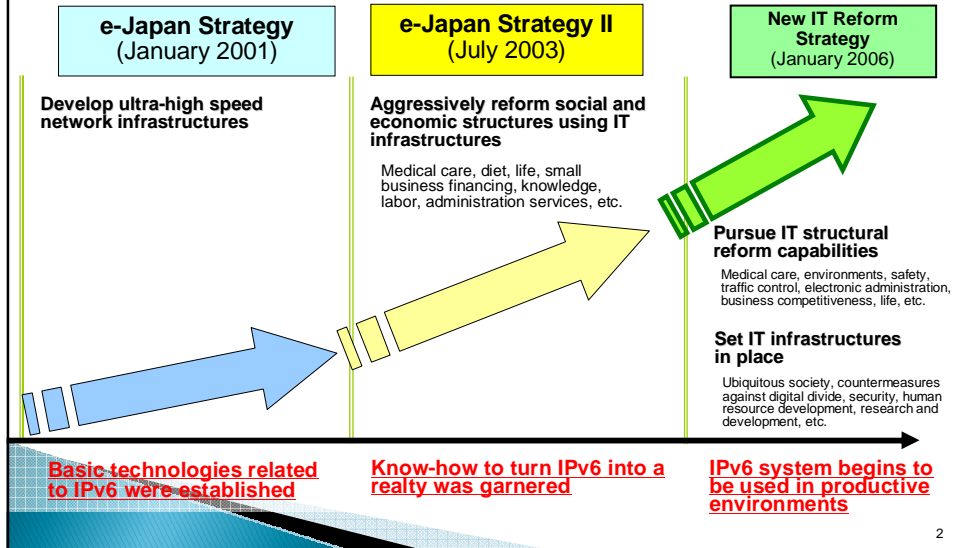MIC
Ministry of Internal Affairs and Communication
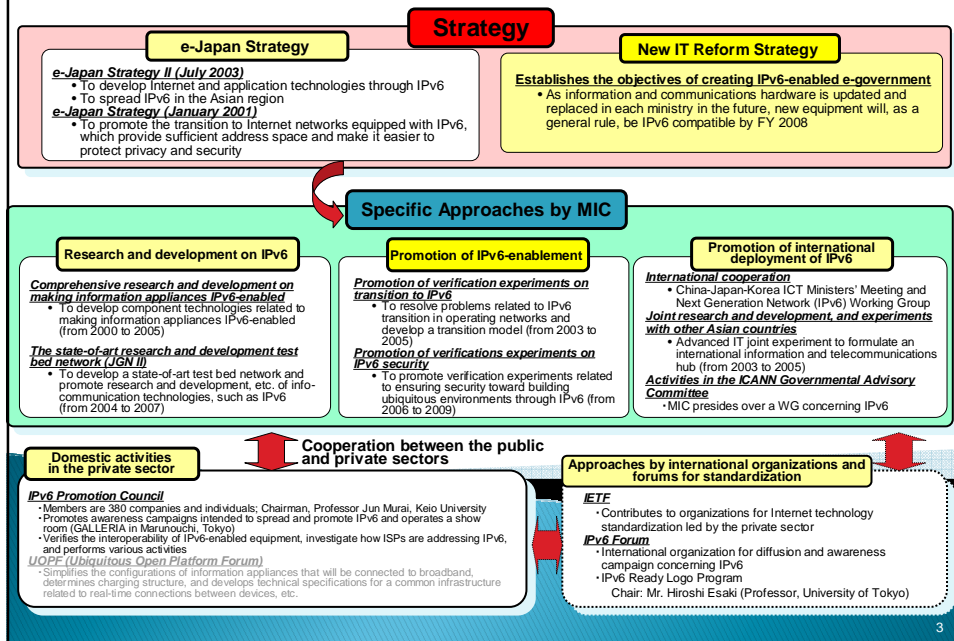
MIC's Efforts Geared Towards Transition to IPv6

December 11, 2007
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Approaches in Japan towards Making the Internet Compatible with IPv6

IPv6 Policy Transition

e-Japan Strategy
(January 2001)

e-Japan Strategy II
(July 2003)

New IT Reform Strategy
(January 2006)

Develop ultra-high speed network infrastructures

Aggressively reform social and economic structures using IT infrastructures

Medical care, diet, life, small business financing, knowledge, labor, administration services, etc.

