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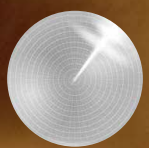
INTERNET OF THINGS IN LOGISTICS

A COLLABORATIVE REPORT BY DHL AND CISCO ON IMPLICATIONS ANDUSE CASES FOR THE LOGISTICS INDUSTRY



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PREFACE

We at DHL and Cisco are excited to share this new trend report with readers from the logistics industry on a topic that fires the imaginations of both our companies: the Internet of Things (IoT).

IoT presents a unique technology transition that is impacting all our lives and will have huge implications for the business of logistics. As we move from 15 billion connected devices today to some 50 billion by 2020, and embed sensor technology and analytics throughout our organizations, companies will enjoy unprecedented visibility into operations, enabling new sources of value. This visibility, in turn, will transform how logistics providers make decisions, including about how goods are stored, monitored, routed, serviced, and delivered to customers, as well as operational health and safety practices.

Furthermore, the proliferation of IoT for our homes, work environments, cities and even ourselves (with the emergence of wearable technologies and biomedical sensors) creates opportunities for new business models in logistics. We believe there is hidden value yet to be realized.

This trend report aims to deepen readers' understanding of IoT, covering three main issues:

- What is the Internet of Things, and why is it a big deal?
- What are some of the leading practices and applications of IoT that are generating value across sectors?
- What are some of the key use cases for IoT in the logistics industry specifically, and what will be their implications?

DHL and Cisco share a belief in the potential of IoT to revolutionize business processes across the entire value chain, and particularly the experiences of our customers. In our collaboration, we will explore a few of the many innovations presented by IoT, and their application to the logistics industry. We hope you find the journey illuminating.

Yours sincerely,

James Macaulay
Cisco Consulting Services

Dr. Markus Kückelhaus
DHL Trend Research

1 UNDERSTANDING THE INTERNET OF THINGS

1.1 Introduction: Connecting the Unconnected

In today's society, the Internet is often considered a "given" due to its ubiquitous presence and accelerating influence on the ways in which we live, work, and communicate with one another. But how did the Internet get so large so quickly, and what role will it play in the future?

The Internet has undergone numerous stages of development, dating back to the founding days of ARPANET, the first TCP/IP network from which today's Internet evolved. Throughout these stages, the Internet has fundamentally been about connecting computers. These computers, of course, continue to evolve in parallel with the build-out of the Internet, with significant developments in PCs, laptops, tablets, smartphones, and more. Regardless of the many different form factors and computing architectures, the Internet essentially revolved around connecting these devices whose sole reason to exist was to send, receive, process, and in most cases store information. Until relatively recently, the Internet has been composed entirely of computers connected to one another over the network.

Today this is no longer the case. We have entered a unique period in the life of the Internet — the Internet of Things (IoT). IoT is not an entirely new concept, having originated in the early 2000s with the work of MIT's AutoID Lab.[1] While definitions vary, perhaps the simplest way to think of IoT is to consider it as the networked connection of physical objects.

With the advent of IoT, Internet connections now extend to physical objects that are not computers in the classic sense and, in fact, serve a multiplicity of other purposes (see Figure 1). A shoe, for example, is designed to cushion the foot while walking or running. A street light illuminates a road or sidewalk. A forklift is used to move pallets or other heavy items. None of these have traditionally been connected to the Internet — they did not send, receive, process or store information. Nonetheless, there is information latent in all of these items and their use. When we connect the unconnected — when we light up "dark assets" — vast amounts of information emerge, along with potential new insights and business value.

A connected shoe can tell its owner (or a researcher, or a manufacturer) the number of footfalls in a given period of time, or the force with which the foot strikes the ground. A connected street light can sense the presence of cars, and provide information to drivers or city officials for route planning and to optimize the flow of traffic. A connected forklift can alert a warehouse manager to an impending mechanical problem or safety risk, or be used to create greater location intelligence of inventory in the warehouse.

Figure 1: The Connected Home and Consumer

[1] http://newsoffice.mit.edu/2012/auto-id-cloud-of-things-big-data

To light up such dark assets, IoT encompasses a diverse array of different technologies including wireless local (e.g., Bluetooth, RFID, Zigbee, Wi-Fi), mesh network, and wide area connections (e.g., 3G, LTE), as well as wired connections. Increasingly, IoT represents the convergence of information technology (IT) and so-called "operational technology" (OT). OT is characterized by more specialized, and historically proprietary, industrial network protocols and applications that are common in settings such as plant floors, energy grids, and the like.

