Smoothing the Transition from the Fixed Telephone Network to the IP Network

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1. Introduction

In November 2015, due to declining numbers of subscriber telephone contracts and the expectation that transit exchanges and other such systems will reach their maintenance limits in or around 2025, we announced our intention to migrate from a public switched telephone network (PSTN[*1]) to an IP network. Under NTT's vision:

- The core network (relay network) parts will be migrated to IP networks (NGN[*2]) operated by NTT East and NTT West.
- The access lines leading to user premises will continue to use existing metal lines after the transition to IP networks, and existing subscriber exchange equipment will be used as access points for metal lines.
- While allowing users to continue using their existing phones, we will also put forward the idea of providing new metal IP phones.

Since the fixed communication networks of NTT East and NTT West form Japan's basic communication infrastructure, we are obliged to follow the various systems currently prescribed by the Telecommunications Business Act. For this reason, we consulted with the Information and Communications Council in February 2016 on the subject of how to achieve a smooth transition in fixed telephone networks. Following this consultation, discussions were held at the Smooth Telephone Network Transition Committee[*3] across a wide range of issues while conducting interviews with service providers and related organizations. This committee compiled two reports, which were published in March 2017 ("The post-transition IP network") and September 2017 ("Planning for a smooth transition").

Based on these council reports, the Ministry of Internal Affairs and Communications is developing a system to realize a smooth transition to the IP network of the fixed telephone network.

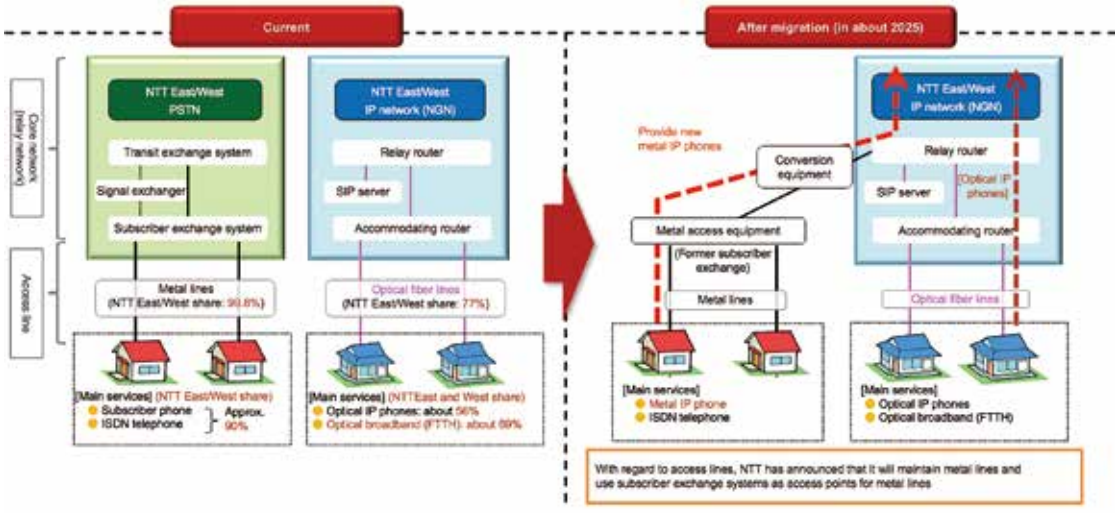
This article presents an overview of the main points of these reports and the systems and facilities that will be affected, with a particular focus on efforts related to the migration of facilities.

