Data-integrated Building Systems Task Group

GSA Green Building Advisory Committee

12 September 2019

Agenda

- Introduction
- DIBS Overview
- Market Drivers
- DIBS in Green Buildings
- DIBS Programming and Design
- DIBS System Architecture
- DIBS Case Studies
- Federal Examples
- Healthcare Systems Integration
- Key Findings and Challenges
- Recommendations
- Other Related Activities

DIBS Task Group Members

Patrick Cigole Patrick.Cigole@secritical.com

Jennifer Frey jfrey@sazan.com

Don Horn donald.horn@gsa.gov

David Kaneda dkaneda@integralgroup.com

Bill Livingood William.Livingood@nrel.gov

Clay Nesler Clay.G.Nesler@jci.com

Taw North taw.north@tlc-eng.com

Andrew Persily andrew.persily@nist.gov

Kent Peterson kent.peterson@p2sinc.com

Jane Rohde jane@jsrassociates.net

Task Group Coordinator

Michael Bloom michael.bloom@gsa.gov

DIBS Introduction

What is the Problem?

- Buildings underperform to their potential
- Volume of data on building performance is exploding
- Building systems aren't interoperable
- Integrated buildings are "one offs" and expensive

What is the Promise?

- Leverage best practices and emerging standards to deliver "plug & play" data integration to significantly improve building and organizational performance

What was our Approach?

- Interview SMEs in DIBS projects (16)
- Evaluate successful federal and non-federal projects
- Identify organizations that are driving DIBS adoption
- Recommend areas for continued work

DIBS Overview

Definition

- Data-integrated building systems improve building performance by providing advanced sensing, monitoring and controls through the automated exchange of data from building automation, energy management, lighting, security, life safety and other building systems, equipment and devices.

Key Enabling Technologies

- Key enabling technologies include wireless sensing, data analytics, machine learning, device integration, systems interoperability and cybersecurity.

Common DIBS Applications

- Common DIBS applications include fault detection and diagnostics, on-going commissioning, building energy optimization, IEQ management and occupant-based control.

