Ministry of Internal Affairs and Communications

New IPv6 Strategy for Launching the IoT Era

From the Fourth Report of
"Study Group on Advanced Use of Internet with IPv6"

April 27th, 2016
Computer Communication Division
Telecommunications Bureau
Ministry of Internal Affairs and Communication

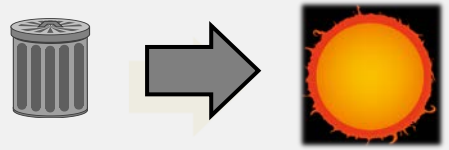
Introduction

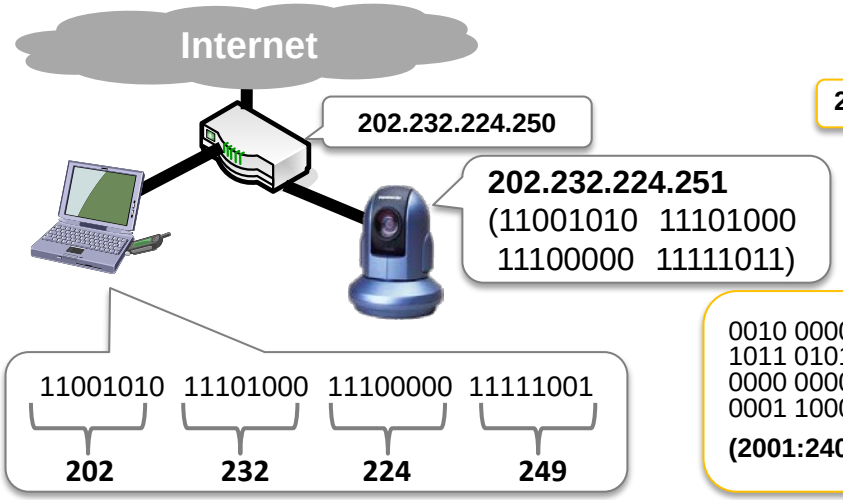
- As a result of the explosive growth of the internet until now, IPv4 addresses were exhausted in Japan and the Asia-Pacific region on April 15, 2011.
- This Study Group has been discussing matters such as measures for IPv6 deployment, as replacement for IPv4 addresses. In December 2011, the Third Report was put together. After that, we checked the progress status, and Progress Reports were produced in July 2012 and July 2013.
- Although IPv6 Internet connection services are gradually expanding among fixed-line network operators and major internet service providers (ISPs), actual use of IPv6 is not enough.
- Deployment of IPv6 addresses, which can mediate an almost infinite number of devices, is necessary for the emergence of IoT (Internet of Things), which will create new added values and industries, and may change the global socio-economic system.
- This Study Group discussed how IPv6 should be deployed and compiles the Fourth Report as a strategy towards achievement of IoT society.

From IPv4 addresses to IPv6 addresses

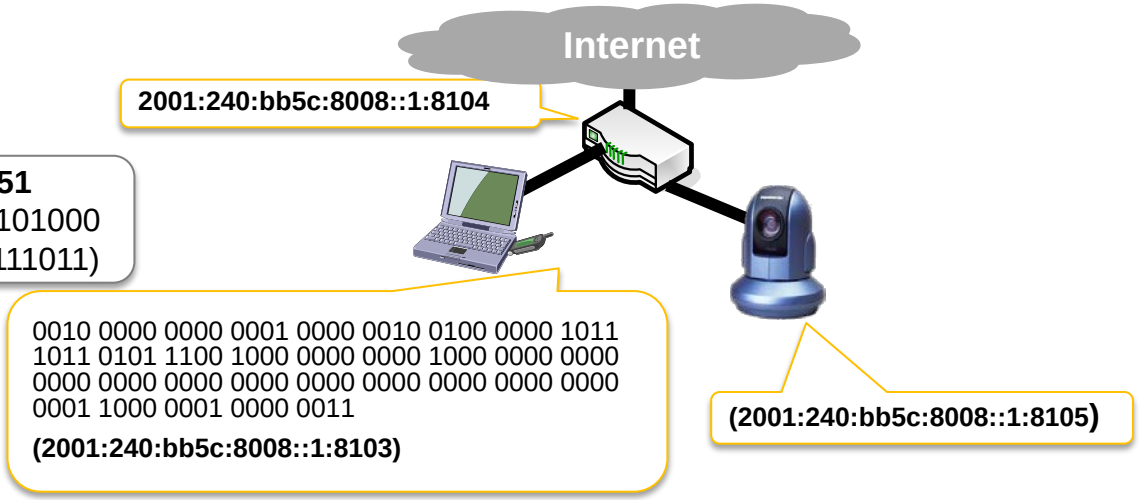
All devices connected to the Internet are assigned an IP address (online version of a physical address).

IPv4 address (32 bit)	IPv6 address (128 bit)
4.3 billion **Number of grains of sand in one bucket**	**340 undecillion** **Number of grains of sand that would fill the Sun's total volume**
Address pool was exhausted in April 2011	**Astronomical number of connected devices** enough to last 1 trillion years, even if 1 trillion people use and discard 1 trillion addresses per day





When humans use it, the address is divided into 4 sets of 8 digits, and each set is expressed as a decimal number

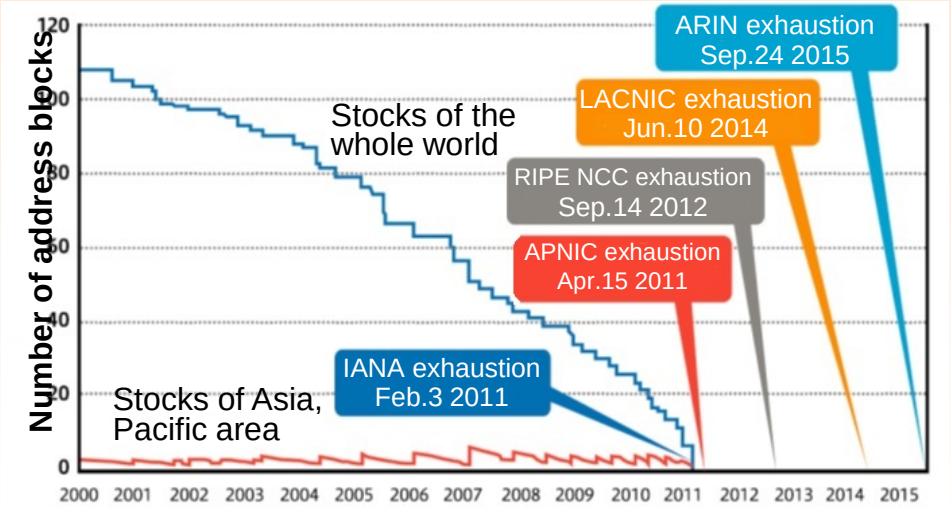


When humans use it, the address is divided into 8 sets of 16 digits, and each set is expressed as a hexadecimal number (chains of "0000" may be abbreviated)

