



**Better
Buildings®**
U.S. DEPARTMENT OF ENERGY

The Internet of Things (IOT) and Energy Management in the Modern Building

Better Buildings Summit

Tuesday May 10, 2016

2:00-3:15

Today's Presenters

- Moderator: David Nemtzow, Building Technologies Office, U.S. Department of Energy
- Kevin Kampschroer, U.S. General Services Administration
- Ethan Goldman, Vermont Energy Investment Corporation
- Dr. Marina Sofos, Emerging Technologies, U.S. Department of Energy

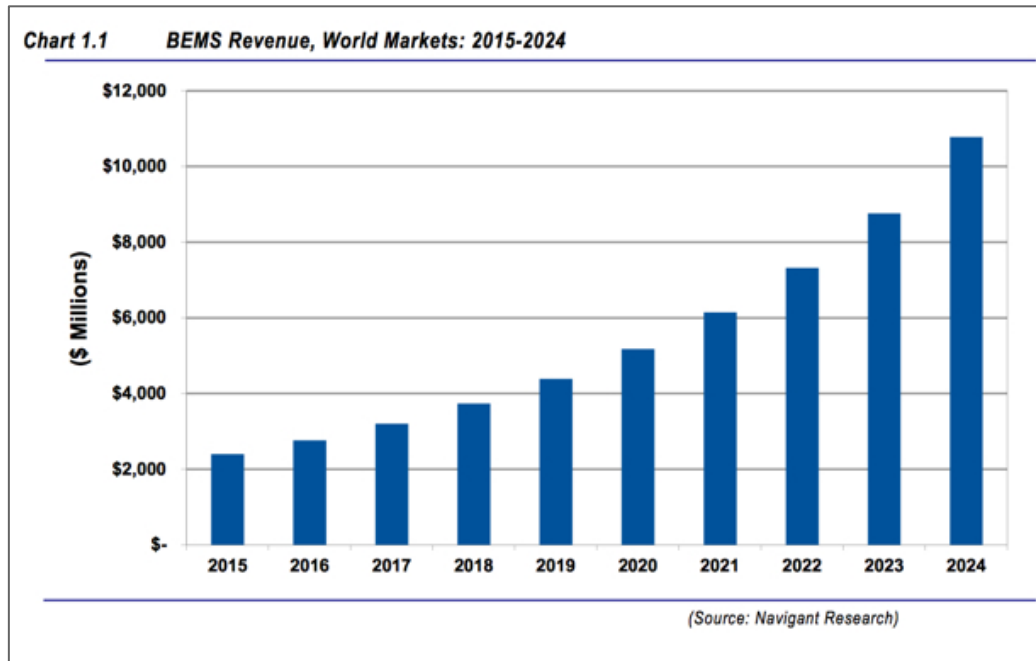
The Internet of Things

- “...the real value that the Internet of Things creates is at the intersection of gathering data and leveraging it. All the information gathered by all the sensors in the world isn’t worth very much if there isn’t an infrastructure in place to analyze it in real time.
 - Wired Magazine, April 18, 2016

W I R E D

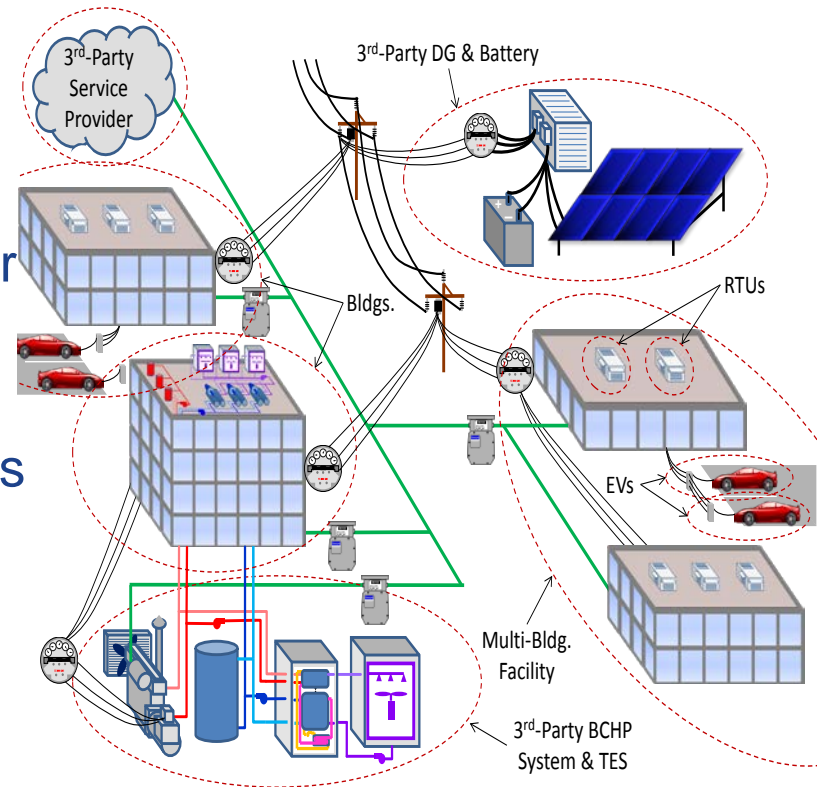
Why does it matter?

