Attaining IoT Value: How To Move from Connecting Things to Capturing Insights

Gain an Edge by Taking Analytics to the Edge

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Key Insights

1. The Internet of Things (IoT) presents private and public sector organizations with an unprecedented opportunity to drive new sources of value – including the potential to automate up to 50 percent of manual processes.

2. This value will come to those who focus on improving their data capabilities (integration, automation, and analysis) and overall process agility – not to those who simply connect the most devices to the network.

3. Success requires new workforce skills, effective teaming between IT and OT, an extended partner ecosystem, and a platform approach.

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Attaining IoT Value: How To Move from Connecting Things to Capturing Insights

Gain an Edge by Taking Analytics to the Edge

Cisco estimates that the Internet of Everything (IoE) – the networked connection of people, process, data, and things – will generate $19 trillion in Value at Stake for the private and public sectors combined between 2013 and 2022. More than 42 percent of this value – $8 trillion – will come from one of IoE's chief enablers, the Internet of Things (IoT). Defined by Cisco as "the intelligent connectivity of physical devices, driving massive gains in efficiency, business growth, and quality of life," IoT often represents the quickest path to IoE value for private and public sector organizations (see https://www.iotwf.com/iotwf2014/deployment_map for more than 250 examples of global IoT deployments).

This paper combines original and secondary research, as well as economic analysis, to provide a roadmap for maximizing value from IoT investments. It also explains why, in the worlds of IoT and IoE, the combination of edge computing/analytics and data center/cloud is essential to driving actionable insights that produce improved business outcomes.

The Innovation Imperative

Perhaps more than at any time in history, private and public sector organizations face intense pressure to innovate faster. While this "innovation imperative" is produced by a host of factors, increased globalization and heightened customer or citizen expectations are most responsible for keeping executives up at night.

History provides many examples of market leaders who suffered the dire consequences of failing to foresee the shift to digital business models.

In addition, digital technology advances now enable new market entrants to threaten – and overtake – incumbents who fail to answer the innovation challenge. Recent history provides many examples of market leaders who suffered the dire consequences of failing to foresee the shift to "digital" business models (Kodak and Blockbuster come immediately to mind). The stakes are high – it is estimated that by 2027, new firms will replace 75 percent of the companies that were in the S&P 500 Index in 2011.[1] A significant part of this competitive turnover will result from technology-driven market disruption.

The increased demands for faster innovation, globalization, and better customer experiences have a downstream impact on operational complexity, leaving many companies to face critically important questions such as:

- How do we continually optimize our development and manufacturing processes to support faster innovation cycles?
- How do we meet rising demands from technology-savvy customers who expect flawless service?
- How do we manage a complex, expanding portfolio of physical assets that are distributed across the globe?
- How do we effectively manage our growing ecosystem of supply-chain partners?

To address these and other challenges, organizations are increasingly looking to the Internet of Things (IoT).[2] [Figure 1, next page]

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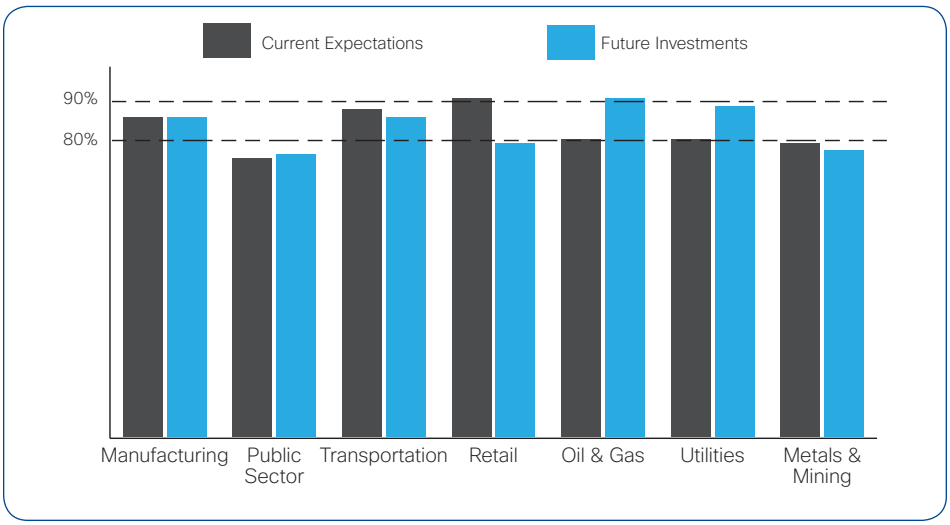
IoT comprises networks of physical objects and connected sensors that automate operations by:

- Gathering information automatically about physical assets (machines, equipment, devices, facilities, vehicles) to monitor status or behavior
- Using that information to provide visibility and control to optimize processes and resource use, and to improve decision-making

Figure 1
A large majority of survey respondents report that existing IoT investments have "met" or "exceeded" expectations. Likewise, most respondents expect to increase investments "somewhat" or "significantly."



Source: Cisco Consulting Services, 2014

IoT is an enabler of the Internet of Everything (IoE) ecosystem, which incorporates people in addition to data, process, and things. The "people" component of IoE typically fuels a variety of collaboration-based solutions; IoT-driven solutions, on the other hand, comprise data, process, and things, but not people.

IoT deployments have skyrocketed in recent years. According to Zebra Technologies, in a study conducted with Forrester Research, enterprise IoT deployments have grown by 333 percent since 2012. According to the survey, 65 percent of respondents had deployed IoT technologies in the enterprise in 2014, compared to only 15 percent in 2012.[3]

Cisco recently conducted a blind global survey to learn more about how organizations are harnessing IoT to transform their businesses – and what they can do to drive more value. The survey's 1230 respondents represented:

- 16 countries: Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Mexico, Russia, South Africa, South Korea, Spain, United Kingdom, United States
- Seven IoT-intensive industries: manufacturing, public sector, transportation, retail, oil and gas, utilities, metals and mining
- IT executives (47 percent of respondents) and executives with a line of business (LoB) / operational technology (OT)* focus (53 percent)

The results of the survey yielded important insights about the role that IoT can play in helping organizations remain competitive, along with recommending specific actions they should take.

* Operational Technology (OT) leaders are executives who have responsibility for technology that is used in specific operational processes, such as supply chain, manufacturing, and transportation.

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Big Data Is Getting Bigger – Largely Thanks to IoT

The sheer size and variety of data traversing today's networks are increasing exponentially. This highly distributed data is generated by a wide range of cloud and enterprise applications, websites, social media, computers, smartphones, sensors, cameras, and much more – all coming in different formats and protocols.

