Chapter 1

5G Infrastructure for the Reiwa Era

Chapter 1 provides an overview of 5G and traces the course of 5G deployment in Japan. The chapter also looks ahead to the structural changes in the ICT industry that the launch of 5G will bring.

Section 1 Mobile Communication Systems Generating New Value

Mobile communication systems in Japan have made tremendous advances and developments over more than 40 years since the first systems were commercialized in 1979. 5G commercial services started in March 2020, about 10 years after the first commercial fourth-generation (4G) mobile communication systems. 5G, because of its characteristics, is expected to be the platform in the era of the Internet of Things (IoT), in which all things are connected via the Internet. As such, 5G is expected to be widely used in people's lives and in company activities. This section traces the evolution of mobile communication systems and provides an overview of the basic 5G concepts and the technologies deployed to realize those concepts.

1. Data on the proliferation of mobile communications

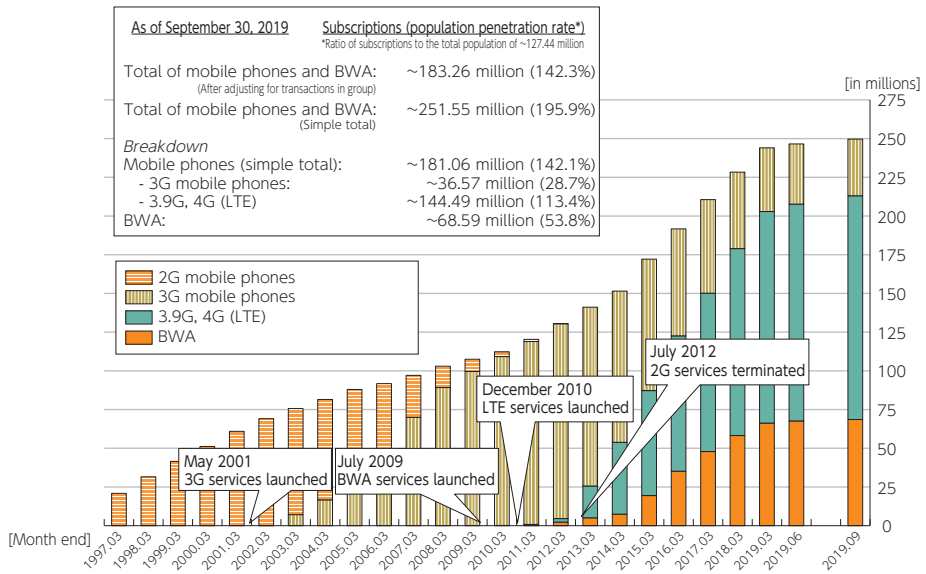
a. Subscriptions to mobile communication systems

1996 marked an inflection point when the number of subscriptions to fixed-line telephones (subscriber telephones) began to fall. Mobile phone subscriptions, on the other hand, soared after reforms of the systems (introduction of handset sold-out system and the abolishment of the fee-approval system), and in 2000 they overtook subscriptions to fixed-line telephones (subscriber telephones). Mobile phone subscriptions have continued to climb, reaching over 180 million as of September 30, 2019 — a population penetration rate of 142 percent (Figure 1-1-1-1).

b. State of mobile communication traffic

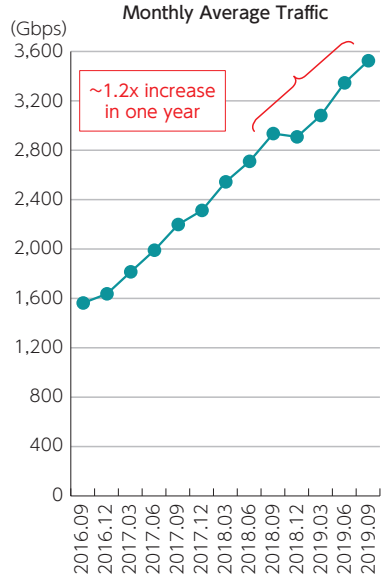
The monthly average mobile communication traffic across Japan at the end of September 2019 was 3529.8 Gbps, about a 2.3-times increase compared to traffic three years previously (September 2016). Traffic has jumped by about 1.2 times in the most recent year (Figure 1-1-1-2). Mobile carriers' provision of fee plans adjusted for the use of larger content after the 4G rollout is thought to have been a factor in creating conditions for users to more easily consume larger content.

Figure 1-1-1-1 Changes in the number of communication service subscriptions



Source: Prepared based on "Quarterly Data on the Number of Telecommunications Service Subscriptions and Market Share (FY 2019 Q2) (end of September)", MIC Official Announcement (2019) and the Basic Resident Register

Figure 1-1-1-2 Changes in mobile communication traffic



Source: "Current State of Mobile Communication Traffic in Japan (September 2019)", MIC

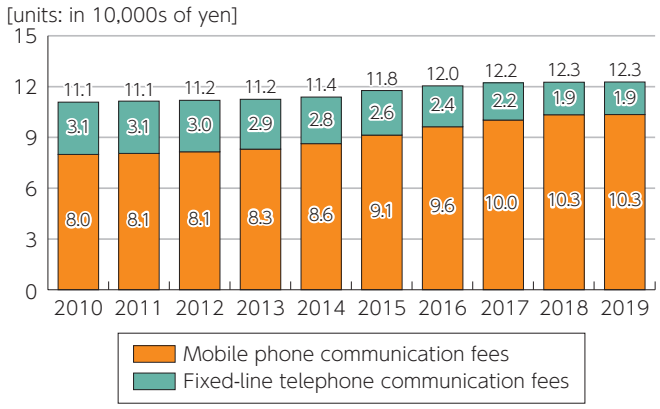
c. Household spending on mobile communications

