Section 2 The Super Smart Society of the Future

Based on the shared elements in the various aspects of the super smart society that were envisioned in Section 1, Chapter 2 elaborates on the future of Japan's super smart society, and on the need for the whole nation to share the vision of a super smart society and to realize such a vision before the rest of the world. Significant socioeconomic changes that will take place in the process of creating a super smart society are also examined. Additionally, government policies and private-sector efforts of foreign countries towards the realization of such a society are described together with similar efforts made in Japan.

1 Toward the Realization of a Super Smart Society

(1) Elements common to various aspects of our future society

A future society was envisioned above in line with the social problems that Japan is under pressure to deal with now. Multiple fields in that society share several elements as stated below. Clarification of these elements helps outline Japan's super smart society.

In Section 1, seven different aspects of the future society were found to have the following three common elements.

First, vast amounts of data are used to facilitate interactions between different value chains in order to provide advanced services to everyone. Value chains used to be developed and utilized separately by each specific industry. In the future society, data are collected from all sources available, including our living environment, workplaces, farms and databases of health information and vehicle travel distances. The collected data are stored in cyberspace and used for the successive creation of new value-added businesses and services. These services touch every aspect of our lives, such as food supply, medical care, regional community and infrastructure. Additionally, various systems used in different fields interact with each other to expand the sphere of automation and autonomous operation, which benefits every aspect of society.

Second, with innovations in artificial intelligence and robotics technologies, work in hazardous situations and physical labor are partly undertaken by robots, and specialized, knowledge-intensive services are assisted by robots. Consequently, work safety and productivity increase, and people can focus on creative jobs. In addition to these changes to the work environment, technological innovation helps people to spend their time more meaningfully than before, irrespective of age and despite the physical distances that may otherwise constitute obstacles in their lives. For instance, a person who is too old to go out can attend the wedding of a relative by using a robot that acts on her behalf by reading her brain waves. Potentially serious diseases are controlled adequately by preventive medicine, so patients do not have to visit the doctor regularly or be hospitalized for prolonged periods. The changes brought by technological innovation make it possible for people to focus on creative work, increase intergenerational exchanges, hand down culture and tradition to future generations, and enjoy active, affluent lives.

Third, the science and technology that support the future society described above are those of the IoT, big data, artificial intelligence and robots. In addition to messages posted on social networking sites and data exchanged online, diverse information will be digitized in the future society. Such information includes data collected in people's everyday lives, such as personal health data (e.g., blood pressure, pulse, brain waves) and data on the internal structural conditions of deteriorated buildings. Various technologies play critical roles in collecting these data. Sensor technology is used for instantly detecting, digitizing, collecting and storing information. Big data analysis technology is necessary for analyzing large amounts of digitized information. Artificial intelligence technology helps suggest the need for a doctor's therapeutic decision according to big data analysis results, or the need to implement an efficient repair plan for a building by referring to past inspection results of that building. Robot technology will diversify in the future society. For example, there will be robot chefs, robot vacuum cleaners, robots serving as conversation partners for the elderly to help prevent dementia, and robots for motion support. (Note: The science and technology envisioned in this section represent only a part of the science and technology that will support our future society. More will be explained in Chapter 2, Section 1.)

(2) Sharing of a vision toward a super smart society

A super smart society will bring sweeping trends.

In the future society envisioned in Section 1, diverse systems interact to provide advanced services to everyone. This suggests that the current industrial structure will undergo substantial changes and that cross-sectoral cooperation and coordination will lead to the creation of products and services that are totally different from those which are currently used separately in each of the various sectors of manufacturing, distribution, marketing, traffic, healthcare, medicine, etc. Such structural changes in industries are likely to radically alter the country's socioeconomic situation and the ways that people work. Additionally, it will be necessary to review social rules, implement regulatory reforms and enhance cybersecurity and the security of personal information.

Once various new services are created and made available on the basis of consumer needs and novel ideas, these services will capture the global market. In cyberspace, these services are offered without being bound by geographical and time constraints. Thus, such services bring significant changes in competitiveness to industries and to the country as a whole. This suggests that "game changes" will take place frequently. In anticipation of the major changes that are called "the fourth industrial revolution," many countries have been making bold efforts. Specifically, strategic initiatives such as *Industrie 4.0* of Germany, the *"Advanced Manufacturing Partnership"* of the U.S.A., and *"Made in China 2025"* of China, for example, have been promoted under cooperation between the government and the private sector by capitalizing on the strengths of each country.

Japan is at the forefront of efforts to solve emerging issues that other countries will also be confronting. The socioeconomic problems that Japan is facing now came to the surface in the midst of major changes in the social structure caused by the declining birth rate and rapid population aging. Thus, conventional approaches have difficulty addressing these problems. Against this backdrop, pioneering initiatives, as fragments of a super smart society, have emerged in manufacturing and other sectors. Efforts to identify original, optimum solutions to the problems that Japan is encountering before the rest of the world will turn the country's disadvantages into advantages. Consequently, the super smart society of Japan is likely to lead the way in worldwide efforts to solve diverse socioeconomic problems in the future.

To lead the world in realizing a super smart society, the whole nation needs to share a vision of such a society as the ideal future society of Japan, and necessary efforts should be advanced. Section 2 focuses on major socioeconomic changes that will take place in the course of realizing a super smart society, as well as on government policies and private-sector efforts toward a super smart society of foreign countries. The current situations and problems related to Japan's super smart society are also described.

2 Major Socioeconomic Changes Associated with the Realization of a Super Smart Society

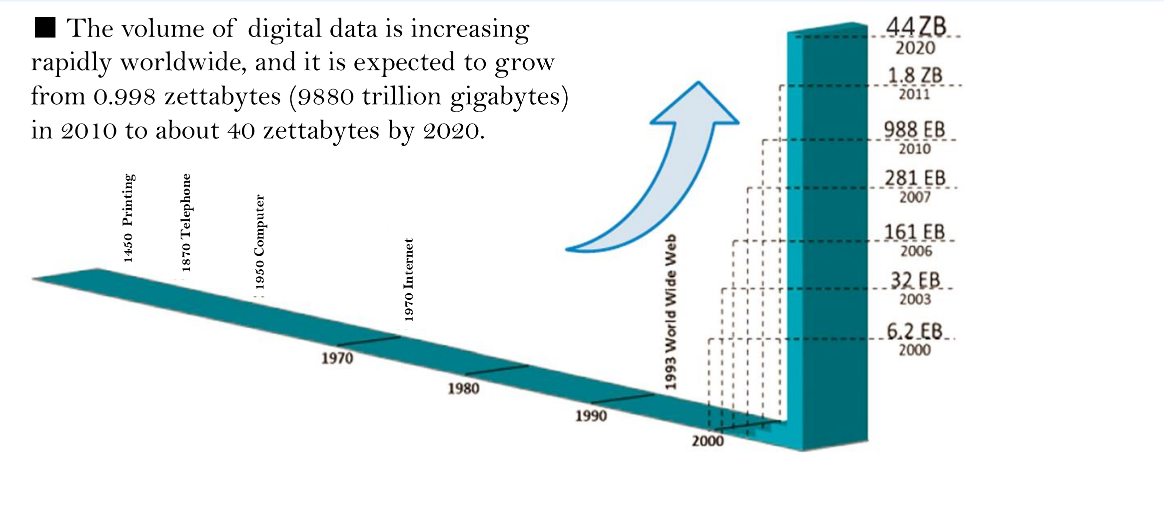
Among the diverse social and economic changes that will take place with the advent of a super smart society, changes in industrial structure and employment situations are described in Section 2, as these changes are expected to have particularly close connections with a super smart society.

(1) Changes in industrial structure

① Industry servitization based on data

The volume of digital data is increasing rapidly worldwide, and it is expected to grow from 1.8 zettabytes[1] (1.8 trillion gigabytes) in 2011 to about 40 zettabytes in 2020 (Figure 1-1-4). An exponential increase has been achieved in CPU[2] speed, data storage capacity and Internet connection speed (Figure 1-1-5). Furthermore, the revolutionary development of artificial intelligence and other technologies is anticipated.

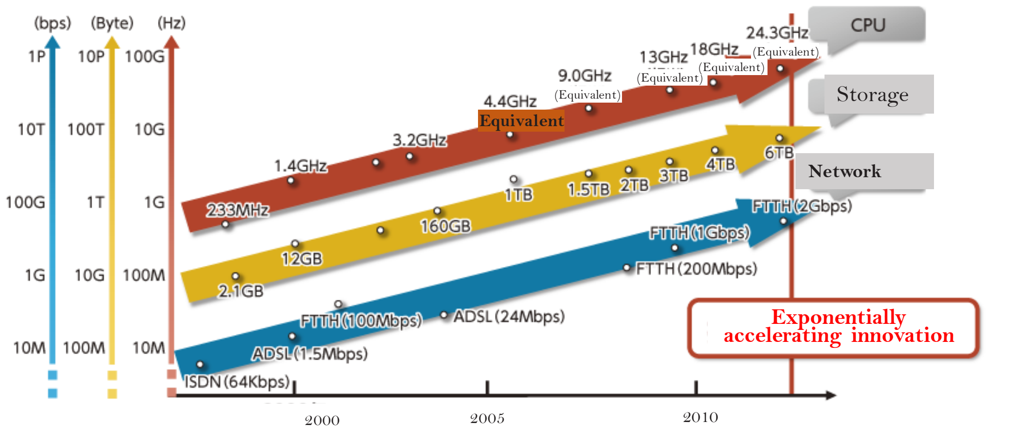
■ Figure 1-1-4 / Forecasted increases in the volume of global digital data



Note 1: 1 exabyte (EB) = 1 billion gigabytes (GB); 1 zettabyte (ZB) = 1 trillion gigabytes
Note 2: Report of "ICT Kotozukuri Panel," MIC
Source: *White Paper 2014: Information and Communications in Japan*, MIC

1 The prefix "zetta" indicates multiplication by 1021 in the International System of Units (SI).
2 Central Processing Unit

Figure 1-1-5 / Hardware evolution

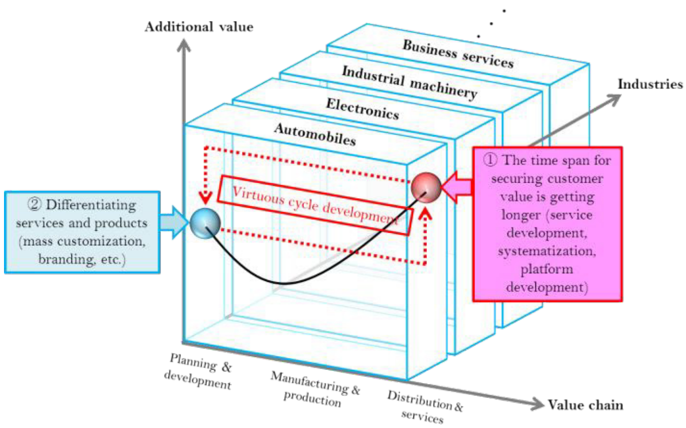


Note: "Equivalent" means the converted processing capacity of a multicore processer to a singlecore processor. The processing capacity of 2 core, 4 core, 8 core, 10 core and 12 core processors are assessed 1.5 times, 3 times, 6 times, 7.5 times and 9 times of normal singlecore processor, respectively. From 2006, in the order of year, processing capacities for 2 core processer is calculated by 2.93 GHz X 1.5 = 4.4 GHz, 4 core processer is calculated by 3 GHz X 3 = 9 GHz, 8 core processer is calculated by 2.26 GHz X 6 = 13 GHz, 10 core processer is calculated by 2.4 GHz X 7.5 = 18 GHz and 12 core processer is calculated by 2.7 GHz X 9 = 24.3 GHz.

