Chapter 4

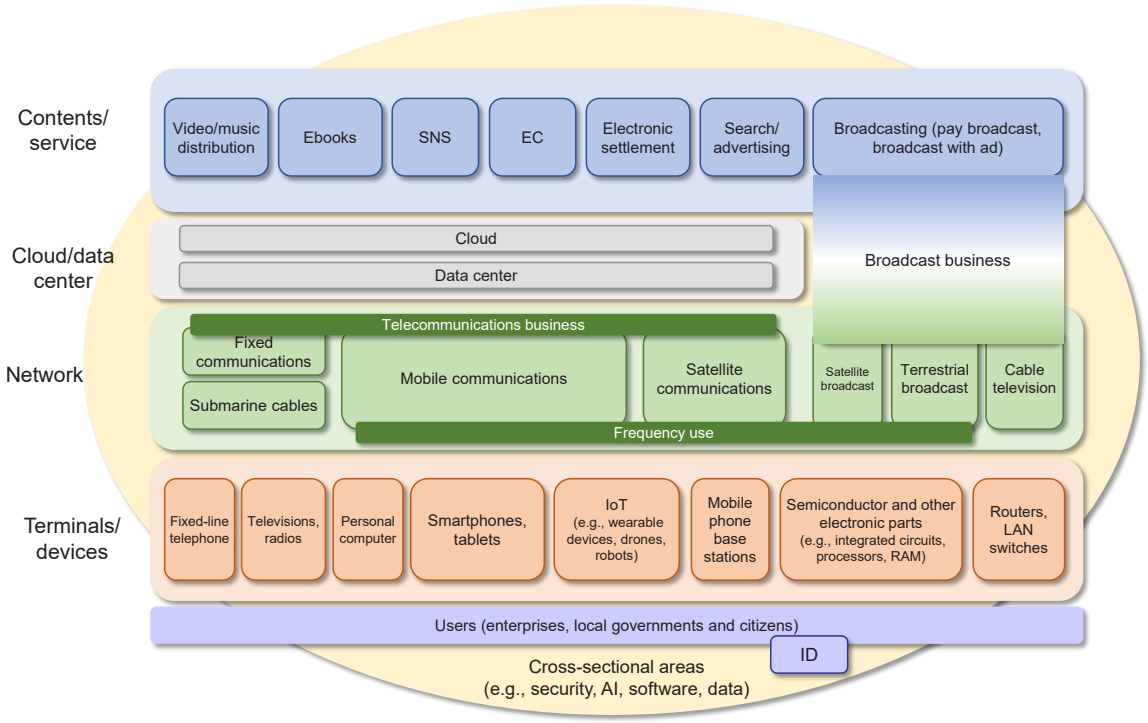
Trends in the ICT Market

Section 1 Trends in the ICT industry

1. Size of the ICT market

The ICT market includes equipment and devices that serve as the interface with users, networks provided by telecommunications carriers and broadcasters, etc., clouds and data centers, content services including video and music distribution, security, and, AI **(Figure 4-1-1-1)**.

Figure 4-1-1-1 Structure of the ICT market by layer



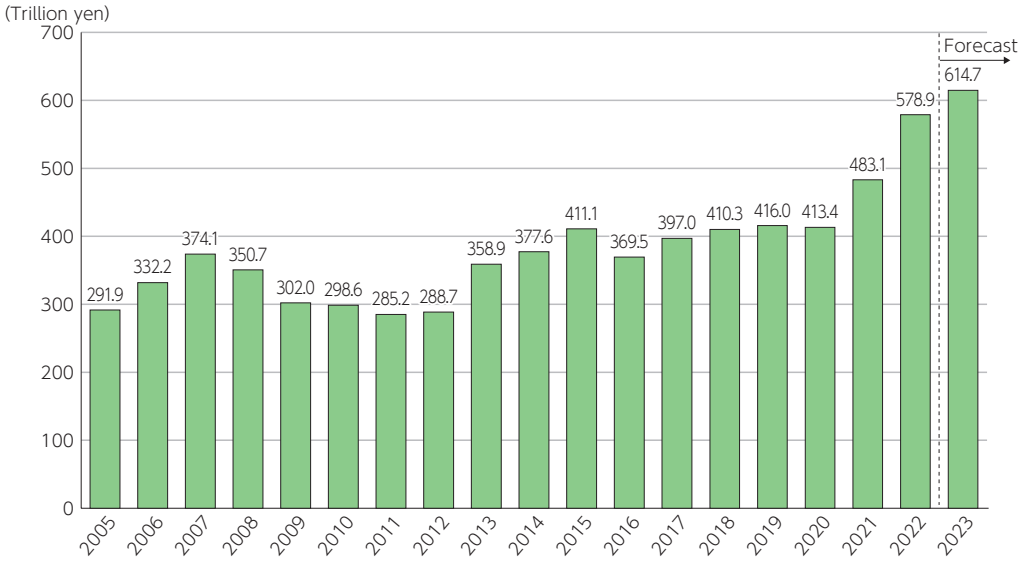
(Source) Created by MIC

Due to the spread of smartphones, cloud service and other factors, the global ICT market (in terms of expenditure)[1] has been on the increase since 2016. In 2022, it increased significantly to 578.9 trillion yen [2] (up 19.8% from the previous year[3]), and is forecasted to increase to 614.7 trillion yen in 2023 [4] **(Figure 4-1-1-2)**.

