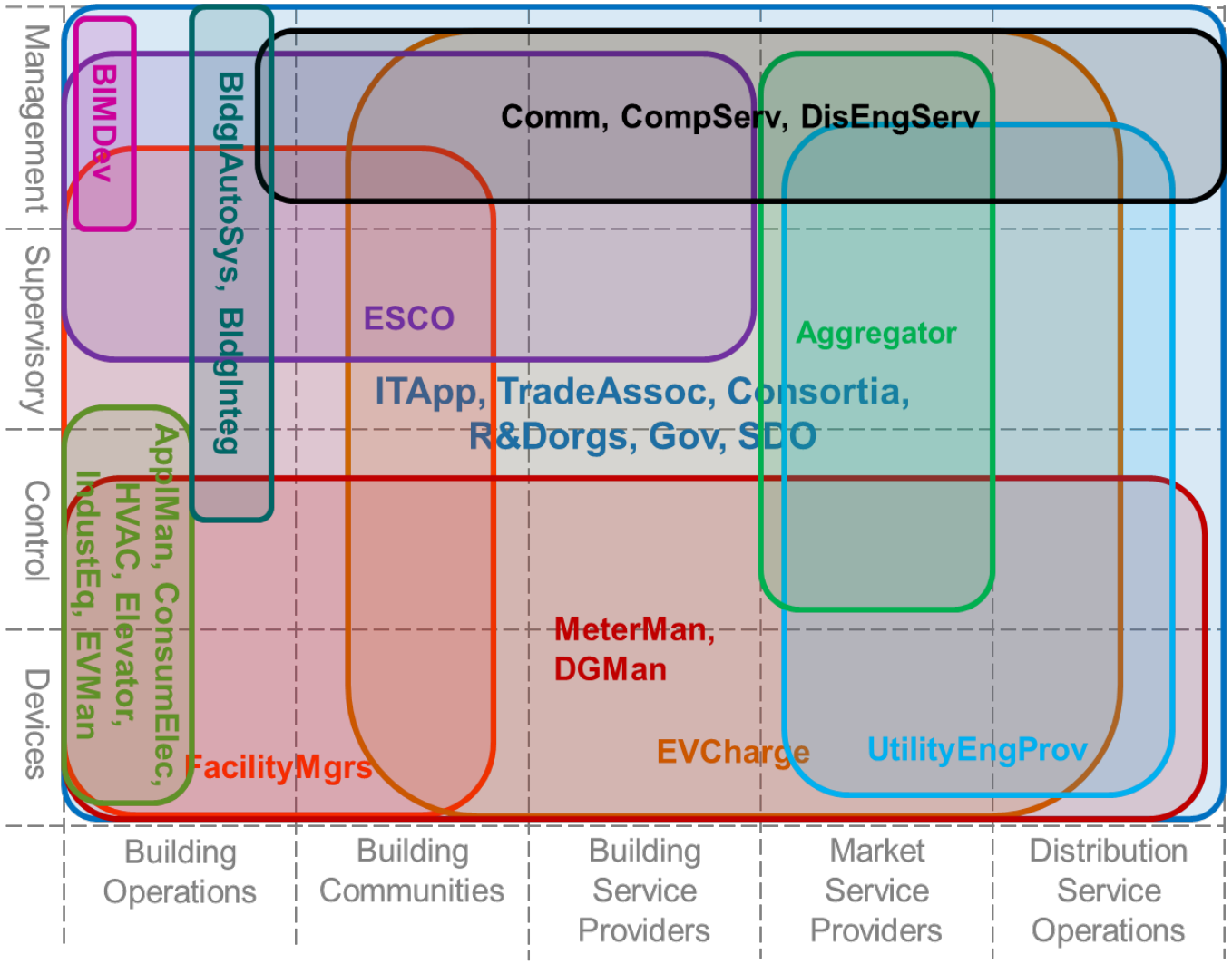
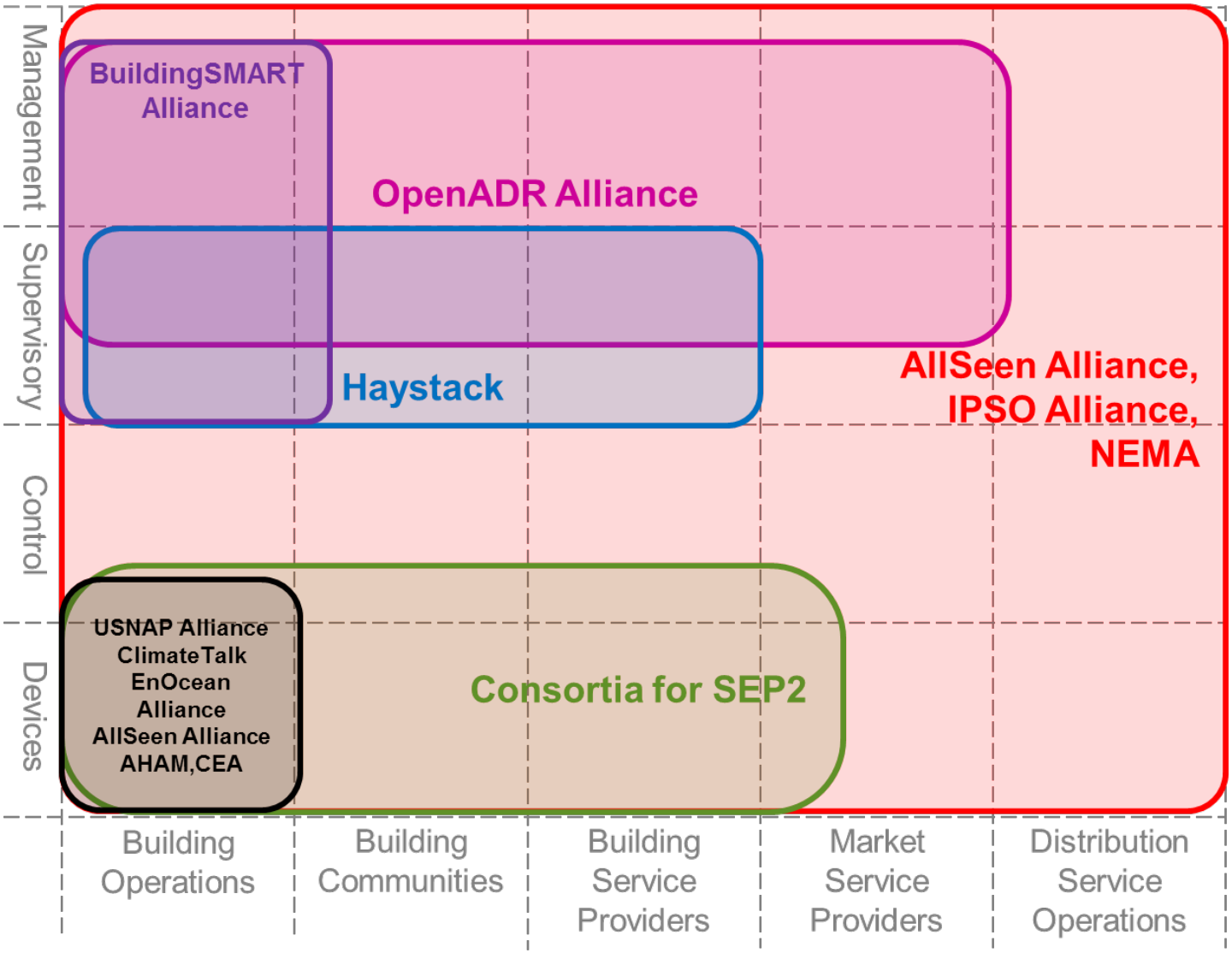
Stakeholder Name	Abbreviation	Stakeholder Name	Abbreviation
Appliance Manufacturers	ApplMan	**Smart Meter Manufacturers**	MeterMan
Consumer Electronics Manufacturers	ConsumElec	**Distributed Generation and Storage Manufacturers**	DGMan
HVAC and Water Heating Equipment Manufacturers	HVAC	**Communication Infrastructure & Service Providers**	Comm
Elevator/Escalator Manufacturers	Elevator	**Computing Service Providers**	CompServ
Industrial Equipment Manufacturers	IndustEq	**Distributed Energy Service Providers**	DisEngServ
Plug-in Hybrid or Electric Vehicle Manufactures	EVMan	**Information Technology Application Developers**	ITApp
Electric Vehicle Charging Infrastructure Companies	EVCharge	**Trade Associations**	TradeAssoc
Building Automation and Control System Manufacturers	BldgAutoSys	**R&D Organizations and Academia**	R&Dorg
Building Control Systems Integrators	BldgInteg	**Government Agencies**	Gov
Energy Service Companies	ESCO	**Standards Development Organizations**	SDO
Building Information Modeling Software Developers	BIMDev	**Facility Managers-Owners-Operators-Occupants**	FaciltyMgr
Aggregators	Aggregator	**Industry Consortia**	Consortia
Utility Energy Providers	UtilEngProv		