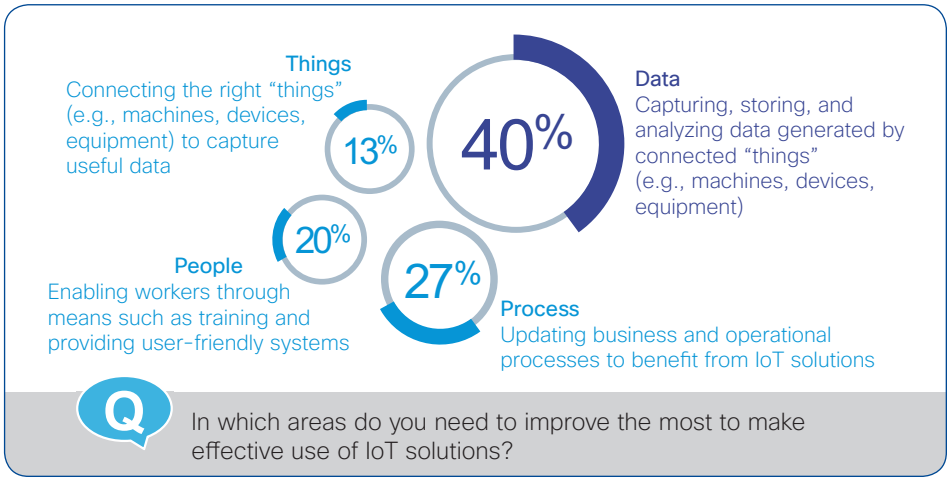
IoT contributes significantly to this rising volume – often by generating a high frequency of relatively small amounts of data. Our survey respondents predict strong growth in all types of connected assets (facilities, vehicles, and production equipment) driven by IoT. In fact, nearly 90 percent expect the amount of data transmitted by their networks to increase "somewhat" or "significantly" over the next five years. There are myriad IoT use cases that generate large amounts of operational data:

- A jet engine generates 1TB of data per flight.[4]
- A large refinery generates 1TB of raw data per day.[5]
- As cars get smarter, the number of sensors is projected to reach as many as 200 per car.[6]
- Sensors of all types will generate immense amounts of data. In fact, analysts estimate that by 2020, 40 percent of all data will come from sensors.[7]

This wealth of widely distributed and often unstructured data is arriving at an accelerating rate – 90 percent of world's data was created in the last two years.[8]

Figure 2

In many cases, it is better to process data at the edge, closer to where it is generated.



Source: Cisco Consulting Services, 2014

IoT Is Not About Things – It's About Data

The IT and OT leaders we surveyed perceive IoT as being about much more than just things. When we asked them which area (people, process, data, or things) they needed to improve most to make effective use of IoT solutions, the largest number (40 percent) indicated "data," while "process" (27 percent) ranked second. "People" placed third (20 percent) and "things" finished last (13 percent). [Figure 2]

These leaders understand that connecting "things" is but a means to an end. The primary value that IoT creates is a direct result of the data that can be captured from connected things – and the resulting insights that drive business and operational transformation.

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Next, we will take a closer look at some of the key challenges facing organizations that hope to benefit from IoT-generated data, and specific strategies they can use to overcome these obstacles.

Integrating, Automating, and Analyzing IoT Data

To capitalize on the wide range of data IoT generates, organizations must overcome three key challenges identified by our survey respondents:

- Integrating data from multiple sources
- Automating the collection of data
- Analyzing data to effectively identify actionable insights

Only by addressing all three can organizations turn raw data into information and actionable insights.

Integrating Data from Multiple Sources

For most IoT use cases, data must be captured and integrated before it can be processed and analyzed.

The unparalleled distribution and variety of devices and data today make data integration a bigger hurdle than ever before. Organizations must consider multiple factors, including the physical installation of devices, the best communication standards, how to handle many different types of data (e.g., video, geolocation data), and how to effectively integrate IoT data with data from other sources, such as third-party data providers from the cloud, as well as internal, historical data stores.

Clearly, integrating data from multiple IoT sources – particularly when those sources are varied in nature and highly distributed – poses significant challenges. Because copying all data to one centralized node for integration is no longer feasible for a variety of reasons – cost, technical difficulty, and possible regulatory issues[9] – organizations are now starting to rely upon data virtualization to integrate widely dispersed data. Data virtualization makes a heterogeneous set of data sources look like one logical database to users and applications. These data sources don't have to be stored locally – they can be anywhere. This is particularly valuable for an IoT application that relies on data from many distributed sources, such as embedded sensors, video cameras, and third-party data sources.

As Rick van der Lans explains in "The Network Is the Database: Integrating Widely Dispersed Big Data with Data Virtualization,"[10] data virtualization provides another powerful advantage: "Data virtualization technology is designed and optimized to integrate data live. There is no need to physically store all the integrated data centrally. It's only when data from several different sources is requested by users that it's integrated, but not before that. In other words, data virtualization supports integration

CASE STUDY

Dundee Precious Metals Improves Worker Safety and Production Levels

IoT Solution: Wireless network coverage along 50km of underground mining tunnels. RFID tags on miners' hats and vehicles enable location tracking via 3D maps, and also real-time status tracking (e.g., vehicle maintenance needs).

Outcome: Improved miner safety. Production increased by 400 percent, exceeding original 30 percent goal. Lower energy and communication costs. Improved asset utilization.

Learn more here.

See more examples of IoT in action here.

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> "The time is over that we can push the data to a centralized location for integration purposes – we have to push the integration to the data."
>
> Rick van der Lans
> "The Network Is the Database: Integrating Widely Dispersed Big Data with Data Virtualization"

on demand. The time is over that we can push the data to a centralized location for integration purposes – we have to push the integration to the data."

Automating the Collection of Data

After IoT data is captured and integrated, organizations face the challenge of getting the data to the right place at the right time so it can be analyzed. This includes assessing the data to determine whether it needs to be moved or analyzed where it is, at the "edge" of the network ("moving the analytics to the data").

In this paper, we consider the edge of the network to be the place where IoT data is captured. On the other hand, the "center" of the network refers to offsite locations such as the cloud and remote data centers – places where data is transmitted for offsite storage and processing. Based on the growing and varied number of IoT use cases, the edge effectively could be anywhere, such as on a manufacturing plant floor, in a retail store, or on a moving vehicle. [Figure 3, next page]

In "edge computing," therefore, applications, data, and services are pushed to the logical extremes of a network – away from the center – to enable analytics and knowledge generation at the source of the data.[11]

This edge-computing capability is enabled by *fog computing* – a paradigm that extends cloud computing and services to the edge of the network. Fog creates a platform that provides compute, storage, and networking services between end devices and cloud computing data centers. Fog computing supports emerging IoT applications that demand real-time/predictable latency (such as industrial automation, transportation, networks of sensors, and actuators). Thanks to its wide geographical distribution, the fog paradigm is well positioned for real-time data analytics.[12]

It's important to point out that IoT value comes from the combination of edge computing and the "center" (data center or cloud), not one or the other. Edge computing is about ensuring that the right processing takes place at the right place and the right time, making optimal use of available network resources and bandwidth. This requires strength both at the edge and in the "center" (data center and/or cloud). It's critical to have a system that determines which data needs to be processed immediately – at the edge – and which data should be moved.[13] Organizations,

CASE STUDY

Edge Computing / Analytics Can Save a Typical Retail Store Nearly $34k Annually

To witness the economic advantages of edge computing/analytics, look no further than the security and video analytics cameras employed by a typical retail store. By processing these cameras' data locally – at the edge – rather than pushing it to a centralized data center, the store can reduce the overall load on its network. This has significant economic benefits.

