Infinite Internet Address (IPv6)

Expansion Roadmap to Promote a New Internet Industry

- Launching IPv6 based commercial service in 2014 -

March 2014

Ministry of Science, ICT&Future Planning

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I. Background

❑ Previously the government (old: Ministry of ICT, KCC) pursued a policy to be able to switch early to the IPv6 system in case the existing number of IPv4 addresses became exhausted, so a transition plan was established first in 2004, then modified in 2007, then modified again in 2010.

* Whereas the number of IPv4 addresses is about 4.3 billion (2^{32}), the number of IPv6 addresses is 2^{128} (3.4×1,038) which is, for all practical purposes, inexhaustible.

- This is because an IPv6 address is composed of 16 bits and 8 units, for example: 2001:dc2:0:40:135:72df:9e74:d8a3.

• The government has over the years made consistent efforts to improve preparations for adopting IPv6 in both the private and public Internet, but support for each IPv6 network product needed to implement the network (routers, switches, servers, etc.) and commercialization of IPv6-based services (Network Enabled Service, etc) has been very poor nonetheless.

• The preparation rate for the backbone network was 92%, 65% for the subscriber network (as of Dec. 2013), and 60% for the public network (as of Dec. 2010.)

* In fact, there was only one IPv6 service available which is the LGU+ LTE voice service that launched in August 2013 and gained 800,000 subscribers by the end of December 2013.

❑ In February, 2011, ICANN* declared its IPv4 address exhaustion and final allocation policy, which states that each organization can be assigned up to 1,024 IPv4 addresses at once.

* ICANN (Internet Corporation for Assigned Names and Numbers) is a nonprofit

private organization established under the auspices of the US Department of Commerce in 1998 to manage the domain name systems and allocate IP addresses.

** Final allocation policy : Each organization can be assigned 1,024 IPv4 address each time.

- Whereas the public and private sectors of other major countries are quickly switching to IPv6, Koreans are not yet using it very much.

* For example, IPv6 service use rate (as of Dec., 2013) was, in descending order, in Switzerland 12.5%, Romania 10.78%, Luxemburg 9.55%, Germany 7.22%, Japan 6.81%, USA 6.41%, and China 1.13%. But in Korea it was only 0.01%.

❑ As domestic IPv4 addresses will be used up within two or three years, we will be unable to expand existing services and handle newly created demand (Cloud, Internet of Things (IoT), etc.) without switching to IPv6.

* One reason is because when providing mobile Internet (LTE) services, each subscriber requires two IP addresses (voice and data).

☞ To successfully respond to the impending huge growth in demand for Internet services and promote smooth execution of the Internet-based “creative economy”, we must now establish a strategic roadmap to expand the infinite Internet address system (IPv6) to encompass the entirety of the network including all fixed and mobile entities.

< IPv6 transition concepts >

❑ IP address concepts

- IP (Internet Protocol) is a mutual communication protocol for PC communication. An IP address is absolutely required for connection and communication between networks and/or mobile devices.

※ Each IPv4 address consists of eight bits and four units (ex. 211.192.38.1) so the total number available is 232 (about 4.3 billion). Meanwhile, each IPv6 address consists of 16 bits and 8 units (ex. 2001:dc2:0:40:135:72df:9e74:d8a3) so the total number available is 2128 (3.4×1038) which is practically infinite.

❑ IPv6 transition concept

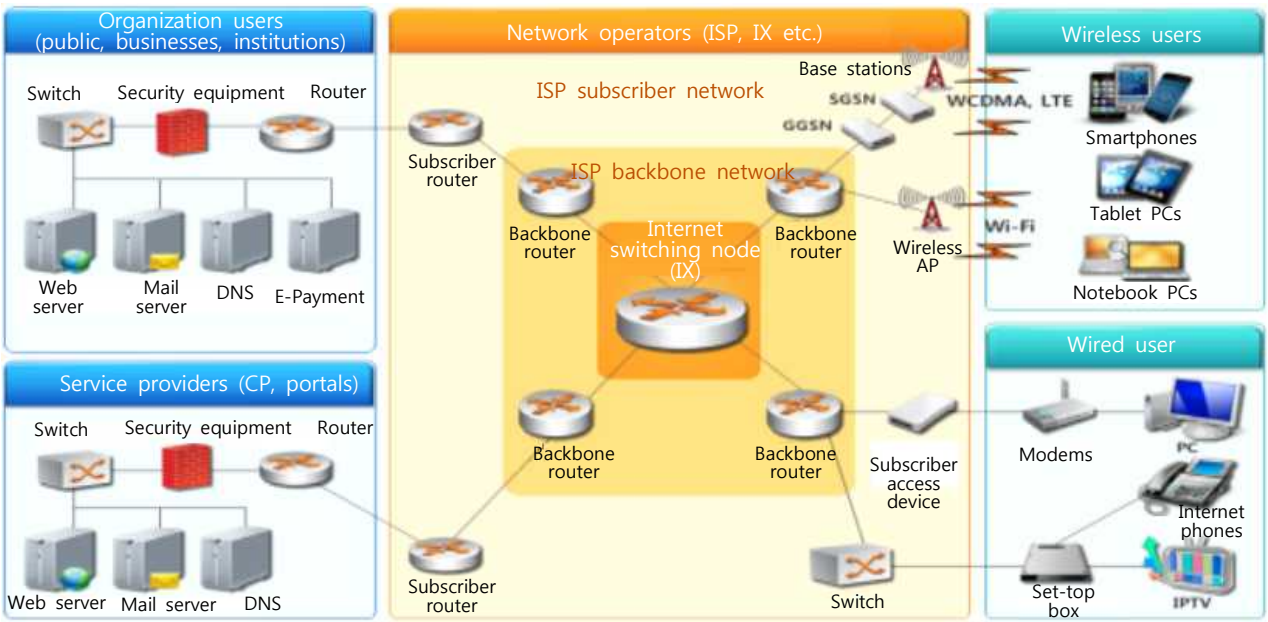
- This means that existing IPv4-Only equipment (routers, switches, servers, etc.) are replaced with IPv4/IPv6 compatible equipment or IPv6-Only equipment.

❑ IPv6 transition methods

- Check if the existing equipment support IPv4-Only, IPv4/IPv6 or IPv6-Only and replace the equipment or update the software.

※ Check whether the hardware chipset supports IPv6 and whether the software version supports IPv6. Determine whether it is necessary to replace the equipment for IPv6 transition.

< IPv6 Transition in the Wireless/Wired Internet network>



< IPv6 transition concepts >

❑ IPv6 transition technologies

- IPv6 transition technologies include dual stacks, tunneling and address transitions. B Compatibility will have to be ensured as both addressing protocols will co-exist for the next 30 years or so.
  - Dual Stack : Both IPv4 & IPv6 are supported by this technology.
  - Tunneling : Technology to achieve end-to-end communication by passing through the IPv6 network which lies in the middle.
  - Address translation : Technology to achieve communication between IPv4 and IPv6.

※ IPv4 are IPv6 are expected to co-exist until the year 2046. (KISA research results, Dec. 2012)

Ⅱ. Status of Korea/Overseas

1 Execution Status Overseas

❑ The international organization ISOC (Internet Society) hosted 'World IPv6 Launch Day' on June 1st, 2012, officially signaling the start of IPv6 commercial services with about 3,100 companies including Google participating.

※ Soon after many companies such as Google, Yahoo, Facebook and YouTube began providing IPv6 commercial services. In Korea, KISA (Korean Internet Security Agency), Daum and other companies also participated, but as of now they are only providing test services.

- The IPv6 Forum (launched as a non-profit organization headquartered in Luxemburg in July, 1999) actually began assigning the "IPv6 Ready" logo to all IPv6 supporting products worldwide starting in September, 2003.

※ As of January 1, 2014, the total number of IPv6 Ready products in the world was 1,587 with 94 being Korean.

- Currently the IETF (Internet Engineering Task Force) is seeking out issues related to network switching technologies and operation for IPv6 introduction and making consistent efforts to establish the international standards.

※ Mobile communication (LTE) provides voice and data service are using the 464xLAT standard.

- PC versions of Microsoft Windows higher than Vista 2007 can support IPv6 as well as all smartphones launched after 2010.

※ Both Apple iOS 4.0 or higher (2010) and Android 2.3 or higher (2011) can support IPv6.

❑ **The United States:** Although the USA has the most IPv4 addresses in the world, in order to maintain their reputation as the leader of the Internet in the IPv6 environment, the nation has prepared a public sector IPv6 transition roadmap and is now aggressively executing it.

