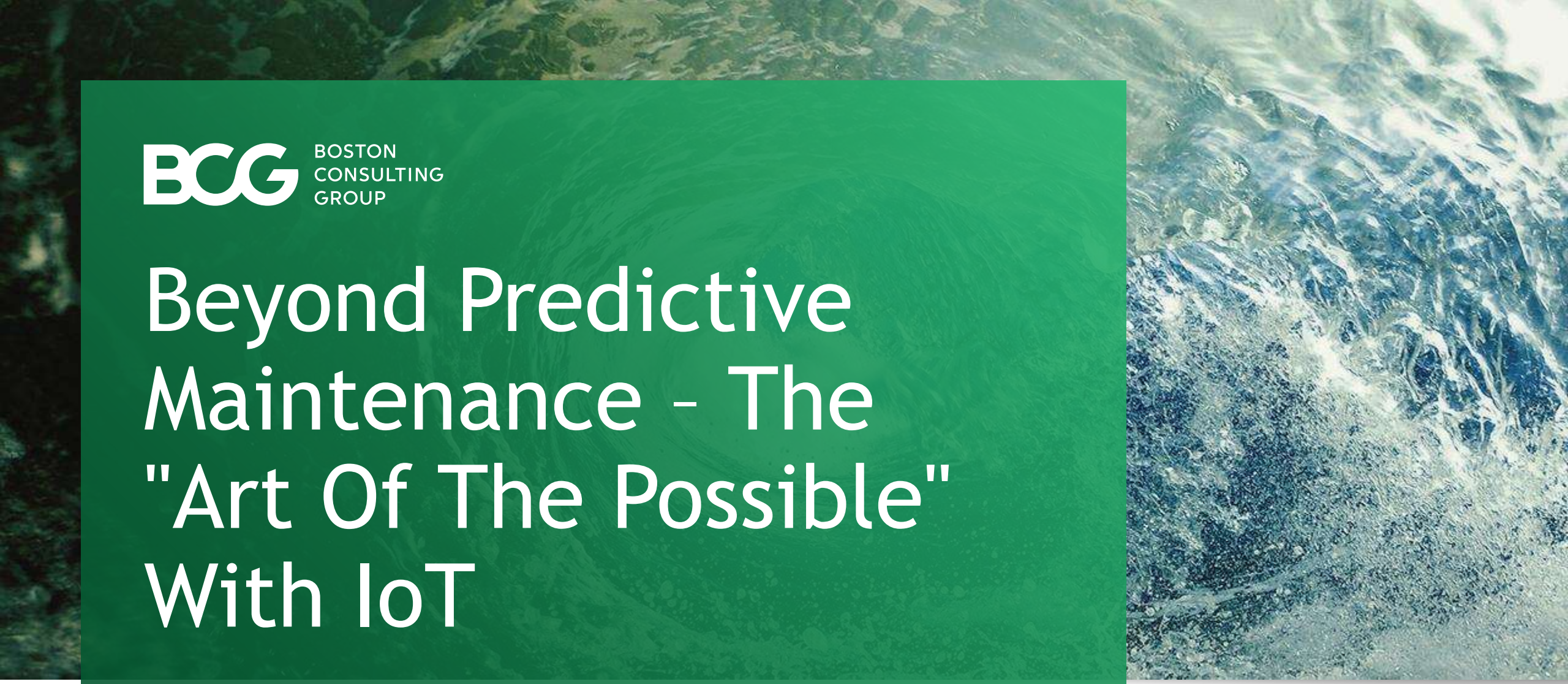


BOSTON CONSULTING GROUP

Beyond Predictive Maintenance – The "Art Of The Possible" With IoT

Key use cases and success ingredients in Enterprise IoT

OCTOBER 30, 2019

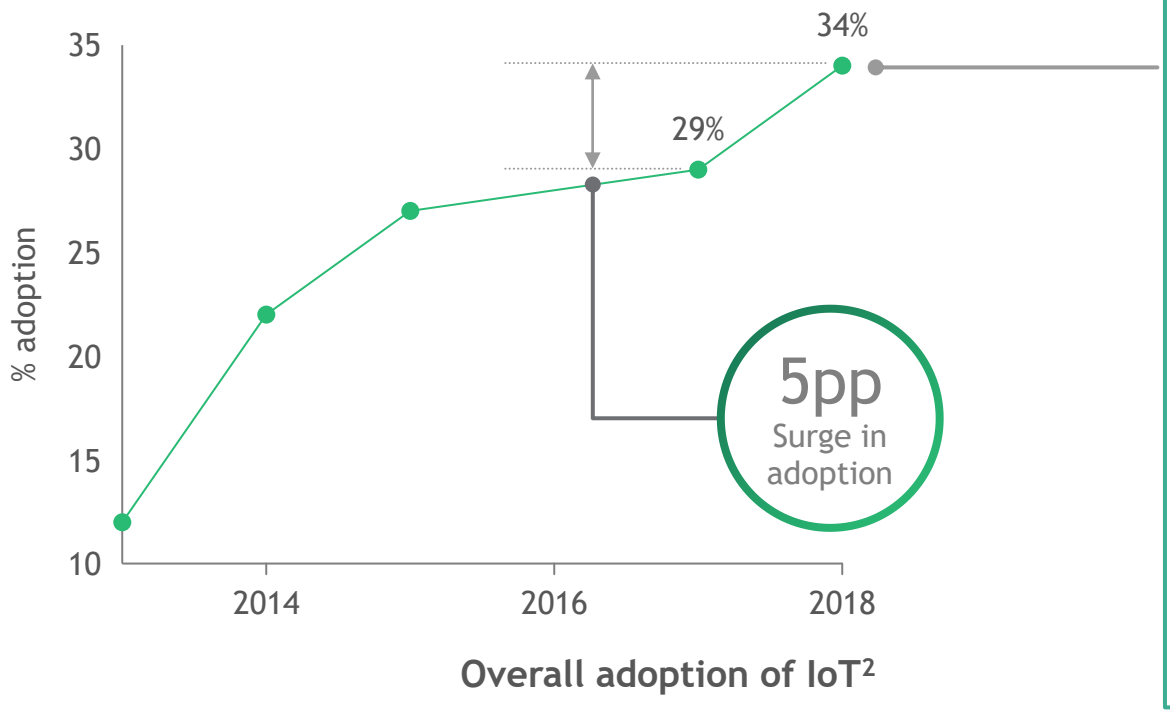
IOT SOLUTIONS WORLD CONGRESS | THE LEADING IOT INDUSTRY EVENT

Contents

State of the market

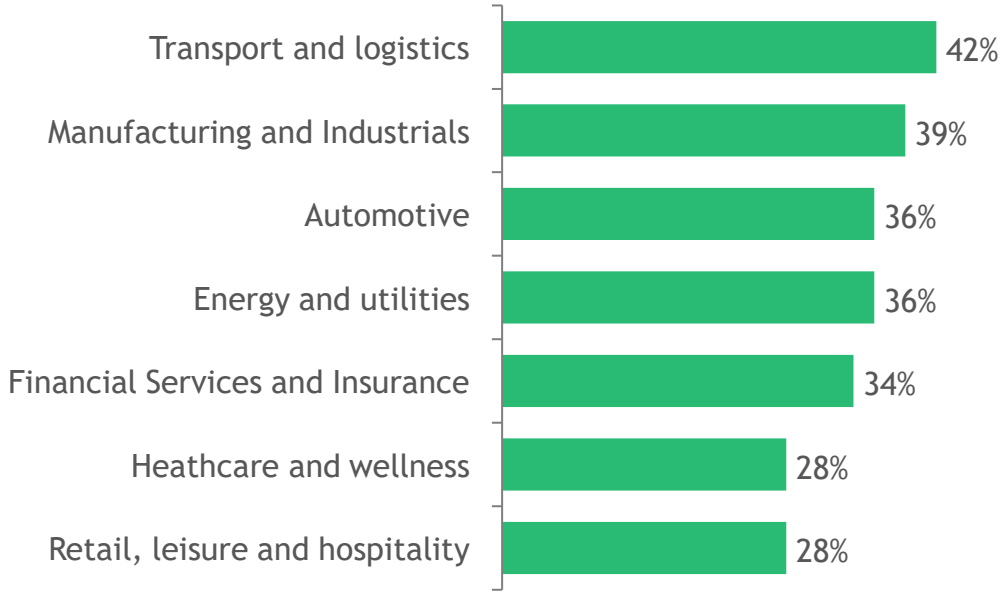
State of the market: Adoption continues to grow across verticals

… IoT adoption is continuing to increase …



Overall adoption of IoT[2]