According to analysis by Cisco Consulting Services, for a retail store with $20 million in annual sales and 100 security and video analytics cameras, edge computing/analytics can deliver **annualized savings of $33,800 – and a 1.7 percent annual EBIT increase** – versus employing a traditional data center/cloud computing approach.

The cost of edge-computing infrastructure is more than offset by reduced bandwidth costs enabled by processing the cameras' data locally.

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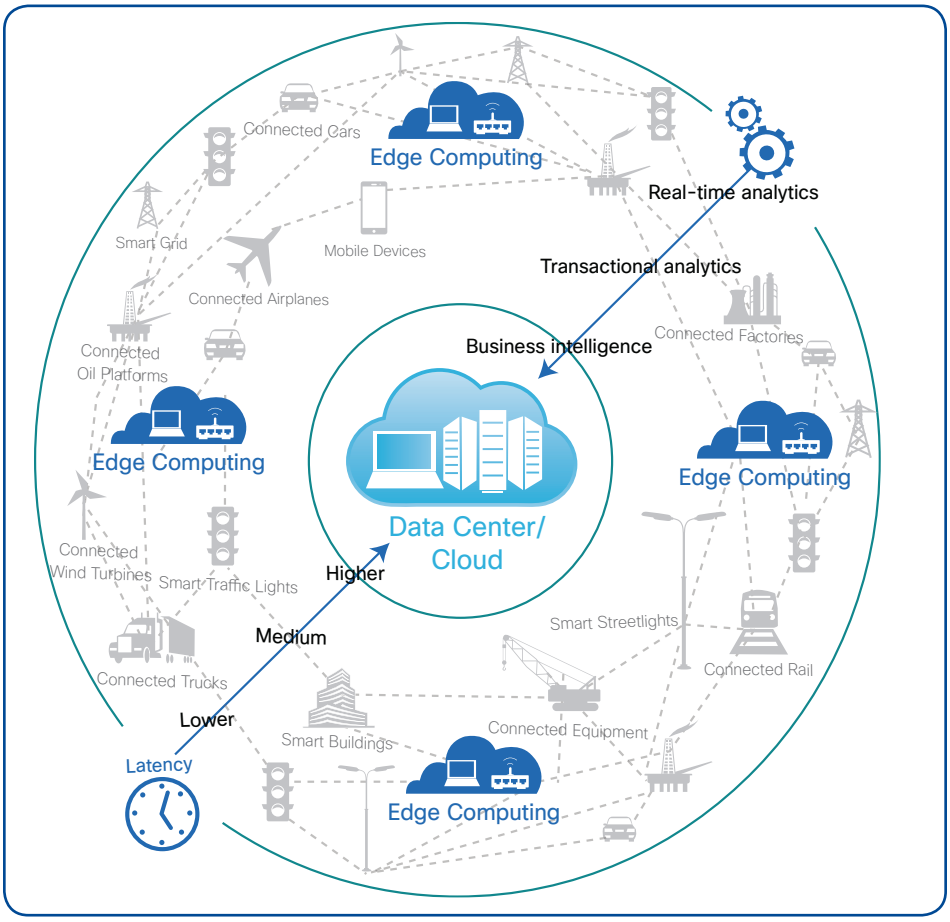
Figure 3
Edge computing helps ensure that the right processing takes place at the right time and place.



Source: Cisco, 2014

therefore, require a connected infrastructure that enables insight from the data center to the edge.

Here are some important considerations when it comes to data automation and IoT:

- **Performance requirements of the IoT application:** Are there requirements for low latency that will impact where the data should be processed? There are certain IoT use cases where low latency may be a requirement (e.g., gaming, safety).
- **Data preprocessing opportunities:** In many instances, it will not be appropriate to transmit all the data generated by an IoT solution to the cloud for processing. It may make sense to process or compress IoT data before transmitting it to the cloud, or to transmit only select data (e.g., anomalies, exceptions, averages).
- **Highly distributed IoT applications:** Some IoT applications (e.g., pipeline monitoring, connected oil rigs, smart grid) may involve a high degree of distribution, making processing at the edge more attractive.[14]

The oil and gas industry provides a prime example of the need for edge computing. Offshore oil platforms generate between 1TB and 2TB of data per day.[15] Most of this data is time-sensitive, pertaining to platform production and drilling-platform safety. The most common communication link for offshore oil platforms is transmitting data via a satellite connection, with data speeds ranging from 64Kbps to 2Mbps. This means it would take more than 12 days to move one day's worth of oil-platform data to a central repository.

According to our survey, IT and OT leaders understand the importance of edge computing/analytics to meeting their business objectives when it comes to IoT. In fact, nearly 40 percent of respondents believe that within the next three years, "most" of

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the data produced by their IoT solutions will be processed at the edge of the network – near where it is generated – using intelligent devices and appliances. [Figure 4]

In the world of IoT, both the data center and the edge play critical roles in enabling organizations to extract maximum value from data.

Analyzing Data to Effectively Identify Actionable Insights

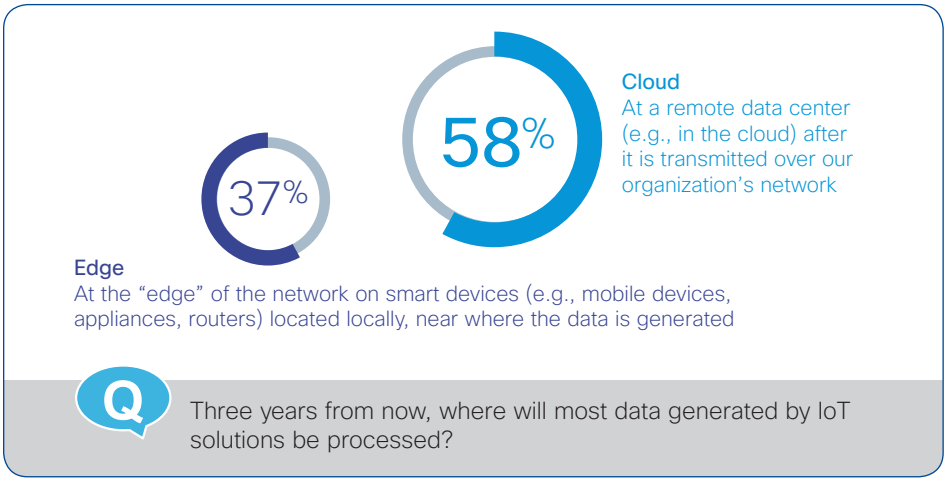
Whether it is in the cloud or at the edge, IoT data must be analyzed to identify actionable insights that can be used to create better outcomes (such as from process optimization or improved customer engagement). Without this critical step, data remains just "data." Insights then need to be embedded into efforts such as process re-engineering and broader business transformations.