2. Key points of the Information and Communications Council report

2.1 Basic philosophy concerning fixed telephones

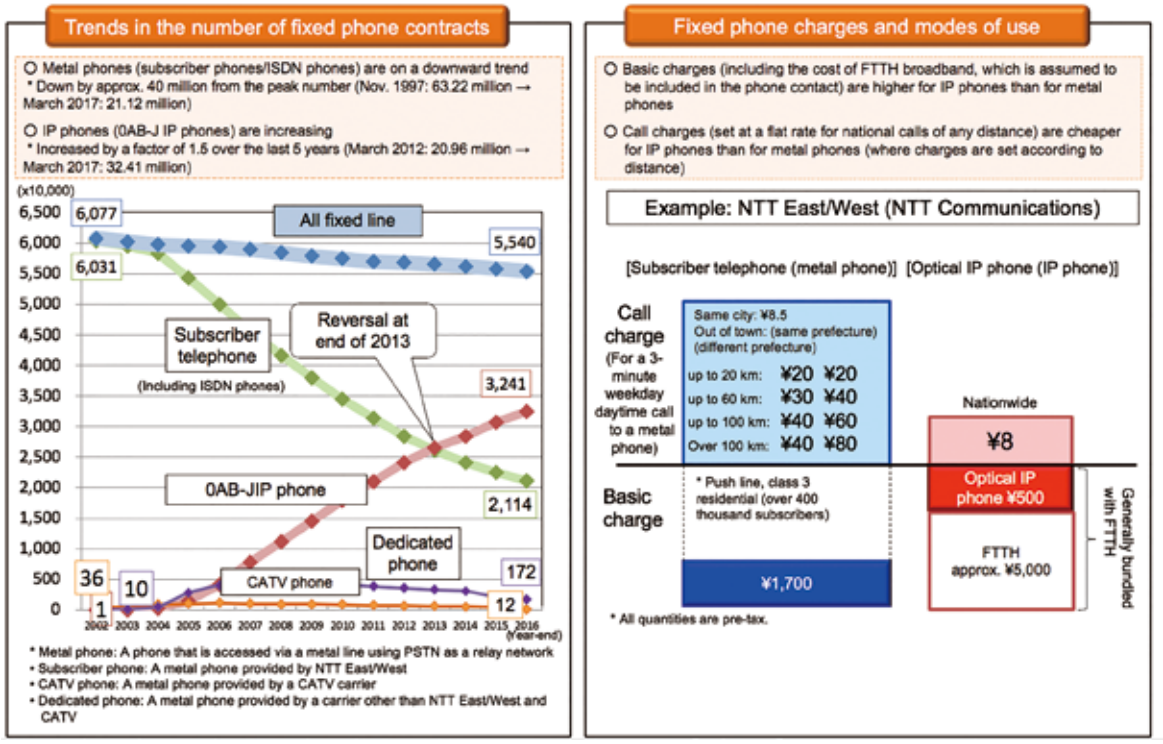
In recent years, the number of metal phone (subscriber phone and ISDN) subscribers[*4] has been on a downward trend, but if

Figure 1: Transition of fixed telephone network to IP network



*1: Public Switched Telephone Network.
*2: Next Generation Network.
*3: The committee is chaired by professor Hirotaka Yamauchi of the Graduate School of Commerce at Hitotsubashi University. This committee set up two working groups — one to study telephone connection functions (headed by Professor Hitoshi Aida of the University of Tokyo Graduate School of Engineering), and another to study user protection (headed by Yoshinori Sakai Professor Emeritus of Tokyo Institute of Technology and Associate Professor at the Open University of Japan) — and also conducted technical and special investigations.
*4: Number of subscriber phone contracts (including ISDN): 21.14 million (as of March 2017).

Figure 2: Current status of fixed telephones (number of contracts and charges)



these are added to the growing number of IP phone (0AB–J IP phone) subscribers,[*5] then the total number of fixed telephone subscribers in Japan is still over 55 million.

Today, a wide variety of means of communication are in an advanced state of use, including mobile phones and broadband. However, the fixed telephone network is available in every part of the country and provides a basic means of communication to people's homes, businesses, public buildings and the like, and therefore plays an important role as part of the essential infrastructure of social and economic activity. This important role will remain unchanged even after migrating to an IP network.

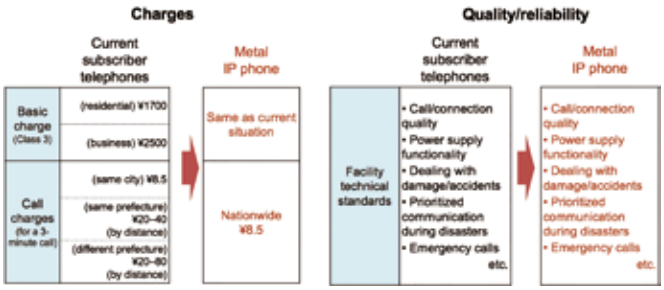
Furthermore, once fixed telephone services have transitioned over to an IP network, it will be possible to charge a low tariff[*6] for calls of any distance within Japan while ensuring that the communication quality is at least as good as what is currently available, and it is expected that a range of new services will also be made available to users by exploiting the characteristics of IP networks such as their ability to perform data communication as well as voice communication.

Based on this idea, NTT East and NTT West will start offering metal IP phones instead of ordinary metal phones. Like existing subscriber telephones, these metal IP phones are expected to provide a universal service, and we should aim to maintain the same standards of quality and reliability that people expect of existing metal phones.

2.2 Ensuring the quality and reliability of fixed telephones

Under the current system, communications carriers are obliged

Figure 3: Metal IP phone charges and quality/reliability



to ensure their facilities comply with technical standards so that users can be provided with reliable and stable telecommunications services.

With the transition from PSTN to an IP network, NTT East and NTT West will provide new metal IP phones by incorporating metal lines into NGN as well as optical lines, and the telephone networks of each communications carrier will be reconfigured so that their respective IP networks will be interconnected (IP-IP connection) without passing through the NTT East/West exchange system.

