

Section 2 Trends in the telecommunications field

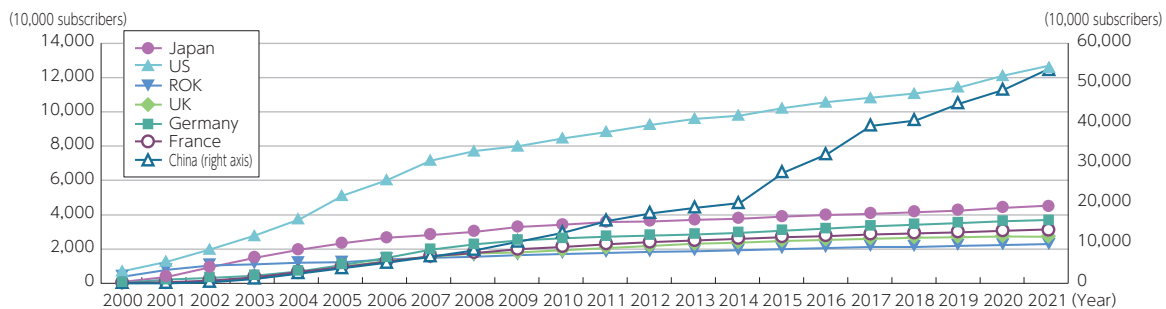
1. Trends in the domestic and overseas communications markets

The number of fixed broadband service subscriptions¹ has been increasing in all major countries since 2000 (Figure 4-2-1-1). By country, China rose to the top position overtaking the U.S. in 2008 and has been sharply increasing the number since 2015. China's compound annual growth rate (CAGR) from 2000 to 2021 is 62%, which is far higher than the U.S.'s 15% and Japan's 21%.

The number of mobile phone subscriptions² has also

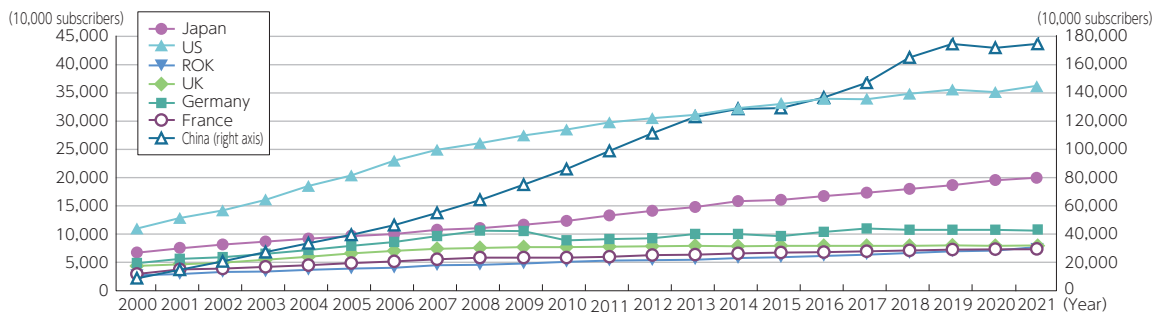
been on the increase in major countries, with China showing an especially sharp increase (Figure 4-2-1-2). China's compound annual growth rate (CAGR) from 2000 to 2021 is 15%, which is far higher than the U.S.'s 6% and Japan's 5%. In 2021, the percentage of the number of mobile phone subscriptions compared to the population was 159.7% (63.5 point increase from 2010) in Japan, 107.3% (15.7 point increase from 2010) in the U.S. and 121.5% (57.8 point increase from 2010) in China.³

Figure 4-2-1-1 Changes in fixed broadband service subscriptions in major countries



(Source) ITU⁴

Figure 4-2-1-2 Changes in the number of mobile phone subscriptions in major countries



(Source) ITU⁵

¹ Statistics from ITU. Fixed-broadband subscriptions are shown. Fixed broadband refers to high-speed lines providing a communication speed of 256 kbps or faster for either or both uplink and downlink. High-speed lines include cable modems, DSL, optical fiber and satellite communications, fixed wireless access and WiMAX, etc., but do not include mobile network (cellular system) based data communications subscriptions.

² Statistics from ITU. Mobile-cellular subscriptions are shown. The number includes deferred-payment subscriptions and prepaid subscriptions. Prepaid subscriptions are included only when the service was used for a fixed period of time (e.g., three months). Data card and USB modem subscriptions are not included.

³ Number of mobile subscriptions includes prepaid-based subscriptions.

⁴ <https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>

⁵ <https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>

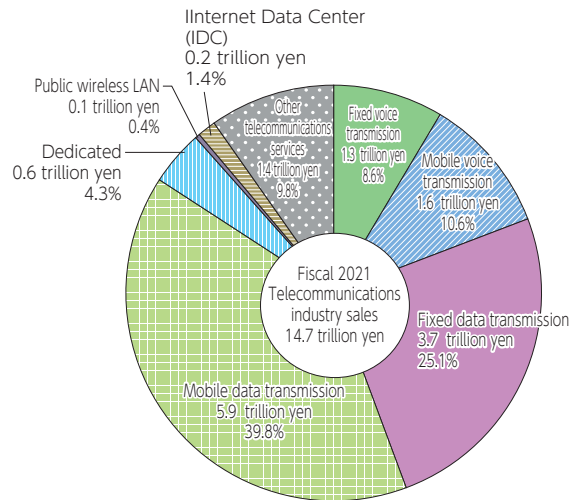
2. Current status of the telecommunications field in Japan

(1) Market size

Total sales of the telecommunications industry in fiscal 2021 are estimated to be about 15 trillion yen. Looking at the breakdown, data transmission (fixed and mo-

bile) accounted for about 9.6 trillion yen (65%) and voice transmission accounted for about 2.8 trillion yen (19.2%) (**Figure 4-2-2-1**).

