

Understanding Technology Enablers for Building Efficiency 2.0

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Agenda

- › Identifying forces and opportunities for growth
- › The new normal: Building Efficiency 2.0
 - › Opportunities in the smart city
 - › Business model innovation
- › Discussion

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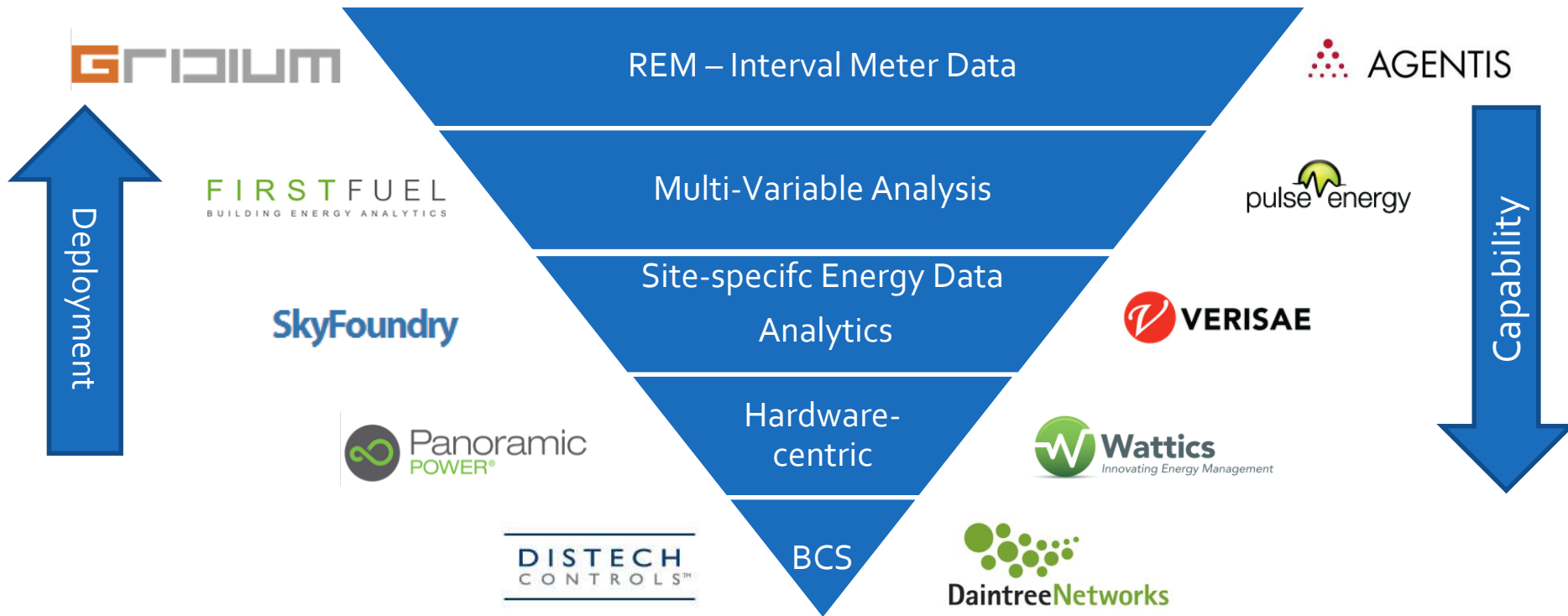
Sustainable Building Materials

Water

Wearable Electronics



Energy efficiency is an expectation, not a disruption



- BEMS has expanded in capability beyond the walls of the building, and now ranges from low-touch rapid energy modelling to wireless control of sub-systems
- Pricing is less than \$0.01/ft² for low-touch tools and under \$0.49/ft² if hardware is



Energy is only part of the equation, and forward-looking companies are targeting the 3-30-300



Energy

- Electricity and other fuels
- Cost = \$3/ft² per year

- **Expense oriented:** to which stakeholders take a reactive approach to reduce energy through efficiency upgrades



Facilities

- Real estate procurement
- Cost = \$30/ft² per year

- **Income oriented:** to which stakeholders take a proactive approach to increase gains
 - Affects top-line revenue
 - Requires firm understanding of business operations
 - Identification and optimization of business processes



People

- Human capital
- Cost = \$300/ft² per year

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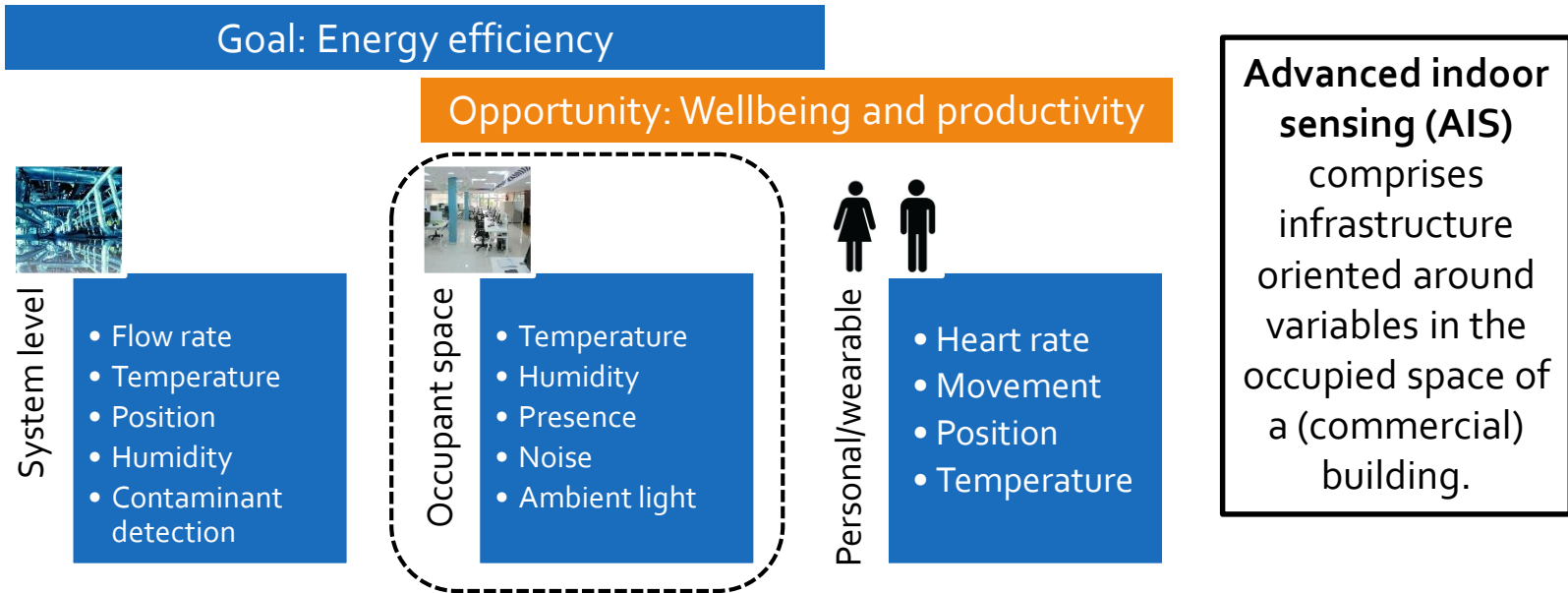