To adapt to these changes, we must ensure that the IP network is able to provide lifelines in emergency situations and a reliable and stable supply of fixed telephones to support everyday social and economic activities. It is therefore necessary to draw up technical standards for communication equipment to ensure that it can provide the same standard of quality and reliability as the existing telephone network.

*5: Number of 0AB–J IP phone contracts: 32.41 million (as of March 2017).
*6: NTT has announced plans for a flat rate of ¥8.5 per 3 minutes for metal IP phone calls to anywhere in Japan after the IP network transition. Currently, three-minute daytime calls to subscriber phones in NTT East and NTT West are charged according to distance: ¥8.5 for calls in the same city, ¥20–40 for calls in the same prefecture, and ¥20–80 for calls to a different prefecture.

2.3 Ensuring the ability of phones to connect

In the existing PSTN, the NTT East/West exchange system serves as a hub that connects between the telephone networks of each communications carrier at points of interface (POIs) in each of Japan's administrative divisions.

With the IP network transition, the NTT East/West exchange system will be abolished, the POIs will be consolidated, and in principle every communications carrier in Japan will establish IP-IP connections with either of two "connecting POIs", one in Tokyo and the other in Osaka. It has been confirmed that they will be allowed to share communication facilities (routers and SIP servers), which will require the implementation of new call connection functions.

It is expected that the connecting POIs used for IP-IP connections between communications carriers will have dual support for connections via L2 switches[*7] and without L2 switches (using a patch panel[*8] instead).

In addition to sorting out the role of these phone connection functions, their connection rules and technical standards, we are arranging a scheme[*9] whereby NTT East/West will maintain, manage and operate the communication facilities and L2 switches used by communications carriers inside connecting POI buildings.

2.4 Ensuring emergency call capabilities

Currently, in emergency calls, the PSTN line hold function ensures that calls from metal lines are held unless the emergency service disconnects, even if the caller drops the handset. On the other hand, a callback from the emergency service is required when reporting from a mobile phone.

Since it will be difficult to implement a line hold function after the IP network transition, NTT has proposed replacing it with a callback function. However, the emergency services have raised issues with the speed and reliability of existing callback functions, so NTT must adequately demonstrate how functions equivalent to those of current systems can be offered, or provide suitable alternatives.

To address this situation, the Smooth Telephone Network Transition Committee interviewed representatives from emergency services and business operators including NTT, and examined the functions of emergency calls after the IP network

Figure 4: Phone network configuration after the IP network transition

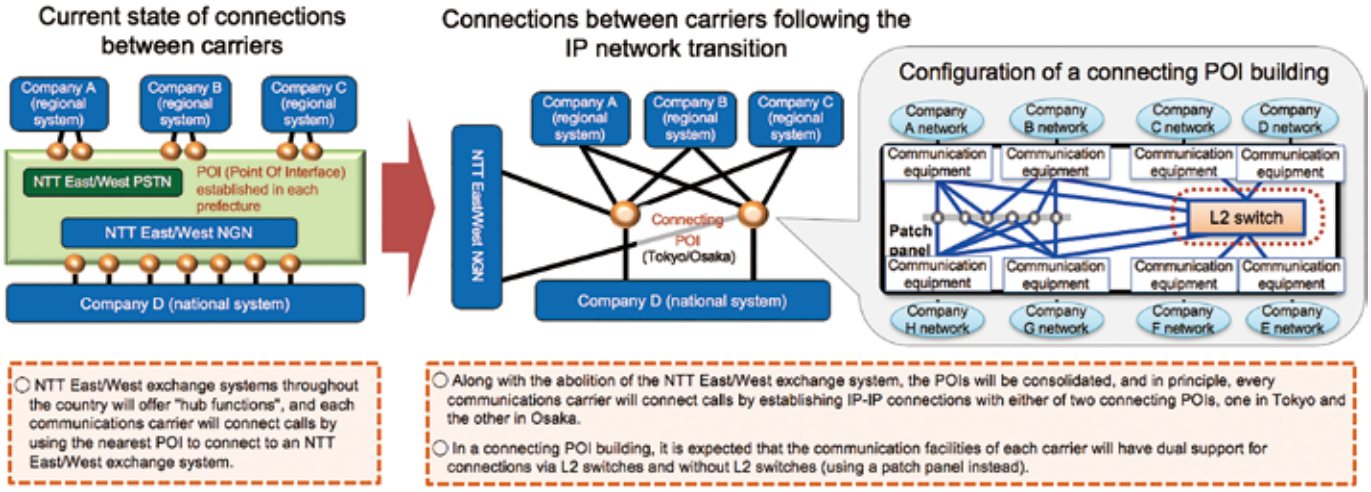
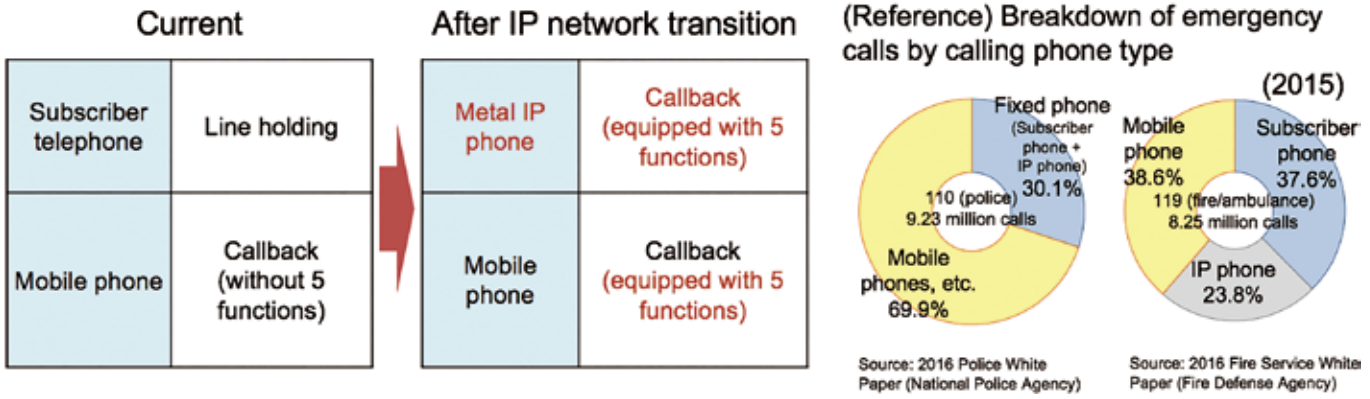


