Chapter 5

The Internet of Things in a Smart Connected World

Hyun Jung Lee and Myungho Kim

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.76128

Abstract

The internet of things (IoT) constitutes a network of embedded devices that incorporate sensors and communication functions. The IoT is becoming one of the core technologies of the Fourth Industrial Revolution. This is because the IoT creates new values in the connected smart world by collecting big data, uploading data into clouds, and processing data in intelligent systems. The newly created values in intelligent systems differ from previously generated values that were based on the simple automated systems of the Third Industrial Revolution. In this chapter, we present a brief introduction of the IoT, which connects to the Internet through incorporating sensors and communication functions in various smart objects. In the IoT era, it is possible to create a networked smart world with powerful new services and products that create new values. As applications of the IoT, we introduce smart homes, smart electronics, smart connected cars, smart grids, smart healthcare, smart wearable devices, etc. In addition, we illustrate a specific IoT complex in a smart city as one of the smart connected applications of the IoT. Finally, we describe the predicted hyper-connected smart world that will be achieved through the IoT.

Keywords: internet of things, IoT, big data, cloud, intelligent systems, hyper-connected, smart world

1. Introduction

The internet of things (IoT) can connect the enormous offline world with people through the Internet. To achieve this, developed sensors are used to collect data from connected smart objects in the physical world. The gathered data are then uploaded into the cloud and become big data. These data are then integrated and utilized for the development of intelligent systems. Therefore, the IoT is one of the core technologies that is driving the Fourth Industrial

Revolution. Moreover, intelligent systems are continually being developed to process big data through the IoT. One of the special characteristics of these intelligent processing-based services and products is the capacity for customization and personalization. Consequently, new and potent values can now be created in smart systems using smart technologies, including the IoT, for a dynamic smart world.

In the early 2000s, during the advent of the IoT, radio frequency identification (RFID) technology was developed for logistic and inventory management applications. It was mainly applied to reduce product distribution and factory production costs. It was also utilized to trace the locations of products being delivered using location-based information systems. RFID technology then continuously evolved and developed into machine-to-machine (M2M) applications, which enable direct communications, monitoring, and controls between devices with a remote application infrastructure using communication channels. More recent M2M communication has expanded into the Internet. Specifically, utilizing wired or wireless communication channels between IP networks, it transmits data between humans and things and between things and other things, such as between household appliances. The Internet itself has also evolved into the IoT as the third generation of the Internet. The first generation of the Internet was developed to be enterprise oriented as the Internet of Computers (IoC), and the second generation of the Internet focused on customers as the Internet of People (IoP) [1]. Eventually, the internet of things (IoT) became an advanced form of M2M.

In 1999, the term "the Internet of Things" was first coined by Kevin Ashton [2]. Initially, the term referred to a type of computer network that can gather a lot, and a wide variety, of data from all of the physical things in the offline world. In order to obtain these data, these things have embedded sensors that record data and transmit them through connections to the Internet using IP networks. According to Kevin Ashton [2], the unique importance of the IoT comprises the following factors. First, the IoT was introduced as a new and powerful method to gather information that was not possible to be gathered in the past. From these tremendous amounts of collected data, the IoT enables the discovery of an almost infinite amount of previously inaccessible facts. Consequently, many manufacturing companies are now attempting to transform themselves from manufacturing to service-based companies, such as the General Electric (GE) Company. Predix is GE's cloud-based platform (PaaS) for industrial Internet applications that combine people, machines, big data, and analytics [3]. Applications of IoT technology are manifold and diverse. For example, government organizations can use discovered data extracted from the IoT to discover and prevent terrorist attacks. It is also easy to extend IoT-based systems due to good scalability and flexibility. In fact, IoT-based systems can be extended as much as the Internet itself has been extended. For example, new services that are based on IoT applications, such as IoT-based new car-sharing services or parking lot searching services, can be added to previously built systems, leading to the possibility of an infinite extension of the services. Indeed, with relatively little effort, systems and services can be expanded to create new and massively powerful values and opportunities. It is anticipated that the world will witness exponential expansion of diverse applications of the IoT in the near future.