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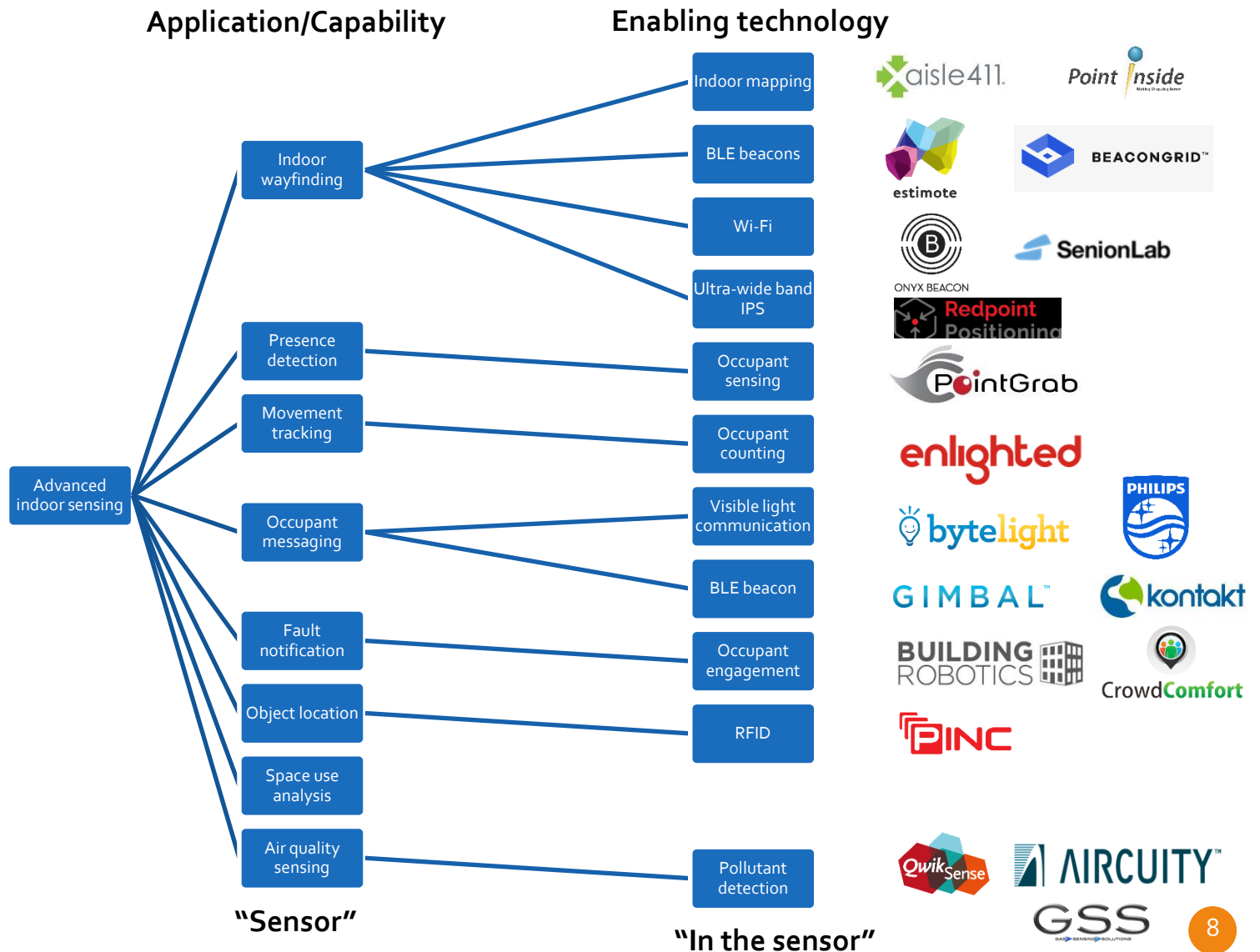
Advanced indoor sensing (“AIS”) enables “top-line” adding activities

