

# Overview of Report

## Study Group on Internet's Smooth Transition to IPv6

---

June 2008  
Secretariat of Study Group on Internet's Smooth  
Transition to IPv6

# Actions for IPv4 address space exhaustion

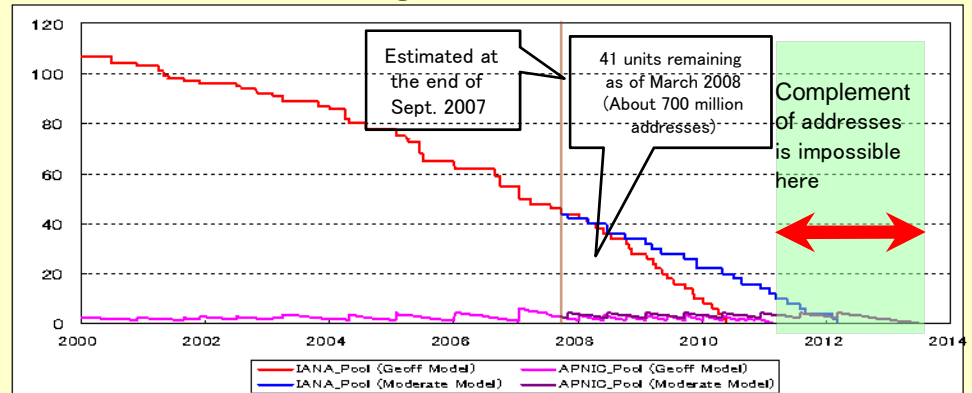
International stock of addresses (equivalent to telephone numbers) based on the communication protocol (IPv4) used on the Internet will be exhausted in about three years.

- Even if IPv4 addresses are exhausted, existing Internet users can continue to use it.
- On the other hand, **it will be difficult to accept new users or services.**

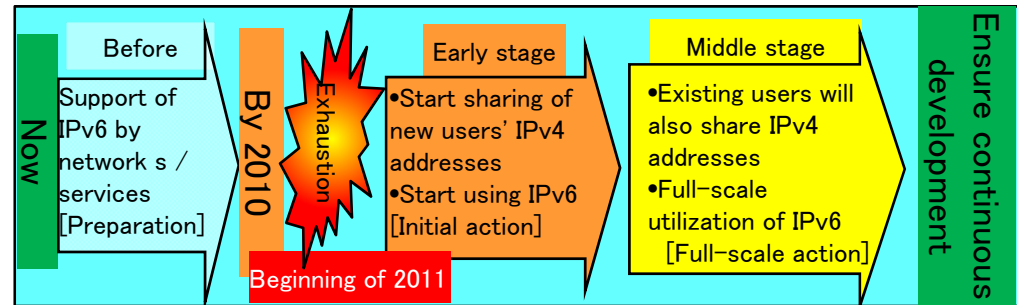
- For continuous development of the Internet, from three viewpoints of feasibility within a time limit, continuity of service on the Internet, and continuance of effect, **the transition to a new address system (IPv6) and sharing of one address by multiple users** must be combined and carried out.
- It is appropriate to **introduce the countermeasures in three stages**: before exhaustion, early, and middle stages of exhaustion.

- **Create the action plan** consisting of 68 items, concerning networks, services, and users, which are involved in the Internet, and manufacturers/vendors, system integrators, relevant organizations, and the government, which support them.
- **Reconstruct IPv6 Promotion Council** as the promotion framework of the action plan in Japan in cooperation of the government and the private sector

Number of the remaining IPv4 addresses in international stock



The unit is the number of blocks each of which contains 1/256 of the whole IPv4 address space. One block is equivalent to 16,770,000 addresses.



Example of the action plan:

- Networks and services should support IPv6 by 2010. The plan for the transition should be created and released in 2008
- Manufacturers/vendors should promote the support of IPv6 by products. Authentication system (IPv6 Ready Logo Program) should be used to indicate support.
- Considering that IPv6 will start in 2011 or later, users should promote the transition to IPv6 when the devices and software are replaced.
- The government and relevant organizations should promote the action plan, while seeking consistency with international trends.



# Reference: Study Group on Internet's Smooth Transition to IPv6

The international stock of IPv4 addresses (equivalent to telephone numbers) required for each device connected to the Internet is running short. To take a global initiative and mainly examines measures for maintaining continuous development of the Internet, the study group examines measures from an engineering perspective.

## 1. Examination

- Estimate of exhaustion date of international IPv4 addresses and its influence
- Examination of the measures for IPv4 address space exhaustion
- Examination of the problems in the introduction of the measures and solutions (creation of action plan)

## 2. Members

- 20 members, including academic experts, telecommunication service operators, Internet service providers, and device vendors (see the next page)
- Workgroups are established for the detailed study.

## 3. Period

- From August 8, 2007 to April 2008  
(4 meetings of the study group and 11 meetings of the workgroup were held)

# Reference: Members of the Study Group on Internet's Smooth Transition to IPv6

◎Chairman ○Deputy chairman ●WG manager

## [Academic experts]

- ◎ Tadao Saito CTO, Toyota InfoTechnology Center, Co., Ltd. (Professor emeritus at the University of Tokyo)
- Jiro Kokuryo Professor, Faculty of Policy Management, Keio University
- Hiroshi Esaki Professor, Graduate School of Information Science and Technology, The University of Tokyo

## [Telecommunication service operators]

- Takashi Hanazawa Director, Director of Research and Development Planning Department, NTT
- Yutaka Yasuda Corporate executive officer, Senior Core Technology Division Director, KDDI Incorporation
- Noriyuki Tsuchimori Executive Director, K-Opticom Corporation
- Keiichi Makizono General manager of the network division for SOFTBANK Telecom
- Yoshihiro Obata CTO, eAccess Ltd.
- Yoshimasa Tokui General Manager, Network Business Division, NTT Communications
- Takamichi Miyoshi Manager of Strategy Planning Division, Internet Initiative Japan Inc.
- Toshihiro Naito Corporate Officer, Infrastructure System Division Director, NEC BIGLOBE, Ltd.

## [Service provider]

- Hitoshi Niki CTO, Director, Usen Corporation

## [Manufacturers]

- Tetsuo Takemura COO, Information & Telecommunication Systems, Hitachi, Ltd.
- Mario Tokoro Senior Vice President, Sony Corporation
- Mikio Mizutani Executive Vice President, CTO, Panasonic Communications Co., Ltd.