http://dx.doi.org/10.5772/intechopen.76128

Using big data collected, processed, and integrated through the IoT, intelligent systems have been developed to connect intelligent things. The IoT is thus closely related to intelligent systems because its development is based on the enormous amount of collected data. Generated data in the online and offline world can be propagated and shared in real time by anyone who needs or wants it. They can be also used and analyzed to provide products or services in business and public sectors. Using the IoT, it is possible to collect personalized data, such as at what time someone came to a physical location, in what he or she is interested in, and how long he or she remained in that place. After data analysis, customized and personalized services can be generated that are dynamically developed depending on users' analyzed characteristics, as well as requirements. To analyze data and generate a relevant service, it is also necessary to utilize intelligent applications and systems. For instance, Amazon's Dash Button device uses Wi-Fi and Bluetooth technology. It is enabled by a mobile phone, collects personalized data, and provides a corresponding customized service. To do this, the Button technology must be connected to the IoT, intelligent systems, big data, cloud, etc. It processes different contents each time that the button is pushed through the use of smartphone apps to send and receive information. In this way, it provides valuable customized content. In this system, big data technology is also requisite because data are accumulated each time that the button is pushed. By using this button system, it is possible to connect the online to the offline world by gathering so much data from the offline world. Therefore, the IoT is clearly different from previously developed electronics and technologies because it can create new opportunities, services, businesses, and platforms by connections and communications with the online to the offline world.

This chapter is organized as follows. In Section 2, we introduce the global growth of the IoT, trends in the global markets, and current and potential uses of the IoT in government and business sectors. Section 3 introduces sensors, networks, and service interfaces of IoT-based technologies and created services. In Section 4, we discuss IoT-based service applications, such as smart workplaces, smart factories, smart healthcare systems, etc., as well as an example of a smart city application and potential hazards of the IoT. Finally, we present some conclusions.

2. Global growth and trends of the IoT

2.1. Global market growth

In the global market, a variety of expectations exist regarding the internet of things (IoT). These expectations are related to how IoT devices will be connected, what are the services and values that will be created, how it can be used to increase a company's market share, etc. Although forecasts may vary slightly regarding the ubiquity of the IoT, it is obvious that it is growing dramatically. This rapid growth is attributable to the creation of new service markets, the expansion of the IoT devices, and the ease with which the IoT can be applied to industry, governments, products, and services. It is also clear that the growth of the service market, in particular, will comprise a major portion of the IoT market.

Concerning this IoT device market, Gartner predicts that, by 2020, the number of connected things will reach 25 billion and the service market will grow to USD $ 300 billion by the same year [4]. In Directions 2016 [5], the IDC forecasts that the number of terminals connected to the Internet will reach approximately 80 billion units in 2025. In addition, Cisco expects that, by 2030, there will be over 37 billion Internet units, the number of IoT devices will reach 50 billion, and the IoT will develop into the Internet of Everything (IoE) [6]. Gartner also predicts that China, North America, and Western Europe will be most active in adopting IoT devices, which will account for 67% of all Internet devices in 2017 [1].

In addition, the service market is also expected to occupy a large proportion of the IoT market. According to Gartner, in 2020, more than half of all existing Internet devices will connect with regular customers. Moreover, the number of customers using home automation systems and entertainment information will amount to 13 billion [7]. Cisco also predicts that 250 million people will be connected to the Internet by 2020. According to IDC, the expected IoT market will be USD $ 1.46 trillion by that same year [8]. These forecasts are based on the development of IoT-related products and the increase of related software and applications. Business and labor markets associated with data centers and management infrastructures will also be expanded to manage increasing data traffic. The consumer segment is predicted to comprise 5.2 billion units, accounting for 63% of the total installed capacity, leading to the ubiquitous use of IoT devices. Moreover, the business sector is anticipated to reach 3.1 billion connected units by 2017 [9]. To leverage the IoT, Mckinsey [10] defined nine key relevant environments: factories, cities, healthcare, retail stores, workplaces, logistics, transportation, housing, and offices. Economic effects range from USD $ 3.9 trillion to USD $ 11.1 trillion, depending on the availability of the IoT [10]. Machina Research (2015) predicts that the global market for the IoT will reach USD $ 1.2 trillion by 2022 [11]. In 2013, the market was USD $ 200 billion, but Machina Research forecasts that the market will grow 22% annually [11]. In addition, market size is expected to increase in the order of terminal, platform, and service by 2022. The average annual growth rate of service and platforms from 2013 to 2022 is expected to be 90.0 and 66.1%, respectively.