Pursue IT structural reform capabilities

Medical care, environments, safety, traffic control, electronic administration, business competitiveness, life, etc.

Set IT infrastructures in place

Ubiquitous society, countermeasures against digital divide, security, human resource development, research and development, etc.

Basic technologies related to IPv6 were established

Know-how to turn IPv6 into a realty was garnered

IPv6 system begins to be used in productive environments

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Approaches to Promoting IPv6

Strategy

e-Japan Strategy

e-Japan Strategy II (July 2003)
• To develop Internet and application technologies through IPv6
• To spread IPv6 in the Asian region

e-Japan Strategy (January 2001)
• To promote the transition to Internet networks equipped with IPv6, which provide sufficient address space and make it easier to protect privacy and security

New IT Reform Strategy

Establishes the objectives of creating IPv6-enabled e-government
• As information and communications hardware is updated and replaced in each ministry in the future, new equipment will, as a general rule, be IPv6 compatible by FY 2008

Specific Approaches by MIC

Research and development on IPv6

Comprehensive research and development on making information appliances IPv6-enabled
• To develop component technologies related to making information appliances IPv6-enabled (from 2000 to 2005)

The state-of-art research and development test bed network (JGN II)
• To develop a state-of-art test bed network and promote research and development, etc. of info-communication technologies, such as IPv6 (from 2004 to 2007)

Promotion of IPv6-enablement

Promotion of verification experiments on transition to IPv6
• To resolve problems related to IPv6 transition in operating networks and develop a transition model (from 2003 to 2005)

Promotion of verifications experiments on IPv6 security
• To promote verification experiments related to ensuring security toward building ubiquitous environments through IPv6 (from 2006 to 2009)

Promotion of international deployment of IPv6

International cooperation
• China-Japan-Korea ICT Ministers' Meeting and Next Generation Network (IPv6) Working Group

Joint research and development, and experiments with other Asian countries
• Advanced IT joint experiment to formulate an international information and telecommunications hub (from 2003 to 2005)

Activities in the ICANN Governmental Advisory Committee
• MIC presides over a WG concerning IPv6

Cooperation between the public and private sectors

Domestic activities in the private sector

IPv6 Promotion Council
• Members are 380 companies and individuals; Chairman, Professor Jun Murai, Keio University
• Promotes awareness campaigns intended to spread and promote IPv6 and operates a show room (GALLERIA in Marunouchi, Tokyo)
• Verifies the interoperability of IPv6-enabled equipment, investigate how ISPs are addressing IPv6, and performs various activities

UOPF (Ubiquitous Open Platform Forum)
• Simplifies the configurations of information appliances that will be connected to broadband, determines charging structure, and develops technical specifications for a common infrastructure related to real-time connections between devices, etc.

Approaches by international organizations and forums for standardization

IETF
• Contributes to organizations for Internet technology standardization led by the private sector

IPv6 Forum
• International organization for diffusion and awareness campaign concerning IPv6
• IPv6 Ready Logo Program
   Chair: Mr. Hiroshi Esaki (Professor, University of Tokyo)

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IPv6 Deployment in e-Government

New IT Reform Strategy

"As information and communications hardware is updated and replaced in each ministry in the future, new equipment will, as a general rule, be IPv6 compatible by FY 2008."

**The First National Strategy on Information Security
(finalized on February 2, 2006)**

Basic policies to address the issues of information security in Japan
- It is important "to introduce Internet Protocol version 6 (IPv6)… from the perspective of establishing a new infrastructure itself having the built-in function of information security…"

Consideration for the introduction of a new system (function) contributing to security enhancement and its realization in government agencies
- Towards the establishment of the next generation E-Government, it is essential to consider the construction/development of a common platform for the basis of operations and systems of the entire government. In order to strengthen the security platform, the government will consider a comprehensive way of installing a new system (function), such as an IPv6… promote the realization of the system.
- Particularly, in order to expedite the use of IPv6 in the information systems of all government agencies, information and telecommunications equipment and software will be made compatible to IPv6, in principle, by fiscal 2008, in accordance with the new development (installation) or modification of information system of each government agency.