User

Building Systems

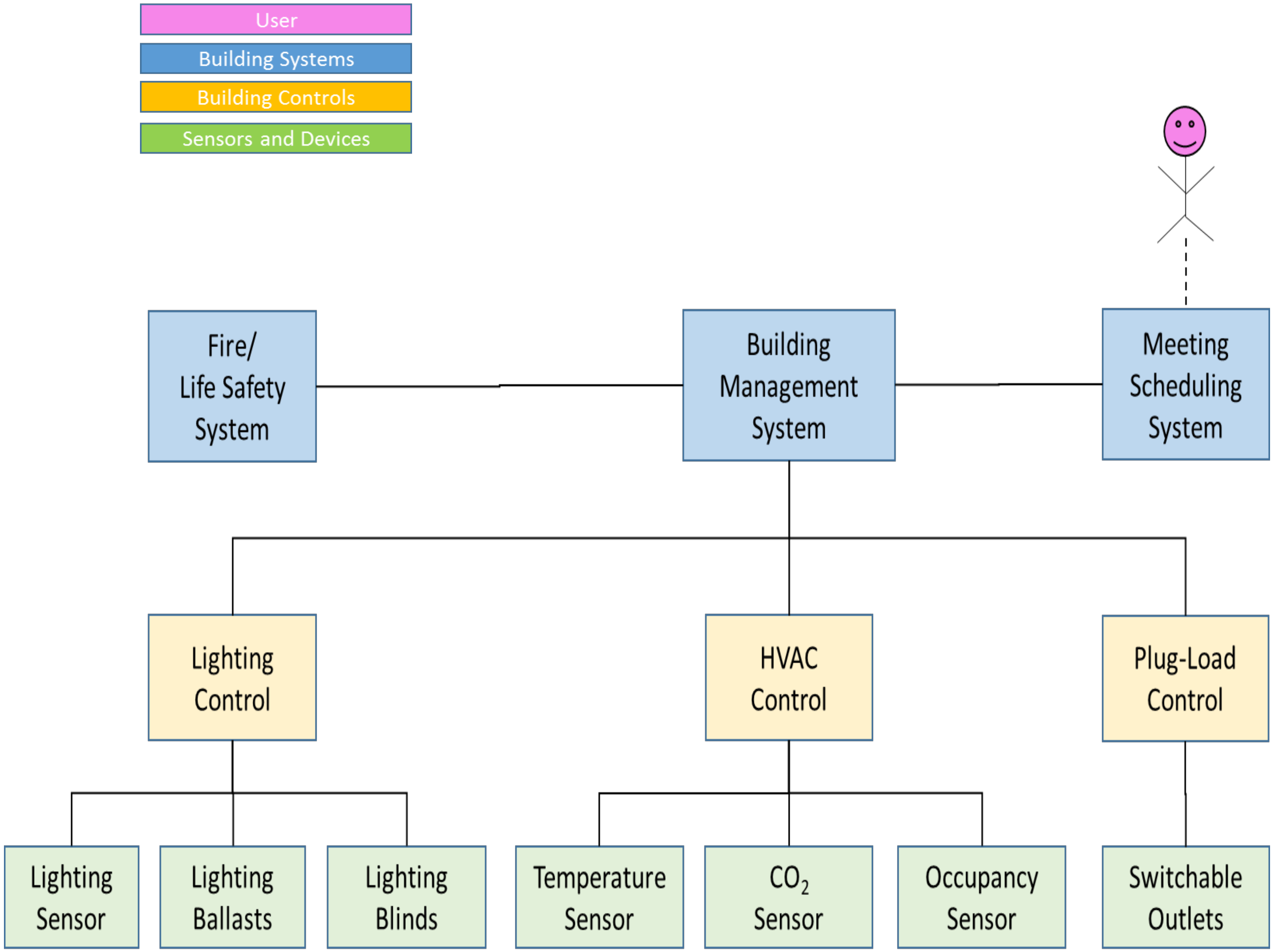
Building Controls

Sensors and Devices

Smart Conference Room Use Case

1. A meeting organizer searches for a conference room in the scheduling system with the required amenities and invites the required attendees.
2. The building management system releases the conference room temperature controls from setback mode so that the room will be comfortable 15 minutes before the meeting starting time.
3. 15 minutes before the meeting start time, the lighting control system adjusts the motorized blinds to allow daylighting without glare using a light sensor. Dimmable ballasts are adjusted to a low level to allow the meeting organizer to prepare for the meeting.
4. The light level increases when the room occupancy sensor detects an occupant entering the room and the plug-load control system turns on the switchable outlets.
5. At the meeting starting time, the ventilation rates are adjusted to match the number of confirmed attendees. If more attendees participate in the meeting than expected, a carbon dioxide sensor overrides ventilation rates. If fewer attend, the ventilation rates will be further reduced.
6. If no one shows up for the meeting, the building management system releases the meeting time in the scheduling system so others can use the room.
7. In an fire/life safety emergency, the lighting controls turn up the light level and the color to red.
8. When the room is unoccupied and the next meeting is more than 15 minutes in the future, the blinds are closed (assumes cooling season), the lights are turned off, the temperature controls set back, ventilation controls set to minimum and the power outlets turned off.

Smart Conference Room Scenario



DIBS
Market Drivers

Energy and Resource Efficiency

- Data analytics for FDD
- Retro-commissioning
- Building optimization

Comfort, Health and Productivity

- High IEQ
- Improved occupant/organizational productivity

Facility Optimization

- Facility layout and workflow
- Collaboration through occupancy sensing and tracking

DIBS

Energy Savings Potential

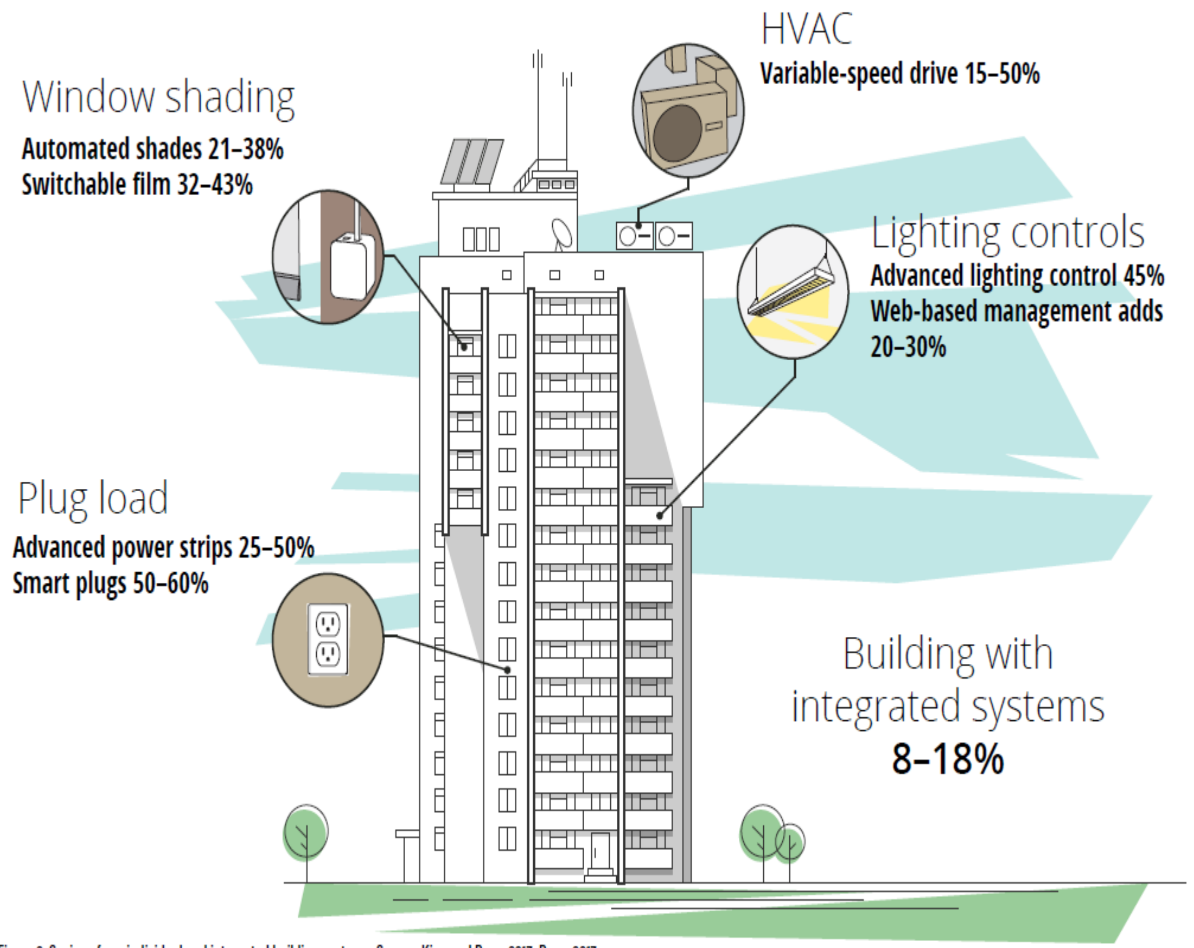


Figure 2. Savings from individual and integrated building systems. *Source:* King and Perry 2017; Perry 2017.

Emerging Opportunities: Achieving Deeper Energy Savings through Integrated Building Systems
https://aceee.org/topic-brief/eo-building-systems

DIBS: Sustainability, Resiliency and Better Operations

Operating Cost Savings from Performance Improvements

Utility Demand Response & Adjustment Coordination

Improved Productivity & Security

Emission Reductions

Automatic Response to Real-Time Changes in Conditions

Sensors Crowd-Sourcing Air Quality Data

DIBS Supports GREEN BUILDING CERTIFICATION Achievement

Improves Point Contributions

- Energy and water reduction
- Metering & monitoring
- Lighting quality & control

Creates Exemplary Performance

- Reduce "unregulated" loads
- Power-Over-Ethernet (POE)
- Target Net Zero

Receive Innovation points for new ideas and pilot credits

- New Ideas
- Pilot Projects
- Case Studies

Certification Plus…

- WELL Credits
- LBC Petals
- LEED Credit O+M
- GPC Category

DIBS

Transform the Marketplace Together

Achieve Green Building Certifications

- Change how products are manufactured
- Improve how buildings are designed and built
- Track accountability of impacts

