



# Summary of Report Study Group on Internet's Smooth Transition to IPv6

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

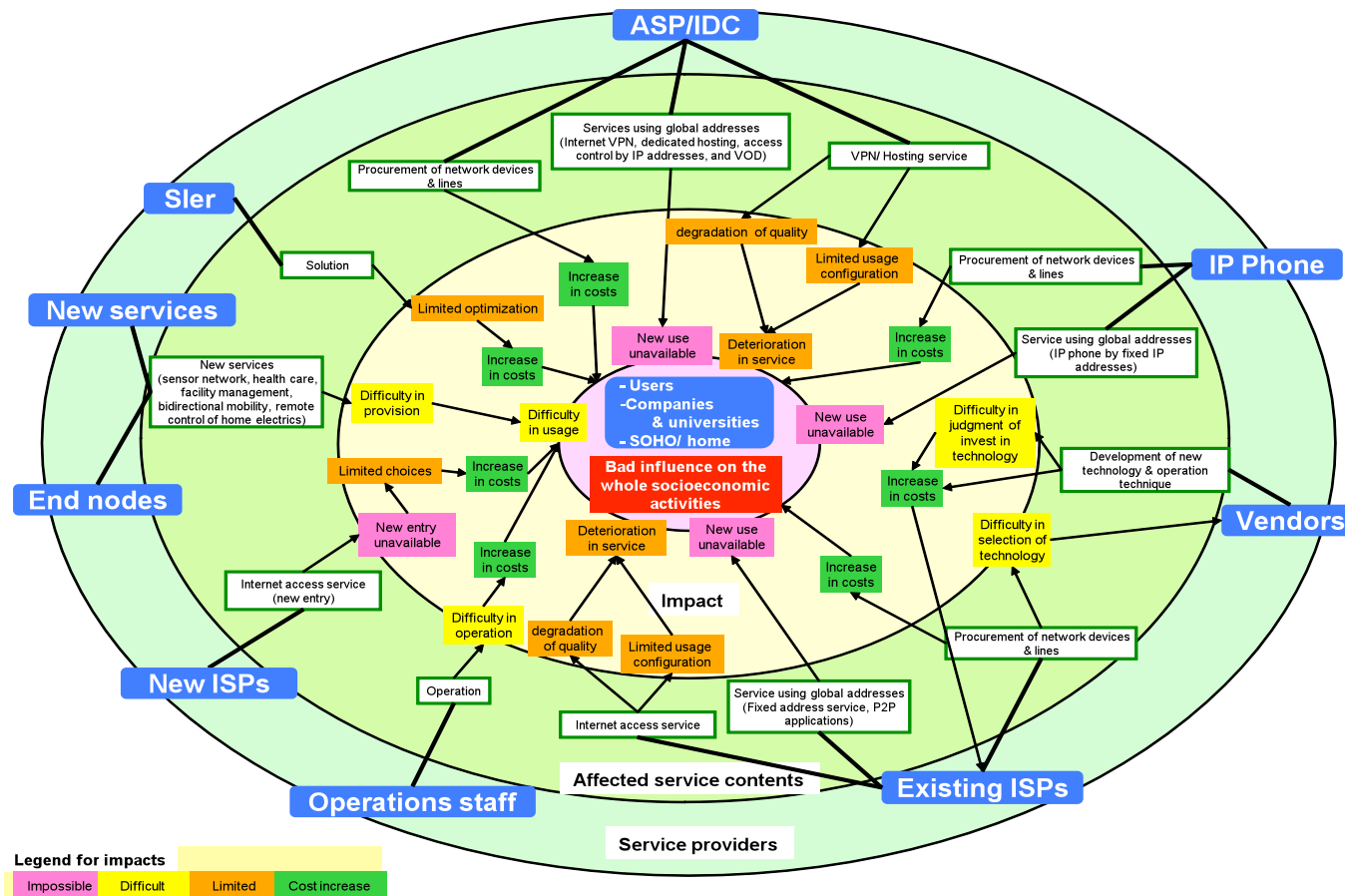
*Edited by Izumi Aizu*

# 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 is 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.

# 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.



# Actions for IPv4 address space exhaustion

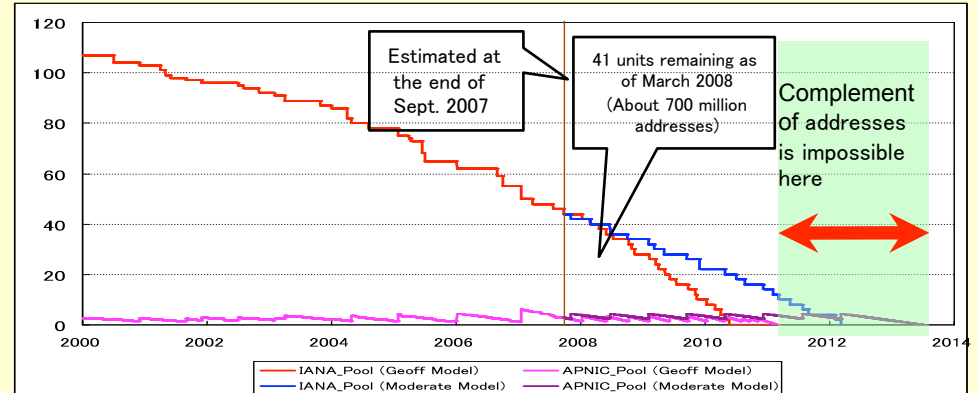
International stock of addresses (equivalent to telephone numbers) based on the communication protocol (IPv4) used on the Internet will be exhausted in about three years.

- 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.