Source: 2014 White Paper on Information and Communications in Japan (MIC)

How will technological innovation affect the industrial structure?

One factor that causes changes to the industrial structure is the addition of value not only from the virtual data generated in cyberspace through the use of SNS, etc. but also from innovative techniques for collecting, storing and using data. With the advancement of sensor technology and the IoT, it has become possible to acquire data on the real-world activities of individuals and businesses, including health information, vehicle travel data and data on the operational status of appliances and facilities. These real data are likely to be utilized for many applications in the future. As described below regarding the efforts made by multiple companies, the use of these data will lead to the rapid improvement of operational efficiency at factories and will accelerate mass customization, or the production of custom-tailored goods and services to meet consumers' diverse needs with no increase in production costs. Thus, the businesses that are expected to gain a competitive advantage are those that can strategically use the real data mentioned above in association with their respective strengths and can create innovative products and services to meet customer needs that these businesses were unable to apprehend before.



Diagrammatic illustration of a business model that secures customer contact points for a positive growth cycle

Source: Adapted by MEXT based on data from the New Industrial Structure Committee, Industrial Structure Council

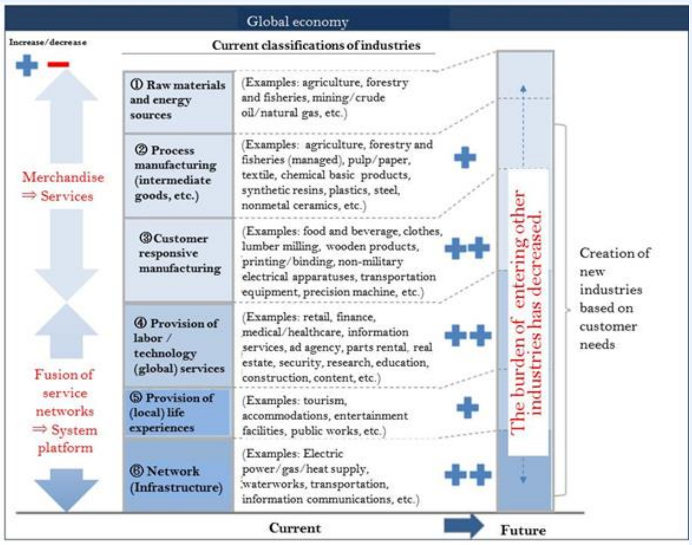
A key to such competitive advantage is to secure contact points with consumers who keep generating real data. By securing customer contact points, it will be possible to develop a business model in which:

(i) vast amounts of real data on consumer information and customers' precise preferences are collected and used; and

(ii) value is added to such products and services by taking advantage of the strengths of a specific business, and consequently, a positive growth cycle is maintained through the continuous collection of real data.

With changes to global industrial structures, businesses and industries using this business model are likely to grow substantially by identifying consumer needs that had been invisible. In light of this, it is possible that the industry sectors that operate close to customer contact points and are expected to benefit significantly from the formation of a positive growth cycle (i.e., ③, ④, ⑤ and ⑥ in Figure 1-1-6) will achieve strong growth, as will the industry sectors that collaborate strategically with those industrial sectors (i.e., ③, ④, ⑤ and ⑥ above, plus ②) .

■ Figure 1-1-6 / The global industrial structure



Source: New Industrial Structure Committee, Industrial Structure Council. February 2016

② The rise of "platformers"

In the process of securing contact points with customers who keep generating real data, the industrial structure will be changed further. For instance, to meet consumer needs that were not obvious and thus could not be dealt with before, businesses may pursue expansion by starting operations in different business domains or by incorporating new lines of business. Then, barriers between existent industries may be reduced, and these industries may be reorganized into

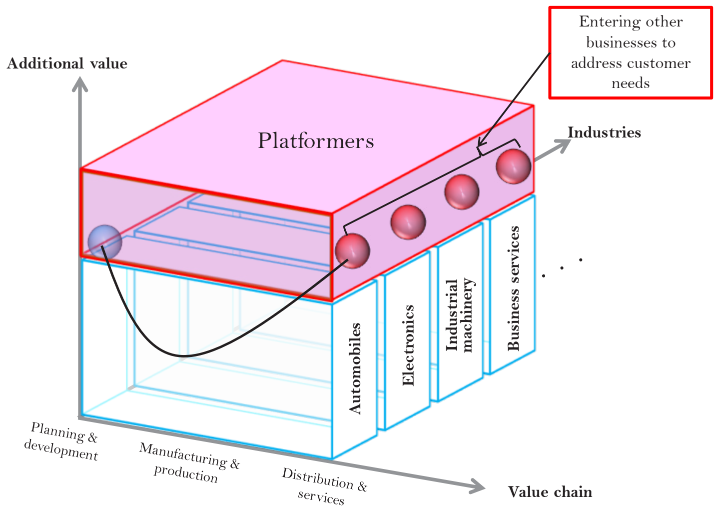


Diagram illustrating the rise of platformers

Source: Adapted by MEXT based on data from the *New Industrial Structure Committee*, Industrial Structure Council new industry sectors or markets on the basis of consumer needs. Businesses that initiate innovations, such those of the industrial structure, are called "platformers."

Actually, platformers have always existed within each conventional industry sector. But recently, companies have begun to provide services across the boundaries of industry sectors. For example, Google Inc., the American technology company that grew chiefly by providing an Internet search service, has started the development of self-driving cars. A super smart society is a society where different industry sectors are interrelated across sectoral barriers via cyberspace. Thus, it is expected that businesses that can boost their competitiveness are those which are able to build systems across conventional industry sectors, such as automotive, electronics, industrial machinery and business services, to remove barriers between products and services produced in these sectors and provide consumers with the services they need.

The manufacturing industry in Germany and the U.S.A. has seen a rise in platformers. Specific examples are shown below.

＜Platformers in Germany＞

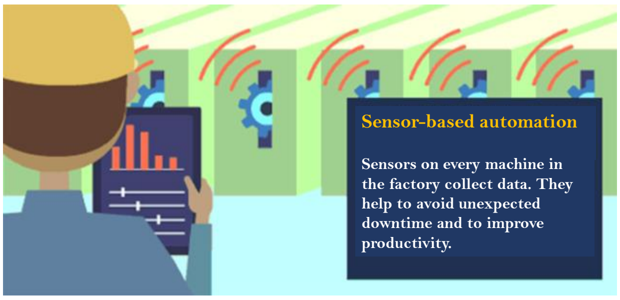
Siemens AG, a leading German company, has been specializing in control equipment and control network systems for manufacturing plants. The company expanded its business domain upstream in order to involve itself in the execution and management of manufacturing. As a supplier of production lines that include tools for manufacturing execution and management, Siemens has an edge in the integration and digitization of all information in a plant. SAP AG, a German software maker, is a leading vendor of tools for the sales order management of parts and materials. Information on product life cycles is used for sales order management. Under Industrie 4.0, SAP has expanded its business to support production planning on the basis of information exchanged between plants or between companies when orders are placed.

Siemens expanded their business from production to production management, and SAP, which has been specializing in management, is now interested in production. It is possible that competition between the two companies as platformers has helped to stimulate initiatives for promoting Industrie 4.0 throughout Germany[1].

＜Platformers in the U.S.A.＞

In March 2014, the Industrial Internet Consortium (IIC) was founded by General Electric Co. (GE), Intel Corp., Cisco Systems, Inc., IBM and AT&T in the U.S.A. (As of 2015, the IIC had more than 250 members, most of them American companies.)

The Industrial Internet is an initiative for enhancing industrial efficiency to increase profits. For this purpose, all sorts of industrial equipment and computers used in manufacturing and all



Optimization of production by means of sensors at a GE plant

Source: GE Japan Ltd.

1 *White Paper on Manufacturing Industries (Monodzukuri)*, 2015

other industries are networked for the collection and analysis of huge amounts of data. GE has been calling for standardization of the IoT. GE is an American conglomerate that chiefly specializes in industrial equipment for infrastructure. It is a business giant that grew through the manufacture and sales of aircraft engines and other equipment. Recently, GE changed its business model substantially by putting weight on software. The company reinforced its software business as part of its efforts toward promoting the Industrial Internet, focusing on the enhancement of capacity utilization rates by using sensors and software for the sharing, collection and analysis of information on a variety of industrial equipment and devices. GEnx is GE's cutting-edge jet engine. Dozens of sensors on this engine collect 5,000 data per second, including those on temperature and oil differential pressure, for constant monitoring of the state of an aircraft. This feature of the engine is useful for aircraft maintenance and fuel efficiency improvements, leading to significant cost reductions. In the energy sector, GE has collected large quantities of data on locational conditions, wind directions and other conditions of wind power generation, and has proposed techniques for efficient power generation to power companies. E.ON SE, the German energy provider, used GE software to increase their annual production of wind-generated electricity by 4%.

Through the Industrial Internet, GE has been helping improve the operational efficiency of infrastructure equipment that has not benefited from digitization before. Systems that GE develops for this purpose are provided to a broad range of users, including direct GE customers, so that GE is able to collect big data concerning user companies' information on the use of the systems. GE aims at becoming a platformer by serving as an asset manager in various fields of industry.

③ Economic impacts

A major factor that facilitates changes to the industrial structure is the IoT's ability to collect and accumulate big data, or vast amounts of data sent from things connected with each other via the Internet. Furthermore, effective analysis of big data is made possible by advances in artificial intelligence. It is expected that big data will be utilized in business, the social arena and many other sectors.

At this point, it is difficult to describe what the full picture of the economic impacts brought by a super smart society will look like. However, private think tanks have conducted research on the economic impacts of artificial intelligence, big data and the IoT on the world as well as on many countries (Figure 1-1-7). The research results show that the economic impacts are significantly large.