It should be noted that the growth of the service market is intimately related to semiconductor chipsets, communication modules, terminals, platforms including systems and solutions, and communication and service applications for device markets that support the IoT. From 2013 to 2022, each of these markets is forecast to have 19.2, 18.7, 8.8, 66.1, 17.0, and 90.0% of the compound average annual growth rate (CAGR). Global consulting firms, Gartner and IDC, forecast that the global IoT market will grow at a CAGR of 31.4 and 17.5% in 2013 and 2020, respectively. According to Cisco, the market value created by IoT corporations is expected to be USD $ 14.4 trillion over the next 10 years, and the public sector will be approximately USD $ 4.6 trillion. IDC expects that the IoT market will increase from approximately USD $ 2 trillion in 2013 to USD $ 7 trillion in 2020. Demands related to software applications, services, and devices for the IoT will also continue to increase. Consequently, in accordance with this demand, service markets from smart factories, smart healthcare systems, connected services, etc. [12] will also grow.

2.2. Trends in governments around the world

Currently, in order to realize economic and social innovations, governments and public sectors are also focusing on the internet of things (IoT) as a means of announcing policies that they want to promote. Through this, national governments around the world are rapidly establishing public goals, such as strengthening national competitiveness, improving people's quality of life, and taking actions that will catalyze major economic development. Certain large countries, based on developed information and communications technology (ICT), are strongly supporting the development of the IoT as a national project, including the USA, Japan, China, Europe, and South Korea. China, for example, established the Sensor Network Information Center in 2009 and the Intelligent Things Communications Center in 2010. Through these two institutions and others, China is announcing, establishing, and promoting various national projects. One of them is the "12-5 Plan for Development of the IoT" as part of the twelfth 5-year plan from 2011 to 2015 in 2011. It is building IoT pilot complexes targeted at facilitating the use of the IoT and the cloud as strategic measures [13]. The EU has also announced an implementation plan, including the 2009 IoT Detailed Treatment Plan. The UK is increasing IoT development funds and has announced that it is planning to invest $ 100 billion in the development of IoT technology by 2025. In 2008, the USA focused on building a hyper-connected network infrastructure to extend its existing communication infrastructure to the IoT. In early 2000, Japan accelerated national projects related to the IoT. In 2013, Japan implemented major ICT strategies, such as building smart towns, smart grids, and remote monitoring capabilities. In 2013, South Korea announced a comprehensive IoT plan for the development of technology and related market creation.

2.3. Global business trends

Many large global companies are actively participating in technology development and building ecosystems of technology focused on the internet of things (IoT) market. For example, Google has announced an ambitious plan to include the smartphone operating system "Android" on all major devices, such as televisions, automobiles, and watches. The company is also continuing strategic mergers and acquisitions (M&As) with related companies, e.g., the Nest company, which provides control services for room temperature, and Dropcam, an Internet surveillance camera manufacturer. Cisco has also led the IoT platform with IOx as an environment for the execution of IoT applications. In addition, Cisco recently announced that it had acquired Tail-f Systems, as a provider of network management solutions, and will acquire Assemblage, a real-time collaboration solution provider. Cisco, as the global market leader in networking equipment, has built an "Interloud" for the entire Internet of Everything (IoE) and is actively pursuing the IoT business through its "Smart Connected Communities" project. In addition, Qualcomm leads the open-source object Internet framework to connect devices with AllJoyn. General Electric (GE), as a leading equipment manufacturer, has announced that it will create new value with the "Industrial Internet Consortium" in connection with the IoT. In GE, the adopted IoT is available to provide new types of services or events. For example, GE's Predix collects data to monitor factories or systems, estimate possible faults during factory or system operations, and provide appropriate solutions for these faults [3]. AT&T is also working with Cisco, GE, IBM, Intel, and IoT network providers that connect all devices [12]. In recent years, M&As have also been increasing in global IT companies, such as Cisco and Google. This has been identified as a major activity that is preparing for the dominance of the IoT era. Therefore, it is important to ensure competitiveness in each service industry, including distribution, healthcare, security, and finance. It is also essential to possess the capabilities of an IoT value chain, such as content, platform, networks, and devices. For example, platform vendors, such as Microsoft and Oracle, are working to take advantage of their platforms, Microsoft Azure (Azure) and Java ME (Java Platform, Micro Edition), respectively, to prepare for a strong position in the IoT platform market. Moreover, Qualcomm, Intel, and other chipset vendors have focused their devices on the IoT network through AllJoyn and Quark. They are specifically focused on wearable devices and smart homes in the IoT market [12].