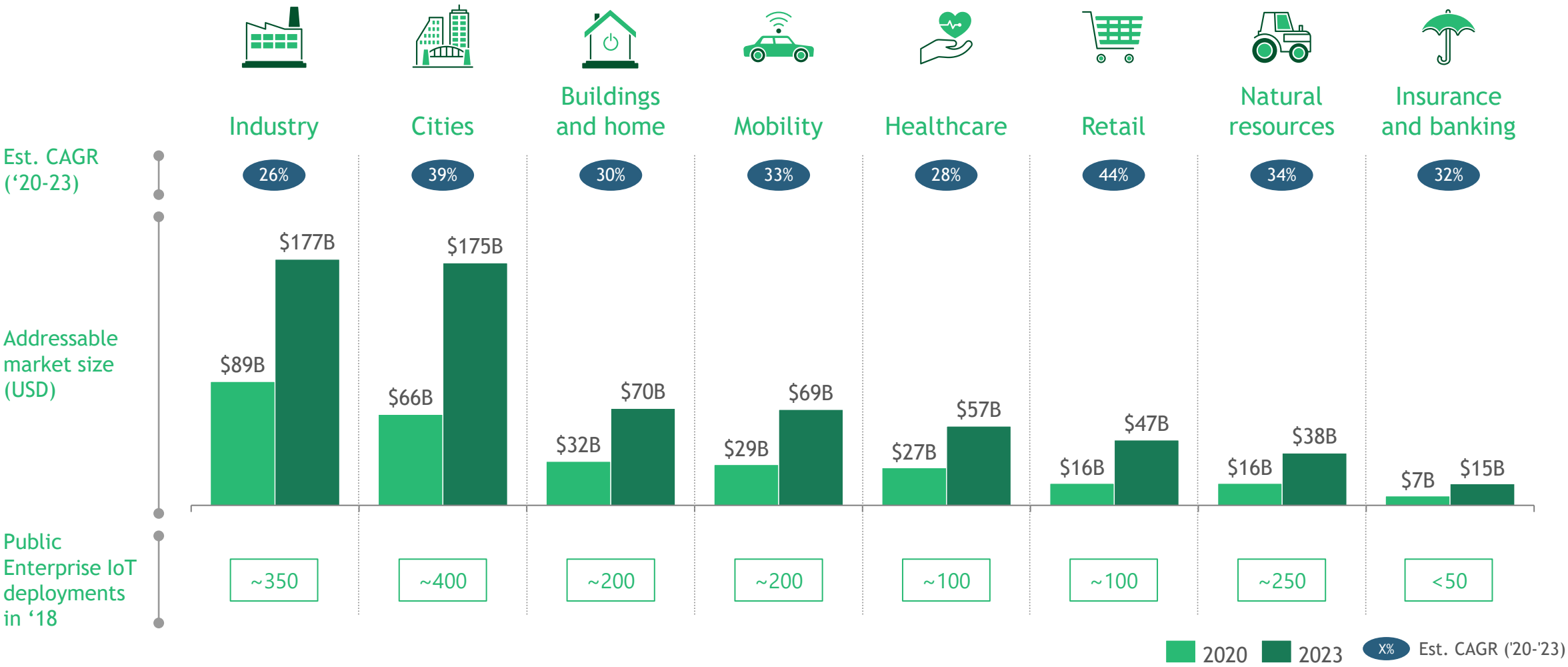
… approaching critical mass in most industries



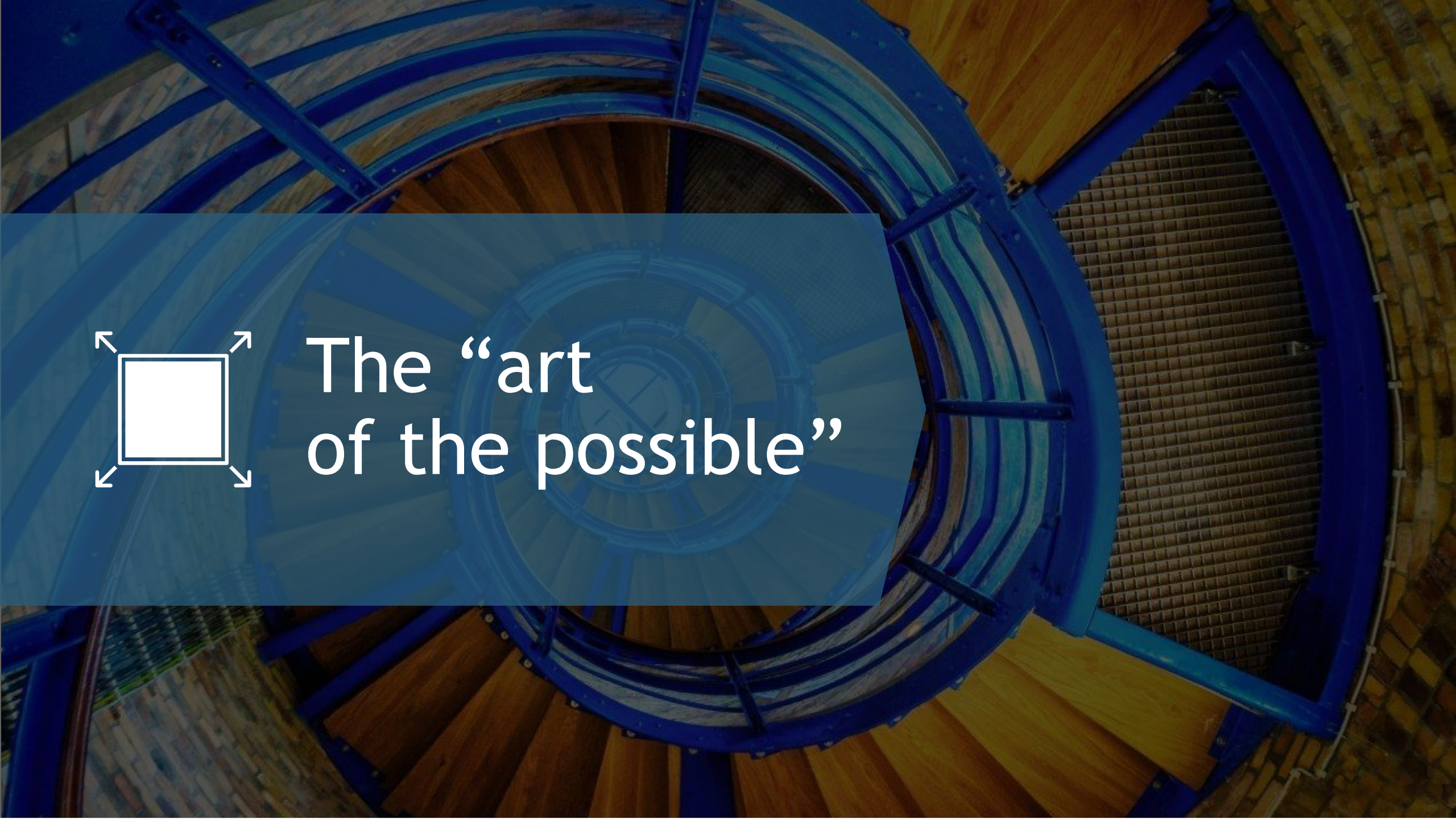
Adoption of IoT by industry[2]

1. Based on 1,845 respondents from mid-market & enterprise companies in 2017 2. Based on core sample of 1430 respondents
Source: Cisco 2017 survey of 1845 IT decision-makers, Vodafone IoT Barometer 2019, BCG analysis

Enterprise IoT market estimated to grow strongly across domains



Note: Number of Enterprise IoT projects rounded to closest 50. Supply chain projects assigned between Industry and retail/consumer goods
Source: BCG market model, IoT Analytics database of 1600 public IoT projects, BCG analysis



The “art of the possible”

Moving beyond predictive maintenance—there is a whole new world in IoT

	From	To
Value	Cost and efficiency	New revenue streams, safety, customer intimacy and improved experiences
Business models	Connected or smart products	New business models and services, platforms and data, increasingly outcome based
Technology	Sensors and connectivity	IoT incorporating AI, Blockchain and other advanced technology
Value chain	Point solutions	Larger connected systems across entire value chains
Environments	Equipment, buildings and manufactured objects	Increasingly being deployed in natural environments like agriculture, conservation, etc.
Impact on us	Business processes	Increasing prevalent in leisure, safety and smart city environments

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“Art of the possible”: Multiple examples in production already

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Penske & Shell created new revenue streams with fleet mgmt. and construction equipment tracking

Customer discovery

Coke’s freestyle machines allow it to develop new flavors based on customer preferences

