# Chapter 1

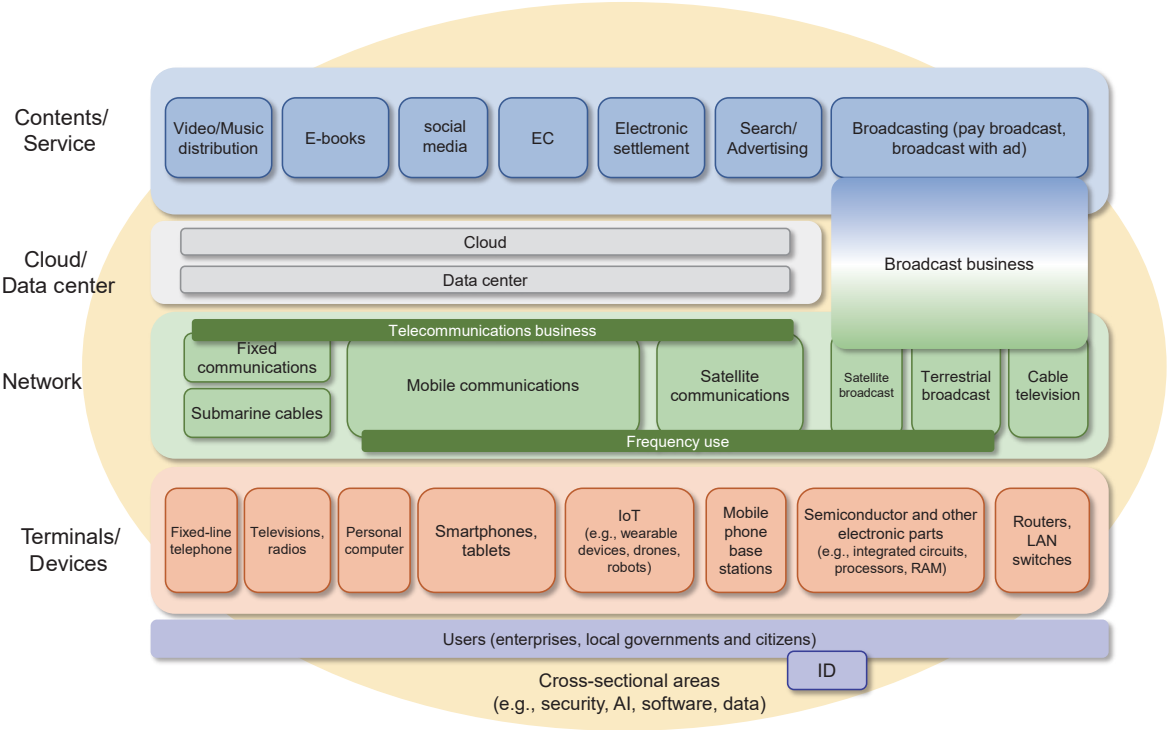
# Trends in the ICT Market

## Section 1 Trends in the ICT industry

### 1. Size of the ICT market

ICT includes devices and terminals that serve as user interfaces, networks provided by telecommunications and broadcasting companies, cloud and data centers, content services such as video and music streaming, and security and AI **(Figure 2-1-1-1)**.

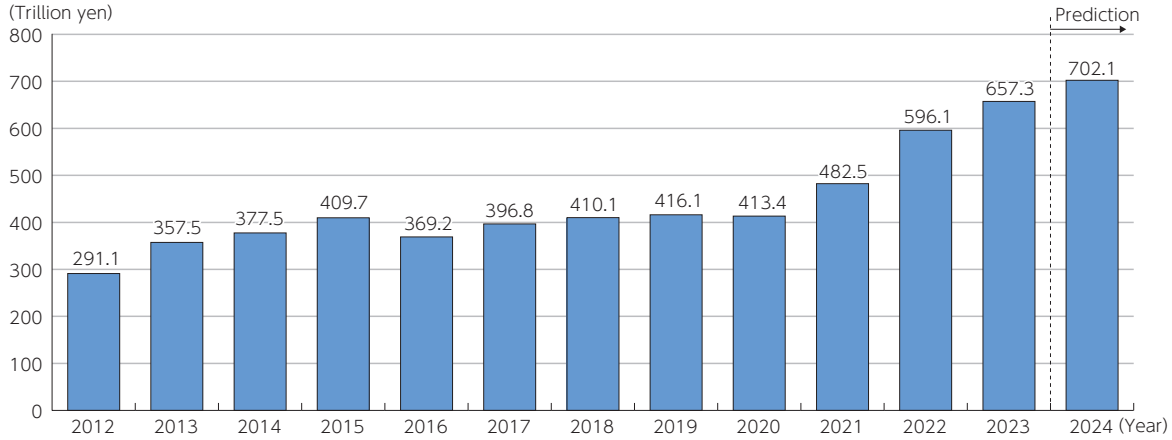
**Figure 2-1-1-1 Structure of the ICT market by layer**




The global ICT market (expenditure)[1] has been on an upward trend since 2016, driven by the proliferation of smartphones and cloud services. In 2023, it is expected to reach 657.3 trillion yen[2] (a 10.3% increase from the previous year[3]), and it is forecasted to expand to 702.1 trillion yen in 2024[4] **(Figure 2-1-1-2)**.