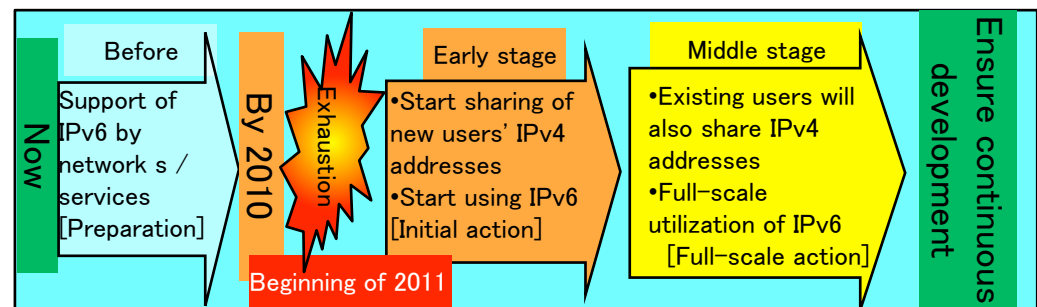
- For continuous development of the Internet, from three viewpoints of feasibility within a time limit, continuity of service on the Internet, and continuance of effect, the transition to a new address system (IPv6) and sharing of one address by multiple users must be combined and carried out.
- It is 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.

# 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 Continuation of effect: ~~Reattempt actions are unnecessary because general users are influenced.~~

|                                    | Utilization of NAT/<br>NAPT (Sharing of<br>IPv4 addresses) | Reallocation of the<br>assigned IPv4<br>addresses | Transition to IPv6  |
|------------------------------------|--|---|---------------------|
| Feasibility<br>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.



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

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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 (Tokyo) 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]

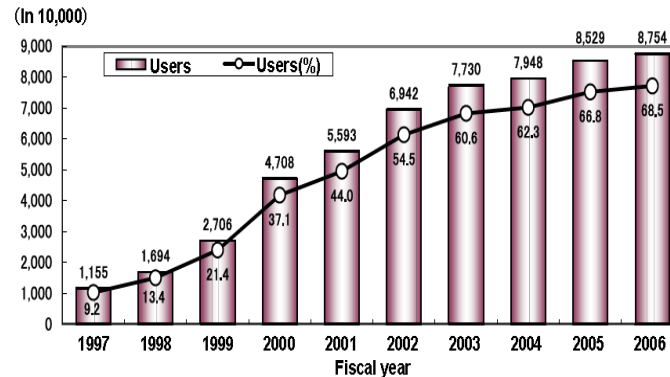
- Takashi Arano Executive Officer, Japan Network Information Center
- Taketsune Watanabe Chairman, Japan Internet Providers Association
- Takamasa Nakamura (Association) President, Japan Cable Laboratories (Director, Japan Cable and Telecommunications Association)

## [Representative of users]

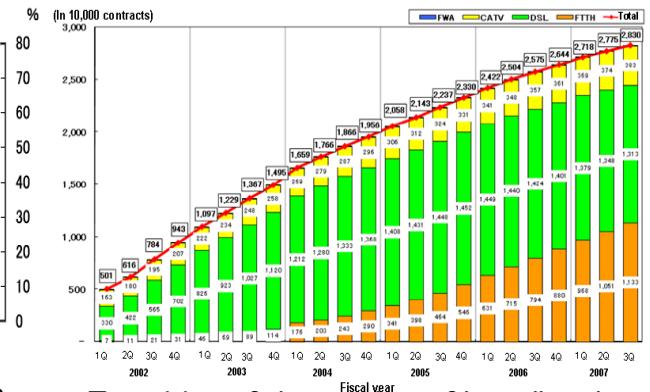
- Kimiko Yamakami Executive director, Japan Association of Consumer Affairs Specialists

# Internet address space exhaustion

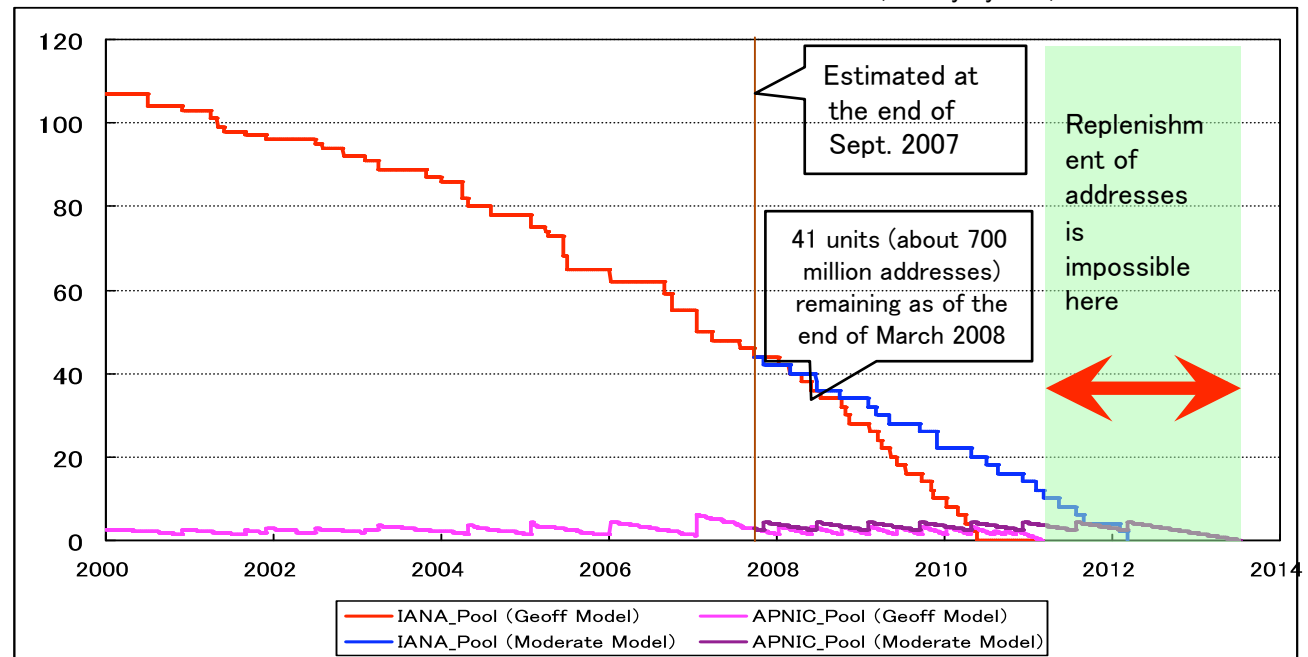
1. There are 87 million Internet users (over 2/3 of total population), and 28.3 million broadband contracts (more than 50% of total household) in Japan. The Internet is indispensable for socioeconomic activities.
2. IPv4 addresses (equivalent to the telephone numbers) required for each device link to the Internet remain only about 700 million of 4,300 million.
3. 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.
4. The addresses will run short as early as the beginning of 2011 unless demand decreases.