## [Relevant organizations]

- Takashi Arano Executive Officer, Japan Network Information Center
- Taketsune Watanabe Chairman, Japan Internet Providers Association
- Takamasa Nakamura President, Japan Cable Laboratories (Director, Japan Cable and Telecommunications Association)

## [Representative of users]

- Kimiko Yamakami Executive director, Japan Association of Consumer Affairs Specialists

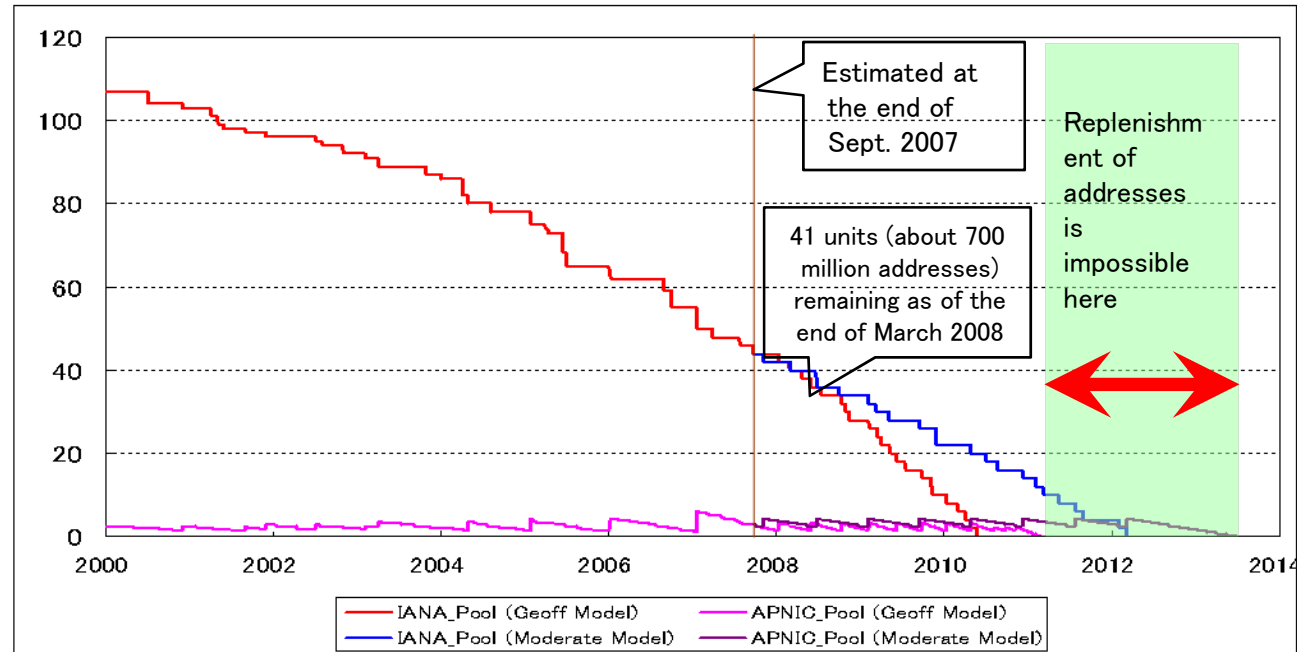
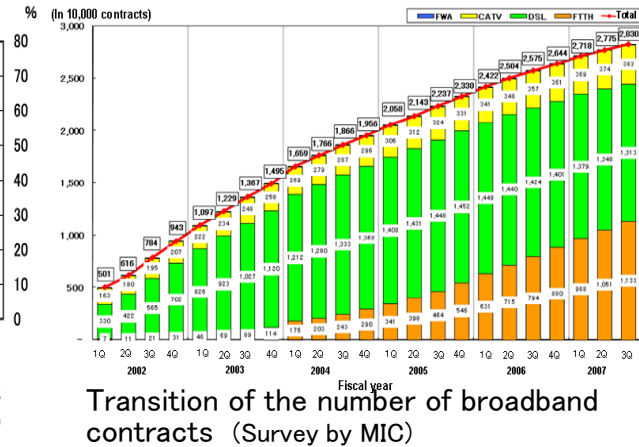
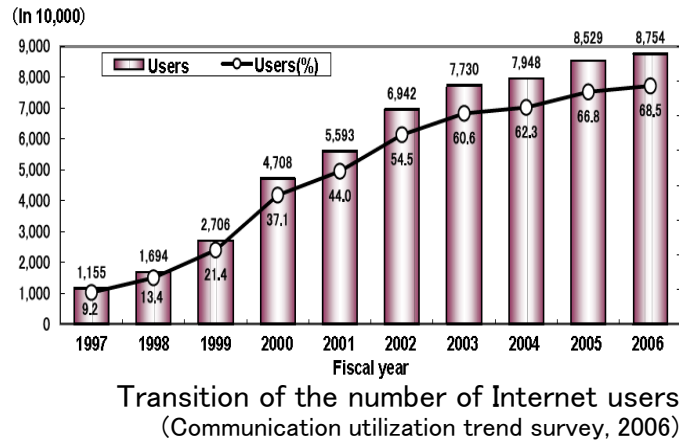


# Reference

---

# Internet address space exhaustion

- There are 87 million Internet users (over 2/3 of total population), and 28.3 million broadband contracts (more than 50% of total household) in Japan. The Internet is indispensable for socioeconomic activities.
- IPv4 addresses (equivalent to the telephone numbers) required for each device link to the Internet remain only about 700 million of 4,300 million.
- About 80 million addresses were consumed every year until about 2003. Consumption has doubled because of the increased demand in Asia, South America, and Europe since around 2004.
- The addresses will run short as early as the beginning of 2011 unless demand decreases.



Estimated number of the remaining IPv4 addresses in international stock  
 (The vertical axis is shown in units called "/8". "1" is equivalent to about 16.8 million addresses)