Indoor sensing today is focused on the system level targeting energy use

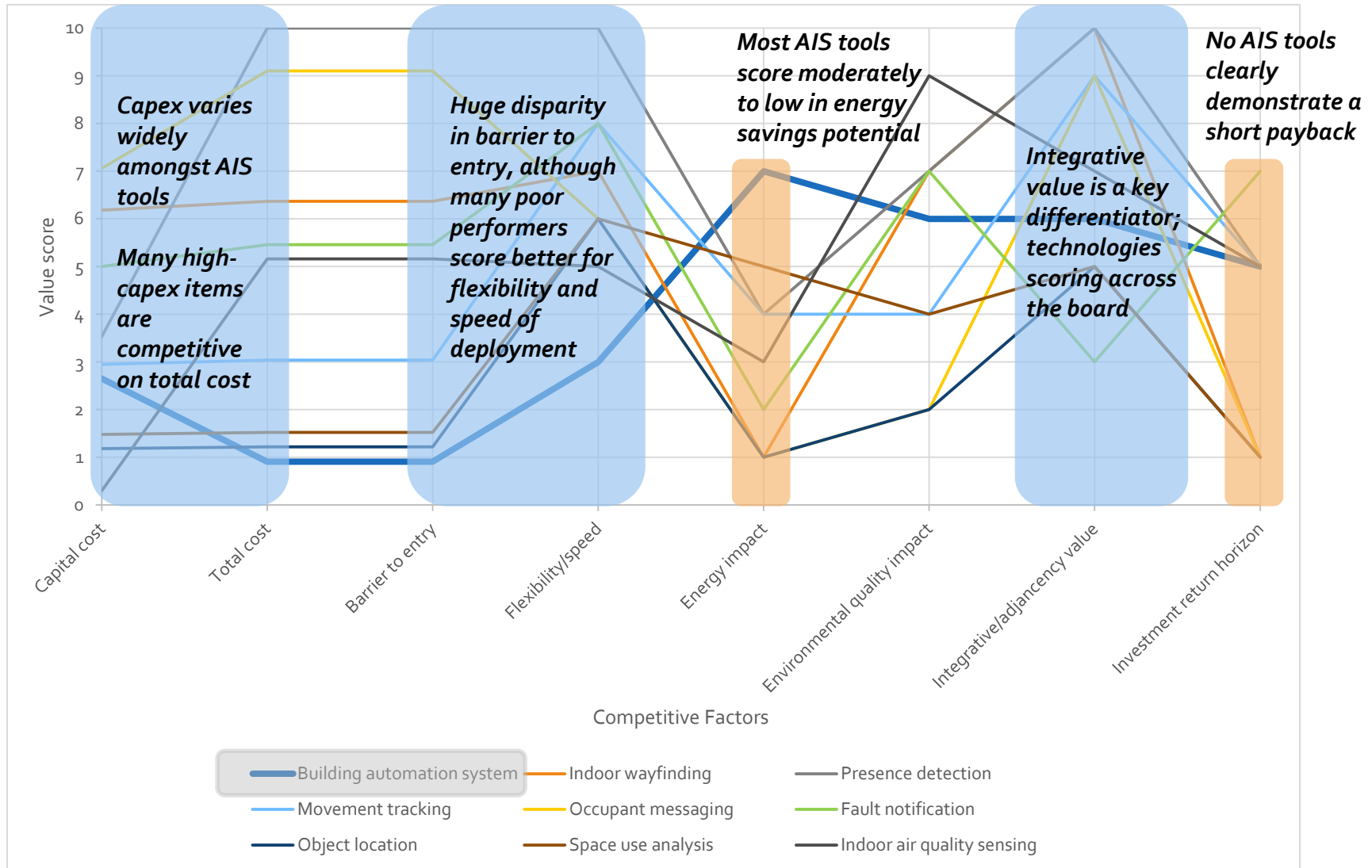


- Buildings are relatively poorly instrumented, particularly in interior spaces
 - Small buildings are most often neglected, often equipped with only temperature sensing
- Granularity is lacking, as most sensors have been placed at the system level in order to target energy use, rather than a personal level
- There is very limited proliferation of “personal” sensors in commercial buildings, beyond common RFID access control tags

Startups are active in almost all aspects of AIS, while large companies are almost absent



Blue Ocean strategy canvas reveals areas offering differentiation among AIS capabilities



AIS drives top-line value, but impact is not uniform across building types

- Advanced indoor sensing is not about decreasing costs, it is about increasing operational value. It is a “top-line” opportunity vs. a “bottom-line” problem.
- Each technology outlined in the AIS toolkit varies in granularity from tens of centimeters to tens of meters.
- Retail is by far the most active segment in experimenting with AIS, and is interesting for these reasons:
 - Brick and mortar stores have not been subject to the same scrutiny as online operations; online retailers are moving back to physical stores for further customer engagement opportunities and deeper analysis at the “point of inspiration.”
 - Retailers are often in a highly competitive environment and thus willing to experiment.
 - AIS solutions, such as those by Aisle411 and Point Inside, offer operational benefits not only to customers but also to retail staff, allowing retailers to double-down on their infrastructure investment.
- Commercial offices have received some attention, but largely around operational and maintenance efficiencies, such as restroom cleaning, recycling monitoring, and space utilization (see Yanzi Networks).



Mapping technologies onto sectors with the most potential for value

- Using a heat map, we can evaluate the disruptive potential of AIS technologies on particular segments (see Figure).
- Warehouses and storage present an opportunity as asset tracking further evolves and can be integrated with building infrastructure
- Hotels present an opportunity for AIS entry:
 - The segment's high energy use (approximately double that of office buildings) allows AIS tech with energy savings potential to present a strong case.
 - Guest comfort is a key competitive advantage; companies like [Entic](#) have demonstrated success in this segment by translating comfort into increased bookings.
- Health care leads in potential, with a particular interest in technologies that enable indoor asset and people tracking.

	Building segment						
	Commercial office	Retail & mall	Education	Warehouse & storage	Lodging	Health care	Food service
Indoor wayfinding							
Indoor mapping and location	4	4	4	4	4	4	4
BLE beacons	4	4	4	4	4	4	4
WiFi	4	4	4	4	4	4	4
WiFi + BLE	4	4	4	4	4	4	4
Ultrawideband IPS	4	4	4	4	4	4	4
Presence detection							
Occupant counting	4	4	4	4	4	4	4
Occupant engagement	4	4	4	4	4	4	4
Movement tracking							
Occupant counting	4	4	4	4	4	5	4
Occupant messaging							
VLC	4	4	4	4	4	5	4
BLE beacon	4	4	4	4	4	5	4
Fault notification							
Occupant engagement app	4	4	4	4	4	4	4
Object location							
RFID	4	4	4	4	4	5	4
RFID (UHF)	4	4	4	4	4	5	4
Space use analysis							
Occupancy sensing	4	4	4	4	4	4	4
Workstation sensors	4	4	4	4	4	4	4
Air quality sensing							
Pollutant sensing	4	4	4	4	4	4	4
	1	2	3	4	5		
	not useful		Incremental		disruptive		