Figure 5: Emergency call functions compatible with the IP network transition



*7: A type of device that relays data on a network. Specifically, a switch that acts as a relay by forwarding packets to other relays based on the MAC addresses in the packet headers. (Called a Layer 2 switch because MAC addresses are handled by the second layer (data link layer) of the OSI reference model.)
*8: A panel used for accommodating and connecting a group of communication lines. Capable of selecting signal paths easily without using dedicated switching equipment.
*9: For L2 switches inside connecting POI buildings, communications carriers (consortiums) that want to use them enter into an IRU (indefeasible right of use) contract with NTT East/West, and NTT East/West maintains, manages and operates the L2 switches.

transition. As a result, it was concluded that the alternative functions for line holding should have the following properties:

- To facilitate callbacks from the emergency services to callers, it is realistic and rational to implement five functions: (a) emergency service number notification,[*10] (b) cancellation of call transfers,[*11] (c) cancellation of call barring,[*12] (d) restrictions on three-way calling,[*13] and (e) priority call handling in the event of a disaster.[*14]
- Based on the growing proportion of mobile phone usage in emergency calls, it makes sense to ensure that these five functions are also implemented for mobile phones.[*15]

2.5 How to manage the allocation of numbers to telecommunications lines

(1) Converting the number allocation mechanism for IP network migration (IP-IP connection)

In the current PSTN, when a telephone call is made to a number allocated to a user by NTT East/West, the call control signals from the caller's device (a metal telephone, optical IP phone, or mobile phone) must always be connected to the NTT East/West exchange system via the PSTN to provide a redirection mechanism whereby communication can take place with the call destination. However, this mechanism cannot deal with cases where connections between the telephone networks of each carrier are formed by IP-IP connections without involving the PSTN.