- Authorities will make sure that the government and public organizations switch to IPv6 preemptively as a role model so that security issues can be alleviated and the private sector can be encouraged to adopt IPv6.
- All federal organizations adopted IPv6 for its backbone network by September 2012, and all the federal government public service websites and internal systems must migrate to IPv6 by September 2014.

※ 546 (41.1%) out of 1,294 federal government websites already introduced IPv6 as of December 2013.

❑ **Europe:** The EU formed an IPv6 task force to promote IPv6 transition and is now encouraging its introduction in various areas such as infrastructures, applications and services.

- In 2011, the EU invested €6 million in its 'Gen6 Project' to implement secure and efficient electronic government services based on IPv6.

❑ **Japan:** In 2002, the government allowed for a special, one-year corporate tax deduction whereby communication service providers were able to deduct 12% of the purchase price of routers for IPv6 services. This was done as an incentive to entice companies and institutions to voluntarily switch to IPv6.

- In 2008, the Ministry of Internal Affairs and Communication established an 'IPv6 Execution Plan' that aimed to have the nation switch to IPv6 by the end of 2012. They recommended ISP service providers to finish implementing the IPv6 system by the end of 2011.

※ As of Mar. 2013, 54% of all the ISP service providers and 13% of CATV service providers were providing commercial services based on IPv6.

❑ **China:** To quickly avoid impending problems arising due to a lack of IPv4 addresses, China has been encouraging introduction of IPv6 at the national level.

- By 2006, they had implemented thirty IPv6 regional network bases throughout the nation and in 2013 they performed a slew of small scale tests on IPv6. China is now ready to pursue commercialization in the 2014-2015 timeframe.

❑ **India:** In March 2013, India revealed its IPv6 introduction roadmap that applied to service providers, content providers, manufacturers and government organizations.

※ All government organizations will finish switching to IPv6 by Dec. 2017. Service providers have already been offering IPv6 LTE services since July 2013. IPv6 services will be available for wired networks starting in July 2014.

Viewpoints

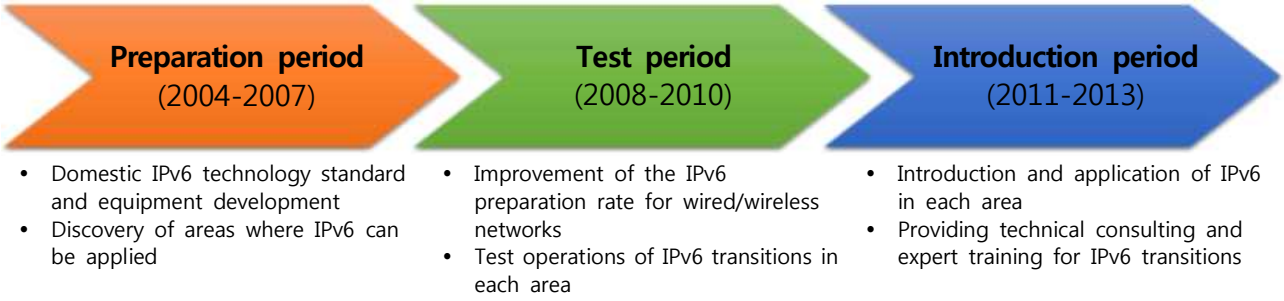
◈ Other countries are taking the following actions:

- Announcing an IPv6 transition plan/roadmap
- Introducing IPv6 first in the public sector so encourage widespread adoption
- Increasing the demand for related technologies and equipment

⇒ Korea also needs to seek out various political plans suitable for the current situation such as preparing an IPv6 roadmap, introducing IPv6 to government and public organizations, allowing tax deductions and providing special support for small & medium size companies.

2 Execution Status of South Korea

① Execution progress



❑ **(2004-2007)** In 2004, the First Basic Plan for IPv6 Distribution was established and IPv6 based equipment/technology development and technology standardization was pursued.

- Technologies were developed such as IPv4/IPv6 linked gateways, small & medium sized routers, VPN equipment, network management servers, firewall/IPS (Intrusion Prevention System).
- Next generation network technology development and standardization such as IPv6 address management systems, IPv4/IPv6 transition methods and linking technologies and IPv6 mobility supports were pursued.

❑ **(2008-2010)** In 2007, the Second Basic Plan for IPv6 Distribution was established and a test project to promote the IPv6 distribution in the public sectors and research organizations executed.

- (2008) The administration/public organization's information system implementation/operation guidelines, budget and fund operation plans and execution guidelines to mandate the purchase of IPv4/IPv6 equipment was revised.

- A test project to prepare the basic infrastructure for self governing local organizations and research institutions' wireless/wired backbone network, websites and IPTV was executed

❑ **(2011-2013)** In 2010, the Third IPv6 Transition Plan was established to implement the backbone of commercial IPv6 services and provide technical support for small & medium companies.

- A consortium of private sector and government organizations collaborated on a project to support commercial services for high speed Internet, mobile communication (3G, LTE and WiFi) and university networks.
- Customized technical consulting and technical support were set up to assist small medium companies not having the resources needed to train experts and introduce IPv6 in each area.

② Execution status

❑ **(IPv6 address availability)** In December of 2013, a total of 5,214 IPv6 addresses /32 (2^{96}) were obtained.

- Following the USA (31,636), China (16,670), Germany (11,976), Japan (11,249) and other countries, Korea is ranked number nine in the world. (Dec. 2013, APNIC)

❑ **(Network)** Network operators' preparation for the IPv6 subscriber network is greatly improved. (2013)

Year	Backbone network	Subscriber network
2012	91.2%	19%
2013	92.1%	65%

※ Preparation rate: The ratio of equipment for backbone networks (routers, switches, etc.) and subscriber networks (OLT, CMTS, etc.) supporting IPv6.

* OLT: Optical Line Terminal, CMTS: Cable Modem Termination system

- **(Public sector)** Mandatory purchase of equipment supporting both IPv4 and IPv6. (2008 Information System Implementation/Operation Guidelines and Funds/Budget Operation Plans) At the end of 2010, the preparation rate was around 60%.

※ For IPv6 traffic flows in Korea and overseas, KISA has installed and operated an IPv6 link network (6NGIX). (Jan., 2008): KT, SKT, Cheonnam University, Hurricane (USA) and about 70 other networks linked.

❑ **(Service)** In August, 2013, LGU+ launched its IPv6-based Voice over LTE (VoLTE) service but the actual services for content/data and websites are yet to be provided.

※ Since December of 2013, Daum has been testing additional websites based on IPv6.

❑ **(Equipment)** About 70% of domestic companies' network equipment such as routers support IPv6 but only 15% of the information security products support IPv6, which is very low.

※ 94 (70%) out of 134 network equipment products (routers, switches, etc.) made by 28 small & medium companies in Korea are "IPv6 Ready" certified (in accordance with the international IPv6 forum), and 30(15%) out of 197 CC* certified products support IPv6.

* CC (Common Criteria): Common security certification system that is mutually approved by 26 countries in the world.

❑ **(User devices)** About 68% of Korean PCs and smartphones support IPv6. (2013, KISA)

※ Notebook PCs: 82.6%, desktop PCs: 77%, tablet PCs: 61.3%, smartphones: 50.9%

< Domestic IPv6 Preparation Survey >

❑ Overview

○ Survey period: Aug. — Dec. 2013(KISA)

Classification	Classification	Target Internet users
Target	Main ISP, small & medium ISP, CSP	Ages 15 — 60
Sample size	Main ISP(4), small & medium ISP (115), CSP (250)	2,000 persons
Survey methods	Individual interviews, fax and email surveys at the same time.	Online panel surveys
Content	IPv6 support status, transition costs, awareness, etc.	IPv6 supporting handset status

※ CSP (Contents Service Provider): Service providers providing Internet content such as portals.

※ Main ISP : KT, SKB, LGU+, SKT (four companies)

❑ Main results

- **(ISP network preparation rate)** backbone network 92.1% (2012: 91.2%), subscriber network 65% (2012: 19%)
- **(IPv4 scarcity)** Main ISP (75.0%), small & medium ISP (71.4%) and CSP (22.4%) stated that they lacked IPv4 addresses.
- **(Transition plan)** Main ISPs said that they are switching to IPv6. 58.4% of small & medium ISPs, and 19.1% of CSPs said that they planned to switch to IPv6, but the rest of them said they had no plan to do so.

– Service periods for those service providers who have plans to switch to IPv6: Main ISPs (SKT/SKB 2014, KT 2015, LGU+ 2016). Small & medium ISPs said 5.2 years on average while CSPs said 7.9 years on average.

