Chapter 2

Analysis of ICT Industrial Trends in the IoT Era

Part 1

This chapter organizes the overall structure of the ICT industry, given IoT progress, and provides quantitative verifications of each market's size, growth potential, and competitive environment.

Section 1 Current Status of the ICT Industry and Its Structural Reorganization

1. Growth in things connected to the Internet

With advances in Internet technology, as well as in sensors and other technologies, household appliances, vehicles, buildings, factories, and many other things in the world are starting to be connected to the Internet, in addition to conventional Internet-connected devices such as PCs and smartphones. In the Internet of Things (IoT) era, the number of things connected to the Internet is predicted to explode.

2. Growth in data traffic

The data traffic on networks is certain to skyrocket, given the growth in things connected to the Internet, as mentioned in the previous paragraph, the global penetration of the Internet, and the emergence of various services and applications.

3. Creation of new markets and business model transformations

How will the explosive growth in Internet-connected things and data traffic transform existing ICT industries and market structures?

The first projected effect is the creation of new markets and the development and expansion of existing ICT industries and markets. Potential new markets are those for new services and applications focused on adding value to big data collected from devices. Artificial intelligence (AI) technologies are expected to analyze and make use of big data created by the IoT. AI advances, then, will likely accelerate the IoT's creation of markets.

The second projected effect is further competition, as new business domains emerge. The competition around new added value from data and business domains will arise not just between traditional ICT industry enterprises but also between entrants from other industries and sectors, including ICT user industries.

In this way, an ecosystem of new ICT industries is expected to form, while existing ICT platforms and new ICT trends, driven by IoT, big data, and AI, influence and interact with each other.

Section 2 Quantitative Verification of the Market Size, etc.

1. Platforms

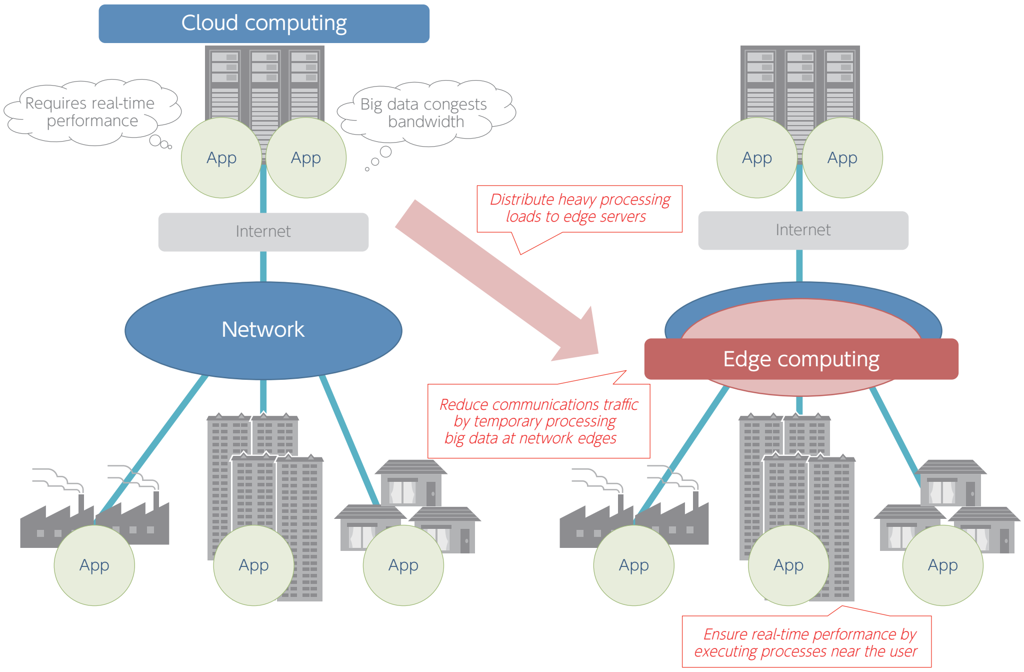
(1) Cloud service market

Cloud services provide Internet resources such as servers, applications, data centers, and cables.