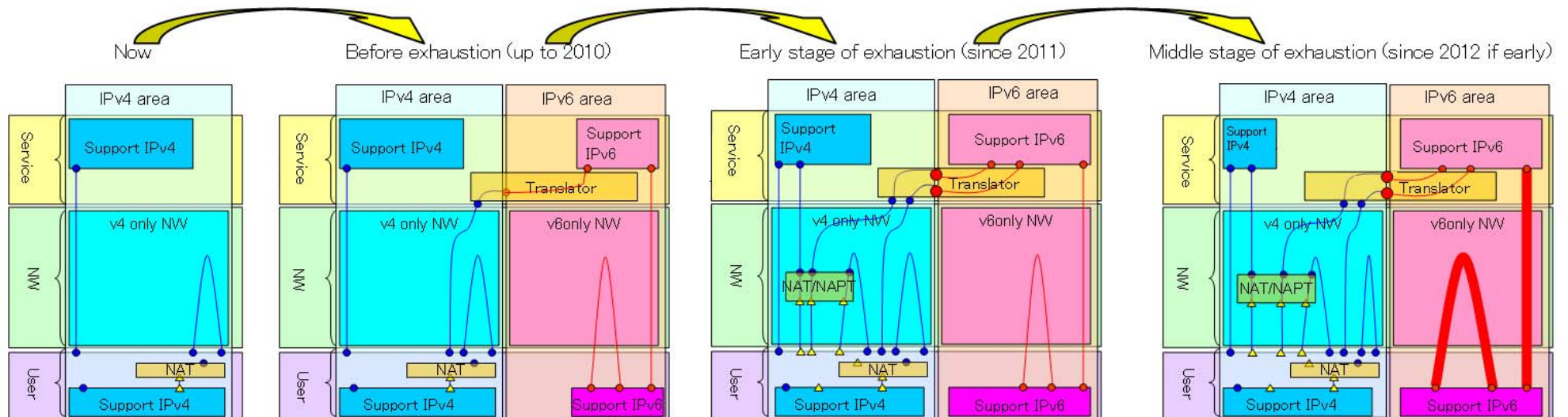
# Measures for address space exhaustion

- For continuous development of the Internet since 2011, the combination of **the transition to a new address system (IPv6)** and **sharing of one address by multiple users (using NAT/NAPT)** must be performed from three viewpoints of *feasibility within a time limit, continuity of service on the Internet, and continuance of effect*,
- It is appropriate to **introduce the measures in three stages**: before exhaustion, early, and middle stages of exhaustion.




• Support of IPv6 by networks/services [Preparation]

• Sharing of one v4 addresses by multiple users (NAT/NAPT)  
 • Support of NAT/NAPT by services [Initial action]

• Existing users will be accommodated under NAT/NAPT  
 • Full-scale utilization of IPv6 [Full-scale action]



NAT : Network Address Translation, NAPT : Network Address Port Translation

 : Shared v4 addresses  
 : Occupied v4 addresses  
 : Occupied v6 addresses  
 Blue line: v4    Red line: v6

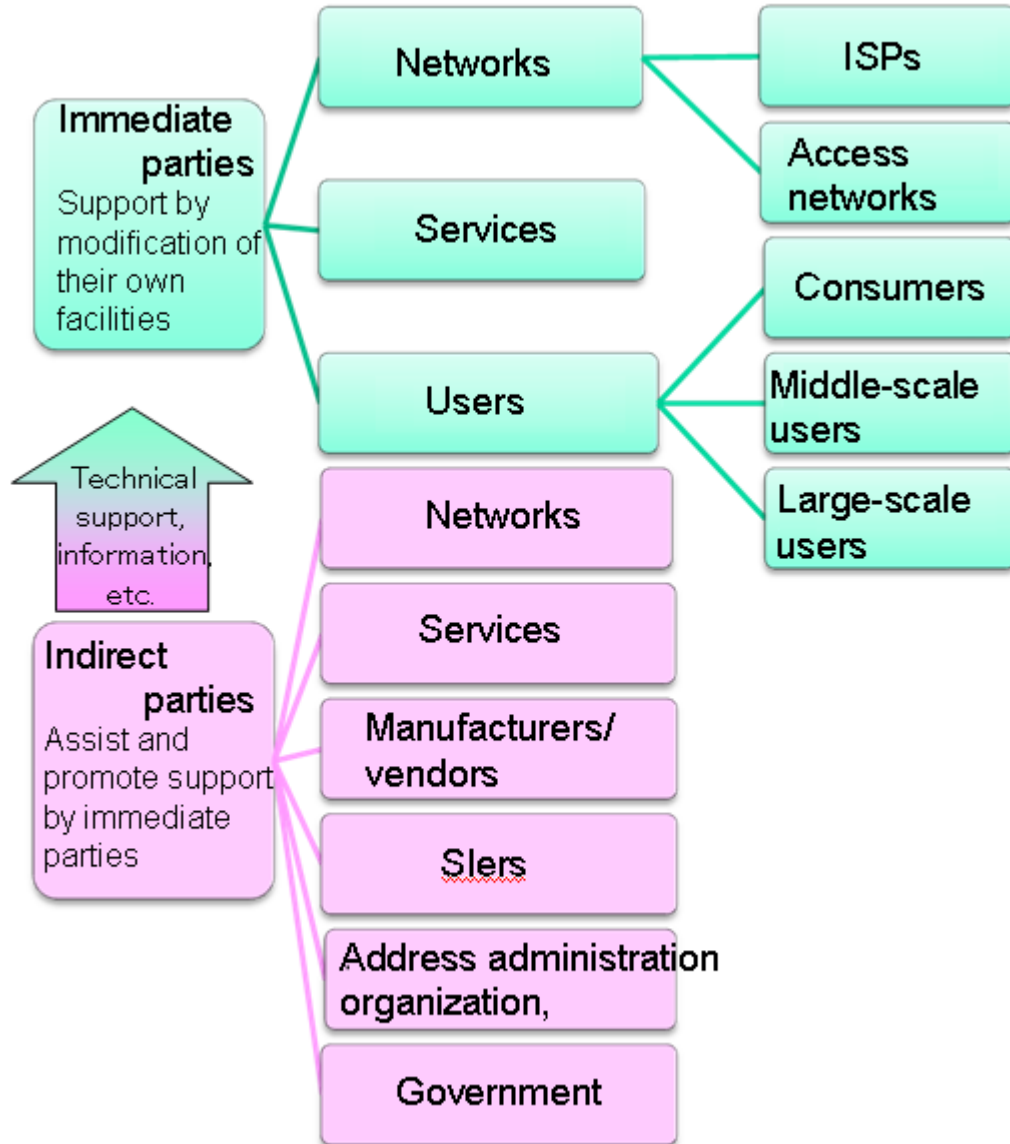
Model of the procedure for introduction of measures for address space exhaustion

# Action plan (1: Organizing players)

1. **The measures for IPv4 address exhaustion will be expected to implement by networks, services, and users (immediate parties) primarily.**
2. The above three elements have technical problems that cannot be solved by themselves. **Indirect parties need to cooperate to solve them.**