Customer experience

Rebecca Minkoff smart mirror

Carnival's guest experience via sensors+wearable

Improving safety

Guardhat for worker safety guidance at work sites

Wellness

Hospital beds to reduce ER wait

Tracking elderly patients

Seating new business models in industries

Connected things

Diabetes mgmt

Connected lighting

Cyber tires

Services

Michelin's Fleet management services

Medtronic care mgmt services

Platforms

Domain experts offering their core tech as platforms

Manufacturing

Retail

Outcomes

Refund on train delays

Guaranteed energy saving

Medication adherence

Data

Companies monetizing the data IoT creates

Synergistically building on other advanced tech

Advanced endpoints

Exoskeleton for rehabilitation

Drones for insurance adjustment

AR/VR/Vision

In truck cameras + AI

Porsche's remote support for techs

Enhanced CX for dirtbike owners

Virtual patients to reduce large incisions

Blockchain

BC-based data monetization

Food quality management

Luxury goods authentication

Threading previously unconnected domains

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VW fleet sensors send reliable weather data to Tennet for grid load optimization

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Utilities have partnered with smart home devices for Demand Response & new services

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Dental insurance

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Conservation

Illegal logging

Tuna traceability

Endangered species

Honeybee research & health monitoring

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EpicMix app registers skier activity at resort

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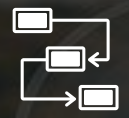
Key Success Ingredients

Six key enablers of success in IoT found from recent BCG survey

Business strategy and rationale

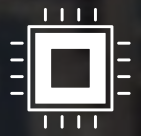
Leadership and org model

Talent



Operations and core business processes

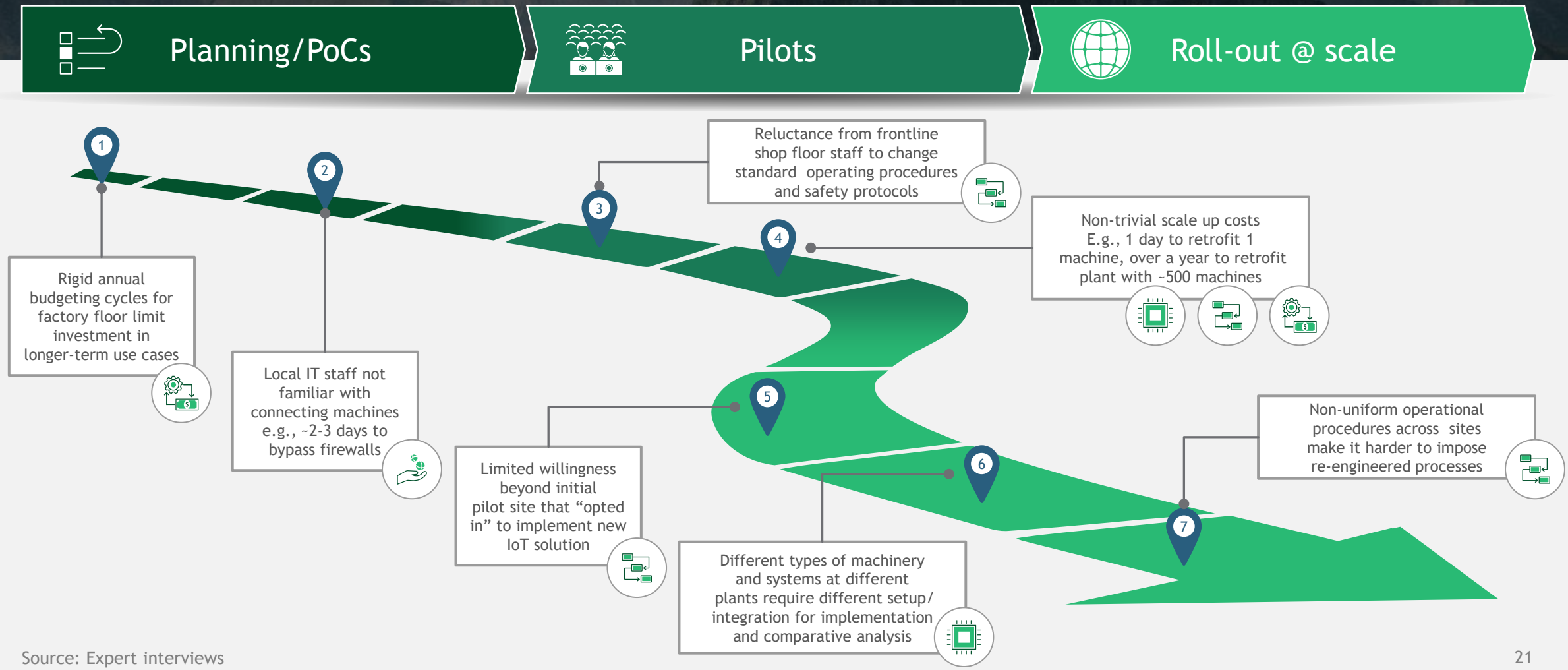
Partnerships and ecosystem



Technology

Several friction points along customers' IoT journeys

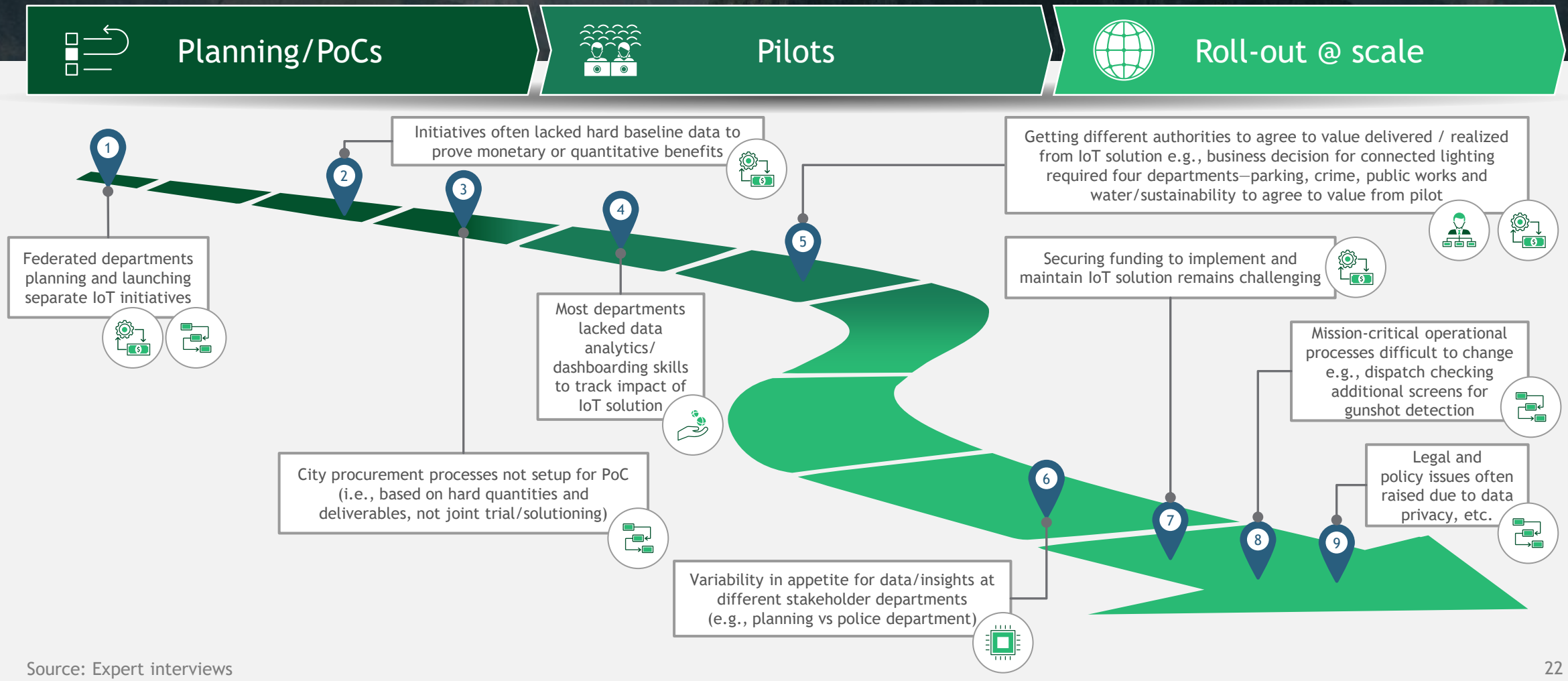
Example 1: Challenges at mid-sized manufacturing company