There is often an immense gap, however, between the amount of data with hidden value and the amount of value that is actually being extracted. According to IDC, less than 1 percent of the world's data is currently being analyzed.[16]

Organizations often lack analytical capabilities due to an absence of both the skill sets (such as those possessed by data scientists) and tools to deal with the exploding size, speed, variety, and distribution of data.

The solution often requires the ability to receive detailed, real-time information via analyze-first, store-later capabilities, as discussed in the previous section. Edge analytics distributes intelligence to the edge, enabling the network to deliver the full power of IoT.

Figure 4
Among survey respondents, the move toward edge computing is already underway.



Source: Cisco Consulting Services, 2014

Our survey respondents clearly understand the potential of analytics to drive critical business outcomes. **When we asked them which technology developments are the most important enablers of IoT use, "better, more powerful analytical tools" was the No. 1 choice.**

As IoT use cases proliferate, tools and techniques such as streaming analytics to handle continuous incoming data, machine learning to enable performance improvement of IoT applications over time (by "learning" from IoT data), and data visualization capabilities may rise in importance.

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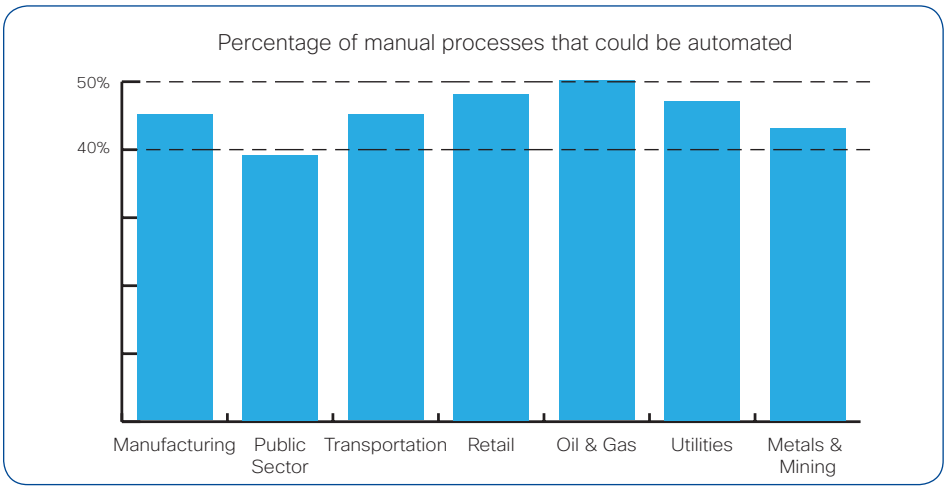
As we've discussed, organizations must effectively tackle the integration, automation, and analysis of IoT data before they can generate the kind of actionable insights that will maximize value from their IoT investments. Let's look at how these insights can serve as the catalyst for an unprecedented economic opportunity.

From IoT-Data Driven Insights to Process Improvement

Analytics-driven insights will drive the opportunity for process change and optimization. In many cases, these insights will foster transformative rather than incremental changes in business and operational processes. For example, our survey respondents indicated that IoT has the potential to fully automate up to 50 percent of their existing manual operational processes. [Figure 5]

The implications of this opportunity are difficult to overstate. In most cases, a company that automates 50 percent of its existing manual processes will look nothing like it does today. Consider the following hypothetical scenarios:

Figure 5
Across industries, respondents indicated that nearly half of all manual processes could be automated through the use of IoT solutions.



Source: Cisco Consulting Services, 2014

- What if a transportation company could fully automate half of the driving of its trucks?
- What if a retailer could fully automate the customer experience for shoppers, including payments and delivery?
- What if a manufacturer could automate half of its current manual production processes?

While many organizations have not advanced as far as these examples on the IoT maturity curve, we are beginning to see process improvements of this magnitude.

Amazon, for example, is currently employing scores of autonomous robots in its huge Seattle warehouse, which could help the online retail giant save as much as 40 percent on fulfillment costs.[17]

In the manufacturing industry, Flextronics – a leading end-to-end supply chain solutions company – is combining IoT-driven automation and real-time data analytics capabilities to dramatically improve production assembly processes. Enhanced data visibility and analytics now enable the company's customers to perform real-time data correlation and, as a result, quickly react to irregularities in supply chain components. In

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addition, real-time data visibility on the factory floor reduces assembly and machining lead times, and decreases the cost of quality.[18]

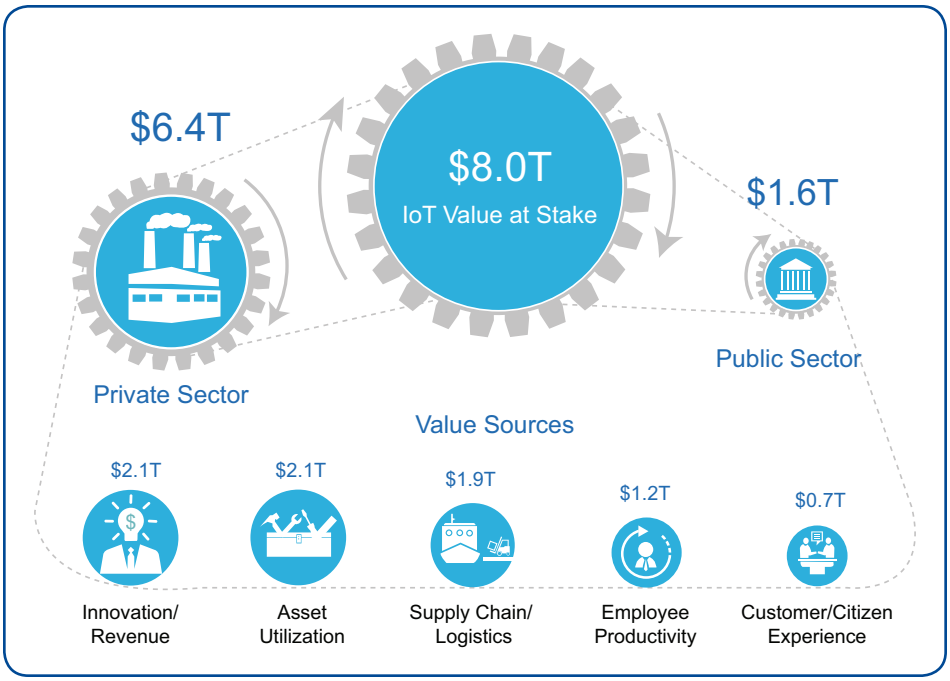
Process Transformation Promises Unprecedented IoT Value-Creation Opportunities

When organizations optimize their processes for IoT, they can achieve a number of important business outcomes, including:

- Enhanced quality of products and services
- Reduced costs with OpEx savings
- Improved decision-making
- Faster innovation

These outcomes translate to significant value. According to economic analysis by Cisco Consulting Services, IoT will generate $8 trillion in Value at Stake over the next decade – $6.4 trillion in the private sector, and $1.6 trillion in the public sector. Value at Stake refers to the potential bottom-line value that can be created, or that will migrate among private and public sector organizations, based on their ability to harness the Internet of Everything (or, in this case, the IoE enabler IoT) over the next 10 years. [Figure 6] At $8 trillion, IoT will drive more than 42 percent of IoE's overall Value at Stake during the next decade.