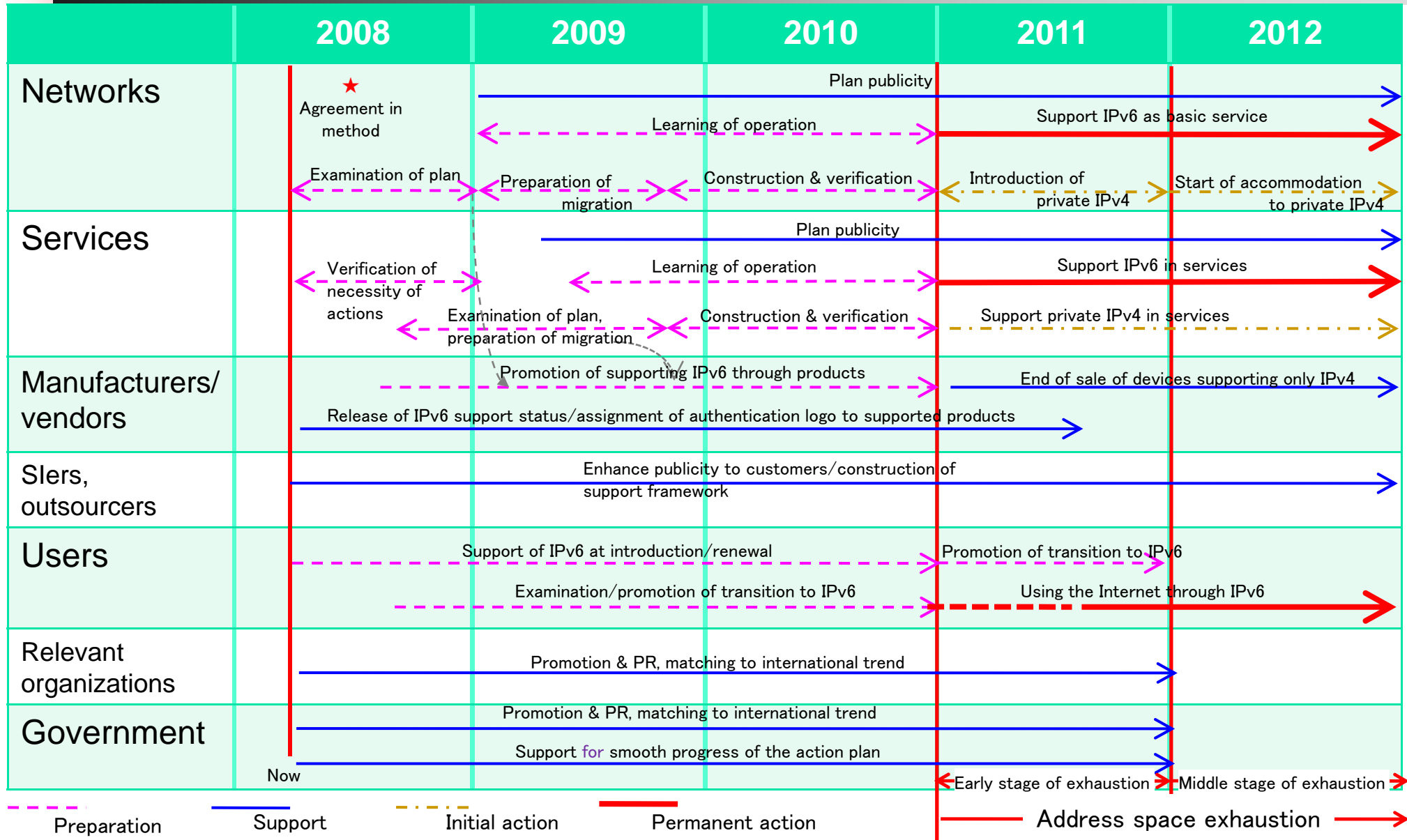


Reconstruction of IPv6 Promotion Council as the promotion framework in cooperation with the government and the private sector





# Action plan (2: Overview)



# Role of the government in the action plan

## ● Nature of the action plan

The government will not force each player to perform what is described in **the action plan. It is extremely important that each player recognizes its role and promotes the actions for itself.**

## ● Action plan for the government

- ① Publicize the Japanese policy internationally **so that international trends will confirm to**
- ② **Publicize** the necessity of the transition to IPv6 to users
- ③ **Pay attention to the promotion of the action plan and improve the environment so that the adjustment and negotiation go smoothly** between players.
- ④ **Promote the development** of Ipv6-compatible supporting communication devices.
- ⑤ **Examine the support for the initial cost burden in cooperation with relevant organizations.**
- ⑥ **Support the enhancement of education programs** for engineers to learn the appropriate **skills.**
- ⑦ Examine the creation of tests for engineers on the development capability for IPv6-compatible systems to offer the basis of selection to users, services, and Sler's.

## ● How to promote the action plan

- ① For smooth promotion of the action plan, it is necessary to establish a framework for grasping the progress and urging those who are behind schedule to take action.
- ② Strengthen the following functions of **the IPv6 Promotion Council to reconstruct it as a promotional framework in cooperation with the government and the private sector**
  - Grasping the status of promotion of the action plan
  - Information sharing in the promotion of the action plan
  - Improvement of knowledge of related parties through the construction and employment of the test bed
  - Examination of amendments to the action plan as required



# Simplified version

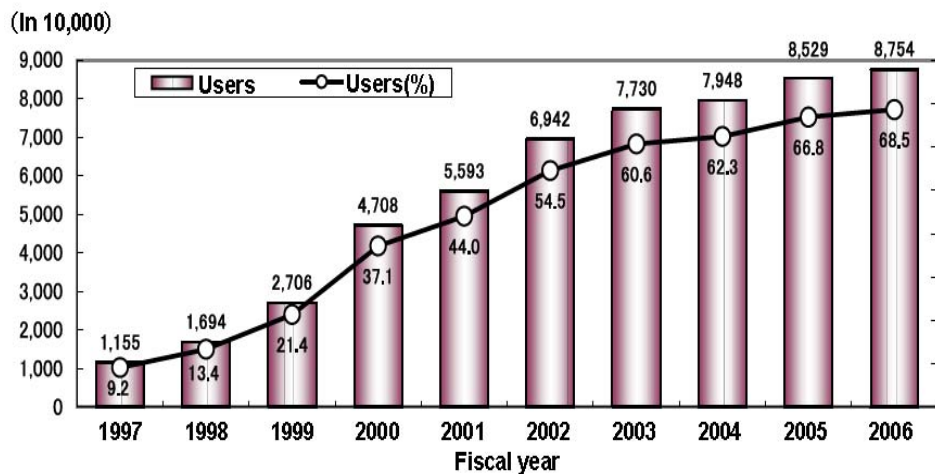
---

# Overview of the report

1. The total number of **addresses** (separate numbers required for devices connecting to the Internet) **of IPv4**, which is the basic technology supporting the current Internet system, is **4,300 million**.
2. Among them, **3,600 million have already been allocated**, and the remaining are at most 700 million. If there are no particular changes in the circumstances, **IPv4 addresses will run short as early as the beginning of 2011**.
3. **To cope with IPv4 address exhaustion, the transition to IPv6 as an essential action**, and sharing of the IPv4 addresses as an initial action are required.
4. Because both of these actions require the modification of networks and systems,
  - ① The providers of **networks and services should create an action plan in 2008 for compliance completion by the end of 2010**.
  - ② It is important for **users to advance the supporting IPv6 through to the modification or system renewal**, assuming that the Internet connection with IPv4 will be limited after 2011.
  - ③ It is also important for **product suppliers**, such as vendors/manufacturers, **and technology suppliers**, such as system integrators/outsourcing companies, **to strengthen the support system for Networks and Services**.
  - ④ It is important for **the government and relevant organizations, such as an address administration organizations, to support the whole progress**.