Source: Expert interviews

Several friction points along customers' IoT journeys

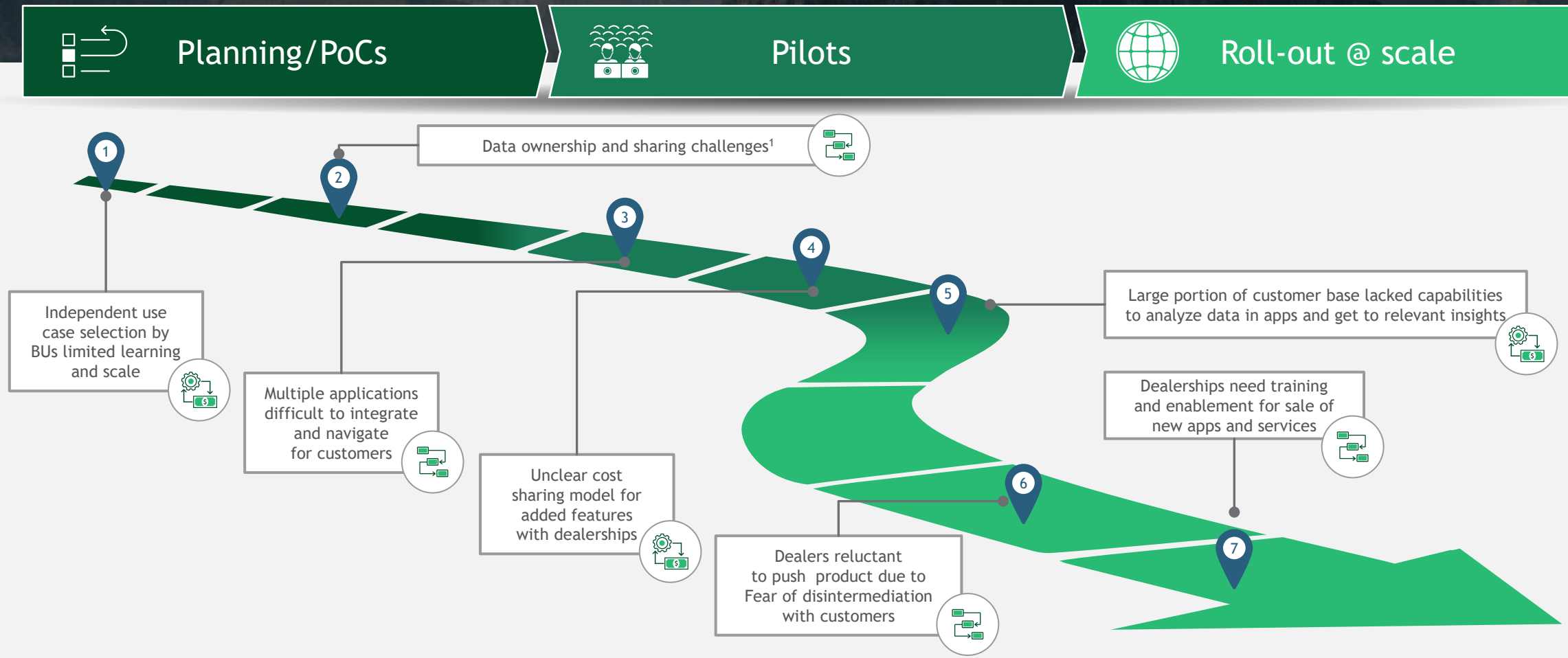
Example 2: Mixed results for Smart City initiative at major US city



Source: Expert interviews

Several friction points along customers' IoT journeys

Example 3: Slow progress, channel conflict at heavy equipment manufacturer

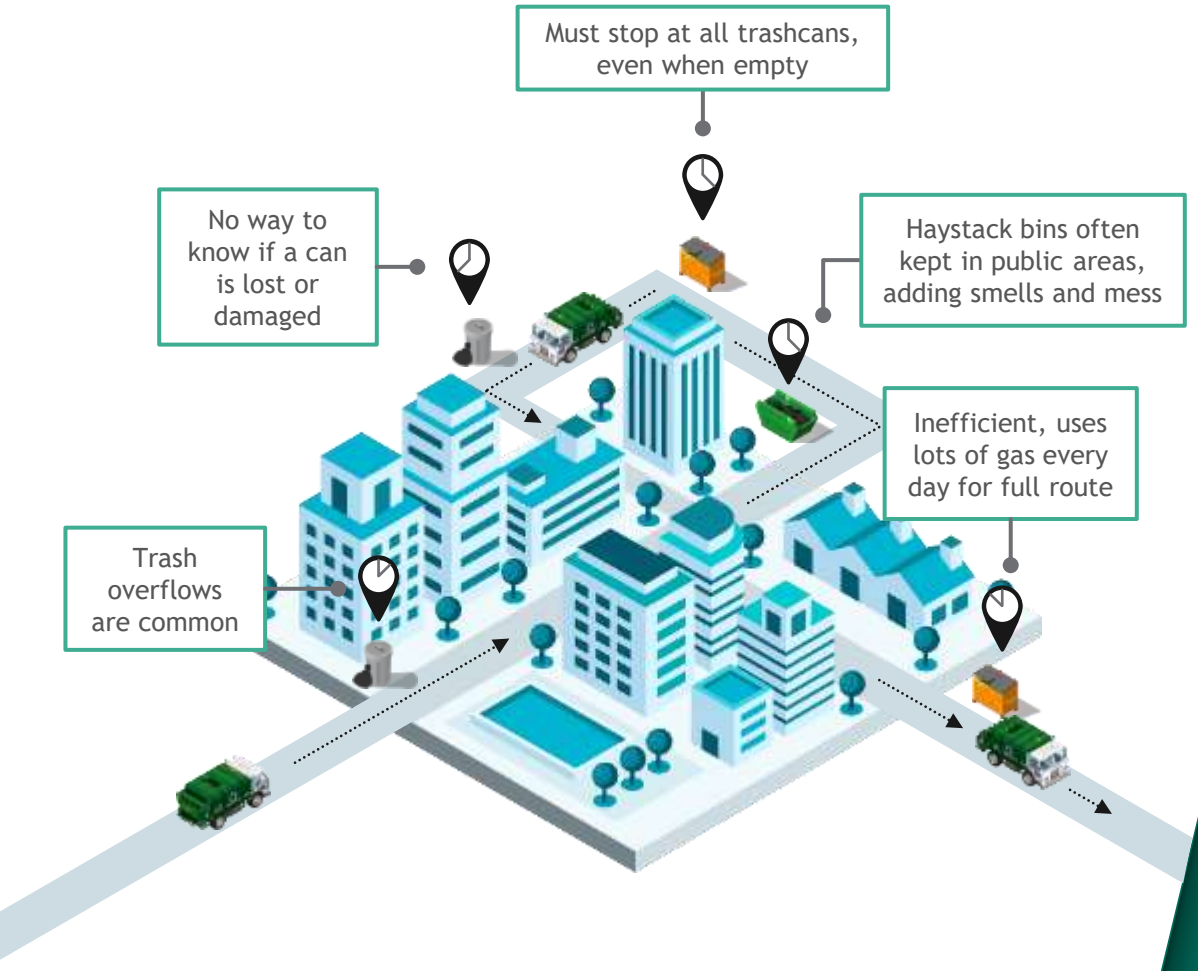


1. Dealers unwilling to share data from assets with key partner focused on Machine Learning from data
Source: Expert interviews