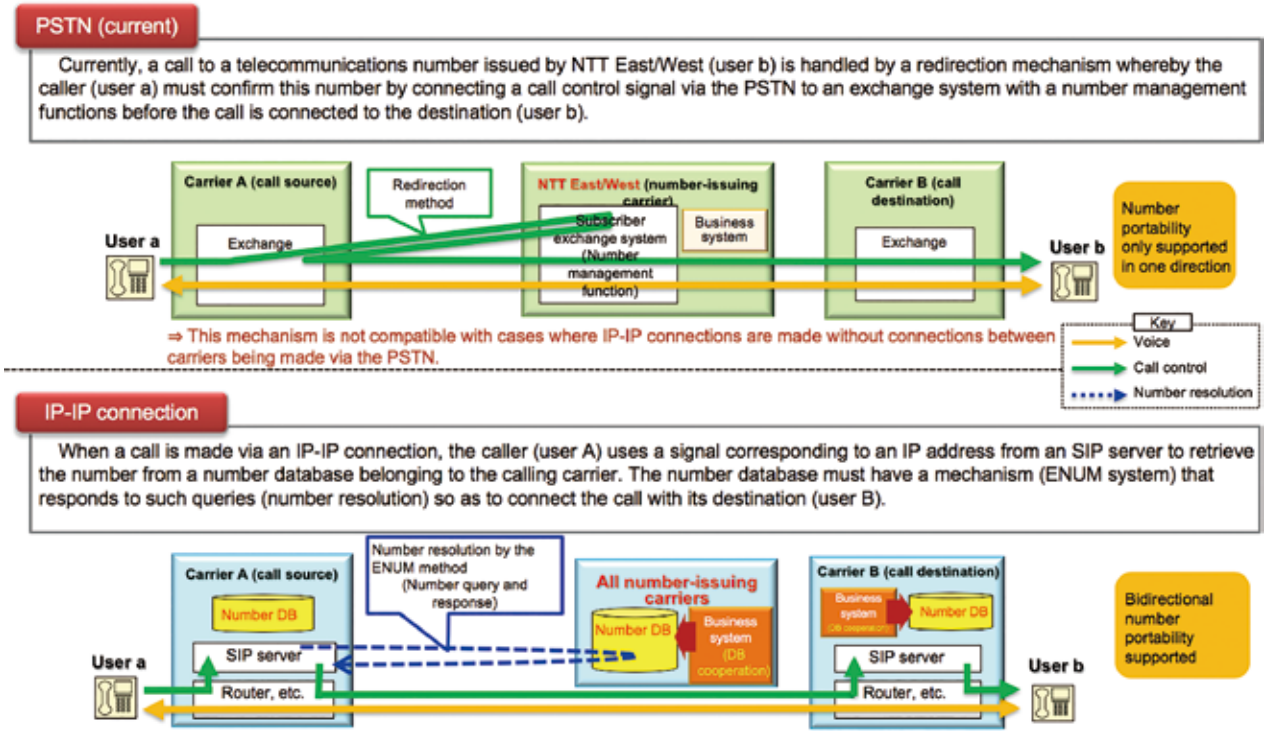
In an IP-IP connection, when a call is made to a number that all the carriers associate with a particular user, the calling equipment uses a signal corresponding to an IP address to retrieve the number from a number database belonging to the calling carrier. This number database must have a mechanism that performs a process called number resolution to connect the call with its destination (ENUM system[*16]).

For this reason, to support the phased introduction of IP-IP connections from January 2021, there is a need for the introduction of systems such as obliging all carriers that originate and/or receive calls to set up a proper number database for number management in IP-IP connections (including number resolution by the ENUM system).

(2) Providing bidirectional number portability for fixed phones

In the current fixed phone system, number portability (the ability to move telephone numbers) is only supported in "one way" when migrating from an NTT East/West metal phone to a fixed phone of another carrier by signing up for a new contract, and is not supported when migrating from an IP phone or from the fixed phone of another carrier besides NTT East/West.

Figure 6: Number management mechanism for IP-IP connections



*10: Japan's emergency services have so-called 1XY phone numbers (i.e., three digits starting with 1). This function reports the 1XY number of the corresponding emergency service back to the caller's phone.
*11: A function that cancels the forwarding of incoming calls to a caller's terminal, even if the caller is using a call forwarding function.
*12: A function that cancels the rejection of incoming calls to a caller's terminal, even if the caller is using a call barring function.
*13: A function that temporarily restricts calls between the caller and any third party other than the emergency service.
*14: Currently, calls to the emergency services are handled with higher priority in the event of a disaster, but this priority treatment is not extended to calls made by the emergency services back to the original callers.
*15: Since May 2017, with the aim of implementing these five functions in mobile phones, we have taken part in regular studies and discussions with a group of organizations including the emergency services (police, fire and coastguard), three mobile communication companies (NTT DOCOMO, KDI and Softbank), and the Ministry of Internal Affairs and Communications. A primary report detailing the results of these studies was reported to the Smooth Telephone Network Transition Committee on May 22, 2018.
*16: E.164 number mapping: a standard system that uses IP address query techniques to obtain information about the destinations to which phone numbers should be connected on the Internet.

The proportion of numbers in the fixed phone system (0AB–J) that cannot have number portability has been on an upward trend in recent years due to progress in the IP transition, and is currently at 16%.*17 This figure is expected to continue increasing in the future.

Following the IP network transition, all fixed-line users in the future will be using IP phones. For the convenience of these users, and in order to secure a competitive infrastructure for fixed phones, we plan to introduce bidirectional number portability by the end of the IP network transition (January 2025). This will require some systematic improvements.

(3) Ensuring fair and efficient use of number resources

Currently, the national allocation rate of mobile phone numbers starting with 090/080/070 and toll-free numbers starting with 0120 (i.e., the proportion of all numbers that have been made available) is in excess of 90%, and it is becoming difficult to deal with new allocation requests.

On the other hand, the actual number allocation rate of communications carriers (the proportion of available numbers that are currently in use) is about 70% for mobile phones and about 55% for toll-free numbers. At the national level, about 90% of available toll-free numbers have been assigned to a single carrier.