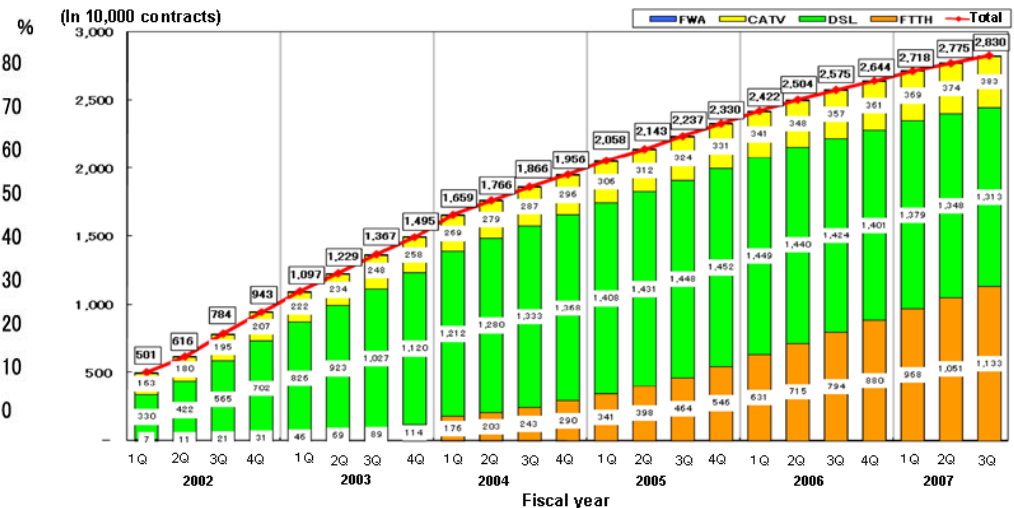
# Introduction

1. **87 million Internet users (over 2/3 of total population), and 28.3 million broadband contracts (more than 50% of total households) in Japan**
2. The market size of the **electronic commerce** through the Internet **totaled 147 trillion yen** in 2006 (survey by METI)
3. The Internet is **indispensable for socioeconomic activities in Japan**
4. **Examine technical measures** because **the limitations of IPv4** are beginning to show.



The number of Internet users

(Communication utilization trend, 2006)



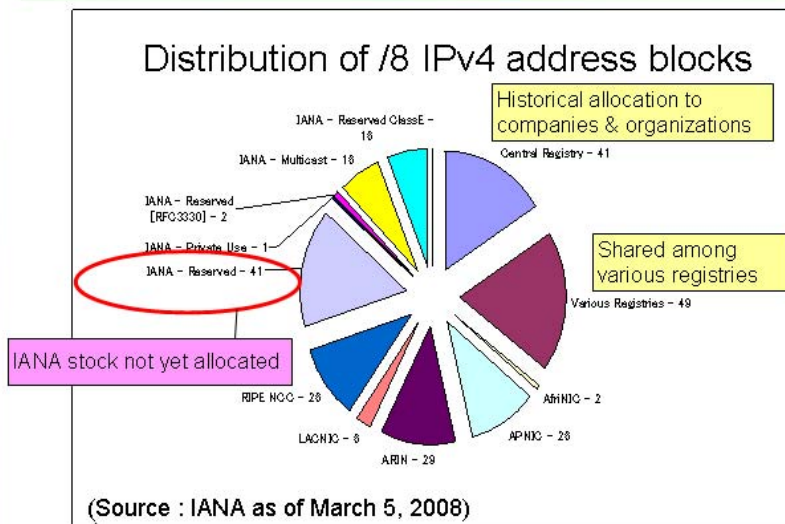
The number of broadband contracts

(Survey by MIC)

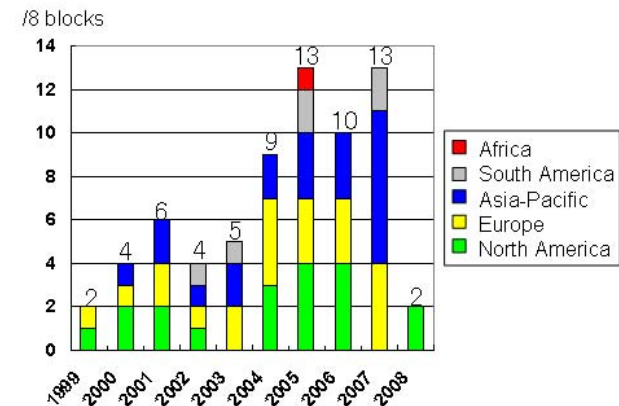
# 1. Current consumption of IPv4 addresses

1. The total number of IPv4 addresses is 4,300 million. There are about 700 million (41 blocks) remaining .
2. About 80 million were consumed every year until about 2003. Consumption has doubled because of the increased demand in Asia, South America, and Europe since around 2004.
3. The addresses will run short in 4 years all over the world unless demand decreases.  
 (The IP addresses are impartially assigned for every area according to demand, and the shortage in addresses is not a problem peculiar to Japan)