The Japanese ICT market (in terms of enterprise IT expenditure)[5] is expected to increase significantly to 27.2 trillion yen in 2022 (up 5.2% from the previous year). By industry, growth in banking and investment services (+ 7.9%) and government offices/local government (+ 7.7%) was significant. In addition to cost reductions through automation and labor savings, renewal of legacy systems, and increased investment in efficiency improvements, investment in a wide range of industries is expected to increase as a result of the easing of COVID-19 restrictions.

[1] The ICT market includes data center systems, enterprise software, devices, ICT services, and communications services.a
[2] The average exchange rate for each year is used to convert to yen. In 2023, the average exchange rate between January and March is used (the same applies hereinafter).a
[3] Note that 2022 was also affected by the depreciation of the yen (the same applies hereinafter).
[4] MIC (2023) "Survey Study on the Trends in the Market Environment Surrounding ICT" (the same applies hereinafter)a
[5] The ICT market includes data center systems, software, devices, IT services, telecom services and internal services.a

Figure 4-1-1-2 Changes in global ICT market size (in terms of expenditure)

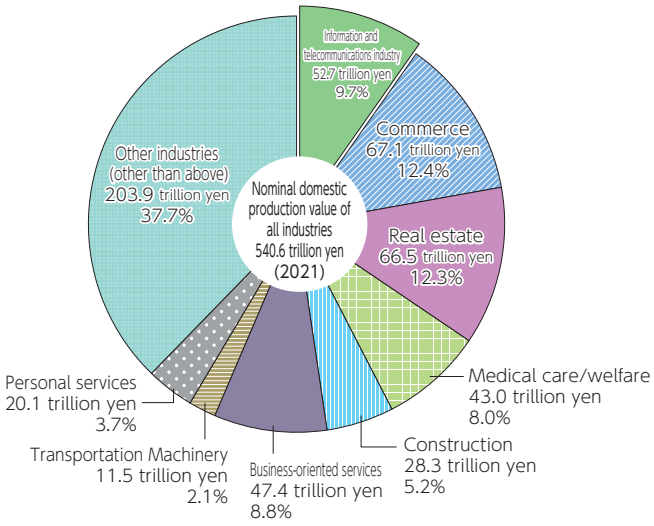


(Source) Statista (Gartner)[6]

2. Gross domestic product (GDP) of the ICT industry[7]

The nominal GDP of the ICT industry in 2021 was 52.7 trillion yen, an increase of 0.8% compared to 52.2 trillion yen in the previous year **(Figure 4-1-2-1, Figure 4-1-2-2)**. Looking at the changes in nominal GDP by sector in the ICT industry, while the trend in most sectors has remained almost flat, the information services sector and the services incidental to the Internet sector are showing increases **(Figure 4-1-2-3)**.

Figure 4-1-2-1 GDP of major industries (nominal)

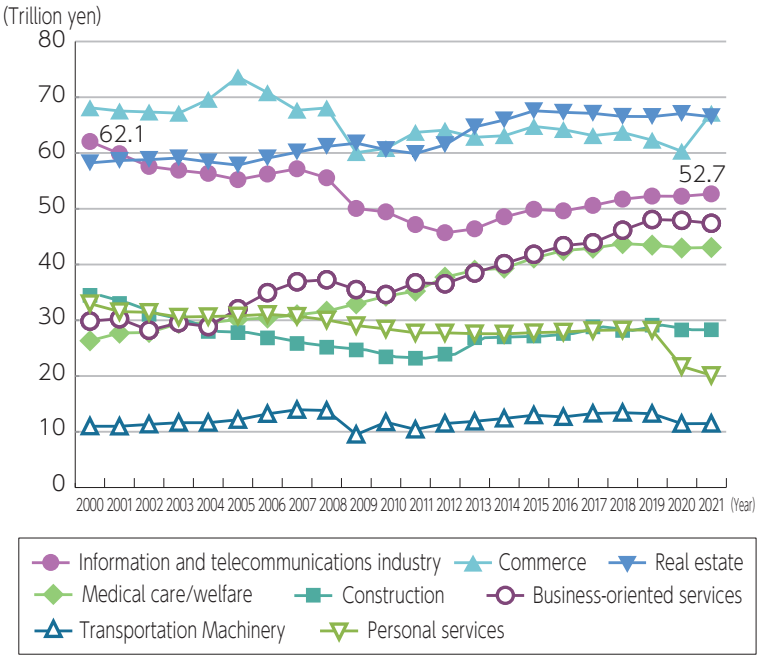


(Source) MIC (2023) "Survey on Economic Analysis of ICT in Fiscal 2022"