3. IoT technology and service

Sensors play a critical role in the internet of things (IoT). Sensors collect data on the Internet by smart devices, which are then used to upload information to the cloud. To achieve this, sensors are embedded in physical devices or exist in the form of external devices. Sensing technology is utilized to acquire a broad range of information, such as position, motion, images, etc. They can also collect surrounding environmental data, including temperature, humidity, heat, atmosphere composition, light, and sound. The IoT is also used to remotely control air conditioning, heating, and lighting. It is important to note that many physical sensors are also evolving into smart sensors with built-in standard interfaces for improving information-processing capabilities and applicable functions. Sensors can also include virtual sensing functions that extract specific information from the sensed and accumulated data. Moreover, virtual sensing technology can be implemented in the actual IoT service interface. Using multidisciplinary sensor technology, which is one-dimensional higher than existing independent sensors, it is also possible to extract more intelligent and high-dimensional information.

For the connection of sensors, the network interface plays the role of connecting physical network devices. For wired and wireless IoT networks, physical devices include wireless personal area networks (WPAN), Wi-Fi, 3G, 4G, LTE, Bluetooth, Ethernet, broadband convergence network (BcN), satellite communication, microwaves, serial communication, and PLC. These and other advanced communications systems enable the possibility for people, things, and services to become closely and rapidly connected.

The devices, such as sensors and network modules, are fixed on terminal devices for the collection of data. In other words, the development of sensor technology is essential to collect and extract data from objects. In addition, it is obviously necessary for network modules to communicate with these sensors, constituting an interworking of Internet communication, an application system, and an embedded system for providing user interfaces (UI). For activating the IoT, optimization and evolution of network technology are very important. The IoT can be connected to a network in a variety of ways. For example, things can be directly connected to a wireless network or connected to a smartphone through communication systems, such as Bluetooth. In the case of non-portable products, it can be connected to a protocol such as Wi-Fi, which is fixed in a certain place, such as a smart home or Industry 4.0.

It is important to note that the IoT service interface differs from traditional network interfaces. The primary aim of the IoT service interface is to offer value-added services through

http://dx.doi.org/10.5772/intechopen.76128

transformation, processing, extraction, and accumulation of sensed data. Additionally, it must make it possible to judge, contextualize, recognize, protect privacy, ensure security, authenticate, allow, discover, shape, etc., for the creation of services. The IoT service interface interlocks three major components: people, things, and services. For the application services to perform specific functions, the IoT must provide some interfaces for accumulating, processing, and transforming data for services, such as ontology-based semantics, open-sensor APIs, augmentation, virtualization, location identification, process management, open platform technology, etc.

The new types of value chains can be created based on the sensor devices, networks, and services in the IoT environment. This means that it can create new types of services that are based on different types of value chains on a data platform that is based on the particular device's sensing technology. The IoT contributes greatly to the derivation and creation of services based on connections between devices, things, and people. Ultimately, the created services, operations, and products will be based on convergence between data and services using data collected through sensors.

The processed data can also be accumulated in a cloud computing environment as big data. It is obviously critical to integrate data collected from distributed things through the IoT for the creation of advanced services. To achieve this, a data platform that can integrate distributed, collected, and aggregated data is requisite. This platform enables the creation of services that can generate value from different types of data. Service applications on such a data platform are introduced in the next section.