- Building Energy Management Systems (BEMs) attracted \$1.4 B in VC Funding from 2000-2014 (26% of all investment in building energy technology).
- In 2020, about 77% of the \$2.14 billion U.S. market will comprise BEMS applications, and 40% will come from buildings below 50,000 square feet.
- U.S. market for sensors and controls for BEMs will rise at a 17% compound annual growth rate to \$2.14 billion in 2020.



What does it mean?

- 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.

**Kevin Kampschroer, U.S. General
Services Administration**

1800 F

- Historic 1917 Building
- Last Upgraded in 1935

Plan:

- Modernization with Infill
- \$161 M from Recovery Act, as Phase I
- Must Redesign for Energy Goals
- Future Funding Needed for Phase II

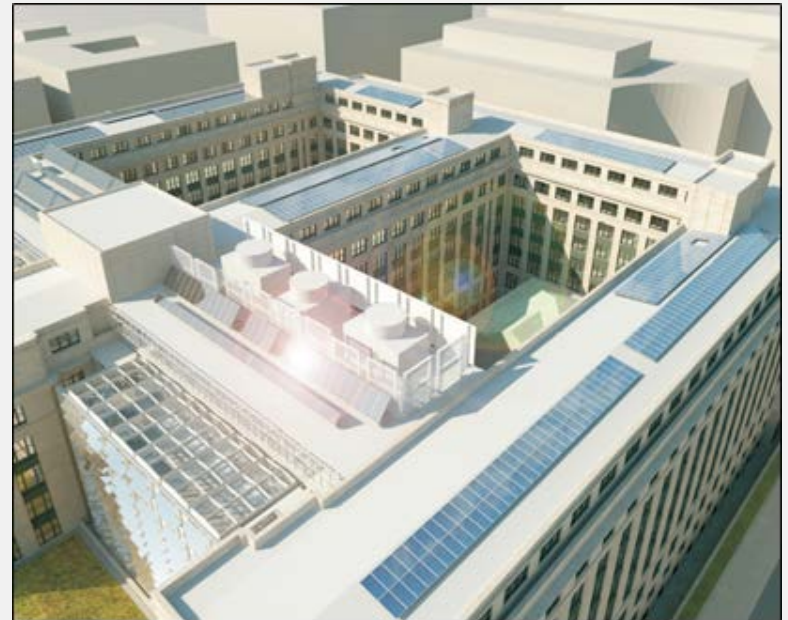


1800 F – Phase I

- 2,500 People → 4,400
- Eliminates 6 Leases; Saves \$24 million/year
- 50% Occupancy → 85% Occupancy
- <20% Assigned Workstations
- Lockers; Booking System
- 250% Increase in Meeting/Quiet Rooms
- Telework & Mobility
- 100% Laptops; Strict Standardization
- Reduce Private Offices 90%
- Swing Space = Practice

1800 F – Phase I

- Energy down 2/3 from Baseline
- 100% Daylighting in Working Space
- LED in Hallways, Stairwells & Outside
- 100% Rainwater Capture
- New Cisterns
- Solar Direct to Computer Servers (DC to DC; No Inverter)
- 100% Solar Hot Water



1800 F Workspaces





1800 F – Full Renovation Renderings



Edith Green-Wendell Wyatt (Portland, OR)

- 1975 Federal Building
- Never Upgraded

Plan:

- Updating Cutting Edge 'Green' Design
- \$133 M from Recovery Act
- Full Building Modernization
- High Aims for Sustainability and Curb Appeal
- Reoccupied 2014



Edith Green-Wendell Wyatt

- Integrated Design
- Reduced Load from Envelope
- Radiant Heating & Cooling
- Raised Ceiling (Water vs. Air: No Ducts)
- 100% Rainwater Capture & Re-use
- 70 % ↓ Water Consumption
 - Collect All Rainwater
 - Create Cistern from Firing Range
 - No Potable Water for Chillers, Flushing or Landscape
- Lighting ↓ 50%: Daylighting & Controls
- PV = 20% Electricity
- Floor Space Re-capture: Equivalent to Adding One Full Floor





New Carrollton Federal Building

PROJECT SNAPSHOT:

Location	New Carrollton, MD
Building Size	1.2 million ft ²
Original Construction	1994
Development & Construction Duration	38 months (2012–2015)
Investment Value	\$40.0 million
Appropriated Funds	\$586,000 (1%)
Contract Term	22 years
Cost Savings	\$2.5 Million/year
Energy Savings	94,588 MmBtu/year (60%)
Energy Service Company	Ameresco, Inc.

Rocky Mountain Institute, 2015



New Carrollton Federal Building

- Central Chilled-Water Plant
- Integrative Building Controls and Sensors (2,000 Occupancy Sensors)
- 11,000 LED Replacements
- 808 kW Solar PV
- Solar Canopies and Solar Thermal Heating
- Geothermal Heat Rejection
- Exhaust-to-Outdoor-Air heat-Recovery Loop