"Guidelines Developed for e-Government IPv6 System"

- In order to assist all government agencies in making their systems compatible with IPv6, MIC established the "Guidelines Developed for e-Government IPv6 System" in March 2007 (http://www.soumu.go.jp/s-news/2007/070402_5.html)
- These Guidelines were intended to segregate the IPv6-enablement process into the following three phases, and to facilitate "the development of IPv6-compatible environments":
  ◦ "Phase to develop IPv6-compatible environments" where systems are managed in ways that prevent communications through IPv6
  ◦ "Phase to start to use IPv6" in which incoming IPv6 communications can be addressed at a required minimum level
  ◦ "Phase to use both IPv4 and IPv6" in which all communications can be transmitted via either IPv4 or IPv6

- Government agencies are currently considering developing the "IPv6-enablement Plan" based on the "Secure Japan 2007" and "e-Government Promotion Plan."

Priority Policy Program 2007 (finalized on July 26, 2007, by IT Strategic Headquarters)
Secure Japan 2007 (finalized on June 14, 2007, by Information Security Policy Council)

● **IPv6-ready e-Government systems**

In light of the fact that use of IPv6 in e-Government will strengthen security in preventing information leakage and misuse, make workflow interactive, and be beneficial in building an inter-ministry shared use system, and as an early countermeasure before IPv4 address depletion expected as early as FY2010, each ministry will make information and telecommunications equipment and software IPv6 compatible, when new information systems are developed (integrated) or updated, by FY2008, in principle. The following measures will be put in force for smooth implementation.

   1) Each ministry will consider the results from each e-Government system's IPv6 readiness following the guidelines established in FY2006, and deliberate on the benefits of making each e-Government system compatible to IPv6 and beginning in FY2007, establish specific plans to attain IPv6 compatibility in various information systems.

e-Government Promotion Plan
(finalized by the CIO Liaison Committee, partially revised on August 24, 2007)

● **Information security countermeasures, etc.**

  (1) Effective deployment of information and telecommunications technologies

Each ministry shall effectively introduce information and telecommunications technologies that are expected to spread, such as IPv6, after clarifying the applicable scope and benefits of such technologies.

Concerning IPv6, each ministry shall clarify the specifics, such as the scope, benefits, transition schedule, etc. of IPv6-enablement, in a specific plan that the ministry will develop to address IPv6-compatibility by referring to the "Guidelines Developed for e-Government IPv6 System" (finalized on March 30, 2007, by MIC).

Study Group on Internet's Smooth Transition to IPv6

MIC will convene a study group to promote Internet transition to IPv6 in Japan ahead of any other country in the world; the study group intends to consider issues and solutions in facilitating the transition of domestic Internet networks to IPv6.

1. Study items
   - Estimation of the limit of Internet use via IPv4, and measures regarding this limit
   - Issues and solutions in facilitating the prompt transition of domestic Internet networks to IPv6
   - Global strategy in this area, including response to standardization of IPv6-related technologies

2. Members
   - The Study Group will consist of approximately 20 persons, including academic experts, telecommunication carriers, service providers on the Internet, equipment vendors, and the like.
   - A WG will be set up for each of the detailed considerations.

3. Active Period
   - The study group is expected to work from August 8, 2007, to the end of March 2008.

Consideration Schedule

	August	September	October	November	December	January	February	March
Study Group meeting	▲ First meeting		▲ Second meeting			▲ Third meeting		▲ Fourth meeting

First interim report
- To predict when the IPv4 addresses are depleted
- To predict what impacts the depletion of IPv4 addresses will have

Second interim report
- To describe solutions to the depletion of IPv4 addresses and the advantages and disadvantages of such solutions
- To analyze the bottlenecks to promoting the above solutions
- To describe the solutions that Japan should select

Final report
- To describe "technical solutions" to the bottlenecks mentioned on the left and the advantages and disadvantages of those solutions
- To describe action plans, such as announcements, that the government should take, toward the depletion of IPv4 addresses

WG

To consider matters related to the prediction of IPv4 address depletion and the first interim report

To consider the solutions to the depletion of IPv4 addresses and the second interim report

To consider the technical solutions to the depletion of IPv4 addresses and the draft final report

Public comments

To consider the draft final report

Discussions over the Depletion of the Remaining Pool of IPv4 Addresses

- When the remaining pool of IPv4 addresses will be depleted
  - ICANN and the IP address management organization in charge of each global region officially announced that the international pool of IPv4 addresses was likely to be depleted by around 2010.