[1] The ICT market includes data center systems, enterprise software, devices, ICT services, and communication services.
[2] Converted to yen using the average exchange rate for each year, and for 2024, the average exchange rate for 2023 is used (the same applies hereafter).
[3] It should be noted that 2023 was also affected by the weaker yen (the same applies hereafter).
[4] MIC (2024) "Research on trends in domestic and international ICT markets" (the same applies hereafter).

**Figure 2-1-1-2 Changes in global ICT market size (expenditure)**

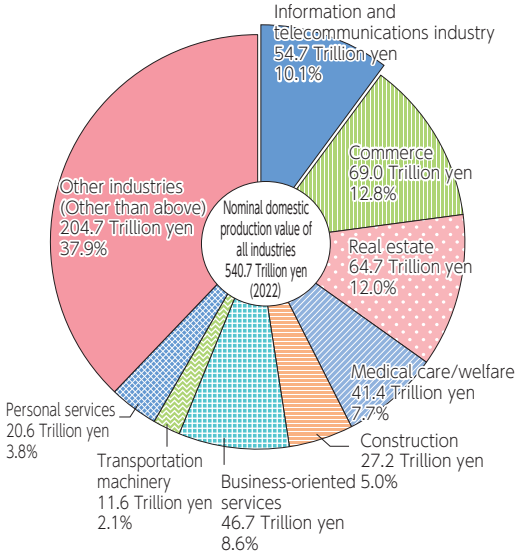



(Source) Gartner (cited from Statista) [5]

## 2. Gross Domestic Product (GDP) of the ICT industry[6]

The nominal GDP of the information and communication industry in 2022 was 54.7 trillion yen, a 1.5% increase compared to the previous year (53.9 trillion yen) (Figures 2-1-1-3, 2-1-1-4). When examining the nominal GDP trends by sector within the information and communication industry, most sectors have remained relatively stable, while the information services and internet-related services sectors have shown an increasing trend **(Figure 2-1-1-5)**.

**Figure 2-1-1-3 GDP of major industries (nominal)**

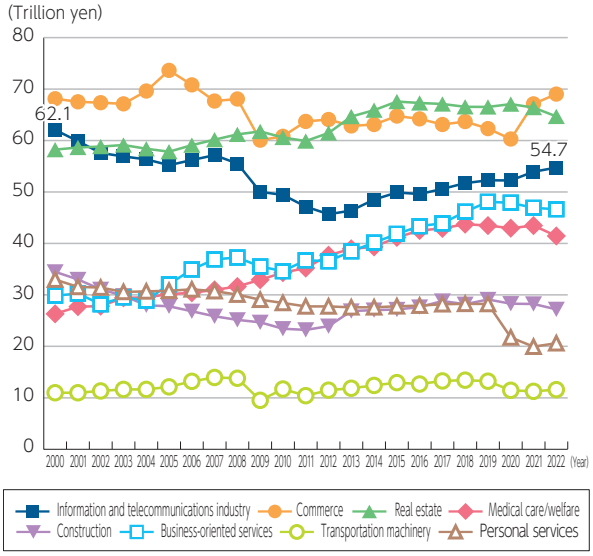



(Source) MIC(2024) "Survey on Economic Analysis of ICT in FY2023"

[5] https://www.statista.com/statistics/268938/global-it-spending-by-segment/

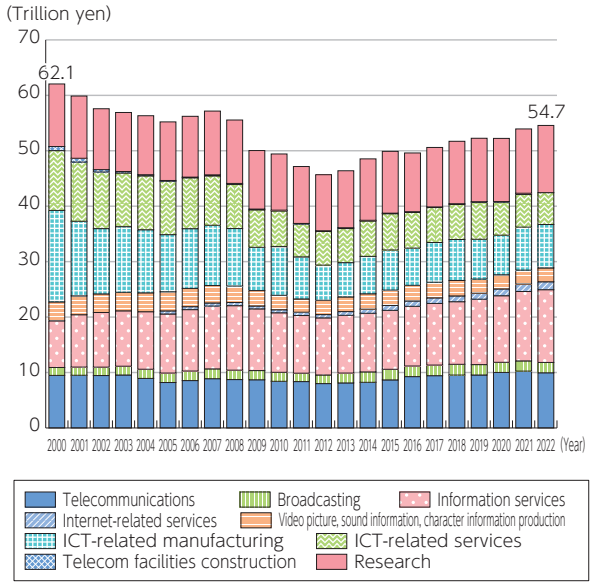
[6] The ICT industry has nine areas: telecommunications, broadcasting, information services, services incidental to the Internet, video/sound/text information production, manufacturing related to information and communications, services related to information and communications, construction related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

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




(Source) MIC(2024) "Survey on Economic Analysis of ICT in FY2023"

**Figure 2-1-1-5 Changes in nominal GDP of the ICT industry**




(Source) MIC(2024) "Survey on Economic Analysis of ICT in FY2023"