Figure 6
IoT Value at Stake reflects the potential bottom-line value that can be created or will migrate among private and public sector organizations as they harness IoT solutions over the next 10 years.



Source: Cisco Consulting Services, 2014

This value will come from five primary drivers: innovation and revenue ($2.1 trillion), asset utilization ($2.1 trillion), supply chain and logistics ($1.9 trillion), employee productivity improvements ($1.2 trillion), and enhanced customer and citizen experience ($700 billion).

While IoT will impact all private and public sector segments over the next decade, two-thirds of the estimated $8 trillion in IoT Value at Stake will be driven by three industries: manufacturing (including energy/oil and gas), public sector (particularly cities), and retail.

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Manufacturing Value at Stake

Improved Asset Utilization
Value: $117 million annual EBIT
Outcome: reduced maintenance expenses; decreased asset losses and theft; longer life of machinery and equipment; higher plant uptime; avoidance of accidental or purposeful downtime, cabling costs

Process/Supply Chain Efficiencies
Value: $68 million annual EBIT
Outcome: reduced scrap and rework costs; lower risk of IP theft; decreased planning costs; reduced inventory carrying cost; optimization of inbound/outbound fleet operations and warehouse operations; improved quality control

Smart Factory Capabilities
Value: $16 million annual EBIT
Outcome: physical security; reduced energy consumption; improved yield of raw materials

Public Sector Value at Stake

Smart Parking
Value: $18/parking spot/month
Outcome: revenue from dynamic pricing, data sales, and fines; cost reductions; fuel savings

Smart Lighting
Value: $21/lightpoint/month
Outcome: energy and OpEx savings; crime reduction (and corresponding impact on real estate value)

Smart Waste Pickup
Value: $2/month/household
Outcome: smart truck routing; reduced fleet size and maintenance

Positive Train Control
Value: $3/citizen/month
Outcome: improved safety (prevents collisions and derailments); increased train frequency; better traveler experience

IoT Value at Stake: Manufacturing

With its emphasis on asset monitoring, supply chain/logistics, and automation, manufacturing is arguably the most IoT-intensive private-sector industry. According to Cisco's economic analysis, the manufacturing industry will drive 34 percent of all IoT value over the next decade. Cisco's global survey results support this finding, with 86 percent of manufacturing companies indicating they expect their IoT investments to increase "somewhat" or "significantly" over the next three years.

To identify the specific sources of IoT value for a large manufacturing company, Cisco Consulting Services performed a bottom-up use-case analysis to create an IoT value framework for the industry. The results show that for a manufacturing firm with $20 billion in yearly revenue, 78,500-plus employees, and 72 manufacturing facilities, IoT can deliver $141 million in annual earnings before interest and taxes (EBIT). This value comes from three primary drivers (see sidebar). These capabilities drive an annual EBIT contribution of $201 million, which nets $141 million after annual IoT enablement costs ($60 million) are subtracted.

IoT Value at Stake: Public Sector (Cities)

Cisco's economic analysis determined that public sector will drive the second-highest IoT value among industry segments over the next decade (20 percent of the global total). According to Cisco's research, the public sector is bullish on IoT: 76 percent of public sector organizations surveyed expect their IoT spending to increase "somewhat" or "significantly" over the next three years. Cities will generate most (42 percent) of the public sector's IoT value.

To help cities focus on the best use cases for driving IoT value, Cisco Consulting Services developed an economic framework based on a city of 3 million people, with a concentrated downtown area and a shared infrastructure. Cisco's analysis identified several drivers of IoT value for cities (see sidebar).

IoT Value at Stake: Retail

Retail will generate the third-highest IoT Value at Stake (10 percent of global total) of any industry over the next decade, according to Cisco's economic analysis. In addition, nearly 4 out of 5 retailers surveyed (79 percent) indicated that they would increase their IoT investments "somewhat" or "significantly" over the next three years.

According to Cisco's economic analysis, IoT has the potential to deliver an annual EBIT contribution of $107 million for a retailer with $20 billion in annual revenue, 140,000-plus employees, and 1000 stores. This value comes from three primary IoT drivers (see sidebar, next page). These capabilities drive an annual EBIT contribution of $153 million, which nets $107 million after annual IoT enablement costs ($46 million) are subtracted.

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In many of these manufacturing, public sector, and retail use cases, value comes from analyzing data and using insights from that analysis to change processes – thereby enabling realization of improved outcomes.

How to Drive Process Transformation and Value from IoT

As discussed earlier, companies are highly aware of IoT solutions and the benefits they can deliver. In fact, they are planning to invest heavily in these solutions over the next three years. While they understand the benefits of IoT, they are less clear about the steps required to successfully implement and realize value from IoT solutions. In this section of the paper, we will highlight some key recommended actions for companies looking to benefit from IoT solutions and the data they generate.

Plan for the Future Workforce

While the potential automation of nearly half of an organization's manual processes will provide significant economic benefits, it will also eliminate many jobs – an impact already felt across many global occupations. According to Gartner, digital businesses will require 50 percent fewer business process workers by 2018. In addition, 1 in 3 jobs will be replaced by software or robots by 2025.[19] And, according to Oxford Martin, about 47 percent of total U.S. employment is at high risk of having their jobs being automated as a result of computerization over the next decade or two.[20]

According to IDC, 51 percent of CIOs are concerned that the digital torrent is coming faster than they can cope, and 42 percent don't feel that they have the talent needed to face this future. Gartner concurs, saying, "Few organizations will escape the need to connect smart objects with corporate systems and applications. Therefore, IT organizations must master the new skills, tools, and architectures required by the Internet of Things."

Organizations will need to prepare for the workforce of the future – one that can drive the transformational opportunities promised by IoT and data, with competencies aligned to industry-specific concerns and outcomes.

Already, we are witnessing tremendous interest by those looking to enter these areas of opportunity. For example, the online Big Data course taught by MIT's Computer Science and Artificial Laboratory attracted more than 3,500 students from 88 countries for its inaugural session in 2013.[21]

In addition to workers with data science and analytics expertise, organizations will need skilled IoT developers to help implement IoT solutions. Research firm VisionMobile estimates that the number of IoT developers will grow from 300,000 in 2014 to 4.5 million in 2020.[22]

Another critical need is expertise to address the anticipated global shortage of information security workers over the next five to seven years. For example, the U.S.

Public Sector Value at Stake (cont.)