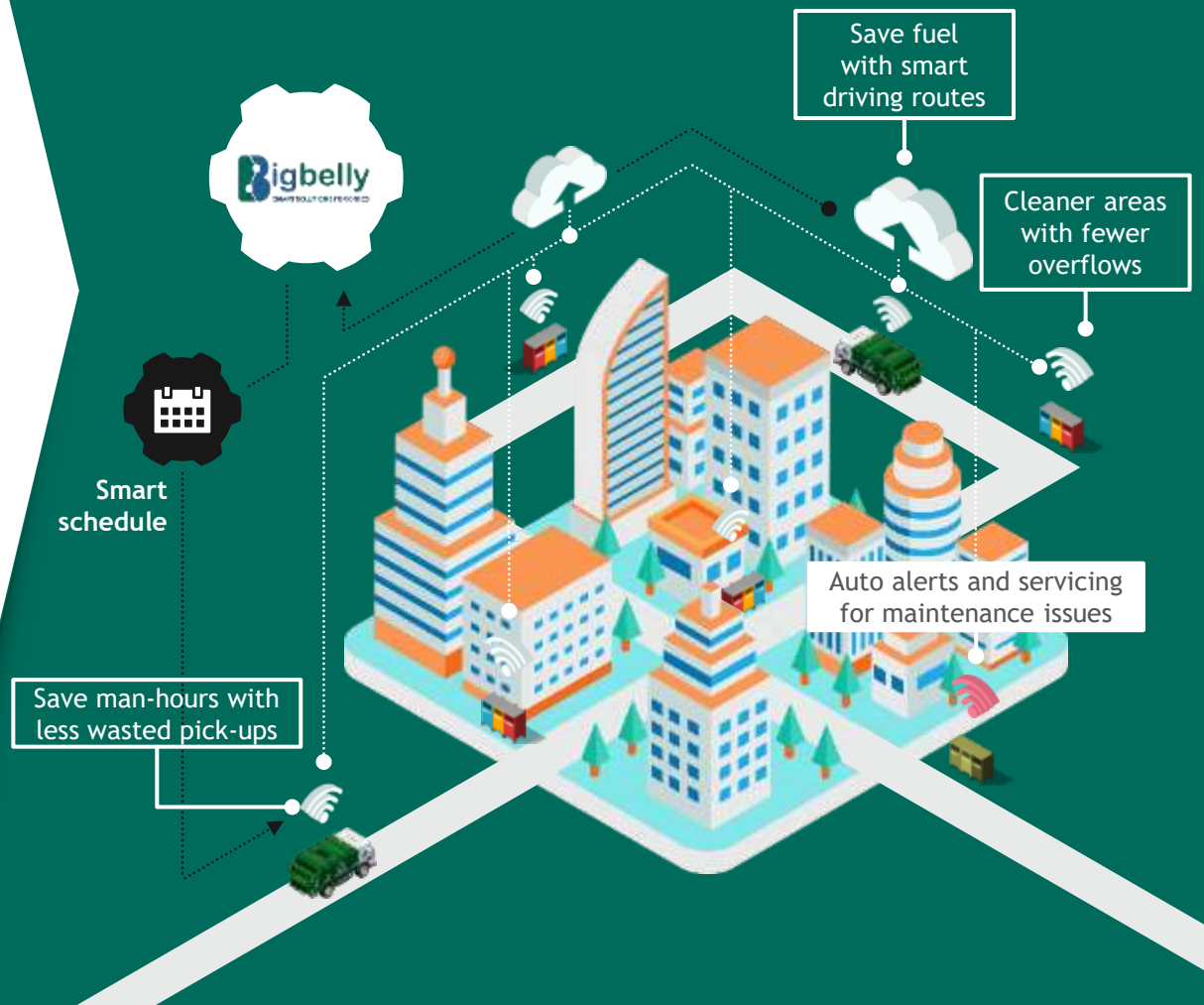
Case studies

Trash-as-a-Service based on BigBelly's smart bins

Traditional



With Trash-as-a-Service



Success ingredients—BigBelly

Business strategy and rationale

- Business model pivoted from hardware investment to trash-aaS ($3-4K upfront per unit to ~$2,200 per year inc service[1])
- Additional Revenue Sources under consideration (Cellular/Wi-Fi, Ad space …)

Leadership and org model

- Built as a tech company from the start
- Leadership willing to extend sales cycles in the transformation of their business model
- Invested in extensive training with all stakeholders

Talent

- Proximity to Boston made hiring easier
- Focus on hiring experienced industrial engineers who understand reliability

1. sfchronicle.com

Success ingredients—BigBelly

Operations and core business processes

- Executives employees embedded throughout customer journey
- Heavy investment in support - Helping cities decide what's best, training end-users, customer engagement and support, preventative maintenance and easy-to-read reports

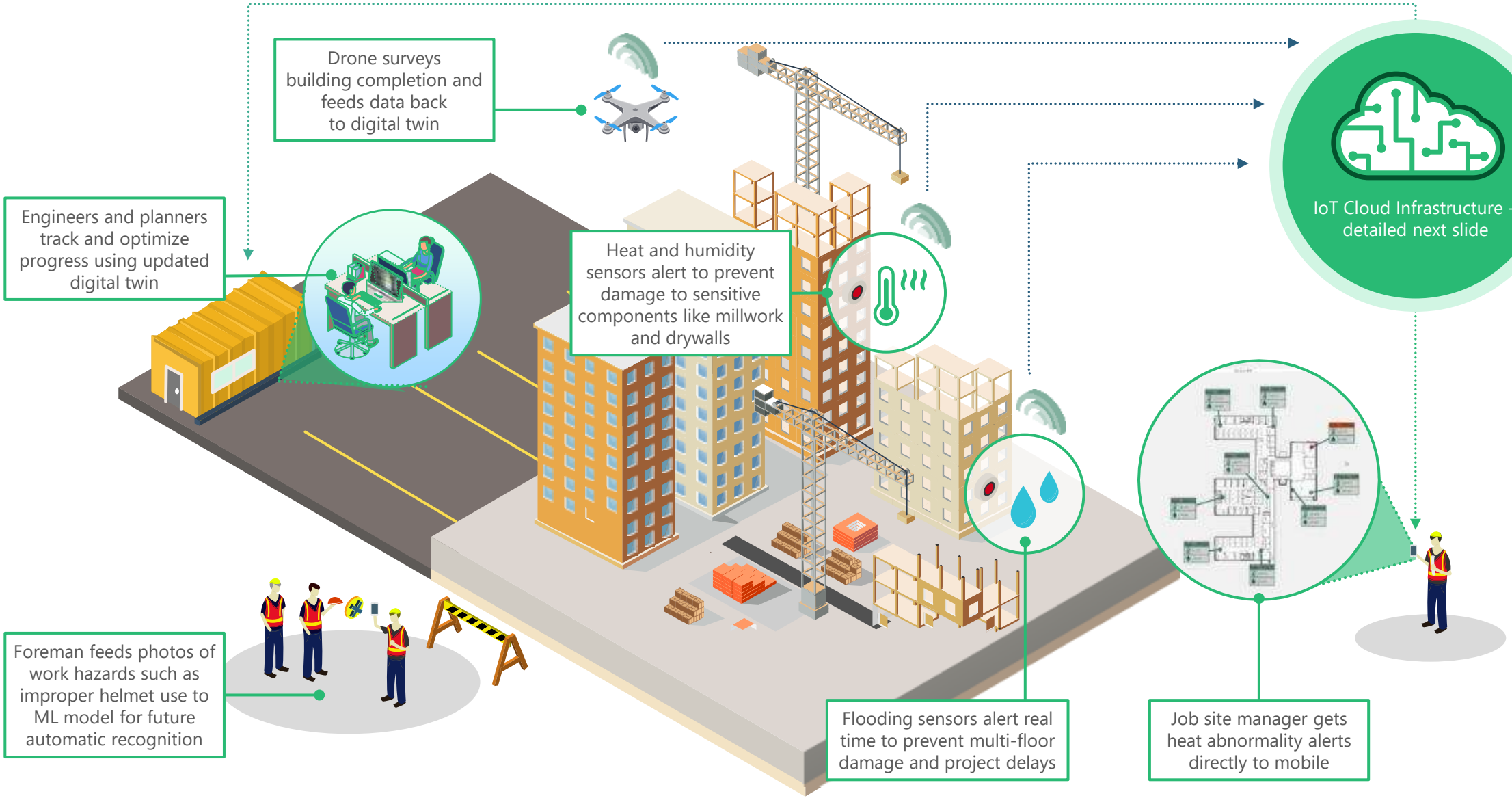
Partnerships and ecosystem

- Tech partnerships for value-added tech offerings (e.g., wi-fi/cellular access)
- GTM partnerships (Telcos and financial firms) help close the sales (Telcos) or financing gaps

Technology

- Started off small with off-the-shelf parts and simple use cases
- Added connected solutions (maintenance alerts, trash status) + quick wins
- Lower technical complexity means reliability and simpler upgrades

PCL is using a diverse set of IoT solutions to advance its job sites



Success ingredients—PCL

Business strategy and rationale

- Understanding the strategic potential offered by IoT, data and digitalization
- Strict "business-first" mindset in adopting and vetting businesses cases

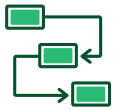
Leadership and org model

- IoT initiatives driven by CIO office, but with tight integration to BUs
- Senior leadership driving cultural changes, pulling in the right leaders

Talent

- Good starting point with staff & capabilities from cloud/digitization journey
- Invested heavily in re-skilling existing employees to minimize sourcing needs

Success ingredients—PCL

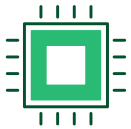


Operations and core business processes

- Ensured feedback loop to apply best practices and lessons learned
- Used “promoters” or early adopters as change agents to spread to field

Partnerships and ecosystem

- Early Microsoft Azure IoT partner with preview access to Azure Digital Twins
- Recognized early need to look outside for new ideas and solutions



Technology

- Careful planning and evaluation of sensor technology for harsh environments
- Heavy investment in AI/ML to automate hazard detection, digital twin updates etc.