Integrate DIBS into Certifications - Accelerate Data Analysis

- Discover immediate and real impacts
- Improve building performance
- Deliver Occupant Health and Wellbeing

Consider Technology Forward Certifications

- WIREDSCORE™

DIBS

Programming and Design

Photo by Danielle MacInnes on Unsplash

Goal Setting – Functional Programming

- Who are your users?
- What activities will occur within space – to meet Mission?
- What data is important to collect?
- How will data be analyzed?
- Document Framework

Examples of Identifying Goals

- Reduce absenteeism
- Decrease energy use

Evaluate data collected and analyzed based upon identified goals

- Update on annual basis

DIBS
Programming and Design

Photo by Austin Distel on Unsplash

Prioritization of Goals

- Evaluate balancing of goals
- Evaluate current evidence for building and occupant outcomes
- Balance building sustainability goals and health & wellness goals
- Programming developed based on goal prioritization

Use Multi-disciplinary Team for Programming

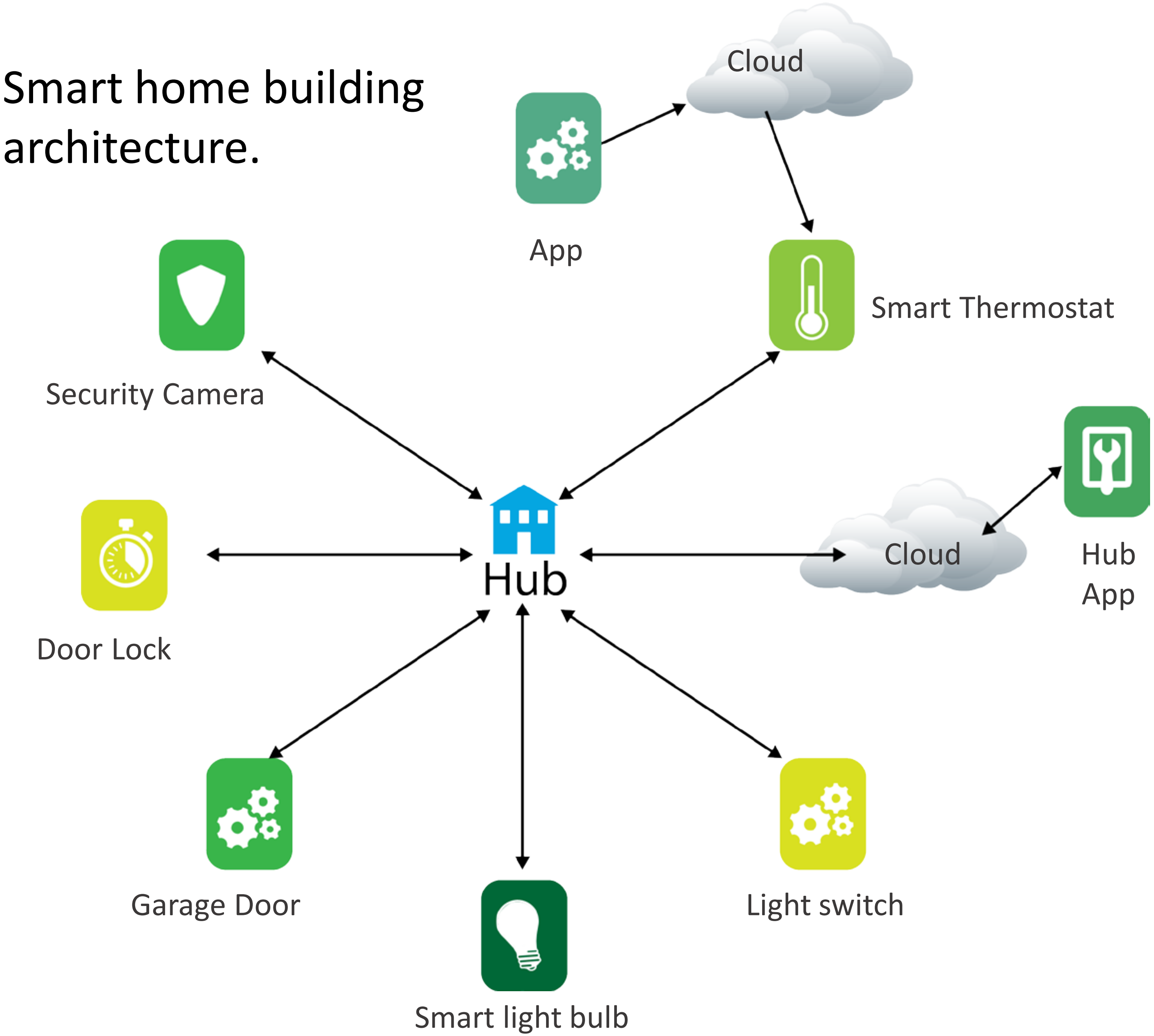
- Identify current and predict future needs
- Technology consultant recommendations
    - Infrastructure (holistic planning)
    - Systems Planning – Correlation Implementation
    - Adaptable to continual change
    - Expect change

