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Reaping the Benefits of the Internet of Things

Ubiquitous Internet connectivity and devices present organizations with tremendous opportunity to create innovative products and services, drive down operational costs and serve up additional revenue streams. Before IoT's potential can be realized, organizations must deal with shortcomings in IT standards, skill sets, and data and infrastructure management capabilities.

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Executive Summary

The Internet of Things (IoT)[1] is a fast-emerging ecosystem of IP-connected devices with the potential to deliver significant business benefits valued at trillions of dollars in the coming decade across industries. Organizations can use IoT to drive considerable cost savings by improving asset utilization, enhancing process efficiency and boosting productivity. More importantly, IoT-driven innovations are expected to increase return on R&D investments, reduce time to market, and open up additional sources of revenue from new business models and opportunities.

IoT is driven by a combination of forces, including the exponential growth of smart devices, a confluence of low-cost technologies (sensors, wireless networks, big data and computing power), pervasive connectivity and massive volumes of data. Even though IoT offers huge value potential, organizations must overcome key challenges, such as the lack of interoperable technologies and standards, data and information management issues, privacy and security concerns, and the skills to manage IoT's growing complexity.

These steep challenges, however, are surmountable. Organizations need to take an integrated and holistic view of IoT, examine the opportunities it offers and build strong business cases for enhancing revenue, increasing efficiencies and improving asset management. They also need to master IoT's growing intricacy and identify initial business areas and operations where IoT can deliver significant benefits. Developing robust data management and analytics capabilities will be crucial for organizations to mine valuable insights from the data generated by the transactions and interactions that occur within

Internet of Things: A Transformational Force

Industry	Key Change	Potential Benefits
Automotive and Transportation	Real-time driving behavior, traffic and vehicle diagnostics.	Improved customer experience, reduced pollution, increased safety and additional revenue streams.
Healthcare	Remote monitoring of staff and patients ability to locate and identify status of equipment.	Improved employee productivity, resource usage and outcomes that result in efficiency gains and cost savings.
Manufacturing	Quick response to fluctuations in demand; maximized operational efficiency, safety and reliability, using smart sensors and digital control systems.	Enhanced agility and flexibility, reduced energy consumption and carbon footprint.
Retail	Stock-out prevention through connected and intelligent supply chains.	Ability to predict consumer behavior and trends, using data from video surveillance cameras, social media, Internet and mobile device usage.
Supply Chain	Real-time tracking of parts and raw materials, which helps organizations preempt problems, address demand fluctuations and efficiently manage all stages of manufacturing.	Reduced working capital requirements, improved efficiencies and avoidance of disruptions in manufacturing.
Infrastructure	Smart lighting, water, power, fire, cooling, alarms and structural health systems.	Environmental benefits and significant cost savings with better utilization of resources and preventive maintenance of critical systems.
Oil and Gas	Smart components.	Reduced operating costs and fuel consumption.
Insurance	Innovative services such as pay-as-you-go insurance.	Significant cost savings for both insurers and consumers.
Utilities	Smart grids and meters.	More responsive and reliable services; significant cost savings for both utilities and consumers resulting from demand-based and dynamic pricing features.

Source: Ericsson, M2M Magazine 2013, Zebra Consulting/Forrester Research, IBM, McKinsey & Co., Data Informed, ZDNet
Figure 1

the IoT ecosystem. We call this rich data source a "Code Halo™" – the information that surrounds people, organizations, processes and products. Increasingly, Code Halos are forming the new basis for competition, as they contain a richness of business meaning that today's high-flying companies are using to dominate their sectors.[2]

Further, managing the IoT ecosystem, the myriad technologies that underlie it, and the data it generates – not to mention developing use cases to improve business – will require organizations to hire, recruit and train skilled talent, which is in short supply. Because IoT ecosystems comprise numerous technologies and devices running on different networks, organizations will need to partner with third-party specialists to complement their in-house capabilities. These partner organizations should be evaluated on their strength of expertise, industry knowledge and ability to address the complexity of connecting a wide array of technologies and platforms on which the devices will run.

The state of IoT remains fluid. However, the forces driving it are gaining momentum. Winning organizations will be those that master and hone the ability to manage a pervasive, IP-aware infrastructure for a diversity of devices and sensors. From there, organizations that can apply Code Halo thinking to the torrent of resulting interactional and transactional data in ways that drive more informed (perhaps even clairvoyant) decision-making will achieve new thresholds of performance.