■ Figure 1-1-7 / Outlook for the economic value brought by artificial intelligence, big data and the IoT

	Expected economic value brought by AI, big data and the IoT
McKinsey[1]	**In 2025, economic impact of AI and big data, etc.: 5.2 - 6.7 tril. $U.S.** Note: Impact of automation on intelligent work by Ai, big data or the like.
McKinsey[2]	**In 2025, the economic value of the IoT*: 3.9 - 11.1 tril. $U.S.** (Major fields) Smart homes, offices, retail, medical care, smart factories, smart cities, external environment between cities, automobiles (maintenance- and insurance-related)
Cisco[3]	**From 2013 to 2022, economic value created by the IoE for private companies*: 14.4 tril. $U.S. (public services: 4.6 tril. $U.S.)** ("Drivers" behind value creation) Effective use of assets: 2.5 tril. $U.S. Improvements in employee productivity: 2.5 tril. $U.S. Efficiency improvements in supply chain logistics: 2.7 tril. $U.S. Improvements in customer experiences: 3.7 tril. $U.S Acceleration of innovation: 3 tril. $U.S
Gartner[4]	**In 2020, economic value created by the IoT*: 1.9 tril. $U.S** (Breakdown) manufacturing: 15%; health care: 15%; insurance: 11%; banking and securities: 10%
GE[5]	**Efficiency improvement through the industrial Internet** (Breakdown: When 1% efficiency improvement is achieved by the industrial Internet) air travel industry: annually 2 bill. $U.S.; power generation: 4.4 bill. $U.S.; medical care: 4.2 bill. $U.S.; railways: 1.8 bill. $U.S.; petroleum and gas: 6.0 bill. $U.S.
Fraunhofer	**As a result of Industrie 4.0 undertakings, economic growth in Germany will increase by 1.7% by2025**.

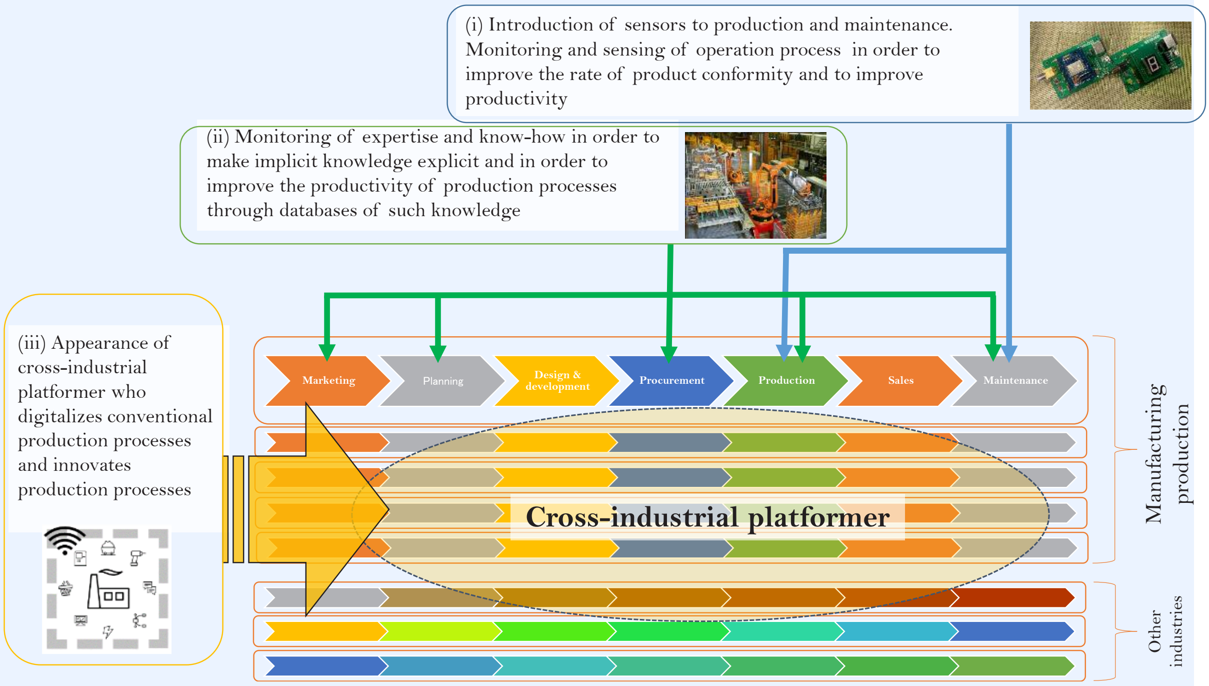
References：
1. McKinsey, *Disruptive Technologies: Advances That Will Transform Life, Business, and the Global Economy*
2. McKinsey, *The Internet of Things: Mapping the Value Beyond the Hype* (2015)
3. Cisco, *Internet of Everything*, (2013)
4. Gartner, *The Internet of Things, Worldwide*, (2013)
5. Website of GE (Industrial Internet)
http://www.ge.com/jp/industrial-internet
6. *Industrie 4.0 – Volkswirtschaftliches Potenzial für Deutschland* (Fraunhofer IAO/BITKOM)

Source: MEXT

【Economic value】
This is the total effect not only of increased sales by IoT suppliers but also from IoT users' economic effects, cost reductions through operating efficiency improvements, etc. and sales increases by advanced marketing of businesses that introduce the IoT.

Under the Science of science, technology and innovation policy program (SciREX) analyses were conducted regarding the ripple effects that IoT-related technologies might have on Japan's economy through the influence of these technologies on the production processes in the manufacturing industry. In the analysis, the effects of investment in IoT-related technologies are forecast according to the scale of investment. The technologies concerned are those for (i) the real-time assessment and analysis of machinery operation by means of various sensors, (ii) the compilation of a database of implicit knowledge through the monitoring of experienced engineers' expertise and know-how and (iii) the creation of a platform for digitizing a series of processes that include maintenance, sales and marketing (Figure 1-1-8). The analysis shows that, regarding technologies for (iii), the development of a cross-industrial platform beyond the boundaries of the manufacturing industry is likely to lead to dramatic long-term productivity enhancements. Thus, economic ripple effects that exceed the cost of investment are expected from investments in technologies for (iii)[1].

■ Figure 1-1-8 / Impacts on production processes from policies and advanced technologies related to the IoT/ICT



Source: Created by MEXT and the SciREX Center based on data from the Center for Research and Development Strategy (CRDS), Japan Science and Technology Agency (JST)[2]

(2) Changes in the employment situation

As shown above, the economic benefits from changes in the industrial structure that take place in the process of realizing a super smart society are estimated to be worth several trillion to more than 10 trillion dollars. However, the impacts of these changes on the employment situation have not been quantitatively or comprehensively forecast, and various predictions have been made on possible impacts. Changes in the employment situation that are likely to take place with the advent of a super smart society are discussed below by referring to examples in foreign countries

① Changes in the employment structure resulting from advances in the IoT, big data and artificial intelligence

Rapid advances in artificial intelligence and other technologies in the super smart society are expected to affect unskilled jobs and many other occupations, and the capabilities required of workers are expected to

1 *Masahiro KURODA, Kenta IKEUCHI, Yasushi HARA. Policy Option Simulator for Science, Technology and Innovation Policy (1. Theoretical Framework and Model Formulation). SciERX Working Paper. 2016.* (http://id.nii.ac.jp/1295/00001341/)

2 Center for Research and Development Strategy, JST, Policy Option Simulator for Science, Technology and Innovation Policy (Creation Process of Policy Options for ICT). Research Report CRDS-FY2015-RR-07. March 2014.

change in such a society.

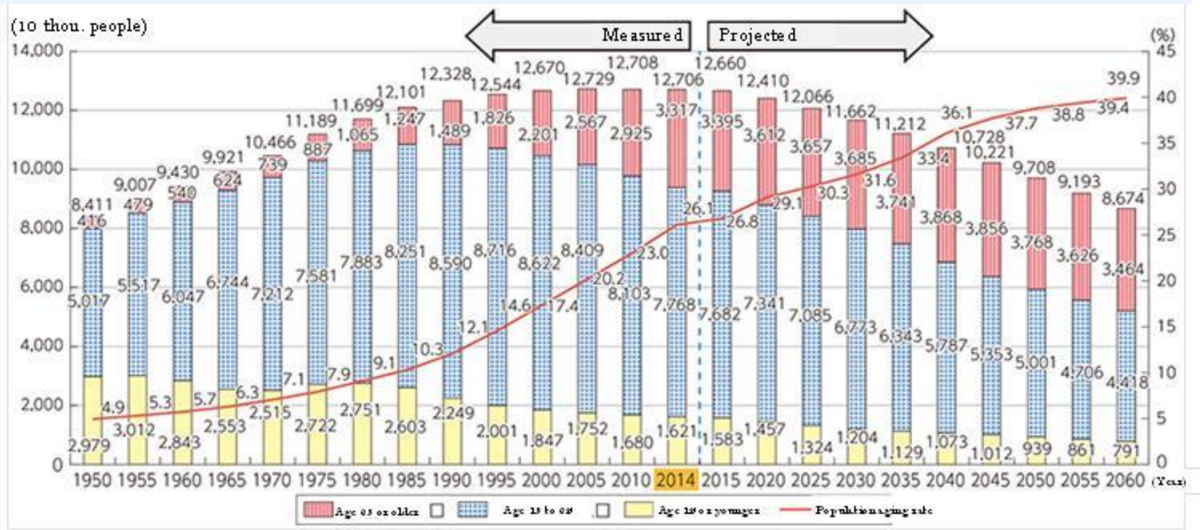
Jobs that are likely to be replaced by artificial intelligence have been determined from an analysis in a study jointly implemented[1] by the Nomura Research Institute, Ltd., Dr. Michael A Osborne, Associate Professor at the University of Oxford, and Dr. Carl Benedikt Frey, Senior Fellow at the University of Oxford. This collaborative study is part of research that has been conducted on the topic of "Thinking of Japan from the viewpoint of the year '2030': Preparing "now" for the situation in Japan in 2030."

In anticipation of Japan's future society in which a dwindling population leads to a decrease in the workforce (Figure 1-1-9), the research focuses on the societal effects of the use of artificial intelligence and robots to compensate for the labor shortage.

In a collaborative study, the probability that each of 601 selected jobs in Japan could be replaced by artificial intelligence or robots was estimated. The estimation result shows that about 49% of these jobs are likely to be replaced by artificial intelligence or robot technologies within 10 to 20 years. This replacement rate is as high as those in the U.S.A. and the U.K. (Figure 1-1-10). As Figure 1-1-11 shows, the researchers in the collaborative study analyzed jobs that are unlikely or likely to be replaced by artificial intelligence/robots. The researchers concluded that humans would continue to engage in non-routine jobs and jobs that require creativity, cooperation or coordination.

In the World Economic Forum Annual Meeting 2016 in Davos, the Fourth Industrial Revolution and its impacts were discussed from a multilateral perspective. Erik Brynjolfsson, an economist and Professor at MIT Sloan School of Management, and Andrew Paul McAfee, Associate Director of the Center for Digital Business at the MIT Sloan School of Management, presented the following views.

Figure 1-1-9 / Japan's demographic trend



Sources: *National Census* (excluding people whose age was not reported), MIC, for years up to 2010; *Population Estimates* as of Dec. 1, 2014, MIC, for 2014; *Population Projection for Japan* as of Jan. 2012 (moderate-range estimates for births and deaths), the National Institute of Population and Social Security Research, for 2015 and onwards

[1] "Forty-nine percent of jobs in Japan could be replaced by artificial intelligence and robots: Probabilities of replacement with computer technologies regarding 601 jobs." The Nomura Research Institute, Ltd. December 2015.