Figure 4-2-2-1 Composition of sales in the telecommunications industry



*1 Fixed voice transmission is the sum of domestic and international services.

*2 Fixed data transmission includes sales through Internet access (ISP, FTTH, etc.), IP-VPN, and wide area Ethernet.

(Source) Prepared based on the MIC "Basic Survey on the Information and Communications Industry"⁶

(2) Number of business operators

The number of telecommunications carriers at the end of fiscal 2022 was 24,272 (334 registered business operators and 23,938 notified business operators), with

the number continuing to increase following the previous fiscal year (**Figure 4-2-2-2**).

Figure 4-2-2-2 Changes in the number of telecommunications carriers

End of FY	2015	2016	2017	2018	2019	2020	2021	2022
Number of telecommunication carriers	17,519	18,177	19,079	19,818	20,947	21,913	23,111	24,272

(Source) Information and Communications Statistics Database⁷

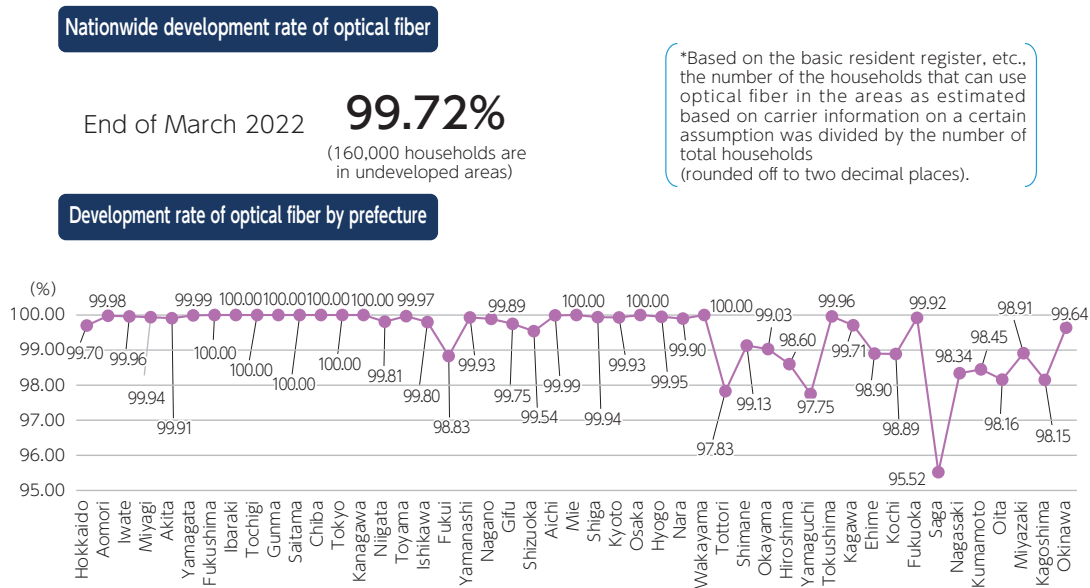
⁶ <https://www.soumu.go.jp/johotsusintokei/statistics/statistics07.html>

⁷ <https://www.soumu.go.jp/johotsusintokei/field/tsuushin04.html>

(3) State of infrastructure development

The household coverage rate of optical fiber in Japan at the end of fiscal 2021 was 99.72% (Figure 4-2-2-3).

Figure 4-2-2-3 State of preparation of optical fiber as of March 31, 2022 (estimated)



(Source) MIC "Survey on Broadband Infrastructure Coverage Rate at End of Fiscal 2021"⁸

According to the OECD, the percentage of optical fiber connections in total fixed broadband as of June 2022 in Japan is the second highest among member coun-

tries, indicating that Japan's digital infrastructure is advanced even by international terms.


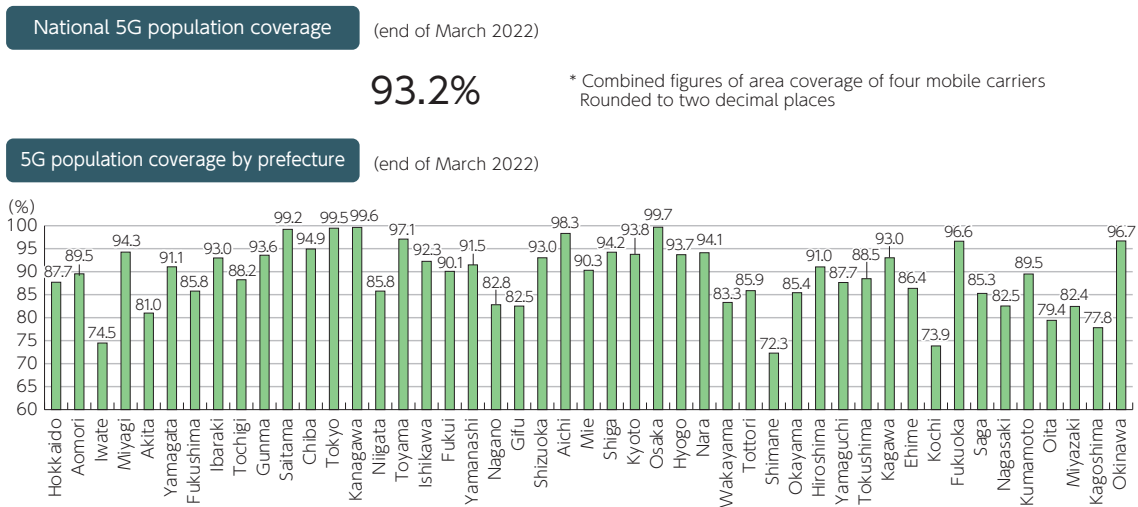


Figure (related data) Percentage of optical fiber in fixed broadband in OECD member countries
 Source: OECD Broadband statistics. 1.10. Percentage of fiber connections in total fixed broadband, June 2022
 URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2023/data_collection.html#f00108
 (Data collection)

As of the end of fiscal 2021, Japan's national 5G population coverage rate was 93.2%, and by prefecture, it ex-

ceeded 70% in all prefectures (Figure 4-2-2-4).