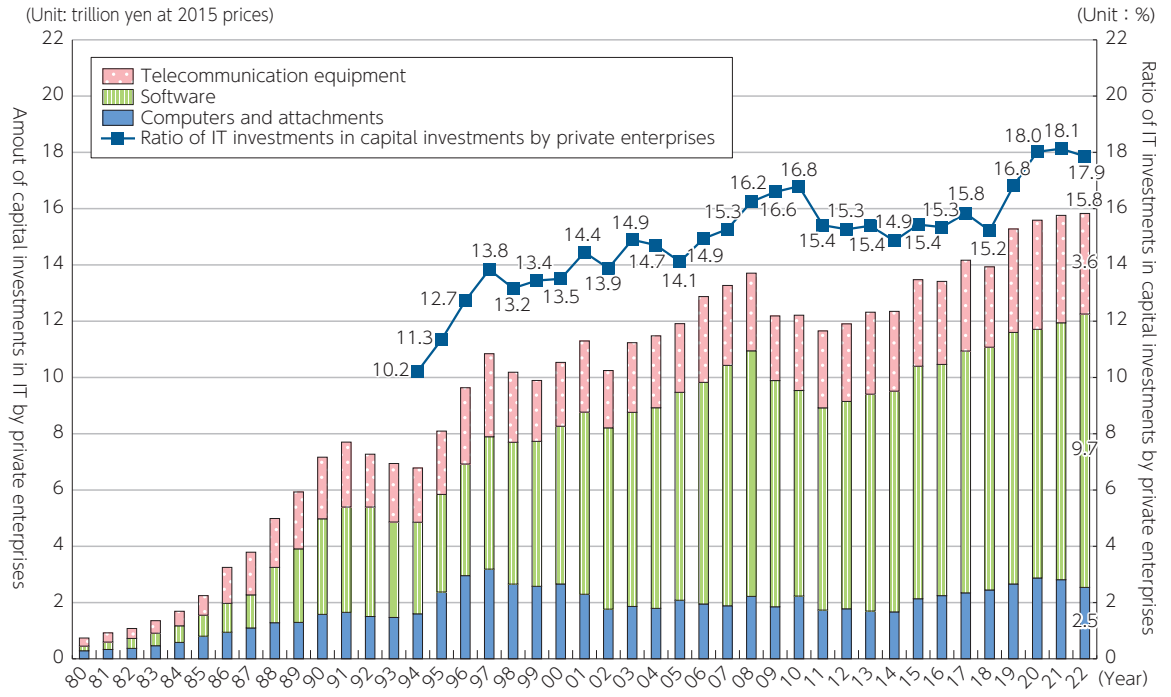
## 3. IT investment[7]

In 2022, private sector IT investment in Japan amounted to 15.8 trillion yen (2015 year prices), a 0.4% increase from the previous year. Software (custom development and packaged software) accounted for 9.7 trillion yen, nearly 60% of the total. The ratio of information investment to total private sector capital investment was 17.9% (a 0.2 percentage point decrease from the previous year), indicating that IT investment holds a significant position within capital investment **(Figure 2-1-1-6)**.

Comparing the trends in IT investment between Japan and the U.S. IT investment showed a rapid recovery after the 2008-2009 Lehman Shock, while Japan's IT investment, although less impacted immediately after the Lehman Shock, has shown a more gradual recovery compared to the U.S. **(Figure 2-1-1-7)**.

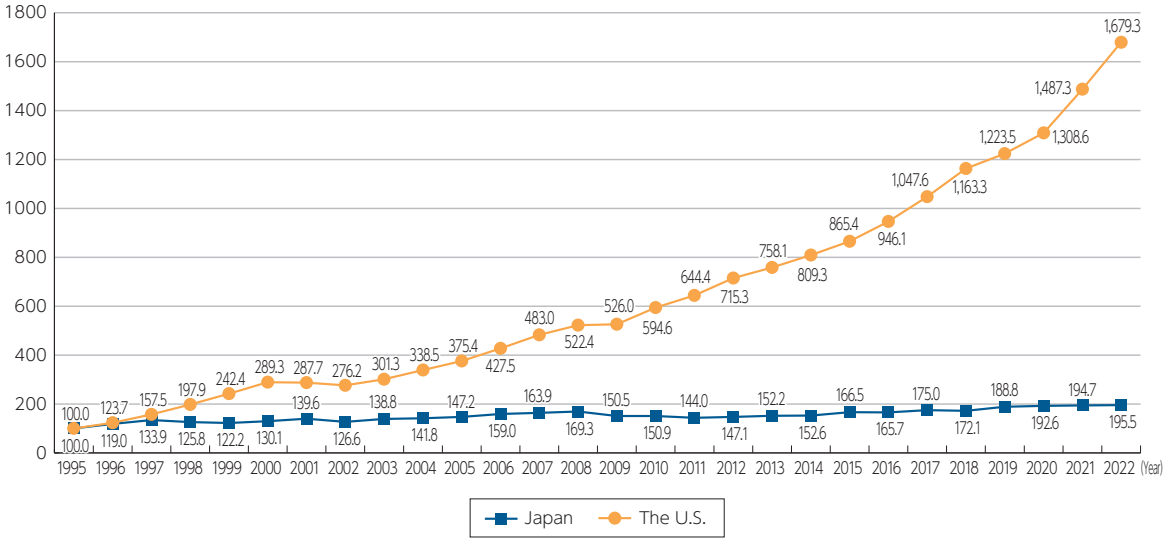
[7] Here the term refers to investment in information and communications capital goods (computers and attachments, telecommunications equipment, software). The use of cloud services that have spread drastically in recent years is the purchasing of a service rather than the purchasing of capital goods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