Transition of the number of Internet users  
(Communication utilization trend survey, 2006)



Transition of the number of broadband contracts  
(Survey by MIC)



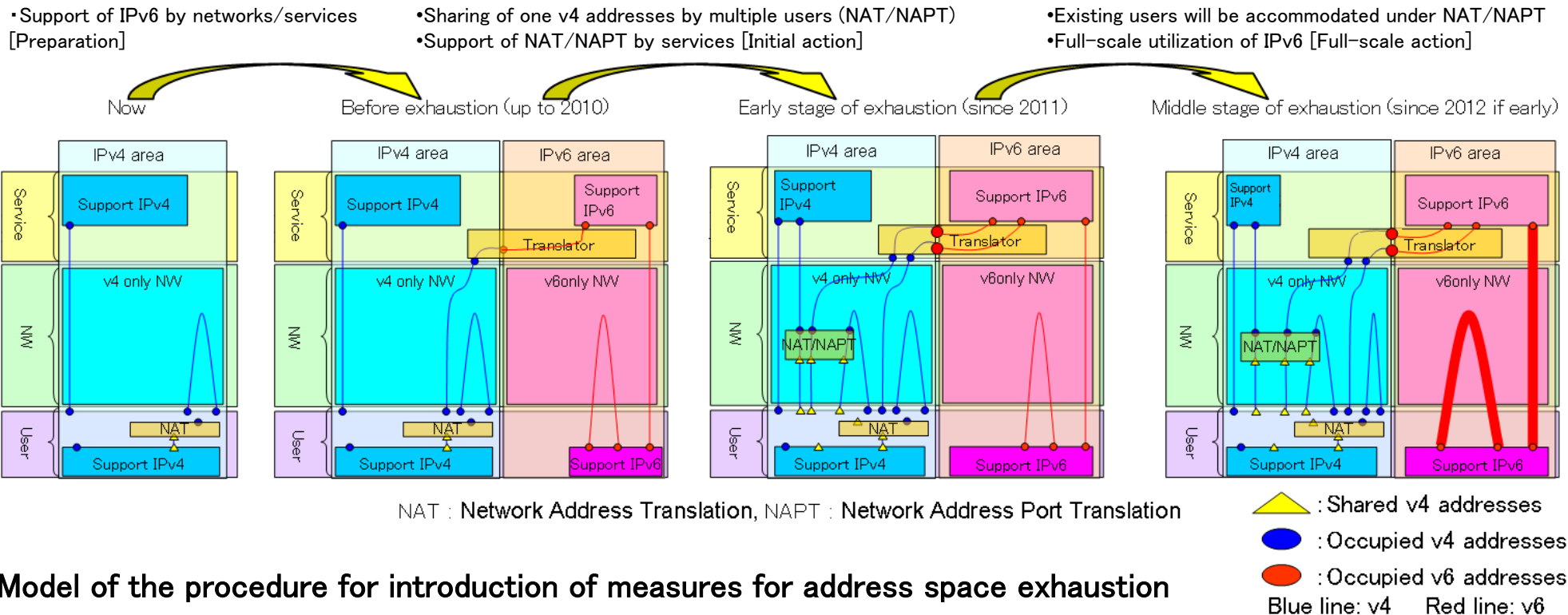
Estimated number of the remaining IPv4 addresses in international stock