Figure 4-2-2-4 Japan's 5G coverage as percentage of population (as of end of March 2022)



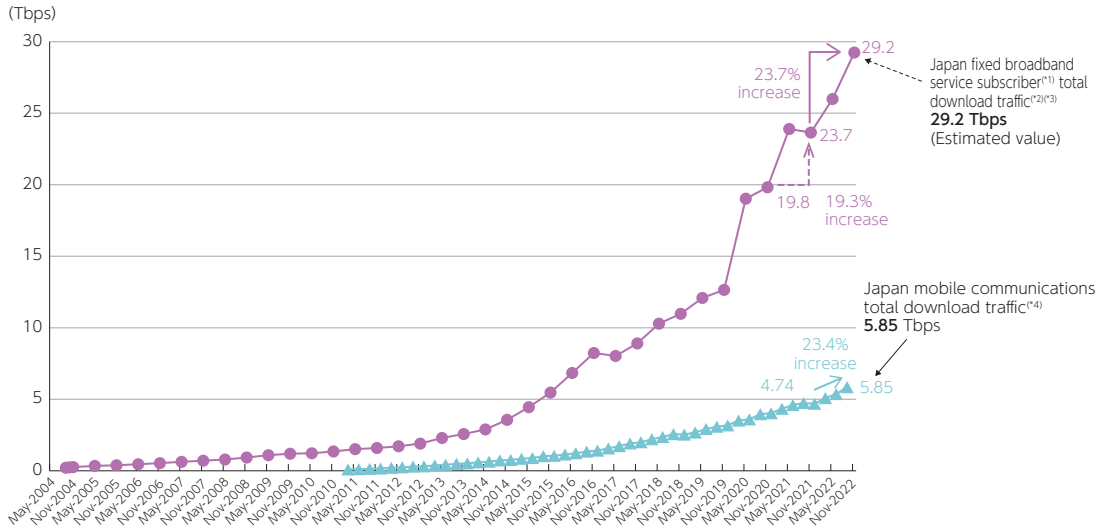
⁸ https://www.soumu.go.jp/menu_news/s-news/01kiban02_02000476.html

(4) State of traffic

Total download traffic for fixed broadband service subscribers in Japan has surged since the start of the COVID-19 pandemic. Since then, although the rate of change has fluctuated, it has generally continued to increase. As of November 2022, it was up 23.7% from the

same month in the previous year. Total download traffic for mobile communications has also continued to increase on the whole, with an increase of 23.4% as of September 2022 compared to the same month of the previous year (Figure 4-2-2-5).

Figure 4-2-2-5 Changes in Internet traffic (fixed systems, mobile systems, download traffic)



*1 Services for individuals (FTTH, DSL, CATV, FWA) (including some corporations)

*2 Prior to May 2011, this also includes some mobile communications traffic to and from mobile phone networks.

3 Since May 2017, the number of cooperating ISPs increased from five to nine, resulting in discontinuities due to aggregated and estimated values based on information from the nine ISPs.

*4 From "MIC Current State of Mobile Communications Traffic in Japan (Sept. 2022)" (measured in March, June, Sept., and Dec.)

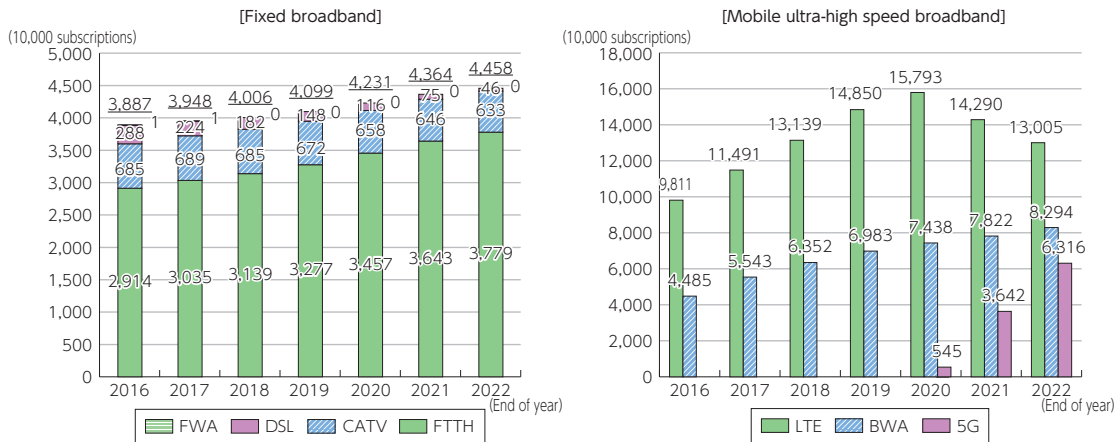
(Source) MIC (2023) "Results of Aggregating Internet Traffic in Japan (for November 2022)"⁹

(5) State of broadband usage

As of the end of December 2022, the number of fixed broadband subscriptions¹⁰ was 44.58 million (up 2.2% from the same period of the previous year), and of the mobile ultrafast broadband subscriptions,¹¹ 130.05 million were 3.9th or 4th generation mobile phones (LTE)

(down 9.0% from the same period of the previous year), 63.16 million were 5th generation mobile phones (up 26.74 million from the same period of the previous year), and 82.94 million were BWAs (up 6.0% from the same period of the previous year) (Figure 4-2-2-6).