Stakeholder Landscape

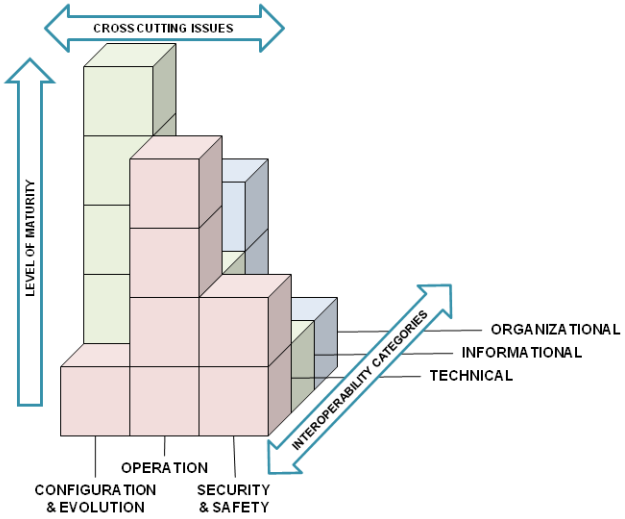


Consortia and Trade Association Landscape



Can we measure interoperability?

- Identify desired attributes to integrate equipment and systems
  - Articulate interoperability goals and objectives (e.g., GWAC IMM)*
- Examples
  - Organizational goal
    - Compatible business processes exist across interface boundaries
  - Informational goal
    - There is an information model relevant to the business context
  - Configuration and Evolution goal
    - A migration path from older to newer versions exists
  - Security, Privacy, and Safety goal
    - Security policies (e.g., confidentiality, integrity, availability, and accountability) are defined, maintained, and aligned among parties



* GridWise Architecture Council, *Smart Grid Interoperability Maturity Model*, Beta Version, December 2011. http://www.gridwiseac.org/about/imm.aspx

Inspirations for a Buildings Interop Vision

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- Vision scenarios for building interoperability in-line with mobile equipment (phone/tablet) and home electronics connectivity that is emerging
- General ICT standards impacting interoperability
  - Open data initiatives, community vocabularies, information modeling languages
  - Data encoding, messaging
  - Hardware, operating systems, virtual machines
  - Programming languages, databases, application programming interfaces
  - Open source licenses
  - Internet of Things (IoT), business to business (B2B) initiatives
  - Cybersecurity and privacy

Comments Requested

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- Please circulate and review the Buildings Interoperability Landscape* draft and send comments to,

  Steve Widergren
  steve.widergren@pnnl.gov

* http://energy.gov/eere/buildings/downloads/buildings-interoperability-landscape-draft

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Summary Observations

- Buildings have **little richness of representation from an information modeling point of view**
- Where information modeling exists, the full **richness of the methods and tools has not been embraced**. Tradition breeds a re-implementation of an old style of interaction (get/put, read/write) and data structures with new tools. A missed opportunity to leap forward.
- **Standards processes continue to struggle** with containing scope and schedule goals. Without a big stick or major mandate, it remains a multi-year process.
- Interested parties in government and industry that want to enable buildings energy, security, and comfort management with interactions along the lines of smart cities concepts, but the **value propositions and a path for progress are not aligned**.
- Community is **very diverse with different levels of technology and capability** to interact with other parties. Any path forward needs to bring them along and be prepared to evolve as even better integration approaches emerge in the future.

Conundrum

- Traditional standards approaches problematic
  - Suffer from slowness, scope creep, incremental, compromise
- But deliberate process with stakeholder alignment and participation is necessary for change