4. IoT service applications

The internet of things (IoT) is expanding the service market that is focused on public safety and distribution through merging with various industries. It is anticipated to be expanded to intelligent transportation services; social infrastructure, such as buildings and bridges; remote management services, existing healthcare, and smart energy-related fields. If the IoT becomes firmly established, its influence is expected to include everyday life, as well as all industries, due to the development and increased use of certain technologies, such as wireless networks, communication modules, sensors, and smart terminals. Furthermore, medical, transportation, manufacturing, distribution, education, and other fields will bring significant changes to existing processes and services.

4.1. Smart workplace

The smart workplace constitutes a new paradigm for working that will greatly increase collaboration, communication, and intelligent decision-making. It is based on connected, knowledge-based, integrated, and intelligent work facilities that depend on the new technology platform. One of the core technologies involved in creating smart work places is the IoT [7, 14]. Software applications that will be supported by the IoT have also been developed to support smart workplace environments, such as videoconferencing, new knowledge-sharing capabilities, and tracking the location of key mobile business assets.

4.2. Smart factory

The smart factory is not the automation-based factory system that existed in the Third Industrial Revolution, but is rather an intelligent system to support customization according to customers' requirements. This results in greatly increased production efficiency, more accurate and less expensive inventory systems, etc. Smart factories are developed by intelligent systems that are based on collected data from intelligent devices, integration of the collected data for the creation of services, and uploading the data to the cloud. In factories, it is important to interconnect facilities, such as overall systems, processes, and machines, in order to enable advanced services, such as innovation of production processes and cost reduction in supply chains. The IoT has also assumed a role in monitoring and maintaining infrastructure in smart factories.

4.3. Smart health

For smart health, hospital information systems usually use the internet of things (IoT) to monitor and connect patients, doctors, medical devices, and application systems, such as X-rays, using sensors. Some healthcare systems, such as IBM Watson, possess partnerships between people and systems. For example, instead of always requiring the presence of a medical doctor, in some cases, IBM Watson can treat patients by itself because it possesses expert knowledge and constitutes an intelligent system. In this type of case, the IoT is used to track, collect, and integrate remote data and the location of mobile assets in order to create and provide intelligent and advanced medical services. It is also applied to greatly increase the efficiency of healthcare infrastructure and resource usage. It is important to note that the developed applications can also substantially increase profits. Consequently, the more resources that can be saved, the greater the likelihood that new services will be developed. In fact, eight out of ten healthcare leaders (80%) stated that innovation has expanded since the advent of IoT use [7, 14].

4.4. Smart connected retailers

Nearly half of retailers worldwide allow network access on individual mobile devices to build the internet of things (IoT). This can create many new experiences and services for customers. For example, such applications of the IoT use a store's location service to provide customized information about products. It also assists in obtaining and retaining customers due to customization systems based on collected, accumulated, and processed data concerning individual customers. Currently, the retailing process is changing from a supplier-based value chain to a value-added value chain that is based on customer-centric services. Through the IoT, it is now possible to collect customers' personalized information, and the accumulated data can be applied to develop new types of services that can be based on intelligent systems. Since the IoT can facilitate more beneficial and customized services for individual customers, developing such services is currently very popular.

4.5. Smart farm

Recently, with smart farms, many countries and farmers are actively attempting to utilize the Internet, nano-based devices, and robot technology. In 2014, the National Weather Service and

http://dx.doi.org/10.5772/intechopen.76128

the Department of Agriculture established an open data policy and developed various smart agricultural services [15]. For example, Fujitsu grows hydroponic lettuce using its Internet technology platform (Akisai) and is developing it as a new type of farm. In agriculture, food seeds, seedlings, and information about them can be sent directly to consumers, allowing people to grow agricultural products themselves at home. Of course, commercial farmers can also use such services supported by the information provided by the IoT. In addition, by using the IoT, it is now possible to remotely monitor and control conditions for crops and farms. It can monitor and control essential factors, such as humidity, sunshine, temperature, etc.

