A Study on the Internet of Things (IoT) Applications

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Abstract

The government has adopted the field of “Internet of Things” as a national strategic project, announcing the Internet of Things master plan to achieve a leading country of hyper-connected digital revolution last May. The government has the promotional strategy of reinforcing the competitiveness in software (SW) sensor components devices, training specialists that will lead Internet of Things (IoT) services and products, and internalizing security for Internet of Things products and services. Internet of Things, thus expected to grow from ₩2 trillion and 300 billion last year to ₩30 trillion by 2020 in the market, refers to the Internet environment where people, things around, data, etc. are all connected to the wired and wireless network to mutually create, collect, share, and utilize information. Internet of Things is the technology and service that includes generating information (sensor) - acquisition (parts, devices) - sharing (Clyde) - utilization (Big Data) - application software. Internet of Things is getting a lot of attention from the public due to the effect of increasing export businesses and jobs and has become a buzzword among businesses. The Internet of Things market has a tendency to grow in the future as it is extended from social infrastructure (utilities, transportation, automation, etc.) and safety management to the consumer sector centered on life services. Sophisticated wireless communication technology is expected to form a huge network connected to all object units as a communication function.

Keywords: IoT, M-Internet, RFID, B2C

1 Introduction

OECD has recognized the IoT as a new growth engine that will promote the innovation of information and communication and of other sectors that will bring a new – added value. But the IoT is vague in definition and discussion has only been focused on its description. In addition, it has been pointed out that general users did not easily accept the IoT. This study attempted to introduce innovative practices using the latest IoT and to view the new demand that can be used in other areas, such as the maximizing of the use of data derived through the IoT. This study put an emphasis on the point that we need to worry about how to use the IoT considering current situations, internal capabilities, market environments, policy goals, etc. Our society is entering the hyper connected society where all the things are connected to the Internet because of the rapid development of information and communication technologies. In the hyper connected society, adding communication functions to all the things, such as houses, cars, watches, and cameras, connects new values. With the stream of times and as the key means of the

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realization of a 'creative economy,' the government has adopted the sector of the IoT as a national strategy and the ‘basic plan of the IoT to realize a leading country of hyper-connected digital revolution last May. The government has a plan of reinforcing the competitiveness of software (SW), sensors, components, and devices. The strategy is to promote the security internalization of IoT products and services from the planning phase in the special enterprises that will lead the creation and innovation of the IoT services and products. This study attempted to mention the concept, market environment, and main applications of the IoT to identify the evolutionary process of the IoT quickly evolving at an early stage and to make the proactive response. Based on this, the government plans to allow the IoT market to grow from the current size of ₩2 trillion and 300 billion to the size of ₩30 trillion by 2020, and expects the effect of increasing export enterprises and creating jobs. Thus, this study tried to review the concept, market environment, and main applications of the IoT to identify the evolution of the IoT evolving rapidly and to proactive respond to it.

2. Concepts and Coverage of the IoT

Recently, the term ‘Internet of Things’ (IoT) has been appearing frequently in the media. The IoT has been highlighted as a new growth engine of the ICT industry. However, it was 15 years ago that the term ‘things of Internet’ was first used, when Kevin Ashton of P&G mentioned that the IoT mounted with RFID and sensors would be built in 1999. It was 150 years ago when the communication between men was done via telephone. To the exclusion of communication other than the Internet and simple communication, network devices have made a ‘direction’ long ago for the Internet to go smoothly and to allow men to communicate with each other through various routing protocols. The IoT means the Internet environment of generating, mutually collecting, sharing, and using information by allowing all the things, such as people, around things, data, etc., to be connected to wired and wireless networks. The IoT is the technologies and services, including information generation (sensors), information collection (parts, devices), information sharing (Clyde), information literacy (Big Data), and application software (SW). Through this, consumers have extended the scope of connection to the virtual world by communicating with each other about things networked. In the machine to machine (M2M: Machine to Machine) period, in the initial phase of things of internet, the IoT has been used for the management of transportation cards, bar codes with pricing information when purchasing goods, courier delivery tracking systems, navigation, ATM machines, and plants/ facilities. Then, the recent advance in high-speed wireless technologies has accelerated along with the supply of connected devices based on networks, such as smartphones, tablet PCs, e-book devices, etc. and the implementation of communication in day-to-day things has become possible. Thus, the scale of the IoT market is rapidly increasing. Currently, the IoT tends to show the commercialization of smart grid, smart home, healthcare, and intelligent vehicle services through the convergence between various industries. For example, previously, when you entered your house after returning home late, automatic sensors were turned on as you took off your shoes. In addition, you may have adjusted the temperature of the house through a heating and cooling control system. Now, it has become possible to adjust interior lights, temperature, and humidity via remote control using a smartphone before returning home. Even each of the intelligent devices in the house informs you of the optimum temperature and humidity and the time tailored to you as the device comes to learn the existing data automatically. As seen above, the IoT is the one where the scope of connection has been expanded by connecting communications networks through computers and
connected devices in the connection (M-Internet) of the network via the existing computer, and furthermore adding communication functions to all the units around.