## IPv4 address allocation as of Mar. 2008



## IPv4 address allocation to each RIRs

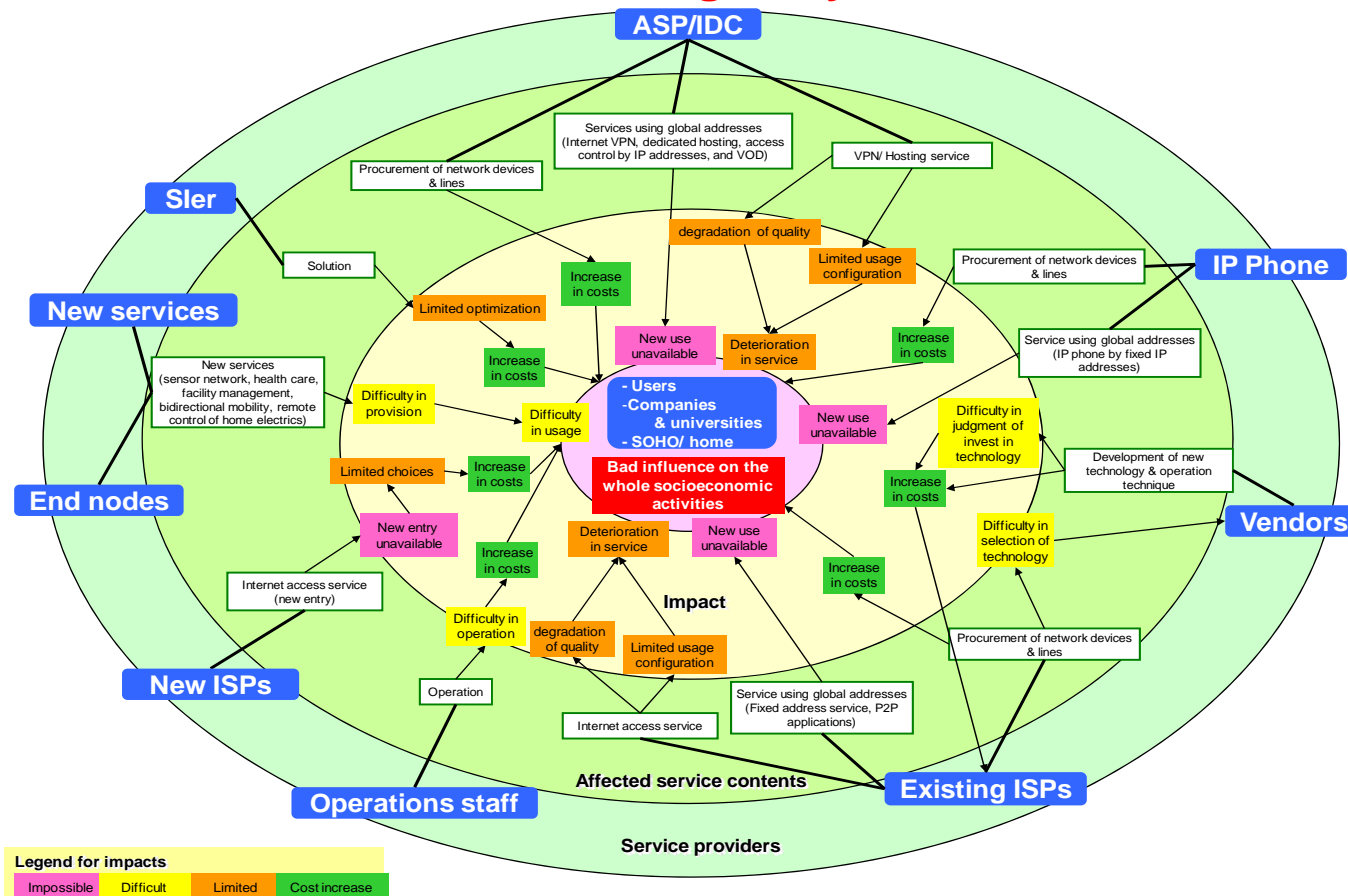


(Source : IANA as of March 5, 2008)

“/8” is 1/256 of the whole addresses, equivalent to about 16.8 million addresses

# 2.1 Influence of address space exhaustion

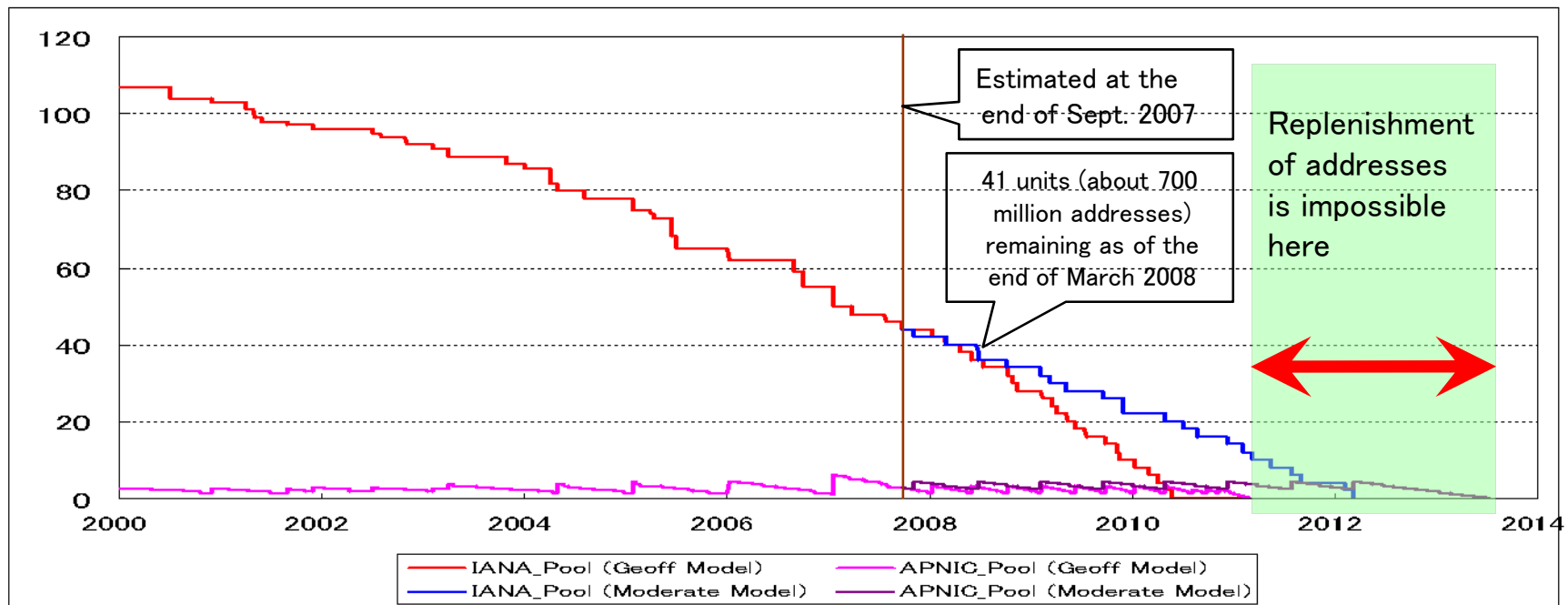
1. When the IPv4 address space is exhausted, it is possible to maintain the Internet at that point but it is impossible to develop the Internet further.
2. The influence widely reaches across various areas, and the services that users receive via the Internet are also greatly influenced.



## 2.2 Estimated date of the IPv4 address exhaustion

**Unless there will be no significant changes in the circumstances** (there will be no change in the rules concerning international address allocation or address maintenance, and that those to whom addresses are allocated will not try to retain surplus addresses arbitrarily), the following is estimated:

- IANA pool will be exhausted in the middle of 2010 to the beginning of 2012
- No more allocation of the addresses used in Japan at the beginning of 2011 to the middle of 2013



(The vertical axis is shown in units called "1/8". "1" is equivalent to about 16.8 million addresses)



# 3. Actions for address space exhaustion

1. Because the initial action must be completed by the beginning of 2011, the three actions that are possible with the existing technology were examined
  - ① Share one address among multiple nodes (saving of IP addresses) ⇒ Use NAT/NAPT (Sharing of IPv4 addresses)
  - ② Use all addresses (maximum density of IP address usage) ⇒ Reallocate the distributed IPv4 addresses
  - ③ Utilize new address resources ⇒ Transition to IPv6
2. These are compared from the following viewpoints
  - ① Feasibility within a time limit: Problems that should be solved can be solved in about 3 years.
  - ② Continuity of service: The uses that can be provided in the current Internet will continue to be used.
  - ③ Continuance of effect: Reattempt actions are unnecessary because general users are influenced.