Citywide Wi-Fi
Value: $0.70/citizen/month
Outcome: new revenue from selling access and advertising; reduced emissions from increased bus ridership

Traffic Optimization
Value: $10/driver/month
Outcome: reduced travel time and increased fuel savings; lower operating costs for buses; improved traffic incident management

Environmental Sensing
Value: $0.03/citizen/month
Outcome: data sales

Smart Buildings
Value: $0.20/square foot/month
Outcome: energy and OpEx savings

Retail Value at Stake

Supply Chain/Logistics Efficiency
Value: $104 million annual EBIT contribution
Outcome: reduced out-of-stocks; improved fleet operations; assortment optimization

Improved Customer Experience
Value: $38 million annual EBIT contribution
Outcome: personalized promotions; interactive point-of-purchase capabilities; higher revenue from self-service channels; smart lockers; incremental in-store sales; higher online revenues; revenue lift from "endless aisle" capabilities

Asset Utilization
Value: $11 million annual EBIT contribution
Outcome: "Checkout Optimizer" driven by edge analytics; smart buildings; IP-based physical security

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Department of Labor predicts that from 2012 to 2022, the number of "information security analyst" jobs will grow by 37 percent (compared with low-single-digit growth for other skilled jobs over the same time span). According to Cisco's 2014 Annual Security Report, an estimated 1 million information-security staff and managers are needed to fill the global demand over the next five years.[23]

The greatest value, however, will come from employees whose knowledge intersects data science, design, and enterprise architecture. To deliver true value, data insights must link to specific business processes and outcomes.

To help enable this linkage, the role of chief data officer (CDO) is becoming increasingly common in organizations around the world. According to Stuart Coleman, commercial director at The Open Data Institute, CDOs are "essentially responsible for determining how data can be used across an organization and the operational environment to drive better business outcomes."[24] Gartner predicts that 25 percent of large global organizations will have appointed CDOs (also known as "Big Data Czars") by January 2015.

Develop Business Process Agility

While IoT presents tremendous opportunities for process improvement, many organizations lack the agility to capitalize on these improvements. Our survey respondents agree. When we asked them to identify the biggest challenges to effective use of IoT, "Difficulty of updating the organization's business processes for new IoT solutions" topped the list – ahead of "Inadequate funding" and "Lack of a clear business case for deploying IoT solutions."

One challenge is the increasing difficulty of actually "seeing" what an organization's processes look like, especially as processes have become embedded into software such as ERP (Enterprise Resource Planning). Research and experience have shown that it's important to address process efficiency first – before using technology to automate it. Business process agility is also dependent on factors such as organizational culture, business process management capability, and process characteristics unique to a particular organization.[25]

In addition, unless it is a startup, each organization already has established business processes that define its operations. These processes are often extremely complex and incorporate labor and assets in a unique way. Legacy equipment and assets further complicate matters.

Foster the IT/OT Partnership

Much has been written about the evolving and converging roles of information technology (IT) and operational technology (OT) leaders. Because IoT solutions bridge both IT and operational technology, it will be critical for organizations to develop a strong IT-OT partnership.

CASE STUDY

IoT Helps Israel's Hagihon Save Water, Cut Costs, Boost Profits

IoT Solution: Sensors and advanced analytics for smart water management and conservation; solution includes SCADA and GIS systems, water-usage analytics, and leak-detection sensors.

Outcome: Reduced water loss; improved efficiency and cost savings from sensor-based data collection and monitoring; higher profitability.

Learn more here.

See more examples of IoT in action here.

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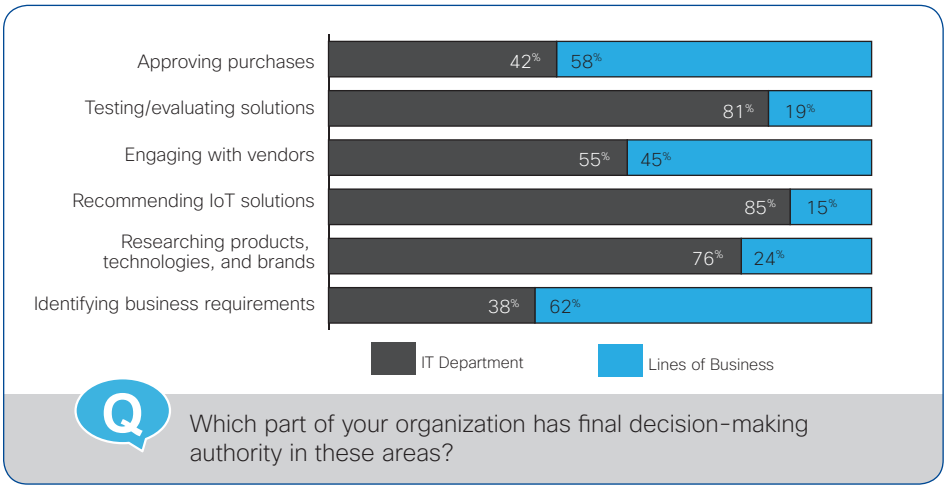
IT typically comprises the whole technology stack, including the hardware, infrastructure, and software applications used to process data. IT systems accept data flows as inputs to deliver a new data flow, but do not interfere with the physical world. IT includes, for example, ERP systems and CRM (Customer Relationship Management) applications.

OT, on the other hand, consists of devices and processes that act in real time on physical operational systems, such as electricity distribution networks, facilities, or vehicle production plants. Examples of OT elements include MES (Manufacturing Execution Systems), SCADA (Supervisory Control and Data Acquisition) devices, meters, valves, sensors, and motors.

Until now, most industries have developed and managed OT and IT as two different domains, with separate technology stacks, protocols, standards, governance models, and organizations. However, over the last few years, OT has started to progressively adopt IT-like technologies. For example, OT and other line-of-business functions now have direct access to cloud services and applications that didn't exist even a few years ago. In many cases, they can procure these services without IT's involvement. However, they still have a responsibility to procure cloud security that aligns with corporate interests.[26]

Figure 7
IT and OT will share increased responsibility for IoT solutions in the future.



Source: Cisco Consulting Services, 2014

At same time, IT now has to consider sales and other key business drivers. IT can no longer afford to be "reactive" – it must now act as a business partner. Both IT and OT must work together to make business decisions.

Effective IT–OT convergence has many benefits, including optimized business processes, enhanced information for better decisions, reduced costs, lower risks, and shortened project timelines.[27]

To achieve these advantages, the IT and OT executives we surveyed feel that both groups will share increased responsibility for IoT solutions in the future. However, they are not completely aligned on who will have decision-making authority over each stage in the adoption process – particularly in the areas of engaging with vendors and approving purchases. [Figure 7, previous page]