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



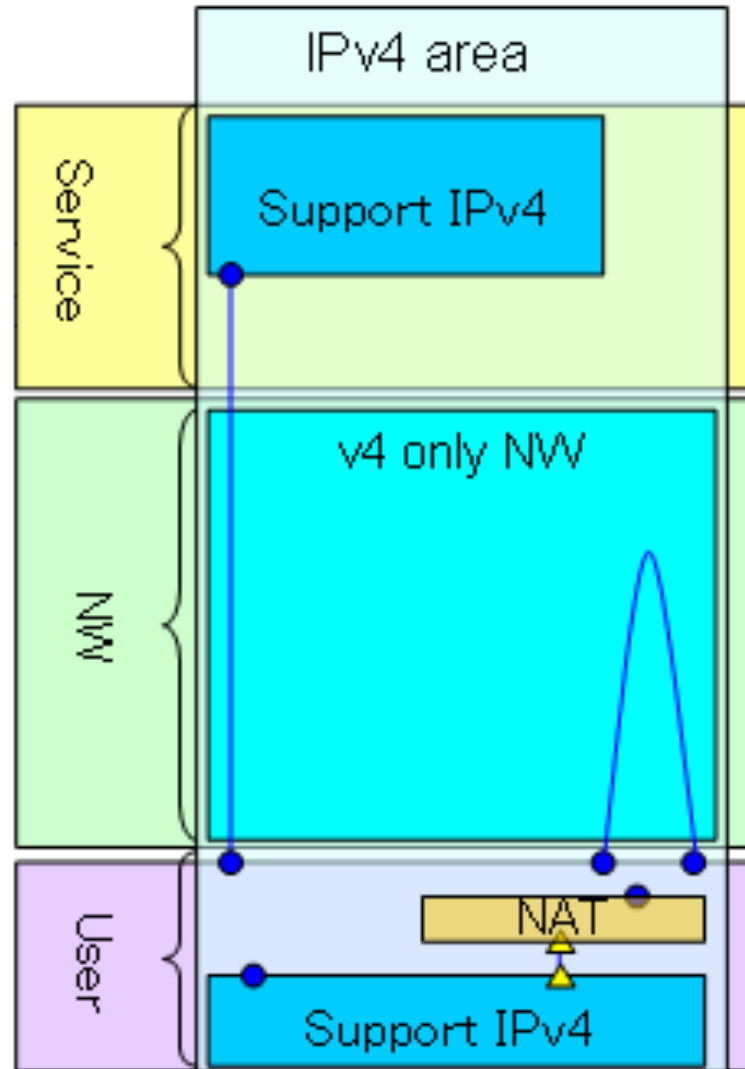
# Measures for address space exhaustion

- 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.



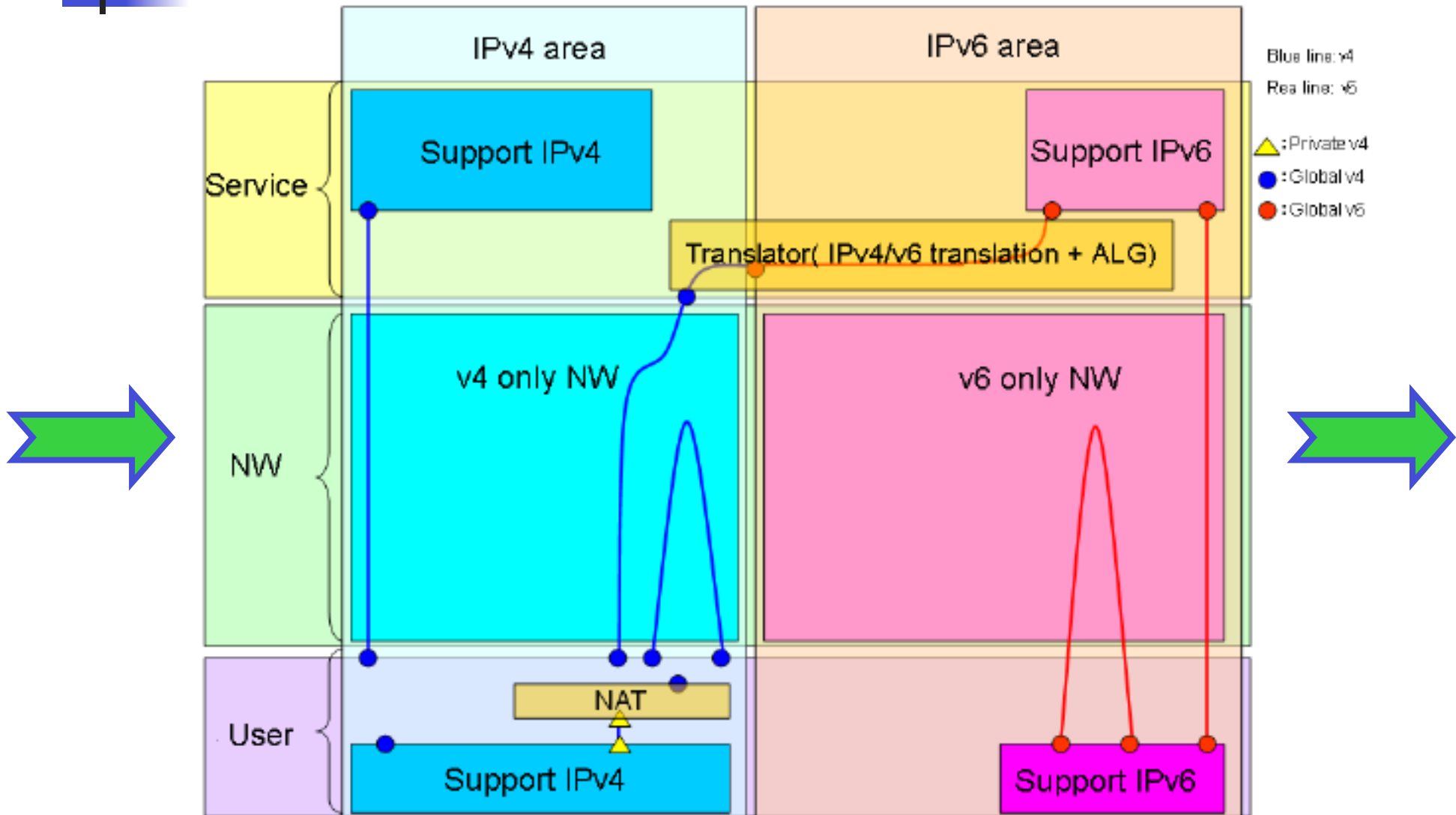
Model of the procedure for introduction of measures for address space exhaustion