- **(ISP equipment preparation rate)** DNS servers 52%, email servers 71%, security equipment 40%, DHCP servers* 33%. Security equipment and DHCP servers' preparation rates are relatively low.

* DHCP (Dynamic Host Configuration Protocol) server: a server that automatically selects and assigns an IP address when a PC accesses the network.

< Domestic IPv6 Preparation Survey >

- **(Government support)** ▲Technical support, ▲Roadmaps and policy revisions/updates, ▲Support for equipment development costs, ▲Supply of technical trend information, ▲Support for content development costs
- **(IPv6 transition costs)** In the private sector, a total transition cost of KRW 2.1 trillion will be required in the future.
  (Average costs for each group: Main ISPs about KRW 19.27 million each, small & medium ISPs about KRW 3.9 billion each, and main CSPs about KRW 5.1 billion each.)
- **(Resolving the issue of scarcity of IPv4 addresses)** ISPs have said they will redistribute IPv4 addresses while CSPs said they will use private IP addresses.
- **(Rate of user devices supporting IPv6)** About 68% of user devices support IPv6. (Notebook PCs: 82.6%, desktop PCs: 77.0%, tablet PCs: 61.3%, smartphones: 50.9%)

3 Demand and Transition Forecasts

① Demand forecasts

❑ Higher demand for IP addresses as more handsets access the Internet.

- The widespread promotion of wireless services such as integrated wireless/wired services, smartphones and emergence of 4G services has lead to a parabolic increase in the demand for IP addresses.

  - More than 12 billion devices including servers, PCs and smartphones in the world are connected to the Internet. By 2020, this figure will be increased to 50 billion units.

    * Cisco Visualization(http://share.cisco.com/internet-of-things.html)

❑ Domestic IPv4 address scarcity and demand forecasts

- According to IPv4 address availability surveys, about 15 million (13.6%) of the total of 112 million IPv4 addresses are yet to be used.

  - Considering the pattern of IPv4 address use in the past, we expect a shortage within 3 to 4 years. Main service providers will face a shortage within 1 to 2 years.

- Considering the changes in the number of IPv4 addresses available during the years 2006 to 2010 before IPv4 address scarcity was declared in 2011, and taking into account future demand until 2017 based on the standard deviation method, we can conclude that we will need about 330 million IP addresses in 2017.

< IPv4 Address Annual Supply/Demand (Unit : Million) >

② Transition forecast

❑ Since the declaration of IPv4 scarcity in 2011, the amount of IPv6 traffic in the world has suddenly increased.

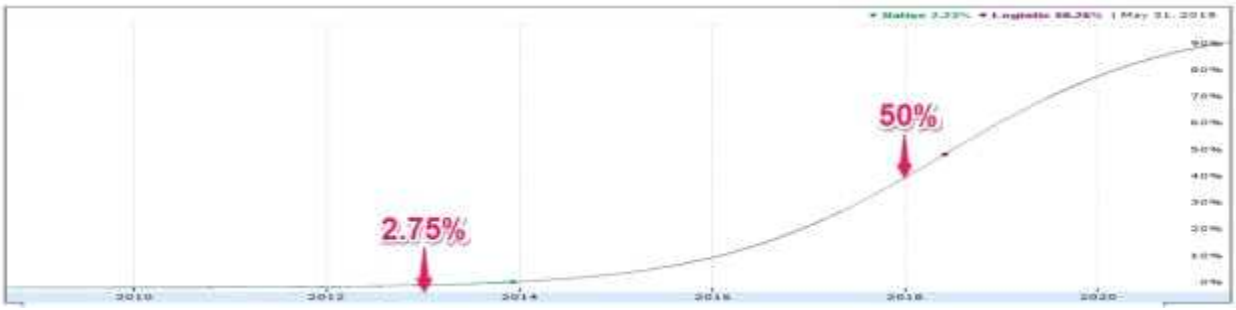
- For the first 10 years after being launched in 1998 there was only a slight annual increase in the amount of IPv6 traffic, but after the scarcity of IPv4 addresses was announced in Feb 2011 the amount of IPv6 traffic has increased drastically.

  - Until 2011, the years prior to the announcing of IPv4 address scarcity, the amount of IPv6 traffic had increased to only 0.27% of all traffic, but as of Dec. 2013 it had suddenly increased to 2.75%.

*Source : Google IPv6 statistics

❑ The amount of IPv6 traffic will be suddenly rise from 2.75% (end of 2013) to 50% (by 2018).

- Considering the trends of IPv6 traffic changes around the world, Google conducted a study to forecast IPv6 traffic growth from which they concluded it will jump from 10% at the end of 2015 to 50% by the middle of 2018.



*Source : Google IPv6 statistics

- Countries like the USA and Japan will introduce IPv6 aggressively in an attempt to lead the Internet market and improve national competiveness, while countries like China and India will do so mostly to resolve the issue of IPv4 address scarcity.

Country	IPv4 address availability (2012.4)	Population (2012.5)	# of IPv4 per capita	Country	IPv4 address availability (2012.4)	Population (2012.5)	# of IPv4 per capita
Korea	112,147,226	48,580,000	2.3	Vietnam	15,564,561	87,840,000	0.17
Japan	204,861,213	127,650,000	1.6	Thailand	8,562,096	65,479,483	0.13
China	**330,727,691**	**1,347,350,000**	**0.24**	Philippines	5,421,534	92,337,852	0.058
Malaysia	6,370,142	28,334,135	0.22	**India**	**35,164,844**	**1,210,193,422**	**0.029**

Ⅲ. Anticipated problems (Trouble Factors)

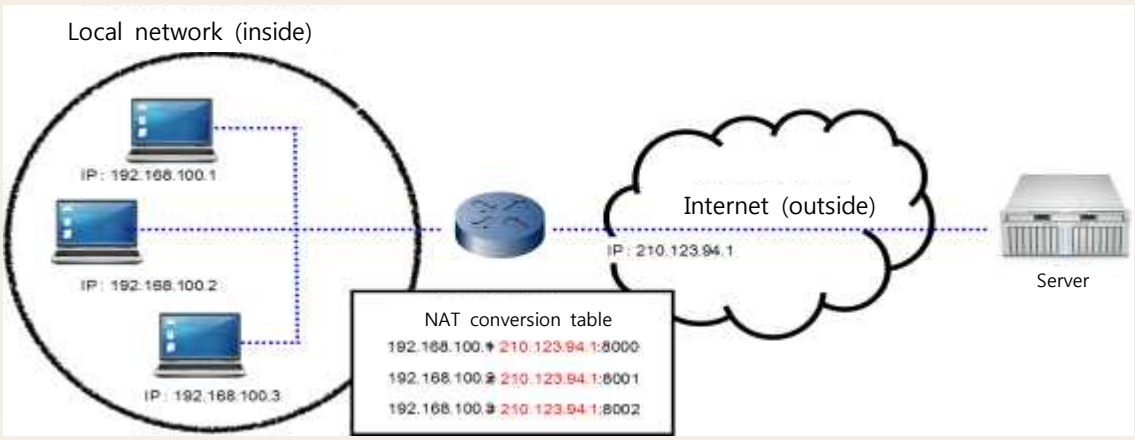
❑ Delayed supply of commercial IPv6 services

- (Private sector) According to the existing IPv6 transition plan, the rate of network preparation is increasing consistently, but there are some delays in promoting IPv6 support related to various network equipment availability and service transition.

  - Different participants such as network and service providers and device manufacturers are trying to avoid taking responsibility for introducing IPv6 ("chicken-egg" problem).
  - As there exists the burden of investment costs such as equipment replacement and software updates, they are reluctant to introduce IPv6.

※ Companies lacking IP addresses use a private IP address to provide service. As a result, there are problems such as increased complexity, limited bi-directional communication, and increased costs for Network Address Translation (NAT).

<NAT Concepts>



* Using Network Address Translation (NAT) that converts a private IP address to a public IP address and vice versa, you can generate and use several thousand (theoretically 65,000) private IP addresses from a single public IP address

- (Public sector) For network equipment, IPv6 service has been mandatorily required since 2008, but websites have not been mandated to do so, so there has been a delay in the IPv6 service.

❑ Concerns over security vulnerability of IPv6 and the absence of service models

- There have not been any significant efforts for developing information security products by verifying quality through any functional/performance evaluations and also there are some vague concerns about security and threats in the IPv6 environment.
- There have been an insufficient number of new services developed to generate profits from the given IPv6 investments.

❑ There is a lack of specialists and absence of successful cases of transition.

- There is no sufficient system operation or manpower development for the newly introduced IPv6 system and there has not been any sufficient number of accumulated experience and successful cases of IPv6 transitions, so industry participants are reluctant to be the first to introduce IPv6.