Figure 4-2-2-6 Changes in the number of broadband subscriptions



*The figures for the past differ from those published last year due to revisions in business operator reports.

(Source) Prepared based on the MIC "Quarterly data on the number and share of subscriptions to telecommunications services (Fiscal 2022 Q3 (End of December))"¹²

⁹ https://www.soumu.go.jp/main_content/000861552.pdf

¹⁰ The number of fixed-line broadband subscriptions is the sum of the FTTH, CATV (limited to coaxial, HFC), DSL, and FWA subscriptions.

¹¹ This is the number of LTE, BWA, and 5G subscriptions, and does not include 3G or PHS subscriptions.

¹² https://www.soumu.go.jp/menu_news/s-news/01kiban04_02000215.html

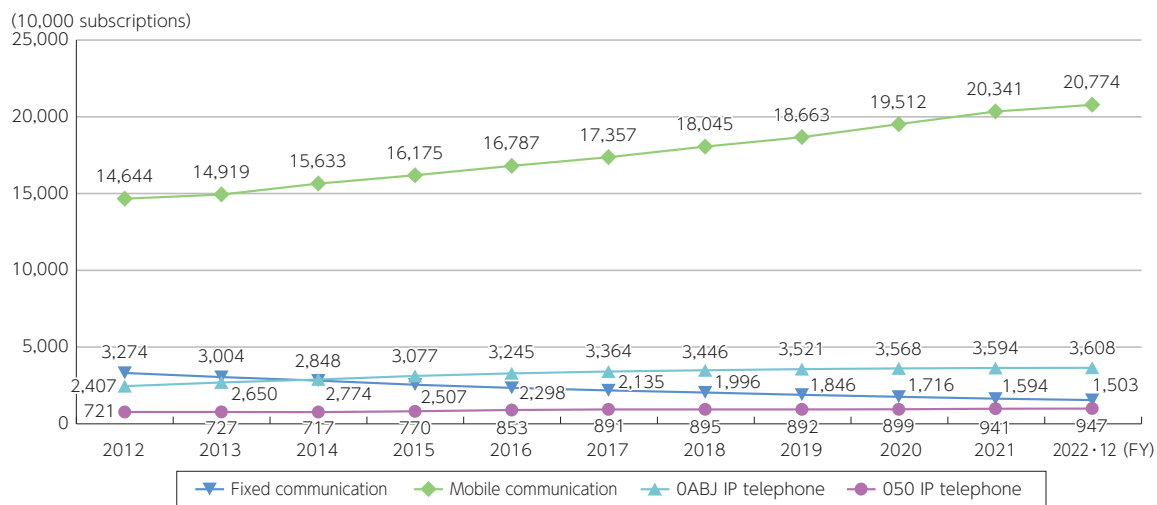
(6) State of the number of subscriptions with voice communications services

In recent years, the number of subscriptions to fixed communications (NTT East/West subscribed telephones (including ISDN), chokushu telephones¹³ and CATV telephones, excluding OABJ type IP phones) has been on a downward trend, while the number of subscriptions to mobile communications (mobile phones, PHS and BWA) and OABJ type IP phones has shown solid growth. As of the end of December 2022, the number of subscriptions to mobile communications was approximately 13.8x that of fixed communications (Figure 4-2-2-7).

As of the end of December 2022, the share of each business operator by number of subscriptions in the mo-

bile communications market was NTT DOCOMO with 36.1% (down 0.5 points from the same period of the previous year, 41.7% when including provision related to MVNOs), KDDI Group with 27.0% (down 0.1 points from the same period of the previous year, 30.4% when including provision related to MVNOs), Softbank with 20.9% (± 0 points, 25.7% when including provision related to MVNOs), Rakuten Mobile with 2.2% (down 0.1 points from the same period of the previous year), and MVNOs with 13.8% (up 0.6 points from the same period of the previous year) (Figure 4-2-2-8).

Figure 4-2-2-7 Changes in the number of subscriptions to voice communications services



*1 For fiscal 2022, data up to the end of December was used, so care must be taken when comparing over time.

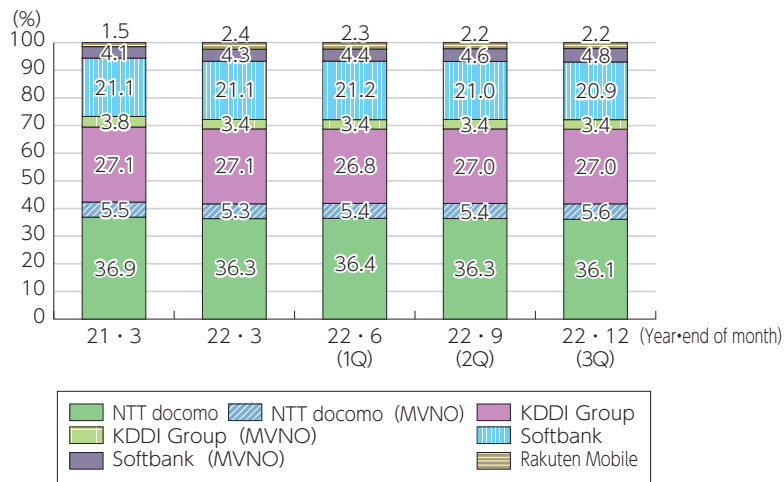
*2 Mobile communications is the sum of mobile phones, PHS, and BWA.

*3 For mobile communications since fiscal 2013, figures are adjusted for intra-group transactions. Adjusted for intragroup transactions means when an MNO receives mobile phone and BWA services as an MVNO from another MNO in the same group and then provides them together with their own services on a single mobile phone, etc., the contracts are counted as one contract instead of two contracts.