Current situation/issues regarding IP addresses

Current exhaustion status of IPv4 addresses

Stocks of IPv4 addresses



⇒At present (Apr 2016), **Africa is the only region with an unallocated IPv4 address pool.**

Current usage status of IPv4 addresses

- IPv4 addresses already in use can continue being used.
- New devices will be connected using **IPv4 address sharing,** and **transfers of IPv4 addresses** between organizations, etc.

Issues regarding use of IPv4 addresses

- Shared use requires multiple address mappings, and **complex log management**. For this reason, maintenance and expansion are costly.
- **Deteriorating service quality and risks of malfunctions** in some applications.
- The amount of IP addresses that can be transferred is limited. Concerns about rising prices due to a decrease in distribution.

Responding to IoT society

- Assignment of **IPv6 addresses are indispensable for the IoT**, in which various devices will be connected to the internet securely and directly.

Efforts by MIC

- **"Study Group on Advanced Use of Internet with IPv6"** (chaired by Tadao Saito, Honorary Professor at University of Tokyo), which reviews how to **respond to an increase of terminals/devices in IoT era**, particularly key issues such as speeding up IPv6 deployment among **mobile network operators.**
- After a public comment period, tne Fourth Report of the Study Group is sent out a press release on Jan 26th, 2016.

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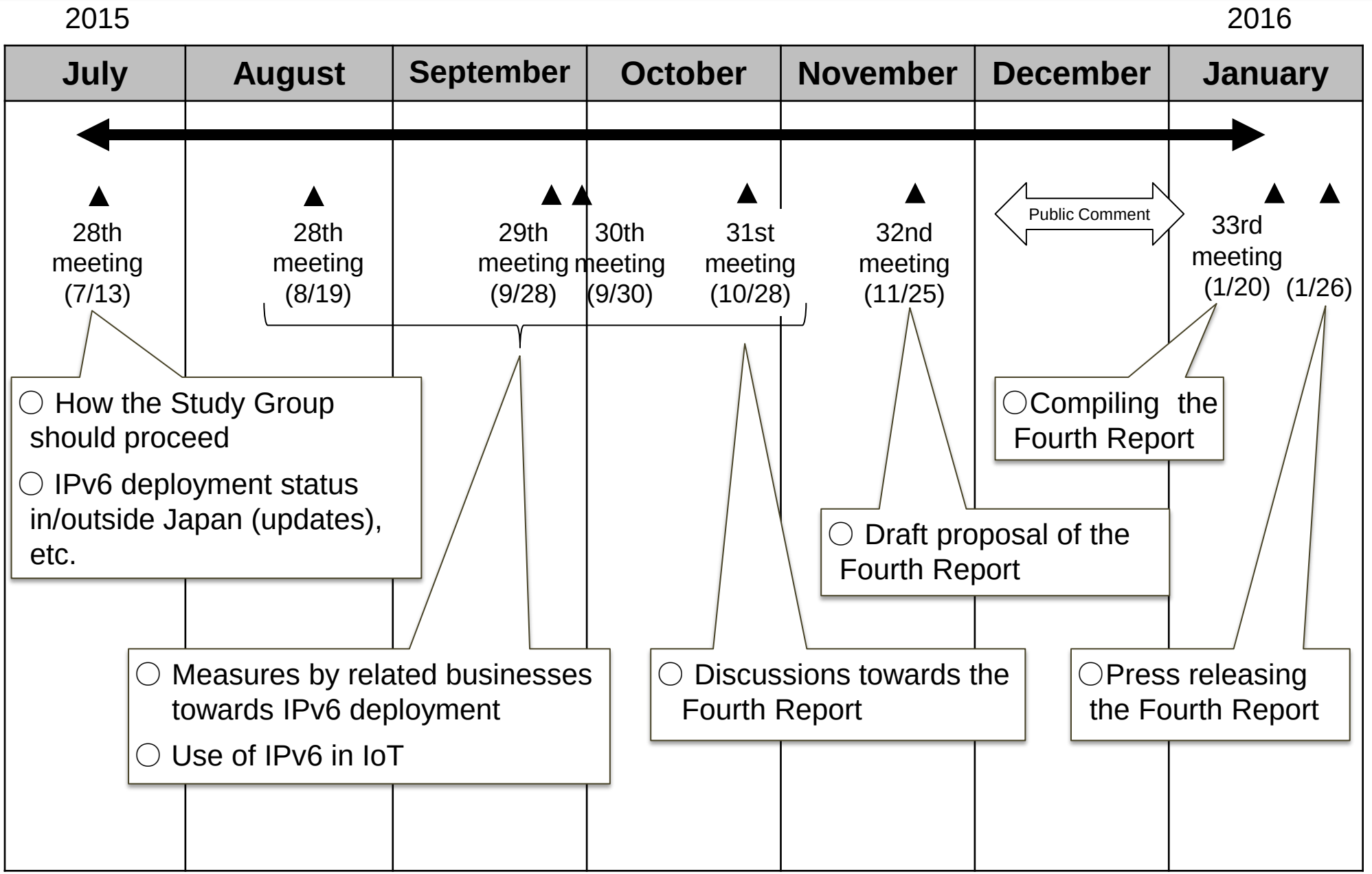
	Tomohiro FUJISAKI	Managing Trustee, Japan Network Information Center
	Toshihiro MATSUMURA	Professor, Institute of Social Science, University of Tokyo
	Shuichi MATSUMOTO	President, Japan Cable Laboratories