**Ethan Goldman, Vermont Energy
Investment Corporation**

Efficiency in the Age of the Internet of Things

Ethan Goldman
VEIC
May 2016



Vermont Energy Investment Corporation

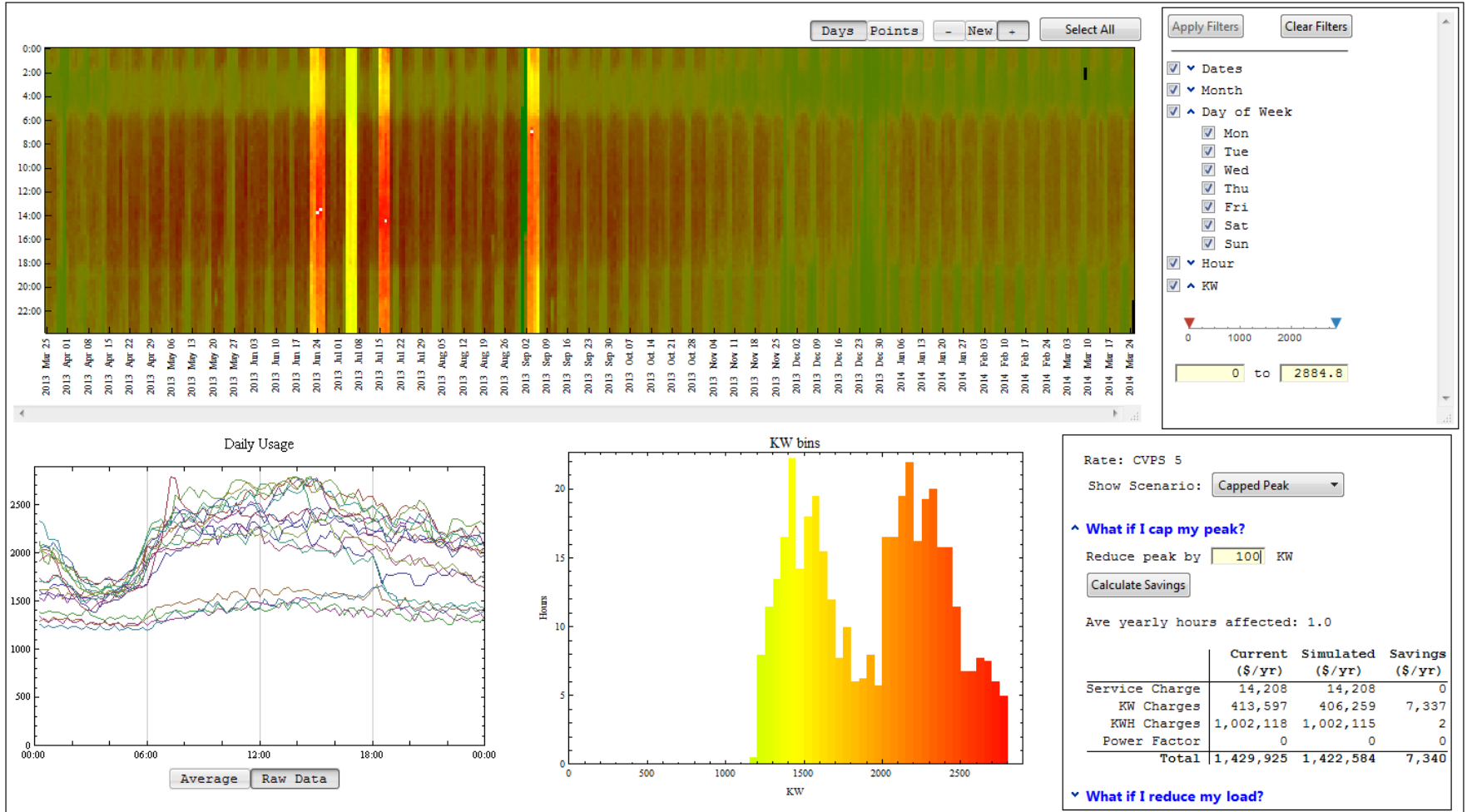
- Mission-driven nonprofit
- Over 25 years reducing economic, environmental costs of energy
- Energy efficiency, renewable energy & transportation
- Consulting & implementation
- 3 energy efficiency utilities