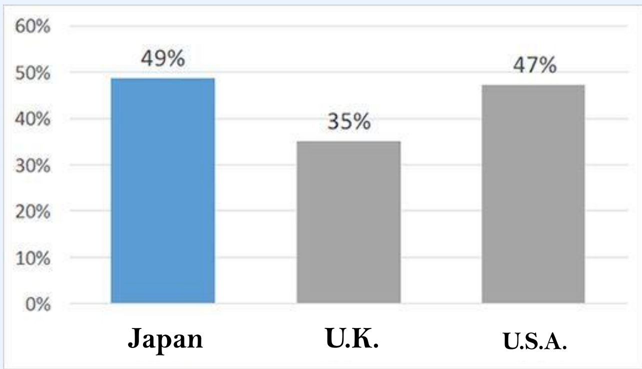
- The Fourth Industrial Revolution could yield greater inequality, particularly in its potential to disrupt labor markets
- Automation could substitute for labor and workers could be displaced by machines. On the other hand, it is also possible that the displacement of workers by technology will, in aggregate, result in a net increase in safe and rewarding jobs

These views suggest the following.

- Rapid advances in artificial intelligence and robotics will have significant impacts, as these could displace people in low-skill jobs.
- At the same time, it will be increasingly important for humans to engage in non-routine jobs and jobs that require creativity, cooperation or coordination.
- The displacement of workers by artificial intelligence and robots will result in net increases in safe, fulfilling jobs.

Thus, substantial changes are expected to take place in the employment structure in the future.

■ Figure 1-1-10 / Jobs that are likely to be replaced by artificial intelligence or robots (Comparison among Japan, the U.K. and the U.S.A.)



Source: Nomura Research Institute, Ltd. and the University of Oxford

■ Figure 1-1-11 / Jobs that are unlikely or likely to be replaced by artificial intelligence or robots

✔Jobs unlikely to be replaced by artificial intelligence or the like

Jobs that require knowledge for sorting and creating abstract concepts, such as art, history and archaeology, philosophy and theology, and jobs that require coordination with others, understanding of others, and persuasion, negotiation and service orientation.
Examples: economist, business consultant, medical doctor, childminder, teacher, etc.

✔ Jobs likely to be replaced by artificial intelligence or the like

Jobs not always requiring specialized knowledge or skills, and jobs requiring data analysis and systematic handling of data
Examples: clerical worker, sales clerk at super market, taxi driver, automobile assembler, etc.

Source: Created by MEXT from the material produced by the Nomura Research Institute, Ltd. and the University of Oxford

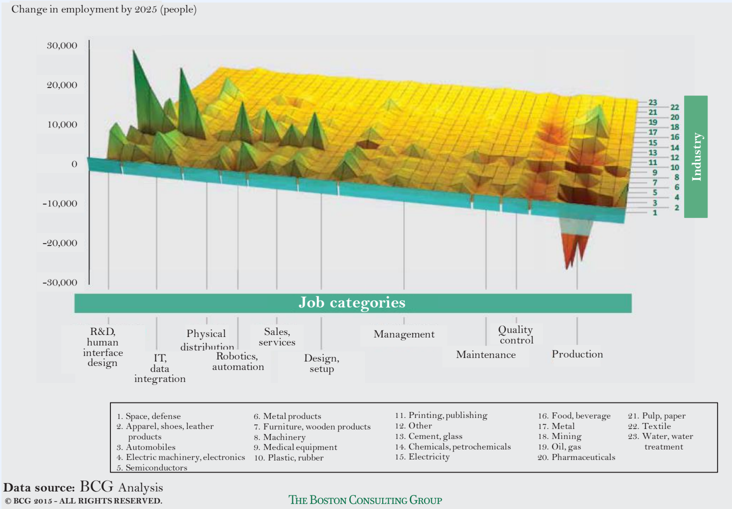
② The IoT, big data and artificial intelligence that help boost productivity and create new jobs

As stated above, changes in the employment structure include enhanced work safety because technological innovations in robotics are expected to lead to the replacement, by robots, of jobs that have been traditionally undertaken by humans. Replacement of human workers with robots will help eliminate labor shortages resulting from population aging in Japan. And with the help of robots, people will be able to enjoy active lives for as long as they wish, regardless of physical constraints due to age or gender.

Robots will also help create an environment in which people can focus on fulfilling jobs. As a result of technological innovations in artificial intelligence and big data, productivity will increase in knowledge-based, specialized jobs. For example, databases of technical knowledge will be created, and STI techniques including data-driven research techniques will be advanced. Consequently, it will take less time than before for attorneys and scientists to search for judicial precedents or for suitable materials. Attorneys and scientists will be able to secure enough time to concentrate on their other specialized tasks. In other words, parts of some professions will be replaced by technology, but other parts will not. This suggests that people will be able to devote themselves to creative tasks and thus will be able to generate additional value from their creative tasks.

It is not easy to quantitatively estimate and describe the employment structure of a super smart society. A survey by the Boston Consulting Group on changes in employment resulting from Industrie 4.0 (Figure 1-1-12) shows that there will be 350,000 additional jobs in Germany by 2025 in a baseline scenario that assumes Industrie 4.0 will achieve an annual average sales growth rate of 1.0% and a technology diffusion rate of 50%. The 350,000-job increase is equivalent to 5% of the current 7-million-strong labor force. Specifically, while 610,000 jobs will be lost chiefly in the manufacturing and assembly sectors, 960,000 jobs will be added in IT and data science services. It is expected that these 960,000 jobs will consist of 210,000 jobs related to IT, data analytics and high-skill tasks in R&D, and 760,000 jobs added because of the sales growth from Industrie 4.0[1].

■ Figure 1-1-12 / Changes in employment to result from Industrie 4.0 (by category of business/industry, from 2015 through 2025)



Source: The Boston Consulting Group

According to the analysis that was conducted under the aforementioned SciREX program regarding the economic ripple effects of IoT-related technologies on Japan's manufacturing industry, there will be fewer jobs in in-house information-processing sections of businesses that manufacture general machinery and consumer electronic appliances, but more jobs in the in-house research sections of Internet-related businesses. The overall number of jobs will decrease due to the long-term trend of population decline. The analysis results indicate that a decrease of jobs in the manufacturing industry will be offset by an increase of jobs in information services and other service businesses[2].

The analysis conducted under the SceREX program suggests the following.

- Low-skill jobs in the manufacturing sector will decrease in number, and job opportunities will increase in information services and other service businesses.
- Although Japanese society will face short-term disruption of employment during the change in

1 The Boston Consulting Group. "Man and Machine in Industry 4.0: How Will Technology Transform the Industrial Workforce Through 2025" 2015.
2 *Masahiro KURODA, Kenta IKEUCHI, Yasushi HARA. Policy Option Simulator for Science, Technology and Innovation Policy (1. Theoretical Framework and Model Formulation). SciERX Center Working Paper. 2016.* (http://id.nii.ac.jp/1295/00001341/)

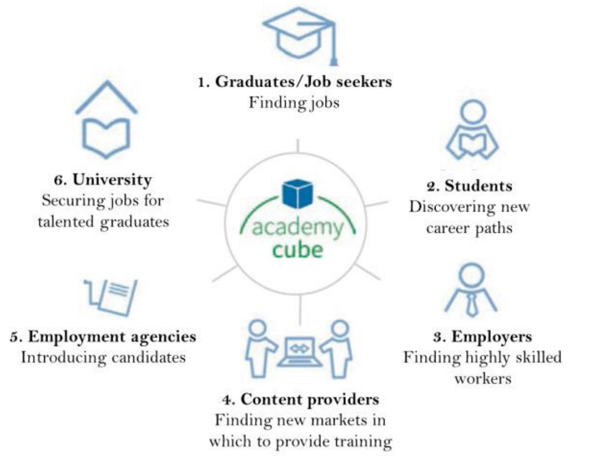
industrial structure, additional jobs in information services and other service businesses will rectify that disruption.

③ Preparedness for changes in the employment structure

As described above, Japan's employment structure will drastically change with the advent of a super smart society. How should we be prepared for the anticipated changes?

First, because rapid advances in artificial intelligence are expected to help replace low-skill jobs and some other jobs with robots, various measures should be taken to support workers. For example, workers should be given opportunities to retrain and reorient themselves through e-learning and the like, so that they can obtain the new jobs that will emerge in growing sectors.

The importance of reeducation and retraining has been discussed in foreign countries. A working group of the Industrie 4.0 project came to the following conclusion: "The roles of workers will substantially change at smart factories. Thus, continual professional development will be required. It is necessary to investigate the digital learning technologies that need to be promoted for an effective combination of lifelong learning and continuing education/training[1]." One initiative to support the development of human resources in Germany is Academic Cube, an integrated recruiting and learning platform. It serves as a platform for matching talent and job openings in computer science, IT and engineering. To help job seekers gain the skills and knowledge they are missing, Academic Cube provides education and training through e-learning. At the World Economic Forum Annual Meeting 2016 in Davos, Vishal Sikka, the Chief Executive Officer of Infosys Ltd. and a former member of the Executive Board of SAP SE, gave the following report: "The digital revolution is a human revolution. In this revolution, the biggest challenge is the education system, which was established 300 years ago and can't respond to rapidly advancing digitization. That is why Infosys Ltd. built the largest corporate university on the planet. Up to 15,000 people can take our courses by taking advantage of digitization." Thus, various efforts are being made to promote reeducation through digital means.



Academy Cube

Source: The Japan Institute for Labour Policy and Training

Second, major players of the next generation need to be fostered, because servitization will advance in various industries and platformers will play an active role as a result of technological innovations in artificial intelligence and robotics. Section 3 of Chapter 2 below elaborates on the need for human resource development and continuing learning.

In responding to the changes in the employment situation that are anticipated in Japan's super smart

1 The Japan Institute for Labour Policy and Training (JILPT), "Industrie 4.0 and the Future of Labor." 2015.

society, joint efforts by the public and private sectors are important for realizing a society where people can work in diverse ways according to their individual situations. It is also necessary to increase the happiness and affluence of each citizen by ensuring the dynamic engagement of all citizens in such a society. These efforts should be based on the recognition that sound, sustainable economic growth needs to be attained through the enhancement of corporate value and productivity.

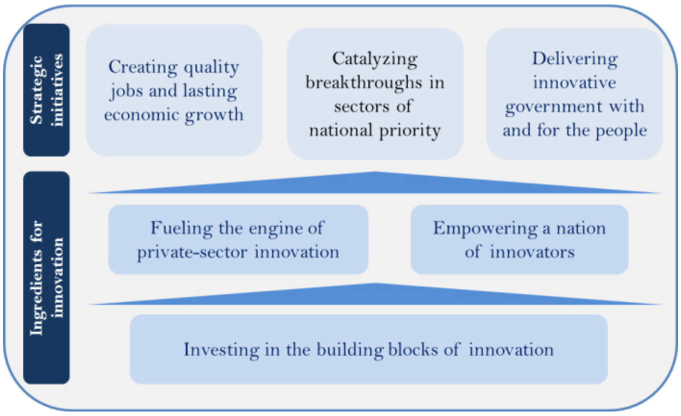
3 Trends of Foreign Countries towards a Super Smart Society

Section 3 focuses on government policies and private-sector efforts towards super smart societies of foreign countries.

(1) Policy trends of foreign countries

① The U.S.A.