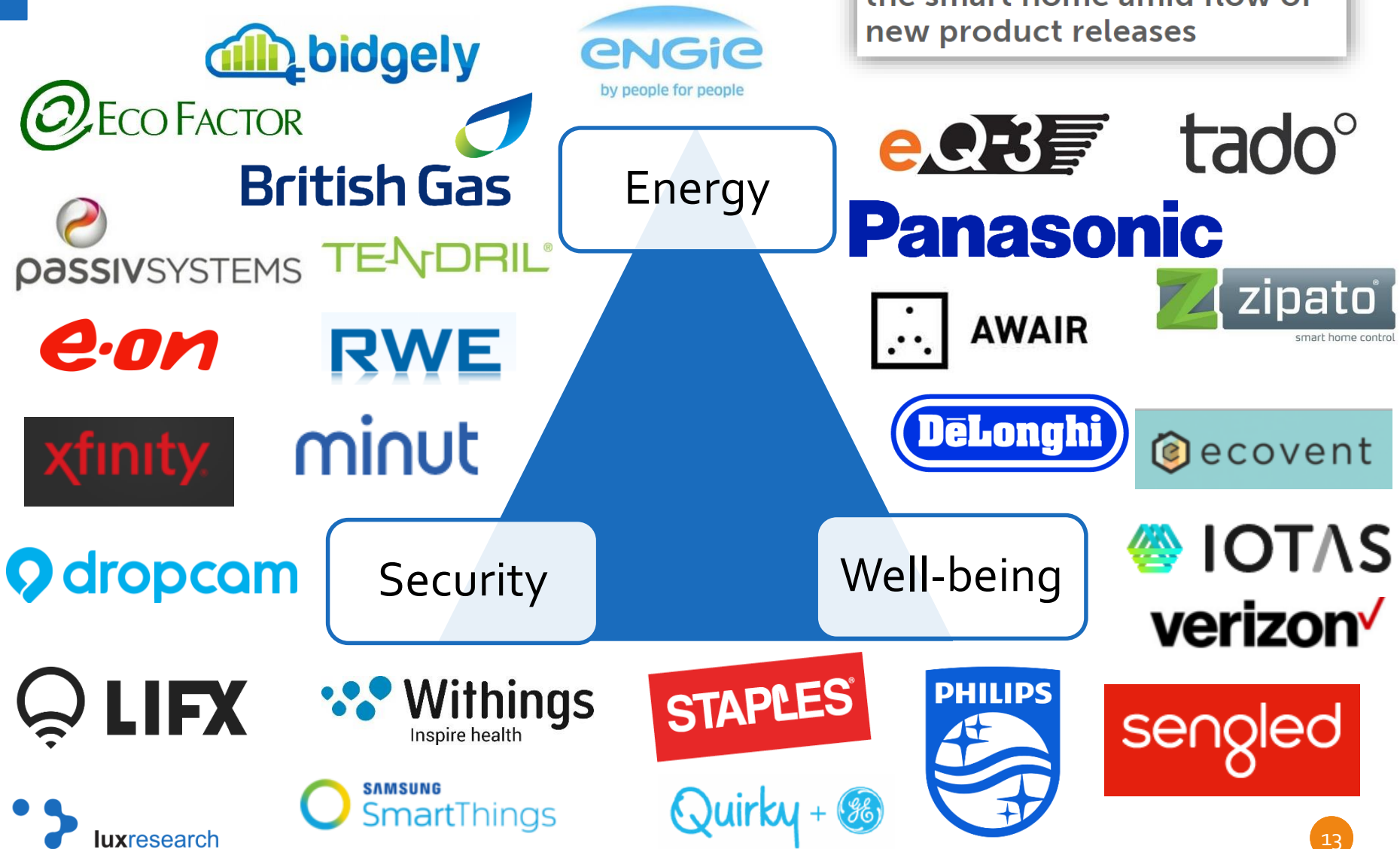
AIS will succeed in the same way as the smartphone: Open up robust sensor capabilities and scale

- The blue ocean canvas shows that most variation is in costs and barrier to entry; therefore, companies should work toward solving a winning platform using a two-pronged approach:
 - **Create volume.** Economy of scale helps reduce sensor costs.
 - **Exploit “sensor fusion.”** Leverage existing sensors for as many applications as possible, sharing total costs and lowering overall barriers for entry for new applications.
- To do this successfully, such an offering must:
 - Target *multiple applications* at once (i.e. not just energy, but also not just air quality); these should be segment-specific and address the most pressing pain-points
 - Build a *versatile sensor platform* that other companies can also use (i.e. form partnerships across sensor capabilities and applications)
 - Find business models and deployment methods to *lower the barrier* to installing sensors (e.g. integrate with lighting, or finance as part of an energy retrofit)
- One case study of this is Enlighted:
 - Has scaled to over 100 million ft², and has built its OccupancyONE platform and is now actively seeking partners to build applications to leverage its data on presence, movement, and environmental sensing

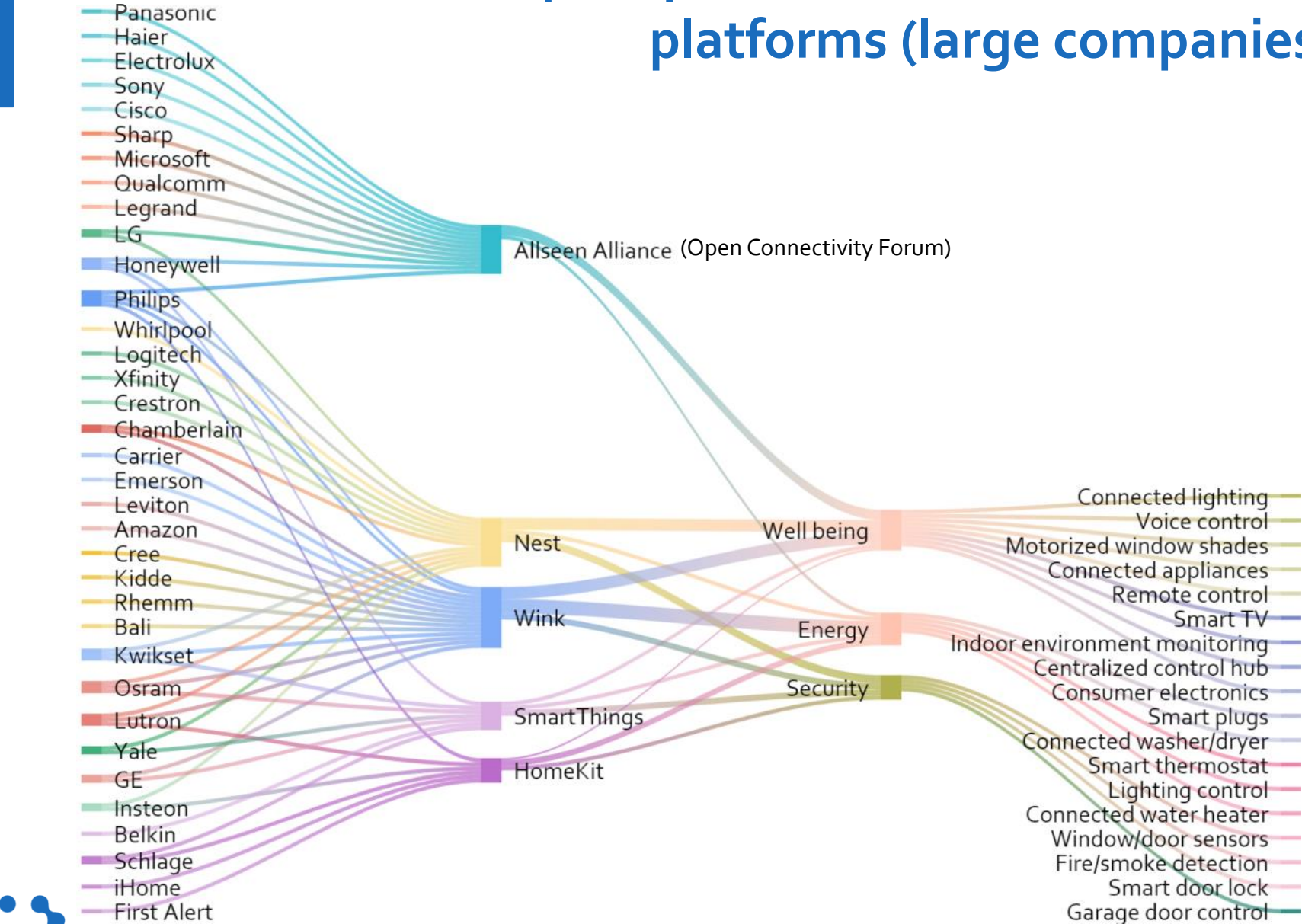
The logo for Enlighted, featuring the word "enlighted" in a lowercase, red, sans-serif font.