Household spending on telephone communication fees[1] in 2019 was 122,741 yen, a 10.8 percent increase from 2010. Mobile phone communication fees made up 103,466 yen of this total in 2019, a 29.5 percent increase from 2010 (Figure 1-1-1-3). Mobile phone communication fees accounted for 3.45 percent of all household expenditures in 2019, up from 2.64 percent in 2010 (Figure 1-1-1-4).

d. Expansion of mobile Internet use

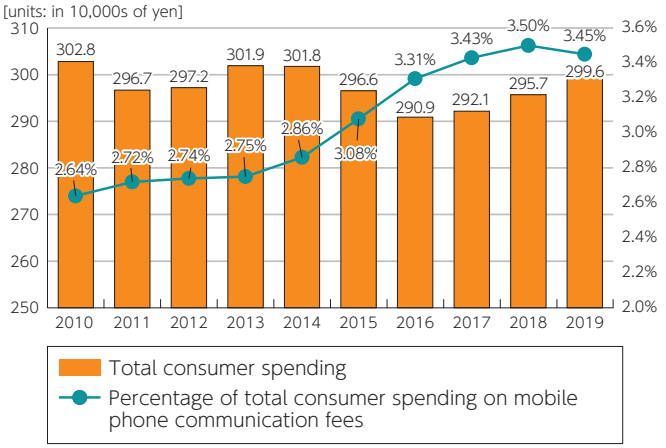
The percentage of users connecting to the Internet from mobile devices has skyrocketed since Internet access services for mobile phones were first provided in 1997. In 2010, the number of users who access the Internet from mobile devices surpassed those who access from computers for the first time in Japan. Since 2011 when mobile-device data were first collected separately for mobile phones (feature phones) and smartphones, the smartphone Internet usage rate has climbed while, conversely, the mobile phone Internet usage rate has dropped (Figure 1-1-1-5).

Figure 1-1-1-3 Changes in telephone communication fees



Source: Prepared based on each year's "Family Income & Expenditure Survey (all households)", MIC

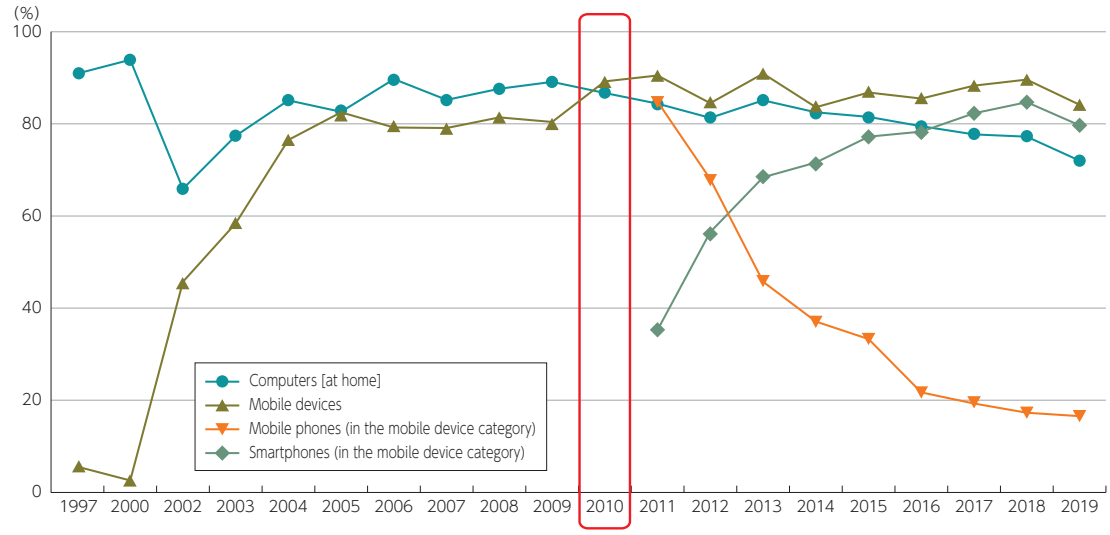
Figure 1-1-1-4 Changes in the percentage of total consumer spending on mobile phone communication fees



Source: Prepared based on each year's "Family Income & Expenditure Survey (all households)", MIC

[1] Telephone communication fees are the total of fixed-line telephone communication fees and mobile phone communication fees.

Figure 1-1-1-5 Internet usage rates[2] by device



Note: Mobile devices refers to mobile phones, PHS handsets, and smartphones.

Source: Prepared based on each year's "Communications Usage Trend Survey", MIC

2. Evolution of mobile communication systems

(1) Generational changes happen in approximately 10-year cycles

Mobile communication systems in Japan have seen a change of generations on roughly a 10-year cycle, from the first-generation services that began in 1979 to the fifth generation that launched this year. The performance of mobile communication systems has gotten better with each generational change, leading to the following dramatic improvements in user convenience: (1) higher communications quality; (2) faster and larger capacity communications; (3) service diversification; (4) cheaper communication fees; and (5) expanded usage scope.