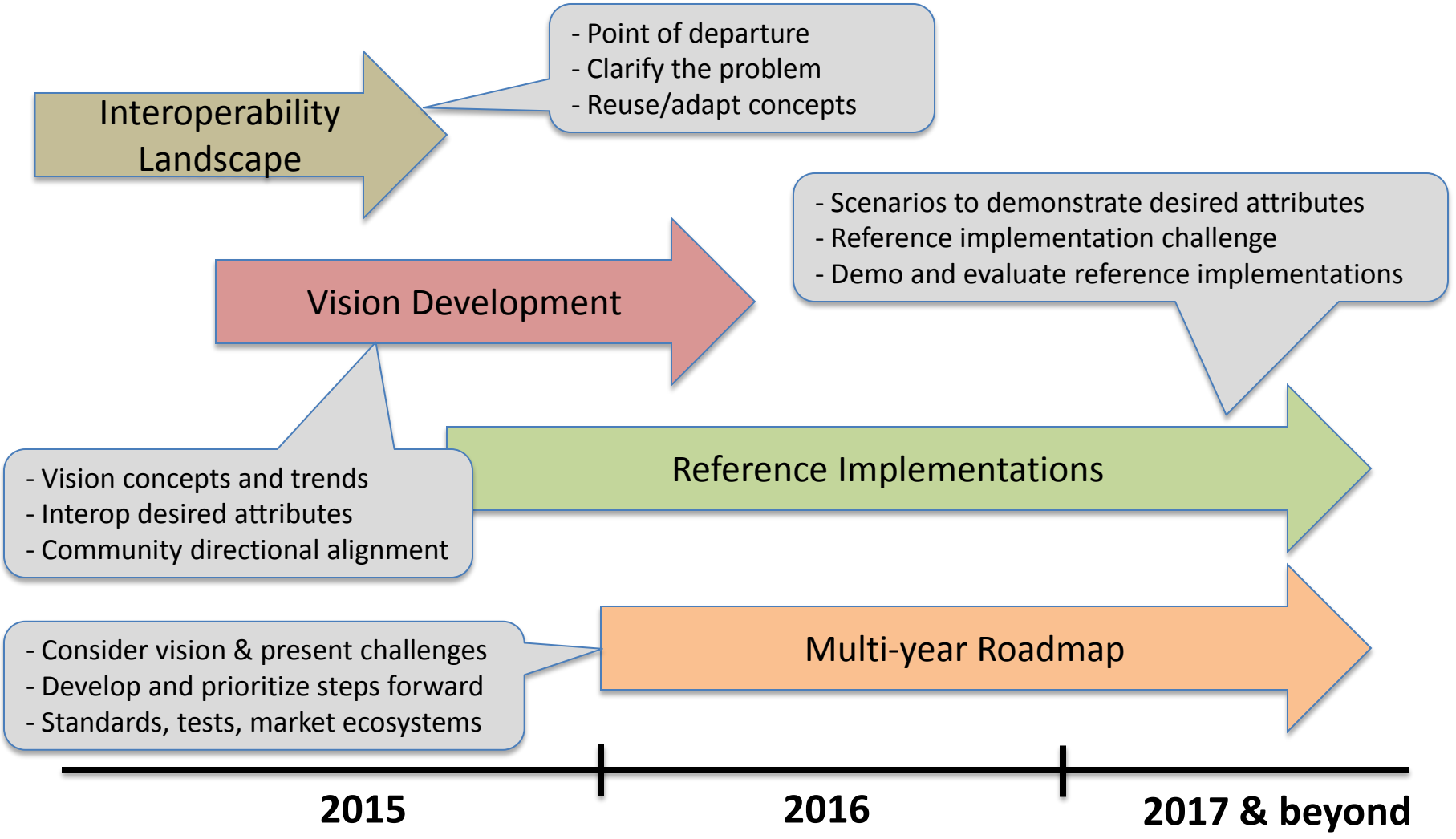
Strategy

- Initially target small-medium commercial building scenarios
  - Requires low cost installation to penetrate market
  - Simpler (unitary) components and systems
  - Most to gain from interoperability advancements
  - Example for other types and sizes of buildings
- Offer an alternative to entering a standards process
  - Engage stakeholders to develop a building interoperability vision
  - Leverage work of related efforts: ANSI-EESCC, SGIP, GWAC, IEC, ASHRAE, …
  - Develop open, examinable reference implementations
- Define interop roadmap informed by vision and reference implementations
  - Roadmap considers reference-inspired interface standards, testing, and the market ecosystems to support related products
  - Roadmap addresses approaches to work with existing technology investments
  - Roadmap acknowledges that new methods, tools, and technology will emerge

*"The deployment of connected equipment is an untapped national opportunity – for operational efficiency, for new business growth, and to lessen the effects and burdens of climate response."**

* Joe Hagerman, "Towards a National Strategy for the Interoperability of Connected Equipment," 14 Aug 2014

Buildings Interoperability Plan of Attack



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Design of this Meeting

- Point of departure
  - Review Buildings Interoperability Landscape doc – comments desired
- National Strategy for Buildings Interoperability
  - Approach for developing a roadmap and progress for interoperability
- Vision concepts
  - Provocative buildings interaction stories
  - Interoperability desired attributes
- Industry transformational directions
- Vision discussion topics
  - What does the future look like?
  - What are the interoperability attributes to consider?
  - What should a buildings interoperability vision include?
- Outcomes
  - Outline scope and contents of a buildings interoperability vision

Thank you!

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Questions/discussion