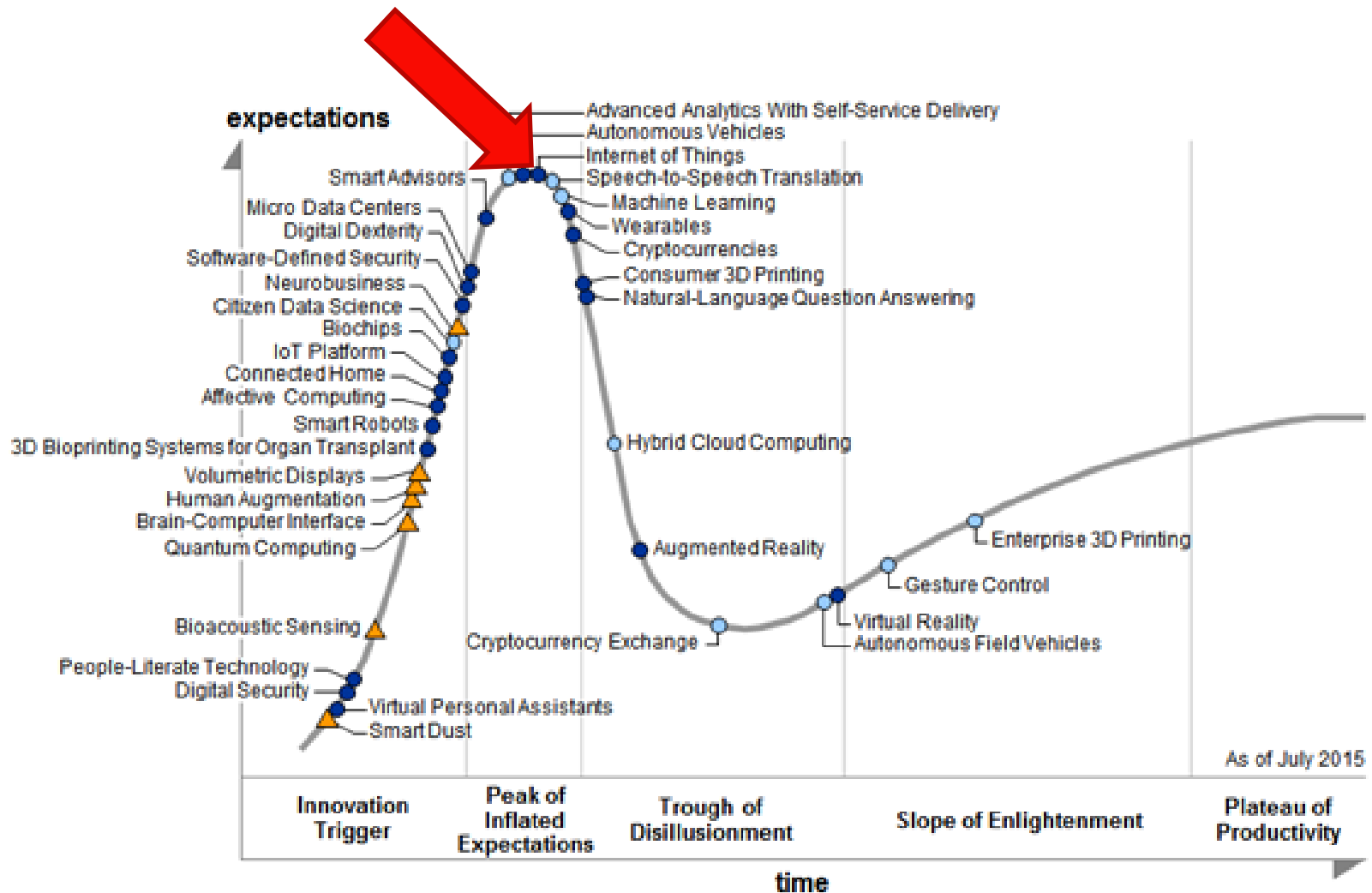
Sub-metering (Old-School Data Collection!)



Smart Meter Interval Data Analysis



Gartner's 2015 Hype Cycle



Plateau will be reached in:

○ less than 2 years

● 2 to 5 years

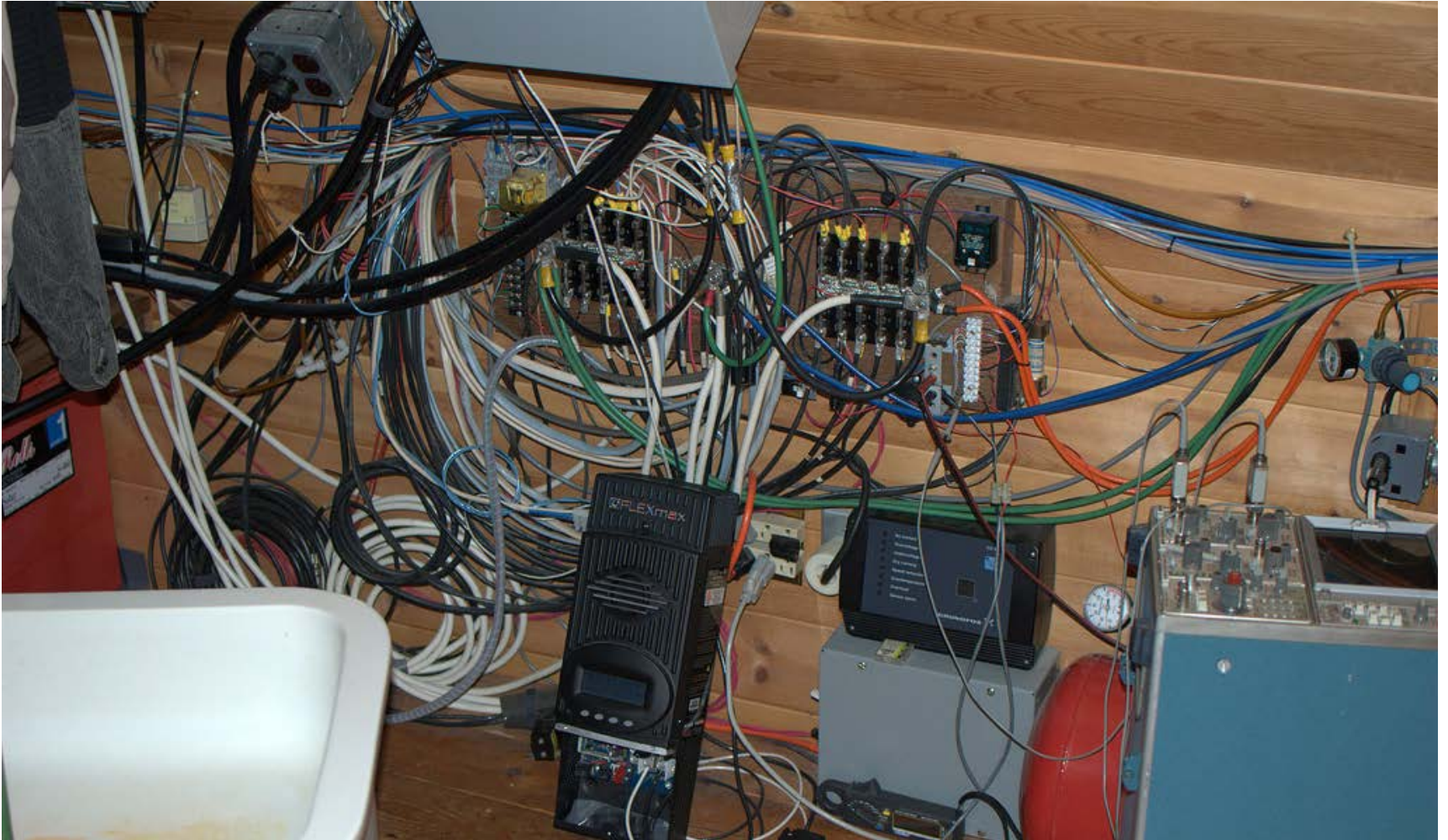
● 5 to 10 years

▲ more than 10 years

○ obsolete

○ before plateau

But Does It Save Energy?



CC Image courtesy of Nicolás Boulosa on [Flickr](#).

Connected Thermostats

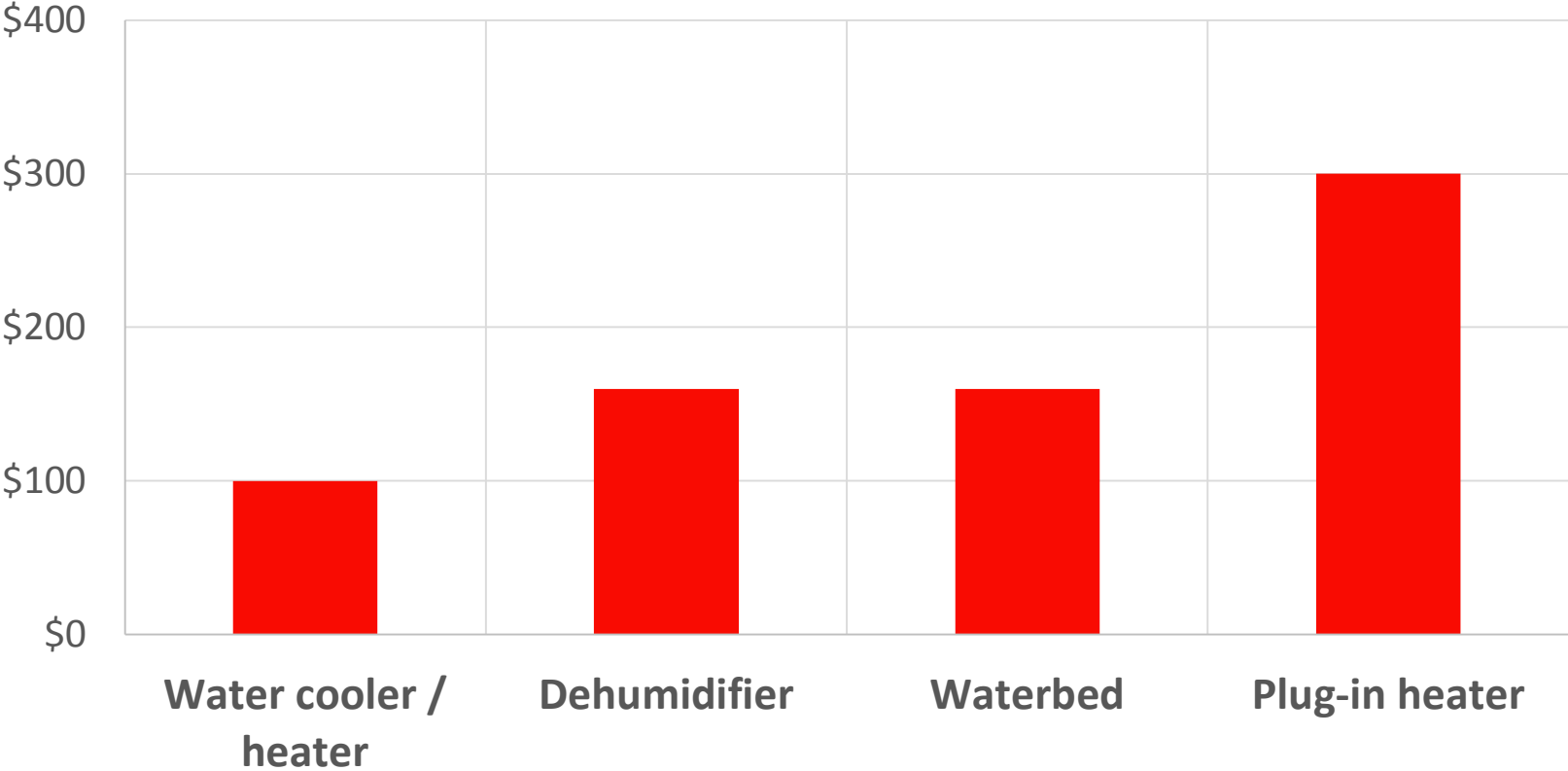


Connected Outlets



Controllable Plug-load Appliances

Annual cost to operate



Storage



Really Large Home Appliances



HEMS Lighting Study – Participant Motivation

- Remote control
- Dimming
- Controlling single bulb on circuit
- Scheduling automatic on / off
- Correcting switch placement
- Ambient lighting (dimming scenes)

Connected Appliances - Belkin



Connected Home – Iris (Lowes)



Interoperability



Poll: is Zigbee a Standard?