(2) New value generated by the evolution of mobile communication systems

1G was limited to voice communications. The highest value of 1G was primarily for the ability of business professionals to make calls while out of the office. The digital transmission methodology introduced for 2G not only improved call quality; it allowed for data communications such as email and Internet surfing via a web browser. Use of 1G was rather limited, but 2G mobile communication systems grew quickly and became established as a parallel infrastructure with fixed-line communications.

Once 3G was rolled out, the growth of mobile phones skyrocketed and an ecosystem was formed around mobile phones as various mobile phone services appeared. This kicked off the "industrialization of wireless". Most 3G handsets in Japan were SIM-locked and sold as a package with the mobile carrier subscription. Mobile carriers also served as fee-collection agents for Internet access services on mobile phones. This created an ecosystem led by mobile carriers that built ties with handset makers and content providers.

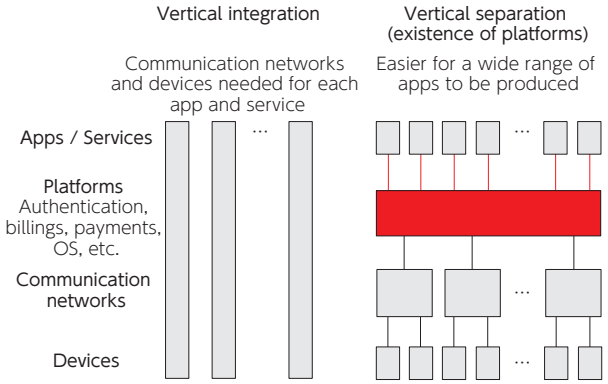
The arrival of the iPhone 3G in 2008 completely transformed the structure of this ecosystem. With the release of Android by Google the following year, mechanisms were in place that enabled third parties to develop and deliver smartphone services as apps. This let Apple, Google, and others that supplied smartphone operating systems carve out positions as platformers. The existence of platforms meant app providers had much lower barriers to mobile business entry because they only had to ensure connectivity with the platform. As a result, a huge range of apps were developed and distributed (Figure 1-1-2-1).

The smartphone itself revolutionized the mobile interface, which quickly gained support from users. Moreover, the smartphone shifted ecosystem leadership from mobile carriers to digital platformers. And as mobile communication systems advanced from 3G to 4G, the ecosystem further evolved as an ICT industry, with digital platformers at the center and encompassing mobile carriers, device makers, and providers of content and apps on the platforms. This led to the development and provision of apps and services that went beyond music, videos, games, and other forms of entertainment and became rooted in users' lives. In this way, mobile communication systems transformed from simple communications infrastructure to infrastructure supporting users' livelihoods.

As mobile communication systems advanced from 1G to 3G, the main application of mobile phones gradually shifted from voice communications to data communications. Nevertheless, the primary functional value of mo-

[2] Non-responses have been added to the parameters in the usage rate calculation. Caution must be exercised when comparing the 2019 survey with previous years' surveys because the tabulation methods are different and because the rate of non-responses is high. Therefore, excluding non-responses gives the usage rates of 80.5 percent for computers, 94.0 percent for mobile devices, 18.8 percent for mobile phones, and 89.0 percent for smartphones.

Figure 1-1-2-1 Comparison of vertical integration and separation (existence of platforms)

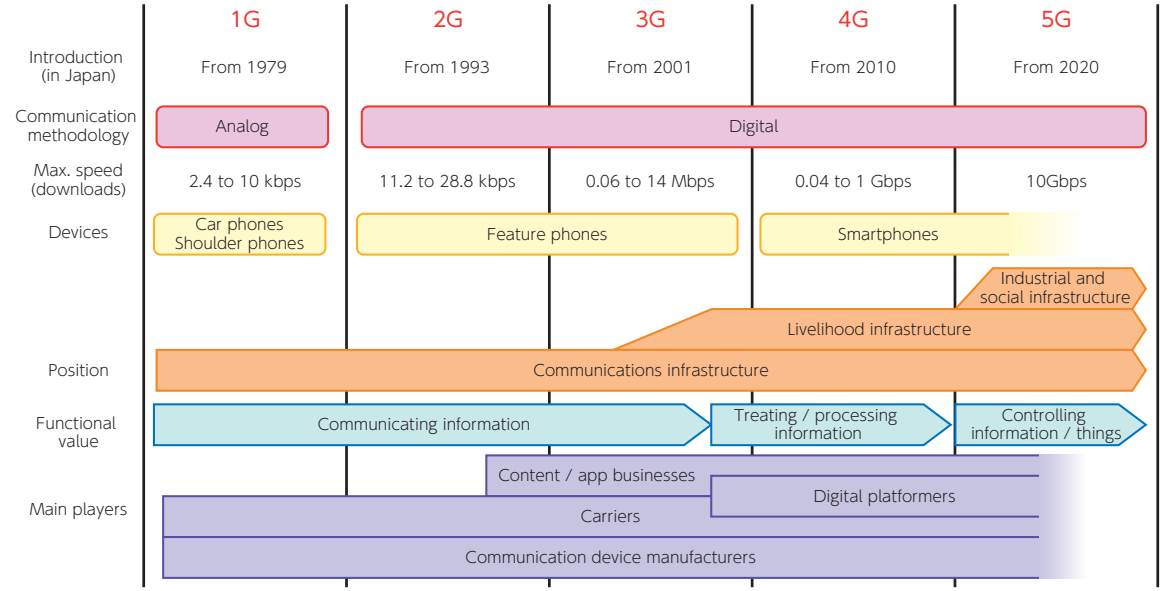


Source: "2017 White Paper on Information and Communications in Japan"

bile communication systems as feature phones were used for "communicating information". The entry of smartphones, however, boosted the performance of handsets to rival that of computers. This transformed the functional value of mobile communication systems to "treating or processing information to add new value", in addition to communicating information.