![Diagram of Internet of People (IoP) and Internet of Things (IoT)](image)

Figure 1. Changes in Things of Internet Depending on Changes in the Communication Environment [1]

Thus, all the devices are provided with the service that the consumer can check anytime, anywhere, and whatever. This explains the concept of the IoT.

3. Environment of the Market of Internet of Things

The market of Internet of things around the world is expected to grow highly centered around equipment and services. Thus, major economies of the world have published subsequent promotion policies by selecting the IoT as a means to realize industrial innovation for economy and industry innovation. A review of the growth rate of the IoT by sector found that the service market is expected to grow significantly focused on smart energy-related areas, intelligent transport services, industrial automation, and industrial infrastructures. In addition, the expansion of the service market is expected to be centered around public safety, distribution, and logistics through the convergence of various industries in the future. The Korean market of the IoT is in the initial step and limited to inter-company services. In addition, the activation is also rated to be low compared to developed countries. The domestic market of the IoT mainly consists of small sensor network services led by mobile operators, for example, logistics tracking, telemetry services, public services, etc. However, it has not been significantly expanded into the consumer market. In the consumer area, high-pass systems have been activated and the services where the recent technologies have been applied are being commercialized, such as simple payment and security services provided by mobile operators as well as telematics, healthcare, smart farm, etc.

3.1. Market of Things of Internet in Korea

The Korean market of the IoT increased by about 24% on an annual average in the number of M2M-lines since 2008. Currently, the number exceeds 2.1 million. Most importantly, the proportion of billing, security, smart meters, telematics, mobile POS (point of sales), etc. based on 3G communication networks has been found to be high.
The M2M lines accounts for a low proportion in the entire wired and wireless communication market. However, the M2M service shows a high growth compared to other communication services of late. According to Machina Research (2013), the Korean market of the IoT showed 29.2% of growth rate on an average rate from ₩ 2 trillion and 80 billion, and is expected to exceed ₩ 22 trillion and 800 billion in 2020. By category, the service and application market is expected to sharply grow by 98% annually until 2022, and to account for a high proportion of 33% of the total.

A review of the domestic market of the IoT by category in 2012 found that the automotive sector showed a relatively high prevalence proportion, followed by intelligent buildings, home appliances, and so on. More importantly, the security sector including high-pass systems (7.73 million units) and CCTVs (2.74 million units) showed a relatively high prevalence proportion, followed by AV devices, mobile POS, smart meters, etc. The domestic market of the IoT in the future is expected to be expanded significantly into the ‘consumer area,’ such as health care, living convenience, etc. and the automotive and smart meter sectors are expected to grow rapidly.

4. Main Applications of Things of Internet in the United States

Freestyle Soda Machine, supplied by the world’s largest beverage maker ‘Coca-Cola’, is a typical case where the technology of things of Internet has been applied. The vending machine allows consumers to mix 147 kinds of tasty drinks according to their tastes. Consumers will select their desired taste in advance through an app. Then, the vending machine will automatically prepare and provide the drink through the recognition of the QR code. Wireless Internet chips are mounted on each vending machine. Thus, the information on beverage consumption, sales statistics by time, and popular beverages will be transmitted to the main office in real time. The Coca-Cola Company can exactly identify popular beverages and additive kinds for particular regions. Then, it will reflect the information on the establishment of marketing strategies considering regional tastes. In addition, it becomes possible to check the inventory of beverages and additives by mounting RFID tags on each cartridge for additives within each vending machine. In addition, Deconstruction, a start-up of the IoT in the United States, is in the spotlight as it developed a monitoring support solution in dissolving the construction site using sensor data. Deconstruction developed an mBuilder sensor where the software that monitors and analyzes the temperature, humidity, noise, and vibration of the construction site in real time has been combined. Deconstruction provides the service of informing you of a certain degree of damage with an analysis engine designed to predict the perceived noise and vibration level of the surrounding area by analyzing the data measured via an mBuilder sensor. The services also allow you to identify whether fines or protests are likely to occur or not by comparing the regulatory situation corresponding to the construction area and the situation in the field through the dashboard. Thus, it supports the decision-making of the contractor and the proactive prevention of unnecessary costs.