As pointed out in the previous section, the explosive growth in Internet-connected devices will fuel exponential growth in the data generated by these devices. Extracting value from huge numbers of devices and massive volumes of data with conventional cloud services entails very significant costs and labor. Furthermore, applications requiring real-time performance and services handling big data suffer from latency problems because cloud computing lacks sufficient processing power.

Edge computing is a recent technological trend to overcome these problems. Edge computing is a concept that expands conventional cloud computing to the edges of networks and distributes and allocates resources physically close to end users. The *edges* of a network refer to the borders where a communications network interfaces with external networks or the areas where end terminals are connected to the network. In other words, applications are distributed close to where data are created instead of concentrating data and their processing in the cloud. The goal of edge computing is to make use of more data and derive more value from the data (Figure 2-2-1-1).

Figure 2-2-1-1 Edge computing concept



(Source) "Study Report on a Structural Analysis of the ICT Industry in the IoT Era and Verification of ICT's Multifaceted Contributions to Economic Growth," MIC (2016)

Edge or fog computing, when combined with deep learning and other AI technologies, should lead to the implementation of various services and applications. One leading example is the FANUC Intelligent Edge Link and Drive (FIELD) System, a shared IoT development platform for manufacturers created in Japan that automatically controls machines running in factories. The FIELD System was announced by FANUC, Cisco Systems, Preferred Networks, and Rockwell Automation. FANUC is a Japanese electronics manufacturer involved in machine tool robotics and industrial robots. Preferred Networks is a Japanese startup specialized in business applications of real-time machine learning technologies, with a focus on the IoT. The FIELD System is a platform for developing applications to be positioned in the fog layer. The platform is provided together with applications needed for factory workplaces or deep learning. The system takes data from computer numeric control (CNC) machines, robots, machine tools, and various sensors and realizes real-time connectivity between machines through distributed cooperative machine learning that processes data in the fog layer. Through this interconnectivity, the FIELD System aims to boost the productivity of industrial robots.

2. Networks

(1) Fixed broadband and mobile communications services

a. M2M market

Before the IoT had garnered any attention, machine-to-machine (M2M) communications that connect machines via communications carrier networks were in use in many fields. OECD statistics by country on the number and penetration rate of M2M connections using communications networks show that the United States leads the way, with 44 million connections, followed by Japan, with 12 million.

As the penetration of smartphones and other personal communications devices reaches saturation, communications carriers in many countries are moving ahead strategically with the provision of M2M services running on their own mobile communications services in anticipation of the IoT's emergence. Although no M2M or IoT business models have been established, risings costs, accompanying the increase in connections, is a pressing issue.

Because of this, communications carriers have 2 major challenges: (1) creating unified platforms for M2M services and (2) cutting sales costs. The first challenge involves developing a common platform for M2M functions, instead of building separate M2M services for each customer, and using the platform as a model to lower service rollout and operation costs. Jasper Technologies is the largest platform provider and supplies platforms to many communications carriers. In Japan, NEC, Fujitsu, NTT Data, and others offer similar platforms. For the second challenge, the key to lowering sales costs is a B2B model that can capture large numbers of devices per contract — in particular, capturing global corporations with large user bases. But to capture global corporations and to resist gigantic communications carriers like Vodafone that possess their own global networks, communications carriers in many countries have to establish environments in which they can provide one-stop services around the world. To this end, communications carriers are forging stronger alliances with each other.