At the same time, industries outside the ICT industry began studies to improve productivity, using smartphones and other wireless technologies in earnest for the social implementation of wireless technologies in combination with the cloud, big data, the IoT, AI, VR / AR, and various other technologies. It was a time when the first inklings of the "wireless-ization of industry", the next step in the "industrialization of wireless", appeared (Figure 1-1-2-2).

Figure 1-1-2-2 Evolution of mobile communication systems



Note: In this figure, 3G includes 3.5G and 4G includes 3.9G.

Source: Prepared from MIC materials

3. Emergence of 5G

(1) Usage Scenario and Key Capabilities of 5G

5G, featuring ultra-high-speed communications, is a natural extension of mobile wireless technology's progress all the way through to 4G. But 5G is also a next-generation mobile communication system with new functions such as ultra-low latency communications and multiple simultaneous connections that had not existed in the 4G era. Consequently, 5G promises to be more than a tool for communications between people as in the past; it is expected to become the ICT infrastructure for the IoT age, when everything around us is connected to networks.

Furthermore, the implementation of 5G in a variety of industries and economic sectors is hoped to have a greater social impact than previous mobile communication systems in terms of making business operations more efficient and generating new services.

(2) 5G as a Communications Technology in support of the IoT

On the other hand, although IoT devices and related

applications are seeing explosive growth in numbers, they have a myriad of use cases and widely varying communication traits. This is especially true of wireless IoT devices, which have many constraints such as power consumption and unique radio-signal properties. Addressing all these needs with a single communications technology or standard is impossible. Quite a few communications technologies and standards have been conceived and developed in recent years to meet these divergent needs, and 5G is one of them. As different industries and economic sectors move ahead with digitalization, it will be important to combine and use 5G aptly with other technologies to fulfil different objectives and applications.

Section 2 5G Implementation and Deployment

This section describes the measures taken prior to the launch of 5G services and the measures taken to deploy and expand 5G further after service rollout.

1. International standardization activities

ITU and 3GPP began full-fledged standardization activities around 2015 to implement 5G by 2020. ITU approved Recommendation M.2083 "IMT Vision" in September 2015.

3GPP has examined and standardized specifications for mobile communication systems since 3G. For Release 14, announced in June 2017, 3GPP carried out preliminary examinations of 5G requirements, deployment scenarios, and core technologies. For Release 15, announced in June 2018, it established initial 5G specifications for ultra-high speeds (enhanced Mobile Broadband (eMBB)) and ultra-low latency (Ultra-Reliable and Low Latency Communications (URLLC)). Release 16 established specifications for all technical performance requirements, including multiple simultaneous connections (massive Machine Type Communications (mMTC)).

As international standardization activities moved forward, leading countries and regions set up 5G promotion organizations through industry-academic-government partnerships. Japan set up the Fifth Generation Mobile Communications Promotion Forum (5GMF) in September 2014. Ahead of 5G's implementation, 5GMF compiled core technologies and requirements, promoted R&D, shared information with other 5G promotion organizations and strengthened international cooperation, ran demonstration experiments, and carried out other initiatives.

2. 5G implementation initiatives

While monitoring international standardization, MIC moved ahead with initiatives for 5G implementation in Japan. The initiatives included research and development into essential core technologies, demonstration experiments to generate new markets, and establishing specific 5G frequencies and setting technical conditions. The following segments describe the details of each initiative.

(1) 5G R&D

MIC conducted R&D into core technologies essential to 5G implementation from FY 2015 through FY 2018. R&D projects started in FY 2015 and worked toward establishing technologies to achieve the huge wireless communication capacity increases needed for 5G, the massive speed increases required to implement an array of applications, the construction of low-power mobile communication systems, and the highly efficient radio spectrum usage necessary to optimize the use of multiple private networks and multiple mobile communication networks.

Starting from FY 2016, MIC carried out R&D into high-efficiency communication methodologies for mobile phone networks anticipated to accommodate huge numbers of 5G devices. Envisioning heterogeneous 5G network environments, the ministry conducted R&D to ensure interconnectivity between networks of different parties in a form that allows flexible and appropriate handling of various frequencies and wireless access technologies.

(2) Comprehensive 5G demonstration trials

It is pointed out that establishing 5G businesses after 5G's commercial rollout requires new business approaches that differ from the conventional mobile industry approaches. Under 4G, carriers and other companies primarily relied on BtoC models that provided wide variety of services to ordinary users. With 5G however, carriers and other companies are expected to provide services under B2B2X models in collaboration with vertical industries[3] and other partner firms. The key to new business success will be who to partner with and what business models to construct. For this reason, carriers and other companies have been joining up with companies in various industries in pursuit of initiatives to pioneer 5G use cases.