Smart Home: Value propositions are converging in a crowded landscape

CES 2016 declared the year of the smart home amid flow of new product releases

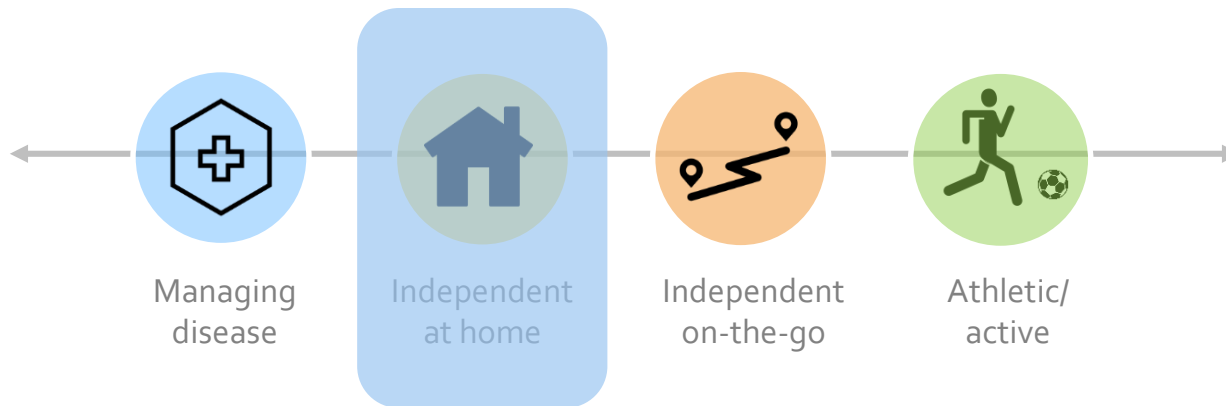


Partnership map for dominant smart home platforms (large companies)



The “over 60” population is rapidly growing, but they have different needs

- There is no single type of seniors
- The needs of the elderly population can be mapped on a spectrum:

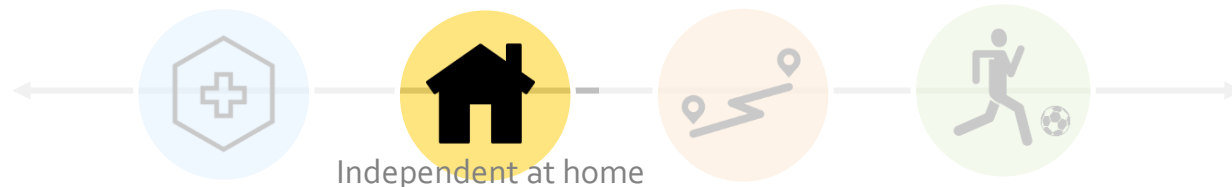


Source: Across the States 2013: Profiles of Long-Term Services and Supports

There are several approaches to enable seniors to be independent while at home

- Some technologies utilize physiological tracking. *dorsaVi* is an example of such a technology.
- **Environmental monitoring**, which can arguably achieve "senior monitoring" in a less invasive way and can address social stigmas in adopting and using medical alert systems. Within environmental monitoring, approaches include *load disaggregation*, *smart plugs*, *wearables*, and *multi-function sensors*.
- Questions for consideration include: how to identify times at which the senior is not well? How to seek the right type of help at the right time?

Company	Product	Price (\$USD)	Data collection approach				Connectivity	Origin	Stage of development
			Load disaggregation	Smart plugs	Wearables	Multi-function sensor			
Intelesant	Howz	\$290	●			●	Hub + ethernet	U.K.	Development
Lively	Lively safety watch (+ hub)	\$50 + \$35/month			●	●	Hub + 3G	U.S.	Scale (acquired by GreatCall)
Silverline	TBC	TBC		●	●	●	TBC	Singapore	Development
Sen.se	Mother	\$310 hub + \$30 sensor				●	Hub + Ethernet	France	Introduction
Notion	n/a	\$200 (three sensors)				●	Hub + WiFi/BLE	U.S.	Development
Minut	Point	\$120				●	WiFi	Sweden	Introduction
Limmex	Emergency watch	\$550-\$1,000 + \$20/month			●		GPS + GSM	Switzerland	Introduction