- Solutions to the depletion of the remaining pool of IPv4 addresses
  - ICANN and the management organizations controlling IP addresses for all regions officially announced that the solution to the depletion of the IP address pool was transition to IPv6.
  - At the same time, the management organizations in Africa, Asia, North America, and South America, have been discussing "the possibility of transferring the allotted IPv4 addresses to others," including the idea of marketing them.
    - In Africa and South America:
      Many opinions vehemently opposed to the idea of marketing IPv4 addresses are being voiced in discussions because the countries in which the Internet has not become widely used will be forced to bear higher costs than now when they obtain the addresses in the future if marketing the IPv4 addresses is allowed.
    - In Asia:
      There were suggestions for discussing the possibility of making assigned IP addresses transferable, setting aside whether such transfers are chargeable or not (these suggestions are suspended for the time being).
    - In North America:
      The majority of opinions are for creating a market to sell and buy the IPv4 addresses only if trading rules for IPv4 addresses can gain an international consensus.
  - Various discussions over treating the last pool of IPv4 addresses are under way (for details, see the following page).

Discussions over Treating the Last Pool of IPv4 Addresses

- Idea of "deciding in advance the day when IPv4 addresses are no longer allotted"
    - In discussions, many participants expressed their strong objection to the idea that "the IPv4 addresses not allotted will continue to stay in the pool."
    - At the same time, as some pointed out that "deciding on the last date when the IPv4 addresses are allowed to be allotted" could trigger heightened demand in a last ditch attempt to obtain them before the due date, more than one region rejected the idea. The discussions were concluded.
- Idea of "allotting IPv4 addresses out of the last international pool to regions based on special rules"
    - Africa:
        - It was officially announced as a consensus of all the African countries that one "/8" network prefix (approx. 16 million IPv4 addresses) should be allotted to Africa when the international pool falls below a certain number of IPv4 addresses.
    - South America:
        - It was proposed in an APNIC meeting that 2 "/8" network prefixes should be allotted to each region when the international pool reaches 10 "/8" prefixes.
        - It was proposed to the address management organization in each region that an opportunity for discussing how to allot the last pool should be established (this proposal is suspended for the time being).
    - Asia and Europe:
        - Discussions over how to allot the last international pool are under way.
    - North America:
        - The secretariats announced in various opportunities for discussions their stance that everyone should be treated equally and they were unsympathetic to the idea of introducing any special rules.

(Reference) Outline of Official Announcements by Address Management Organization for Each Region regarding IPv4 Address Depletion

ARIN (North America) (Council resolution)	2007/5/5	Bearing in mind that the IPv4 addresses are on the brink of depletion, the council resolved that: - If a substantial number of the IP addresses are required in the future, it is necessary for a transition to IPv6 - Every possible action must be taken to guarantee the credibility of applications for IPv4 addresses - ARIN should consider whether it is possible to change the address distribution policy to promote the transition to IPv6 - ARIN should engage in outreach activities dedicated to IPv6, grasping every possible opportunity
LACNIC (South America) (Announcement)	2007/6/20	- LACNIC recognizes that the pool of IPv4 addresses will be depleted by 2011 - It will run a campaign so that all networks in the region will adopt IPv6 by January 1, 2011 - The IPv6 allotment cost by LACNIC will not be charged
ICANN (Council resolution)	2007/6/29	- ICANN recognizes that the pool of IPv4 addresses will be depleted in a few years - The future growth of the Internet depends on the timely adoption of IPv6 - The ICANN Council will tackle training and outreach activities in cooperation with other organizations such as RIR
AfriNIC (Africa) (CEO announcement)	2007/7/25	- AfriNIC recognizes that the pool of IPv4 addresses will be depleted before the previously announced expected time of 2010/2011 - All networks must implement IPv6 while maintaining compatibility with IPv4 - It will run a campaign until 2010, including offering training for smooth transition to IPv6
APNIC (Asia) (Community resolution)	2007/9/6	- APNIC recognizes that the remaining pool of IPv4 addresses will have been consumed in two to four years from now - It understands that there is a possibility that the address management policy will change to address new environments - It recognizes that IPv6 is of decisive importance and will strive to ensure that IPv6 may be adopted in the widest possible area of the Asia-Pacific region.
RIPE (Europe) (Community resolution)	2007/10/26	- The remaining pool of IPv4 addresses will have been consumed in 2 to 4 years from now - Priority should be given to the wide deployment of IPv6 - RIPE not only recommends all service to be made compatible with IPv6, but also encourages the governments of the world to take a key role in deploying IPv6