[Ref.] Course of MIC's actions towards IPv6 deployment

- 2008	Discussions at "Internet Policy Council meetings", etc.
2009	**February Establishment of "Study Group on Advanced Use of Internet with IPv6"** June Release of the Interim Report
2010	March Release of the Second Interim Report April Release of Guideline of information disclosure for ISPs to cope with IPv4 address exhaustion
2011	**December Release of the Third Report** Feb. 2011 IANA exhausts IPv4 Apr. 2011 APNIC exhausts IPv4
2012	July Release of the Third Progress Report Sep. 2012 RIPE NCC exhausts IPv4
2013	July Release of the Second Progress Report October Release of Manual for Coping Effectively With Issues That Arise Upon Exhaustion of IPv4 Addresses(1) vol.1
2014	Jun. 2014 LACNIC exhausts IPv4 July Release of Guidelines for IPv6 Support, and Specification Model for IPv6 Compatibility
2015	April Release of Manual for Coping Effectively With Issues That Arise Upon Exhaustion of IPv4 Addresses (2) Sep. 2015 ARIN exhausts IPv4 **July "Study Group on Advanced Use of Internet with IPv6" resumed**
2016	**January Release of the Fourth Report**


2015
2016
July
August
September
October
November
December
January
28th meeting (7/13)
28th meeting (8/19)
29th meeting (9/28)
30th meeting (9/30)
31st meeting (10/28)
32nd meeting (11/25)
Public Comment
33rd meeting (1/20)
(1/26)
○ How the Study Group should proceed
○ IPv6 deployment status in/outside Japan (updates), etc.
○ Measures by related businesses towards IPv6 deployment
○ Use of IPv6 in IoT
○ Discussions towards the Fourth Report
○ Draft proposal of the Fourth Report
○Compiling the Fourth Report
○Press releasing the Fourth Report

Progress of the Internet & Exhaustion of IPv4

Advanced Internet use and its issues

(1) Changes in modes of internet use

- Progress from e-mail, world wide web and search engines, to cloud services, streaming/broadcasting, and M2M/IoT
- ”Social ICT”, which selectively analyzes big data collected via IoT, and feeds back data that is useful for actual socio-economic systems, attracting increased attention

(2) New issues regarding more advanced use

① Increased internet traffic

- Total download traffic of broadband contractors is 5.4Tbps (53.5% increase year-on-year), a record high (←rich contents, mobile traffic offloading, etc.)
- Traffic from late night to early morning on the increase (←software updates for smartphones, etc.)
- While traffic between domestic ISPs increase, traffic inflow from overseas ISPs showing slowed increase (← increased distribution from domesic cache servers, etc.)

② Ensuring safety and reliability

Importance of ensuring safety and reliability of electronic communication facilities, in order to ensure continued connection to internet, on which the economy/society rely, at times of disasters, etc.,

③ Cybersecurity measures

Cybersecurity measures are an urgent issue, with 2020 Tokyo Olympics coming up

④ Deployment that presupposes an open network

Assumption that closed networks are safe actually increases security risks, and may make internet less convenient. An open network with cybersecurity measures are preferable

Current status of exhaustion and re-use of IPv4 addresses

(1) Exhaustion status in Japan and overseas

Since APNIC's IPv4 address exhaustion in April 2011, IPv4 addresses have been exhausted in 4 out of 5 world regions (all except Africa)

⇒ **Transfers of IPv4 addresses within regions are possible in certain cases, but only a limited number of addresses can be transferred. Not a fundamental solution**

(2) Deploying LSN to share use of global IPv4 addresses

Implementation of shared use of global IPv4 addresses that use LSN (Large Scale Network address translation) as a countermeasure for IPv4 exhaustion, particularly among mobile network operators

⇒ **Continued IPv4 services, due to factors such as unpredictable returns on additional capital investment for IPv6 deployment**

(3) Recycling IPv4 addresses through transfers

IPv4 addresses can only be acquired by procuring them via transfers from organizations in possession of previously distributed IPv4 addresses

⇒ **Further decrease of distribution and increase of price expected**

(4) Risks with continuing IPv4 use

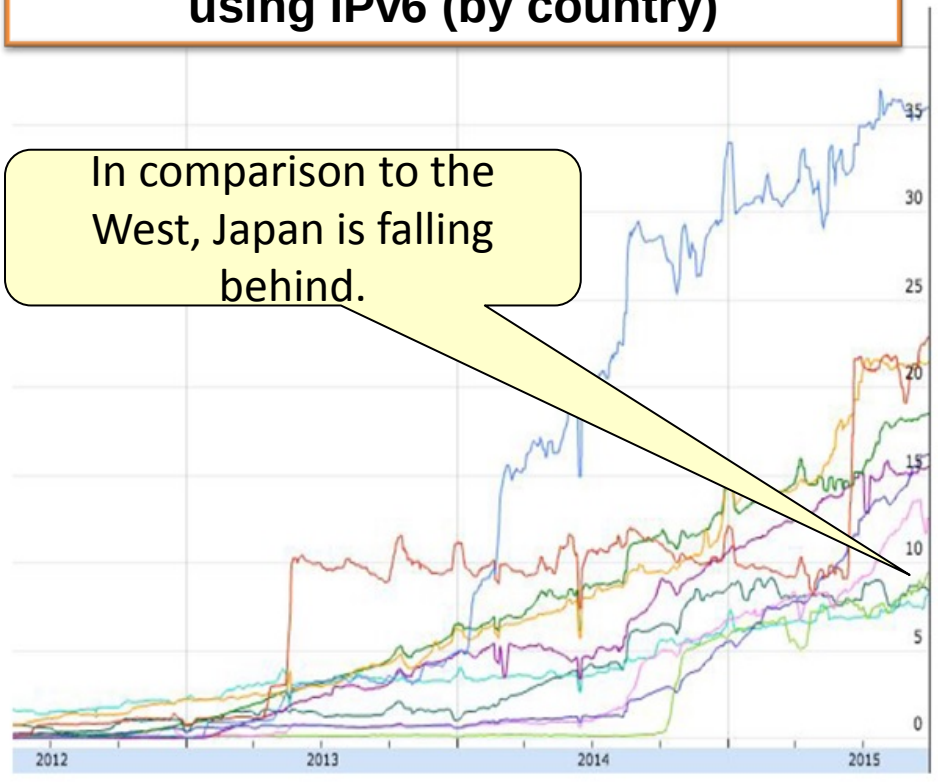
- Risk of malfunctioning applications due to multiple NAT, etc., and security issues at IPv6-incompatible businesses due to devices with default IPv6
- Loss of domestic and international business opportunities, e.g. exporting infrastructures for clients/businesses requiring IPv6 services, etc.