※ About 70% of small & medium companies want to receive support in the form of expert training and technical consulting. (2013, KISA)

〈 Problems Anticipated by a Delayed IPv6 Transition 〉

❑ **Limited number of responses to new service demands and newcomers entry to the market**

- There is a restriction on starting new services requiring IP addresses and expanding existing services.

  * (Hosting company A) Complains about difficulties in attracting new customers as so many IP addresses are required to conduct business.
  * (Cable company K) As it was unable to acquire sufficient IP addresses, it failed to execute its service expansion plans but was finally able to take over IPv4 addresses from company D that went out of business.

❑ Use of additional equipment such as NAT leads to a cost increase and degraded quality.

- Due to the conversion between private IP addresses and public IP addresses, there is difficulty in bi-directional one-to-one communication, so it is hard to remotely control sensors and electronics.
- Duplicate use of private IP addresses leads to an increase in complexity of network management. Public-private IP address conversion degrades network quality and increases NAT purchase costs.

❑ Foreign companies eating up the domestic market and difficulties in exploring overseas markets

- In the entire Internet industry including network/system integration (NI/SI) and professional consulting, there is a huge gap of technology power with foreign companies who are very willing to switch to IPv6, so there is significant concern about losing domestic market share to foreign companies.
- Due to the lack of IPv6 experience and technology, domestic companies are having a hard time exporting equipment or receiving orders on infrastructure implementation projects.

  * (IPv6 conversion equipment manufacturer A) They tried to participate in the IPv6 implementation project funded by the Malaysian government, but they failed in doing so because they had no experience in domestic IPv6 transitions or implementation.

❑ Issues of unfairness between companies having many IPv4 addresses and those without

- Service is not what they are competing for but it is more about how they get IPv4 addresses, so the problem can degrade the overall fairness of the Internet service market.

  * (Companies A and B competing for exclusive company sales) Company A tried to make a contract on the condition that they get more IPv4 addresses than company B. Company B suffered from the lack of IPv4 addresses.

Ⅳ. Execution Strategy and Roadmaps

1 Visions and Goals

Vision

To become the strongest Internet supplier with infinite Internet addresses (IPv6)

Goals

- 100% implementation of main IPv6 infrastructure(backbone network in 2014, subscriber network in 2017)
- First commercial service for wireless/wired Internet and websites in 2014.

Key tasks	Detailed tasks
Expanding the IPv6 infrastructure/ services	• IPv6 infrastructure to be supplemented • Commercial IPv6 services to be launched and expanded • Mandatory introduction of IPv6 to government/public organizations
IPv6 equipment and service development	• IPv6 network equipment to be developed and demand expanded • IPv6 information security industry to be promoted • New IPv6-based services to be developed
IPv6 transition promotion and user environment creation	• Tax deductions for companies introducing IPv6. • IPv6 transition rate auto measurement system to be implemented and operated • Comprehensive support system including technical support for small & medium companies to be implemented

2 Execution Strategy

❑ Switch from 'equipment improvement' to 'service oriented' efforts.

- In the past, the existing IPv6 expansion policy focused on equipment (network preparation rate improvements) but now a shift has been made to focus on practical IPv6 service use.
- By launching commercial services for mobile communication, the wired Internet and websites at the same time, we can implement a virtuous IPv6 cycle involving all aspects of the system (network, services, devices).

❑ Mandatory introduction of IPv6 in the public sector for increased use of IPv6

- When the government/public organizations implement a new website or make changes in their existing website, they must use IPv6, so that use of IPv6 can be extended to websites in the private sectors.

❑ Strengthening the competitiveness of IPv6-based information security products and promoting the security industry

- To alleviate groundless concerns over IPv6-based security equipment and to promote the relevant security industry, we will develop competitive products and establish more strict evaluation criteria for IPv6 security vulnerabilities.

❑ New IPv6-based service model development

- Discover new IPv6-based service models and execute private/government collaboration test projects and commercialization to create new values and attract IPv6 investments.

❑ Supplementing the system/infrastructure to promote IPv6 transitions

- Provide tax deductions on the amount of money used for purchasing IPv6 equipment to alleviate the burden on those companies introducing IPv6. Implement a comprehensive IPv6 support system for those companies lacking professional manpower and technological capabilities.

3 IPv6 expansion roadmap

❑ IPv6 expansion plan

- Expansion period (2014-2017): Finish implementing the main infrastructure and launch services.
- Maturation period (2018-2022): Finish implementing all the infrastructure and expand services.

Classification	Expansion period (2014-2017)	Maturation period (2018-2022)
Network implementation	• Finish implementing the government/public organization network. (100%) • Finish implementing the main ISP network. (100%) • Finish implementing the networks for three service providers. (100%) • Finish implementing the small & medium ISP backbone network. (100%)	• Finish implementing the small & medium ISP subscriber network. (100%)
Service delivery	• Start and expand all LTE commercial services. • Start and expand the main high speed Internet commercial service. • Start and expand small & medium ISP commercial	• Provide the government/public organization's civil web service. (100%) • Provide the small & medium ISP commercial service. (80%) • Provide the main CSP web service. (80%)

Classification	Expansion period (2014-2017)	Maturation period (2018-2022)
	services. (30%) • Start and expand main CSP website commercial services. (30%) • Start and expand the government/public organization's civil web service. (30%)	
Network /security equipment implementation	• Rate of network equipment support for IPv6 (100%) • Rate of security equipment support for IPv6 (50%)	• Rate of security equipment support for IPv6 (100%)
Devices	• Rate of device (smartphones, tablet PCs, etc.) support for IPv6 (80%)	• Rate of device (smartphones, tablet PCs, etc.) support for IPv6 (100%)

※ The results for the domestic IPv6 preparation rate surveys in 2013 (KISA) and service providers' IPv6 transition plans are considered.

※ (Main ISP) KT, SKT, LG U+, SKB / (Main CSP) 250 (top 100 websites + AS number owned, 100 + web hosting 50)

❑ IPv6 expansion steps

Classifi-cation	Execution	Expansion periods					Maturation period
		2013	2014	2015	2016	2017	2018~2022
Network implementation	Main ISP backbone network implementation (4 companies)	99%	100% (KT/SKT/ SKB/LGU+)				
	Main ISP subscriber network implementation (4 companies)	66%				100% (KT/SKT/ SKB/LGU+)	
	Small & medium ISP backbone network implementation (115 companies)	81%				100%	
	Small & medium ISP subscriber network implementation (115 companies)	42%				70%	100%
	Government and public organization network implementation(594)	60%				100%	
Service suppliers	Main ISP service suppliers (3 companies)	0%	SKB	KT	LGU+		
	Mobile communication (LTE) service suppliers (3 companies)	0%	SKT	KT	LGU+		
	Small & medium ISP service suppliers (115 companies)	0%				30%	80%
	Main CSP service suppliers (250 companies)	0%	Daum	Naver		30%	80%
	Government and public organization service suppliers (594)	0%		Integration center/ Ministry of Science, ICT and Future Planning		30%	100%
Equipment and device suppliers	Rate of network equipment support for IPv6	70%				100%	
	Rate of device support for IPv6 (smartphones, tablet PCs, etc.)	0%	Devices (Samsung/ LG/ Pantech)			80%	100%
	Rate of information security products support for IPv6	15%				50%	100%

※The transition period and target are determined based on information submitted by each company and the survey performed by KISA.

Ⅴ. Project Execution Details

1 IPv6 infrastructure service expansion

① IPv6 Infrastructure Supplementation

◇ IPv6 network infrastructure to supply wired/wireless Internet and website commercial services will be implemented well in advance.

❑ Swift IPv6-based network implementation

- For IPv6 transitions, a private/government discussion board and comprehensive support system have been set up. For early implementation of the IPv6 network, private/government collaboration projects have also been formed.

※ Korea's major ISPs (KT, SKT, SKB, LGU+) will finish integrating IPv6 into their backbone networks by 2014, and subscriber networks by 2017. Small & medium ISPs will finish implementing IPv6 into their backbone networks by 2017, and subscriber networks by 2022.

❑ Providing and advancing IPv6 for promotion of commercial services (2014-)

- The IPv6 network operated by KISA will be provided in the early phase of IPv6 expansion for free.