[6] https://www.statista.com/statistics/203935/overall-it-spending-worldwide/

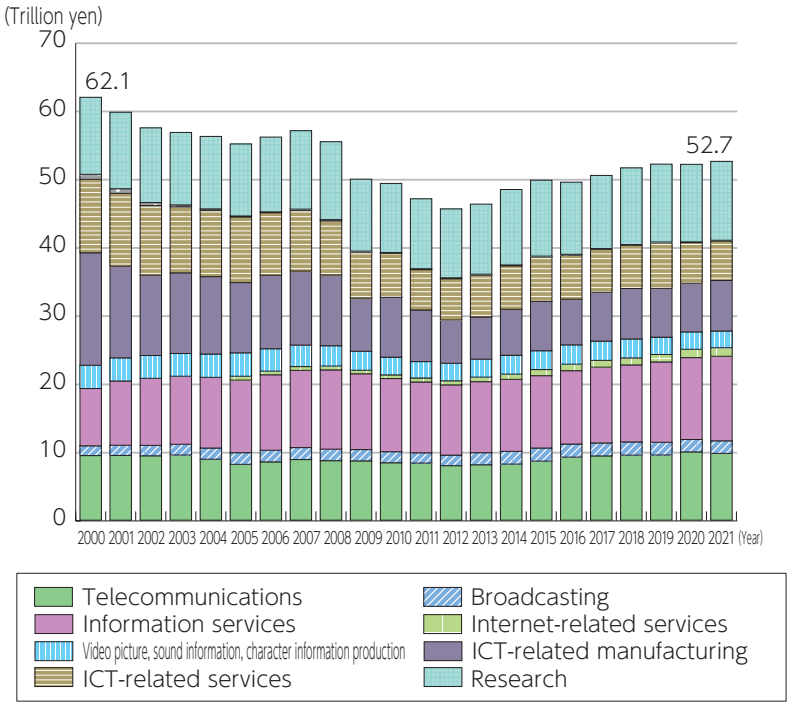
[7] The ICT industry has nine areas: telecommunications, broadcasting, information services, services incidental to the Internet, video/sound/character information production, manufacturing related to information and communications, services related to information and communications, construction related to information and communications, and research.

Figure 4-1-2-2 Changes in nominal GDP of major industries



(Source) MIC (2023) "Survey on Economic Analysis of ICT in Fiscal 2022"

Figure 4-1-2-3 Changes in nominal GDP of the ICT industry



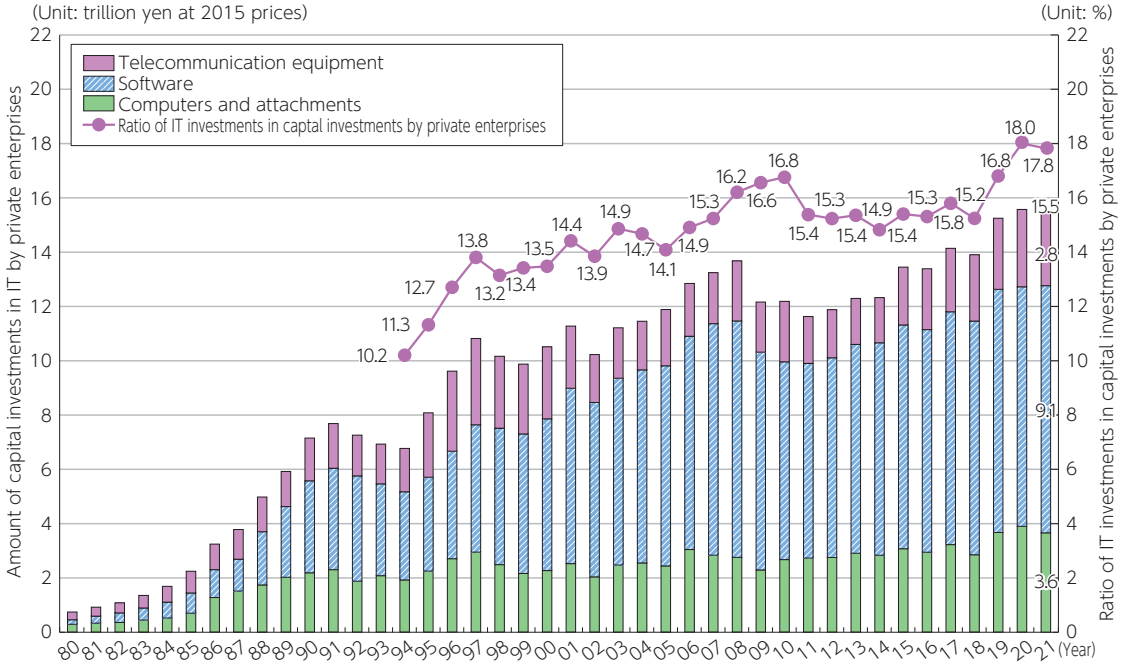
(Source) MIC (2023) "Survey on Economic Analysis of ICT in Fiscal 2022"