Cross-Industry Transformation

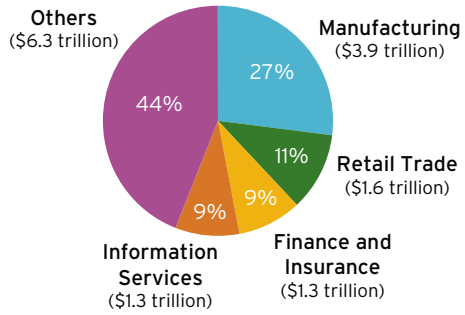
IoT is already heralding transformation across industries, and it will bring about even more significant change in the coming years (see Figure 1, previous page).

IoT can help organizations utilize their business infrastructure and assets in innovative ways to offer new services and deliver additional revenue. Moreover, deriving meaningful information from the huge volumes of data that IoT produces can improve decision-making and enable proactive, predictive insights. While the scope and potential of IoT is vast, four industries are best poised to reap the benefits (see Figure 2).

Compelling Benefits of IoT

IoT offers compelling business benefits and value that organizations cannot afford to ignore

Four Industries with Most to Gain from IoT



(Total value: $14.4 trillion)

Source: Cisco

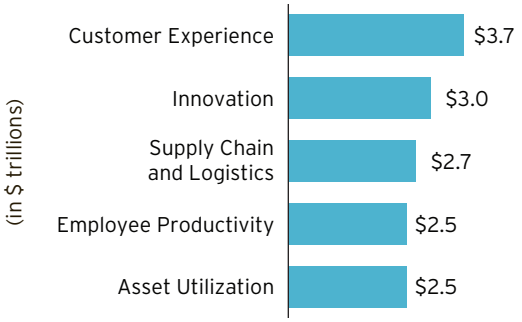
Figure 2

(see Figure 3), including cost savings, improved revenues and opportunities to innovate.

- **Cost savings:** Costs can be reduced through improved asset utilization, process efficiencies[3] and productivity. Customers and organizations can benefit from improved asset utilization (e.g., smart meters that eliminate manual meter readings) and service improvements (e.g., remote monitoring of patients in clinical settings).[4] General Electric has estimated that if intelligent machines and analytics caused even a tiny reduction in fuel, capital expenditures and inefficiencies, it would result in billions of dollars in cost savings (see Figure 4, next page).

- **Improved asset utilization:** With improved tracking of assets (machinery, equipment, tools, etc.) using sensors and connectivity, businesses can benefit from real-time insights

IoT Levers that Unlock Value



Source: Cisco

Figure 3

and visibility into their assets and supply chains.[5] For instance, they could more easily locate assets and run preventive maintenance on critical pieces of infrastructure and machinery to improve throughput and utilization.[6]

- **Efficient processes:** Organizations can use real-time operational insights to make smarter business decisions and reduce operating costs. They can use real-time data from sensors and actuators to monitor and improve process efficiency, reduce energy costs and minimize human intervention.