# Current state of IPv4-only Network

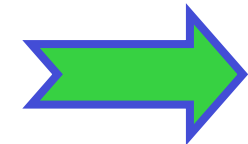
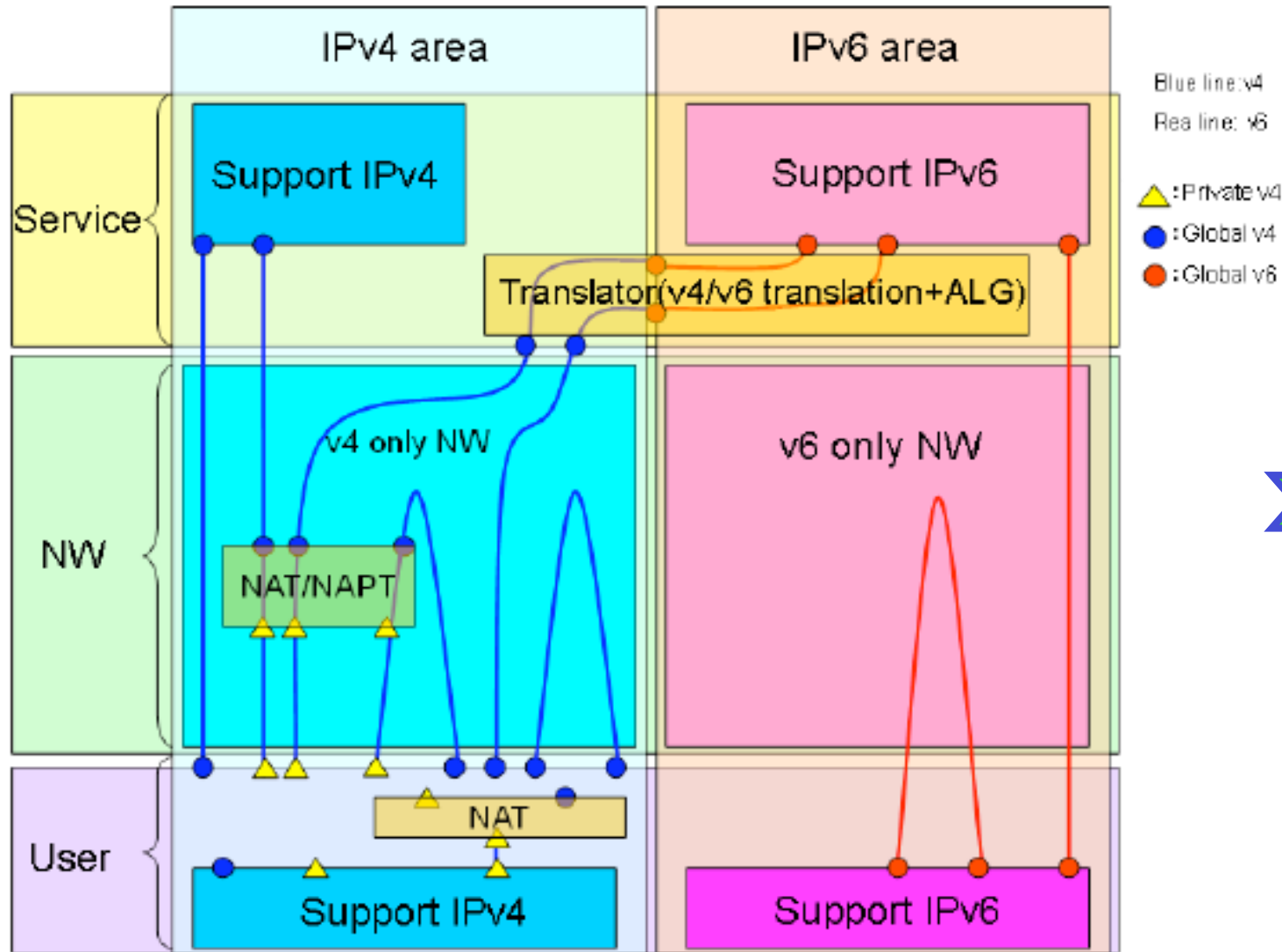
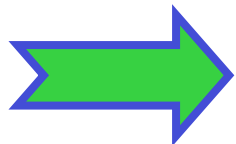