3. IT investments[8]

In 2021, IT investment in Japan's private companies was 15.5 trillion yen (down 0.4 % from the previous year) in terms of 2015 prices. By type of IT investment, investments in software (entrusted development and packaged software) accounted for nearly 60% of the total at 9.1 trillion yen. The ratio of IT investments to capital investment by private companies in 2021 was 17.8% (0.2 point decrease from the previous year), with IT investment accounting for a certain position in capital investment (**Figure 4-1-3-1**).

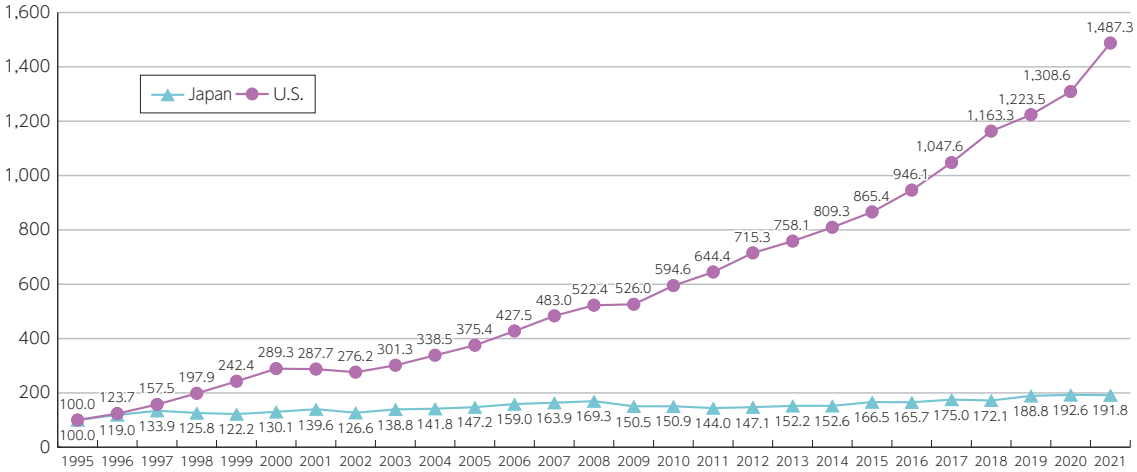
A comparison of the trends in IT investment between Japan and the U.S. shows that although IT investment in the U.S. stalled during the Lehman shock from 2008 to 2009, it has shown a rapid recovery since then, while IT investment in Japan has shown a slower recovery than that in the U.S., although the decline immediately after the Lehman shock was small (**Figure 4-1-3-2**).

Figure 4-1-3-1 Changes in IT investment in Japan



(Source) MIC (2023) "Survey on Economic Analysis of ICT in Fiscal 2022"

Figure 4-1-3-2 Comparison of IT investments in the private sector in Japan and the U.S.



*1995 = indexed as 100 (Japan: 2015 price; U.S.: 2012 price)

(Source) MIC (2023) "Survey on Economic Analysis of ICT in Fiscal 2022"

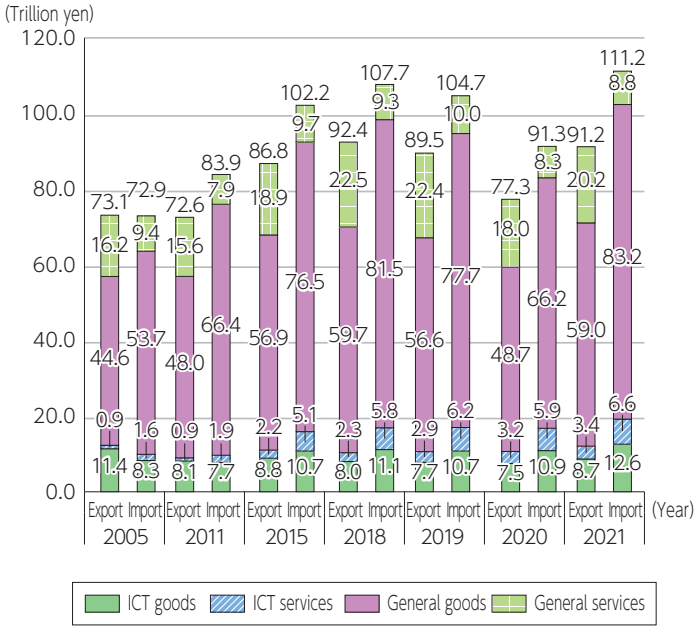
[8] Here, the term refers to investment in information and communications capital goods (computers and attachments, telecommunications equipment, software). The use of cloud services that have spread drastically in recent years is the purchasing of a service rather than the purchasing of capital goods and therefore is not included in IT investment here.