Section 3 IoT Progress In and Outside Japan

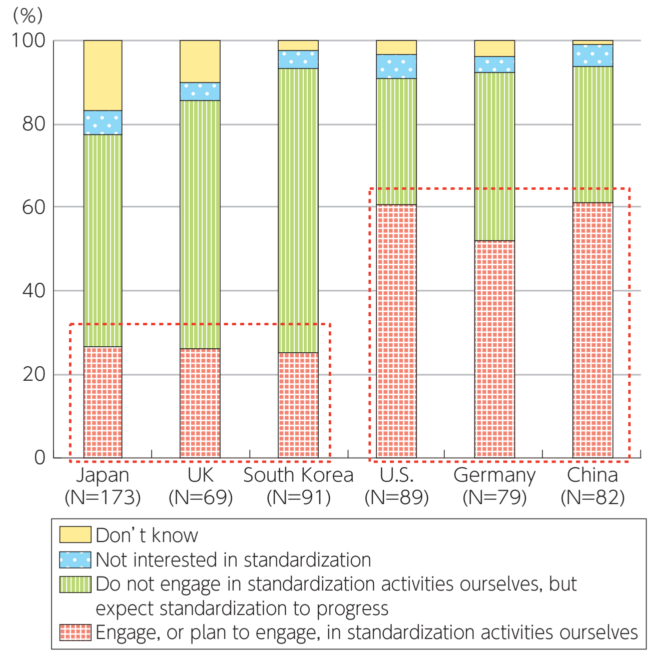
1. IoT expansion efforts domestically and abroad

(1) Developments in IoT standardization

Many players in the IoT world are moving ahead aggressively with R&D and standardization. In particular, alliances and consortiums are actively working on international standards.

In our international survey of enterprises (in Japan, the United States, the United Kingdom, Germany, South Korea, and China), we asked enterprises about their perspectives on IoT standardization initiatives. The answers fell into 2 camps: countries with many corporations taking their own initiatives — the United States, Germany, and China; and countries without many such enterprises — Japan, the United Kingdom, and South Korea (Figure 2-3-1-1).

Figure 2-3-1-1 IoT standardization stances of enterprises in 6 countries



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2. IoT adoption by enterprises

Enterprises, when using and applying data, tend to pass through 3 stages: they begin by collecting and accumulating data, then make future forecasts based on visualizing and ascertaining current conditions, and finally optimize the target of the data. Through these stages, enterprises change their business processes, add supplementary services to existing products, provide consulting services based on their data, or even trigger business model transformations. In the first stage of collecting and accumulating data, either the added value created with the data is small or it is very difficult for the enterprise to predict how much value will be created by continuing to use and apply the data. This is why enterprises often start small when adopting IoT, using cloud services first and then expanding while observing the benefits of adoption.

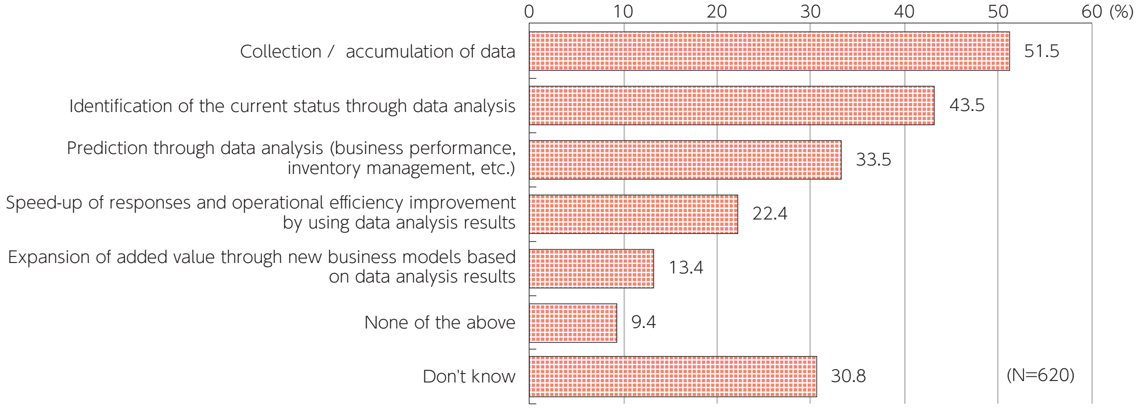
The survey of Japanese enterprises found that while 51.5 percent were involved in collecting and accumulating data, only 13.4 percent had expanded added value through business model transformations. This finding suggests many enterprises currently remain at the collecting and accumulating stage (Figure 2-3-2-1).