Under these circumstances, the current system allows carriers to voluntarily return numbers that have been allocated to them, regardless of whether or not these numbers are in use (voluntary notification). As a result, numbers that have remained unused for long periods of time are not being returned, leading to problems such as inability to manage or redistribute numbers flexibly.

To adapt to the different situation regarding number management brought about by the IP network transition (IP-IP connection), it will be necessary to set up systems for dealing with this shortage of numbers and the issues of unused numbers, and for implementing the fair and efficient usage and redistribution of finite and scarce number resources. These include:

- A mechanism for regularly confirming the state of use of telecommunications numbers and the discharge of obligations related to telecommunications numbers
- A mechanism that enables the disposal of numbers, such as the cancellation of telecommunications numbers that have been left unused for a certain period, or the cancellation of numbers when obligations relating to the handling of these numbers have not been not fulfilled

Figure 7: Current status of number portability in fixed phones

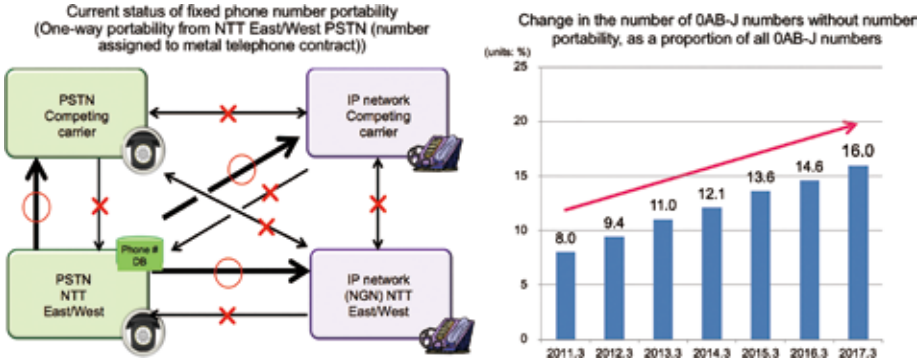


Figure 8: Principal forms of telecommunications number allocation and usage

Number	Use	No. of allocated carriers	Number capacity	Allocated	Allocation rate (number allocated/ number capacity)	In use	Usage rate (number in use/ allocation rate)
0AB-J	Fixed phones	23	419.92 million	238.33 million	56.8%*2	62.43 million	26.2%
090/080/070	Mobile phones/PHS	4	270 million	244.1 million	90.4%*3	171.7 million	70.3%
020	Exclusive numbers (M2M, etc.)	4	80 million	16.4 million	20.5%	0	0.0%
0204	Pagers	2	10 million	1.2 million	12.0%	20,000	1.9%
0600	FMC	0	10 million	0	0.0%	0	0.0%
050	IP phone	20	90 million	23.67 million	26.3%	9.43 million	39.8%
0120	Reverse charging (10 digits)	7	1million	990,000	99.2%	550,000	55.3%
0800	Reverse charging (11 digits)	7	10 million	3.03 million	30.3%	360,000	11.8%
0570	Unified number	3	1million	120,000	11.8%	10,000	11.7%

*1: As of the end of March 2017 (except 020 numbers, for which data was obtained at the end of May 2017)
*2: The area codes of fixed phones (0AB-J numbers) account for over 80% in 138 out of 582 regions nationwide (average rate: 18.6%)
*3: The allocation rate of mobile phones and PHS phones is 100% for 080/090 numbers, and 71.2% for 070 numbers.

2.6 Road map for facility migration

The migration from PSTN to IP networks is to proceed according to the following stages and schedule:

- Stage 1: Following preparatory work (development, verification, etc.) by communications carriers, establish a connecting POI building environment for IP-IP connections between carriers (by January 2021)
- Stage 2: Connect the subscriber exchange systems of NTT East/West to the IP network (NGN), and gradually implement IP-IP connections between optical IP phones and other carriers, and IP-IP connections between other carriers (from January 2021 to January 2024)
- Stage 3: Implement IP-IP connections between NTT East/West metal IP phones and other carriers (from January 2024 to the completion of transition in January 2025)

(Note: The migration of services from subscriber telephones to

*17: As of March 2017, there are currently 9.97 million fixed phone numbers that do not have number portability. This constitutes 16% of all phone numbers (62.43 million), a proportion that has been increasing in recent years.