MIC has been conducting comprehensive 5G demonstration trials, with the participation of stakeholders from various 5G application sectors since FY 2017 to

[3] Vertical industries refer to specific industries in which the same type of products and services are developed by the same method and sold in markets.

help develop new markets through 5G implementation. In January 2019, MIC held the "5G Utilization Idea Contest" for the demonstration of various 5G application ideas focusing on using 5G to realize comprehensive solutions to regional issues. The contest attracted 785 submissions of 5G application ideas conceived by local communities around the country. The ministry selected a large number of outstanding ideas that will help solve regional issues and incorporated the ideas submitted through the contest as part of the comprehensive 5G demonstration trials for FY 2019.

(3) Approval of specified base station establishment plans

MIC adopted a system for mobile phone base stations and other radio stations (specified base stations) that must be established in considerable numbers by the same carrier. Under the system, MIC first accepts applications for approval of specified base station establishment plans (development plans) from carriers prior to granting radio station licenses and only carriers approved by the Minister for Internal Affairs and Communications can apply for licenses (Figure 1-2-2-1).

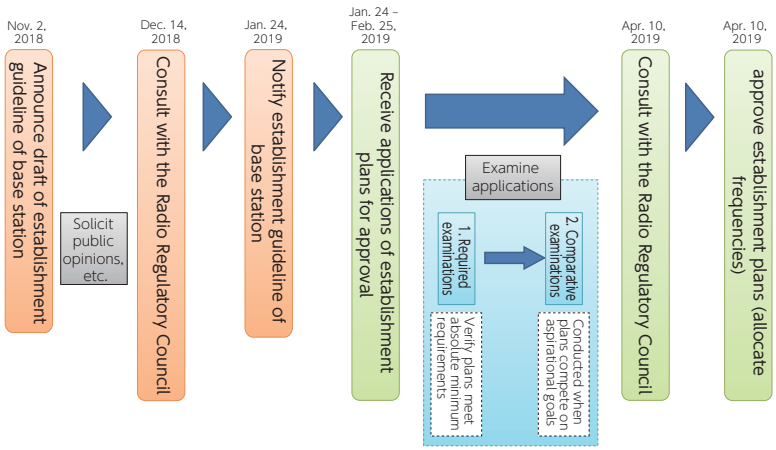
Unlike 4G and earlier mobile communication systems, 5G is expected to cover both people and things and to be used to solve social issues and for local creation. When formulating the examination criteria for 5G, it was deemed important to establish indicators to evaluate a carrier's ability to deploy flexibly in locations where business deployment is feasible, regardless of whether the area is urban or rural, and to evaluate the early deployment into regional areas.

Accordingly, the 5G infrastructure deployment rate (calculated, after dividing the entire country into square 10-kilometer blocks, from the number of blocks where an advanced specified 5G base station will be established within five years) was adopted as an evaluation indicator of 5G establishment plans in place of the population coverage rate, which had been used in examinations of 4G and earlier mobile communication systems. Other considerations included are the schedule for launching services in all prefectures, the number of specified base stations to be established nationwide, and plans for 5G use and application.

Four companies — NTT Docomo, KDDI / Okinawa Cellular Telephone, SoftBank, and Rakuten Mobile — submitted applications for establishment plan approval by the February 25 deadline. After the submitted plans were examined, it was decided to assign two blocks each to NTT Docomo and KDDI / Okinawa Cellular Telephone and one block each to SoftBank and Rakuten Mobile in the 3.7 GHz band and 4.5 GHz band. It was also decided to assign one block each to the four companies in the 28 GHz band. The Radio Regulatory Council was consulted on the decisions on April 10 and the establishment plans were approved (Figure 1-2-2-2).

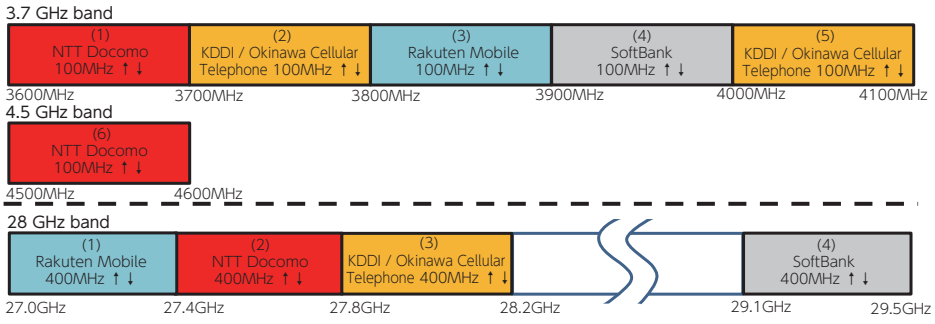
The establishment plan approvals attached nine con-

Figure 1-2-2-1 5G frequency allocation procedure for mobile carriers



Source: Prepared from MIC materials

Figure 1-2-2-2 Assignment results



Source: Prepared from MIC materials

ditions to all four companies. These included ensuring the extensive and sound expansion of diverse services that take advantage of 5G's merits, improving the safety and reliability of telecommunications equipment, implementing adequate cybersecurity measures including measures against supply chain risks, and conducting amicable negotiations with MVNOs. Separate conditions were attached to individual companies.