When enterprises adopt IoT, either they adopt IoT to internal processes with the enterprise acting as the user or they adopt IoT to goods and services the enterprise provides as a supplier. The description below defines the former as *IoT adoption to processes* and the latter as *IoT adoption to products*.

(1) Purpose of IoT adoption by enterprises

Enterprises that adopt IoT to processes are primarily interested in cutting costs. ICT enterprises may consider developing IoT services themselves, but in the majority of cases IoT solutions from external vendors are used. In either case, suitable capital investments are necessary. The primary benefit of IoT adoption to processes is lower costs, but there are examples of secondary benefits, such as increasing employee ambition. For example, Omron, together with Fujitsu, introduced data visualization for a production line at its Kusatsu factory. By

Figure 2-3-2-1 State of data use and application by Japanese enterprises



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being able to verify the outcomes of improvements visually, workplace motivation was boosted significantly and a virtuous circle leading to more improvements resulted. Overall, production efficiency was increased by about 30 percent.

The main goal of enterprises that adopt IoT to products is increasing sales. Initially, enterprises invest in R&D to a degree commensurate with the expected increase in sales and proceed with applying IoT to products.

(2) Typical example of IoT adoption to products

The main target of enterprises adopting IoT up to now has been cutting process costs, but expectations are mounting that adopting IoT to products will increase sales. IoT adoption to products is typically done in several stages.

The first stage is to equip the product with sensors and communications modules so it can connect to the Internet. The next stage is to use data obtained from the product to add more value to the product. The final stage is to either develop new services using the data obtained from the product or to use the enterprise's internal ICT platforms, or else laterally develop applications, to collect and analyze data from the product.

3. International comparison of IoT initiatives by enterprises

Based on the state of IoT initiatives and examples given in the previous paragraph, we conducted a survey of enterprises (in all industries) in 6 countries (Japan, the United States, the United Kingdom, Germany, South Korea, and China) to verify the actual state of IoT adoption as well as the benefits and issues with IoT adoption.

(1) IoT adoption rate

We first confirmed the current state of IoT adoption among enterprises and their intentions to introduce IoT in the future (around 2020). The current adoption rate in the United States is far ahead, with over 40 percent of companies adopting ICT to both processes and products. The United States enjoys rates double the other 5 countries, including Japan, which are around the 20-percent level.

As for the intention to adopt IoT by 2020, IoT adoption rates are projected to double or triple current rates in both processes and products. Comparing countries, however, finds that Japanese enterprises have lower intentions to adopt IoT in the future. Therefore, there is a real possibility that the current gap will grow with not only the United States but also other countries (Figure 2-3-3-1).

(2) Views on IoT markets

Japanese enterprises showed less enthusiasm, on the whole, than their counterparts in other countries when asked for their forecasts about how much IoT would add to the market size of their respective industry in the coming years (i.e., their expectations for IoT to increase market sizes). There was also a considerable gap between Japanese ICT enterprises and non-ICT enterprises on this question, suggesting that non-ICT enterprises have rather low expectations for IoT (Figure 2-3-3-2). It is possible to surmise that this gap in IoT expectations may be a factor why Japan's IoT adoption rate and investment trails that of other countries.

(3) Issues with IoT progress

We compared issues complicating IoT progress between the 6 countries. The countries have common issues in the area of IoT infrastructure build-out. On the other hand, the countries had diverging perceptions of issues in the areas of creating new markets or raising capital. These differences may influence the state of IoT progress in each country. Japanese enterprises, in particular, tended to view "personnel training" as an issue more than those in other countries (Figure 2-3-3-3 and Figure 2-3-3-4).