※ IPv6 network (6NGIX): KT, SKT, Cheonnam University, Hurricane (USA) and about 70 domestic and foreign ISPs and research institutions will be linked to each other over the IPv6 network and access testing and services provided. (KISA, Jan. 2008.-)

- The IPv6 network will be developed to provide reliable commercial services, duplexing with legacy systems, and supplement network management equipment in case of troubles. (2015-)

❑ CDN(Contents Delivery Network) support for the main phase of web service (2014-)

- Multimedia (images, videos, etc.) and IPv6 introduction support projects for CDN service on the web (private and public sector matching) implemented to promote commercialization of web services.

※ CDN: Network to store and distribute large sized contents such as video to end users so that content can be sent quickly and cleanly.

② IPv6 commercial service start and expansion

◇ 2014 is the "year for IPv6 service transition"during which we will ramp up the main phase of mobile communication, high speed Internet and website commercial service implementation to realize a virtuous cycle of IPv6 use in all segments of the network (N), for all services (S) for all devices (D).

❑ LTE commercial service launch and expansion (2014 2nd half-)

Classification	2014		2015		2016	
	Test	Commercial	Test	Commercial	Test	Commercial
Service providers	KT	SKT	LGU+	KT	-	LGU+

※ In foreign countries, T-Mobile provided the first commercial LTE service including data. (2013.11)

- SKT will provide IPv6-only handsets for LTE in the 2nd half of 2014.

※ Considering that the average handset replacement cycle in Korea is 16 months, it is expected that about 80% of LTE users will be using IPv6 in 2017 and nearly 100% of LTE users will be using IPv6 handsets in 2020. (SKT forecasts that nearly 70% of all handsets will be IPv6 handsets in 2016.)

❑ Wired Internet commercial service launch and expansion (2014, 2nd Half-)

Classification	2014		2015		2016	
	Test	Commercial	Test	Commercial	Test	Commercial
Service providers	KT	SKB	LGU+	KT	-	LGU+

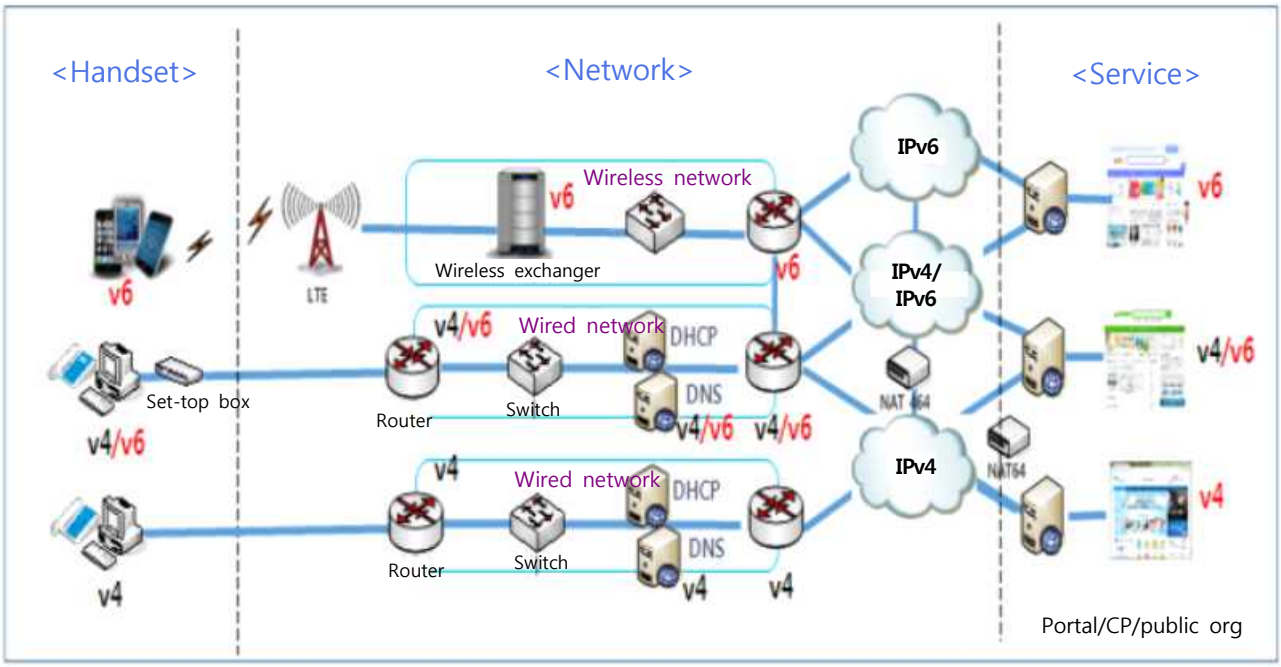
※ The total number of high speed Internet subscribers in 2013 was 17,859,522. Main ISP subscribers claimed 14,824,426 or about 80%.

❑ Website commercial service launch and expansion (2014, 2nd Half-)

Classification	2014		2015		2016	
	Test	Commercial	Test	Commercial	Test	Commercial
Service providers	KT	SKB	LGU+	KT	-	LGU+

- (Small & medium CSPs) By 2017 and 2022, 30% and 80% of small & medium CSPs' websites will be able to provide commercial IPv6-based services.

< IPv6 Handset-Network-Service Diagram >



1. IPv6-only handset for website access

- (v6 website access) v6 handset →LTE wireless exchanger →v6 wired network →v6 website
- (v4/v6 website access) →elect v6 network from v4/v6 wired network → v4/v6 website
- (v4 website access) v6 handset →LTE wireless exchanger →v6 wired network →Converter (v6→v4)→IPv4 wired network →v4 website

2. IPv4-only handset for website access

- (v4 website access) v4 handset →v4 wired network →v4 website
- (dual v4/v6 website access) →Select v4 network from dual v4/v6 wired networks →Select v4 site from dual v4/v6 website
- (v6 website access) v4 handset →v4 wired network →Converter (v4→6) →v6 wired network→6 website

❑ Organizing and operating the private/government discussion board for commercial service (2014-)

- The government, KISA, top three service providers, top three manufacturers, and top three portals will organize the "IPv6 commercial service support discussion board"and resolve concerns resulting from commercial service.

※ When providing IPv6 commercial service, these entities will periodically discuss issues such as subscriber network implementation and technologies, IPv6 network linking, website launching and handset launching, and seek ways of resolving them.

③ Mandatory introduction of IPv6 by the government and public organizations

◇ Promote introduction of IPv6 to the network/websites of government and public organizations to accumulate experience, create profits and implement the basis for expansion to the private sector.

❑ Mandatory introduction of IPv6 by the government and public organizations (2015-)

- According to the national informatization framework act to be newly revised, the government/public organization's network/websites must introduce and use IPv6 so as to spur its use among the private sector.

※ Law revision schedules:

- Early April : Revision of drafts
- Apr-May : Provision of legislation notice and collect opinions from all depts.
- Jun-July : Review of regulations and review by the legal office
- August- : Submission to the national assembly

❑ Providing successful cases of IPv6 introduction to the public sector and relevant guidelines (2016)

- Cases/experiences of IP introduction by government and public organizations should be accumulated. Also, suggestions and solutions for transition should be discussed to encourage small & medium private websites to aggressively switch to IPv6.
  - In conjunction with the government data integration center, government websites (Ministry of Science, ICT and Future Planning) IPv6 test transition (2015) will derive the best practices for transition and,
  - And as a result, we will prepare and distribute the 'IPv6 Introduction Guidelines' (2016) and promote the public and private websites to transition to IPv6.
- Support implementation of a test bed that can evaluate IPv6 equipment implementation in the public sector.

※ Equipment purchased by government/public organizations has IPv6 functionality embedded but very often is delivered without verification.

2 IPv6 equipment and service development

① IPv6 network equipment development and demand expansion

◇ For promoting IPv6 transitions, we will develop low cost yet capable network equipment suitable for the current domestic condition, promote the industry and expand demands.

◇ To reduce the burden of costs and certification time for network equipment manufacturers, we will simplify the certification system and support implementation of test beds.

❑ IPv6-based network equipment development (2015-)

- Considering the global market leaderships and exportation possibilities and substitution for imported goods, develop IPv6 based network equipment such as routers and switches.

< Network Equipment Development Types (6 Types) >

Classification	Network equipment types
Market leadership	• 3.2TB class optical cable packet integrated transmission equipment, • 40G/100G next generation optical subscriber network equipment • 4G/5G small cell BS and gateway equipment
Exports	• SDN-based next generation small & medium type switches
Substitution for imports	• Smart edge router advancement • 480G class carrier Ethernet

※ Execution in conjunction with network equipment development plans such as the "ICT equipment industry competitiveness strengthening strategy (2013)."

❑ Implementing an IPv6-based network equipment test bed (2015-)

- Implement an IPv6 test network similar to the actual commercial service environment where IPv6 based network equipment makers can test their equipment.