Of course, IoT also includes more consumer-oriented devices, embedded technologies, and apps. An important element of this is the incorporation of controllers and actuators (Arduino is a well-known example), so that an action taken in the *digital world*, such as a user clicking a link in an application, can result in a corresponding action in the *physical world* (e.g., an alarm sounds, a lever flips, an assembly line comes to a halt).

However, we are only at the beginning of the IoT revolution. So far, less than one percent of all physical objects that could be connected to the Internet are currently connected. In numbers, that means of the roughly 1.5 trillion items on earth that could benefit from an IP address, just under 15 billion are connected to the Internet today.[2] The average consumer in a developed nation is surrounded by dozens of connectable items. These include computers, consumer electronics, and communication devices (e.g., smartphones); appliances; physical materials in the home (e.g., thermostat, plumbing); clothing and wearable devices; vehicles and much more. By 2020, Cisco estimates there will be more than 50 billion devices connected to the Internet. By that time, computers (including PCs, tablets, and smartphones) will represent just 17 percent of all Internet connections; the other 83 percent will result from IoT, including wearables and smart-home devices.[3]

While this may seem like a low rate of current penetration, 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.[4] Although technical and public policy issues persist, many factors contribute to the accelerating deployment of IoT capabilities. These include progress toward common IP-led standards; the introduction of IPv6 (which resolves the constraint on the number of available IP addresses for connected devices); the proliferation of wireless connectivity; improved battery life; device "ruggedization" and new form factors; open innovation models such as Kickstarter and Indiegogo, as well as the so-called "maker" movement; and the declining costs of technology, following Moore's Law.