Figure 9: Migration of facilities from PSTN to the IP network

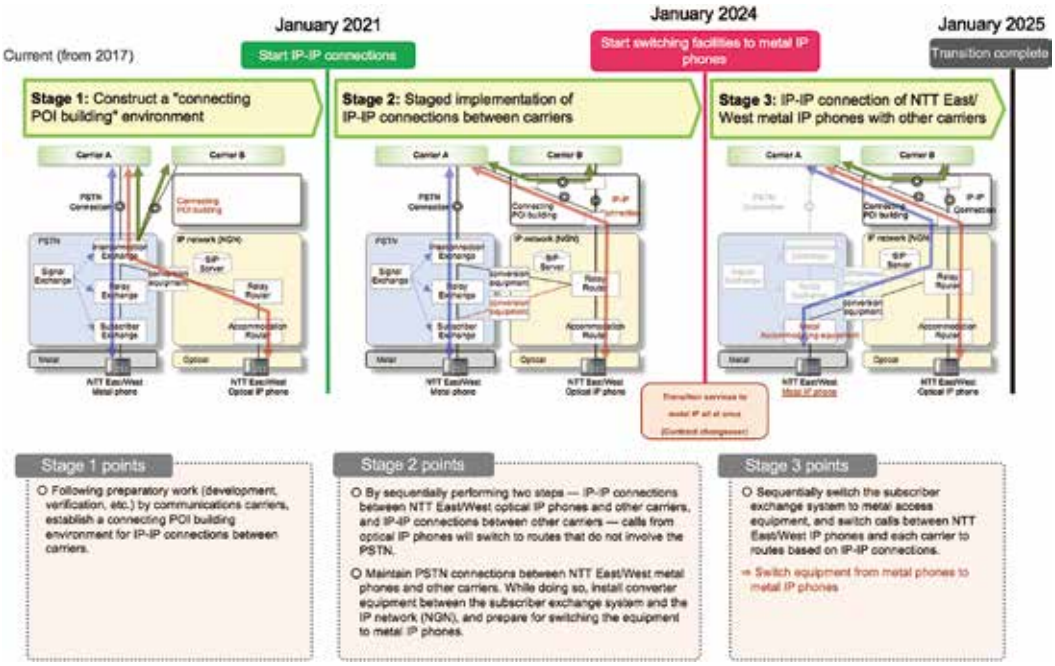
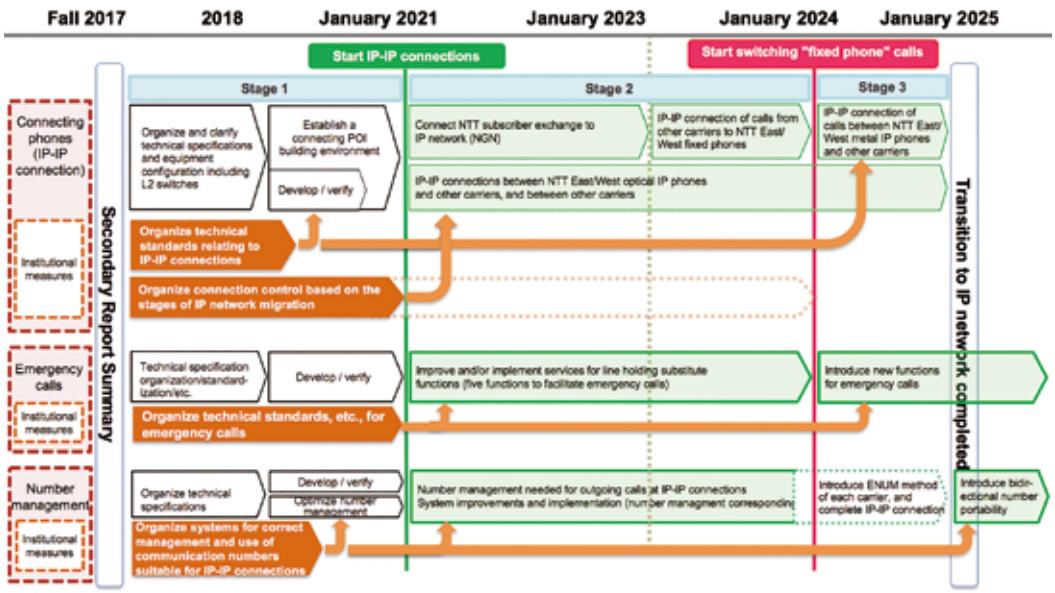


Figure 10: Facility migration road map



metal IP phones (with a simultaneous exchange of contracts) was conducted in January 2024)

To ensure that calls are handled properly during this transition process, it is necessary to establish a telecommunications number system and other such technical standards to ensure there is a functioning number management mechanism that is compatible with IP-IP connections.