❑ Simplifying the IPv6 network equipment certification system

(2015-)

- To reduce the burden of certification costs for manufacturers and to reduce the certification lead time, integrate the IPv6 Ready Logo (international) and the TTA Verified(domestic) for the simplification purpose.
  - Since demanding organizations in Korea and overseas may want different certification marks, provide two types of certification marks until the integrated certification is commonly used.

② Promoting the IPv6 information security industry

◇ Support development of IPv6 information security products that companies introducing IPv6 can trust, that can conquer the global market, and promote the domestic industry and domestic competitiveness.

◇ For better safety and reliability of IPv6 information security products, the IPv6 security vulnerability evaluation criteria will be stricter than for IPv4, and a test bed prepared to evaluate/verify performance criteria.

❑ IPv6-based information security product development (2015-)

※ IPv6 information security products are still in the early development phase, so if you are the first one to develop and supply any, you can create a new market for information security and conquer the world market.

- To improve IPv6-based security in a new industry with high demand for IP addresses, such as cloud-based storage ad services and the Internet of Things (IoT/M2M), original technologies must be developed.

※ In conjunction with information security development plans such as the "Comprehensive Information Security Industry Development Plans (2013)."

❑ IPv6 security research and test bed implementation (2015-)

- To create a mutual survival environment of IPv4/IPv6 or IPv6, security vulnerabilities will be researched as well as how IPv6 address changes affect various offense/defense stances.
- After launching IPv6 information security products, support implementation of a test bed to verify it through all phases from development to post management.

❑ Stricter IPv6 security vulnerability and performance evaluation criteria(2014-)

- Products having IPv6 security features will be more strictly evaluated for security vulnerability by a security certificate (CC) organization.* (added as a test item)

* Evaluation organizations (5): KOSYAS, KTL, KSEL, TTA, KISA

- Prepare and provide IPv6 mandatory security functions and performance evaluation criteria for security products for manufacturers and review mandatory application of security certificates (CC) under the same criteria.*

* Consider excessive evaluation items, priorities for introducing products, and preparation of manufacturers resulting from retrospective application of existing certified products.

③ IPv6-based new service development

◇ Developer IPv6 service-based technologies such as access technology to implement networks that can perform IPv6-based communication between various objects.

◇ Test projects and commercialization to discover new service models based on IPv6 such as big data, cloud-based services, ITS and U-health by using new access technologies.

❑ IPv6-based Internet of things technology development (2015-)

※ At present, RFID, M2M, USN and mobile communication are serviced only partially and independently, so it is impossible to share and utilize information obtained from them.

※ The limited number of IPv4 addresses and number of resources (012, 010) are too limited for use as unique numbers to identify all objects.

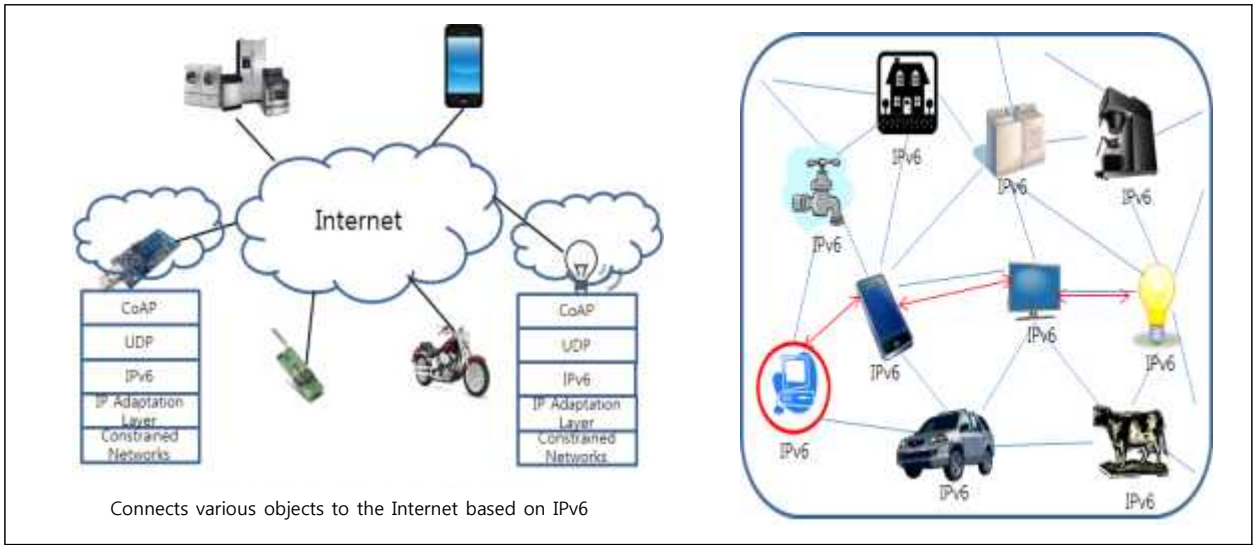
⇒ "Infinite Internet address (IPv6)" is the bestalternative for unique numbers and a common resource that can work as a medium for various communication methods such as RFID, M2M, USN and mobile communication.

- To implement a network that can connect objects and perform mutual communication based on IPv6, develop technologies that are lightweight, lower power and heterogeneous.

* IPv6 requires a long string of digits and its basic protocol memory size is too big, so it is hard to implement ultra small sized objects.

** In case of ultra small sized objects, there is a need to maintain performance for a long time with little power consumption.

*** Need to interconnect a network to different types of communication methods such as RFID, M2M and USN.



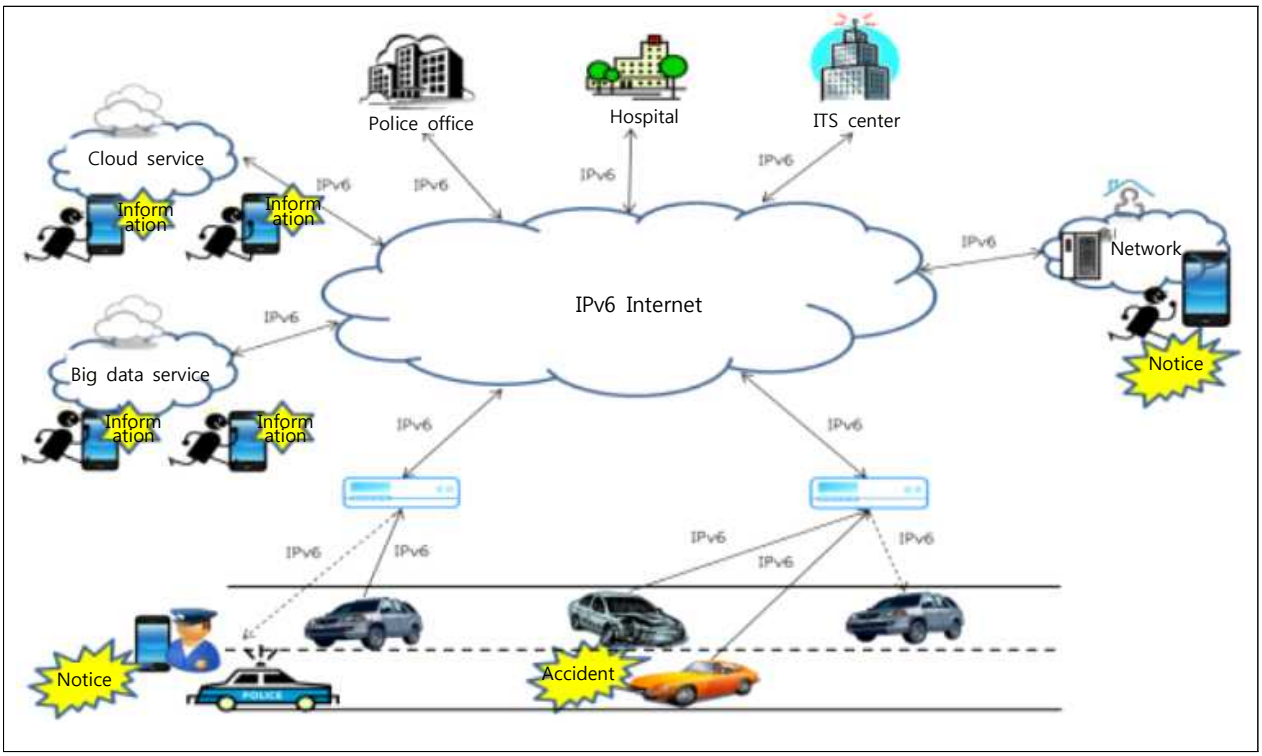
Connects various objects to the Internet based on IPv6

❑ IPv6-based new service development (2015-)

- Develop new business models using light weight/low power/distinct model access technologies that can connect various communication methods and services with IPv6.
  - Develop various convergence/fusion services by connecting big data, cloud services, ITS, U-health, and home network services.