4. Exports and imports in the ICT field

In 2021, nominal value of exports and imports of all goods/services were 91.2 trillion yen and 111.2 trillion yen respectively. Of the above, exports of ICT goods/services[9] were 12 trillion yen (13.2% of all exports), while imports were 19.2 trillion yen (17.3% of all imports). The import surplus of ICT goods was 3.9 trillion yen (up 15.2% from the previous year) and the import surplus of ICT services was 3.3 trillion yen (down 18.7% from the previous year) (**Figure 4-1-4-1**).

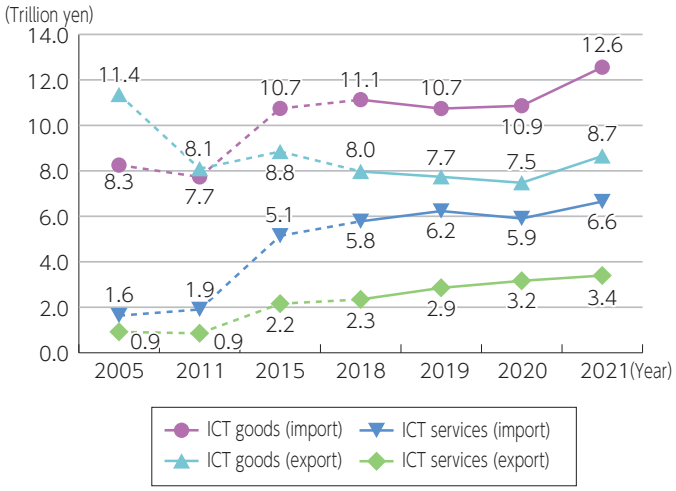
Looking at the change in the value of imports and exports of ICT goods and services, ICT services have consistently had an import surplus since 2005. However, regarding ICT goods, although there was an export surplus in 2005, the trend of an import surplus has continued in recent years due to a subsequent decrease in exports and increase in imports. Furthermore, ICT goods accounts for nearly 70% of both exports and imports of ICT goods and services (**Figure 4-1-4-2**).

Figure 4-1-4-1 Changes in the value of imports and exports of goods and services (nominal)



(Source) Prepared based on the MIC "ICT Industry Linkage Table" (for each fiscal year)

Figure 4-1-4-2 Changes in the value of imports and exports of ICT goods and services (nominal)



*There are different blanks in the data from 2005 to 2018 so trends are shown using dashed lines.

(Source) Prepared based on the MIC "ICT Industry Linkage Table" (for each fiscal year)

[9] In the table of 77 endogenous sectors, ICT goods and services refers to 1 to 43 and general goods and services refers to 44 to 77 (see note 4 at the end of this document). ICT goods includes communications devices such as personal computers and mobile phones, electronic components such as integrated circuits, televisions and radios, etc. and ICT services includes fixed and mobile telecommunications services, broadcasting services, software businesses, newspapers and publications, etc.

5. Trend of R&D in the ICT field

(1) State of research and development expenditure

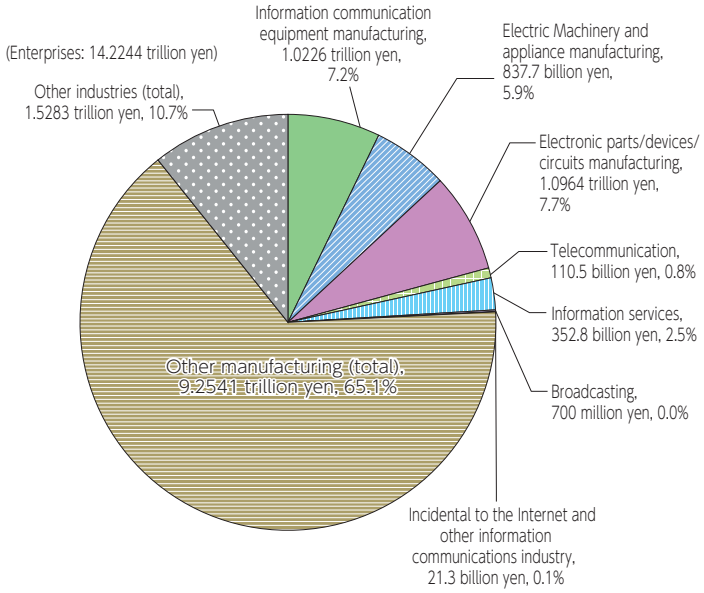
a Changes in R&D expenditures in major countries