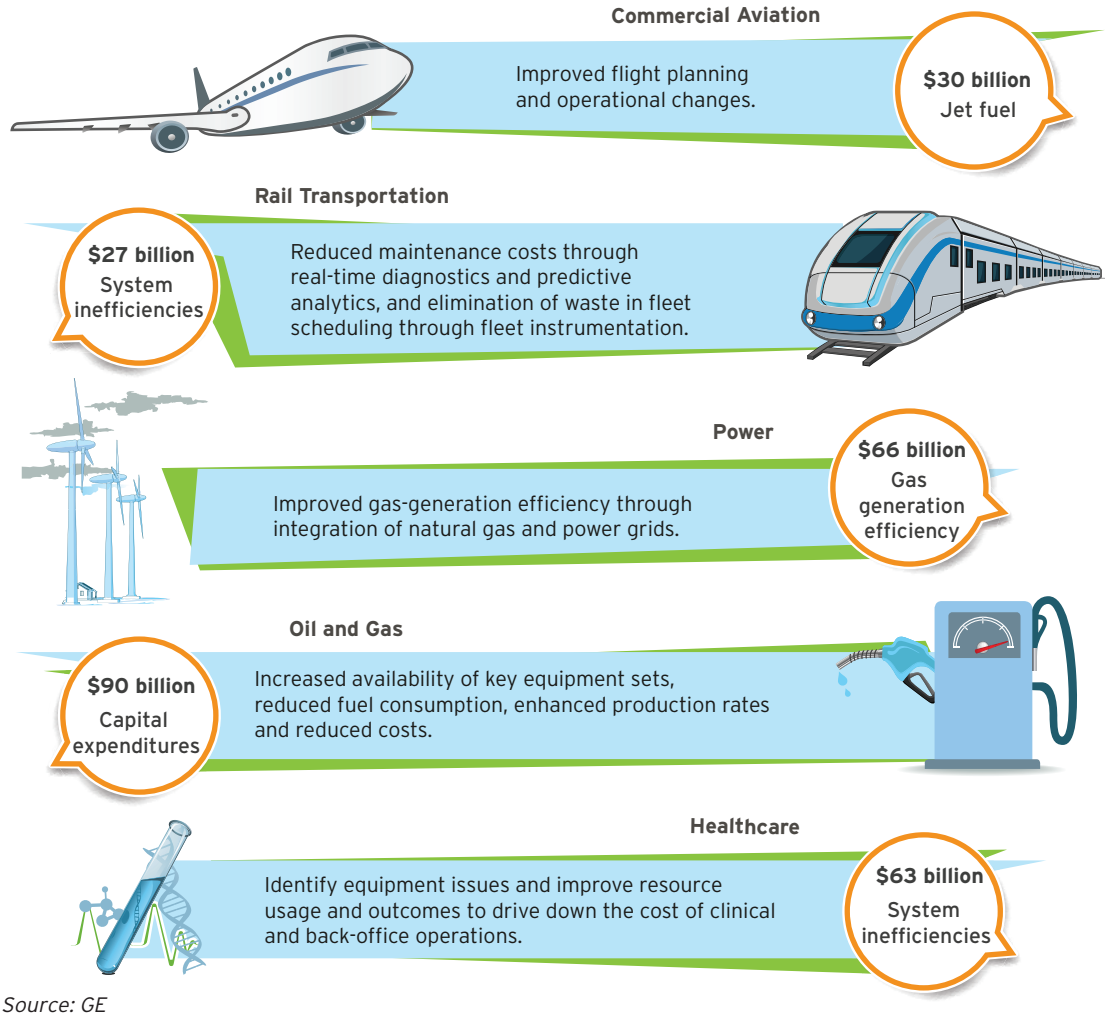
- **Improved productivity:** Productivity is a critical parameter that affects the profitability of any organization. IoT improves organizational productivity by offering employees just-in-time training, reducing the mismatch of required vs. available skills and improving labor efficiency.[7]

Opening New Revenue Streams with Innovation

IoT introduces innumerable opportunities for innovative services that can be offered using smart devices, machines and products. Organizations can benefit from new revenue streams generated by new business models and services, as well as reduced time to market and increased returns from their R&D investments. According to some forecasts, the sale of connected devices and related services (such as pay-as-you-drive car insurance) could result in $2.5 trillion in revenues by 2020.[8] Further, IoT's value to organizations

How IoT Generates Value

Estimated cost savings (cumulative) in five industries over 15 years, propelled by a 1% reduction in fuel, capital expenditures and inefficiencies.



Source: GE

Figure 4

across industries is estimated to reach $14 trillion in the coming decade, which will likely result in a 21% increase in global corporate profits by 2022.[9]

IoT Futures

The acceleration of IoT from lofty concept to reality is predicated on the projected exponential growth of smart devices and the confluence of low-cost infrastructure, connectivity and data. Declining device costs, widespread and pervasive connectivity, and an ever-increasing focus on operational efficiency and productivity is leading to wide deployment of IoT solutions. In a 2012 survey by Zebra Consulting and Forrester, only 15% of organizations had an IoT solution in place, but more than half (53%) had plans to implement one in the next two years, and an additional 14% planned to implement in the next two to five years. Roughly 21% of respondents from the transportation and logistics sector indicated that an IoT solution was already in place.[10]