※ In conjunction with new service development plans such as the basic Internet of things (IoE) plans.

< (Example) Car Accident Detection and Notice Service >



※ Examples: (1) Service to automatically detect vehicle accidents and notify the emergency rescue organization, highway police, local hospital, railroad corporation, and the insurance company. (2) A remote health diagnosis service using big data and U-health ITS.

❑ Commercialization and testing of new services (2016-)

- Research institutions and companies participate in verifying interoperability and analyzing problems with new service application and possibility for commercialization.
- For technical verification and new service commercialization, a group of experts from the government, academia, industry and research fields is invited to form a "technical verification and commercialization discussion board."

3 IPv6 transition promotion and user environment creation

① Tax deductions for companies introducing IPv6

◇ Tax deduction on IPv6 equipment

❑ Tax deduction on IPv6 equipment (Mar. 2014-)

※ Most companies have difficulties in creating profits when introducing IPv6 equipment, so they want incentives/assistance such as tax benefits from the government.

- A certain portion of the cost of purchasing IPv6 equipment (routers, switches) should be tax deductible (big companies 3%, small & medium companies 7%) to reduce the burden on any company introducing IPv6.

※ Special tax treatments were revised. (Announced and enforced on Mar 14, 2014.)

② IPv6 Transition rate auto measurement system implementation and operation

◇ Each organization's IPv6 traffic and ranking should be periodically measured and announced to encourage voluntary participation by organizations yet to use IPv6.

❑ IPv6 transition rate automated measurement system implementation and operation (KISA, 2014-)

- At KISA, a system that can automatically measure user traffic at a website and determine the use of IPv6 addresses and IPv6-based website opening will be implemented. (2014.11)

❑ Annual announcement of each organization's IPv6 transition ranking (2015-)

- IPv6 traffic will be periodically measured and annual IPv6 transition rankings announced and published to encourage participation by companies yet to use IPv6.

③ Comprehensive IPv6 support system implementation

◇ Implementing comprehensive support systems to provide customized professional training, technical consulting and guidelines for small & medium companies lacking manpower and technological expertise.

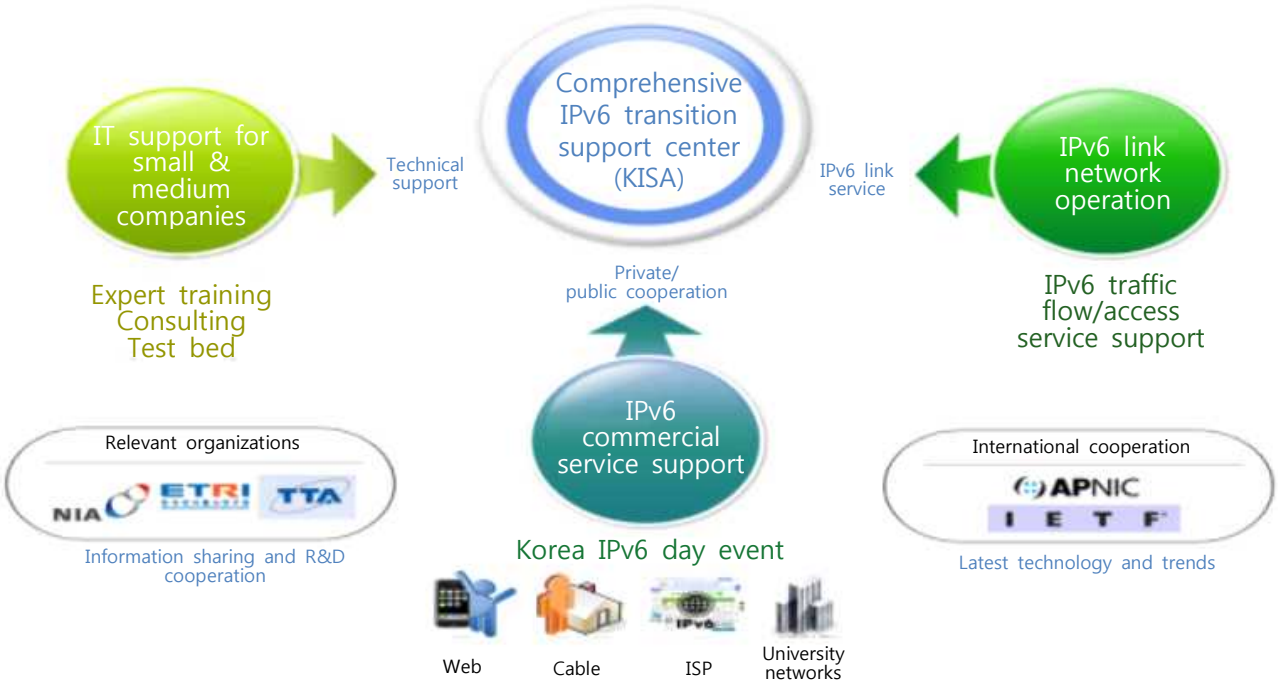
❑ Comprehensive IPv6 support system implementation and operation (KISA, 2014-)

- (Professional training) Customized training for IP address managers, staff, network administrators, and IT engineers will be developed.
  - Professional training will be strengthened such as through operation of an 'international certification program' and 'IPv6 qualification certificate system.'
- (onsulting) Comprehensive support for IPv6 transition consulting (including information on overseas technical trends, supply of test beds, and technical consulting).

❑ Preparing and distributing customized IPv6 introduction guidelines (KISA, 2014-)

- KISA will prepare and distribute IPv6 introduction guidelines covering introduction of IPv6 in each area, introduction plans, procedures /methods, technical review items, verification methods, and costs of introduction.

< Comprehensive Support System for Small & Medium Companies' Transition to IPv6 >



Ⅵ. Expected Outcomes

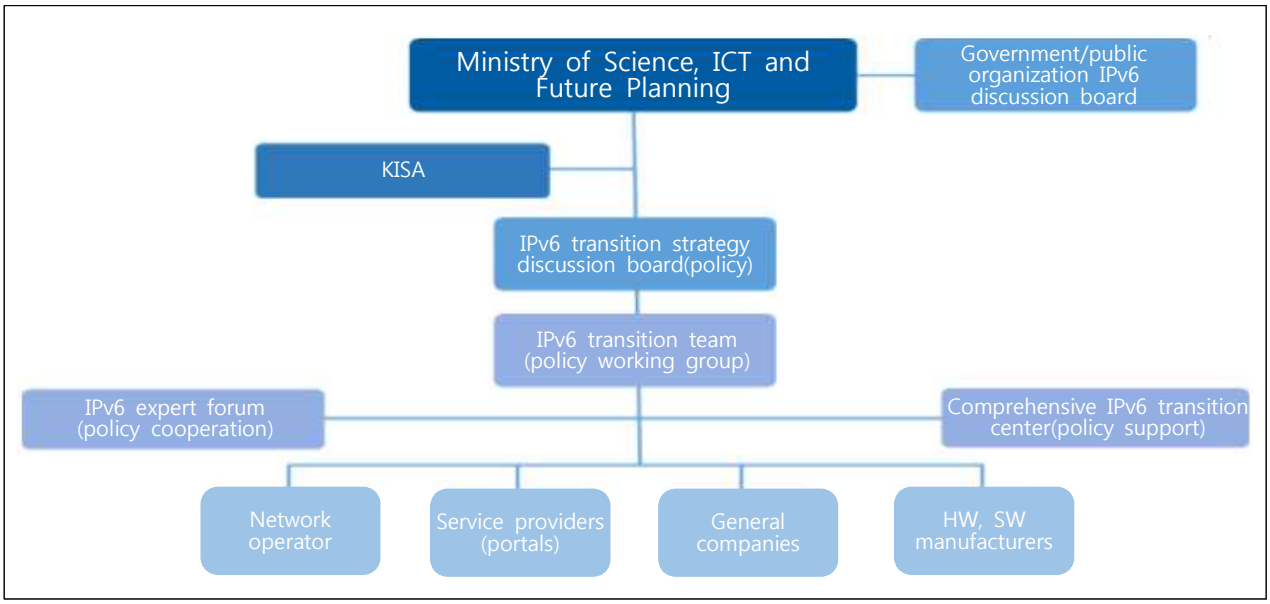
- **(Creation of the foundation for future Internet service)** Resolves the issue of the scarcity of existing IPv4 addresses, and creates the foundation for various Internet services for the future.
- **(Next generation convergence service basis)** By providing infinite IP addresses, a foundation will be secured for convergence services interconnecting big data, cloud services, ITS, U-health and home networks.
- **(Quality services for users)** Good quality service will be provided by taking advantage of IPv6 addresses such as handset mobility, security functions, selective calls, and bi-directional communication.
- **(Domestic industry promotion)** By developing and supplying IPv6-based networks and information security products, the domestic industry will be promoted and global markets conquered.
- **(Economic ripple effects)** We estimated the economic ripple effects of IPv6 related industries based on investments (including government funded projects) in the private sectors from 2014 to 2017 and found that annual production effects will be 2,600.1 billion, added values will be KRW 1,766.7 billion, and creation of 23,900 more jobs.