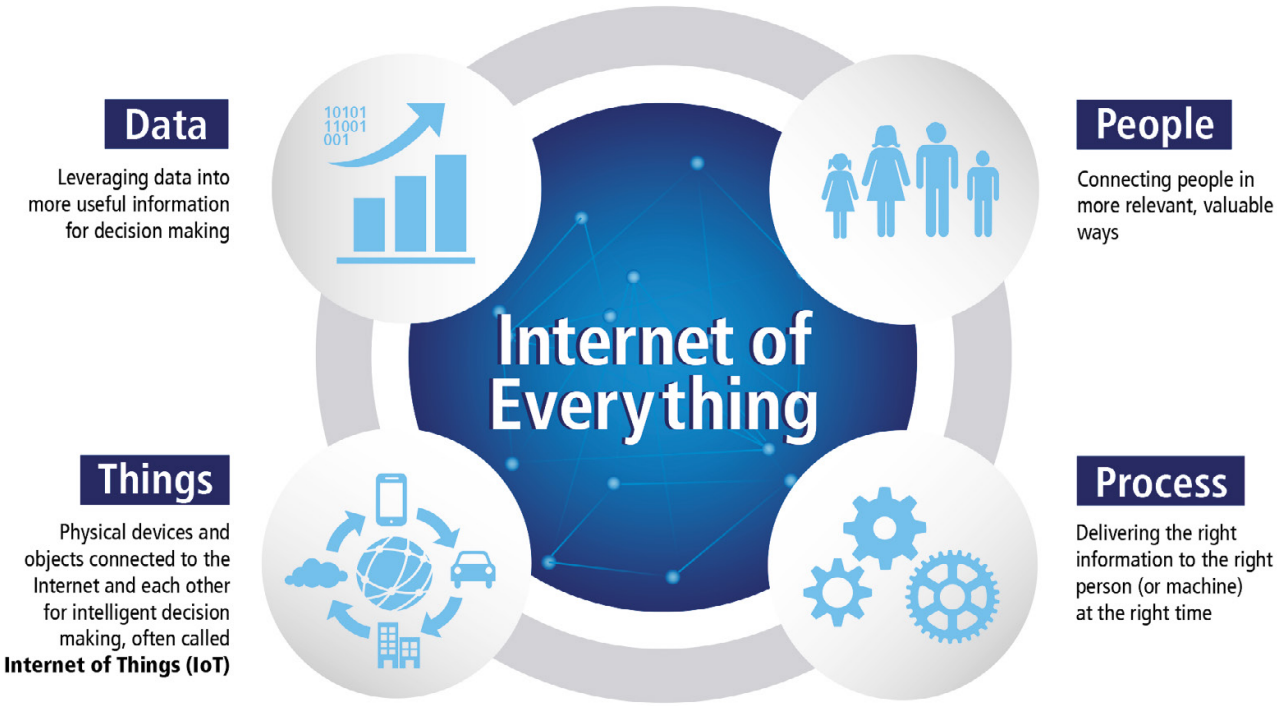

Figure 2: IoE, the Networked Connection of People, Process, Data, and Things[5]

[2] http://blogs.cisco.com/news/cisco-connections-counter
[3] Strategy Analytics, "Connected World: The Internet of Things and Connected Devices in 2020," 9 October 2014.
[4] "IoT in the Enterprise Up Three-Fold, Study Finds," Network World, November 24, 2014
[5] Cisco Consulting Services, 2014

1.2 The Internet of Everything vs. IoT

As critical as IoT is in connecting the unconnected, it is only part of the story. Along with physical objects, people and intangible "things" must also be connected in new and better ways. IoT is a vital enabler of certain types of connection that together make up what Cisco refers to as the "Internet of Everything" (IoE). IoE connections can be machine-to-machine (M2M); machine-to-person (M2P); or person-to-person (P2P). IoE includes not just the networked connection of physical objects, but also includes the links between people, process, and data (see Figure 2). IoT is most often equated to M2M connections but, as noted, definitions of IoT are nearly as diverse as its applications. Nevertheless, most observers agree that IoT implies value beyond just the physical or logical interconnection of objects.[6]

Why is the distinction between IoT and IoE important? While IoT is one of IoE's key technology enablers, so too are cloud and big data, P2P video/social collaboration, mobility (including location-based services), and security. Together, they create the opportunity for unprecedented innovation and organizational transformation. IoE is dissimilar from IoT in that it is not of itself a single technology transition, but rather a larger platform for digital disruption comprised of multiple technologies. In this sense, IoT is a subset of IoE.

Current calculations estimate that IoE represents $19 trillion in "Value at Stake" globally over the next decade.[7] Value at Stake can be understood as the new net profits created as a result of IoE (i.e., from markets that could not have existed before), as well as the migration of profits from losers to winners as a result of IoE-led market dynamics.

IoT by itself will generate $8 trillion worldwide in Value at Stake over the next decade (see Figure 3) which accounts for more than 42 percent of IoE's overall Value at Stake. This value will come from five primary drivers: innovation and revenue; asset utilization; supply chain and logistics; employee productivity improvements; and enhanced customer and citizen experience. Supply chain and logistics alone are estimated to provide $1.9 trillion in value, which is a promising indication of the untapped potential and profits to gain from utilizing IoT in the logistics industry.

The Value at Stake calculations stem from a bottom-up economic analysis conducted by Cisco on dozens of IoT use cases, both public and private sector. Each use case represents a business capability and resulting economic value brought about by connecting the unconnected.