In 2011, the Advanced Manufacturing Partnership (AMP), a national effort that brings together industry, universities, and the federal government to invest in emerging technologies, was launched. The AMP Steering Committee is responsible for identifying technologies that need to be studied and developed intensively as well as systems that should be reformed. In line with the technologies and systems identified by the committee, Institutes of Manufacturing Innovation, industry-academia consortia, were established under the control of relevant government departments for promoting R&D on various technologies for advanced composite materials, power electronics, 3D printers, etc. For example, the Digital Manufacturing and Design Innovation Institute (DMDII), overseen by the Department of Defense, are using CPS[1] to apply cutting-edge digital technologies to manufacturing for the purpose of reducing manufacturing costs and increasing productivity. The FY2017 R&D budget request includes a mandatory spending proposal of $1.9 billion for the National Network for Manufacturing Innovation (NNMI), a core program of the AMP.



Building blocks of *A Strategy for American Innovation 2015*

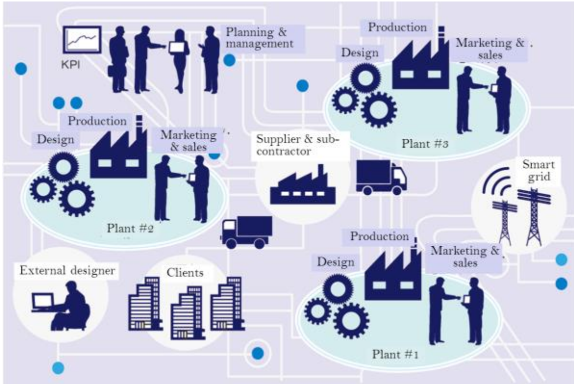
Source: Created by CRDS (JST) based on "A Strategy for American Innovation 2015"

In October 2015, A Strategy for American Innovation 2015 was announced. This strategy focuses on investments in the foundational building blocks of innovation including investments in fundamental research and the training of talented innovators, and on the promotion of breakthroughs in sectors of national priority. The latter includes the promotion of R&D on advanced manufacturing technologies and the building of smart cities.

1 Cyber Physical Systems

② Europe

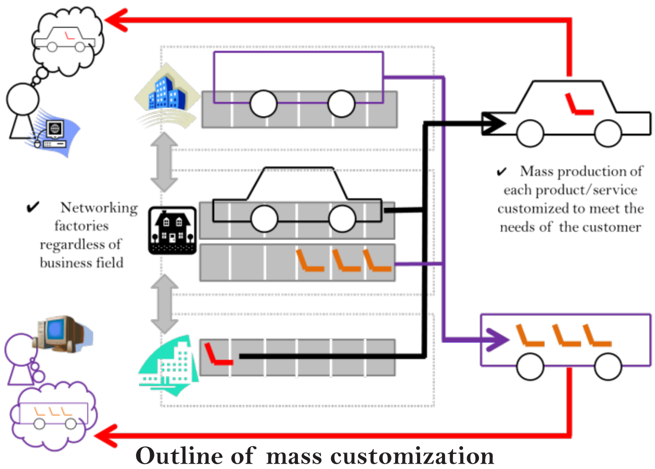
In November 2011, the German federal government adopted the Industrie 4.0 initiative for comprehensive digitization of manufacturing. Industrie 4.0 is part of the High-Tech Strategy Action Plan, which represents the German government's basic policies for science and technology. It is one of the ten future initiatives within the High-Tech Strategy. Under Industrie 4.0, new businesses and value are expected to be generated by utilizing the IoT and automated manufacturing technologies to realize not only smart factories but also connections between goods and services within and beyond the factories. By taking advantage of the IoT and factory automation technologies, smart factories will be connected with each other. Consequently, the manufacturing sector in Germany will function as a big smart factory. Efforts made under the Industrie 4.0 initiative will facilitate mass customization. Orders for value-added products will be accepted from individual customers, and these products will be offered at prices competitive with those of mass-produced products.



Horizontal value network

Source: Created by CRDS of JST, based on the "*Final report of the Industrie 4.0 Working Group*"

To realize mass customization, diverse infrastructure that covers the entire value chain of products, manufacturing facility design, manufacturing and maintenance is necessary. Therefore, aiming at completion by 2025, R&D is being promoted concerning the following: CPSs including those of M2M (i.e., Machine to Machine), sensors and actuators; advances in human-machine interfaces; and technologies for big data, cloud computing, telecommunications networks, and cybersecurity.



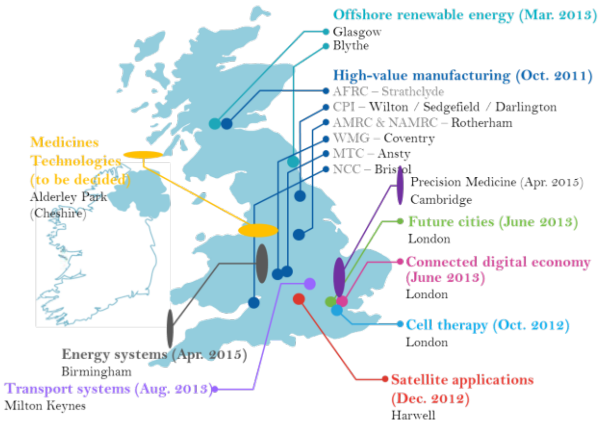
Outline of mass customization

Source: MEXT

Under Industrie 4.0, standards applicable to process automation and factory automation differ from industry to industry, and many different industry organizations and standards/ standardization groups are involved in the development of ICT and robotics technologies. To realize interconnected smart factories, or horizontal value networks, it is urgently needed to define valid standards for a uniform architectural model[1].

1 Reference Architectural Model for Industrie 4.0 (RAMI 4.0)

In the U.K., the Catapult Programme has been implemented, towards establishing Catapult centers as a network of world-leading centers of technology and innovation in specific areas. These centers are designed to use industry-academic collaboration to bridge the so-called “valley of death” that prevents commercialization of research results. At *the High Value Manufacturing Catapult* center created in 2011 by the U.K. Government, various projects have been conducted, including a project for factory automation using ICT. *Our plan for growth: science and innovation*, the U.K.’s basic science and innovation strategy announced in December 2014, states that £61 million in funding is to be provided to the High Value Manufacturing Catapult over the 5 years from 2016 through 2021. This shows that priority is given to supporting the manufacturing sector in the U.K. In this strategy, the 8 Great Technologies are identified as priorities, and these include big data and robotics and autonomous systems.



Catapult centers in the U.K.

Source: CRDS (JST)

In France, after the regime change in 2012, the Law on Higher Education and Research took effect and France Europe 2020, a strategic agenda focusing on consistency with the European program Horizon 2020, was formulated in 2013. The strategic agenda, which was renewed in March 2015, gives priority to R&D concerning advances in the manufacturing industry, the IoT and the use of big data.

③ Asia

In China, *Made in China 2025*, a roadmap for the future development of manufacturing in China, was announced in May 2015. The roadmap, covering the first 10 years of China’s 35-year strategy, takes into account the following: overseas trends in manufacturing advances that benefit from the development of ICT; increases in domestic labor cost; and the economic situation in China. To transform China from a big industrial country to a powerful industrial country by 2025, this strategy aims at developing China’s innovation environment towards realizing smart manufacturing that capitalizes on digitization and networking. Quality improvement and servitization of the manufacturing industry are also aimed at.

In July 2015, China unveiled its Internet Plus action plan, which seeks to fuel economic growth through integration of the Internet with conventional manufacturing businesses by utilizing the technologies of major Internet companies (i.e., Baidu, Inc., Alibaba Co., Ltd, and Tencent). In this action plan, China intends to enrich Internet-based services and to establish closer links between these services and the country’s real economy by 2018. Additionally, a new industrial ecosystem will be developed by 2025 on the basis of the Internet. The industrial ecosystem will feature networking, servitization and smart, Internet-connected industries.

South Korea has formulated five-year Science and Technology Basic Plans. The 3rd Science and Technology Basic Plan (2013-17) is in force. In the 6th Five-year Industrial Innovation Plan under the 3rd Science and Technology Basic Plan, priority is given to system industry members that specialize in wearable smart devices, self-driving cars, etc. because the system industry is regarded as an engine for the growth of future industries. For the purpose of securing seamless coordination between policies as well as of reducing inter-ministry barriers, the Ministry of Science, ICT and Future Planning was established. This Ministry integrates budgetary planning and other administrative functions related to R&D, intellectual property, small and medium sized enterprises, ICT and science and technology.

The government of Singapore has been promoting the Smart Nation initiative since 2014. The vision of the Smart Nation includes the development of human resources, the creation of industrial clusters and the use of ICT to help people lead safer, more comfortable lives. Under the control of the Info-communications Development Authority of Singapore (IDA), data infrastructure called the Smart Nation Platform (SNP) is being built to utilize data collected by various sensors for services of public transportation, energy supply, healthcare, etc.

Policy trends of foreign countries are summarized in (Figure 1-1-13).

■ Figure 1-1-13 / Policy trends of foreign countries

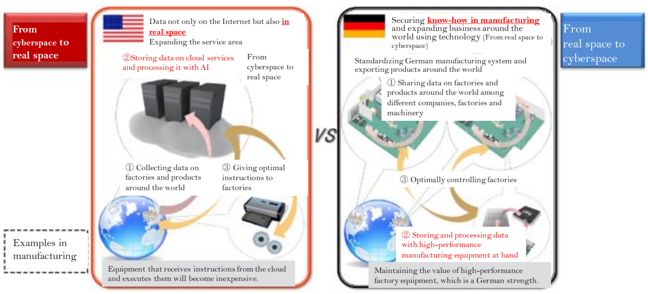
Region/ country		Outline
The U.S.A		✓ It established the Advanced Manufacturing Partnership (AMP) in 2011. Industry-academia consortia were established to promote R&D on various technologies for advanced composite materials, power electronics, 3D printers, etc. ✓ Overseen by the Department of Defense, digital manufacturing and design use CPSs to apply cutting-edge technologies for the purpose of reducing manufacturing costs and increasing productivity.
Europe	Germany	✓ In 2011, Industrie 4.0 was adopted as one of the ten future initiatives of the High-Tech Strategy Action Plan, which represents the German government' s basic policies for science and technology. ✓ Industrie 4.0 is expected to help generate new businesses and value by utilizing the IoT and automated manufacturing technologies to realize not only smart factories but also connections between goods and services within and beyond the factories. ✓ Aiming at completion by 2025, R&D is being promoted for the following: CPSs including those of M2M, sensors and actuators; advances in human-machine interfaces; and technologies for big data, cloud computing, telecommunications networks, and cybersecurity.
	U.K.	✓ "Our Plan for Growth: Science and Innovation", announced in 2014, is the U.K.'s basic science and innovation strategy. The strategy identifies the Eight Great Technologies as priorities, including "big data" and "robotics and autonomous systems." ✓ The Catapult programme has been implemented towards establishing Catapult centers as a network of world-leading centers of technology and innovation in specific areas. These centers are designed to use industry-academia collaboration to bridge the so-called "valley of death" that prevents the commercialization of research results. ✓ At the High Value Manufacturing Catapult center created by the U.K. Government, various manufacturing-related projects have been conducted.
	France	✓ In France, the basic policy is the France Europa 2020, updated in 2015. ✓ The strategic agenda gives priority to R&D on advances in manufacturing, the IoT and the use of big data.
	EU	✓ European Factories of the Future Research Association, a university-industry collaboration organization based on a roadmap that includes issues in improving manufacturing processes and factory linkages using digital technology, provides funding within the EU framework.
Asia	China	✓ To transform China from a "big industrial country" to a "powerful industrial country" by 2025, Made in China 2025, a roadmap for the future development of manufacturing in China, was announced in May 2015. ✓ This strategy aims at developing China' s innovation environment towards realizing smart manufacturing that capitalizes on digitization and networking. Quality improvements and servitization of manufacturing are also aimed at.
	Korea	✓ The 3rd Science and Technology Basic Plan (2013-17) is the basic policy. In the 6th Five-year Industrial Innovation Plan under the 3rd Science and Technology Basic Plan, priority is given to system industry members that specialize in wearable smart devices, self-driving cars, etc., because the systems industry is regarded as an engine for the growth of future industries. ✓ To secure seamless coordination between policies and reduce inter-ministrerial barriers, the Ministry of Science, ICT and Future Planning was established. This Ministry integrates budgetary planning and other administrative functions related to R&D, intellectual property, small and medium-sized enterprises, ICT and science and technology.
	Singapore	✓ Under the Smart Nation Initiative launched in 2014, data infrastructure is being built to utilize data collected by various sensors for services of public transport, energy supply, healthcare, etc.