In 2019, the U.S. continued to hold the top spot in R&D spending by major countries at 71.6739 trillion yen. China is in second place, followed by the EU and Japan, but Japan's R&D spending has been flat and the gap between the major countries in higher positions is widening.

b State of R&D expenditure in Japan

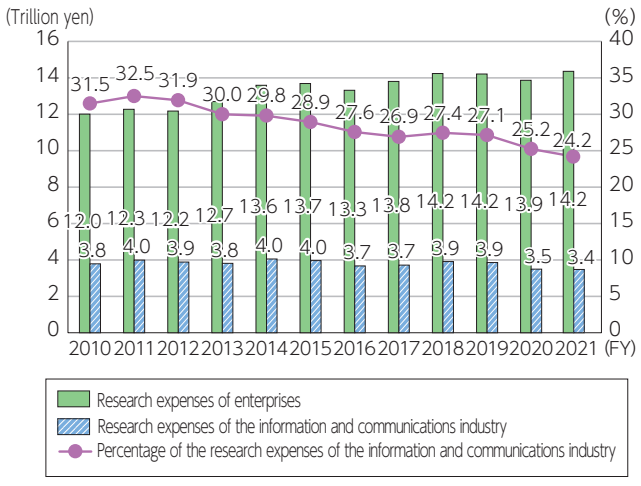
In fiscal 2021, the total expenditure for science and technology R&D in Japan (hereinafter "research expenditure") was 19.7408 trillion yen (sum of the research expenditure of companies, NGOs, public organizations, universities, etc.), which includes expenditure of 14.2244 trillion yen by companies. Of this research expenditure by companies, research expenditure in the ICT industry[10] was 3.4420 trillion yen (24.2%) (**Figure 4-1-5-1**), and in recent years this figure has either trended downward or remained the same (**Figure 4-1-5-2**).

Figure 4-1-5-1 Percentages of research expenditure by companies (fiscal 2021)



(Source) Prepared based on the MIC "2022 Science and Technology Research Survey"[11]

Figure 4-1-5-2 Changes in research expenditure by companies



(Source) Prepared based on the MIC "Science and Technology Research Survey" for each fiscal year[12]

[10] Here, the term refers to information and communications equipment manufacturing, electric machinery and appliance manufacturing, electronic parts/devices/circuits manufacturing, information communications (information services, telecommunications, broadcasting, incidental to the Internet and other information communications industries).
[11] https://www.stat.go.jp/data/kagaku/index.html
[12] https://www.stat.go.jp/data/kagaku/index.html

(2) State of R&D human resources

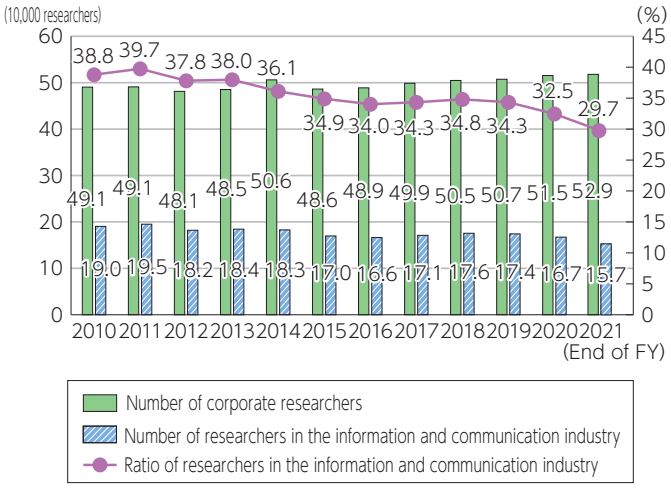
a Changes in the number of researchers in major countries

The number of researchers[13] in all major countries is on the rise. The number of researchers in 2021 in Japan was 690,000, the third largest number after China (2,281,000 in 2020) and the U.S. (1,586,000 in 2019). The most recent year figures for other countries, in descending order, are Germany (452,000 in 2020), South Korea (447,000 in 2020), France (322,000 in 2020), and the United Kingdom (316,000 in 2019).

b Number of researchers in Japan

At the end of fiscal 2021, the number of researchers in Japan (total of the researchers at companies, NGOs, public organizations, universities, etc.) was 908,330, of which 529,053 were at companies. Of the number of researchers at companies, 157,219 (29.7%) were researchers in the ICT industry, and this number has been decreasing in recent years (**Figure 4-1-5-3**).