(Source) Prepared based on the MIC "Publication of quarterly data on the number and share of subscriptions to telecommunications services (Fiscal 2022 Q3 (End of December))"

¹³ Chokushu telephone is a subscribed telephone service by telecommunications carriers other than NTT East/West and includes choku subscription, choku subscription ISDN, new-type chokushu and new-type chokushu ISDN.

Figure 4-2-2-8 Changes in share of mobile communications subscriptions (adjusted for intra-group transactions) by business operator



- *1 Adjusted for intragroup transactions means when an MNO receives mobile phone and BWA services as an MVNO from another MNO in the same group and then provides them together with their own services on a single mobile phone, etc., the contracts are counted as one contract instead of two contracts.
 - *2 The share of the KDDI Group includes KDDI, Okinawa Cellular and UQ Communications.
 - *3 The share of MVNOs is calculated by MNO group that provides services and is indicated by the supplementary note (MVNO) after the name of the MNO group.
 - *4 Rakuten Mobile's share as an MNO. MVNO services provided by Rakuten Mobile are included in NTT DOCOMO (MVNOs) and KDDI Group (MVNOs).
- (Source) Prepared based on the MIC "Publication of quarterly data on the number and share of subscriptions to telecommunications services (Fiscal 2022 Q3 (End of December))"

(7) International comparison of telecommunications charges

Comparing communications charges in Tokyo (Japan) with New York (U.S.), London (UK), Paris (France), Dusseldorf (Germany) and Seoul (Korea) (total of six cities), as of March 2023, charges for smartphones in Tokyo (4G, business operator with the top MNO share, new contract) are low for plans with a monthly data ca-

capacity of 5 GB and 20 GB, and medium level for plans with a monthly data capacity of 50 GB and 100 GB.

Regarding fixed-telephone charges, the basic rate and local-call rate for three minutes at 12:00 on a weekday are at a medium level.



Figure (related data) International comparison of mobile phone charges by model (fiscal 2022)
 Source: MIC "FY2022 Survey on Domestic-Overseas Price Difference of Telecommunication Service"
 URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2023/data_collection.html#f00126
 (Data collection)



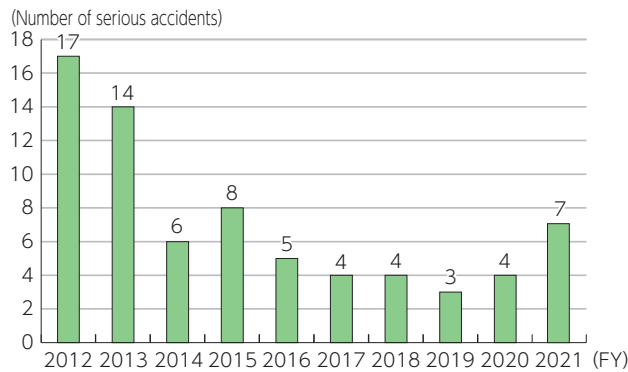
Figure (related data) International comparison of fixed telephone charges based on individual charges (fiscal 2022)
 Source: MIC "FY2022 Survey on Domestic-Overseas Price Difference of Telecommunication Service"
 URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2023/data_collection.html#f00127
 (Data collection)

(8) State of the occurrence of telecommunications service accidents

In fiscal 2021, 6,696 accidents that required quarterly reporting were reported, and of these accidents seven

were serious accidents,¹⁴ with this number on the rise since fiscal 2019 (**Figure 4-2-2-9**).

Figure 4-2-2-9 Changes in the number of serious accidents



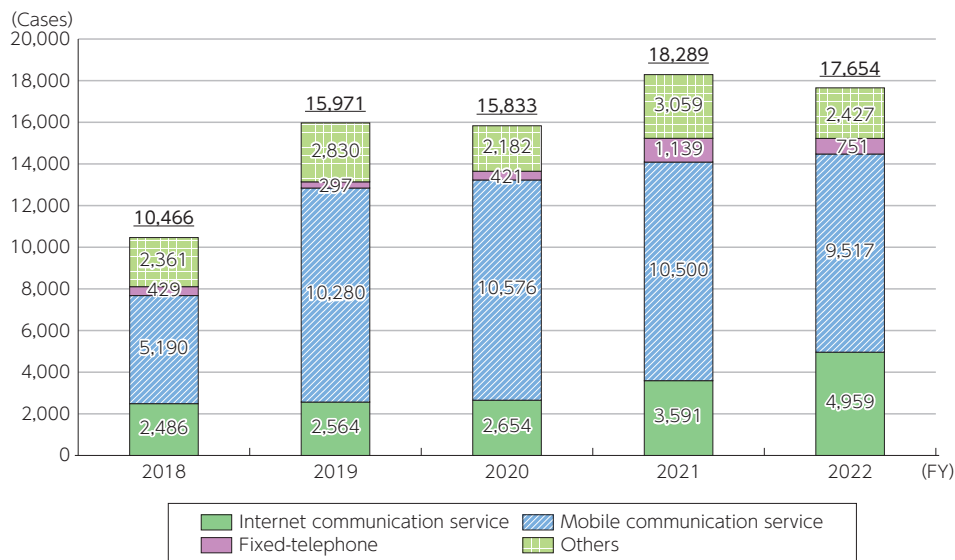
(Source) MIC "Accidents in Telecommunications Services (Fiscal 2021)"¹⁵

(9) Complaints and requests for consultation on telecommunications services, and requests for consultation on illegal and harmful information**a Complaints and requests for consultation on telecommunications services**

The number of complaints and consultations on telecommunications services received by MIC in fiscal 2022 was 17,654, which is a decrease from the previous year (**Figure 4-2-2-10**). In addition, the complaints and

consultations received by consumer centers nationwide and MIC by service were most frequently related to MNO services (**Figure 4-2-2-11**).