# Model of IPv4-v6 Coexistence

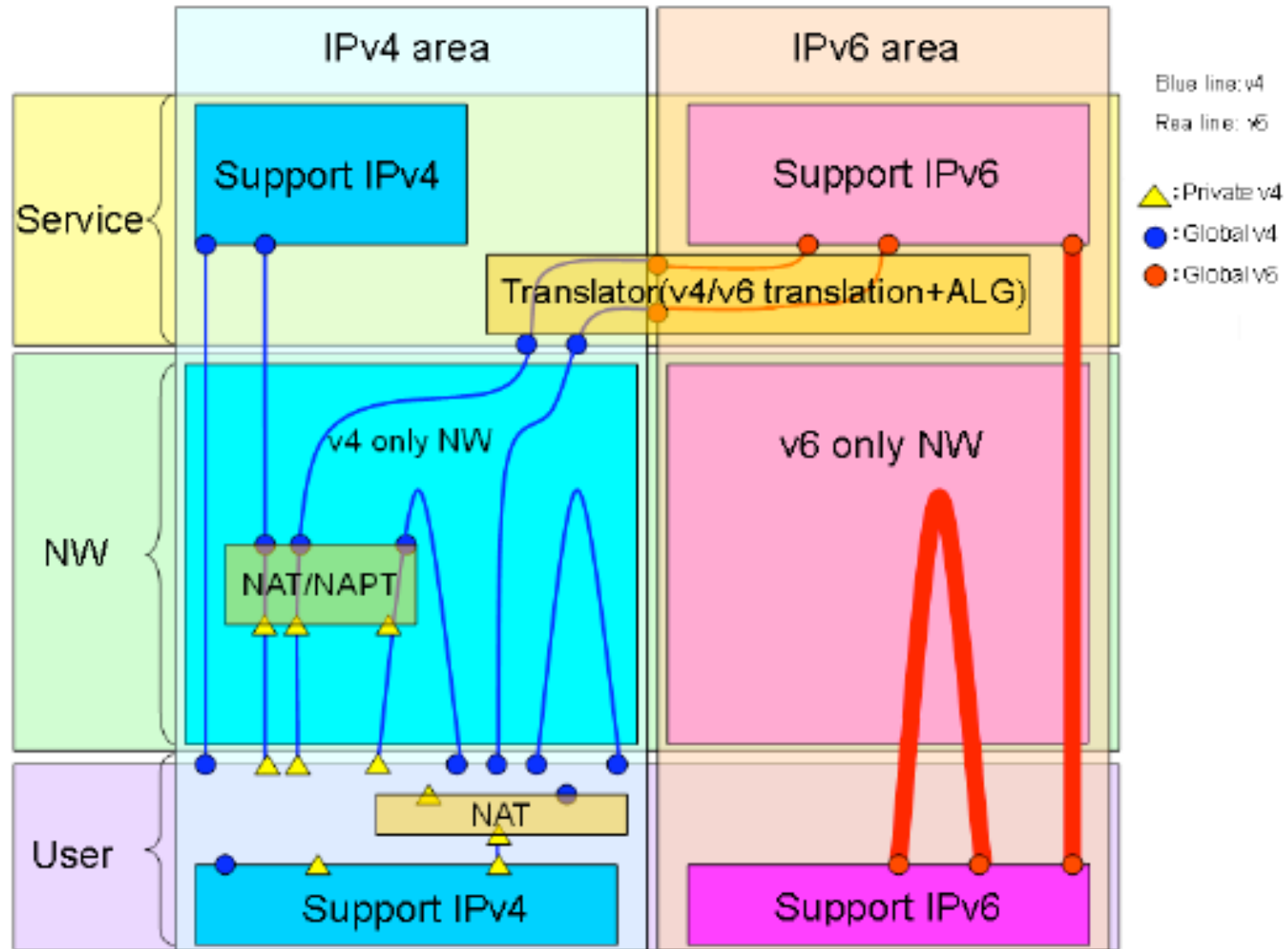
## Immediately before IPv4 Address exhaustion



# In the early stage of address exhaustion



# In the middle stage of exhaustion



# Anticipated Problems for the users

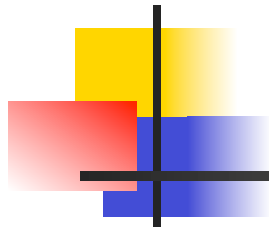
## For consumer users: PC, Appliances

IPv4 and v6 Networks separate

IPv4 and v6 inter-connected with Translator services etc.

|   |                                 |                                   |     |   |     |  |
|---|---------------------------------|-----------------------------------|-----|---|-----|--|
| C<br>o<br>n<br>s<br>u<br>m<br>e<br>r<br><br>u<br>s<br>e<br>r<br>s | D<br>e<br>v<br>i<br>c<br>e<br>s | PC                                | a/b | <p>-Possible if the newest software including OS is used.<br/>Example: In the case of Windows, Vista or later is necessary (Windows XP does not support DNS and file sharing using IPv6).</p> <p>-The mechanism of selecting a suitable communication method under the v4/v6 mixed environment is insufficient.</p> | a/b | <p>-The mechanism of selecting a suitable communication method under the v4/v6 mixed environment is insufficient.</p>  |
|   |                                 | Network connected home appliances | a/d | <p>-Many of the devices including DLNA device are supporting only IPv4.</p> <p>-IPv4 may be going to continue to be indispensable, because some devices have difficulty in updating after shipment.</p>   | a/d | <p>-Few devices are supporting IPv6 now.</p> <p>-Uncertainty about the state synchronization at backup redundancy (may be lacking in stability).</p> <p>-Enough performance may not be obtained for video.</p> |

# For consumer users: CPE



|   |                                 |     |             |   |
|---|---------------------------------|-----|-------------|---|
| C<br>o<br>n<br>s<br>u<br>m<br>e<br>r<br><br>u<br>s<br>e<br>r<br>s | D<br>e<br>v<br>i<br>c<br>e<br>s | CPE | a/b/c<br>/d | <ul style="list-style-type: none"> <li>-Required functions are dependent on the network architecture.</li> <li>-There are some products including DSL modems that do not support IPv6 and have no development plan.</li> <li>-Remote monitoring functions using IPv6 must be developed.</li> <li>-Most equipments at the present are supporting only IPv6 pass-through and cannot perform IPv6 routing. Therefore, it is difficult to manage the devices supporting IPv6.</li> <li>-IPv6 is inferior in throughput to IPv4.</li> <li>-NAT which practically functions as a firewall will be removed.</li> <li>-The existing devices are inferior in the security related functions (packet filter, SPI, IDS, and firewall).</li> <li>-The function to upgrade the old devices at home that support only IPv4 to IPv6-enable may be required.</li> </ul> |
|---|---------------------------------|-----|-------------|---|