Figure 2-3-3-1 Current IoT adoption (2015) and future adoption intentions (by 2020)

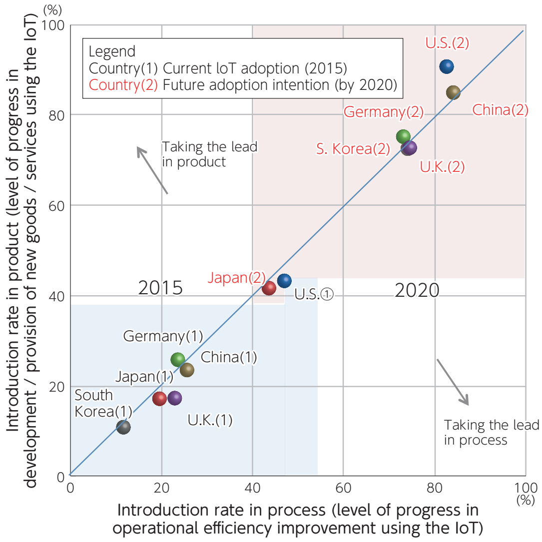

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Figure 2-3-3-2 Predicted market expansion due to IoT in own industry by 2020

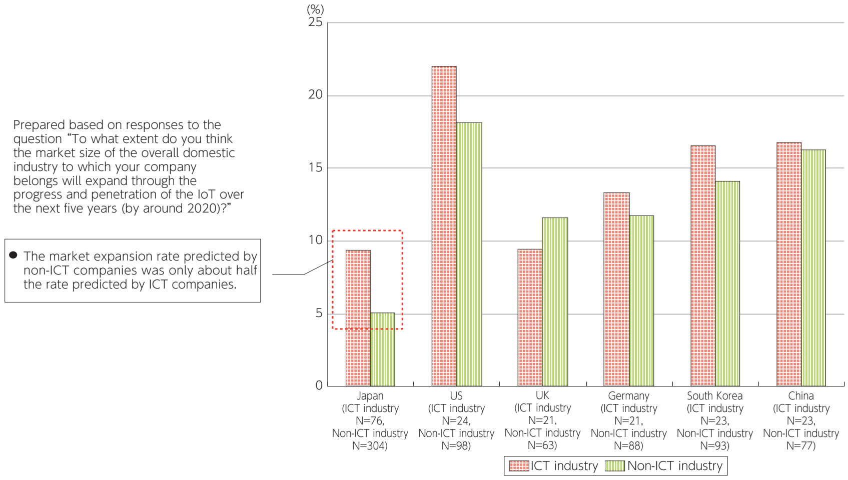

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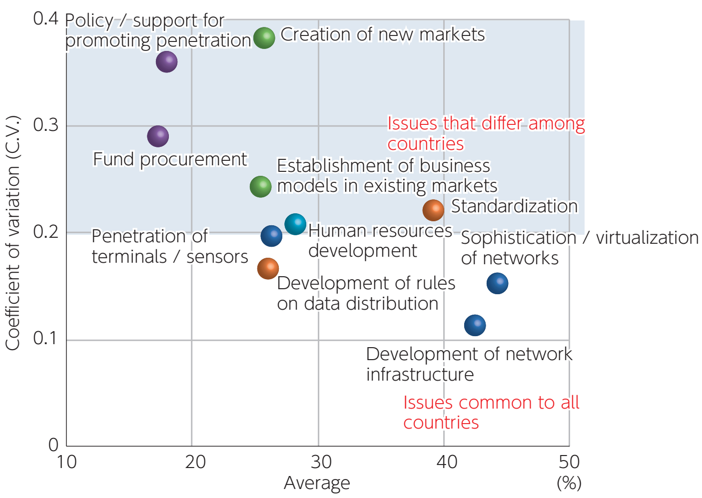
Figure 2-3-3-3 Averages and variation coefficients for IoT progress issues