Buhler is reimagining food processing with IoT solutions

Lumovision
Uses UV light to identify and sort out corn kernels affected by aflatoxin, which is a leading cause of 155,000 new cases of liver cancer per year in the developing world

MoisturePro
Uses real time sensors in food drying to monitor and control process

Buhler Insights IoT
Monitors, analyzes and adjusts industrial processes to make them more efficient.

It can work with any production process to improve quality and yield, and reduce waste, carbon emissions, water and energy

TotalSense Rice
Scans rice grains, in place of manual inspection, to ensure they meet size and other requirements

safefood.ai

Safefood.ai
Scans thousands of official databases, webpages, news and social media channels for events and rumors related to food safety

Success ingredients—Buhler

Business strategy and rationale

- Shift in focus from selling equipment to recurring revenue services
- Faster design and release cycles, tighter integration with customer needs
- Flat fee pricing to encourage small rice processors have access to same QA

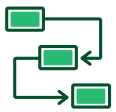
Leadership and org model

- Created a CDO role, challenged every BU to have a prototype in 9 months
- Independent R&D group oversees all 8 business units
- Executive team review and approve all projects

Talent

- Brand new Innovation campus in Uzwil, Switzerland
- Grew internal talent for IoT and digitization initiatives

Success ingredients—Buhler

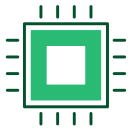


Operations and core business processes

- Move to "Industry 4.0" smart factory processes for AR, smart shelves, etc.
- Dedication to longer sales cycle and recurring vs. up front revenue
- Tighter integration with customers, solving problems

Partnerships and ecosystem

- Simplifier partnership for AR/Augmented Reality equipment
- Nebulus IoT gateway from Codit for connecting machines to the cloud
- Microsoft Azure as the cloud IoT provider



Technology

- Extensive investment in AI to improve food processing and continually drive yield improvements and energy savings
- Blockchain for track and trace and food chain efficiency

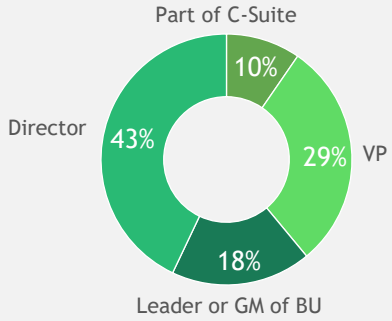
IoT Executive Survey

To decrypt what works, we ran a survey across 177 IOT respondents …

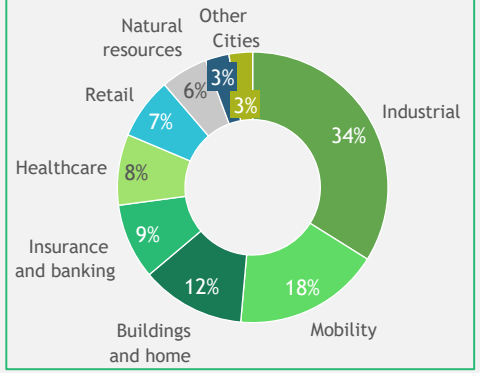
Respondents

N=177

Role in company

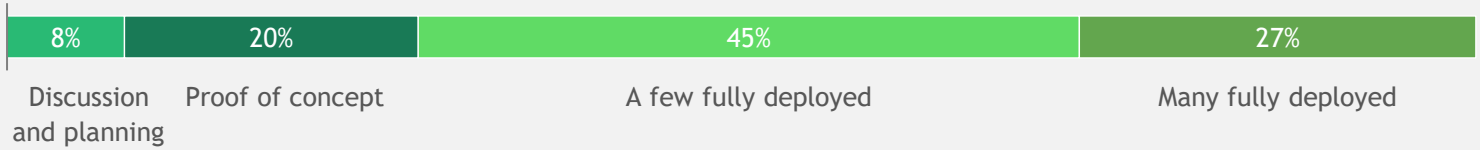


Industry/domain

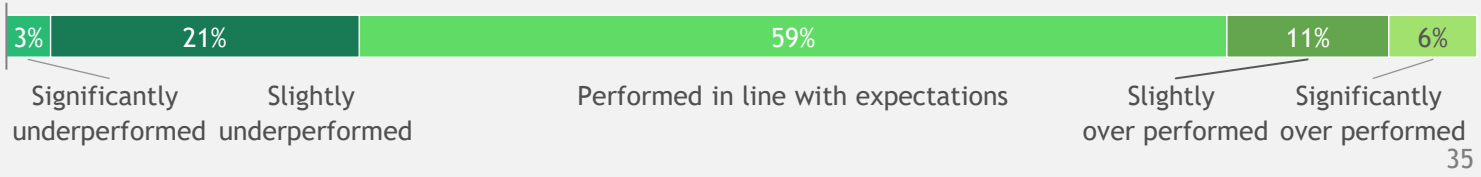


Purpose of IoT offering:

Stage of IoT offering



Success of IoT offering

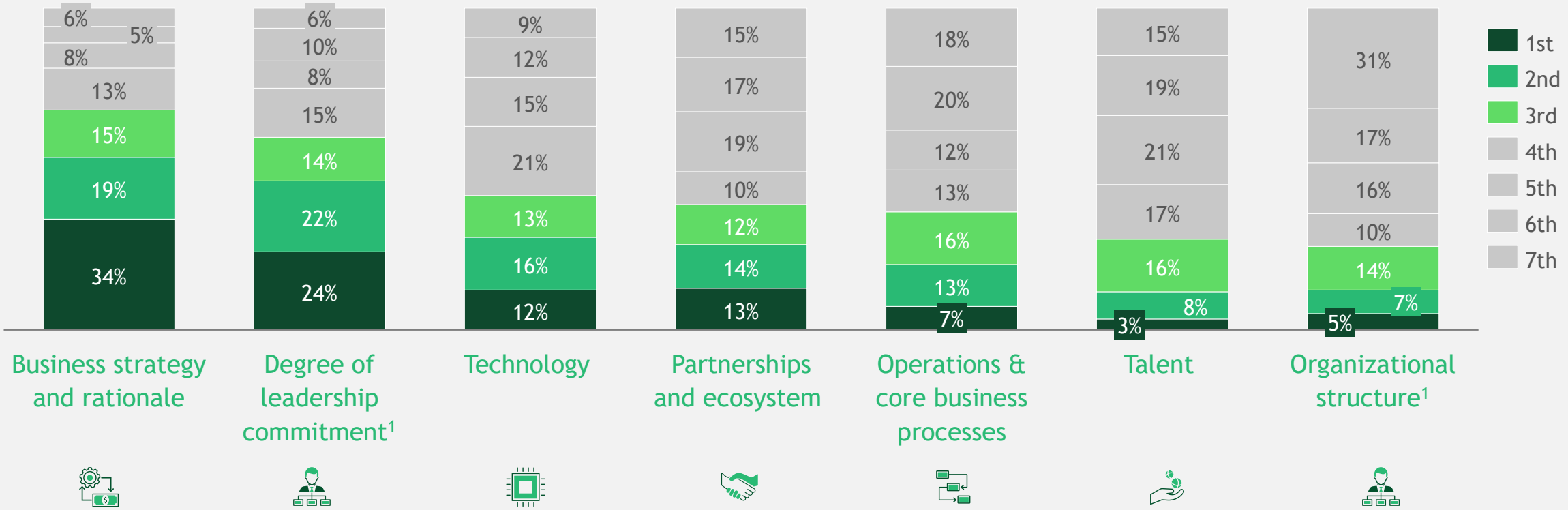


We collected a lot of data …

Business priorities and leadership indicated to be the biggest challenge areas for IoT deployments

Based on your experience with IoT deployments, please rank the following elements for success in implementation and scaling of solutions

Respondents (%)



1. Driven by the hypothesis that significant variance in importance would be noted, leadership and org model were separated into two categories for the purposes of this question

Business strategy and rationale

Findings

- Developing/changing business model top challenge for companies developing IoT offerings
- Successful companies balance outcomes and time to value through a portfolio approach
- Accurately estimating upfront value and cost is biggest challenge while building business case

Recommendations

1. Approach IoT as a journey – balance quick wins with larger more ambitious use cases
2. Ensure business teams involved right from the start to ensure domain knowledge, customer perspective early
3. Be open about business model choices, even if it means changing successful ones