**Figure 2-1-1-6 Changes in IT investment in Japan**




(Source) MIC(2024) "Survey on Economic Analysis of ICT in FY2023"

**Figure 2-1-1-7 Comparison of IT investment in the private sector in Japan and the U.S.**




* Indexing year 1995=100 (Japan: price in 2015, the U.S.: price in 2012)

(Source) MIC(2024) "Survey on Economic Analysis of ICT in FY2023"

## 4. Exports and imports in the ICT field

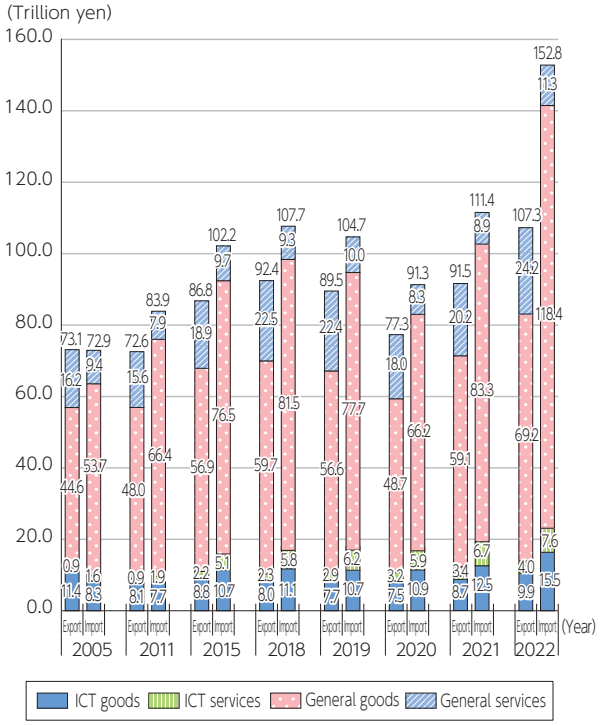
In 2022, the nominal value of exports and imports of goods and services was 107.3 trillion yen for exports and 152.8 trillion yen for imports. Among these, ICT goods and services[8] accounted for 13.9 trillion yen in exports (13.0% of total exports) and 23.1 trillion yen in imports (15.1% of total imports). The trade deficit for ICT goods was 5.6 trillion yen (a 45.6% increase from the previous year), and the trade deficit for ICT services was 3.6 trillion yen (a 10.6% increase from the previous year) **(Figure 2-1-1-8)**.

Examining the trends in ICT goods and services exports and imports, ICT services have consistently

[8] 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 in Annotation 4 of Appendix in the 2023 White Paper on Information and Communications in Japan). 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.

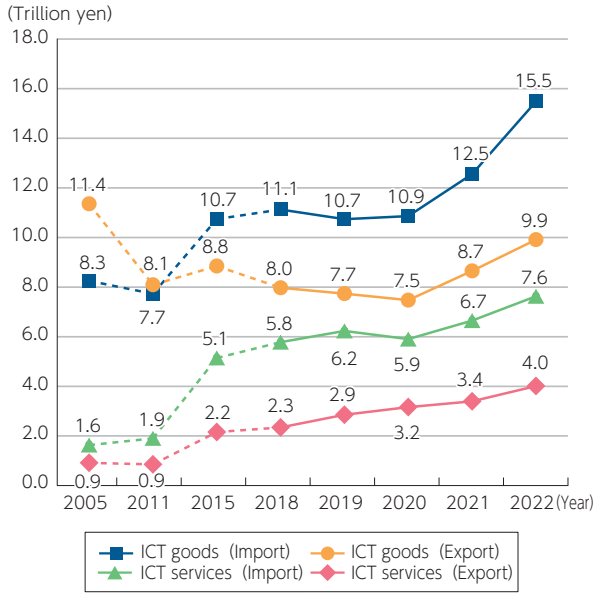
shown a trade deficit since 2005. On the other hand, ICT goods, which had a trade surplus in 2005, have shown a trend of increasing imports and decreasing exports, resulting in a trade deficit in recent years. ICT goods account for nearly 70% of both export and import values **(Figure 2-1-1-9)**.

**Figure 2-1-1-8 Changes in the value of import and exports of goods and services (nominal)**




(Source) Prepared based on MIC "ICT Inter-Industry Table" (for each FY)

**Figure 2-1-1-9 Changes in the value of import and exports of ICT goods and services (nominal)**




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

(Source) Prepared based on MIC "ICT Inter-Industry Table" (for each FY)

The balance of digital-related services has been in deficit in recent years, with a deficit of 5.3 trillion yen in 2023[9]. Among these, "Communication, Computer, and Information Services," which include fees for cloud services and online meeting systems, have the largest deficit with Singapore (341.4 billion yen), followed by the Netherlands (307.0 billion yen) and the U.S. (230.4 billion yen).

[9] Here, it refers to computer services, copyright fees, and management/consulting services. Calculated by the MIC from the Ministry of Finance's balance of payments statistics.