Predictions on When the Remaining Pool of IPv4 Addresses Will Be Depleted

If nothing significant changes, and if the rules relating to international address allotment and address maintenance are not changed, and if those to whom the IPv4 addresses are allotted do not attempt to intentionally reserve extra addresses, it is expected that:

- **The international pool of IPv4 addresses (IANA Pool) will be depleted between mid-2010 and early-2012**
- **In Japan, IPv4 addresses will no longer be supplied from early-2011 to mid-2013**

IANA_Pool (Geoff Model)   APNIC_Pool (Geoff Model)
IANA_Pool (Moderate Model)   APNIC_Pool (Moderate Model)
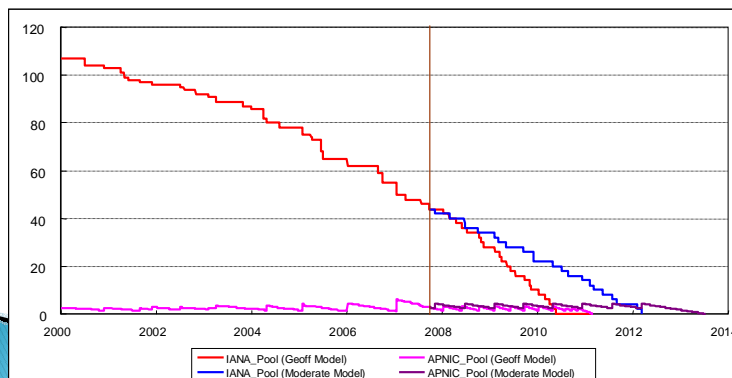
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(Reference) How Predictions Are Made regarding Depletion of the Remaining Pool of IPv4 Addresses

▸ Presuppositions for prediction
  - This prediction presupposes that the IPv4 addresses continue to be allotted based on the assumptions that nothing significant has changed, to remove uncertainties, which means that it presupposes the following three conditions:
    (1) The international rules for allotting the addresses will remain unchanged
    (2) The rules for maintaining the allotted IPv4 addresses will remain unchanged
    (3) Those to whom IPv4 addresses are allotted do not attempt to intentionally reserve extra addresses

▸ Future trends in consumption of IPv4 addresses
  - Considering trends such as the progress of diffusion of the Internet in countries such as BRICs and the development of broadband services in Europe, it would be reasonable to think that the future international demand for IPv4 addresses will remain the same as it is now or has a tendency to further increase.

▸ Prediction model
  - Based on the above presuppositions and the estimated IP address consumption trends, MIC analyzed the most recent IPv4 address consumption trends and predicted when the pool would be depleted based on the analysis results.
  - In addition, MIC assumed the following two prediction models because the results from studying future demand for IPv4 addresses varied significantly:
    (1) The Geoff model (model invented by Mr. Geoff Huston, Chief Scientist for APNIC) or a model used internationally for general prediction, which is equivalent to the case where "the address consumption will continue to increase while following the most recent trend"
    (2) The moderate model or a linear model, which is equivalent to the case where "the demand for addresses will be constant," which means the slowest address consumption speed among the estimates derived from assuming that demand for the IPv4 addresses "will remain the same as it is now or has a tendency to further increase"

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# Impacts from the Depletion of the Remaining Pool of IPv4 Addresses

- As the domestic demand for IP addresses is expected to continue to increase and sufficient measures to cope with the depletion of the pool of IPv4 addresses are not being taken, Japan will directly face the problem of "a shortage of IP addresses" when the pool of IPv4 addresses has been depleted.
- "The shortage of IP addresses" will not only affect a wide range of areas, such as ASP/IDC, networks for enterprises, universities, etc., system integrators, vendors, users, and ISPs building or operating the Internet, but also the provision of services, including Internet telephony.