Yes, has been for years.

Yes, finally!

No, but it's close...

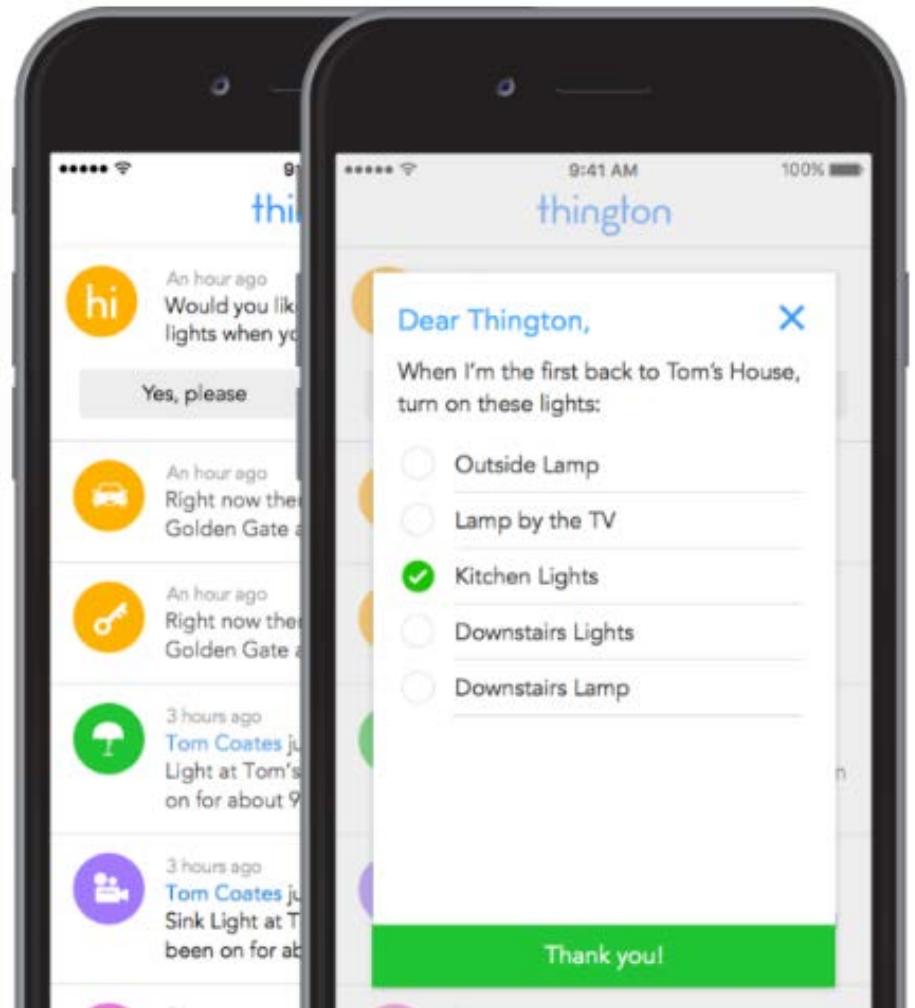
Never going to be.

What-bee?

Wireless Hubs



Integration Services



Data Makes Energy Decisions Tangible





Questions?

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**Dr. Marina Sofos, Emerging
Technologies, U.S. Department of Energy**

Interoperability and the Internet of Things – An R&D Perspective



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Marina Sofos, Emerging Technologies

May 12, 2016

Marina.sofos@ee.doe.gov

What can the future look like?