**Figure (related data) Balance of digital-related services by country (top 3 countries)**
Source: Prepared based on the Ministry of Finance's balance of payments statistics
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/r06/html/datashu.html#f00110
(Data collection)

# 5. Trend of R&D in the ICT field

## (1) Situation of research and development expenditure

### A Trends in research and development expenditure in major countries

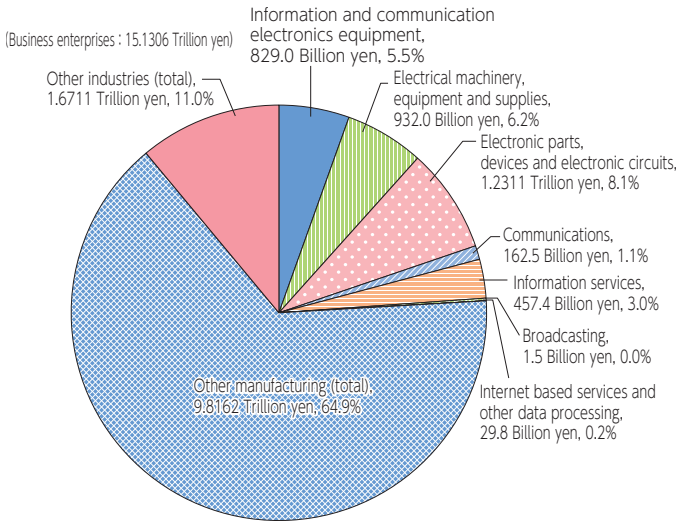
In 2020, the U.S. maintained the top position in research and development expenditure at 76.9738 trillion yen. Following the U.S. are China, the EU, and Japan, with Japan's research and development expenditure showing a flat trend and the gap with the top countries widening.

**Figure (related data) Trend of total expenditure on research and development in major countries**
Source: Japan Science and Technology Agency, Research and Development Strategy Center "Overview of Research and Development Report (2023)"
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/r06/html/datashu.html#f00114
(Data collection)

### B Situation of research and development expenditure in our country

In FY2022, the total amount of research and development expenditure in our country (the sum of research expenditure by business enterprises, non-profit institutions and public organizations, universities and colleges) was 20.704 trillion yen, with the R&D expenditures of business enterprises amounting to 15.1306 trillion yen. Among the R&D expenditures of business enterprises, the R&D expenditures in the information and communications industry[10] was 3.6433 trillion yen (24.1%) **(Figure 2-1-1-10)**, and it has shown a trend of decrease or stagnation in recent years **(Figure 2-1-1-11)**.

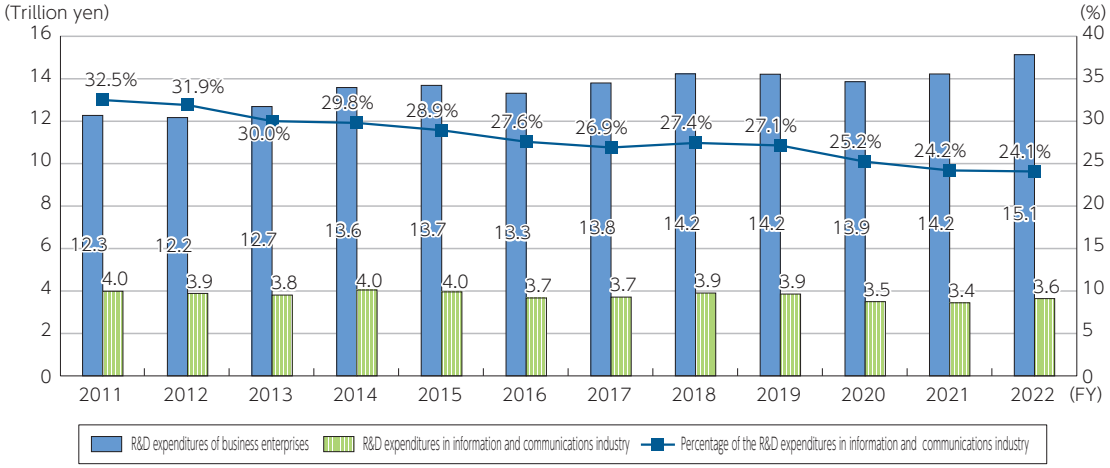
**Figure 2-1-1-10 Percentage of R&D expenditures of business enterprises (FY2022)**




(Source) Prepared based on MIC "2023 Survey of Research and Development"[11]

[10] Here, the term refers to information and communication electronics equipment, electrical machinery, equipment and supplies, electronic parts, devices and electronic circuits, information and communications (information services, communications, broadcasting, and services incidental to the Internet and other ICT businesses).
[11] https://www.stat.go.jp/data/kagaku/index.html

**Figure 2-1-1-11 Trend of R&D expenditures of business enterprises**




(Source) Prepared based on MIC "Survey of Research and Development"[12] for each FY