Connectivity

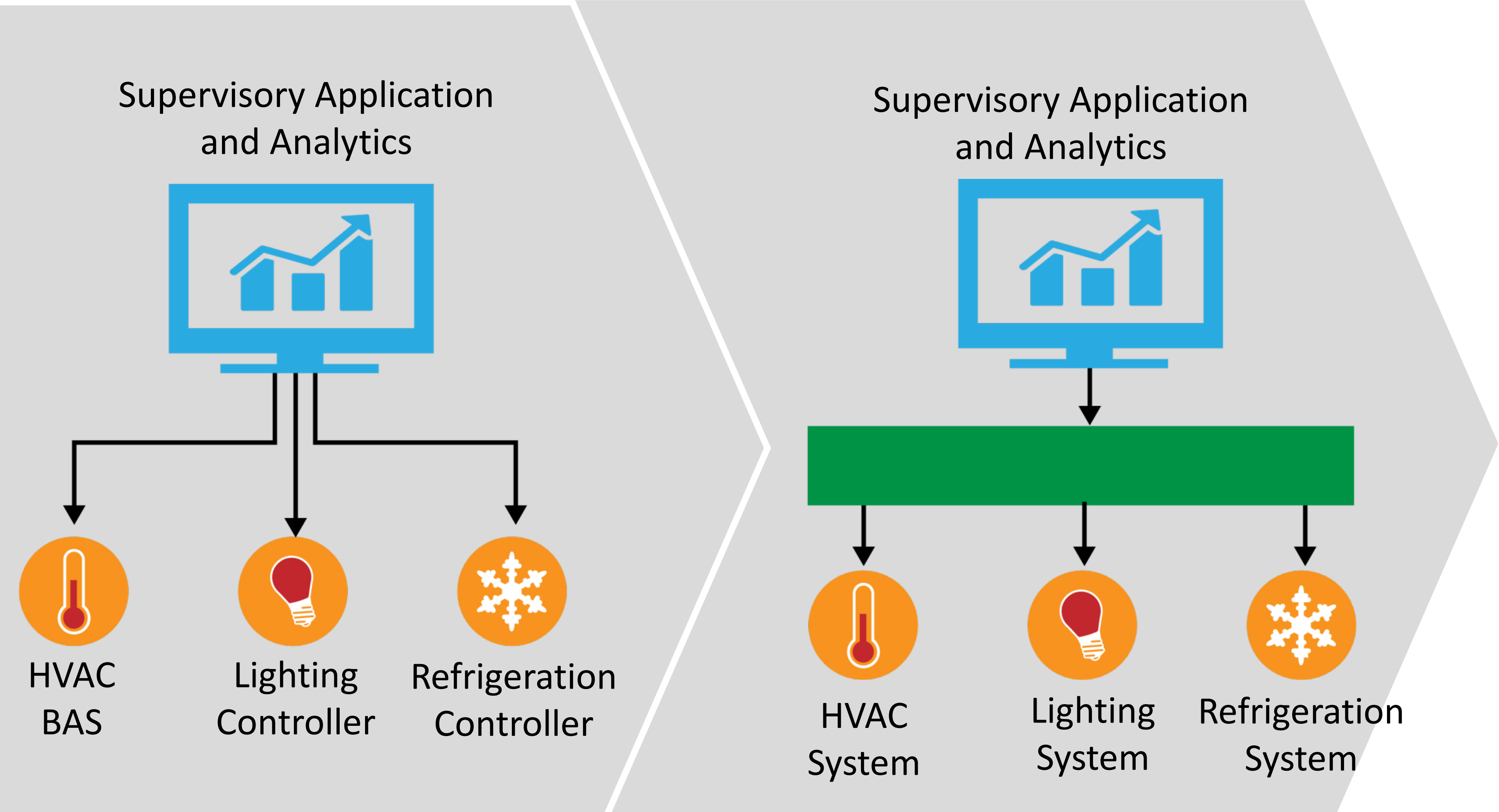
- Connection point: Application Programming Interface (API)
- Language for commonality: Ontologies

Residential Building Hub – API Approach

Smart home building architecture.