| Table 1. IoT Market of the World (2013 ~ 2020, unit: % 1 bil.) |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Segment         | ‘13 | ‘14 | ‘15 | ‘16 | ‘17 | ‘18 | ‘19 | ‘20 | CAGR %|
| Market          | 2,347 | 2,704 | 3,349 | 4,448 | 505 | 9,635 | 12,863 | 17,076 | 26.2 |
| Growth’         | - | 15.2% | 23.8% | 32.8% | 54.9% | 39.8% | 33.5% | 32.8% |
5. Costs of Things of Internet

In the IoT, most basic step is RFID. The main causes for costs are tags or sensors and readers. In the case of the retail sector that started to introduce RFID, it is difficult to recover tags. Thus, the price drop of tags will play an important role in the adoption decision. As the RFID costs fall, the reduction of labor and labor costs is expected after the introduction. With the decline of a rate failure and the improvement of quality, the effectiveness, such as customer satisfaction, etc., will increase. In the first 3 or 4 steps in the IoT presented by Fleisch (2010), the price drop after introduction of equipment due to the improvement of sensor technology seems to be the main factor of the spread of the IoT. In the current moment when the IoT receives attention from the public and becomes a topic of management among enterprises, an enterprises’ attitude toward the IoT appears to be a bit conservative. Given the decline of the overall sensor price and the low network costs, the main cost factors that the enterprises taking advantage of the IoT may recognize seems to included manpower costs to make the use of the IoT, and costs to build up a data management system. The amount of information with the number of sensors increasing is believed to grow exponentially. A method of building up a closed system in SMs or on individual groups may cause high social inefficiency and is very likely to delay the formation of the IoT ecosystem.

6. Things of Internet in the Automotive and Consumer Sectors

RFaxis and CSR, a semiconductor specialist in the next-generation RF solution for wireless communication, promotes a strong partnership for the IoT in the automotive and consumer sectors. A fabless semiconductor company, RFaxis, Inc. (www.rfaxis.com), announced that it would partner with CSR plc (http://csr.com) for the reference design aimed at a plurality of wireless connectivity markets.

CSR provides a variety of portfolios of the chipset connected to ensure end-users experience high quality, high reliability Wi-Fi/Bluetooth, including the seamless, high-performance wireless audio and whole - home coverage. For the reference designs, RFaxis single-chip, single-die CMOS RF Front-end Integrated Circuit Circuit (RFeIC ™)) technology formed in pairs with CSR’s UniFi® CSR6030 ™ 2.4GHz 802.11n Wi-Fi solution, CSR8811, and CSR8311 (CSR8811 ™ and CSR8311 ™) Bluetooth (Bluetooth®) Low Energy radio chipset. These reference platforms are aimed at vehicle infotainment, consumer electronics, IoT, M2M (machine-to-machine, intelligent objects) communications markets being equipped with a variety of goods such as entertainment (ICE) systems built-in a car, car connection kits, wireless speakers, health and fitness - related wearable computers, personal navigation devices (PDN), cameras, scanners, and printers.

The integrated level of RFaxis RFeIC reduces the time-to-design and the time-to-market, and provides a very simple solution that allows device manufacturers to run the same as a plug-and-play. Thus, RFaxis technology reduces the product development cycle scheme within a few weeks, which takes several months for competitors. It also meets standards of all the performances that component manufacturers and producers have proposed.

Thomas Carmody expects that the company can raise attach rates of goods in a strategic focus area in an integrated, low-cost RF front-end approach of the company saying “I am, happy to offer high-performance, low-cost platform solutions so that customer can differentiate end products no matter what sector they are engaged in.
7. Things of Internet in the Automotive and Consumer Sectors

In October 2009, Korea Communication Commission released a basic plan for the build-up of M2M Communication Infrastructures to enhance national competitiveness and promote services in the IoT filed. Through this plan, the committee also promoted the excavation of a service model leading the public sector, development of M2M communication infrastructures, and promotion of national and international standardization, improvement of the legal system, etc. In the Korean situation when the era of IoT began to be visualized due to the development and 3 key technologies, such as high-speed mobile communication, high-sensitivity sensors, big data processing, etc. and to the low price of the services, the IoT technology is collectively referred to as the ICBM with (IoT, Cloud, Big Data, Mobile) technology, which can act as a driving force to be developed into a platform of the hyper-connected network industry. Since 2012, the IoT technology has been considered as the 3rd, 4th as one of the 10 strategic technologies that Gartner has selected. The technology is growing along with the existing M2M communication technology. For the IoT, it is expected to take time more than 10 years to enter the maturity period.