3. Initiatives to deploy and expand 5G

After the specified base station establishment plans were approved and the carriers to provide 5G services were determined, the approved carriers moved ahead with development of base stations and other build-outs to launch services on schedule as detailed in their establishment plans. They also made preparations including pre-services, which combined tests that their systems worked in real-world conditions with publicity and PR about 5G services to users.

Since commercial services launched in the spring of 2020, the carriers have been moving ahead with area expansion as detailed in their respective establishment plans.

In parallel with this, MIC is pressing ahead with examinations of next-stage 5G frequency allocations. The ministry is pursuing other programs to deploy and expand 5G. These programs include technical examinations and systemization work for Local 5G, described later, and R&D into deploying and expanding 5G and further advancing 5G.

(1) Launch of 5G services in Japan

a. Pre-services

Prior to the full-scale commercial rollout of 5G, mobile carriers provided pre-services, along with tests of systems in actual locations, starting in the summer of 2019. The pre-services concentrated on transmitting real-time high-definition (4K and other resolutions) video and providing multi-angle viewing experiences in the sports and entertainment fields, which showcased the advantages of 5G — ultra-high speeds, large capacity, and ultra-low latency.

b. Launch of commercial services

NTT Docomo, KDDI, and SoftBank began rolling out commercial 5G services in March 2020. Rakuten Mobile had planned on launching commercial services in June, but the company announced the launch would be postponed until September.

c. Future area expansion

There were two absolute criteria used in the establishment plan examinations, as described above: achieve a 5G infrastructure deployment rate of over 50 percent within five years; and start operating advanced specified 5G base stations in all prefectures within two years. Figure 1-2-3-1 summarizes the 5G infrastructure deployment rates to be achieved after five years stated in the establishment plans submitted by each applicant to the Minister for Internal Affairs and Communications.

The carriers are now proceeding with the establishment of specified 5G base stations following their submitted plans. The total 5G infrastructure deployment rate, when combining all four plans, is projected to be 98.0 percent. Thus, 5G infrastructure is planned to be deployed in nearly all areas where business is feasible across Japan.

(2) Creation of tax incentives to promote 5G investment

Mobile carriers have to establish more base stations to provide 5G services because 5G uses higher frequency bands than 4G. The four mobile carriers' establishment plans, however, concentrate the establishment of 5G base stations in the final two years (FY 2022 and FY 2023) of the five-year authorization term and call for establishing relatively few base stations in FY 2020 and FY 2021. Now that 5G services have already started in some countries, there is tremendous pressure to build out 5G rapidly throughout the country, given that 5G, as a key infrastructure of the 21st century, will solve social issues, boost productivity, and strengthen international competitiveness in many fields. Consequently, in FY

Figure 1-2-3-1 Summary of mobile carriers' establishment plans

Applicants	NTT Docomo	KDDI / Okinawa Cellular Telephone	SoftBank	Rakuten Mobile
Capital investments in specified base stations and related equipment (Total ~1.7 trillion yen)	~795 billion yen	~466.7 billion yen	~206.1 billion yen	~194.6 billion yen
5G infrastructure deployment rate (Note: Deployment rate of advanced specified base stations (primary stations))	97.0% (nationwide)	93.2% (nationwide)	64.0% (nationwide)	56.1% (nationwide)
No. of specified base stations (Note: Excludes base stations installed indoors)				
(1) 3.7 GHz and 4.5 GHz bands	8,001	30,107	7,355	15,787
(2) 28 GHz band	5,001	12,756	3,855	7,948

Note: Capital investment amounts, 5G infrastructure deployment rates, and numbers of specified base stations are the planned after five years of the date of approval.

Source: Prepared from MIC materials

2020, the tax system was amended and the necessary legislation was arranged to provide tax incentives for 5G investments. The objective of the tax incentives is to assist the early nationwide deployment and smooth adoption of ICT infrastructure needed to provide 5G services.

a. Details of the tax incentives

The salient issue is to urge mobile carriers to invest in and deploy 5G-related equipment and facilities with assured security and reliability as well as to account for supply chain risks. Accordingly, based on the provisions of the Act on Promotion of Developing/Supplying and Introducing Systems Making Use of Specified Advanced Information and Communications Technologies, described later, investments in certain equipment and facilities installed in accordance with authorized installation plans are eligible to receive special tax relief measures limited to a two-year period (FY 2020 and FY 2021).

Figure 1-2-3-2 illustrates the specific tax relief measures that apply to nationwide carriers and Local 5G licensees with regard to equipment and facility investments based on installation plans for systems making use of specified advanced information and communications technologies that have been authorized by the competent Minister.