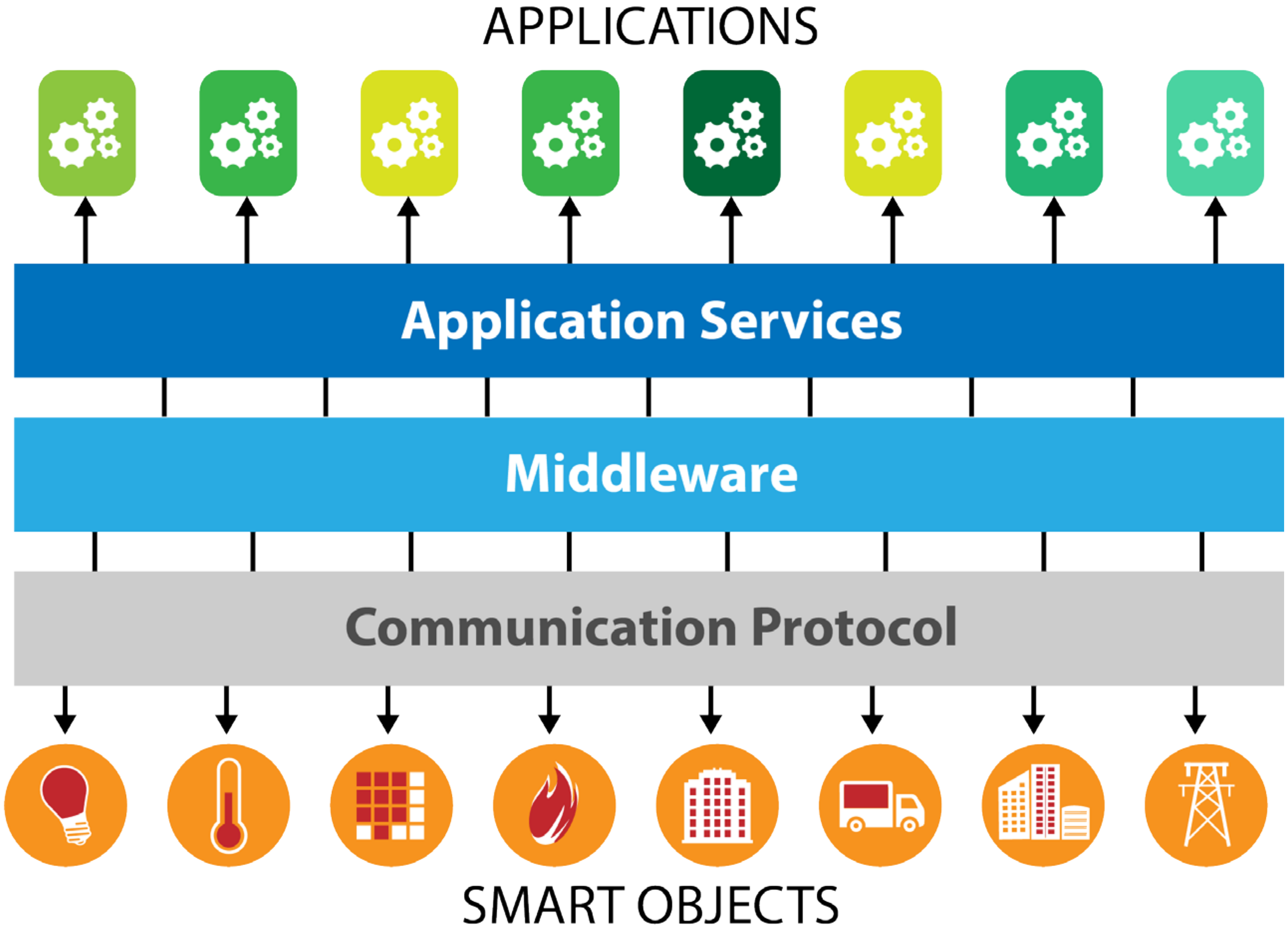


Commercial System-to-System Integration



Different protocols- higher integration costs

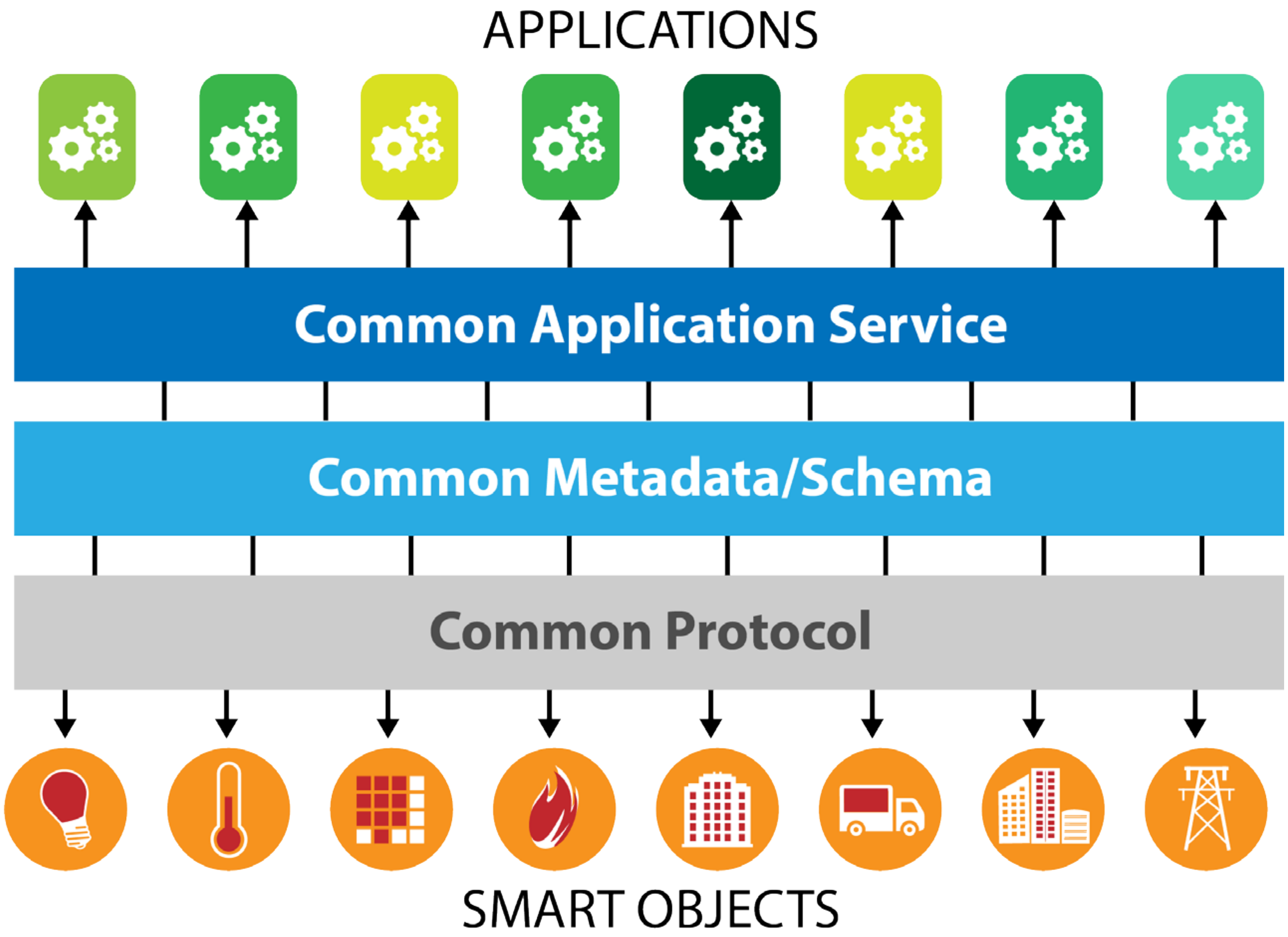
Commercial Building Middleware



Different protocols - higher integration costs

GSA Green Building Advisory Committee – Data-integrated Building Systems Task Group

Commercial Building without Middleware



Common protocols decrease integration costs

GSA Green Building Advisory Committee – Data-integrated Building Systems Task Group