The major impacts of depletion are as follows:

● New entrance into the industry or new usage of existing services will be made difficult or impossible

- It may be difficult or impossible for new service providers who do not own IP addresses or existing service providers who require a large number of IP addresses to launch new services
- Accepting new subscriptions for various IP services will become difficult or impossible

● Services of certain types will become difficult

- Providing new services or expanding existing certain types of services in which a type a global address is allotted to users for each service so that the users can be accessed from the Internet, will be made difficult
- Optimizing services/architectures using the uniqueness of IP addresses will become difficult

● Operating IP addresses will become difficult, costs for using them will increase, and IP services will be limited

- Efforts to economize on IP addresses, including sharing the same addresses, will cause operating IP addresses to become difficult, increase the cost for using them, and limit IP services

> As the depletion of the remaining pool of IPv4 addresses directly hampers the use of ICT, this could have substantial adverse effects on socioeconomic activities in Japan, including a slowdown in the growth of the economy that is driven by improved productivity using ICT, if no significant action is taken.

(Reference) Ramifications of Depletion of the Remaining Pool of IPv4 Addresses
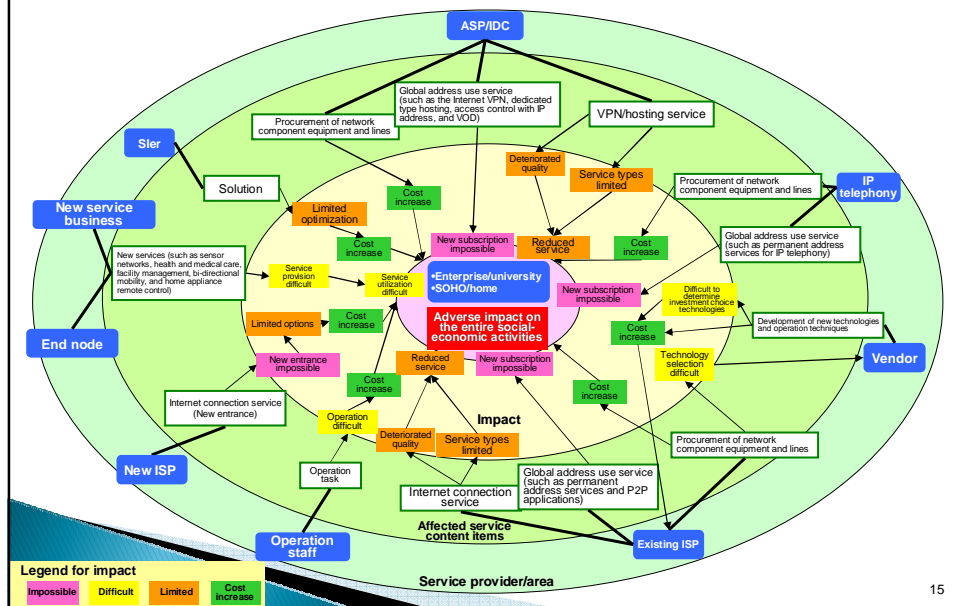
How "Solutions to Depletion of IPv4 Address Pool" Are Being Considered

- The following three proposals have been made for solutions to the depletion of the IPv4 address pool. Each proposal is now being weighed against the other two.
  - "Economizing on IPv4 addresses," which means that the same IPv4 address is shared among more than one subscriber, using an address conversion technology
  - "Marketing IPv4 addresses" that will prompt the redistribution of IPv4 addresses
  - "Transition to IPv6," which offers a gigantic number of IP addresses
- It is clear that each proposal has various issues in addition to the substantial cost required to implement and operate that proposal (it has also been revealed that it is extremely difficult to estimate the costs required to carry out each solution because the current configurations of networks and information systems vary so greatly).
- MIC plans to identify further issues, consider solutions to those issues, and discuss "desirable solutions" in the future.

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(Reference) Main Features of the Three Proposals

- MIC has compared the three proposals against each other and has currently produced the following results:

|	Economizing on IPv4 addresses	Marketing IPv4 addresses	Transition to IPv6
Initial impact on network configurations when implementing the solution	• Additional devices must be added and equipment that does not support it must be updated or modified when implementing this solution • Configurations must be reviewed	• Existing equipment can continue to be used initially when implementing this solution • It is unclear whether configurations must be reviewed	• Additional devices must be added and equipment that does not support it must be updated or modified when implementing this solution • Network configurations must be changed to such a degree that a new network could be built (which poses both burdens and opportunities)
Impact on users	• Direct communications between users will become difficult • Problems caused by "the use of the same IPv4 address by more than one user" may occur	• A problem caused by inconsistencies between the address management register and actual users may occur	• It is highly likely that equipment and applications that do not support this solution must be updated or modified • No limitations on use
Impact on operations	• Although operational know-how is abundant, it is unclear whether this solution can be workable in large networks	• With the mobility of IPv4 addresses, the difficulty of operating the addresses will continue to increase • It is inevitable that larger routers must be produced (in some cases, requests for bigger routers cannot be supported)	• Technicians and operational know-how are not sufficient at the moment • Ingenuity to provide communications between IPv4 and IPv6 will be required
Costs	• Initial costs will be relatively small (however, when users increase substantially, vast reinvestment may be required) • Operational costs will increase (the magnitude of such costs is not clear)	• Initial costs will be close to zero • Operational costs could be huge • Vast transition costs will be incurred to open IPv4 addresses	• Initial costs will be huge • The operational costs will be the same as those now, but double investments for both IPv6 and IPv4 operations will be required for some time
Sustainability as solution	• As some items, such as servers, must have unique addresses, this solution will reach a limit sooner or later. • If requests for direct communications become stronger, this solution will be short lived	• This solution is only a short-term keep-alive measure (because it cannot deal with making cell phones compatible with IP) • It is unclear whether international opinions may allow the allotted addresses to turn to vested rights • The viability of address management is unclear	• It can almost be a permanent solution

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Approaches towards Global IPv6 Enablement

Trends in IPv6 Diffusion across the World

Region	Major Trends
United States	• The Defense Department announced transition to IPv6 by 2008 • OMB (Office of Management and Budget) declared that it will have made government networks compatible with IPv6 by June 2008
Europe	• NATO (North Atlantic Treaty Organization) is considering its network's compatibility with IPv6 • EC (European Commission) is promoting the creation of test beds and research and development related to IPv6 with a financial support system
Asia	• China is promoting the national project (CNGI: China Next Generation Internet) that aims to construct IPv6 infrastructures by 2008 • South Korea announced an IPv6 diffusion and promotion plan by 2010 and is also carrying out verification experiments related to the plan as a national project
Japan	• Each ministry will make information and telecommunications equipment and software IPv6 compatible, when new information systems are developed (integrated) or updated, by FY2008, in principle • MIC plans to consider issues and solutions in facilitating the transition of domestic Internet networks to IPv6 in the "Study Group on Internet's Smooth Transition to IPv6."

Source: Reference by the IPv6 Promotion Council

How IPv6 Addresses Are Being Allotted across the World

- In the number of IPv6 allotments, Japan led other countries in the beginning of 2003, but the United States and Germany passed Japan in the first half of 2003 and in 2005, respectively. The United Kingdom increased the number of IPv6 allotments in 2007 and rose to the third place above Japan as of October 2007.
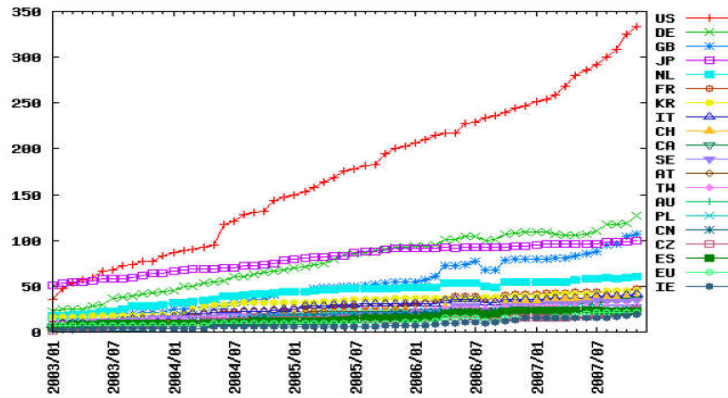
Source: Study by Internet Association Japan
Size of address blocks allotted from RIR (Regional Internet Registry) to LIR (Local Internet Registry) (in terms of /32 address blocks)

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Current Status of Commercial Transactions on the Internet

▸ In Japan, transactions (confirmed orders received and placed) via the Internet between companies amounted to 148 trillion yen on an annual basis in 2006. The total reached 1.5 times that of the United States (95 trillion yen) in terms of monetary amounts.

▸ Transactions in the consumer market amounted to 4.4 trillion yen, recording a rapid increase of 27.1% over the previous year. Its counterpart in the United States reached 19.3 trillion yen

(Excerpts from "2006 e-Commerce Market Survey" by the Ministry of Economy, Trade and Industry, Japan)

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