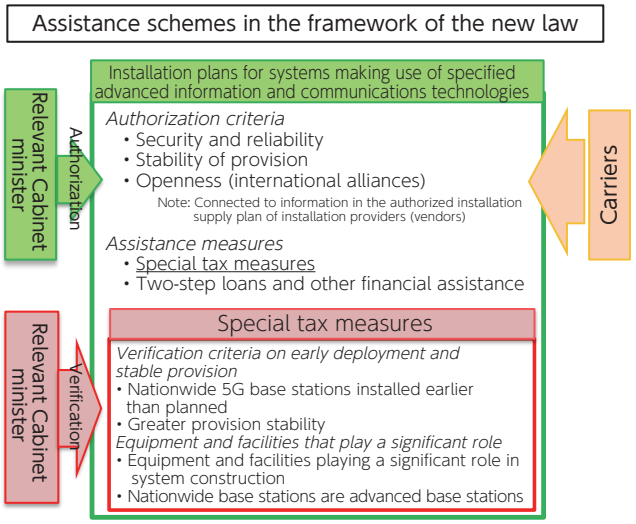
b. Establishment of the Act on Promotion of Developing/Supplying and Introducing Systems Making Use of Specified Advanced Information and Communications Technologies

Accompanying the rapid progress of digital technologies and changes in the international economic landscape around our country, there is an increasing necessity to develop, provide, and deploy systems making use of specified advanced information and communications technologies — i.e., 5G and drones. These systems are essential social infrastructure to realize Society 5.0, but they must be developed, provided, and deployed appropriately and with assurance of cybersecurity and other concerns. It was decided on this reason, and based on the need to construct industrial infrastructure in Japan, to establish a new basic law and take various steps based on the provisions of the law.

The act clarifies the establishment of policies to promote the development, provision, and deployment of systems making use of specified advanced information and communications technologies in the country. It also sets out the creation of authorization systems for development and provision plans and installation plans pertaining to systems making use of specified advanced information and communications technologies. The act stipulates that plan authorizations are to be based on the criteria of security and reliability, stability of provision, and openness. The act also lets businesses developing and providing such systems and businesses deploying systems that have received authorization from the relevant Cabinet minister receive tax incentives to promote 5G investment (limited to businesses deploying systems) and financial assistance.[4]

Figure 1-2-3-2 Creation of tax incentives to promote 5G investment

In the interest of spurring investment in 5G equipment and facilities with assured security and reliability, special tax measures (limited to two years) — tax exemptions and special depreciation allowances — were instituted for investments in certain 5G equipment and facilities installed following an authorized installation plan, based on the provisions of the Act on Promotion of Developing/Supplying and Introducing Systems Making Use of Specified Advanced Information and Communications Technologies.



Details of special tax measures

The following measures apply to certain capital investments based on authorized installation plans

1. Corporation taxes and income taxes

Eligible carrier	Eligible equipment	Tax exemption [Note]	Special depreciation allowance
Nationwide carriers	Mechanical equipment, etc.	15%	30%
Local 5G licensees	Mechanical equipment, etc.	15%	30%

Note: Upper limit of exemption amount is 20 percent of the corporation tax for the given term

2. Fixed-assets tax (limited to Local 5G licensees)
Taxation base lowered by 50 percent for three years

Eligible equipment
- Nationwide base stations (advanced base stations to be installed earlier than the installation plan)
Transceiving equipment, antennas
- Local 5G
Transceiving equipment, antennas, communication modules, core equipment, optical fiber

Source: Prepared from MIC materials

[4] Special exemptions in the operations of the Japan Finance Corporation (two-step loans), special exemptions under the Small and Medium-sized Enterprise Investment Business Corporation Act, and special exemptions under the Small and Medium-sized Enterprise Credit Insurance Act.

Section 3 Structural Changes to the ICT Industry Caused by 5G

Revisiting the evolution of mobile communication systems described in Section 1, we see massive changes in the structure of the ICT industry as mobile communication systems go through generational changes and progress from communication platforms to life platforms. Already in the 2G era mobile carriers in Japan were joining forces with vendors (handset manufacturers), and in the 3G era, a vertically integrated ecosystem was formed where portal services, billing and authentication functions, and content and apps were connected together under the leadership of mobile carriers. The later arrival of smartphones opened up Japan's vertically integrated models, and horizontally separated models, similar to those in fixed-line communications, were extended into mobile communications. This resulted in Google, Apple, and other digital platformers manifesting a huge influence in the ICT industry.

As mentioned before, 5G is expected to be implemented in many industries and economic sectors as an industrial and social platform. In other words, the start of commercial 5G is not just a changeover of mobile communication systems; 5G has the potential to change the structure of the ICT industry through its implementation in industries and economic sectors. This section looks at how 5G may change the structure of the ICT industry.

1. Market size of major products and services in the ICT field

The smartphone, a new mobile communication device, arrived as mobile communication systems moved from 3G to 4G. Smartphones, backed by overwhelming user support for their functionality, surged in popularity all over the world, triggering greater demand on mobile communication networks. As a result, 4G use expanded faster than mobile carriers' initial predictions.

The growth of 5G is expected to proceed relatively slowly compared to the 4G rollout. Reasons given for the cautious predictions are the time needed to build out 5G-capable areas and the lack of factors like the smartphone's arrival that will induce users to switch. These are, of course, only current predictions. They may well turn out to be revised, should innovative mobile communication devices come on the market, attractive fee plans be offered, or revolutionary use cases emerge. The predictions are also contingent on the progress of area expansion.