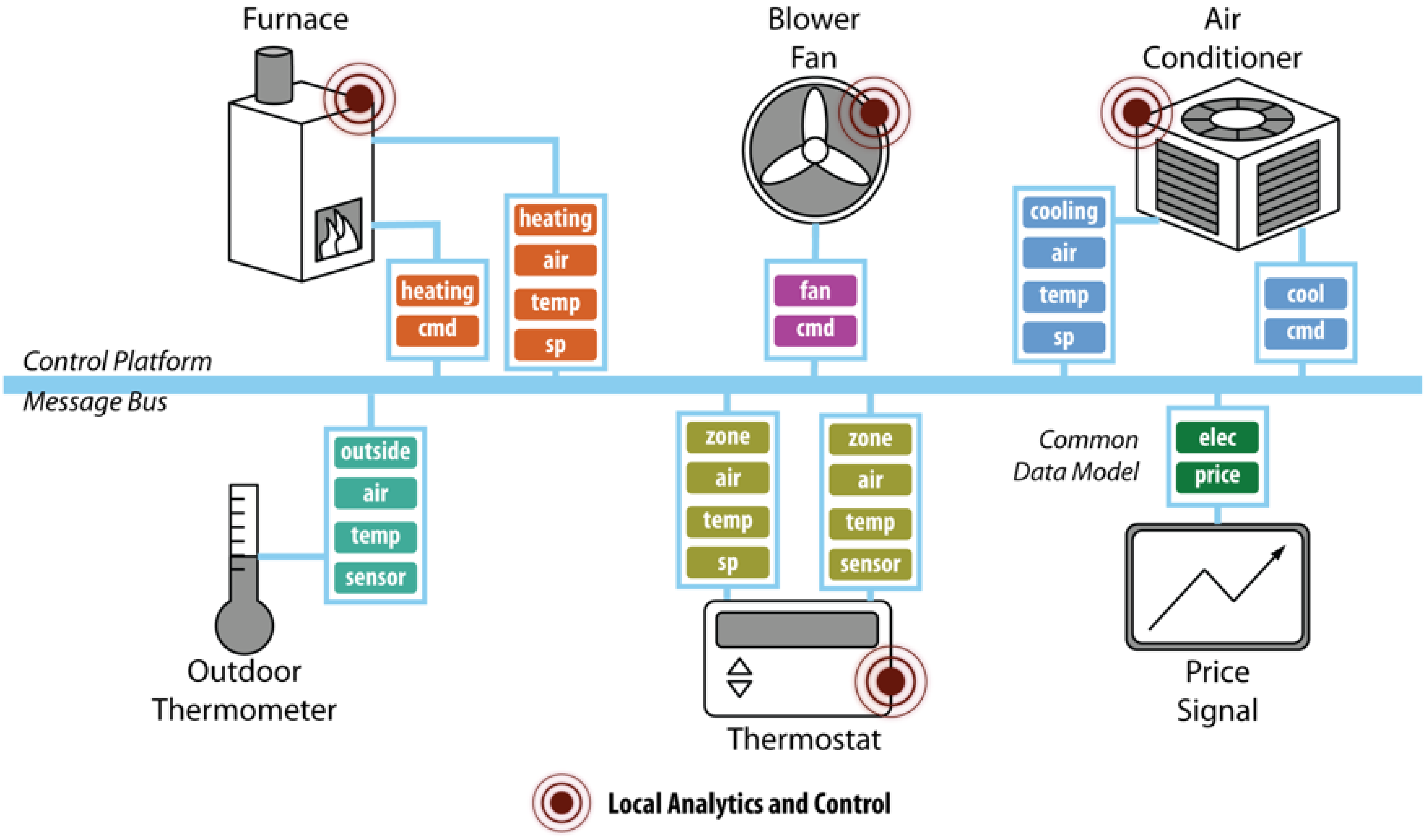
With Interoperability

- Fault detection and diagnostics.
- Demand management.
- Predictive/condition-based maintenance.
- Optimized controls.
- Dashboarding and tenant engagement.