Figure 4-2-2-10 Changes in the number of complaints and inquiries received by MIC



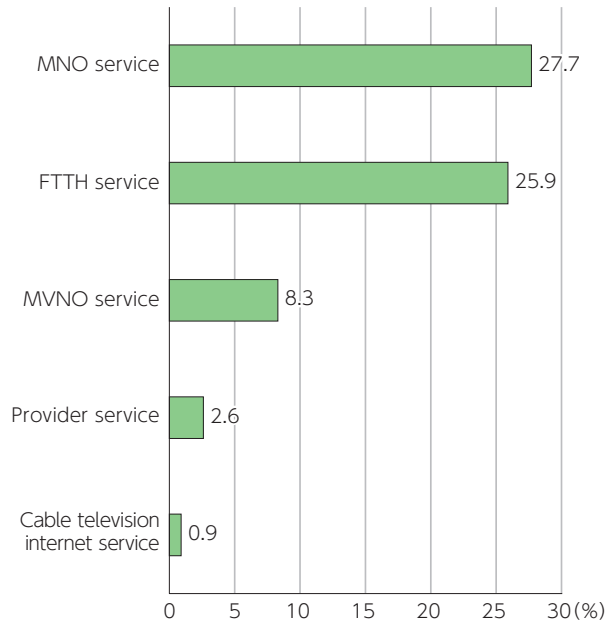
(Source) Created by MIC

¹⁴ Accidents falling under Article 28 of the Telecommunications Business Act "When a serious accident specified by an Ordinance of the Ministry of Internal Affairs and Communications has occurred with respect to telecommunications activities, (the telecommunications carrier) shall report without delay to the Minister for Internal Affairs and Communications to that effect including its reason or cause."

¹⁵ https://www.soumu.go.jp/menu_news/s-news/01kiban05_02000263.html

*Number of reports from business operators. With regard to serious accidents, from fiscal 2008, a decline in the quality of a telecommunications service is also classified as a serious accident, and from fiscal 2015, reporting standards have been set for each category of telecommunications service, rather than uniformly for telecommunications services, so changes from year to year cannot be simply compared.

Figure 4-2-2-11 Breakdown of complaints and consultations received by consumer centers nationwide and the Ministry of Internal Affairs and Communications (random sample of those received between April 2022 and September 2022)



*There is a possibility that ISP services provided together with FTTH lines are only included in provider services.

(Source) MIC "Regular Meeting for Monitoring Consumer Protection Rules and ICT Service Reliability (14th meeting)"

b Requests for consultation on illegal and harmful information, etc.

The number of consultations received by the Illegal and Harmful Information Consultation Center (Illegal Harmful Hotline) operated by the Ministry of Internal Affairs and Communications, continues to remain high,

with 5,745 consultations in fiscal 2022. (Figure 4-2-2-12). In fiscal 2022, the five business operators that were the source of most consultations were Twitter, Google, Meta, 5 Channel, and Bakusai (Figure 4-2-2-13).

Figure 4-2-2-12 Changes in the number of consultations regarding illegal and harmful information

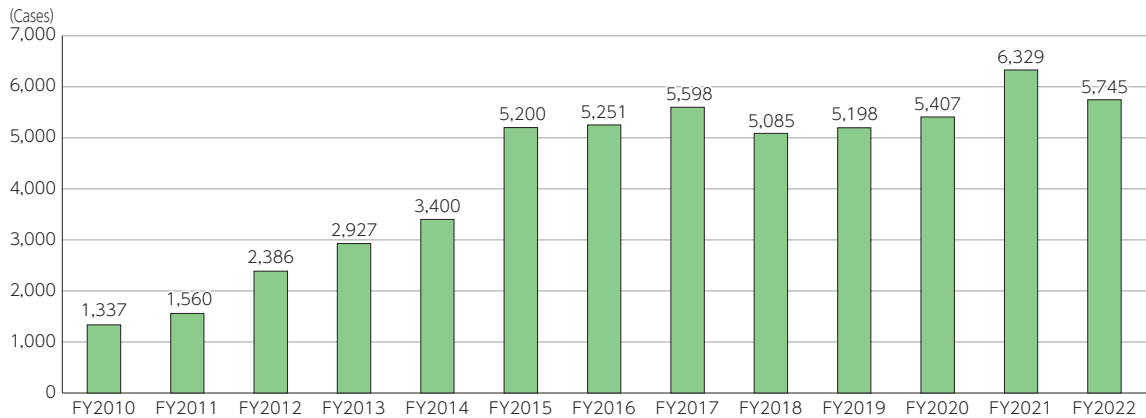
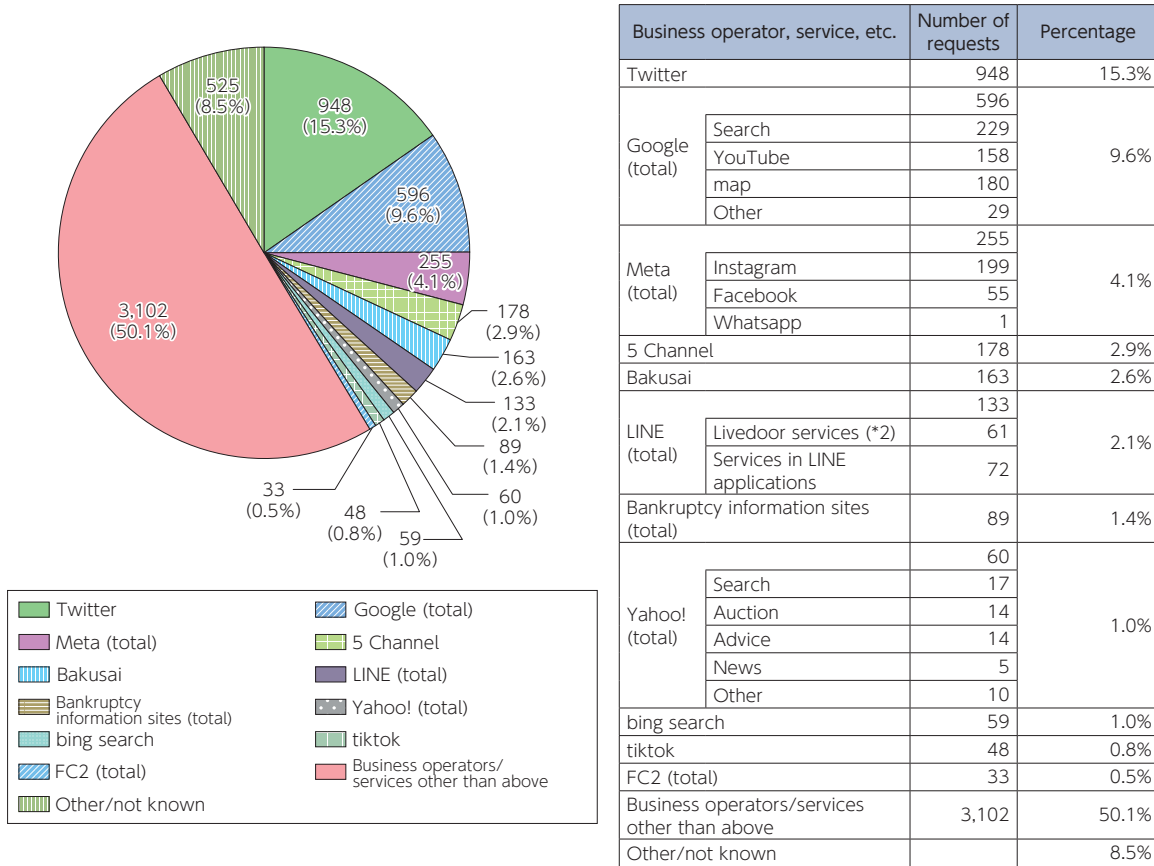