4.6. Smart connected car

Unlike in the past, automobiles can be now viewed as a digital mobile software system and not as a machine with an engine. Accordingly, such modern cars are often termed "connected cars." In fact, advanced cars have more than 100 million lines of source code, which supports autonomous operation, self-parking, control, infotainment, safety, performance monitoring with built-in sensors, and inter-vehicle communication. Gartner predicts that, by 2020, connected cars will deliver a new in-vehicle maintenance service and autonomous navigation capability. It is further expected that there will be more than 250 million such units, and one out of five vehicles globally will be connected to a wireless network through the internet of things (IoT) [16]. This rapid increase in vehicle connectivity will affect the overall functionality of telematics, autonomous navigation, infotainment, as well as mobile services, such as mobile banking and remote offices. Over the next 5 years, the proportion of new vehicles with these features is anticipated to increase at a truly dramatic rate, and connected cars will constitute a major part of the IoT [17].

4.7. Smart city

Hall [18] defines a smart city as a city that "monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens." According to Harrison et al. [19], the smart city is defined by "connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city." Recently, the definition of the smart city has been expanded to include not only physical aspects, such as city infrastructure, but also concepts that comprise nonphysical factors, such as the environment and governance. The United Nations Conference on Trade and Development (UNCTAD) [20] defines the smart city as smart mobility, smart economy, smart living, smart governance, smart people, and smart environment. Data for smart cities originate from all infrastructure and things in the city based on internet of things (IoT) technology. Services are then developed to enable citizens to have greatly expanded and personalized options in their lives by using the collected data. The IoT overall was developed for the purposes of connecting various things to exchange information and realize value-added information services. Consequently, if the IoT is intelligently applied to cities' facilities, management, and security, city functions could be performed much faster and more efficiently than was previously the case. If a hyper-connected society that connects things and cities becomes a reality in the near future, we will experience truly smart cities that can integrate city management systems that were previously operated individually.

As progress has been made in IoT uses and applications, public sectors are linking building security systems (57%), street lighting (32%), and automobiles (20%) to create an organic technological environment that will support the smart city of the future. The most widely deployed IoT applications in this sector comprises remote monitoring and control of urban devices (27% responded that this is the main application) and constitutes an essential step toward actualizing the smart city's integrated infrastructure.

Paul Manwaring [21], cofounder of the IoT Living Laboratory in Amsterdam, stated that "we need to empower communities to solve their own problems." Certainly, problems still exist that need to be solved to achieve sustainable development. These problems are mainly due to industrialization activities that are based on digital technology.

4.8. IoT demonstration complex

The internet of things (IoT) has been identified as a core technology for building smart cities. Therefore, many countries around the world are promoting smart cities to obtain various benefits. As one of the efforts to solve the abovementioned problems, we focus now on trash cans equipped with IoT sensors to assess load quantity in real time. In early 2016, 76 IoT sensors were attached to trash cans in major commercial districts in Seoul, Korea. In June 2017, Goyang city built a smart collection management system based on the IoT [22] as the IoT demonstration complex. The IoT sensors are installed in the trash cans in various locations along city streets and in resident public trash cans to manage loads in real time. A load detection sensor, a solar compression device, and a garbage collection tracker and system are installed in the trash cans. The IoT trash can with the load-sensing control is equipped with a sensor inside of the trash can's lid to measure the load in the trash can in real time, and the compression trash can is automatically compressed to prevent trash can overflow when too much garbage accumulates. In addition, the sensor is powered by solar energy. In garbage collection vehicles, a tracker is installed, and the vehicle position and collection routes are displayed in real time. The amount of garbage collected by each vehicle in the landfill can also be quantified and systematically managed. The measured data in the smart trash can are transmitted to the Goyang city demonstration center server and to environment-friendly smartphones. Finally, garbage-loading information can be checked and managed in real time. This is an example of using the IoT to successfully solve a generally occurring problem in most cities.

4.9. IoT threats

It is certain that the internet of things (IoT) will provide tremendous opportunities in manifold regions and industries. However, a fundamental gap still exists between understanding and preparing for the anticipated ubiquity of the IoT. For example, although 98% of organizations

http://dx.doi.org/10.5772/intechopen.76128

that have adopted the IoT claim to be able to analyze data, almost all respondents (97%) stated that it is still difficult to generate value from these data. In fact, more than one-third of companies are not extracting and analyzing corporate network data and using these insights to improve business decisions. One of the biggest limitations is security of data and information to protect IoT-based systems from external threats.