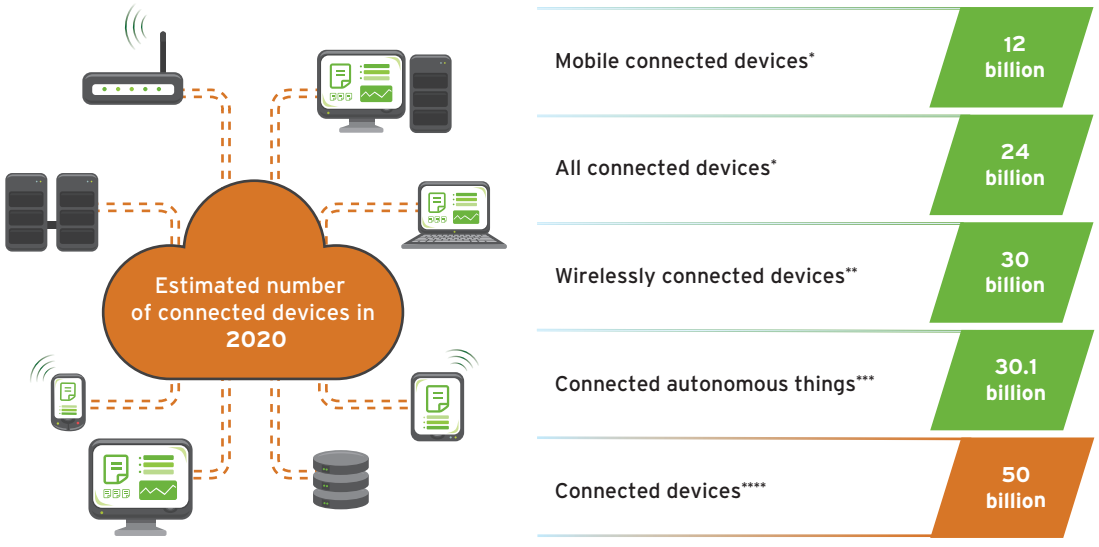
- **Billions of smart devices are becoming connected:** The number of connected smart devices is exploding, with 50 billion devices possible by 2020 (see Figure 5). Similarly, machine-to-machine (M2M) connections – which are a key part of the fabric of IoT – are also on the rise. Machina Research estimates that M2M connections will grow to 18 billion by 2022, up from two billion in 2011.[11]
- **Confluence of low-cost technologies, connectivity, data and sensors:** Declining sensor costs, a dramatic increase in computing and processing power, low-cost data storage and widespread low-cost, high-bandwidth connectivity has brought IoT to a tipping point. For instance, services that require connectivity are becoming affordable as cellular M2M module costs have declined at a rate of 15% per year, and the cost of connectivity has plummeted, with 1GB now costing $1.50.[12] Aiding the connectivity needs of the exploding universe of smart objects is the new standard Internet Protocol (IPv6), which uses a 128-bit address to offer 340 undecillion (or 3.4 x 10^{38}) unique IP addresses, enough to connect the billions of smart objects that humankind will be using in the years to come.

Issues and Challenges

Notwithstanding IoT's tremendous potential, organizations must overcome numerous issues and challenges that are inhibiting IoT's growth. To get grounded in and eventually master IoT, organizations will need to work closely with mature vendors to overcome key hurdles, such as:

- **A lack of standards and interoperable technologies:** The sheer number of vendors, technologies and protocols used by each class of smart devices inhibits interoperability.

IoT Drivers: Exponential Growth of Smart Devices and Sensors



*Source: * GSMA, ** ABI Research, *** IDC and **** Cisco*
Figure 5

The lack of consensus on how to apply emerging standards and protocols to allow smart objects to connect and collaborate makes it difficult for organizations to integrate applications and devices that use different network technologies and operate on different networks.[13] Further, organizations need to ensure that smart devices can interact and work with multiple services.[14]

- **Data and information management issues:** Routing, capturing, analyzing and using the insights generated by huge volumes of IoT data in timely and relevant ways is a huge challenge with traditional infrastructures.[15] The sheer magnitude of the data collected will require sophisticated algorithms that can sift, analyze and deliver value from data.[16] As more devices enter the market, more data silos are formed, creating a complex network of connections between isolated data sources. The lack of universal standards and protocols will make it even tougher for organizations to eliminate data silos.

- **Privacy and security concerns:** Deriving value from IoT depends on the ability of organizations to collect, manage and mine data. Securing such data from unauthorized use and attacks will be a key concern. Similarly, with many devices used for personal activities, many users might not be aware of the types of personally identifiable data being collected, raising serious privacy concerns. And because most devices involve minimal human interference, organizations need to be concerned about hacking and other criminal abuse. A far bigger potential for risk in the future is a security breach or a malfunctioning device that induces catastrophic failures in the IoT ecosystem.[17]

- **Organizational inability to manage IoT complexities:** While IoT offers tremendous value, tapping into it will demand a whole new level of systems and capabilities that can harness the ecosystem and unlock value for organizations.[18] For instance, making sense of the flood of data generated by sensors every millisecond will require strong data management, storage and analytics capabilities. Similarly, policy makers will need to address data, security and privacy concerns. Organizations will also need to develop skills to preempt potential component failures and replacements, using preventive servicing and maintenance practices to ensure business operations run effectively and efficiently.