Figure 4-2-2-13 Breakdown of the number of consultations provided at the Illegal Harmful Hotline by business operator



*1 Breakdown of the number of consultations (work): By business operator/service (n=6,189) <fiscal 2022> *Number of consultations (work): 5,745 cases
 *2 LINE sold the livedoor service on December 27, 2022, so responses from January 2023 are not included.
 *3 Total number of consultations (work), and counseling centers do not determine whether or not individual consultations constitute a violation of rights.
 *4 Since data is compiled by entering a representative domain for each work case, it is not strictly compiled statistical information because there are cases where an applicable domain covers multiple sites.
 *5 Some use their own domains, so the actual domain may not be known.

3. New trends in the communications field

(1) Virtualization

Virtualization is a technology that integrates and reproduces multiple pieces of hardware (servers, OSs, CPUs, memory, networks, etc.) in software to enable the use of hardware of any specifications without being bound by physical limitations. Depending on the hardware to be virtualized, various virtualization solutions are offered, including server virtualization, desktop virtualization, storage virtualization, and network virtualization.

Against the backdrop of the rise of cloud services, the growing adoption of network virtualization and automation, and the strategic initiatives of major companies, advances in network virtualization technology are accelerat-

ing globally. In Japan, too, it has become an established method for constructing and operating infrastructure in data centers, and is experiencing a gradual growth trend due to the growing need for faster and more efficient network construction and operation within corporate LANs.

In 2021, Japan's client virtualization solution (on-premises) market size (sales) was approximately 621.5 billion yen (down 1.9% from the previous year), showing negative growth for the second consecutive year. By vendor, Fujitsu, Hitachi, NEC, Itochu Techno Solutions (CTC), Kindryl Japan, NTT Data, and Hewlett-Packard Japan were the top vendors in that order.



Figure (related data) Market revenue share of domestic client virtualization solutions (on-premises) by vendor sales (2021)

Source: IDC "Japan Virtual Client Computing Market Share" (July 6, 2022)

URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2023/data_collection.html#f00136
(Data collection)

(2) Open-RAN

Regarding the radio access networks (RAN) of telecommunications carriers, initiatives to update the configuration of network equipment, such as to Open RAN¹⁶ that enables multiple vendors, are underway in various countries. According to GSMA Intelligence, as of 2023 there were 18 telecommunications carriers commercially deploying Open RAN, but more than 80 telecommunications carriers have expressed interest or announced plans to deploy a solution.¹⁷

For example, Dish Network in the U.S. is building a cloud-native Open RAN-based 5G SA network that achieved 20% population coverage as of June 2022.

In Europe, five of the largest telecommunications carriers (Deutsche Telekom, Orange, Telefonica, Vodafone, Telecom Italia Mobile) are co-promoting Open RAN, saying they will support the development of Open RAN technology to enable deployment in populated areas.¹⁸ Vodafone also launched Europe's first commercial Open RAN in a populated area in the UK in May 2023.¹⁹

In December 2022 in Japan, NTT DOCOMO, KDDI, SoftBank, and Rakuten Mobile established Japan OTIC (Open Testing & Integration Centre) in Yokosuka City as a center for testing and certification based on the standards stipulated by the O-RAN ALLIANCE. The OTICs that have so far been established in countries in Europe and elsewhere, is led by one major telecom operator and is believed to be the first in the world to be jointly established and operated by multiple telecommunications carriers.²⁰ In January 2023, KDDI began commercial deployment of O-RAN-compliant 5G virtual base stations using Fujitsu wireless equipment and Samsung Electronics wireless controllers.²¹ NTT DOCOMO launched the OREX brand in February 2023 and announced that it will work with global communications device vendors to strengthen its support system for global telecommunications carriers to implement Open RAN.²² In addition, Rakuten Symphony, a subsidiary of Rakuten, is also engaged in external sales of Open RAN, with sales of \$476 million in fiscal 2022.²³

¹⁶ Open Radio Access Network. Mobile Front Haul that is interface between Distributed Unit (DU) and Radio Unit (RU) is standardized as O-RAN Front Haul by the O-RAN Alliance. The standardization is expected to facilitate provision of communications network equipment by various vendors and at the same time facilitate area building and lower equipment procurement costs.