# For consumer users: Applications

|                |              |                   |       |   |     |  |
|----------------|--------------|-------------------|-------|---|-----|--|
| Consumer users | Applications | E-mail            | a/b   | <ul style="list-style-type: none"> <li>-Generally possible if the newest software is used.</li> <li>Example: Thunderbird, Becky!, Winbiff, etc.</li> <li>-Fall back may be occurred, although it depends on the DNS.</li> </ul>     | a/b |  |
|                |              | Web browsing      | a/b   | <ul style="list-style-type: none"> <li>-Generally possible if the newest software is used.</li> <li>Example: Internet Explore, Firefox, Opera, etc.</li> <li>-Fall back may be occurred, although it depends on the DNS.</li> </ul> | a/d | -There may be much content that cannot be supported by a translator (In case the content has the address information in the payload section).  |
|                |              | VoIP              | a/b/d | <ul style="list-style-type: none"> <li>-Depends on products.</li> <li>-The network must provide DNS that support each of IPv4/v6.</li> </ul>  | a/d | -There may be much content that cannot be supported by a translator (In case the content has the address information in the payload section).  |
|                |              | Streaming         | a/d   | <ul style="list-style-type: none"> <li>-Depends on products.</li> <li>-The network must provide DNS that support both IPv4/v6.</li> </ul>   | a/d |  |
|                |              | Dynamic DNS       | d     |   |     |  |
|                |              | P2P application   | a/d   | -Depends on applications.   | a/d | <ul style="list-style-type: none"> <li>-Depends on applications.</li> <li>-There may be much content that cannot be supported by a translator (those are including the address in the payload section).</li> </ul> |
|                |              | NTP               | a     |   | a   | -Simultaneity in communication may not be ensured.   |
|                |              | Personal firewall | a     | -Generally possible if the newest software is used  |     |  |
|                |              |                   |       |   |     |  |



# For Middle Scale Users: Devices

|  |                                 |                  |       |  |
|--|---------------------------------|------------------|-------|--|
| M<br>i<br>d<br>d<br>l<br>e<br><br>s<br>c<br>a<br>l<br>e<br><br>u<br>s<br>e<br>r<br>s | D<br>e<br>v<br>i<br>c<br>e<br>s | Routers/switches | a/b/c | <ul style="list-style-type: none"> <li>-The management function using IPv6 must be developed.</li> <li>-Remote maintenance tools are insufficient.</li> <li>-Many existing devices do not support IPv6 and they are likely to be replaced.</li> <li>-Even if the devices are supporting IPv6, stability may decrease. Especially in the case of old devices, throughput with IPv6 may decrease significantly as compared with IPv4.</li> <li>-Some routers/switches accommodating servers have problems in the redundancy (ALAXALA, NEC, and Nokia have completed implementation).</li> <li>-Being careful with setup of the security related functions (packet filter, SPI, IPSec, etc.) may be difficult, because the address length is long in IPv6.</li> </ul> |
|--|---------------------------------|------------------|-------|--|

# For Middle Scale Users: Devices – IDS/IPS

|  |                |              |  |
|--|----------------|--------------|--|
| <p>e<br/>u<br/>s<br/>e<br/>r<br/>s</p> | <p>IDS/IPS</p> | <p>b/c/d</p> | <ul style="list-style-type: none"> <li>-Few products are supporting IPv6.</li> <li>-In some products, coverage of supporting level is unclear, which including whether the policy rule depending on the address can be created under the IPv6 environment.</li> <li>-Filtering conditions may not be able to specified carefully.</li> <li>-The management function using IPv6 must be developed.</li> <li>-Difficulty in state synchronization at redundancy.</li> <li>-Throughput with IPv6 may decrease significantly as compared with IPv4.</li> </ul> |
|--|----------------|--------------|--|



## And..

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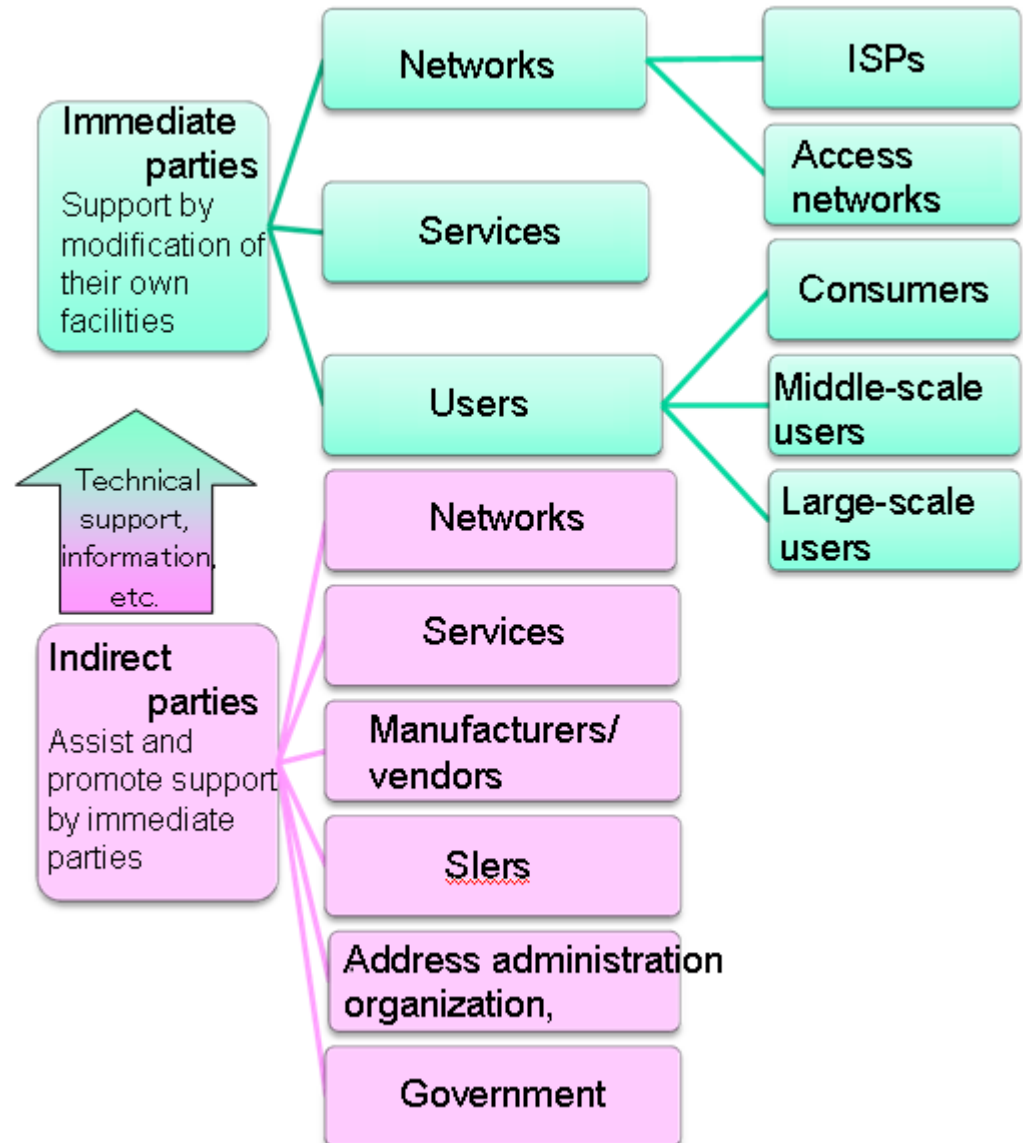
- Anti virus software
- Proxy servers
- VPN devices
- Office equipment
- DHCP
- Authentication
- Database software
- NTP