Figure 4-1-5-3 Changes in the number of researchers at companies



(Source) Prepared based on the MIC "Science and Technology Research Survey" for each fiscal year[14]

Figure (related data) Percentages of the number of researchers at companies by industry (as of March 31, 2022)
Source: Prepared based on the MIC "2022 Science and Technology Research Survey"
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2023/data_collection.html#f00094
(Data collection)

(3) State of patents

In 2020, 597,000 patent applications were filed in the U.S. The percentage of applications filed by non-residents has been on the rise in recent years, suggesting that the U.S. market is attractive overseas. In 2020, the number of applications filed in Japan was 288,000, which was the most after China and the U.S., but the number of patent applications has been decreasing since the mid-2000s, and the gap has widened.

In terms of the changes in the number of patent families[15] by technology area in Japan, the U.S., and China, the information and communications technology percentage is increasing in the U.S. and China, but it is stagnant in Japan.

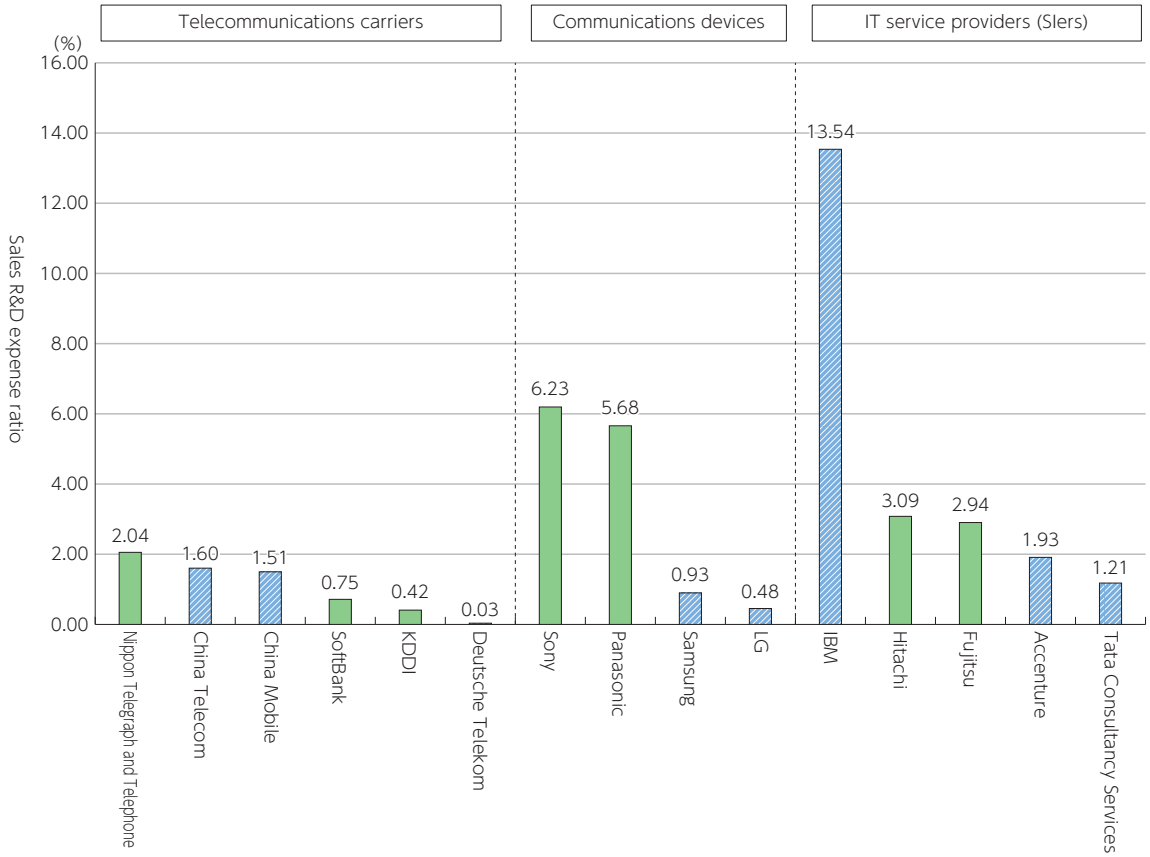
[13] Measured by converting research work into fulltime employment.
[14] https://www.stat.go.jp/data/kagaku/index.html
[15] A patent family is a bundle of patent applications in two or more countries that are linked directly or indirectly by priority rights. Generally, patents with the same content that are filed in more than one country belong to the same patent family. Thus, counting patent families prevents the same application from being counted twice. In other words, the number of patent families is considered to be approximately the same as the number of inventions.
https://www.nistep.go.jp/sti_indicator/2021/RM311_45.html

(4) R&D trends of major domestic and overseas companies in the ICT field

Excluding some companies such as IBM, the percentage of R&D expenditure to sales for major information and communications companies in Japan and overseas in 2021 remains less than 10% **(Figure 4-1-5-5)**.