### (2) Situation of persons employed in research and development

#### A Trends in the number of researchers in major countries

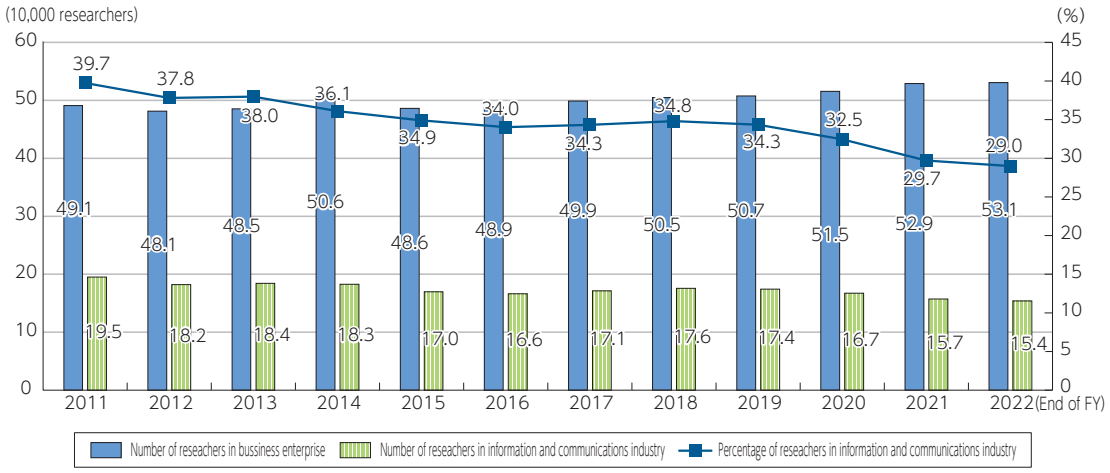
The number of researchers in major countries[13] is increasing. In 2022, the number of researchers in Japan was 705,000, ranking third in size after China (1.866 million in 2018) and the U.S. (1.493 million in 2020). Looking at the latest values for other countries in descending order, the Republic of Korea (471,000 in 2021), Germany (460,000 in 2021), France (340,000 in 2021), and the UK (296,000 in 2017).

**Figure (related data) Changes in the number of researches in major countries**
Source: National Institute of Science and Technology Policy in the MEXT "Science and Technology Indicators 2023"
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/r06/html/datashu.html#f00125
(Data collection)

#### B Number of researchers in our country

At the end of FY2022, the number of researchers in our country (the total number of researchers in business enterprises, non-profit institutions and public organizations, universities and colleges) was 910,393 with the number of researchers in companies being 530,587. Among the researchers in business enterprises, the number of researchers in the information and communication industry was 153,854 (29.0%), showing a decreasing trend in recent years **(Figure 2-1-1-12)**.

**Figure 2-1-1-12 Trend in the number of researchers in business enterprises**




(Source) Prepared based on MIC "Survey of Research and Development" for each FY[14]

[12] https://www.stat.go.jp/data/kagaku/index.html
[13] Measured by converting research work into fulltime employment.
[14] https://www.stat.go.jp/data/kagaku/index.html

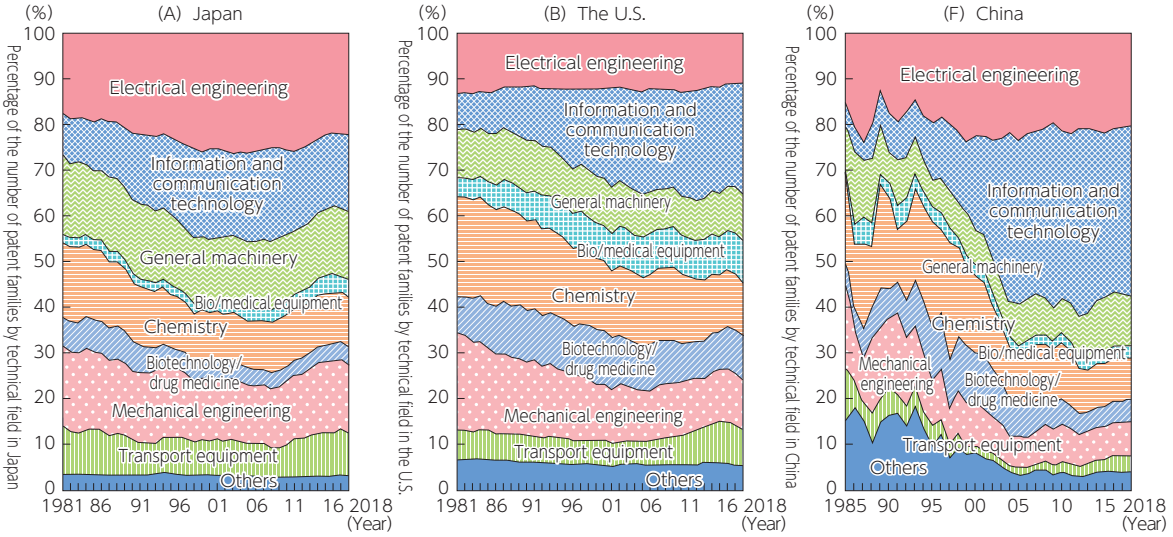
**Figure (related data) Percentage of the number of researchers at business enterprises by industry (as of March 31, 2023)**
Source: Prepared based on MIC "2023 Survey of Research and Development"
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/r06/html/datashu.html#f00127
(Data collection)

### (3) Patent situation

The number of patent applications to the U.S. was 591,000 in 2021. The proportion of applications from non-residents has been increasing in recent years, suggesting that the U.S. market is attractive to overseas entities. The number of applications to Japan was 289,000 in 2021, ranking third in size after China and the U.S. However, the number of patent applications has been decreasing since the mid-2000s, leading to a growing gap.