	Utilization of NAT/NAPT (Sharing of IPv4 addresses)	Reallocation of the assigned IPv4 addresses	Transition to IPv6
Feasibility within a time limit	✓	Doubtful	Extremely difficult
Service continuity	Limited	✓	✓
Permanent effect	Doubtful	NG	✓

▪ Essential action: Transition to IPv6  
 ▪ Initial action: Utilization of NAT/NAPT should be carried out in combination.

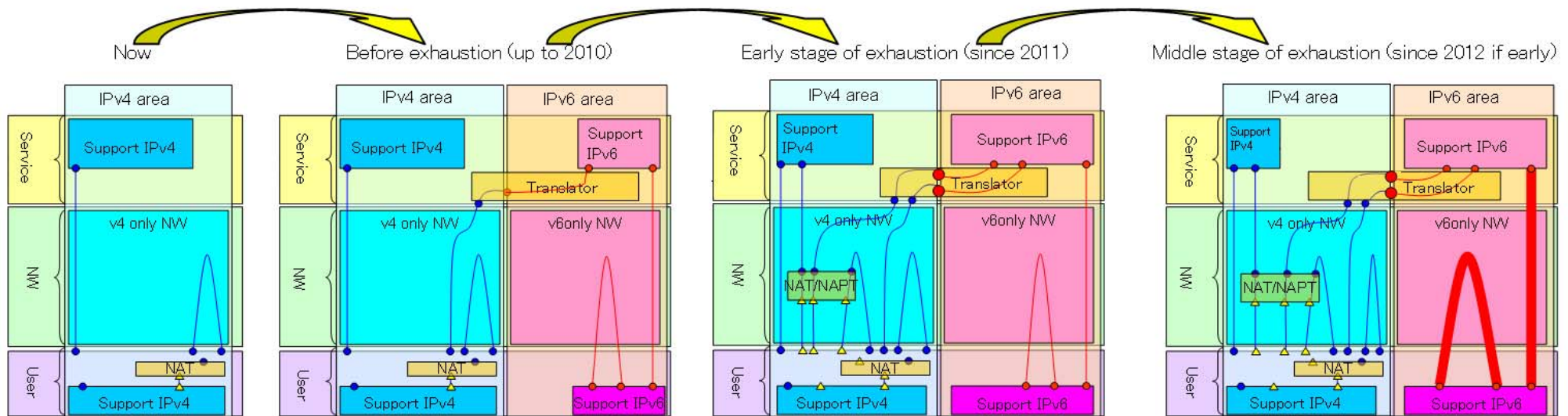
# 4. Introduction procedure of the measures for address exhaustion

1. When NAT/NAPT is adopted, Two-way communication will be difficult. Therefore, it is difficult to install in service providers, and, if it is installed in users, the method of providing services is limited.
2. Communication is impossible between IPv6 and IPv4 networks. Therefore, not only the networks but also the services/users must transit to IPv6.
3. it is appropriate to introduce countermeasures in three stages: before exhaustion, early, and middle stages of exhaustion.
4. The connection method between ISPs and access networks must be immediately agreed on by the relevant parties. (The following page)




•Support of IPv6 by networks / services [Preparation]

•Sharing of one v4 addresses by multiple users (NAT/NAPT)  
•Support of NAT/NAPT by services [Initial action]

•Existing users will be accommodated under NAT/NAPT  
•Full-scale utilization of IPv6 [Full-scale action]



NAT : Network Address Translation, NAPT : Network Address Port Translation

 : Shared v4 addresses  
 : Occupied v4 addresses  
 : Occupied v6 addresses  
 Blue line: v4    Red line: v6

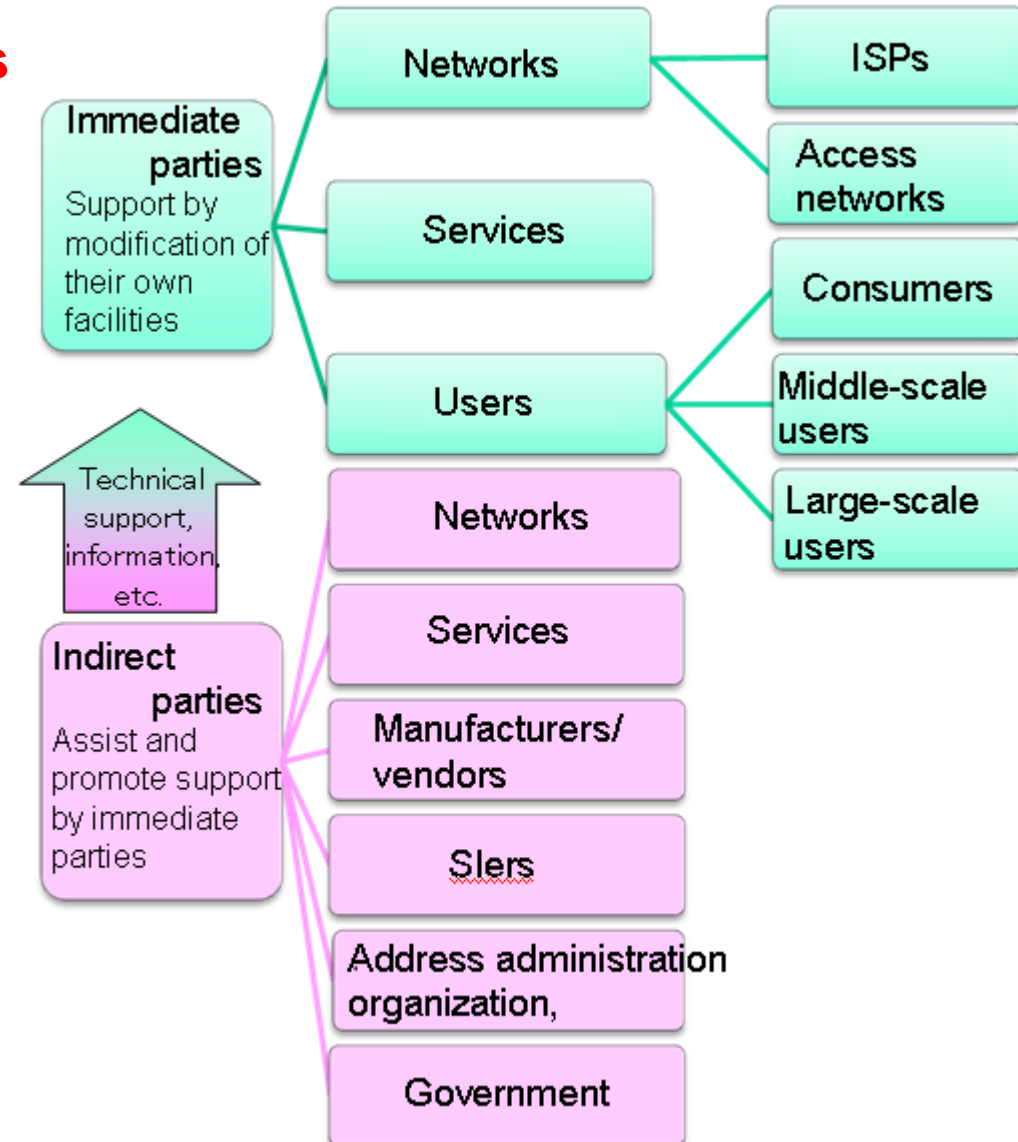
## Model of the procedure for introduction of measures for address space exhaustion