5. Conclusion

In this chapter, we introduced the internet of things (IoT), which is a new type of a network that connects device to device, device to people, device to place, etc. The network communications are based on an Internet protocol (IP), such as that used for the Internet. The communications are conducted using embedding or external sensors in devices or objects. Through these communications, tremendous amounts of data are generated. These data are termed big data and are uploaded to a cloud system. This enormous amount of data can then be utilized to create valuable new services and products. In addition, through using the accumulated data, some systems and markets provide powerful intelligent services and applications, such as smart workplaces, smart factories, etc.

We are already living in a hyper-connected world where people and intangible things are networked through the IoT. Indeed, the IoT is leading the era of superfusion that is creating multifaceted economic, social, and ethical values that converge with various industries and expressed as productive business models. In the era of the IoT, most devices use gathered information and network connectivity that actively exploit collected data through a variety of sensors to drive opportunities for new products and services. From this perspective, the IoT integrates intelligent networks which can be systematically linked with humans, things, and services for distributed sensing, networking, and processing.

As one of the IoT applications, the smart city was introduced in this chapter. The smart city can be understood as a kind of hyper-connected world comprising the overall society, business platforms, the environment, etc., with newly developed technologies, such as big data, cloud, and artificial intelligence. Smart cities can also embed these applications and innovations, such as in connected vehicles, smart homes, etc.

Initially, the IoT was developed for simple communications between devices and objects through RFID and M2M technology. However, the IoT is creating a new type of hyper-connected world that comprises connected societies, connected environments, etc. It also creates entirely new types of services, products, and businesses that were not even envisioned in the past. For example, when the Internet first appeared, it was not expected that it would revolutionize the world, but it did. This time, the IoT is changing the world and to no less of an extent.

In near the future, in our hyper-connected world, we will be able to experience a truly smart world which integrates systems that were previously operated individually and create powerful new values and opportunities that we have never experienced.

Author details

Hyun Jung Lee* and Myungho Kim

*Address all correspondence to: hjlee5249@gmail.com

Department of Economic and Social Research, Goyang Research Institute, Goyang-si, Gyeonggi-do, South Korea

References

[1] Information Research Service Global. IOT·AI-based Smart Home (Home IoT) related Innovation Technology Trend and Future Prospects. Available from: http://www.irs-global.com [Accessed: December 04, 2017]

[2] Ashton K. Making Sense of IoT. 1999. Available from: http://www.google.co.kr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjz3vj-uIXYAhVIgrwKHYGzC6cQFggrMAA&url=http%3A%2F%2Fwww.arubanetworks.com%2Fassets%2Feo%2FHPE_Aruba_IoT_eBook.pdf&usg=AOvVaw2eucTstKelqZE5OGGRCBRC [Accessed: December 04, 2017]

[3] Predix. Available from: https://www.ge.com/digital/predix [Accessed: December 04, 2017]

[4] Gartner. Forecast Analysis: Semiconductor Assembly and Test Services, Worldwide, 3Q14 Update in Direction 2016. 2014. Available from: https://www.gartner.com, https://www.gartner.com/doc/2907217?ref=SiteSearch&sthkw=2014%20November%20IoT&fnl=search&srcId=1-3478922254) [Accessed: December 04, 2017]

[5] IDC Directions. Digital Transformation at Scale, Innovation in a Changed World. 2016. Available from: http://www.cvent.com/events/idc-directions-2016/custom-19-d98c-2b4263944a4cb8c785d4bdbec196.aspx [Accessed: December 04, 2017]

[6] Cisco white paper. Internet of Everything: A $4.6 Trillion Public-Sector Opportunity. 2014. Available from: http://www.cisco.com/web/services/portfolio/consulting-services/documents/internet-of-everything-public-sector-white-paper.pdf [Accessed: December 04, 2017]

[7] Barker C. 25 Billion Connected Devices by 2020 to Build the Internet of Things. ZDNet. 2014. Available from: http://www.zdnet.com/article/25-billion-connected-devices-by-2020-to-build-the-internet-of-things/ [Accessed: December 04, 2017]