Japan’s IPv6 Deployment Status

IPv6 deployment in Japan and other countries

- Percentage of IPv6 access to Google services across the world is currently 9%, and **increasing at a rate of approx. two times per year**.
- Belgium, which formulated a national plan to migrate to IPv6 (2012), Switzerland, USA, are showing big increases in recent years.

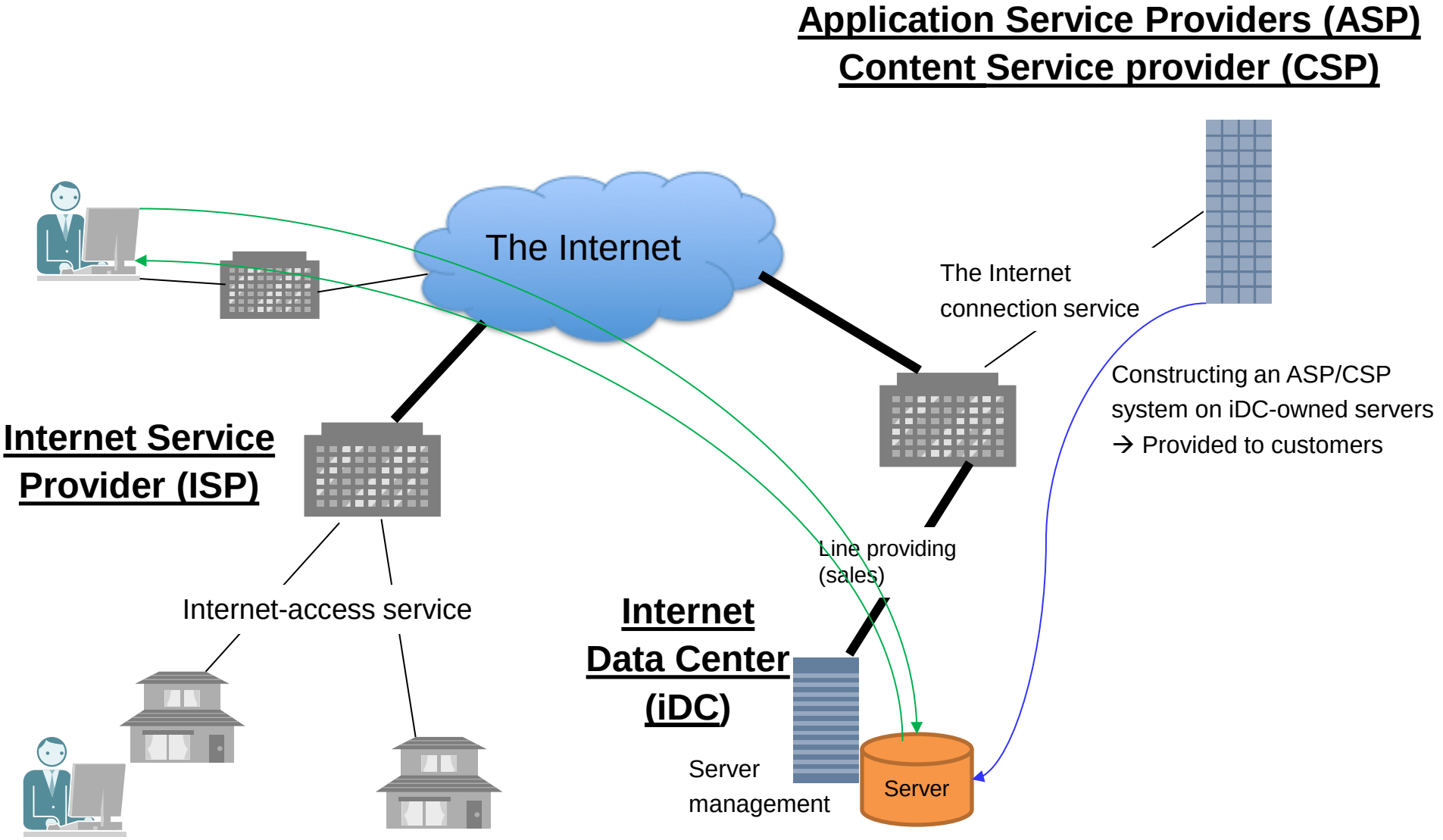
Percentage of access to Google using IPv6 (by country)



	(2014.4.15)	(2015.9.29)	
Belgium	16.9%	35.9%	19.0% increase
Switzerland	9.3%	22.8%	13.5% increase
US	6.9%	21.4%	14.5% increase
Germany	7.8%	18.5%	10.7% increase
Portugal			
Peru			
Greece			
Estonia			
Japan	3.4%	8.2%	4.8% increase
Czech Republic			

(reference)https://www.vyncke.org/ipv6status/compare.php?metric=p&countries=be,ch,us,de,pt,pe,gr,ee,jp,cz