Adjacent opportunity in connected buildings: The “Last Mile” of air quality

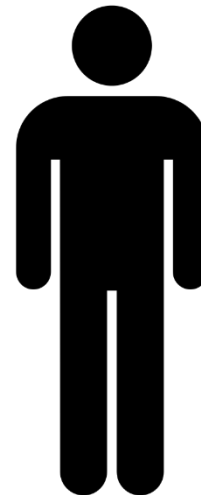


Source: Studio Roosegaarde



Delivering the Last Mile depends upon a services component that connects air quality to results

- Consumers are demanding better houses; 65% believe they will live in an automated home in a decade¹
- **Key Gap:** Few if any *air quality services*; consumers need help
- Consumers in the U.S. spend an average of \$110/month on home utilities alone, and much more for additional services, such as \$130/month cable and internet access



Commodity providers are well positioned to develop a Last Mile air quality offering

Thank you



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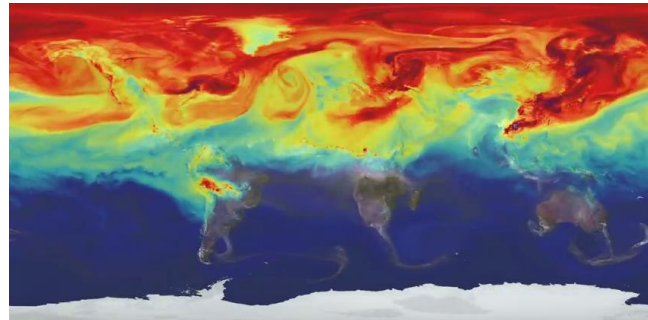
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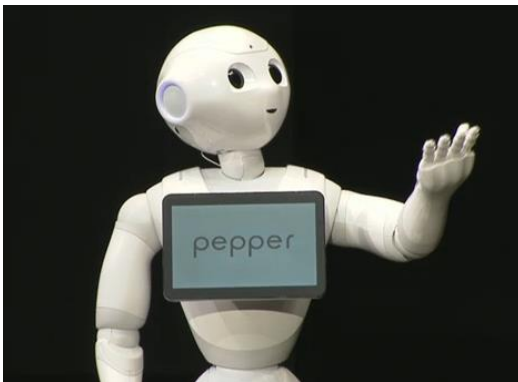
Appendix



Mapping global megatrends point to resources, health, and connectivity



Source: NASA Goddard



Source: SAPhana

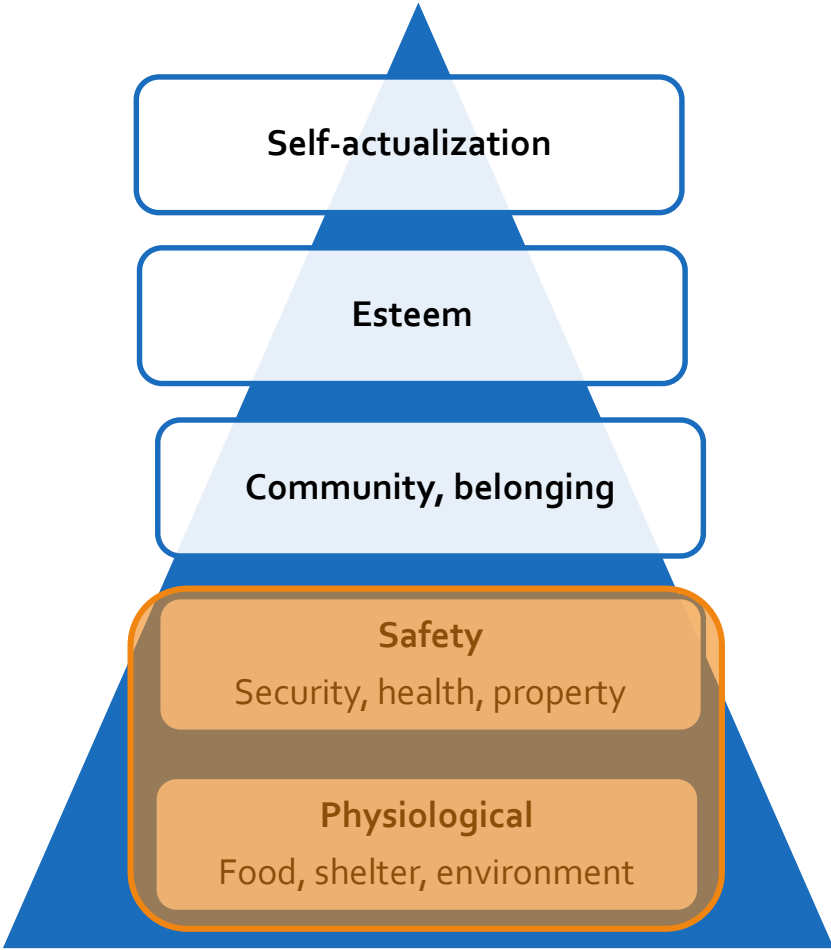


Source: FastCompany



Addressing the core “needs” is a moving target

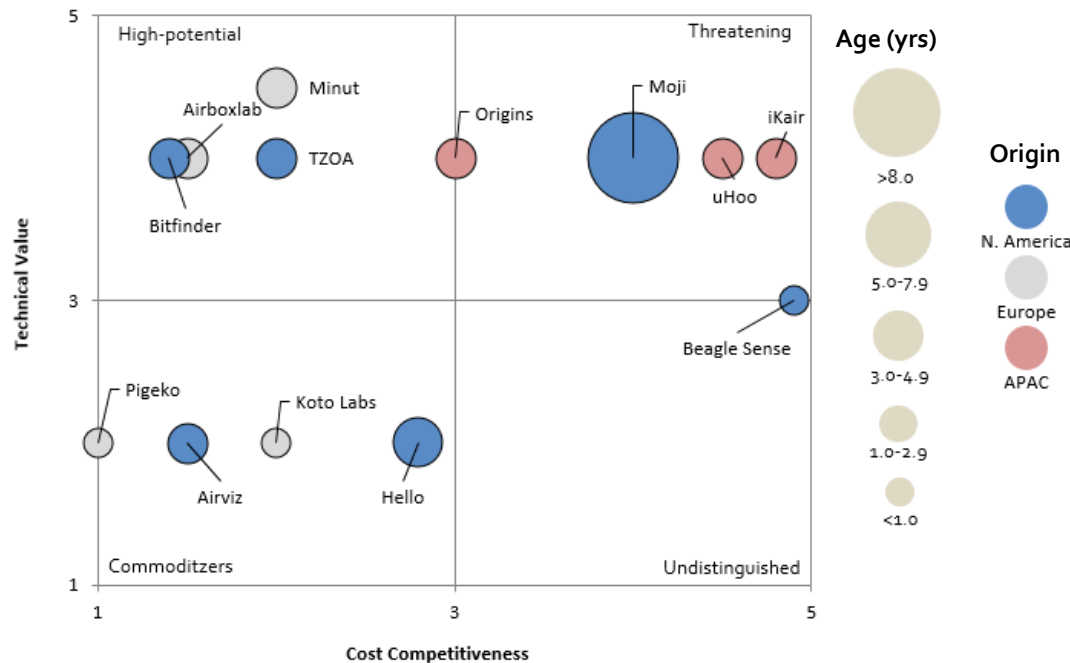
- Changing demographics
- Climate changes
- Urbanization
- Resource scarcity
- Health and food security
- The connected world
- Globalization
- Empowerment of the individual
- Automation