2. ICT industry structural changes following advances in mobile communications

(1) Transitions in ICT industry ecosystems (from 2000 on)

a. Ecosystems in the 2000s: Internet trends and 3G growth

The 2000s saw the emergence of new businesses on the Internet and the start of enormous structural transformations in the information and communications industry. At the same time, 3G commercialization for mobile phones was getting underway. In Japan, business models developed that vertically integrated portal services, billing and authentication (platform services) and applications and content — i-mode was a leading example — under a carrier-led ecosystem that had already formed in the 2G era. In the 3G era, generally all functions related to e-commerce and content delivery (such as site access and product and content purchases / payments) were carried out via the carrier. Content providers paid part of the proceeds of contents handled on mobile phone platforms to mobile carriers, and this became an important income source for mobile carriers. Mobile carriers partnered with multiple vendors and participated from the planning stages to develop proprietary handsets (feature phones). Because of this, services and handsets were unified both on the functional side and on the business side. To further boost profits, mobile carriers established vertically integrated models that assimilated not only basic services, such as voice and data communications, that ran on handsets but also commercial transactions executed on their platforms into their distribution channels. These vertically integrated models were unique to Japan, but they encouraged the development of all kinds of content and apps in the upper layer and led to faster communication connections and the introduction of flat-rate data plans. These developments, in turn, developed the mobile Internet and accelerated expansion of the ICT industry centered on mobile phones.

b. Ecosystems in the 2010s: Arrival of the smartphone

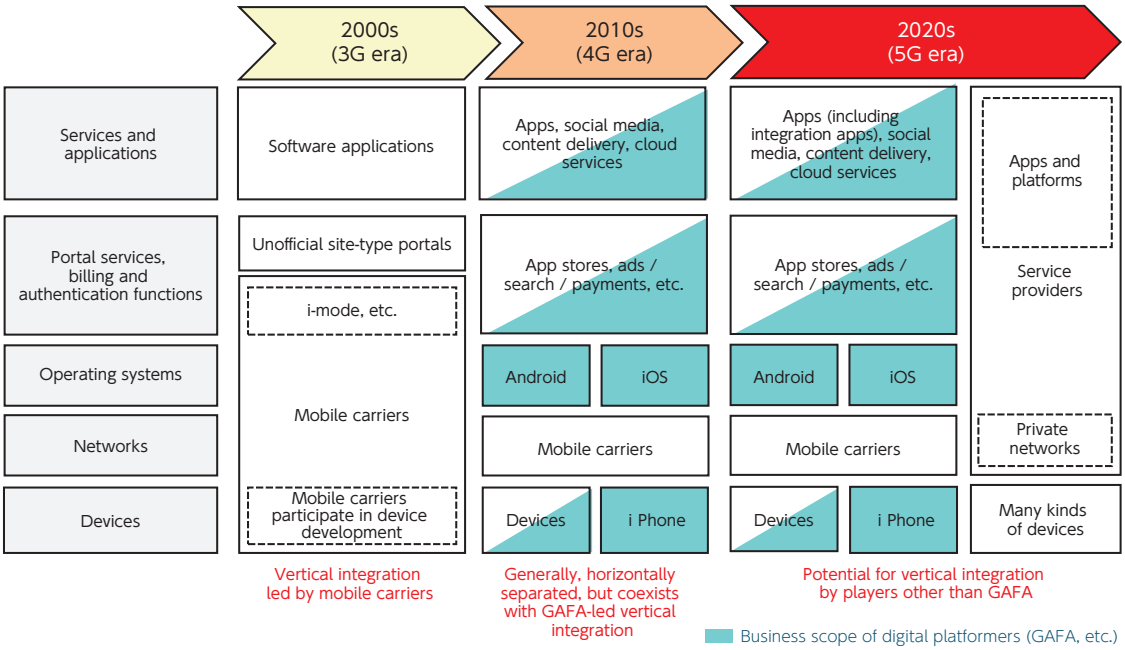
With 4G, the device of choice among users moved from feature phones to smartphones and the world of the Internet converged with mobile communications. Furthermore, device standardization separated devices from services, opening up Japan's vertically integrated model. This opened the way for the entry of overseas vendors and gave users free choice of devices.

As for the overall ecosystem, horizontally separated models from fixed-line communications began to expand in earnest into the mobile field (Figure 1-3-2-1).

Major U.S. Internet businesses — such as the search engine Google, the social network service Facebook, and e-commerce Amazon — drove industry expansion in the mobile sector and dominated markets in the platform and application layers. Among these players, Apple, through the iPhone, created a unique position with a model that vertically integrated upper and lower network layers.

At the same time, the smartphone's emergence sparked new subscriber demand in the mobile communications market, which had been approaching satura-

Figure 1-3-2-1 Ecosystem transitions in Japan's mobile industry



Source: "Survey on Economic and Social Transformations Brought on by 5G Mobile Communication Systems", MIC (2020)

tion, and decisively shifted the market from voice calls to data communication. Mobile carriers, however, had to make huge capital investments for faster and larger capacity networks to handle the explosive increase in traffic.

c. From 2020 on: The 5G age

5G will continue to progress in the network layer, with dramatic performance improvements — "ultra-high speeds and large capacities", "ultra-low latency", and "multiple simultaneous connections". It is also expected to push services into business fields that were not possible with 4G. 5G implementation is predicted to further develop conventional horizontally separated models that will coexist with newly emergent vertically integrated models. 5G is also anticipated to accelerate the implementation of AI and the IoT in industry and in people's daily lives. The main battlefield for technological dominance through the ICT industry is forecasted to shift away from digital spaces and toward real services in the future where digital transformations will be prevalent. Scenarios are envisioned where competitive approaches and ecosystem structures undergo transformations, and continuing digitalization expects to drive platform business growth.