Scope of survey of Japan's IPv6 deployment status

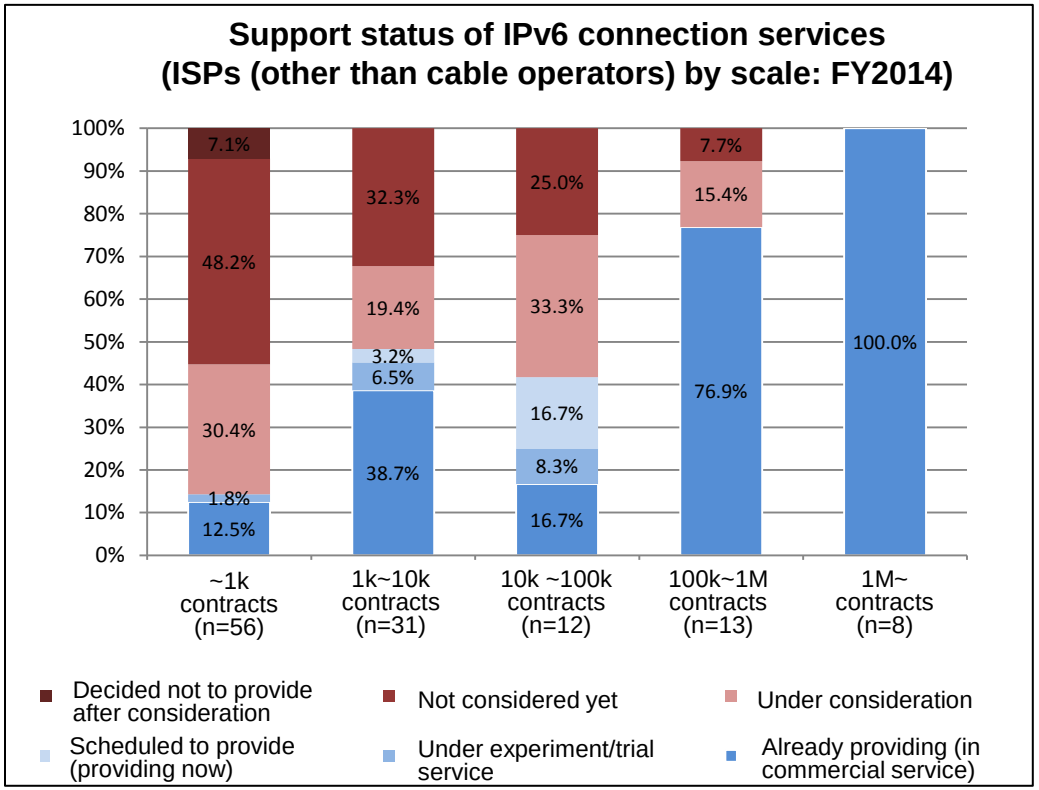


(Source) Study Group on Advanced Use of Internet with IPv6 (27th Meeting) File 27-3 (Mitsubishi Research Institute explanatory material)

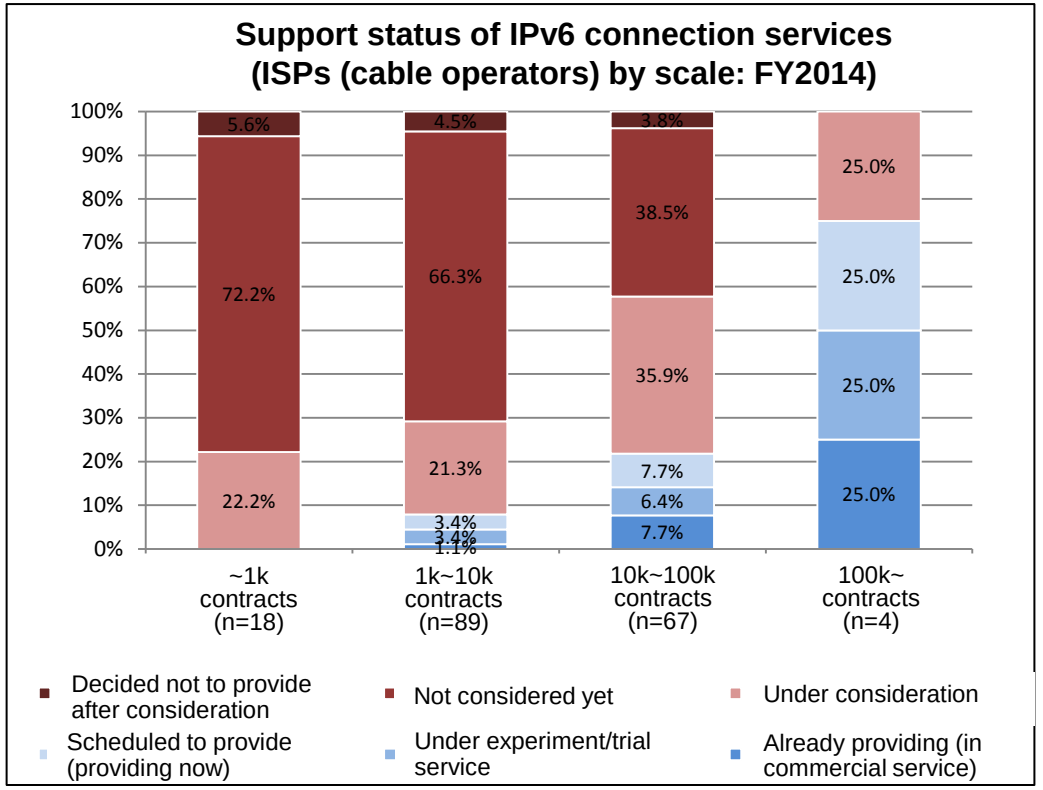
Japan's IPv6 deployment status: Survey result (example)

- 86% of ISPs with 100,000 contracts or more answered "Already providing (in a commercial service)". On the other hand, deployment among smaller operators is not progressing.
- 28% of data center operators are compatible
- Mobile network operators have mostly not deployed IPv6