Key takeaway

Leadership and org structure

Findings

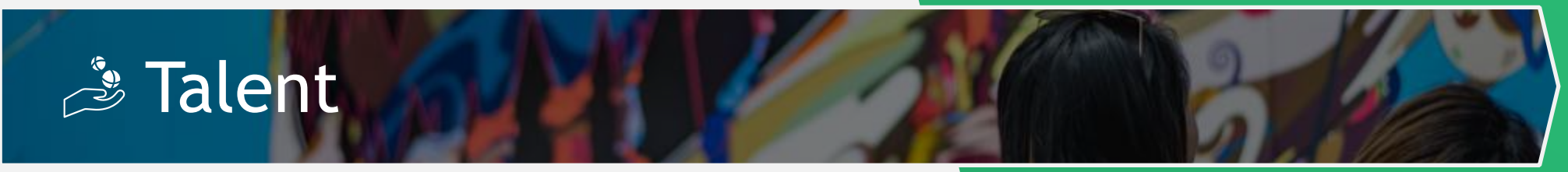
- Leadership accountability and vision biggest success driver
- Leaders' seniority and ability to deliver across org correlated with project success
- Too much focus on just the technology correlated with failure
- BUs most common home for IoT leadership and IoT teams

Recommendations

1. Make IoT a C-level priority
2. Ensure the right leadership for IoT projects to drive accountability and "sell" vision to business
3. Organizational clarity is a must for success
4. Start with quick wins to understand and map the journey

Key takeaway

Talent



Findings

- IoT architecture, Data science, and OT expertise the hardest skillsets to find

Bringing together talent within various departments indicated as biggest talent management challenge

Successful IoT projects list training as common challenge

Recommendations

1. Ensure that the right talent strategy in place given starting point and existing skillsets
2. Plan how groups will work together and communicate using metrics that apply across organizational silos
3. Consider what training is needed for employees to be successful

Key takeaway

Operations and core business processes

Findings

Reengineering business processes top issue for IoT deployments in operational impact

Product development & engineering top department affected by IoT work

Recommendations

1. Dedicate time early on to defining what business operations need to change
2. Make sure all departments are ready to begin executing IoT projects

Key takeaway

Partnerships

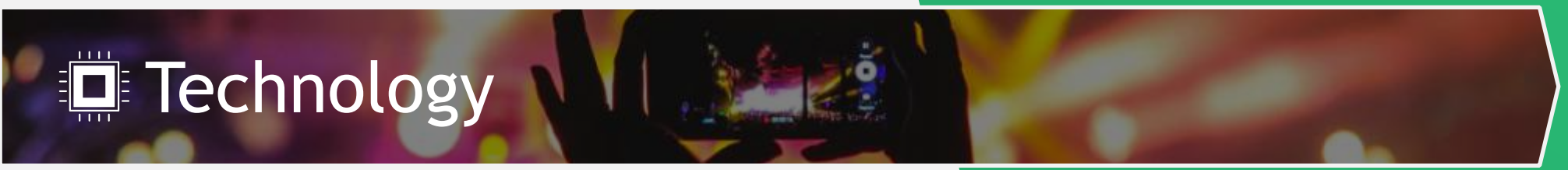
Findings

- Business partnerships indicated to be the most challenging to orchestrate
- Managing and coordinating partners top challenge in working with IoT partnerships
- Despite plethora of alliances, respondents still feel that ecosystems are immature

Recommendations

1. Dedicate the right effort to identify and foster business partnerships upfront
2. Find and participate in the right technology partnerships & alliances - join truly mature ecosystems that add value

Key takeaway



Technology

Findings

- Connected machines/sensors, IoT platforms & security the top 3 most challenging layers of the IoT stack
- Developing scalable IoT architecture, IT/OT integration & make-buy decisions the biggest challenges in Technology

Recommendations

1. Connectivity & hardware remain non-trivial – must address early in design cycle
2. Plan to allocate sufficient time and resources to develop a scalable IoT architecture and integrating IT/OT systems

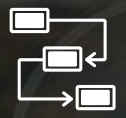
Key takeaway

Six key enablers of success

Business strategy and rationale

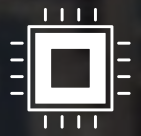
Leadership and org model

Talent



Operations and core business processes

Partnerships and ecosystem



Technology

Thank you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Deep dive—Delivering sources of value beyond cost/efficiency for enterprises

Use case	Impact
Penske—Online tool to access to all your information like preventive maintenance (PM) appointments, invoices, and fuel locations, Fleet Insight™ helps view information about trucks in detail at any time	24/7 connectivity, remote diagnostics and roadside assistance. Data to digitize operations, auto reporting, simplify compliance, and increase fleet efficiency1
Coca-Cola Freestyle—The computer system within the machine records all data involved in every single pour. The data helps shape Coca-Cola fountain beverage offerings	Now a billion dollar business. Servings up 8%, calories per serving down 10%. With 100,000 machines, the biggest mobile payment fleet. Machine helps track flavors trends
 **Rebecca Minkoff**—Store in New York has a video wall for customers to find items, and also has interactive mirrors in the dressing room. The mirrors let consumers set the lighting to match where they will wear the clothing. They also let you order a different size or color with a few taps	Sales have been up over 200% since installation. You don't need to interact with an employee you can request other sizes and checkout on your own in less than five minutes3
Walmart—Pick-up towers: 16x8 foot kiosks that allow customers to pickup online orders in the store, saving time and costs from shipping. Scan and Go Shopping- Customers able to use the Walmart app for checkout. This is a step in the direction of being able to bypass the checkout process entirely with the use of computer vision, sensors and machine learning	Planed in over 700 location by end of 2018, these kiosks now drive over half a million order fulfillments since their launch in 20174
Guardhat—Wearables for safer and more productive work environment for frontline industrial workers in heavy manufacturing industries. The smart hat monitors location, and checks for things like falls and head impacts	By leveraging advanced technology, Guardhat estimates they could reduce workplace injuries by 20%5
Mount Sinai—Smart connected hospital beds matches beds to incoming patients. Sensors in beds track usage in real time, and the system can better match users to unused beds compared to pen and paper	Able to reduce waiting times for 50% of emergency department patients in need of a bed by one hour
Mysphera—Tracking high risk patients with a real time monitoring and alert system. System uses a collection of wearable bracelets, and cards that connect back to hubs and provide location and wellbeing information to healthcare providers	Provides location, tracking and monitoring of more than 1,500 patients and more than 1,000 assets daily. Helping healthcare workers respond to issues, like falls, faster

1. Video 2. Coke 3. CNBC 4. Walmart Blog 5. IoT Now

Deep dive—Seating new business models in industries

Use case	Impact
Tandem's—Basal-IQ algorithm is designed to look 30 minutes into the future to predict where glucose levels are heading	Demonstrated a 31% relative reduction in time spent below blood sugar safe zone
Urbanvolt—Lighting-as-a-service. Allows users to pay a service fee per month, and the company installs and manages all smart LED hardware	Immediately save 75% on energy bill and company manages maintenance for the duration of the agreement
Pirelli—Connesso smart tiers allow car owners to view driving and usage stats. A smart sensor is imbedded in the tire wall and connects back to the user's cell phone app	Able to provide real time alerts and proactive maintenance warnings
Michelin—Sensors to monitor tire pressure and internal temperature and alerts logistics operators when readings are low	Reduction in fuel consumption of 2.5 litres per 100km which represents an annual savings of €3,200/truck
Medtronic—The device will transmit glucose readings via a tiny implantable electrode in real time to the physician, allowing for both the patient and doctor to have immediate access to the patient's health information	Insights help lower A1C, a blood sugar test metric, by up to 1%. 94% of lows detected. The company has helped over 95,000 patients[2]
Trumpf, Axoom—Sensors installed in high tech industrial equipment can connect back to the Axoom platform for remote insights, management and control	Up to a 25% reduction in maintenance costs. Helps manufactures monitor live statuses and everything from output, to uptime
Ocado Smart Platform—The Ocado Smart Platform, enables large brick-and-mortar grocery retailers to automate order fulfilment. Ocado develops large robotic warehouse systems that can store and pack customer grocery orders, saving on order costs and complexity	Managed Morrison's[6] online fulfillment business from 0 to ~$400M in three years[3]
Renfe—Siemens was able to leverage sensor data to optimize preventative maintenance for the trains. Smart sensors would provide advanced notice of train delays	Over the course of around 2,300 trips, only one noteworthy delay was recorded. Guaranteed refund if 15 min delay[4]
Proteus—Use medical sensors to track patient health status and outcomes. Proteus Discover is comprised of ingestible sensors, a small wearable sensor patch, an application on a mobile device and a provider portal	Partnership with Fairview Health in Minnesota, where insurance will only pay Proteus if cancer patients adhere to their prescribed treatment 80% or more[5]
Otonomo—Automotive data services platform, provides connected cars with services while adhering to GDPR. This helps car companies build new business models on data. For example, companies could get a cut from notifying a tow company in the event of a breakdown	Nevada highway Patrol pilot program saw a 17 percent reduction in crashes along Interstate 15, with accidents identified up to 12 minutes faster