Source: Created by MEXT and the SciREX Center on the basis of data from the Center for Research and Development Strategy, JST

(2) Trends of businesses in the U.S.A. and Europe

Corporate strategies in the U.S.A. and Europe are roughly divided into two types.

One is "from cyberspace to real space." Information technology companies in the U.S.A. are looking to manufacturing in particular these days. These companies are expanding their operations into businesses in real space, such as the manufacture of robots and automobiles, by capitalizing on the strengths in cyberspace that they have from offering search and advertising services or through business transactions.



Trends of businesses in the U.S.A. and Europe (From cyberspace to real space vs. From real space to cyberspace)

Source: White Paper on Manufacturing Industries (Monodzukuri), 2014

Mobility and physical distribution are among "real space" business areas into which companies that specialize in operations in cyberspace are advancing. For example, Google

Delivery of goods by drone

Source: Amazon.com, Inc.

Inc. has been testing self-driving cars on public roads. Innovation is taking place with increasing use of drones and the development of new business models that rely on sharing. Amazon.com, Inc. aims to deliver goods within 30 minutes of order receipt by using drones for delivery.

As an example of the sharing economy, Uber[1] provides an on-demand car service. It is a matching service for riders who need to hire a private driver and drivers who have spare time to pick up riders. User can get picked up easily and safely at low cost just by tapping the Uber app downloaded to their smartphones. Drivers can use their own cars to drive passengers in their spare time for pay.

Tapping the Uber app to call a driver

Source: Uber Japan Co., Ltd

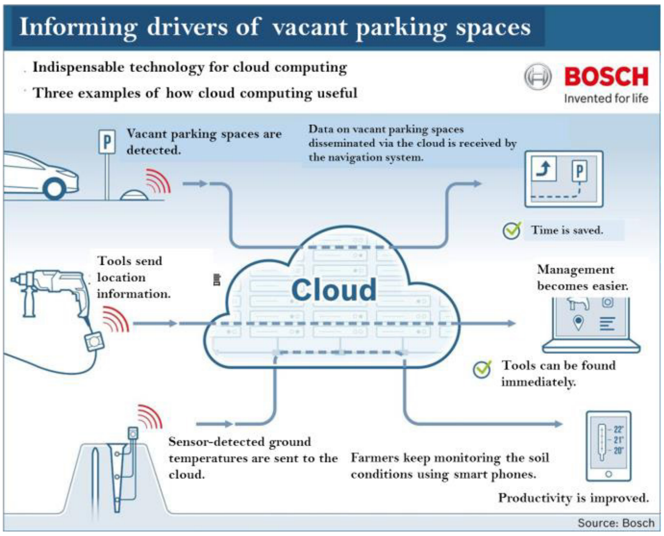
Another corporate strategy is "from real space to cyberspace." In Germany, for example, manufacturing businesses are changing their business model to one that is based on software. By leveraging experience and expertise in production facilities and robots, the manufacturing industry is expanding its network of "real space" data into cyberspace.

A Maserati displayed at the Siemens's booth of the Hannover Messe 2015

Source: Maserati Japan Ltd.

Siemens AG is providing companies with systems for comprehensive management of production processes. With these systems, the flow of products (i.e., planning, design and production of products, and support after shipping) is controlled in an optimal way, and the management of information about the production site, including information on parts and personnel, is optimized. At the Italian factory of Maserati S.p.A., a Siemens system was introduced to improve productivity by digitizing manufacturing.

Bosch Corporation developed and launched the Bosch IoT Suite, an IoT platform connecting Bosch's 265 production facilities around the world through a network for boosting productivity. The company also developed the Bosch IoT Cloud for hosting and analyzing big data necessary for the IoT platform. Bosch's cloud-based services provide information on available parking spaces based on data sent from



Bosch IoT Cloud applications

Source: Bosch Corporation

1 In Tokyo, Uber's service is limited to limousine rental or taxi companies contracted with Uber, and private cars are not included in the on-demand car service.

sensors that detect unoccupied parking spaces, as well as information on underground temperatures which is sent to service users' smartphones for constant monitoring (i.e., Smart Agri service).

4 Japan's Current Efforts and Challenges towards Realizing a Super Smart Society

To lead the way in the significant technological innovation called the Fourth Industrial Revolution and to gain a competitive edge over other countries in the global economy, many countries are leveraging their respective strengths and making aggressive efforts through cooperation between the government and the private sector. Section 4 describes policymaking by the Japanese government and efforts made by the private sector for technological advances.

(1) Policymaking by the government

The 5th Science and Technology Basic Plan was approved in a Cabinet decision on January 22, 2016. Implementation of this five-year plan started in April, and the Japanese government is promoting science and technology on the basis of the plan.

The Society 5.0 program defined in the 5th Science and Technology Basic Plan is different from the Industrie 4.0 of Germany and the Advanced Manufacturing Partnership of the U.S.A., which focus on manufacturing. Society 5.0 covers various aspects of our society, including manufacturing and other industries, with the aim of driving social change. Society 5.0 is a unique approach, in that Japan's efforts to solve emerging issues before the rest of the world are geared to Japan's strengths (Figure 1-1-14).

■ Figure 1-1-14 / Comparison between the 5th Science and Technology Basic Plan and efforts in the U.S.A. and Germany

	Society 5.0 (Japan)	Advanced Manufacturing Partnership (U.S.A.)	Industrie 4.0 (Germany)
Back-ground	**High-level fusion of the cyber world and the real world**		
Fields	**All areas of society (including manufacturing)** (The solution to issues facing Japan and the creation of new value through collaboration among systems, .)	**Manufacturing** (3D printing, power electronics, light-weight metal materials, digital design and manufacturing, advanced composite material manufacturing)	**Manufacturing** (Overall efficiency improvements and productivity improvements from design & production to retail and maintenance through integration of telecommunications technology and production technology)
Objectives	**Hyper-smart society** (Changes in industry, people's lives and lifestyles, so that everyone can live comfortably and actively in society)	**Job creation and strengthening of international competitiveness** (Return of manufacturing industry to U.S.A. after which jobs are created and international competitiveness is increased due to new technology)	**Strengthening of manufacturing competitiveness** (For small quantity/large variation production, the global spread of German production technologies for detecting abnormalities at an early stage)

Source: Created by MEXT and the SciREX Center based on data from CRDS (JST)

The Council for Science, Technology and Innovation (CSTI) established the Committee on Basic Systems Technology in order to examine technological issues that need to be addressed towards realizing a super smart society, and in order to work on challenges in and essential considerations for the use of various technologies for a super smart society. The Conference has been conducting research on the efforts identified in Chapters 2 and 3 of the 5th Science and Technology Basic Plan.

In the light of the direction defined in the 5th Science and Technology Basic Plan, policies and measures that should be emphasized in each fiscal year are enumerated in the Comprehensive Strategy on Science, Technology and Innovation. The Expert Panel on STI Policy Promotion in CSTI was responsible for examining and consolidating the Comprehensive Strategy on Science, Technology and Innovation 2016. The Expert Panel defined features of Society 5.0 for the purpose of strongly promoting Society 5.0 in and after 2016 to increase Japan's technological competitiveness. The development of a common platform and the advancement of systems in various sectors were clearly specified as priority efforts.

The Japanese government has included policies and measures related to a super smart society in its broad range of plans and strategies. Major strategies are shown below:

・Japan Revitalization Strategy (the revision approved by Cabinet decision on June 30, 2015) As part of the prior investment in a productivity revolution, the Japan Revitalization Strategy focuses on the necessity of the following: being prepared for significant changes in the industrial and employment structures in the age of the IoT, big data and artificial intelligence; strengthening the information security infrastructure for enhancing cybersecurity; and promoting the utilization of IT. The Review Guidelines for the Progress of the Growth Strategy deliberated on January 2016 states that a series of efforts, which are collectively called Society5.0, are required in order to realize a super smart society. For the progress of Japan's growth strategy, R&D related to the IoT, big data and artificial intelligence will be promoted in an integrated manner, and the mobile/wireless environment will be improved to enhance the IoT.

・Declaration to be the World's Most Advanced IT Nation (approved in a Cabinet decision on June 30, 2015)

IT strategies are the pillars of Japan's growth strategy, and these are formulated by positioning IT as an engine of economic growth that will help Japan overcome its stagnation and boost economic recovery. The Declaration to be the World's Most Advanced IT Nation revised in June 2015 states that Japan needs to pursue true affluence by developing "problem-solving IT utilization models" based on the IoT and artificial intelligence in advance of the rest of the world.

・Cybersecurity Strategy (approved by Cabinet decision on September 4, 2015)

Under the Cybersecurity Strategy, R&D and human resource development will be promoted in a cross-sectoral manner to enhance Japan's ability to detect and defend against cyber-attacks. This strategy aims at increasing Japan's socioeconomic vitality through the development of safe IoT systems, creating a safe and secure society for citizens, and maintaining peace and stability in the international community.