Graphic: *Justin Stein and William Livingood, NREL*

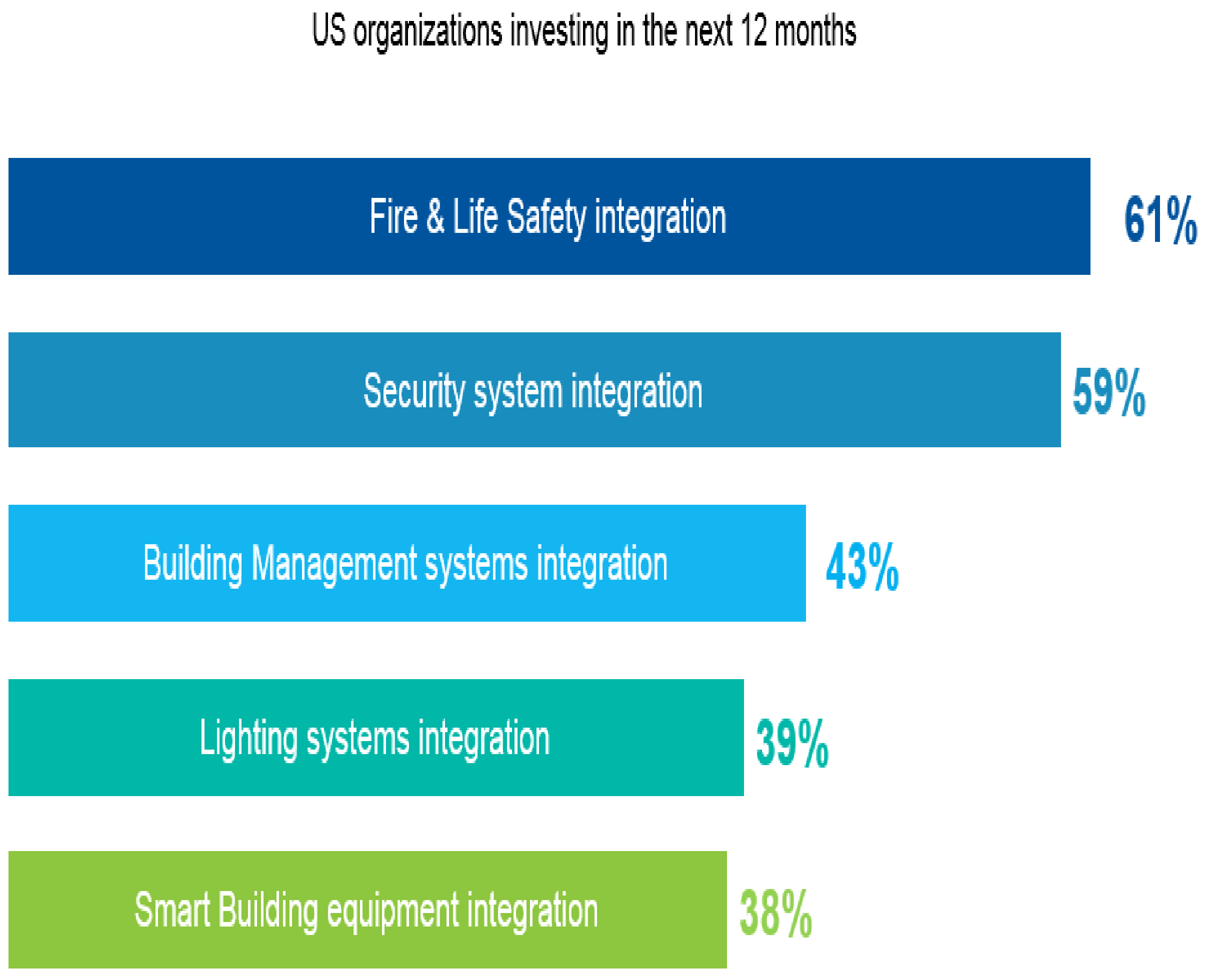
Interoperability

Metadata enables plug-and-play



***Graphic:** Marjorie Schott, NREL*

DIBS Systems Integration Investments



2018 Johnson Controls Energy Efficiency Indicator Survey
https://www.johnsoncontrols.com/-/media/jci/insights/2018/buildings/files/eei-handout-102018-united-states--final.pdf?la=en&hash=F1AF63E5E025A61E1443CEB9877961E642887CF3

Unisphere Net-Zero Building

Unisphere is the net-zero energy corporate headquarters for United Therapeutics, located in Silver Spring, MD. space.

Integrated Systems:
- Generators
- Lighting Controls Hubs
- Water to water heat pumps
- Geothermal optimization
- Electrochromic glass
- Motorized windows
- BTU Metering
- Hazardous gas detection
- UPS & EPMS

BAS Controlled Systems:
- AHUs, Condenser Water System & Terminal Units
- WWHP & WSHP for Earth Cooling (Labyrinth) System

Monitored Systems:
- Exterior Doors
- Window Shades

Monitoring and Reporting:
Energy dashboard and data analytics package with weather monitoring.

Key to Success:
Pre-construction functional integration mock-up.

University of Baltimore
School of Law

192,000 sq. ft., 12 story building located in Baltimore, MD

Integrated Systems:
- Thermal Active Slab (Radiant Heating and Cooling)
- Automated Window Actuation
- Exterior Window Shades
- Rainwater Harvesting

BAS Controlled Systems:
- Mechanical Equipment including AHUs, CHW, CW, and terminal equipment

Monitored Systems:
- Weather Monitoring
- FAS Components

Monitoring and Reporting:
Trending and reporting configured for LEED reporting.

Key to Success:
Pre-construction mock-up of integrated systems for contractor and customer demonstration.

DIBS Federal Examples (GSA)

Building Systems Network (BSN)

- Secure Communications (Fiber) for building information

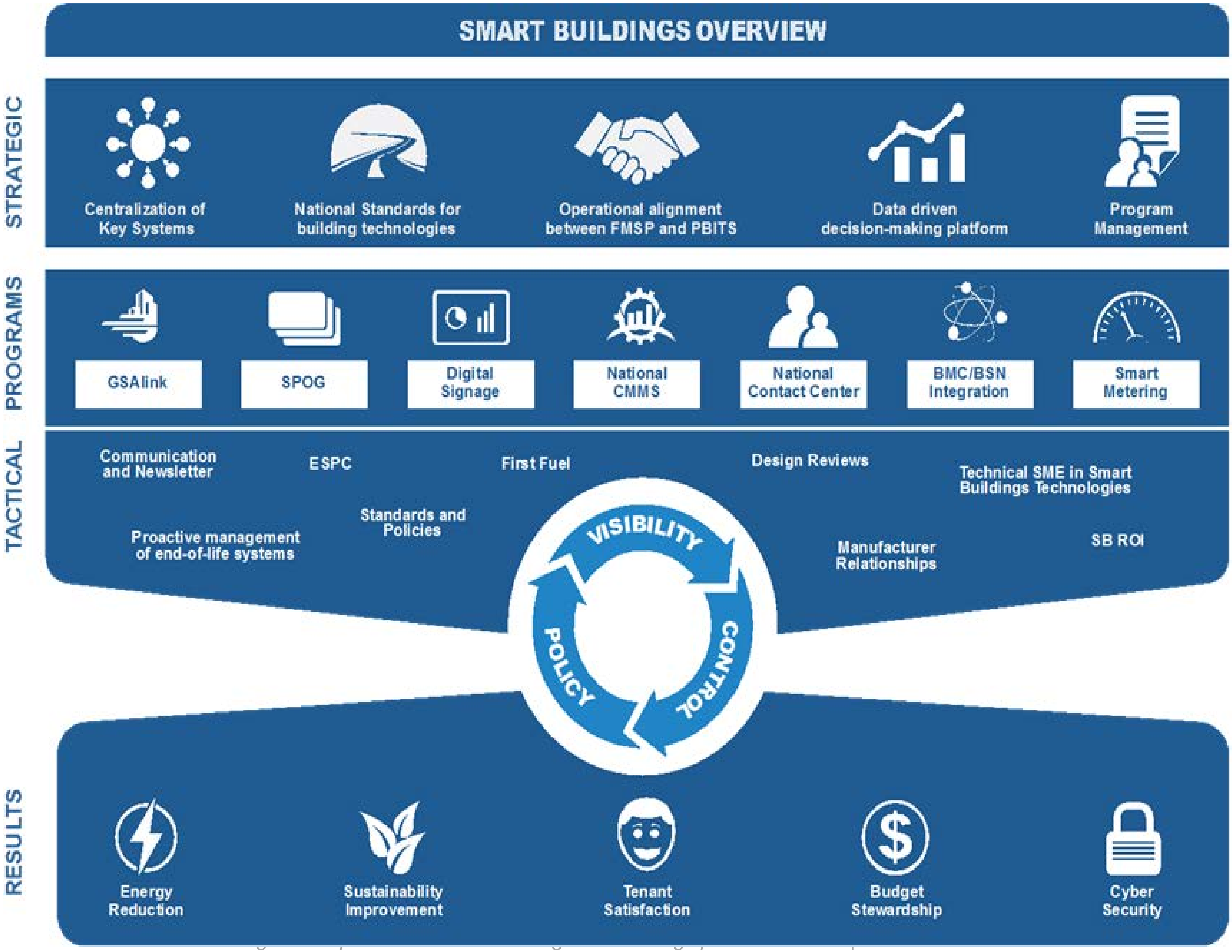
ION Smart Meters

- Remote monitor and analysis of Water, Gas and Electricity

GSAlink

- Continuous commissioning platform
- Links to National Computerized Maintenance Management System (NCMMS)