¹⁷ GSMA [Industry moves to execute on open RAN potential]

<https://www.gsma.com/futurenetworks/latest-news/industry-moves-to-execute-on-open-ran-potential/>

¹⁸ "Major European operators accelerate progress on Open RAN maturity, security and energy efficiency"

<https://newsroom.orange.com/major-european-operators-accelerate-progress-on-open-ran-maturity-security-and-energy-efficiency/?lang=en>

¹⁹ Vodafone "Vodafone's first Open RAN sites deliver better connectivity in busy seaside towns"

<https://www.vodafone.com/news/technology/vodafone-first-open-ran-sites-better-connectivity-busy-seaside-towns>

²⁰ Yokosuka City Website

https://www.city.yokosuka.kanagawa.jp/4430/documents/20221220_japan-otic.pdf

²¹ KDDI news release <https://news.kddi.com/kddi/corporate/newsrelease/2023/01/24/6508.html>

²² NTT DOCOMO news release

https://www.docomo.ne.jp/binary/pdf/info/news_release/topics_230227_00.pdf

NTT DOCOMO now provides Open RAN support for overseas telecommunications carriers to five companies: KT in Korea, DISH Wireless in the U.S., Singtel in Singapore, and Smart Communications and Vodafone Group in the UK.

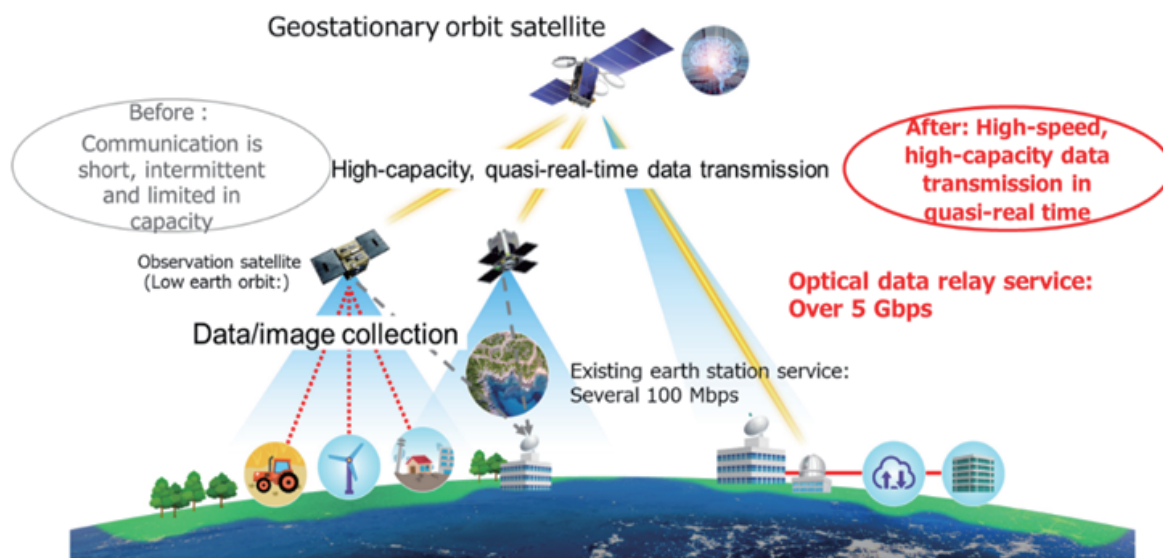
²³ Rakuten Group financial results <https://corp.rakuten.co.jp/investors/documents/results/2022.html>

a Non-terrestrial network (NTN)

The construction of a non-terrestrial network (NTN) is intended to expand communications coverage to seamlessly connect land, sea and air. For example, in August 2022, T-Mobile in the U.S. announced plans to allocate a portion of its mid-band frequency band allocated to mobile phones to communication with SpaceX's Starlink satellite, which will be launched in 2023, to enable communication with remote areas that are currently outside the service area, and a beta version of the new service is expected to be available as early as 2023. In Japan, Space Compass, Inc., which was established by NTT and SKY Perfect JSAT Corporation, plans to launch an optical data relay service in fiscal 2024 that enables large-capacity, near-real-time data transmission by transmit-

ting a vast amount of data collected in space by observation satellites to the ground via geostationary orbit satellites (Figure 4-2-3-1). In addition, Japan Radio Co., Ltd., SKY Perfect JSAT Corporation, the Graduate School of Engineering of the University of Tokyo, and the National Institute of Information and Communications Technology, in cooperation with the European Space Agency (ESA), Eurescom, and the Fraunhofer FOKUS Institute, conducted the first Japan-Europe joint experiment on satellite 5G integrated control including geostationary satellite links in Japan from January to February 2022, and succeeded in transmitting 5G control signals, 4K images, and IoT data over long-distance 5G networks between Japan and Europe.

Figure 4-2-3-1 Overview of optical data relay service



(Source) Nippon Telegraph and Telephone Corporation "NTT and SKY Perfect JSAT Corporation agree to establish Space Compass, Inc."