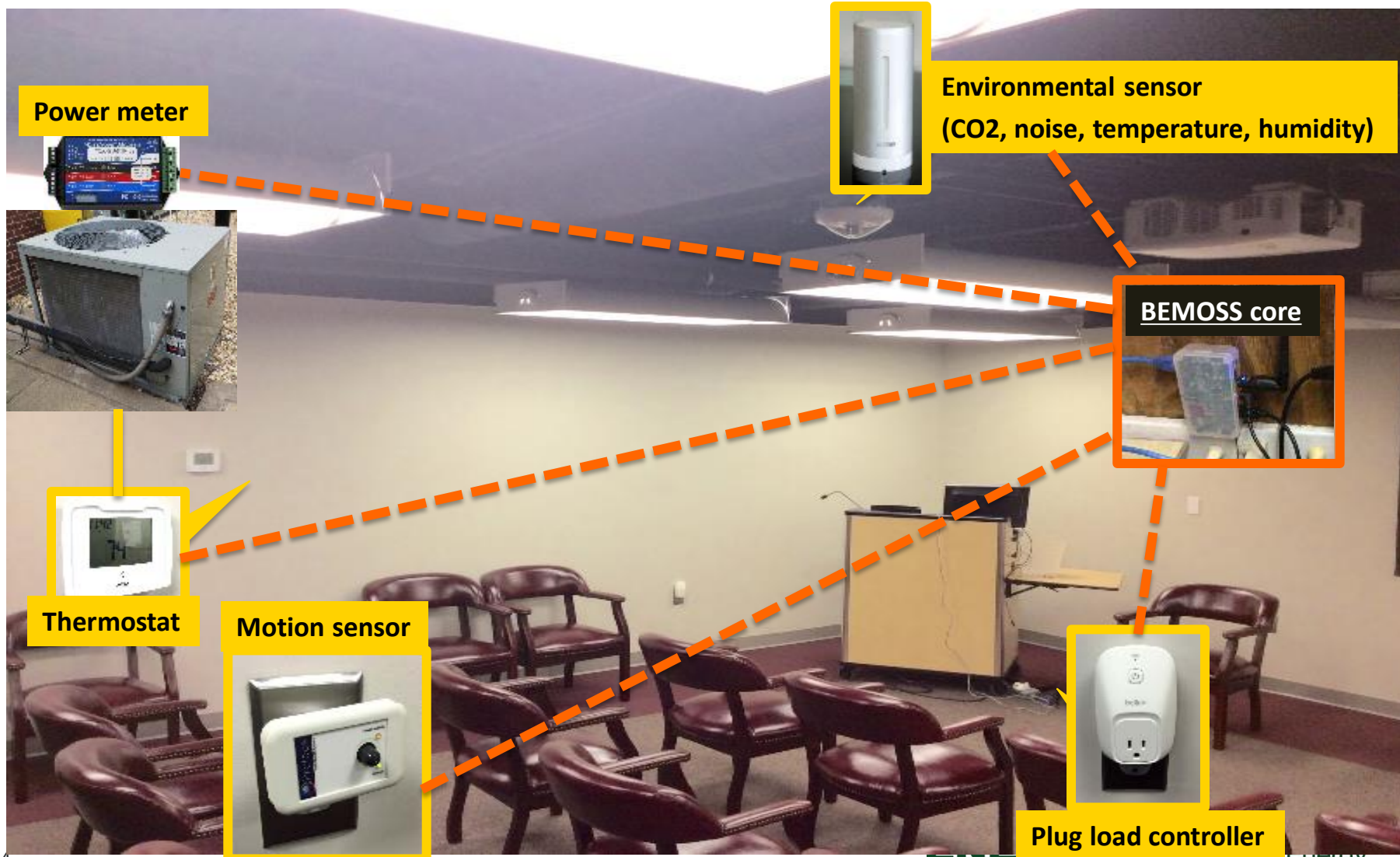
BEMOSS is a Building Energy Management Open Source Software (BEMOSS) solution that is engineered to improve sensing and control of equipment in small- and medium-sized commercial buildings.

It targets to monitor/control three major loads in buildings:

- HVAC
- Lighting loads
- Plug loads



Classroom Wireless Monitoring (Alexandria, VA)



The problem today

The image shows a screenshot of a Wired article page. At the top left is the Wired logo. The main title of the article is "Nest's Hub Shutdown Proves You're Crazy to Buy Into the Internet of Things". Below the title is a navigation bar with categories: BUSINESS, CULTURE, DESIGN, GEAR, and SCIENCE. On the left side, there is a "SHARE" section with icons for Facebook (1743 shares), Twitter, Pinterest, Comment, and Email. The main content area features the article title in large, bold, black serif font. The author's name "KLINT FINLEY" and the date "04.05.18 6:06 PM" are visible above the title. A small back arrow icon is located on the left side of the page.

WIRED

Nest's Hub Shutdown Proves You're Crazy to Buy Into the Internet of Things

BUSINESS CULTURE DESIGN GEAR SCIENCE

SHARE

KLINT FINLEY BUSINESS 04.05.18 6:06 PM

NEST'S HUB SHUTDOWN PROVES YOU'RE CRAZY TO BUY INTO THE INTERNET OF THINGS

f SHARE 1743

🐦 TWEET

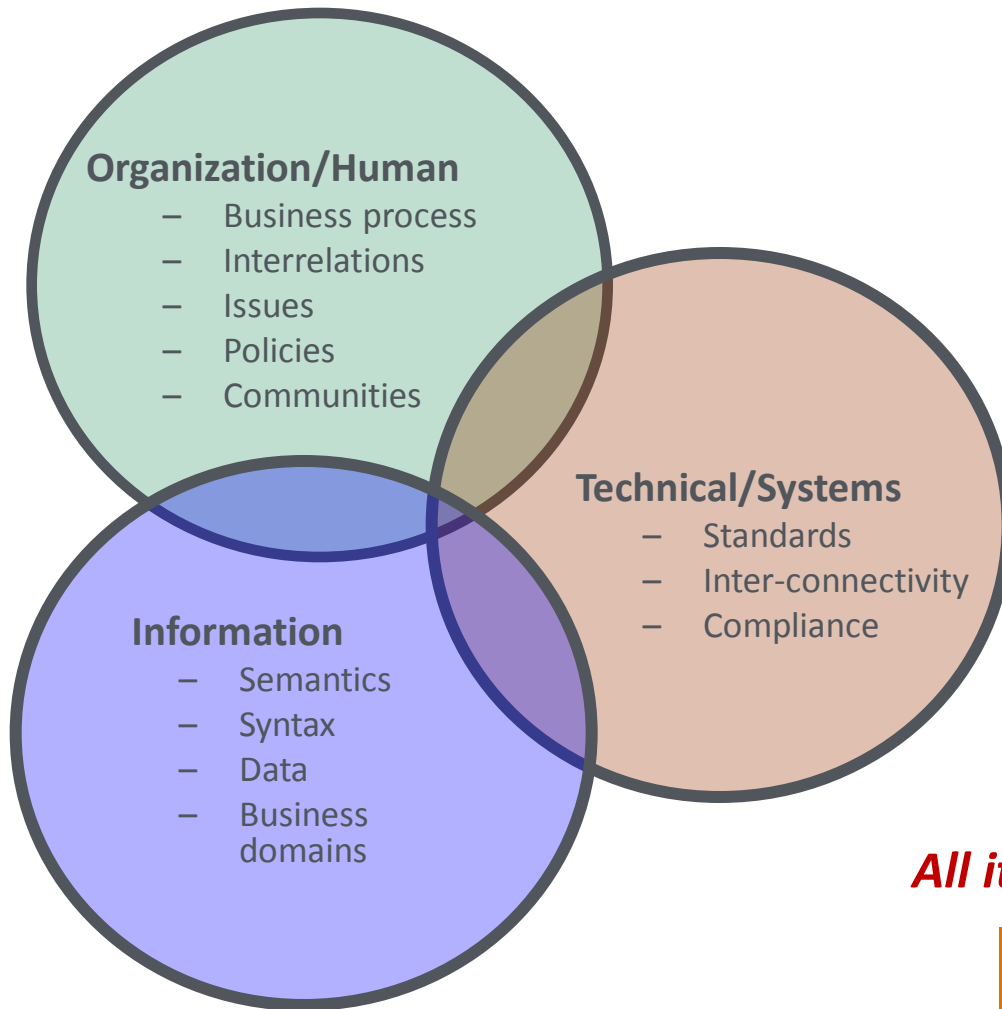
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The solution