# 4. 2 Connection between access networks and ISPs

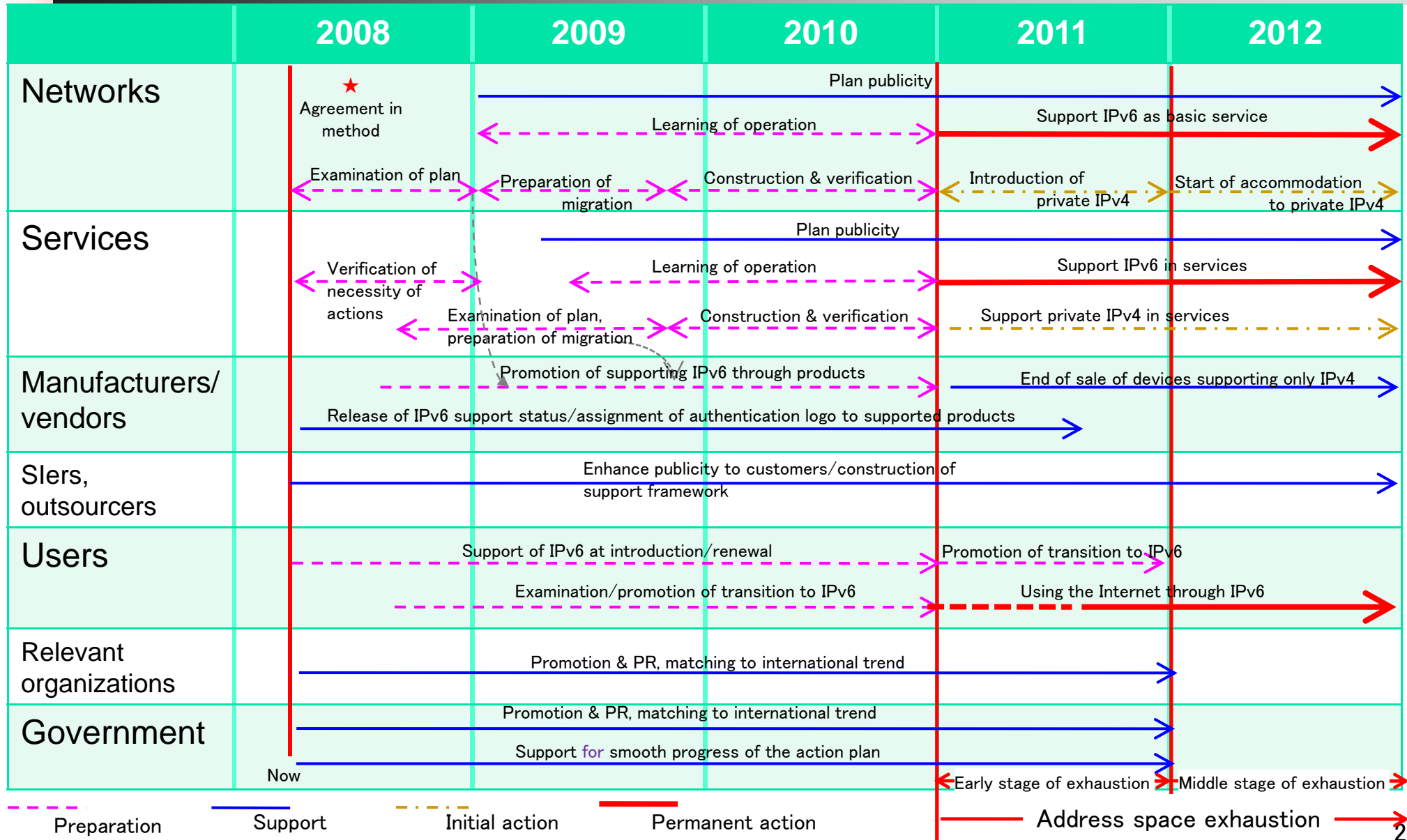
1. From a technical standpoint, following four methods are possible:
  - ① Distinction at Layer 1 (physical layer): Connect to ISP physically on the physical line level.
    - The access network is not involved in ISPs. ISPs can operate IPv4 and IPv6 arbitrarily.
  - ② Distinction in Layer 2 (data link layer): An ISP is selected using the ID of CPE, the equipment installed in a user's premise.
    - CPE is indispensable. ISPs can operate IPv4 and IPv6 arbitrarily.
  - ③ Distinction with an IP address: The IP address is determined in consideration of the distinction of ISPs and the position on the access network.
    - A rule about what kind of IP address should be distributed to a user is necessary between the access network and the ISP.
  - ④ Using tunneling technology: Users are temporarily accommodated in the access network and a virtual network is established between the ISP and the users.
    - CPE and the terminal supporting tunneling technology are indispensable, and also the technical overhead exists.
  
2. It is appropriate that the method will be decided by the discussion between the access networks and ISP's. The following must be noted:
  - ① The rate of burden between the access network and the ISP will change depending on the method, but the cost will be eventually passed on to users. Therefore, the rate does not affect the selection of which system is better.
  - ② If the selected method is different from the international trend, there is a possibility that the communication environment of Japanese users may be different from that of general users in the world.
  - ③ After the decision of the connection method would be made, development of devices by manufacturers, introduction of the devices to the networks, and the verification of the networks will take two and a half years. Therefore, the method must be decided immediately.

# 5. Action plan (1: Organizing players)

1. **The measures for IPv4 address exhaustion will be expected to implement by networks, services, and users (immediate parties) primarily.**
2. The above three elements contain technical problems that cannot be solved by themselves. **Indirect parties need to cooperate to solve them.**
3. The players are organized as shown on the right, considering their natures.



# Action plan (2: Overview)



## 5. Action plan (3: promotion framework)

1. The government will not force each player to perform what is described in **the action plan. It is extremely important that each player recognizes its role and promotes the actions itself.**
2. However, while the information about the method of introduction should be shared widely, it is necessary to establish a framework for grasping the progress and urging those who are behind schedule to take action.
3. Therefore, **the IPv6 Promotion Council** should strengthen the functions regarding
  - Grasping the status of promotion of the action plan
  - Information sharing in the promotion of the action plan
  - Improvement of knowledge by related parties through the construction and employment of the test bed
  - Examination of amendments to the action plan as requiredand it should be **reconstructed as a promotional framework in cooperation with the government and the private sector.**