Looking at the proportion of patent families[15] in the fields of technology in Japan, the U.S., and China, it is evident that the proportion of "Information and Communication Technology" is increasing in the U.S. and China, while it is stagnant in Japan **(Figure 2-1-1-13)**.

**Figure 2-1-1-13 Change in percentage of the number of patent families by technical field in Japan, China and the U.S.**




(Source) National Institute of Science and Technology Policy in the MEXT "Science and Technology Indicators 2023"

**Figure (related data) Changes in the patent application in major countries and from major countries**
Source: National Institute of Science and Technology Policy in the MEXT "Science and Technology Indicators 2023"
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/r06/html/datashu.html#f00129
(Data collection)

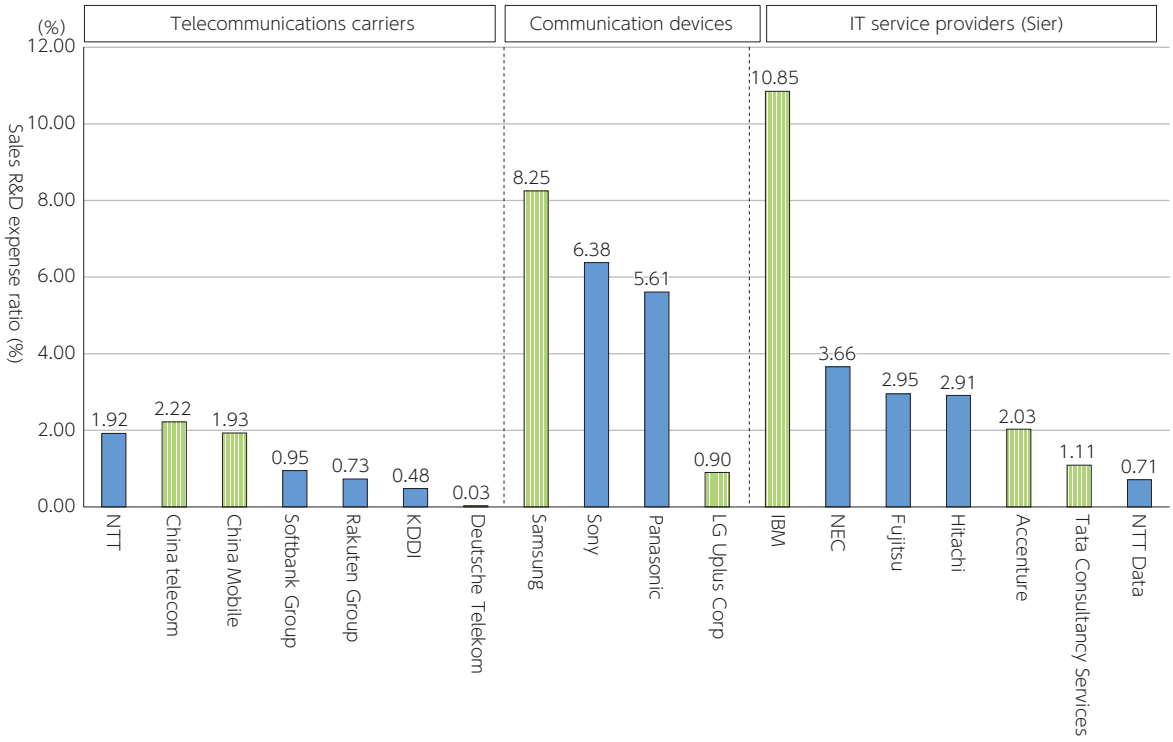
### (4) Trends in research and development of major domestic and international companies in the ICT field

The ratio of research and development expenses to sales in 2022 for major domestic and international information and communication-related companies, excluding some such as IBM, remained below 10% **(Figure 2-1-1-14)**.

For major Japanese telecommunications companies, the ratio of research and development expenses to sales in 2022 was 2% for NTT, and less than 1% for KDDI and SoftBank, while GAFAM[16], excluding Apple, had a ratio of approximately 10% to 35%, indicating an active commitment to research and development **(Figure 2-1-1-15)**.

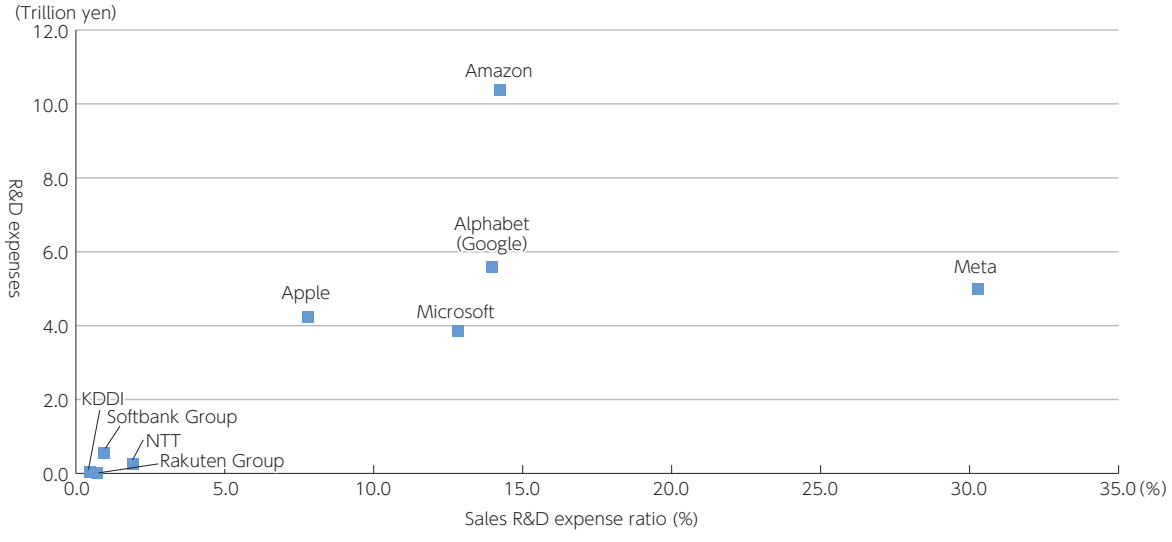
[15] A patent family is a bundle of patent applications in two or more countries that are linked directly or indirectly by priority rights. Generally, patents with the same content that are filed in more than one country belong to the same patent family. Thus, counting patent families prevents the same 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
[16] Alphabet (Google), Amazon, Meta (facebook), Apple, Microsoft