Each component of the “Last Mile” depends on technical partnerships

Pollutant identification

Purification



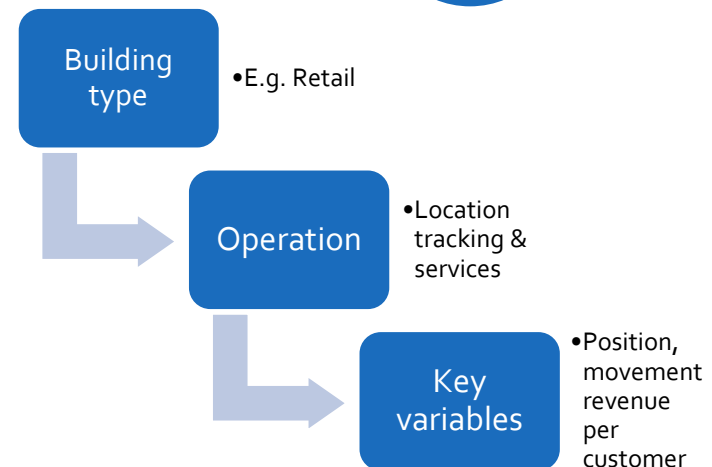
LIGHTAIR
Air purification for life



Credit: MoLEKULE

Deploying AIS is key to improving building and business operations

- Advanced indoor sensing provides data that gives facilities better understanding of *interactions*.
- Buildings have many “actors,” which can broadly be grouped into two categories:
 - People – visitors, workers, occupants
 - Goods – supplies, products, etc.
- Quantity and rate of interactions varies by building type
- For a given building type, it is imperative to understand these interactions, and which ones drive value and which incur cost:
 - Example: Nurses in a hospital environment spend one hour (on average) per day locating medical supplies and equipment
→ asset tracking and indoor location could be used to reduce this



There is no silver bullet among AIS technologies, but some clearly stand out

› Clear winners:

- › Presence detection and occupant messaging are not very costly and are easy to install.
- › They provide immediate and clear value in the building.

› Promising upcoming sensor applications:

- › Indoor air quality sensing has clear and immediate value, but the costs must come down and installation must be streamlined.
- › Indoor wayfinding has clear value when integrated with functions like presence detection and object location; this opens up opportunities for integrators there.
- › Building automation systems can be disrupted by simpler low-cost systems that are easier to install and operate.

› The strugglers:

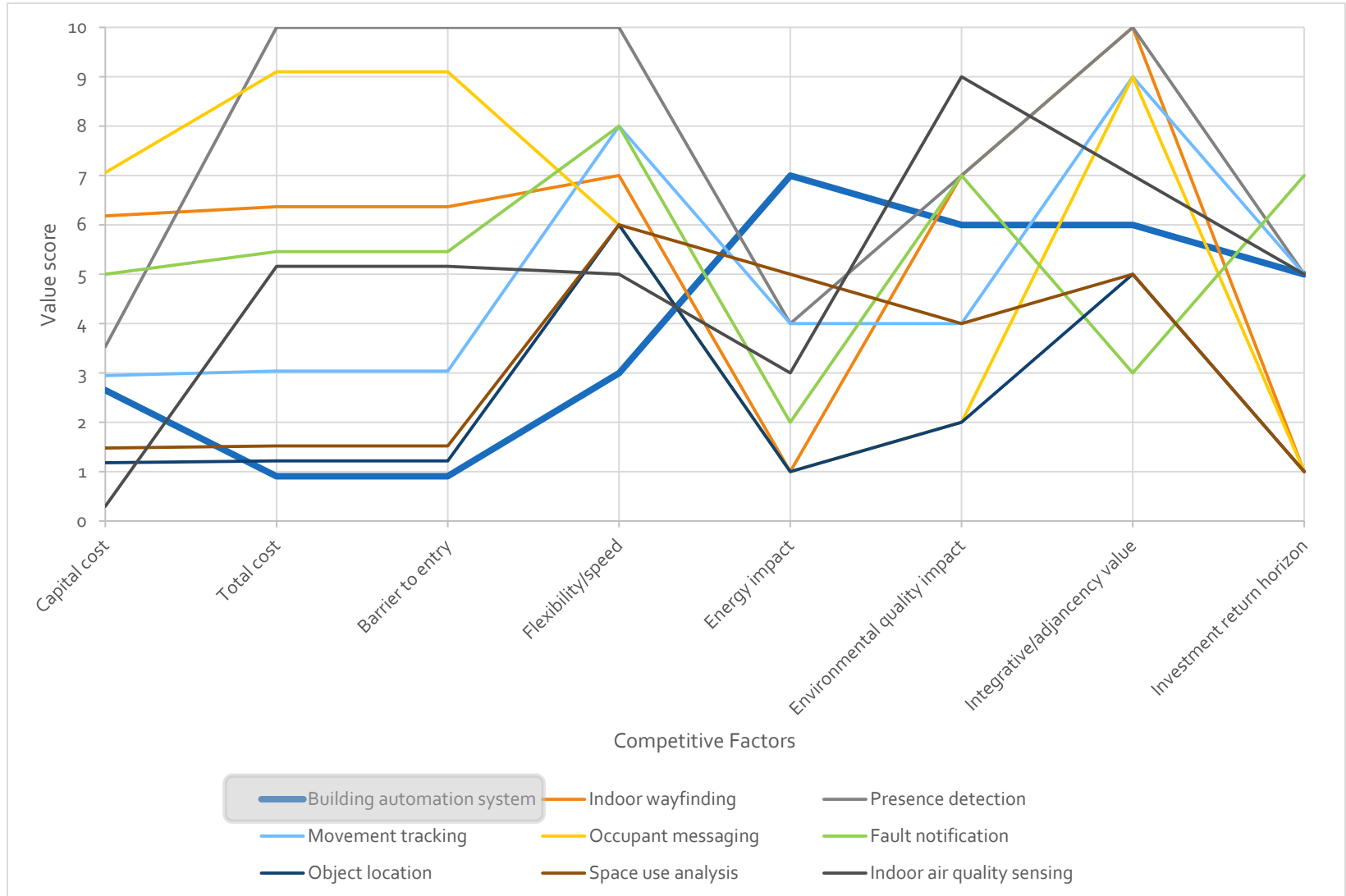
- › Object location struggles with high costs and limited utility, but could present promise for segments (e.g. health care) where this is a key concern.
- › Space use analysis depends upon extensive sensing infrastructure, which carries a high cost. Due to sparsity of offerings, pricing for such “apps” is not yet clear.