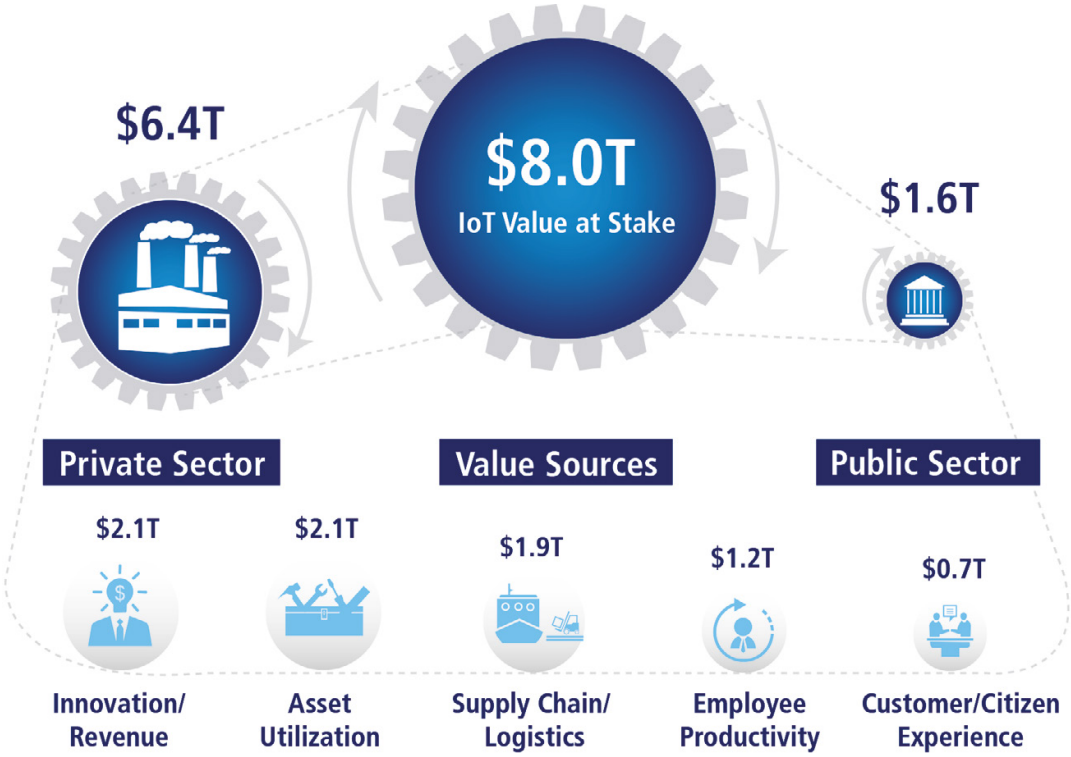

Figure 3: IoT Value at Stake[8]

[6] Machina Research, "What's the Difference Between M2M and IoT?" September 2014. See also IDC, "The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things," April 2014
[7] http://internetofeverything.cisco.com/sites/default/files/docs/en/ioe_vas_public_sector_top_10%20insights_121313final.pdf
[8] Cisco Consulting Services

"The Internet of Things will revolutionize decision making – we know that. By connecting the previously unconnected, we create incredible potential for businesses to improve the speed and accuracy of decision making through the analysis and application of digital information. It enables dramatically faster cycle times, highly dynamic processes, adaptive customer experiences and, through the ecosystem of people and technology, the potential for breakthrough performance gains."

Edzard Overbeek, Senior Vice President, Cisco Services

But what does connecting the unconnected entail? An example of a city government is instructive. For many municipalities, smart parking is the "killer app": parking is a source of important government revenues, but also a cause of process "friction" that yields inefficiency and citizen dissatisfaction. Beyond frustrated drivers, this friction has important implications. It is estimated that as much as 30 percent of all urban traffic is the result of drivers looking for parking.[10] Parking in unauthorized spaces has reached epidemic proportions in many major urban centers, with approximately one third of all parking occurring outside designated (pay or free) spaces.[11] This adds to congestion and undermines city revenues. On a global scale, inefficient parking also contributes to billions of dollars in lost citizen productivity and millions of tons of greenhouse gases.

So how does smart parking create value for cities? It begins with connecting previously "dark" assets in new and better ways, in this case by placing sensors on parking meters and spaces (see Figure 4). This creates new data and intelligence about those assets — which spaces are available, where they are located, how much it costs to park. The resulting insights provide the basis for process innovation, including new services (e.g., "space finder" apps) and new sources of monetization (e.g., dynamic pricing based on availability). Ultimately, this delivers the most important impact: benefit both to city employees and citizens. With smart parking, traffic wardens and city planners can be more productive, and drivers can enjoy greater convenience. Case examples of smart parking include Barcelona, Dubai, Nice, San Mateo County (California), and Santander.

This example illustrates that there is more to IoT than merely connecting assets. Connecting "things" is a means to an end. IoT creates value through the data that can be captured from connected assets and the resulting insights that will drive business and operational transformation.

Thus the use of analytics and complementary business applications (e.g., data visualization) is crucial if organizations are to capture and make sense of the data generated from connected devices. As IDC puts it, "The IoT is innately analytical and integrated."[9] An illustration of this is a network of motion sensors combined with IP cameras and video analytics capabilities – together this system delivers insights beyond the basic detection of motion (e.g., it can intelligently identify an unauthorized human form from a branch blowing in the wind as responsible for tripping a sensor).