DIBS Smart Buildings Overview



DIBS

Federal Examples

Trillium Overlay

- Aggregates GSALink and ION Smart Meters into a unified Trillium system (GSA Region 7)

Wireless Sensor Analytics Platform

- Occupancy and Daylighting Controls
- AIRE HVAC Controls
- Space Use Mapping
- Bluetooth Tracking

DIBS
Healthcare Integration

All Stats – Building & People

Artificial Intelligence (AI) to sift, sort and analyze data and direct key information to right person or department

- Example: spikes in temperature could be a sign of sepsis for patient – requires continual monitoring versus “human” periodic monitoring
- Example: Preventative Maintenance evaluation to avoid shut-downs or equipment failure leading to outages of a service

Use of Virtual Reality

- Overlay of 3D Image from CT Scan on to Patient for accuracy improvements
- Building design processes with workflow

Voice Assistance

- With AI provides opportunity to compare and provide result
- Healthcare outcomes

Contributors: HF Lenz: Robert Mickle, PE - TLC Engineering: Taw North, RCDD, LEED AP

DIBS
Healthcare Integration

Photo by Frederick Tubiermont on Unsplash

Interoperability – Expensive but important in Healthcare Settings

Examples of Interoperability

- Lighting controls and BAS – unoccupied space – ramp down HVAC system
- Window shade controls and BAS – up/down
- Intrusion Detection System and Mass Notification System communication (including emergency lock-down)
- Fire Alarm Systems and Access Control System for Doors (alarm condition)

Standardization

- Equipment
- Data transmitted
- Transmission conduit
- Meshing of data and resultant output
- Mocking up system prior to installation is critical

Benefits

- Increased building occupant safety, IAQ, energy savings, employee performance

Contributors: HF Lenz: Robert Mickle, PE - TLC Engineering: Taw North, RCDD, LEED AP

DIBS

Identifying and Bridging the Gaps

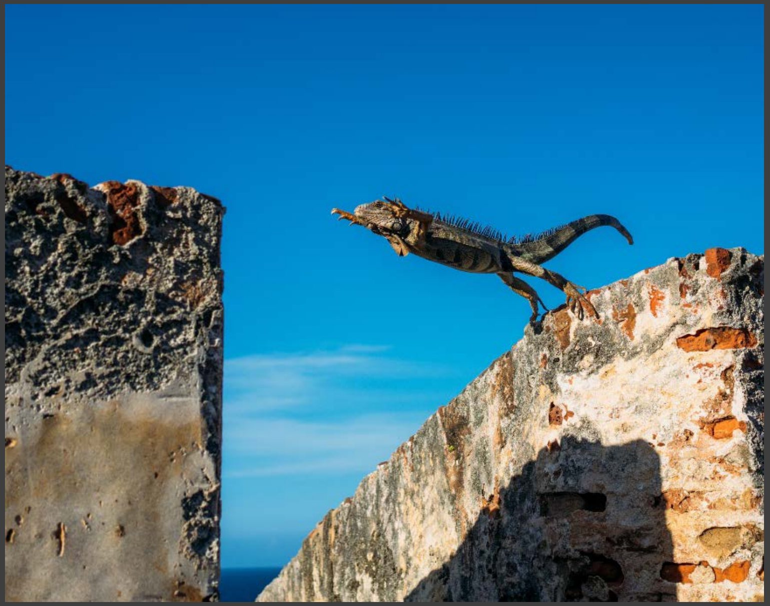


Photo by Denny Luan on Unsplash

	Gaps	Solutions
People	• Education / Training • Workforce Readiness & Development • Loss of Knowledge Workers • Identify Skills Required for System Integration	• Set of Competencies needed for Building Development & Operations
Standards	• No Interoperability Standards • No Contracting Guidance	• Develop Interoperability Standards (evaluate existing sources) • Develop Contracting Process Guidance for Inclusion of DIBS
Data	• Identifying Use of Data – Once Collected • Analyze and Implement Data	• Use Functional Programming to Define Tracking Meaningful Data • Determine Use of Data prior to Collection
ROI Information	• Lack of LCA and LCC Data • Technology Line Item Missing in Facilities	• Provide Framework for Life Cycle Costing – include Operations versus First Cost • Operational Guidance to include Technology within Facility Operations Budgets

DIBS
Key Findings

1. Data-integrated building systems (DIBS) are in a nascent phase with very few examples outside of high profile corporate headquarters and institutional facilities. These buildings are one-off, highly customized projects requiring specialized expertise.
2. The healthcare sector is the most mature in the adoption of DIBS due to the requirement of integrating and storing data from a myriad of clinical, patient and facility devices.
3. Federal implementation of DIBS is lagging due to procurement guidelines which favor standalone systems, the lack of documented life cycle cost data, risk aversion in the contracting chain and cybersecurity concerns.
4. Designing buildings for DIBS requires an integrated, multi-disciplinary approach.

DIBS
Key Challenges

1. Lack of training, education and development of a workforce with specialized systems and data integration skills.
2. Lack of interoperability standards including system communication protocols and the common metadata/schema required for “plug-and-play” installation.
3. Lack of systems specification and procurement guidelines for DIBS installations.
4. Lack of life cycle cost and impact data and a specific budget for data integration and analysis limits the implementation of DIBS in federal and other buildings.

DIBS

Recommendations

1. Initiate demonstration projects in federal buildings and quantify the costs and benefits of these installations.
2. Prepare DIBS specification, implementation and procurement guidelines, leveraging industry efforts from ASHRAE, NEMA, USGBC, GBI and others.
3. Define the required skills and competencies for federal building development and operations personnel to support DIBS facilities.
4. Support systems interoperability standards development and testing in federal facilities and laboratories.
5. Develop guidance for including DIBS in ESPC/UESC contracts taking advantage of energy and non-energy benefits.
6. Investigate cybersecurity concerns specific to DIBS and provide guidance for system specification, maintenance and security.
7. Circle back with stakeholders and organizations working in this area to share our findings and recommendations.