ISP



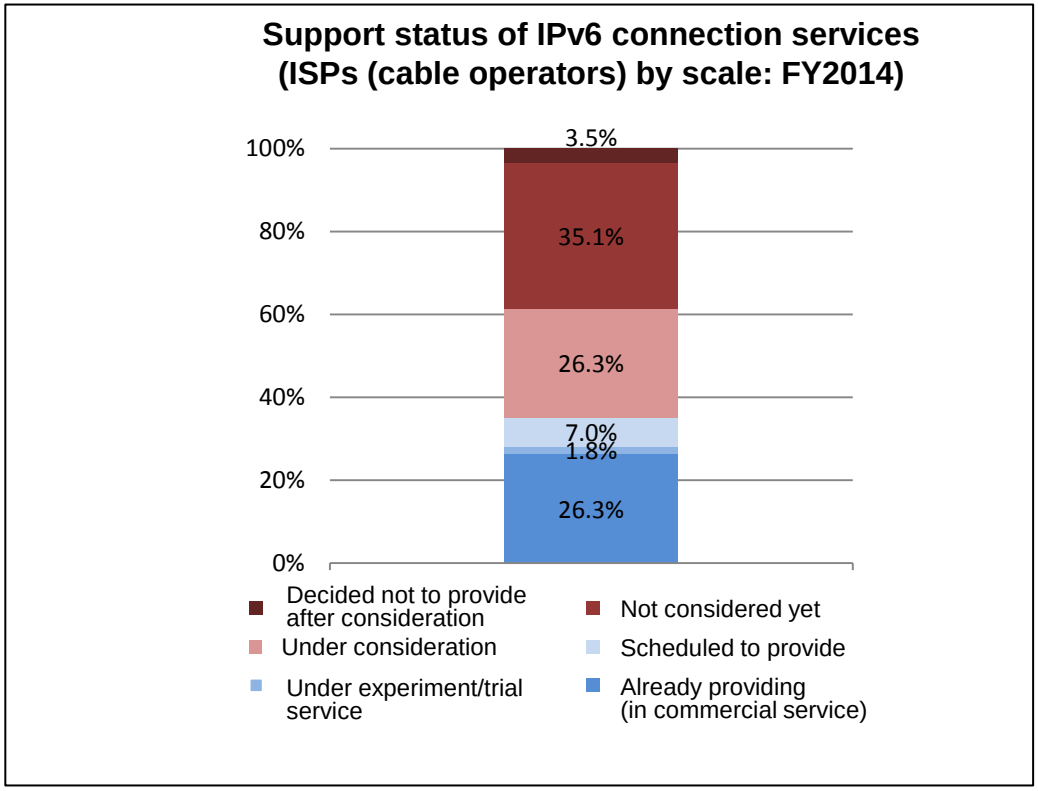
CATV



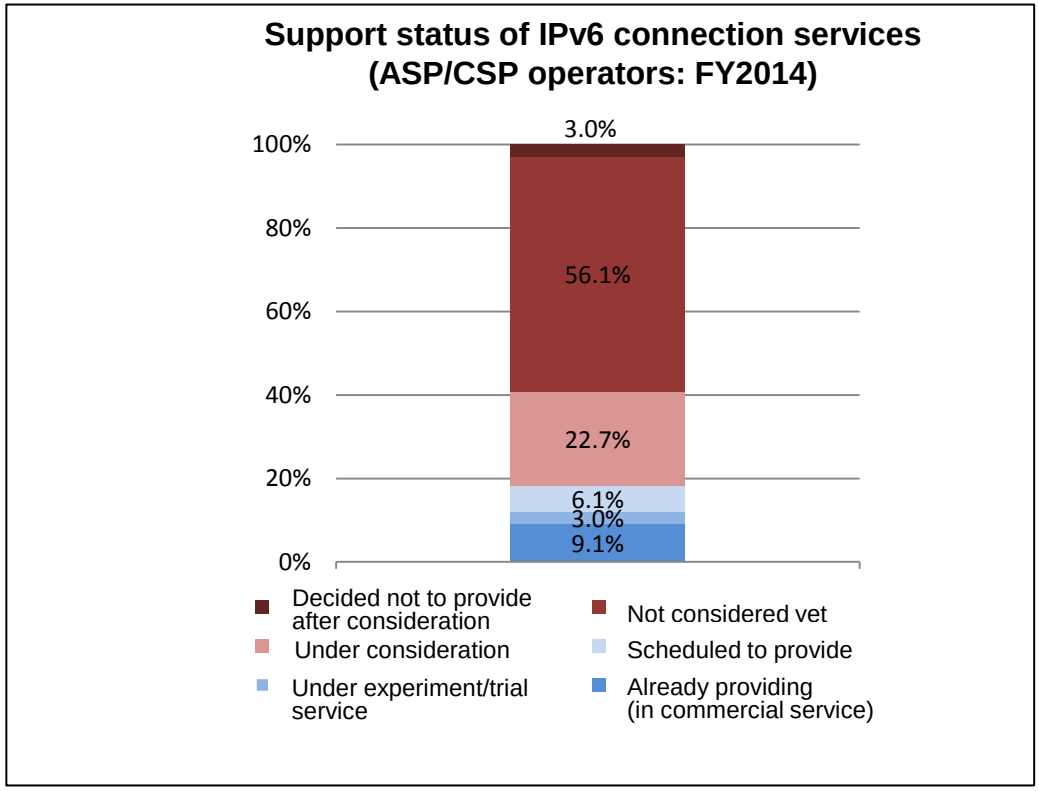
(Source) Study Group on Advanced Use of Internet with IPv6 (27th Meeting) File 27-3 (Mitsubishi Research Institute explanatory material)

Japan's IPv6 deployment status: Survey result (example)

iDC



CSPs/ASPs



(Source) Study Group on Advanced Use of Internet with IPv6 (27th Meeting) File 27-3 (Mitsubishi Research Institute explanatory material)

Overview of Japan's IPv6 deployment status

(1) Usage status of internet connection services in Japan

- Number of subscriptions to fixed broadband services: 37.24 million, 3.0% increase year-on-year (end of June, 2015)
- Number of subscriptions to mobile communication (mobile phone, PHS and BWA): 158.16 million, 4.6% increase year-on-year. (MIC data)
- Percentage of mobile devices surpass percentage of PCs in internet connections