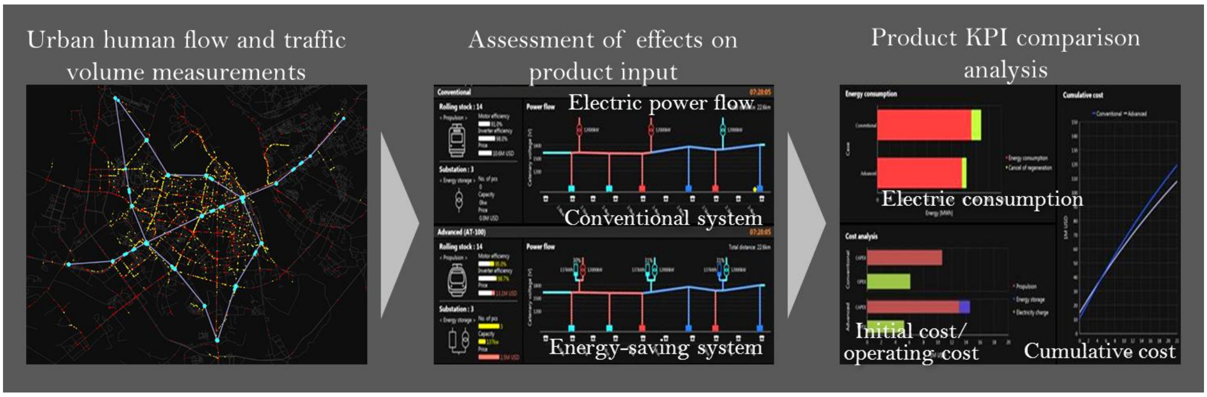
(2) Efforts by the private sector

Efforts to realize a super smart society have been also been made by the private sector. These efforts were reported at the Committee on Basic System Technology, and some major efforts are described below.

① Application of artificial intelligence technologies to solve social issues

Hitachi, Ltd. has been using artificial intelligence technologies in an effort to solve social issues. These issues include a lack of experienced workers in the manufacturing sector due to the aging of this workforce and a next-generation labor shortage, and the need to revitalize Japanese society.

"Hitachi AI Technology/H" is an artificial intelligence technology that Hitachi, Ltd. developed for that purpose. For example, vast amounts of diverse data on management, business operations, working processes and product flows are input into a computer, and Hitachi's artificial intelligence "H" uses the data to extract factors that correlate closely with Key Performance Indicators (KPI), such as sales, maintenance costs and production efficiency, and to efficiently generate a tentative theory that supports measures for improving operations. By utilizing this artificial intelligence technology, it is possible to use data that were once regarded as irrelevant to the KPI and thus were not used for analysis and the generation of tentative theories. Such data are now used for finding critical factors that are available for creating measures for improvement.



Verification of the value using Cyber-PoCC

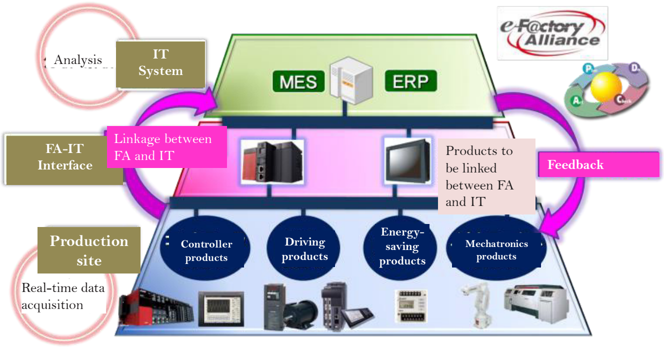
Source: Hitachi, Ltd.

Hitachi, Ltd. also developed Cyber-Proof of Concept (Cyber-PoC) to simulate proposed measures for improvement. Cyber-PoC is a program that is used to verify the effectiveness of improvement measures that are created on the basis of client data. When a railroad company has a plan to build a railroad, for example, the Cyber-PoC program calculates the number of passengers that have used its rail service, the initial and operating costs, etc. that are associated with the railroad and related infrastructure the company has built before. Then, the program estimates the number of years necessary for the railroad company to recoup their investment in the new railroad plan on the basis of the railroad fare that the company offers.

② "e-F@ctory" for next-generation manufacturing

The government of Germany proposed Industrie 4.0 in 2011. Prior to the German proposal, in 2003 Mitsubishi Electric Corporation put forth a proposal for "e-F@ctory," FA (i.e. Factory Automation) integrated solutions utilizing ICT, under the slogan of "human-machine-IT interfaces."

The basic concept underlying e-F@ctory is the optimization of factories for curtailing the Total Cost of Ownership (TCO) in the overall process of development, production and maintenance. Various data on production, product quality, etc. are generated at the point of production. These data are collected in real time for analysis, and the analysis results are fed back to the point of production. By linking production with IT systems, data from the production site can be utilized as information on production, product quality, environmental performance and product safety. Such information is useful for enhancing productivity, quality, environmental performance, safety and security.

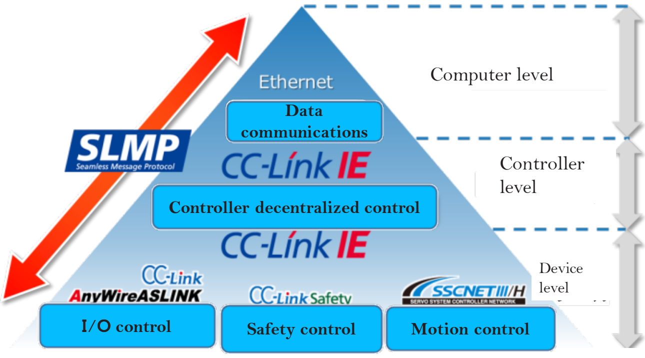


Linkage between FA and IT

Source: Mitsubishi Electric Corporation

To integrate devices at the production site with IT systems, the Seamless Message Protocol (SLMP) is utilized. SLMP achieves seamless communication between applications without awareness of network hierarchies or boundaries. Thus, parameter-setting and the collection of maintenance information can be implemented in an integrated manner.

Advances in technologies for the IoT help increase the quantity of data that can be collected at the point of production. When vast amounts of data are sent to IT systems for processing, bandwidth problems are unavoidable. It is said that such problems can be solved by edge computing, whereby small computing devices are located at the edges of a network. An edge computing platform will be used in the future for analyzing data collected at the point of production, predicting machine failures and reducing workplace accidents based on the analysis of worker behavior.



FA network

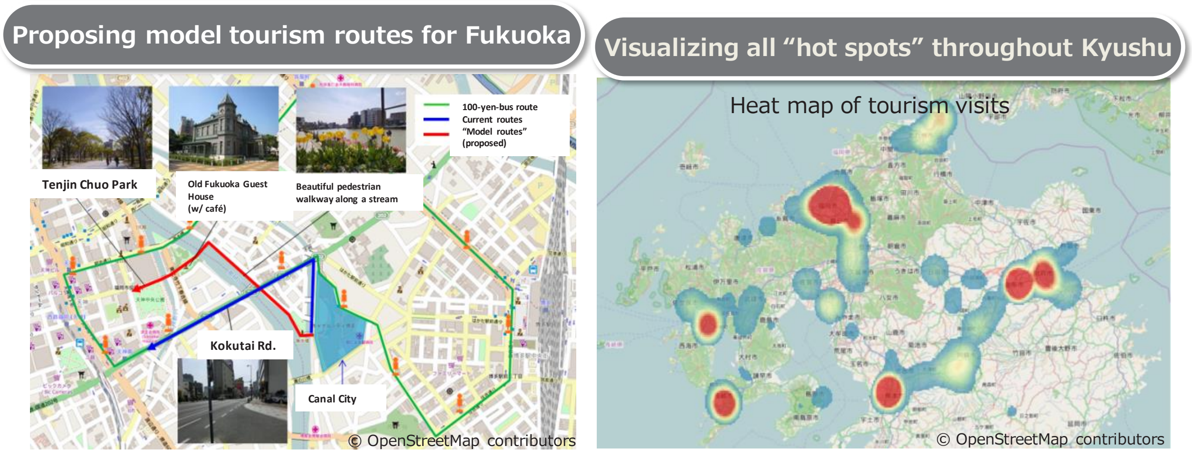
Source: Mitsubishi Electric Corporation

③ Smart social infrastructure for enhanced international competitiveness

"2020 × Regional Revitalization," an initiative of the Nippon Telegraph and Telephone Corporation (NTT) for the 2020 Tokyo Olympic and Paralympic Games as well as for regional revitalization, is described below.

By utilizing Fukuoka City Wi-Fi, the free public wireless LAN provided by the city of Fukuoka, the city and NTT are offering services that are designed to support international visitors and to suggest tourist routes in the city. Wi-Fi-enabled beverage vending machines were placed in the city to provide visitors with tourist information during the Hakata Dontaku Minato Festival and "the Hakata Gion Yamakasa Festival," which attract many international tourists. Beverages in these vending machines are available as emergency supplies that people can take for free in the event of a disaster. The vending machine can serve in disaster prevention.

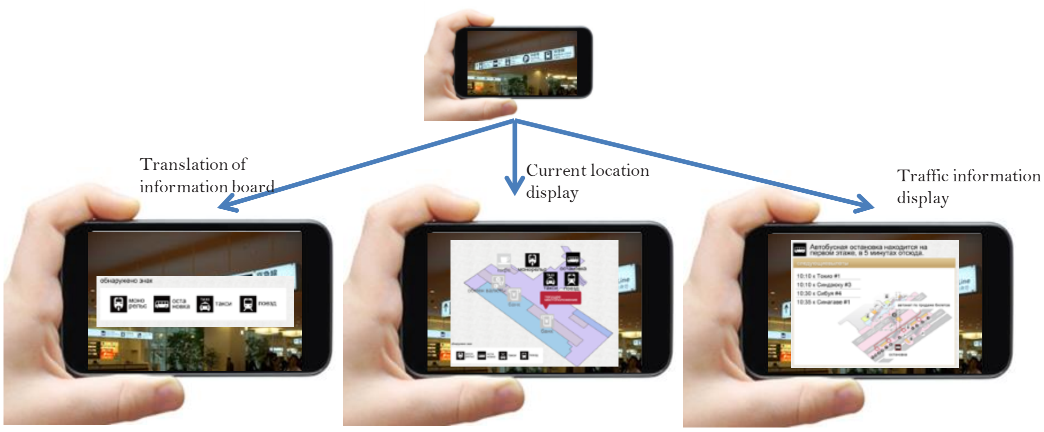
To realize the "UI/UX (i.e., User Interface/User Experience) for hospitality" by utilizing image/big data analysis technologies, R&D and demonstration experiments are conducted at the domestic and international passenger terminals of Tokyo International Airport.



New services provided through comprehensive cooperation between the city of Fukuoka and NTT

Source: NTT

(i) At the airport, signs and notices are usually written in a few major languages, such as Japanese and English. Because of this, some tourists are at a loss about how to search for the relevant transportation or the ingredients of unfamiliar Japanese dishes. In view of this, a new service is being developed so that tourists can access useful information just by pointing their smartphone cameras toward signs or information boards in the arrival lobbies of airport or towards goods in shops or plastic food models in the display windows at Japanese restaurants in the airport.