[8] Framingham M. Worldwide Spending on the Internet of Things Forecast to Reach Nearly $1.4 Trillion in 2021, According to New IDC Spending Guide. IDC. 2017. Available from: https://www.idc.com/getdoc.jsp?containerId=prUS42799917 [Accessed: December 04, 2017]

[9] Gartner. 2017 Will See 8.4 Billion Connected 'Things' Will Be in Use in 2017, Up 31 Percent From 2016. 2017. Available from: https://www.gartner.com/newsroom/id/3598917 [Accessed: December 04, 2017]

[10] McKinsey. The Internet of Things: Mapping the Value beyond the Hype. 2015. Available from: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/The%20Internet%20of%20Things%20The%20value%20of%20digitizing%20the%20physical%20world/The-Internet-of-things-Mapping-the-value-beyond-the-hype.ashx [Accessed: December 04, 2017]

[11] Machina Research. The Global IoT Market Opportunity Will Reach USD4.3 Trillion by 2024. 2015. Available from: https://machinaresearch.com/news/the-global-iot-market-opportunity-will-reach-usd43-trillion-by-2024/ [Accessed: December 04, 2017]

[12] IITP, 2014. IoT Status and Major Issues, ICT Insight 04

[13] Ministry of Science, ICT and Future Planning Ministries of the Republic of Korea. Master Plan for Building the Internet of Things (IoT) that leads the hyper-connected, digital revolution. 2014. Available from: http://www.google.co.kr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjepe_EmNfYAhUBvrwKHZwYAF0QFggmMAA&url=http%3A%2F%2Fwww.kiot.or.kr%2FuploadFiles%2Fboard%2FKOREA-IoT%2520Master%2520Plan.pdf&usg=AOvVaw2Z5CjmAItMtT-rM6S51i-K [Accessed: January 12, 2018]

[14] Hewlett Packard Enterprise. Internet of Things, Today and Tomorrow. 2016. Available from: http://www.arubanetworks.com/assets/eo/HPE_Aruba_IoT_Research_Report.pdf [Accessed: December 04, 2017]

[15] Economic Review. 2016. Available from: https://kerala.gov.in/documents/10180/ad430667-ade5-4c62-8cb8-a89d27d396f1 [Accessed: December 04, 2017]

[16] Gartner. The Internet of Things Challenges Smart City Processes and Culture. 2013. Available from: https://www.gartner.com/doc/2619517?ref=SiteSearch&sthkw=2014%20November%20IoT&fnl=search&srcId=1-3478922254 [Accessed: December 04, 2017]

[17] IT World. Connected Car Occupies Major Part of Internet of Things for Next 5 Years. 2015. Available from: http://www.itworld.co.kr/news/91595#csidxae88edf9540bff89177cf9bba41bbce [Accessed: December 04, 2017]

[18] Hall RE. Thee vision of a smart city. In: Proceedings of the 2nd International Life Extension Technology Workshop, Paris, France, September 28, 2000. Available from: https://www.osti.gov/scitech/servlets/purl/773961 [Accessed: December 04, 2017]

[19] Harrison C, Eckman B, Hamilton R, Hartswick P, Kalagnanam J, Paraszczak J, Williams P. Foundations for smarter cities. IBM Journal of Research and Development. 2010;**54**(4):1-16. Available from: http://fumblog.um.ac.ir/gallery/902/Foundations%20for%20Smarter%20Cities.pdf [Accessed: December 04, 2017]

[20] UNCTAD. Issues Paper On Smart Cities and Infrastructure. 2016. Available from: http://unctad.org/meetings/en/SessionalDocuments/CSTD_2015_Issuespaper_Theme1_SmartCitiesandInfra_en.pdf [Accessed: December 04, 2017]

[21] Paul Manwaring. The IoT Living Lab at The Smart City Innovation Summit Asia—SCIS Asia 2017. 2017. Available from: https://www.linkedin.com/pulse/iot-living-lab-smart-city-innovation-summit-asia-scis-manwaring [Accessed: December 04, 2017]

[22] Kim JH. Goyang City, IoT Garbage Can Appear. May 17, 2017. e4ds. Available from: http://www.e4ds.com/sub_view.asp?ch=30&t=1&idx=6203 [Accessed: December 04, 2017]