⇒**For IPv6 deployment, must promote both fixed and mobile communication**

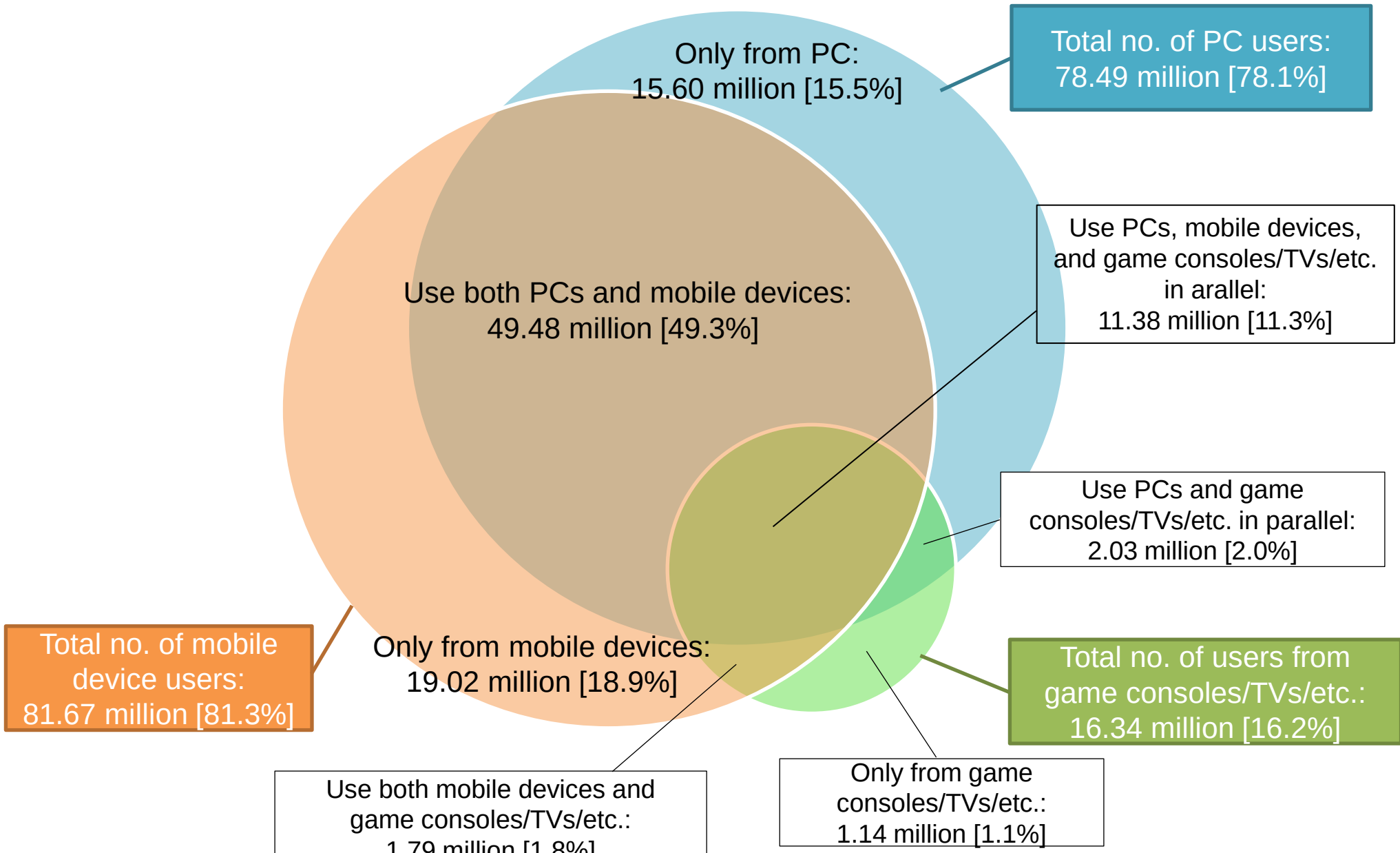
(2) Response status to issues raised in the Third Report

Judging by response status to issues raised in Third Report (December 2011), IPv6 deployment is steadily advancing, but in light of the above global situation, etc., there is **need for strategic review towards expansion of IPv6 deployment in not yet incompatible with businesses, services, etc.**

[Issue 1] Expanding use of IPv6 internet connection services
[Issue 2] Measures towards promoting IPv6 in mid- and small- ISP/iDC, etc.
[Issue 3] Preparing an environment towards spread of services that use IPv6

(3) IPv6 deployment status and issues by operator type

No. of Internet device users



(Source) Created from results of MIC's Communications Usage Trend Survey in 2013

[Ref.] Japan's IPv6 deployment status by operator type

Business operator	Deployment status
Landline network operators	・NTT East & West provide two types of IPv6 services, PPPoE (tunnel method) and IPoE (native method), with "FLET'S Hikari" Next (NGN) ・In Feb. 2015, launched "Hikari Collaboration Model", which offers optic fiber internet wholesale on NGN to other businesses ・KDDI provides IPv6 connection service with "au Hikari". As of Sept. 2014, all subscribers will have IPv6 connectivity by default
ISP (excluding CATV operators)	・ISPs providing IPv6 internet connection services are gradually increasing, from 30% (March 2014) to 32.5% (December 2014) ・IPv6 deployment status of small-scale ISPs is lagging in comparison with large-scale ISPs
CATV operators	・CATV operators that provide IPv6 services gradually increased, from 2% (March 2014) to 4.2% (December 2014)
Mobile network operators (excluding MNVO)	・NTT Docomo: IPv6 available with "mopera U" from June 2011. On the other hand, "sp mode" does not support IPv6. Percentage of IPv6 use on NTT Docomo network: approx. 0.01% ・KDDI: IPv6 available with "LTE NET for DATA" from November 2012. On the other hand, "LTE NET" does not support IPv6. Percentage of IPv6 compatibility on KDDI network: approx. 51.8% (number inc. fixed internet connections) ・Softbank: IPv6 available from June 2015 on some IPv6-compatible devices. Percentage of IPv6 compatibility on Softbank network: approx. 18.9% (number inc. fixed internet connections)
Data center operators	・Data center operators that provide IPv6 services gradually increased, from 23.6% (March 2014) to 24.5% (December 2014)
Content businesses (ASP/CSP), etc.	・Content businesses that provide IPv6 internet connection services gradually increased, from 8.7% (March 2014) to 10.1% (December 2014).
Client environment (OS)	・Currently prevalent OSs such as Windows, Mac OS, Android, iOS are mostly IPv6-compatible ・Apple in particular has announced that all apps listed on AppStore beyond iOS 9 (Sept. 2015) are required to be IPv6-compatible. Moreover, has announced that IPv4 access will have a 25ms delay as of iOS 9 and OS X (10.11) (Sept. 2015)
ICT devices (routers, etc.)	・Availability status of IPv6 passthrough in home/private use routers currently on sale (as at Sept. 1, 2015) by CIAJ member companies are 41.4% (12 models) Of these, only 1 model functions as an IPv6 tunnel adaptor exclusively for NGN connections, so adoption still has a long way to go
MVNO	・Currently, only SIM card-type MVNO providing IPv6 connection services is IIJ. Other companies are still preparing or considering providing services