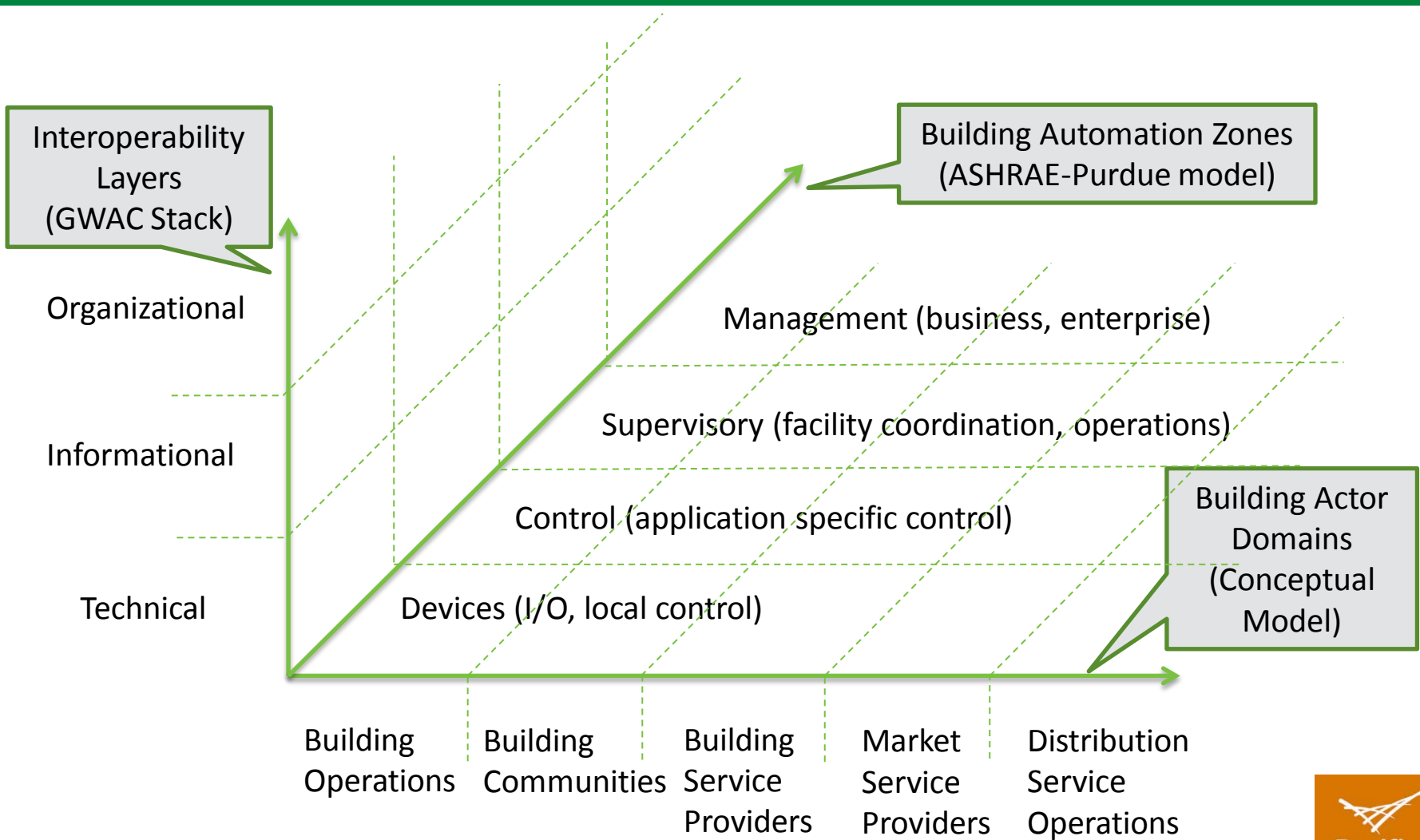


Interoperability - Expected Impact:

- 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

It requires everyone to work together



Transmission services work through market and distribution



Discussion

Thank you!

David Nemtzow

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