# Action plan (1: Organizing players)

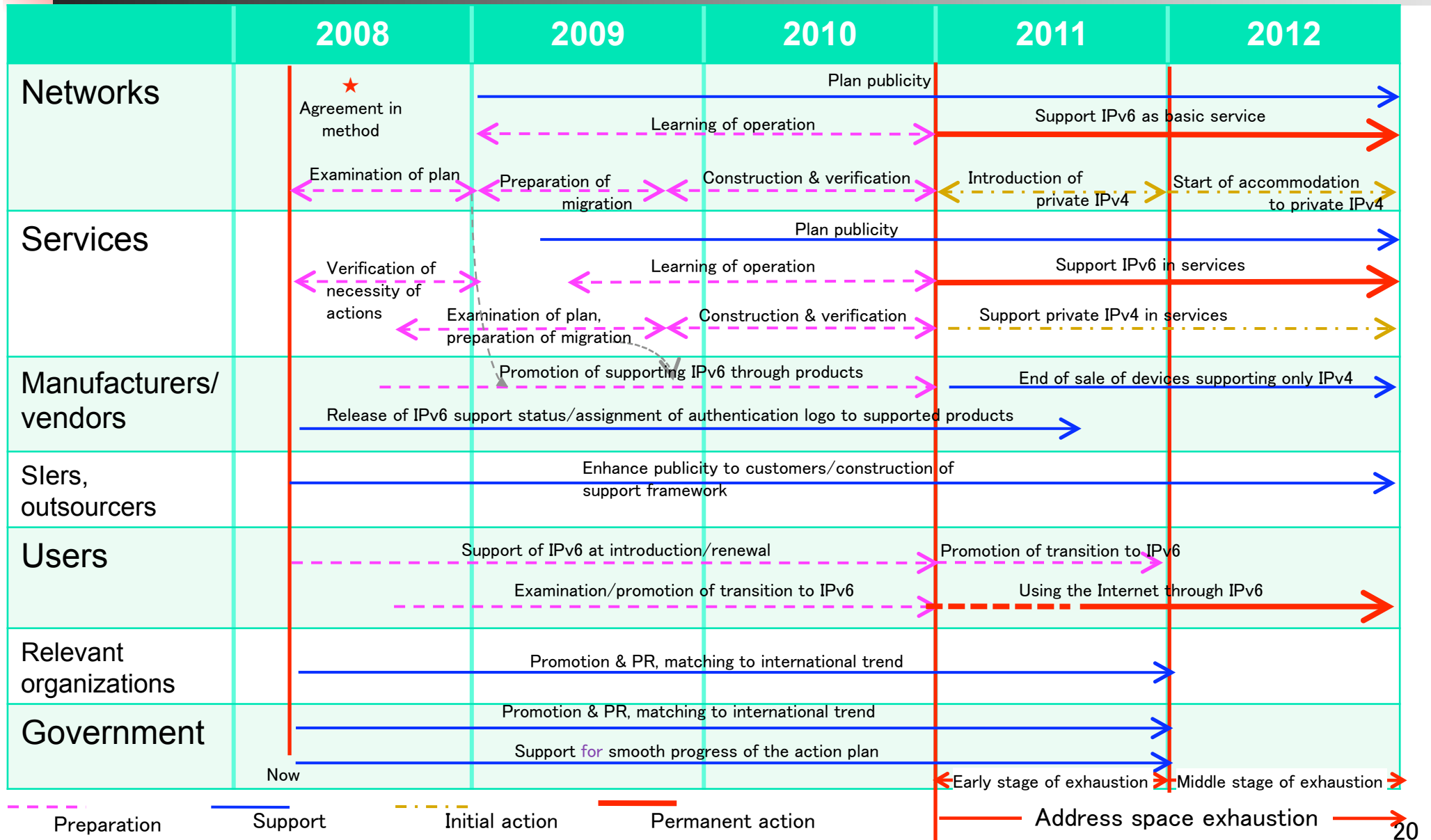
1. **The measures for IPv4 address exhaustion will be expected to be implemented by networks, services, and users (immediate parties) primarily.**
2. The above three elements have technical problems that cannot be solved by themselves. **Indirect parties need to cooperate to solve them.**



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



# Action plan (2: Overview)



## 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.

# 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

## 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.**





# Reference

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[www.soumu.go.jp/joho\\_tsusin/eng/index.html](http://www.soumu.go.jp/joho_tsusin/eng/index.html)