The blue ocean strategy canvas provides a framework to assess the AIS capabilities

- There are many technologies under the umbrella of AIS focused on extracting additional data from occupied building spaces.
- Some of the capabilities of AIS technologies are related to, or extensions of, conventional sensing technologies, such as those used for building automation.
- To evaluate the utility and disruptive potential of AIS applications, we have used a blue ocean strategy canvas, using several criteria related to cost, energy, deployment, and value enablement.
- For each AIS capability, we have conducted extensive primary and secondary research.

Category	Competitive factor
Cost	Capital cost
	Total cost
Energy	Energy savings potential
Deployment	Barrier to entry
	Speed/flexibility
Value	Integrative/adjacent value
	Environmental quality impact
	Investment time horizon

Blue ocean strategy canvas shows AIS capabilities diverge relative to conventional sensing



Stack Labs

Connected light bulbs with embedded occupancy and daylight sensors for residential and commercial buildings

› Technology and differentiators:

- › LED lighting with integrated environmental and occupancy sensing, based on RF motion sensing
- › Differentiates against other sensing networks by its advanced data processing and machine learning algorithms which enable multiple potential use cases; novel occupancy sensing using RF instead of widely used passive infrared

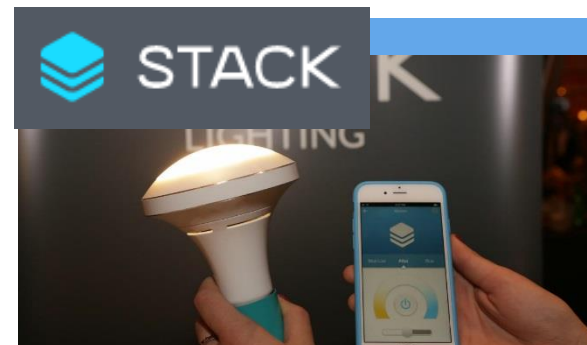
› Strategy and markets:

- › Last funding round was in November 2015 and planning to raise between \$12 and \$15 million in the near term (total amount is undisclosed)
- › Targeting lighting control, security, elderly care, and analytics

› Recommendation:

- › Engage with Stack for potential partnerships, use case development, or technology licensing; Stack's technology can enable multiple use cases in both residential and commercial applications that go beyond lighting control but leverage the existing lighting infrastructure

Lux Take:
Positive



Summary information

<i>Founded in</i>	2013
<i>Location</i>	Cupertino, USA
<i>Revenue</i>	\$75,000 (est.)
<i>Key partners and backers</i>	Lunera, undisclosed investors

Key metrics

<i>Unit cost</i>	\$35-45/LED bulb
<i>License fee</i>	\$0.02-0.03/ft ²

Image credit: CBS Interactive

PointGrab

Occupant monitoring in commercial buildings using edge-analytics sensing technology

› Technology and differentiators:

- › CogniPoint sensor uses imaging, PIR sensor, and onboard ARM processor, with various wireless communication options; power source can be AC, DC or PoE
- › Capable of gathering granular occupant and activity information, with a coverage area of 500 ft²
- › Does not transmit images or video, only event data

› Strategy and markets:

- › Recently raised \$5 million in equity investment from ABB Tech Ventures, EcoMachines Ventures, and Flex Lab IX
- › Installed in 27 million CE devices to date; expanding building automation applications via an API (40 apps)

› Recommendation:

- › Clients interested in indoor sensing are advised to monitor PointGrab; its technology delivers building occupant distribution and commercial space analysis to improve building management, performance, and operations
- › Company is planning to begin commercial sales in Q4 2016, but pricing is not yet disclosed

Lux Take:
Positive



Summary information

<i>Founded in</i>	2008
<i>Location</i>	Israel
<i>Revenue</i>	\$0
<i>Key partners and backers</i>	ABB Tech Ventures, Flex (Flextronics)

Key metrics

<i>Unit cost</i>	TBA
<i>Power requirement</i>	0.1-1.0 W (standby/active)

Yanzi Networks

IoT sensor network for commercial building facility management applications

› Technology and differentiators:

- › Suite of sensors which gather data for informing building operations; use cases include climate monitoring, light surveillance, and space utilization analysis
- › Core value proposition is one of reducing capex and maintenance costs, which are significant considerations in commercial buildings

› Strategy and markets:

- › Received \$3 million in funding from government sponsored fund in Sweden, currently planning to raise additional funding from investors outside of Sweden
- › Targeting existing commercial office buildings, working mostly through facility management companies

› Recommendation:

- › Approach Yanzi with interest, the company is making progress in quantifying the value of advanced indoor sensing; the results of its pilots will be a strong indicator of the viability of its offering to the broader commercial buildings market

Lux Take:
Wait and See



Summary information

<i>Founded in</i>	2009
<i>Location</i>	Sweden
<i>Revenue</i>	\$100,000 (est.)
<i>Key partners and backers</i>	Coor, IBM, Intel
Key metrics	
<i>Unit cost</i>	\$30-50/sensor
<i>SaaS fee</i>	\$0.06/sensor/year

Image source: Intel