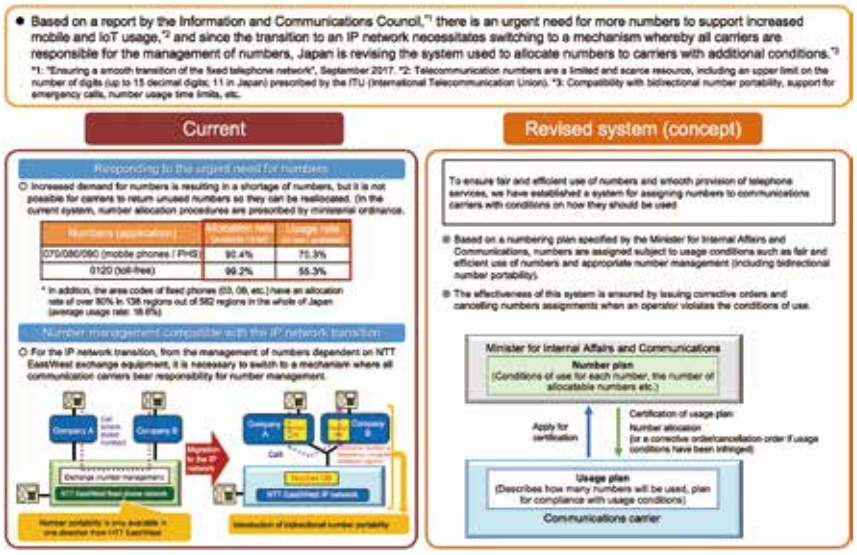
3. System revisions to promote the smooth migration of facilities (revision of the Telecommunications Business Act)

Based on a report by the Information and Communications Council, the Ministry of Internal Affairs and Communications has conducted a study of systematic measures. On March 6, 2018, a report on partial revision of the Telecommunications Business Act and the NICT Act was presented at the 186th Diet session, and was established in law on May 16th and promulgated on May 23rd of the same year.*18

According to this law, from the perspective of promoting a smooth migration of facilities from PSTN to the IP network, efforts are being made to switch to a mechanism where the responsibility for number management is borne by all carriers involved in the IP network transition, and to set up telecommunications number systems that address the urgent need for a larger pool of numbers to meet the needs of growth in the mobile and IoT sectors. The points that were changed in the

*18: The enforcement date of the Act is regarded as the day specified by a Cabinet Order within a period not exceeding one year from the date of promulgation.

Figure 11: Amendment of the Telecommunications Business Act (improvement of rules relating to telecommunication numbers)



revised items were as follows:

- The Minister for Internal Affairs and Communications shall draw up and publish a telecommunications number plan (hereinafter referred to as "number plan") including the contents of telecommunications duties to be provided for each type of telecommunications number, the conditions for using these numbers (handling important communications, supporting bidirectional number portability, expiration dates, etc.), and limits on how many numbers can be specified.
- Communications carriers who intend to use telecommunications numbers for the provision of telecommunications services must prepare a telecommunications number usage plan (hereinafter referred to as a "usage plan") and obtain certification from the Minister for Internal Affairs and Communications.
- The Minister for Internal Affairs and Communications shall examine the usage plans prepared by telecommunications carriers in terms of their suitability based on the number plan, etc., and shall allocate telecommunications numbers after approving the usage plan.*19
- Telecommunications carriers must use the telecommunications numbers designated by the Minister for Internal Affairs and Communications in accordance with the usage plan approved by the Minister for Internal Affairs and Communications. If a violation occurs and a communications carrier fails to comply with a compliance order from the Minister for Internal Affairs and Communications, this carrier's certification is liable to be revoked.

4. Conclusion

The NTT East/NTT West PSTN is a core communication infrastructure that acts as a hub to support phone calls and provides a competitive foundation for many businesses to develop their activities. Users and businesses will therefore be significantly affected by the form taken by the network after the IP network transition, and by the way in which this transition is achieved.

For this reason, prompted by the announcement of NTT's vision, we have spent about two and a half years actively engaged in concrete discussions and studies with business operators, enterprises and related organizations on a wide range of issues. The Ministry of Internal Affairs and Communications has also compiled a council report on how to implement the transition (together with a roadmap) based on about one and a half years of study, and has greatly accelerated the process by concentrating its efforts on achieving a smooth transition, including systematic improvements for greater effectiveness. Preparations for the migration of facilities (including development and verification) are now under way, and the actual transition process will start in 2021. This transition process and the efforts of related organizations will continue until we reach the milestones of service transition in 2024 and the completion of migration in 2025.

Now that we are approaching an important phase in the development of our communication infrastructure, we will continue to make every effort to support this initiative in our role as a policymaker. Above all, we would like to express our sincere gratitude for the great efforts and cooperation of everyone involved in this initiative.

(Source of figures)

- Figs. 1–10: Supplementary materials from reports by the Information and Communications Council ("Ensuring a smooth transition of the fixed telephone network", published March 28, 2017 and September 27, 2017)
- Fig. 11: Ministry of Internal Affairs and Communications

*19: However, telecommunications carriers (MVNO, FVNO etc.) that do not assign numbers to users upon designation of a telecommunications number have established the same usage plan as the standard telecommunications number usage plan stipulated by the Minister for Internal Affairs and Communications , It is deemed to have been accredited by the Minister of Internal Affairs and Communications.