1. HBS 2. Medtronic 3. Ocado 4. Siemens 5. Statnews 6. 4th largest grocery chain in UK

Deep dive—Synergistically building on other advanced tech

Use case	Impact
Ekso Bionics—Connected exoskeleton that aids in patient recovery and therapy. The exoskeleton can assist injured patients during rehab to speed up recovery time	30% year-on-year increase in utilization of the robotic exoskeleton
Farmers Insurance—will now use Kespry unmanned aerial systems (UAS) to help assess damage to residential rooftops after significant weather events. Drones can be deployed in place of claims adjusters	From 1-1.5 hours onsite and a day to process → now just 1 hour to collect and process drone photos. Also increased worker safety, no climbing roofs[1]
Porsche—AR glasses help technicians with repairs. Dealer partners are connected back to Porsche HQ for rare but highly technical escalations to enable joint troubleshooting and remote help	In Porsche's initial trials, these glasses cut down on service time by a whopping 40 percent[2]
Yamaha—Wi-Fi-enabled Yamaha dirt bike showed how augmented reality could reshape the way field service technicians and owners work on machines	Users can drill down into data about the bike— including sensor information, oil pressure, manuals, and history, saving time on home repairs
Da Vinci—Robotic tool can change the way that surgeons operate. The tool can work from inside the a patient's abdomen and result in a far less invasive procedure due to smaller incisions	Less than 3% complication rate. Hundreds of thousands of surgeries are now conducted with Da Vinci systems each year
Continental—A new platform for sharing vehicle data, to enable new digital services that improve driver safety and convenience. Based on blockchain tech., the platform provides data sovereignty, security, transparency, and efficiency to overcome the barriers of sharing vehicle data	Sharing vehicle data across vendors can solve some of the toughest traffic problems and improve driver experience by leveraging the power of swarm intelligence
Trimble—is building a connected network of blockchains that allows all participants in the supply chain to seamlessly communicate and see full history of payments, shipments, and responsibilities. Customers can also see the full history of their goods	Cut down on transaction times from 21 days to 24 to 40 hours by putting the transactions onto the blockchain[3]
Ambrosus—Tracking food shipments with Blockchain. Blockchain-powered IoT network for food and pharmaceutical enterprises, enabling secure and frictionless dialogue between sensors, distributed ledgers and databases to optimize supply chain visibility and quality assurance	To date, all Premium Vanilla tracked by origin, have sold out of stock
Vechain—Tracking luxury goods with Blockchain	Giving the power to shoppers in determining the authenticity of products they purchase

1. Kespry 2. CNET 3. Freight Waves

Deep dive—Threading previously unconnected domains

Use case

Impact

Use case	Impact
VW, tennet—Fleet sensors send reliable weather data to Tennet for grid load optimization. Fleet sensor data collected from vehicles to project the quantity of actual solar energy even more realistically and accurately	Significant cost savings potential from grid load optimization. Better predict the productivity of solar power plants and optimize grid regulation
Nest, EDF, Sowee—Utilities have partnered with smart home devices for Demand Response and new services. Smart thermostats allow for better programing and demand response to peak energy usage patterns	Smart thermostats could save consumers up to £150 a year am generate even greater savings for utilities
Shell and Jaguar—launched world's first in-car payment option for gas. A smart in dash display can find and direct users to the nearest gas station. Mobile payment methods like ApplePay and Samsung pay allow a cashless transaction	Find and pay for gas via an app that's part of the vehicle's in-dash infotainment system, saving time and hassle
Metromile—Insurance industry leveraging new sources of data from connected devices. Device connects to car ODB-II port to monitor distance traveled. Using that sensor data, metromile can offer a unique insurance billing system based on actual driving patterns	Average savings of $611/year for drivers who switch. Metromile is still private, but has grown to 248 employees and raised $295M since its founding in 2011. Estimated revenue$170M[1]
Beam connected toothbrushes—allow insurance providers to track usage and health outcomes to offer better rates and incentivize more brushing. Sensors in the brush report frequency and length of usage	Save up to 15% on dental insurance premiums

1. Owler

Deep dive—Extending beyond man-made environments and things

Use case	Impact
Rainforest Connection—A bio-acoustic platform that monitors endangered animals and logging which destroys their habitats	24/7 alerts of endangered species provide local ecologists data to study and improve outcomes. 26K hectares of forest monitored which is equivalent to 6.5M metric tons CO2 sequestered or 1.3M cars off the road[1]
World Wildlife Fund—(WWF) in Australia, Fiji and New Zealand, in partnership with US-based tech innovator ConsenSys, tech implementer TraSeable and tuna fishing and processing company Sea Quest Fiji Ltd, has launched a pilot project in the Pacific Islands tuna industry that will use blockchain technology to track the journey of tuna from "bait to plate"	Consumers will be able to scan a code on an item and find out exactly where it has been before landing in your hands. Cracking down on the $23bn annual global cost of illegal fishing[2]
 **Connected Conservation Pilot**—endangered animals remain undisturbed and free to roam in their natural habitat—while technology is used to track the movement of people (and potential poachers) coming in and out of the reserve. First pilot in Kruger National Park in South Africa	In just two years of deployment, the Connected Conservation project has reduced poaching in the reserve by 96%
Apis Protect—Honeybee research and health monitoring—"smart hive" technology to monitor honey bee colony health during commercial migratory operations	$1.3 million research initiative well on its way to finding measurable and tangible solutions for improving U.S. honey bee colony health by the end of 2020 including one of the biggest bee health discoveries of the decade[3]
 **The Aotoso system**—provides basic information management to the modern livestock industry, including farm management, cow management, real-time estrus monitoring, and cow positioning and tracking	Aotoso has increased the cow estrus detection rate from 75% to 95%, which helps farmers prolong the period of milk collection, increasing cow utilization
The Yield—Goc oyster farm monitoring data to predict optimal time to harvest reduce unnecessary closures—a series of in-water sensor platforms measure multiple variables such as water salinity, temperature, and water depth, the data collected is then fed into a Microsoft Azure cloud platform	Just measuring that one aspect can help to reduce closures from Pacific Oyster Mortality Syndrome (POMS) by 30 percent

1. https://rfcx.org/ 2. https://globalfishingwatch.org/ 3. Project Apis

“Art of the possible”: Multiple examples in production already

Delivering sources of value beyond cost/efficiency for Enterprises

New revenue streams

Penske & Shell created new revenue streams with fleet mgmt. and construction equipment tracking

Customer discovery

Coke’s freestyle machines allow it to develop new flavors based on customer preferences

Customer experience

Rebecca Minkoff smart mirror

Carnival's guest experience via sensors+wearable

Improving safety

Gaurdhat for worker safety guidance at work sites

Wellness

Hospital beds to reduce ER wait

Tracking elderly patients

Seating new business models in industries

Connected things

Diabetes mgmt

Connected lighting

Cyber tires

Services

Michelin's Fleet management services

Medtronic care mgmt services

Platforms

Domain experts offering their core tech as platforms

Manufacturing

Retail

Outcomes

Refund on train delays

Guaranteed energy saving

Medication adherence

Data

Companies monetizing the data IoT creates

Synergistically building on other advanced tech

Advanced endpoints

Exoskeleton for rehabilitation

Drones for insurance adjustment

AR/VR

Porsche's remote support for techs

Enhanced CX for dirtbike owners

Virtual patients to reduce large incisions

Blockchain

BC-based data monetization

Food quality management

Luxury goods authentication

Threading previously unconnected domains

Utilities & cars

VW fleet sensors send reliable weather data to Tennet for grid load optimization

Homes & utilities

Utilities have partnered with smart home devices for Demand Response & new services

Cars & retail

Shell & Jaguar launched world's first in-car payment option for gas

Insurance & other domains

Insurance industry leveraging new sources of data from connected devices

Pay-per-mile

Dental insurance

Extending beyond man-made environments and things

Conservation

Illegal logging

Tuna traceability

Endangered species

Honeybee research & health monitoring

Livestock

Aotoso monitors cattle estrus to manage treatment & breeding

Aquaculture

Goc oyster farm monitoring data to predict optimal time to harvest reduce unnecessary closures

Improving the way we live and play

Enhancing leisure

EpicMix app registers skier activity at resort

IoT powered golf balls to gamify playing experience

Connected sports items for professional training

Safer communities

Japanese municipal government runs safety alert for kidnapping

Intelligent structure's bridge performance mgmt to reduce risk & increase longevity