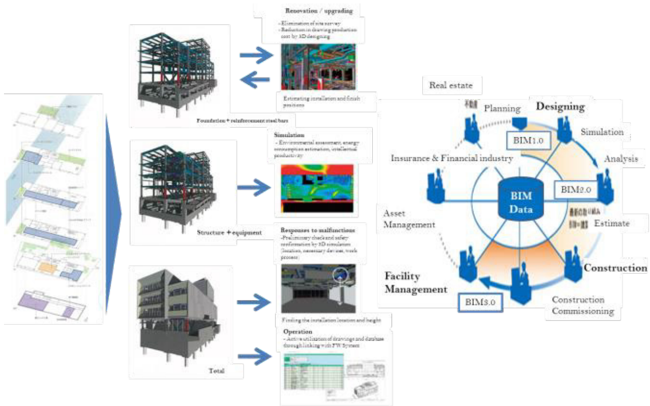
UI and image analysis technology for information acquisition

Source: NTT

(ii) To solve overcrowding problems at the airport, NTT aims at realizing optimum crowd control. For this purpose, NTT utilizes its technologies for forecasting overcrowded places as well as for dynamically changing guidance information, so that people will be encouraged to avoid crowds. Additionally, the effectiveness of a technique for providing hearing-impaired persons with emergency information is being verified. For this purpose, announcements made during emergencies are provided visually.

(iii) Audio guidance service is provided at restrooms and elsewhere to assist visually impaired users. But this service has not been effectively utilized because the audio guidance is often inaudible among the intense ambient noise. NTT is working on technology for providing audio guidance that is easy to hear even in noisy places. Efforts are also made for the practical application of intelligent audio guidance technology, which ensures that audio guidance does not give noise annoyance to others.

Not only at Tokyo International Airport but also at and around Tokyo Station, NTT has been cooperating with the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) on demonstration tests of a seamless indoor/outdoor positioning service that aims to create and disseminate seamless indoor/outdoor maps. Additionally, NTT has been working on contributing to the development of a smart regional society by applying Building Information Modeling (BIM) to social infrastructure. With BIM, large amounts of information on the design, construction and facility management of buildings are controlled in a unified manner.

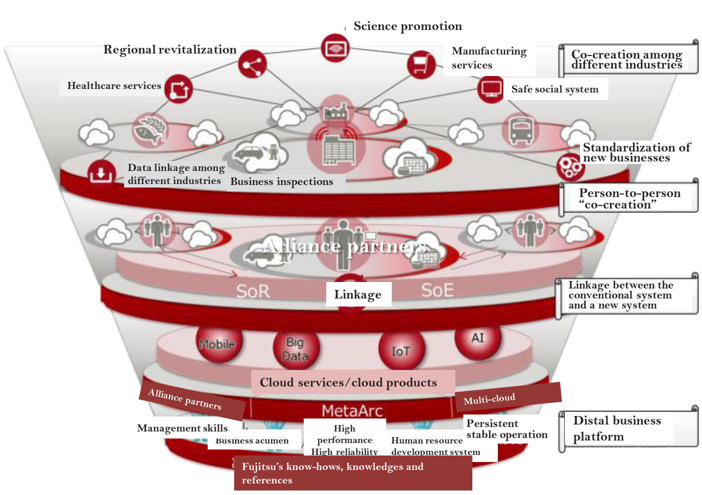


Use of BIM for information management

Source: NTT

④ A Human Centric Intelligent Society for a prosperous future

Fujitsu Ltd. offers MetaArc, a cloud-based digital business platform featuring cutting-edge technology and know-how. This business platform provides an ICT infrastructure that supports co-creation by people and co-creation through cross-industrial collaboration that transcends the nominal boundaries between companies and between industries. MetaArc provides the following benefits: access to cutting-edge ICT applications in areas such as mobile solutions, big data analysis, the IoT and artificial intelligence; and the seamless integration of SoE (Systems of Engagement) and SoR (Systems of



Toward value generation through cross-industrial collaboration

Source: Fujitsu Ltd.

Record) on a single platform. With SoE, technologies are used to bring together talent and infrastructure for innovation and creativity. SoR are traditional means of recording and storing data within an organization.

Fujitsu Ltd. has been promoting the use of ICT infrastructure for generating value through cross-industrial co-creation. As part of such efforts, Fujitsu Ltd. has been addressing the needs of a population aging. As the population is rapidly aging in Japan and in many other countries, it is desirable to have systems in place for extending people's healthy life expectancy and supporting their self-reliance. Currently, Fujitsu Ltd. is utilizing its electronic health record system and regional medical networks to provide efficient regional medical services. By using mobile solutions and sensor networks, Fujitsu Ltd. aims at helping to create a society where the elderly and people with chronic diseases can lead self-supporting, worry-free lives at home, take medicines that are prescribed optimally for each individual patient and receive specific advice on disease prevention, health and lifestyle, according to each individual's situation. The realization of such a society requires collaboration and co-creation by hospitals, nursing-care facilities, research institutes and industries, as well as analysis of big data such as medical and health information, including imaging data and genome information. Various systems and services designed to enhance the convenience of everyday life will also be developed. For example, physical distribution services will be changed innovatively to ensure that goods are delivered at the right time to those who need them. Fujitsu Ltd. connects the expertise of diverse businesses in order to identify solutions to social issues and create innovations.

Preparing for a graying society

Source: Fujitsu Ltd.

(3) For sharing a vision of a super smart society: Closer connections between STI and our society

In a super smart society, we will be able to enjoy affluence and convenience, but at the same time, we will face significant socioeconomic changes that can hardly be dealt with unless closer connections are established between STI (science, technology and innovation) and our society. Therefore, in such societies, the relationship between STI and a super smart society need to be closer than those that the current society maintains with STI.

Science and technology have been considered in some ways to be independent of society. But now it is necessary to enhance dialogue and cooperation among diverse stakeholders such as scientists, citizens, business people and policy makers. Such dialogs and cooperation lead to co-creation. Efforts that are required to establish closer connections between STI and a super smart society and thus to promote co-creation are described below.

① Ethical, legal and social efforts in a super smart society

It is expected that the advent of a super smart society will result in increased opportunities to make social decisions on various problems. These include the protection of personal information and privacy, liability arising from accidents caused by artificial intelligence, and other ethical or legal issues (cf. Section 2, Chapter 2.) Research and development of artificial intelligence technologies that are at the core of a super smart society need to be implemented by following a fundamental principle that artificial intelligence be used to benefit people and society.

The sound development of a super smart society should be supported by ensuring communication among diverse stakeholders and by promoting study on ethical, legal and social issues by researchers from various disciplines, such as the social sciences, the natural sciences and the humanities. From the viewpoint of the need to promote the application of science and technology to social life, studies are also needed on the following matters: technology assessment for multilaterally reviewing the impacts of science and technology on society; science for accurate prediction, assessment and judgment which are necessary for the science-based formulation and implementation of regulations; and management regarding transitions in social systems.

It is also useful to formulate ethical guidelines as needed with the progress in advanced research such as artificial intelligence. The Institute for Information and Communications Policy (IICP) of the Ministry of Internal Affairs and Communications (MIC) published Report 2015 in June 2015. This report was prepared by the Study Group Concerning the Vision of the Future Society Brought by Accelerated Advancement of Intelligence in ICT. This report presents an outlook for "Changes from Advances in Intelligence in ICT"[1,2]. It is also stated that advanced features of Intelligent ICT[3] should be based on the principle of benefiting humans and society; thus, fundamental rules for R&D need to be clarified and systems need to be established to minimize possible negative impacts of Intelligent ICT. Report 2015 refers to Isaac Asimov's Three Laws of Robotics[4] in emphasizing the need for rules governing R&D on robots, and it states that laws similar to Asimov's Three Laws are necessary, especially for artificial intelligence that has high abilities of cognition, judgment and creation.

On the basis of Report 2015, in anticipation of advances in the networking of artificial intelligences towards the 2040s, when AI networks will be at the core of the "Changes by the Advancement of Intelligence in ICT," the IICP established the Study Group on AI Networking[5]. The WG has the following objectives: to develop a vision for an ideal society and the basic principles that would support such a society,

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1 "Changes by the Advancement of Intelligence in ICT", or "CHAIN", refers to changes brought by significant advances in intelligence in ICT (i.e., computers and communication networks), artificial intelligence and data used in ICT, and technology for interfaces between humans and technologies.

2 Changes by the Advancement of Intelligence in ICT are expected to take place in the following order:
① Each "Intelligent ICT" functions independently via the Internet without linking up with other Intelligent ICTs, and supports humans.
② Intelligent ICTs are networked with each other to increase cooperation with humans, and these ICTs adjust themselves to and harmonize themselves with the environment where they function.
③ Human potential is maximized by Intelligent ICTs, and physical and intellectual powers of humans develop.
④ Coexistence between Humans and Intelligent ICT

3 "Intelligent ICT" refers to technologies and systems that support the accelerated advancement of intelligence in ICT.

4 Isaac Asimov's Three Laws of Robotics
First law: A robot may not injure a human being or, through inaction, allow a human being to come to harm.
Second law: A robot must obey the orders given it by human beings, except where such orders would conflict with the First Law.
Third law: A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

5 "AI Networking" refers to the development and advancement of information and communication networks that utilize AI.

to assess the socioeconomic affects and risks associated with AI networking, and to sort immediate tasks[1] from issues that need to be addressed from a mid- to long-term perspective. This group is chaired by Prof. Osamu Sudo of the University of Tokyo Interfaculty Initiative in Information Studies and has held meetings since February 2016.

②Dialogue with, and cooperation from, stakeholders

Outreach activities of scientists, such as Science Cafe, have been increasing in number. While the further development of scientists' outreach activities is important, it is necessary for scientists to face up to issues associated with the relationships between STI and our society. Dialogue and cooperation among diverse stakeholders are also required for the promotion of co-creation of policies and knowledge.

For this purpose, opportunities for dialogue and cooperation need to be secured by holding round-table meetings of various stakeholders and Science and Technology conferences with citizen participation, so that feedback obtained in these opportunities is given consideration when national policies are formulated. Additionally, it is necessary to develop methods and provide an environment for promoting "citizen science," encouraging scientists to collaborate with citizens in planning research projects, increasing research opportunities and disseminating research results.

③ Stakeholders' efforts towards co-creation

For the purpose of increasing co-creation by stakeholders, it is important to improve the scientific and technological literacy of citizens and the social literacy of scientists.

In this regard, elementary and secondary education needs to be designed to help students deepen their understanding about uncertainty and the limitations of science and technology as well as about theories of logical argumentation. It is desirable that science communicators play active roles in promoting dialog and cooperation among stakeholders at facilities for social education and continued learning.

At the same time, scientists are required to explain their research to citizens in an easy-to understand manner from an interdisciplinary viewpoint. Collaboration among scientists in the fields of the natural sciences, the social sciences and the humanities is desirable so that they can increase their awareness about the significance of the connections between society and their respective research.

④ Scientific advice on policymaking in a super smart society

In a super smart society, science and technology will play increasingly significant roles in the policymaking, such as in the maintenance of cybersecurity.

Therefore, scientists need to be responsible for the quality of the scientific advice they give. They are required to explain clearly to diverse stakeholders in society that their scientific advice may involve uncertainty or may conflict with the views of other scientists. Stakeholders are expected to understand that scientists can act as independent experts when providing scientific views. Scientific advice should be valued in the policymaking process, but it should be recognized that such advice is not the sole basis for decision-making.

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1 Immediate tasks include the following: the formulation of basic rules for R&D regarding AI networks; the establishment of innovative and competitive ecosystems; the protection of AI network users; the analysis of basic social rules; and the creation of a framework for continued examination of issues related to AI networking.