Taking Advantage of IoT

The steep business and technological challenges on the path to IoT can be surmounted by taking an integrative and holistic view of the opportunities that IoT offers to build potential business cases. To start with, organizations should consider the choice of integrating traditional infrastructures with the new intelligent assets or building new enabling infrastructure to support them. Organizations should focus on how their ability to manage, control and monitor intelligent remote assets can result in material and measurable improvements in profitability and revenue.[19]

- **Understand IoT complexity and identify areas where it can offer significant benefits.** As organizations brace for digital disruption in their industries, decision-makers from multiple business functions – including finance, sales, marketing and supply chain – should identify and prioritize the resulting opportunities and risks. Similarly, organizations should focus on developing technology-agnostic solutions to help mitigate threats and capitalize on opportunities. Further, leaders should identify key elements that will be required to develop effective solutions to deal with potential scenarios. CIOs should be encouraged to gain a deep understanding of IoT to take advantage of its benefits.

- **Develop robust data management capabilities.** CIOs can play a crucial role in identifying the data types deemed most valuable for improving operational efficiencies. This starts with specifying the equipment and machines that provide such data and determining how that data should be captured, stored and analyzed to gain insights that can lead to operational improvements.

  With data holding the key value in the IoT ecosystem, organizations need to harness the intelligence generated by connected products to transform their businesses.[20] This involves leveraging a combination of social, mobile, analytics and cloud technologies (or the SMAC Stack™) to produce actionable insights and derive more value from IoT.

- **Develop strong analytics capabilities.** Deriving value from IoT requires the ability to manage and analyze large volumes of data. Doing so requires more than basic data management capabilities and traditional infrastructures. Organizations will need to leverage the latest developments in cloud, big data and analytics to mine the large and fast-changing volumes of data for insights.

- **Recruit and train talent to manage IoT.** While technology and capabilities are important, equally important are the skills to manage IoT complexity and large amounts of data that IoT ecosystems will produce. For instance, by 2020, the digital universe will reach 44 zettabytes – a 10-fold increase from 2013.[21] On top of this, analysts will need deep domain knowledge of the specific industries they operate in to ensure they use the right data to generate useful insights. Organizations will be encumbered by the shortage of data scientists expected in the coming years.[22]

- **Seek help from specialists to complement in-house capabilities.** Organizations will likely require help from external specialist organizations to ensure that data is captured and insights are acted upon in timely ways. Specialist partners can offer strong industry and domain knowledge, technical expertise, customer service capabilities and help desk expertise. Numerous surveys indicate that a majority of organizations are planning to partner with device manufacturers and solution providers to implement and benefit from IoT.[23]

- **Take advantage of network-centric operations.** As the IoT ecosystem comprises smart devices and connections between them, organizations should build and take advantage of network-centric operations. In this setup, information is shared with users who are provided with need-based access to information. Network-centric operations with strong system interoperability and enterprise management features will allow users to overcome the limits of organizational barriers to access real-time data and eliminate location dependency.

- **Integrate machine data with enterprise systems to optimize business processes.** The real value of the IoT lies in integrating data produced by devices with business processes to optimize critical functional areas and improve operational performance. Organizations should also focus on how the data produced by the IoT ecosystem can be used to improve products, services and processes or develop new ones. For instance, organizations can improve inventory management by using the real-time data generated by M2M communications to eliminate the manual collection of information on stock levels.

- **Use Code Halos to establish new thresholds of business performance.** The IoT ecosystem, with its billions of connected smart devices, continuously produces and shares digital information. Businesses can use these Code Halos to create unprecedented levels of insights and business value.

Looking Ahead

By mastering and honing their ability to create and manage Code Halos, industry leaders are establishing new thresholds of performance and delivering highly personalized customer experiences, products and services, while achieving high efficiency levels. Organizations can only expect to witness faster transformation and disruption of their traditional business models given the rate at which digital technologies, devices, connectivity and networks are evolving. Clearly, the winners will be companies that weave Code Halos into the fabric of their business to compete with new entrants to keep growing their business.

Footnotes

[1] An intelligent network of interconnected objects with unique identities that have the ability to sense, interact and communicate with each other about their states and environment using embedded communication and processing capabilities/technology.

[2] Code Halo is the coded information surrounding people, companies and things. For more on this topic, see *Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business,* written by Malcolm Frank, Paul Roehrig and Ben Pring, and published by John Wiley & Sons, March 2014, *http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118862074.html*.

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