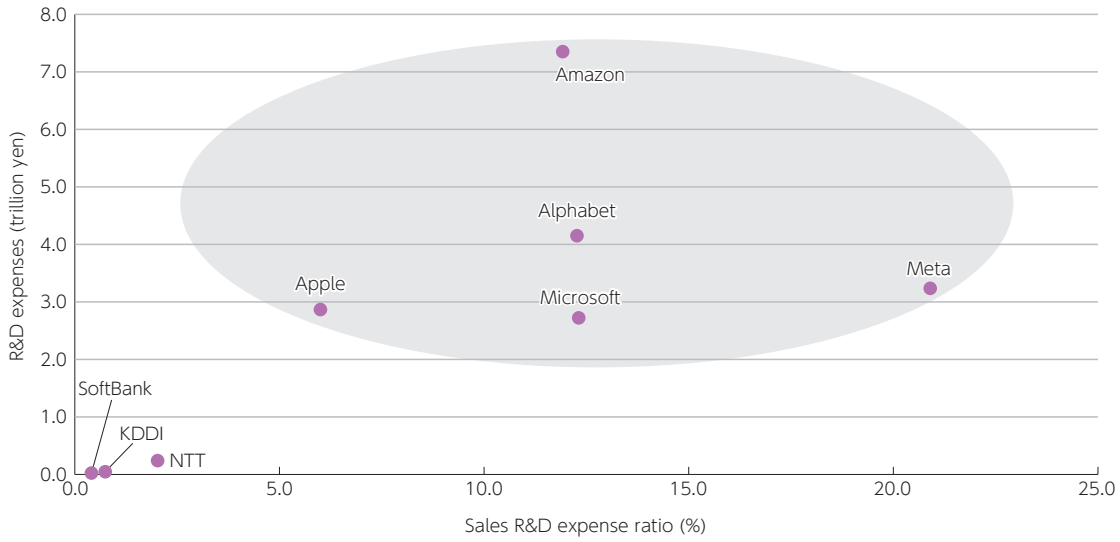
The percentage of R&D expenditure to sales of major Japanese telecom providers in 2021 was 2% at NTT and less than 1% at KDDI and SoftBank, while GAFAM's[16] percentages ranged from 6% to 21%, indicating that they are active in R&D **(Figure 4-1-5-6)**.

Figure 4-1-5-5 Comparison of research and development expenditures by telecommunications carriers, communications devices and IT service providers (2021)



(Source) Prepared based on the annual reports released by companies

Figure 4-1-5-6 Comparison of research and development expenditures between major Japanese companies and GAFAM (2021)



(Source) Prepared based on the annual reports released by companies

[16] Google, Amazon, Facebook, Apple and Microsoft

(5) Examples of research and development of new technologies in the ICT field: Green of ICT using photoelectric fusion technology

Due to the progress of digitalization, the electric power consumption of communications network equipment and data centers, etc. has increased considerably. As global warming intensifies, it is necessary to contribute to the realization of a green society by reducing the power consumption of ICT-related equipment and facilities through the development and introduction of new technologies. Photoelectric fusion technology, a key technology for all-optical networks,[17] is a technology that replaces computer calculations traditionally performed by electricity with processing that uses light. Because light consumes less energy than electricity, this is expected to save a lot of energy.

However, since the light-to-electricity conversion process requires the addition of components and consumes an additional amount of electricity, if this extra electricity consumption exceeds the effect of the power saving mentioned above, overall power saving will not be achieved.

As an element that helps to solve this problem, Photonic Crystal has recently been developed in which extremely small holes are made in silicon used for semiconductors. The smaller the size of the chip (integrated circuit) that performs calculations, the lower the amount of heat generated (= energy loss) when light passes through it, and using photonic crystal enables chips to be made extremely small.

According to the development roadmap of the Innovative Optical and Wireless Network (IOWN) Initiative announced by NTT in 2019, which will realize high-speed, large-capacity communications by utilizing innovative light-centered technologies such as photoelectric fusion, the first step is to establish a technology that connects the chip used for calculation with peripheral components using light, the next step is to connect the chips with each other using light, and the final step in 2030 is to commercialize a photoelectric fusion chip that performs calculations light.

[17] See Section 2 in Chapter 3 of Part 1