Figure 4: IoE-enabled Smart Parking[12]

[9] http://www.streetline.com/2013/10/streetline-and-cisco-expand-collaboration/
[10] http://web.mit.edu/11.951/oldstuff/albacete/Other_Documents/Europe%20Transport%20Conference/traffic_engineering_an/the_time_looking_f1580.pdf
[11] IDC, "IDC's Worldwide Internet of Things (IoT) Taxonomy," October 2013
[12] Cisco Consulting Services

1.3 IoT Impacts on Logistics

IoT promises far-reaching payoffs for logistics operators and their business customers and end consumers. These benefits extend across the entire logistics value chain, including warehousing operations, freight transportation, and last-mile delivery. And they impact areas such as operational efficiency, safety and security, customer experience, and new business models. With IoT, we can begin to tackle difficult operational and business questions in exciting new ways.

As shown in Figure 5, applying IoT to logistics operations promises a substantial impact. We can monitor the status of assets, parcels, and people in real time throughout the value chain. We can measure how these assets are performing, and effect change in what they are currently doing (and what they will do next). We can automate business processes to eliminate manual interventions, improve quality and predictability, and lower costs. We can optimize how people, systems, and assets work together, and coordinate their activities. And ultimately, we can apply analytics to the entire value chain to identify wider improvement opportunities and best practices.

In essence, IoT in the world of logistics will be about "sensing and sense making" (see Figure 6). "Sensing" is the monitoring of different assets within a supply chain through different technologies and mediums; "sense making" is concerned with handling vast amounts of data sets that are generated as a result, and then turning this data into insights that drive new solutions.

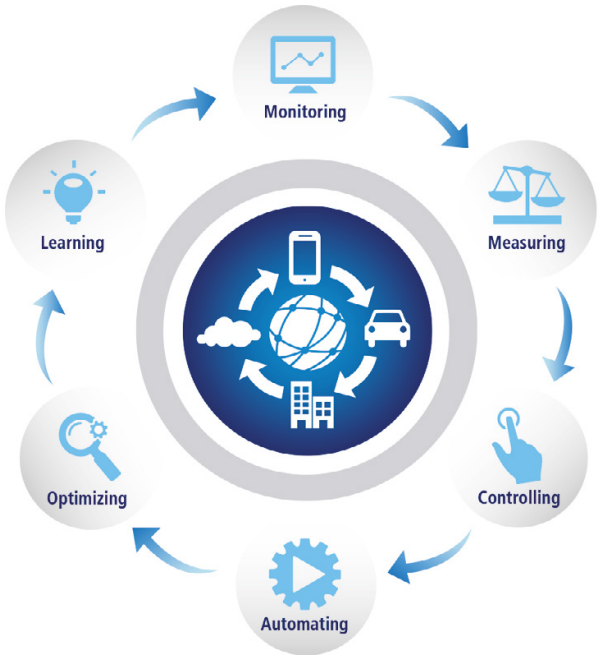

Figure 5: IoT-enabled Capabilities[15]

But is this the right time to leverage IoT in logistics? Today, we see optimal conditions for IoT to take off in the industry. There is a clear technology push through the rise of mobile computing, consumerization of IT, 5G networks, and big data analytics, as well as a pull from customers who are increasingly demanding IoT-based solutions. Combined, these factors are enabling logistics providers to adopt IoT at an accelerating rate.

IoT is "SENSING & SENSE MAKING" in the world of logistics

Technology push

- Mobile computing growing steadily with more mobile phones expected in 2020 than people in the world
- Due to the consumerization of IT, sensor technology has become more mature and affordable to be used for industry purposes in logistics
- With the move towards 5G, wireless communication will reach a new level of maturity connecting everything anytime
- Cloud computing and big data technologies will enable new data-based services

IoT in Logistics

Need for logistics solutions

- High need for transparency and integrity control (right products, at the right time, place, quantity, condition and at the right cost) along the supply chain
- End consumers are asking for detailed shipment tracking to have transparency in real time
- Business customers are asking for integrity control especially for sensitive goods
- Logistics companies need transparency of networks and assets being used for ongoing optimization of efficiency and network utilization

Figure 6: Convergence of Technology and Logistics Trends

[13] Cisco Consulting Services, 2015

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