IoT and measures towards its achievement

1. Emergence of IoT

(1) Emergence of new devices that connect things together

- Wearable devices, drones, autonomous cars, robots, smart meters, various sensors, …
- No. of IoT devices: 15.8 billion (2013) ⇒ 53 billion. (2020)
- Of the 1.5 trillion “things” that exist in the real world, 99.4% are unconnected to the internet.
- 32% of devices connected to the internet in 2019 estimated to be IPv6-compatible

(2) New currents in internet that supports IoT

- Advanced network technologies, such as SDN, CDN, edge computing
- Launch of 4G, and 5G available in 2020

(3) New economy/society brought about by IoT

2. Measures towards achieving IoT

(1) Measures towards achieving IoT

- Measures by USA’s Global City Teams Challenge, and Germany’s Industrie 4.0
- ”New Information and Communications Policy for the IoT/Big Data Era” currently being discussed by Information and Communications Council
- “Outlook for Various Challenges with Consideration of ICT Service Development in the Near Future” released by MIC, October 2015.

(2) Japan’s measures and trends towards 2020

- 2020 Tokyo Olympics and Paralympics
- MIC tackling preparation/advancement of free public wireless LAN environment towards 2020

Role for IPv6 in IoT society

1. Role of IPv6 in IoT society

- IPv6 addresses are essential and Mobile communication is important for IoT

① Advantages of IPv6 compatibility for providers

- Easy to expand for new business, and to design large-scale networks
- Expectations for reducing costs from operation/management, and repairs
- Advantageous for using location information, and for ensuring security
- IPv6 connections with overseas locations made possible, essential for global development of devices, systems, etc.

② Advantages of IPv6 compatibility for users

- Can use without thinking about IPv6, and use the new IoT services
- Due to reduced operator costs, hope for improved services and cheaper usage

2. Issues regarding promotion of IoT

- Responding to further increased internet traffic
- Safety and reliability of communication facilities
- Increased importance of cybersecurity
- If closed networks increase, or assignment of private addresses progresses, internet's convenience may be damaged

(→ For networks that may be connected to the internet, **an open and secure IPv6 deployment** is important)

New Strategies Towards Achievement of IoT Society

- To become the world's frontrunner in IPv6 connections -

(1) Shift to IPv6 deployment for establishing an IoT society

Role of IPv6 is changing from a measure against IPv4 exhaustion to indispensable use in the IoT era. Promoting IPv6 for the entire system, from devices to content

(2) Open and secure promotion of IPv6

Considering the global Internet, promoting open and secure IPv6 using global addresses

(3) Enhance global competitiveness through IPv6 deployment

We need to strategically review and implement IPv6 adoption with a focus on enhancing global competitiveness, and thus create new industries, and pave the way for global development.

(1) Setting clear targets towards 2020

Setting 2017 as the target for expansion of IPv6 use, as it will be fundamental for Tokyo Olympics

(2) Action plans for each field

① fixed-line network operators

Promotion of default provision of IPv6 to previous users other than new users

②ISP

Expansion of IPv6-compatible service area, further promotion of default provision

③ Mobile network operators (excluding MVNO)

By 2017, achieve situation where IPv6 is provided by default to smartphone users with no additional burden (IPv6 Mobile Launch)

④ MVNO

Shift to IPv6, sharing precedents and measures by MNOs

⑤ CATV operators

Further expansion of IPv6-compatible services, and default provision

⑥ Data center operators

Promoting IPv6 deployment of data centers, etc. from a global perspective. Also, need to advance decentralization, along with promotion of IoT

⑦ Content Service Provider

Deploying IPv6 together with IPv6 becoming default in ISPs and MNOs

⑧ ICT device vendors

IPv6 adoption for home routers, promotion of default IPv6 setting for users
Promoting acquisition of IPv6 Ready Logo to make IPv6 compatibility visible

⑨ Government agencies/Local governments

Promotion of providing contents via IPv6, and IPv6 deployment in information systems and Wi-fi networks

⑩ Ordinary businesses

Promoting IPv6 adoption in building company information systems, etc.

(3) Cross-sectoral Measures

① Promoting implementation of IoT that uses IPv6

② Making IPv6 compatibility visible, and compulsory for government procurement

③ IPv6 deployment that takes into account government policies

④ Promoting of human resource development, and awareness promotion

⑤ Globally publicizing Japan’s efforts

⑥ Continuous surveys and implementation of PDCA

Promoting IPv6 adoption in mobile communication networks

Suggestions at previous Study Group meeting

Second Progress Report of "Study Group on Advanced Use of Internet with IPv6" (July 2015)
Proposing to mobile phone operators to **clearly state their plans, and prepare environments for IPv6 use early**.

Progress of mobile phone operators

Although some data communication services have started IPv6 connection services, **IPv6 adoption has not progressed to services for general smartphones.**

IPv6 deployment towards IoT society

- Various devices, various fields
- **Increased number of IoT devices:**
  15.8 billion (2013) → 53 billion (2020)

➢IPv6 is essential for IoT
➢In particular, mobile communication has an important role in directly connecting these devices

IPv6 strategies in key countries/businesses

- IPv6 access rate is 21% in USA, 7% in Japan.
- In countries that rank highly for access rates, **IPv6 deployment is advancing, including mobile network operators.**
  e.g.) Verizon Wireless (USA): 70%
- Apple required IPv6 for all applications

➢IPv6 as a global trend
➢Necessary for global competitiveness.

Propositions in this Report (IPv6 Mobile Launch)

By 2017, achieve a situation where IPv6 is provided by default to smartphone users with no additional burden

Conclusion

- This Study Group has been discussing measures for IPv6 deployment against exhaustion of IPv4 addresses.
- Seeing the paradigm shift due to the emergence of IoT as an opportunity, now reviewing basic thinking concerning future IPv6 adoption, in order to use IPv6 adoption for new innovations, etc., and specific measures and policies.
- Seeing the 2020 Tokyo Olympics and Paralympic as an opportunity, we have set 2017 as a key checkpoint for measures to expand IPv6 use, in order to present ourselves to the world as the front-runner in IPv6-connected IoT society.
- In 2020, Japan will achieve a 5G mobile phone network. To accompany this, we will set forth the “Mobile IPv6 Launch”, to achieve default IPv6 use in mobile communication.

Thank you