![Figure 2. Development of IoT and M2M Technologies](image)

In this situation, the Korean government has promoted the ‘manufacturing innovation 3.0 strategy with a plan of securing the competitive advantage of only manufacturers by creating the new convergence industry through the convergence of IT and SW, creating a new-added value and switching an advanced chase-type strategy to a leading-type strategy. More importantly, the government made a detailed plan to promote a smart system of 10,000 plants by 2020 after the intelligence and optimization of the entire process of production through the convergence of IT SW, IoT, etc. Thus, it is necessary to respond to this. The principles of promoting the spread of smart plants were set as follows (customized application): For the scope (network between individual enterprises and enterprises) and technologies (general purpose (bar, etc.)), the latest ones (IoT, etc.) have been applied. The technologic application has been initially introduced to the business and item highly demanding (bridgehead strategy) smart plants and has been spreading thoroughly in the industry.

In the initial stage of business (gradual advancement), smart plants are being implemented using the S/W H/W already developed, and more advanced technologies are being developed and applied. Therefore, it is necessary to seek a way of enhancing the competitiveness of the entire manufacturing sector and to actively foster new industries along with the promotion of a smart system of the manufacturing industry. To this end, it
is required to conduct a study on how to raise productivity and efficiency utilizing the IoT into the manufacturing process. Preferentially, it is needed to converse thinking into a creative way to give communication capabilities to everything. It is also required to develop technologies. Manufacturers will then enhance corporate competitiveness and will be able to offer value-added services through the appropriate utilization of the IoT. Recently, the Ministry of Science, ICT, and Future Planning selected the IoT as the key technology of the new industry and announced a long-term plan containing the ‘New Industrial Internet Development Plan (June 5, 2013).

The IoT is a creative engine for upbringing Internet access businesses, enlarging the new industrial Internet market, and creating creative jobs. In line with this, the government plans to pursue a policy issue to create a market as a leading business, to enhance technological competitiveness of enterprises, to support overseas expansion of enterprises and to create the foundation, such as R&D.

7.1. Things of Internet based on TRFID-based Sensors, Wearable and Mobile Terminals, etc.

The IoT enables consumers to save medical services expenditures and to create quality improvement effects as it is combined with the personal care services sector, such as remote patients monitoring, home care of the elderly, and treatment and management of chronic diseases. Hospitals are introducing the IoT to build up a smart hospital system, such as a telehealth system to monitor positions, lines of flows, and movements of patients, medical staff, and facilities, to generally manage an access to medical data, and to provide video call services. Recently, the medical industry all over the world has been introduced to the IoT-based system. This introduction is demonstrated through cases of efforts to improve the effect of the medical environment.

7.2. The Latest Technology of Things of Internet

In the Korean case, the IoT is gradually being commercialized from the services of the early stage, such as simple payment services (POS, Point of Sale), security services, etc. around mobile operators, to the latest services, such as healthcare and Smart Farm. However, the environment is still insufficient to create innovative new services through the cooperation among terminal vendors, platforms, networks, and service providers. Last September, SK Telecom provided its open-typed M2M platform to partners free of charge for win-win growth with SMs and industrial activation. The company provides various supports for the partners wishing overseas expansion to export the applications and devices that it developed through the platform. KT also plans to enter platform hosting business while expanding its business extension stayed in B2Bi into the B2C, showing a high average revenue per subscriber (ARPU), such as healthcare, etc. In addition, LG U+ completed the build-up of M2M-based platform plans to build an application platform on three areas this year: connected car, smart retails including vending machines and etc., and video services, respectively.

8. Conclusions

The IoT market in the future trends to grow as its scope is expanded into the consumer sector centered on life style services from the social infrastructure (utilities, transportation, automation, etc.) and safety management sector. Sophisticated wireless communication technologies are expected to make a huge network as communication functions are connected to all object units. From the prospect of the electrical construction industry, we have entered the era of connecting all things via communication through the era of connecting all the things using electricity.

This market of the IoT can be used as the power of the new market in the new industry. However, in contrast, various convergences also may imply threat factors that may cause
inter-industry areas to be vague. Therefore, the electrical engineering industry should respond to and adapt to the era of the IoT as follows: First, it is necessary to converge thinking into one where communication functions can be granted to electric engineering. Second, as communication functions are attached to a variety of electrical equipment such as intelligent lighting, smart meters, distributed generation power, etc., it is expected to be necessary to provide continuous education and training on the properties of these devices and construction methods. There is a need to foster creative, converged human resources based on communication functions on the basis of electricity. Third, as the main functions of electricity and communication works can be vague, there is a need to carry out the standardization to overcome the problem, to establish regulations, and to solidify the partnership between the construction industry and the lighting industry.

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