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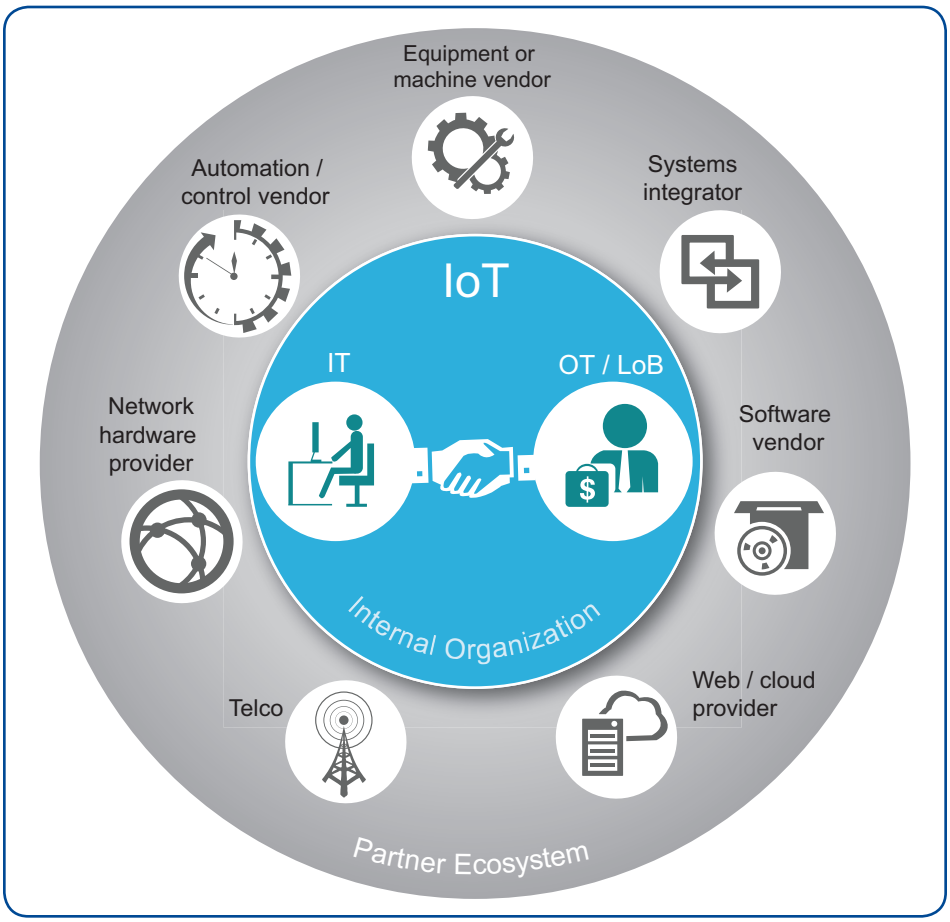
Our study showed that decision-making authority will largely depend on the stage of IoT solution adoption. OT/LoBs will have decision-making authority at the beginning and end of the adoption process – that is, identifying business requirements and approving purchases. In contrast, the IT department will drive decisions regarding specific steps of implementation, such as researching solutions, engaging vendors, recommending solutions, and testing solutions.

In order to make progress with IoT, organizations will need to promote a strong partnership between IT and OT leaders to ensure alignment in helping achieve desired business outcomes.

Figure 8
Success requires an ecosystem of internal and external partnerships.



Source: Cisco Consulting Services, 2014

Build the Right Partner Ecosystem

The complexity of IoT solutions necessitates that organizations seek outside assistance from not just one but a range of vendors. Orchestration of this network of relationships across the adoption lifecycle will be paramount to success.

Among survey respondents who have already adopted IoT solutions, most are already using multiple vendors to meet their IoT needs. [Figure 8]

According to our survey, the area in which organizations need the most assistance from third-party vendors is strategic planning for IoT solutions (cited by 37 percent of respondents). Implementation was the No. 2-ranked area of need (named by 30 percent of respondents). Only 12 percent identified "Understanding the Business Case" as the area where they need the most help. It seems that most companies now understand the value of IoT – they need help realizing the vision.

Our survey revealed that, **when considering third-party vendors, organizations are most interested in**

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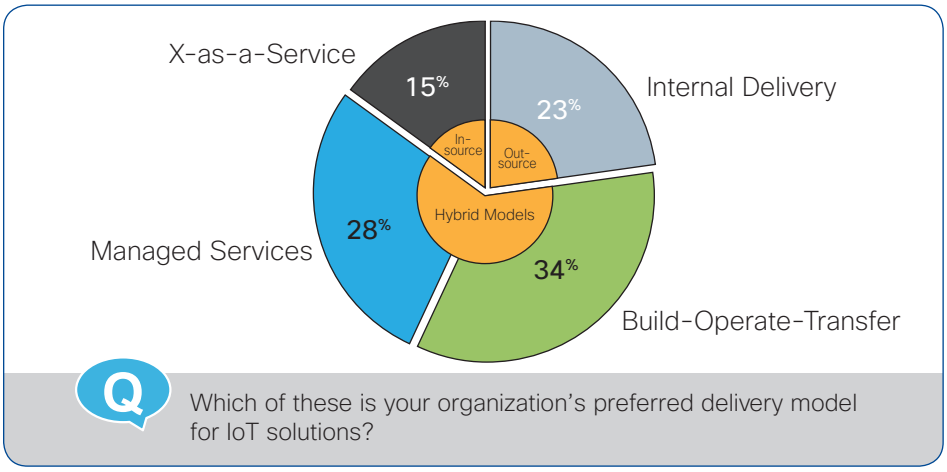
the ability of these providers to 1) ensure security and to 2) offer solutions that are customized for their specific needs.

A focus on security is now regarded as "table stakes" for IoT providers hoping to win business. The enterprise security model of the past 10 years has been marked by two chief tenets:

- First, security has been focused on best-of-breed applications and appliances: solutions for firewall, for network security, for data security, for content security, and so forth.
- Second, security has been "perimeter-based," meaning organizations secured the end device and the server, and reacted to (i.e., recognized) intrusions or threats such as viruses or denial-of-service attacks.

But when we connect the previously unconnected – by placing applications in the mobile cloud, by introducing new devices that enable innovative working modalities for employees, by leveraging sensors and machine-to-machine communications to monitor equipment – new points of ingress for security threats inevitably materialize. This is sometimes referred to as the expanding "attack surface." As the worlds of IT and OT intersect, there are many more opportunities for cross-contamination and new security vulnerabilities.

Figure 9
When consuming IoT services, our respondents expressed the strongest preference for "hybrid" models such as build-operate-transfer (BOT) and managed services.



Source: Cisco Consulting Services, 2014

With the extensive amount of process change required to capitalize on IoT, organizations also want IoT solutions that are built for their unique needs. While vendors may seek to build replicable, scalable IoT offerings, it is clear that some degree of customization will be required to adapt their solutions to the unique operational processes of each customer.

Focus on a Platform Approach

The need to integrate many different technologies into a cohesive IoT platform impacts the ways in which these solutions can be delivered. When asked about preferred delivery models for IoT solutions, our survey respondents expressed the strongest preference for a "hybrid model" – in other words, build-operate-transfer (BOT) and managed services. [Figure 9]

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In both of these models, vendors assume a significant role in building and operating IoT solutions, while the customers still retain control or ownership over certain aspects of the delivery model. Given the operational criticality of IoT solutions for these companies, it is not surprising that they would want to take a "shared risk" approach, obtaining help where they need it most, while retaining control over their operations.