**Figure 2-1-1-14 Comparison of research and development expenditure by telecommunications carriers, communications devices and IT service providers (2022)**




(Source) Prepared based on the annual reports etc. by each company

**Figure 2-1-1-15 Comparison of research and development expenditure between major Japanese companies and GAFAM (2022)**




(Source) Prepared based on the annual reports etc. by each company

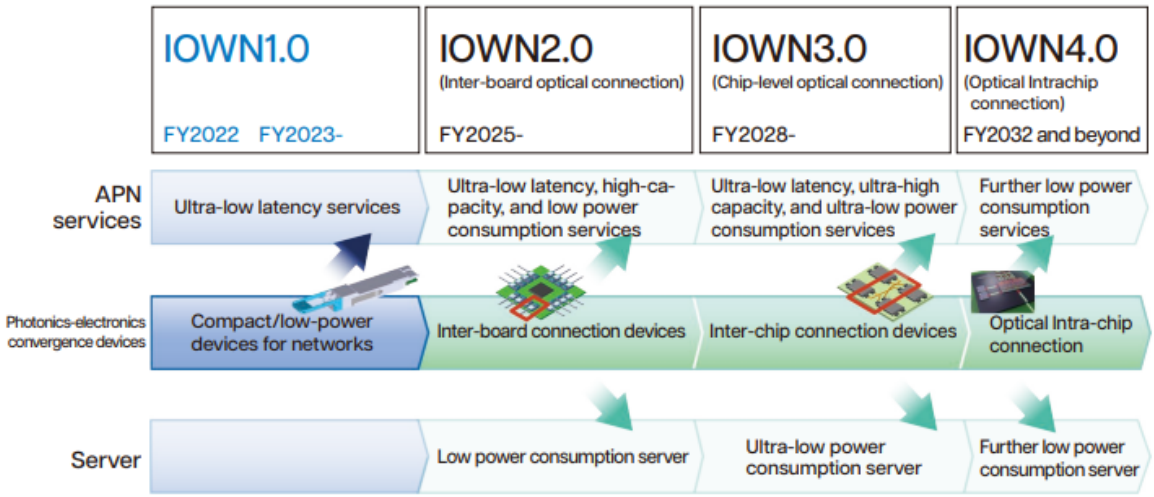
**(5) Example of research and development of new technologies in the ICT field: IOWN Optical and Wireless Network fusion device**

The "Innovative Optical and Wireless Network (IOWN)" concept, led by NTT, aims to create a rich society that optimizes individual and collective diversity based on all information, utilizing innovative technologies centered around light to provide high-speed, high-capacity communication and vast computing resources beyond the limitations of existing infrastructure, including network and information processing platforms, including terminals.

The optical-electronic fusion technology in the IOWN concept is a technology that integrates circuits handling electrical signals and circuits handling optical signals, particularly important for high-speed transfer of large amounts of data in server-to-server communication and internal computer communication. By integrating electronic and optical devices into a single system, optical-electronic fusion devices can improve data transfer speeds and energy efficiency, making them essential in the IOWN concept. The optical-electronic fusion devices developed in IOWN 2.0 achieve optical connections between boards using tile-type optical engines, promoting low-latency and low-power consumption in All-Photonics Network (APN). Furthermore, the optical-electronic fusion devices developed in IOWN 3.0 enable optical con-

nections between packages by placing the optical-electronic fusion parts next to the silicon (die) inside the package, allowing further miniaturization and low-power consumption of boards. IOWN 2.0 realizes optical connections between boards, IOWN 3.0 realizes optical connections between chips, and IOWN 4.0 is expected to achieve optical connections within chips. By FY2025, board connection devices for IOWN 2.0, by FY2028, chip-to-chip connection devices for IOWN 3.0, and from 2032 onwards, chip internal opticalization for IOWN 4.0 are expected to be achieved, aiming to realize new devices with 100 times the power efficiency **(Figure 2-1-1-16)**[17].

**Figure 2-1-1-16 Development of IOWN optical-electronic fusion technology devices**




(Source) NTT (2023) "IOWN Technology Report 2023"

[17] https://www.rd.ntt/download/NTT_IOWN_TR2023_J.pdf (accessed on December 22, 2023)