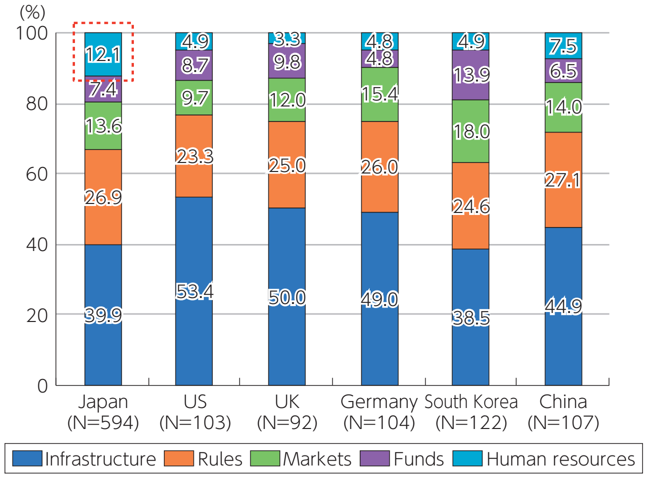
*Deviation value divided by the average. When the coefficient of variation is small, the factor is commonly recognized by all countries as an issue, and when the coefficient of variation is large, there are differences among countries as to whether they recognize the factor as an issue.

Source: "Study Report on a Structural Analysis of the ICT Industry in the IoT Era and Verification of ICT's Multifaceted Contributions to Economic Growth," MIC (2016)

(4) International comparison of IoT progress

Based on the survey results, we created an indicator to measure the state of IoT progress in each country. We also defined an indicator to express the state of wireless communications infrastructure, which is a key factor in creating the conditions for IoT progress. With these 2 indicators, we created a mapping of the 6 countries. In Japan, the percentage of enterprises pointing out infrastructure as an issue hindering IoT progress was low internationally. But as seen from the statistics, the IoT progress index in Japan is low compared to the state of its infrastructure build-out. Measures are needed, then, to further IoT use and application, such as personnel training and publicizing IoT usage scenarios among user enterprises (Figure 2-3-3-5).

Figure 2-3-3-4 Number of IoT progress issues by country



This figure groups the issues from Figure 2-3-3-3 as follows.
- Infrastructure: "sophistication / virtualization of networks" "development of network infrastructure" "penetration of terminals / sensors"
- Rules: "development of rules on data distribution" "tandardization"
- Markets: "creation of new markets" "establishment of business models in existing markets"
- Funds: "policy / support for promoting penetration" "fund procurement"
- Human resources: "human resources development"

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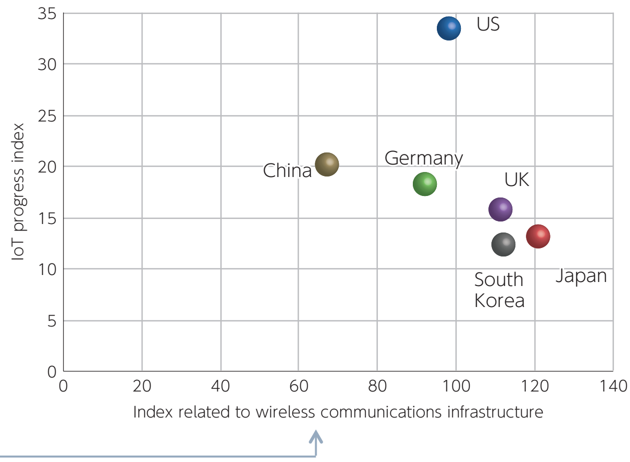
Figure 2-3-3-5 IoT progress index and an international comparison

IoT progress index (based on a questionnaire surveyof companies)	Weight
Process	
Rate of introducing IoT solutions	0.25
Amount of IoT-related capital investment by companies that have introduced IoT solutions (percentage of total sales)	0.25
Product	
Rate of providing IoT goods / services	0.25
Amount of sales of IoT goods / services by companies that provide IoT goods / services (percentage of total sales)	0.25

Capital investment amounts, instead of product cost reduction rates, were used to be able to compare sales ratios

Index related to wireless communications infrastructure (ITU*)	Weight
Mobile-cellular telephone sub scriptions per 100 inhabitants	0.5
Active mobile-broadband sub scriptions per 100 inhabitants	0.5

Source: ITU "ICT Development Index"



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