Finally, it is important to consider whether to employ one of the emerging IoT standard reference frameworks. In just the past two years, the number of IoT-related standards bodies has jumped from two (in 2012) to seven (in 2014). In addition, 260 companies are now participating in IoT consortia.[28]

Cisco recently helped develop the IoT World Forum Reference Model, which seeks to provide a common IoT terminology, bring clarity to how information flows and is processed, and offer a framework for creating a unified IoT industry.[29] The overall goal of the initiative is to define an "open system" for IoT as a first step toward IoT product interoperability across vendors. The IoT World Forum Reference Model assists IT departments, CIOs, and developers by offering practical suggestions for addressing IoT challenges such as scalability, interoperability, agility, and compatibility with legacy systems. The Model resulted from collaboration among the 28 members of the IoT World Forum's Architecture, Management, and Analytics Working Group, which includes Intel, GE, Itron, SAP, Oracle, and Cisco, among others.

Another example is the Human-Centric IoT Platform, which allows Fujitsu customers to leverage that company's sensors, networks, middleware, and applications to test new ideas for IoT applications.[30] Fujitsu hopes to work with more than 100 Japanese enterprise clients on IoT testing in 2014-2015. As of November 2014, Fujitsu had not decided whether it would offer the platform to developers outside Japan.

CASE STUDY

San Francisco Gets Smarter Parking Spaces

IoT Solution: Parking, garage, and roadway sensors for real-time parking and traffic analysis. Deployed in approximately 20,000 parking spaces.

Outcome: Reduced parking search time by 43 percent; 23 percent fewer parking citations; reduced double parking, alleviating traffic congestion.

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See more examples of IoT in action here.

Next Steps

The message is clear: to remain competitive and meet increasing customer/citizen demands, organizations must find ways to innovate faster and more efficiently. IoT can be a double-edged sword – while it provides a potential solution to the innovation imperative, it can also significantly boost operational complexity if not properly integrated with key organizational processes.

To achieve their share of Value at Stake in the future, organizations will need to harness the Internet of Things (and, by extension, the Internet of Everything). The ultimate rewards will make the journey highly worthwhile – but only if organizations keep the following insights in mind:

1. Winners will be those who derive the most value from their connections – not those who simply connect the most devices to their networks. Organizations must focus on honing the data and process components of IoT.

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2. When it comes to data, three things matter: integration, automation, and analytics. All three are essential to convert data to information and subsequent actionable insights.
3. In the world of IoT and Big Data, edge computing/analytics capabilities have become essential. For a variety of reasons – including low-latency requirements and cost – organizations must learn to "take analytics to the data" rather than the other way around.
4. Process agility is essential to capitalize on the opportunities presented by IoT and IoE. As such, strategic planning should the No. 1 priority.
5. Success will hinge on creating an ecosystem of internal and external partnerships. In particular, this includes harmonization of roles between IT and OT, along with partnerships with a variety of external providers. Another critical factor is making sure that IoT and data analytics become foundational elements of the organization's strategy – thereby receiving strong support from company leadership.

Acknowledgements

The authors gratefully acknowledge the important contributions of the following people to the development of this paper: Joel Barbier, Joseph Bradley, Lauren Buckalew, Blair Christie, Wim Elfrink, Scott Fields, Mike Flannagan, Jim Green, Stacy Greiner, Hari Harikrishnan, Inbar Lasser-Raab, James Macaulay, Christopher Reberger, Mike Riegel, Hiten Sethi, Rick van der Lans.

CASE STUDY

Transwestern Achieves Differentiation Through Smarter Buildings

IoT Solution: Automated environmental controls (e.g., air conditioning), remote building monitoring and management via mobile device, connected security cameras, automated work order management, in-building digital signage.

Outcome: Reduced energy costs by 21 percent from 2011 to 2012 and another 11 percent in first eight months of 2013. Improved tenant service and satisfaction.

Learn more here.

See more examples of IoT in action here.

1. "Creative Destruction in the S&P 500 Index," American Enterprise Institute, January 26, 2014
2. The Internet of Things is sometimes referred to as "machine-to-machine" or "M2M communications."
3. "IoT in the Enterprise Up Three-Fold, Study Finds," *Network World*, November 24, 2014
4. "If You Think Big Data's Big Now, Just Wait," *TechCrunch*, August 10, 2014
5. "Chevron Makes Seismic Storage Shift," Enterprise Storage Forum, October 11, 2005
6. automotivesensors2015.com
7. "Trillions of Sensors Feed Big Data," *Signal* Online, February 1, 2014
8. "Big Data and What it Means," U.S. Chamber of Commerce Foundation
9. Largely because of its complexity and lack of structure, Big Data creates a host of regulatory compliance challenges – especially for industries that must adhere to strict regulatory standards, such as financial services and healthcare. The secret to ensuring Big Data compliance is to identify and isolate the compliance-sensitive portions of the data. Fortunately, vendors are starting to offer compliance toolkits designed for the Big Data environment. Industry standard ISO/ IEC 27002 provides a security framework based on the cycle of Plan, Do, Check, and Act (PDCA). Source: "Big Data and Compliance: Isolating Critical Items," GRT Corporation
10. "The Network Is the Database," Rick van der Lans, January 14, 2014
11. Wikipedia
12. "Fog Computing, Ecosystem, Architecture and Applications," Cisco
13. "The Evolution of the Internet of Very Smart Things Will Require a Major Internet Reboot," Irving Wladawsky-Berger, *CIO Journal*, October 17, 2014
14. "Fog Computing: A Platform for Internet of Things and Analytics," Flavio Bonomi, Rodolfo Milito, Preethi Natarajan and Jiang Zhu, 2014

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15. "Internet of Things Technologies Could Transform Oil, Gas Industry," Karen Boman, *Rigzone*, September 1, 2014
16. "Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East," IDC, February 2013
17. "Drones Already Work in Amazon's Warehouses," Voice of America News, December 10, 2013
18. "Data and Analytics for IoT," Mike Flannagan, VP, GM, Data & Analytics Business Group, Cisco
19. "One in Three Jobs Will Be Taken by Software or Robots by 2025," *Computerworld*, October 6, 2014
20. "The Future of Employment: How Susceptible Are Jobs to Computerisation?," Oxford Martin, *The Future of Employment*, September 2013
21. "MIT's 6-Week Big Data Online Class Wins Fans," *InformationWeek*, September 29, 2014
22. "IoT Developers Wanted: 4.5 Million by 2020," IoT Zone, July 7, 2014
23. Cisco 2014 Annual Security Report; Career Builder; Bureau of Labor and Statistics; Cisco Consulting Services
24. "Chief Data Officers: The New 'Big Data Czars'?," *E&T*, July 14, 2014
25. "Influence of ERP Systems on Business Process Agility," *IIMB Management Review*, September 2013
26. "The Convergence of IT and Operational Technology," Atos, November 2012
27. Gartner, July 2012
28. Factiva, Google, IPSO-Alliance, Intel
29. "The Internet of Things World Forum Unites Industry Leaders in Chicago to Accelerate the Adoption of IoT Business Models," Cisco, October 14, 2014
30. "Fujitsu Brews up Cloud Platform to Test IoT Ideas," *Network World*, November 13, 2014

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