< IPv6 Ripple Effects on the Economy >

Classification		2014	2015	2016	2017	Total
Investment	Gov't support (100 million KRW)	20	84	84	86	274
	Private sector (100 million KRW)	3,000	3,000	3,000	3,000	12,000
Production effects (100 million KRW)		6,398	6,533	6,533	6,537	**26,001**
Added values effect (100 million KRW)		4,347	4,439	4,439	4,442	**17,667**
Job creation (persons)		5,881	6,005	6,005	6,009	**23,900**

Ⅶ. Execution Systems and Budgets

1 Execution system



- To discuss the political tasks and issues surrounding introduction of IPv6, the government and industry/academic/research experts are invited to the "IPv6 transition strategic discussion board."

※ To review the IPv6 political tasks and issues, organize and operate the "IPv6 working group."

2 Expected Budgets

(Unit: 100 Million KRW)

Classification		2014	2015	2016	2017	Total
IPv6 infrastructure service expansion	IPv6 infrastructure supplementation	2	7	7	7	**23**
	IPv6 commercial service start and expansion	9	15	15	15	**54**
	Mandatory application of IPv6 by government and public organizations	-	14	14	14	**42**
IPv6 equipment and service development	IPv6 network equipment development and demand expansion	-	15	15	15	**45**
	IPv6 information security industry promotion	2	5	5	5	**17**
	IPv6-based new service development	-	20	20	22	**62**
IPv6 introduction promotion and user environment creation	Tax deductions for companies introducing IPv6	-	-	-	-	**-**
	IPv6 transition rate auto-measurement system implementation and operation	1	2	2	2	**7**
	Comprehensive IPv6 transition support system implementation	6	6	6	6	**24**
Total		**20**	**84**	**84**	**86**	**274**

Ⅷ. Future Schedule

Detailed tasks	Execution schedule			
	2014	2015	2016	2017
Key tasks 1. IPv6 infrastructure service expansion				
IPv6 infrastructure supplementation	ISP subscriber network supporting businesses and IPv6 link network advancement			
	CDN support business for IPv6 commercial services			
IPv6 commercial service start and expansion	Operating the "IPv6 commercial service support discussion board"			
	IPv6 commercial service start (2014 2H)			
	IPv6 commercial service supporting businesses			
Mandatory application of IPv6 by the government and public organizations	Trying to revise the national informatization framework act			
		Government and public organization's website implementation to support businesses		
		Preparing the case of successful implementation of IPv6 by government/public organization and guidelines		
Key task 2. IPv6 equipment and service development				
IPv6 network equipment development and demand expansion		IPv6 network equipment development and test bed implementation and operation		
		IPv6 network equipment certification system simplified		
IPv6 information security industry promotion		IPv6 information security product development		
		IPv6 offense/defense type studies and test bed implementation and operation		
	Prepare security certificate mandatory functions and performance evaluation criteria			
IPv6-based new service development		IPv6-based IoT access technologies and new service development		
		New IPv6 service test operation and commercialization		
Key task 3. IPv6 introduction promotion and user environment creation				
Tax deduction on companies introducing IPv6	Tax deductions			
IPv6 transition rate auto-measurement system implementation"Eand operation		IPv6 transition rate auto-measurement system implementation and operation		
		Disclosure of each organization's IPv6 transition rate ranking		
Comprehensive IPv6 transition support system implementation including support for small & medium companies	Professional training for small & medium companies			
	IPv6 introduction guidelines prepared			
	Customized technical consulting for small & medium companies			

[Attachment]

1 IPv4 and IPv6 address comparisons

❑ IP address types

- There are two types of IP addresses: IPv4 and IPv6. Currently, mostly IPv4 is used.

Classification	IPv4 (developed in '81)	IPv6 (developed in 1998)
Address length	32 bits	128 bits
Address format	Ex.: 211.192.38.1	Ex.: 2001:dc2:0:40:135:72df:9e74:d8a3
Total number of addresses	About 4.3 billion (232)	About 4.3 billion×4.3 billion ×4.3 billion×4.3 billion (4.3×1038, 2128)
Address setting	Manual setting	Auto setting (complex address structure)
Security	IPSec protocols installed separately	Basically provided in the expansion function.
Quality control	No way of supporting	Easy to guarantee the quality

❑ IPv6 advantages

- **(IP addresses increased)** The number of IP addresses is greatly increased as the bit number is increased from 32 bits to 128 bits, therefore IPv6 will be able to handle the immense impending demand to be generated from the IoT and expanded use of smartphones.
- **(Auto address setting)** In the past, IPv4 addresses were set manually but IPv6 allows auto setting without intervention by a user.
- **(1:1 communication)** IPv4 uses a private IP address and cannot achieve one-to-one device communication, but IPv6 does not use a private IP address, so it can achieve one-to-one device communication.
- **(Handset mobility)** Even if a user moves to another base station,

the IP address is not changed and service can be provided without interruption.

- **(Quality control)** It is possible to classify packets depending on user's class and service, and guarantee quality accordingly.
- **(Reduced network management costs)** IPv6 does not require address converters (Network address translation (NAT)) so it is easy to configure the network, and costs for network implementation and management are reduced.
- **(Security)** IPv4 requires additional installation of a security function (IPSec) but IPv6 provides security as a basic unit of its expansion function.

2 IPv4·IPv6 addresses owned in the world

<World's IPv4 Address Rankings>

Ranking	Country	Number of addresses
1	USA	1,581,204,352
2	China	330,309,376
3	Japan	201,707,264
4	UK	123,634,448
5	Germany	119,562,600
6	**Korea(remaining)**	**112,273,152 (15,232,000)**
7	France	95,904,112
8	Canada	80,960,768
9	Brazil	70,174,208
10	Italia	53,261,416

<Asian Pacific Countries' IPv4 Rankings>

Ranking	Country	Number of addresses
1	China	330,309,376
2	Japan	201,707,264
3	**Korea**	**112,273,152**
4	Australia	47,839,232
5	India	35,473,408
6	Taiwan	35,405,568
7	Indonesia	17,513,472
8	Vietnam	15,587,072
9	Hong Kong	11,718,912
10	Thailand	8,577,792

<World's IPv6 Address Rankings>

Ranking	Country	# of addresses (/32)
1	USA	31,636
2	China	16,670
3	Germany	11,976
4	Japan	11,249
5	France	9,338
6	Australia	8,652
7	EU	6,251
8	Italia	5,309
9	Korea	**5,241**
10	Argentina	4,306

<Asian Pacific Countries' IPv6 Rankings>

Ranking	Country	# of addresses (/32)
1	China	16,670
2	Japan	11,249
3	Australia	8,652
4	Korean	**5,241**
5	Taiwan	2,345
6	India	263
7	Indonesia	158
8	New Zealand	156
9	Singapore	150
10	Hong Kong	135

※ 5,239(/32) = 5,239 × 2^{96} (5,239×4.3 billion x 4.3 billion × 4.3 billion)

- Initial IP address allocation date

Classification	Initial allocation	Target
IPv4	Jul. 1986	SNU's computer engineering department and ETRI's SDN (System Development Network) common data network were the first to use allocated IP addresses.
IPv6	Oct. 1999	NIA' broadband network, KOREN (KOrea advanced REsearch Network), received the first IP address.

- ISP with IPv6 (2013)

Classification	2007	2008	2009	2010	2011	2012	2013
ISP with IPv6 (cumulative)	34	40	43	49	57	66	77

3 IPv6 transition costs

- When domestic ISPs and CSPs (content service providers) implement IPv6, we can expect that transition costs after 2014 will amount to about KRW 2.1 trillion.
  - The main ISPs occupy 37.1%, small & medium ISPs occupy 21.6%, and CSPs occupy 41.3% (about KRW85.8 billion),

which means that CSPs occupy the largest portion.

※ Main ISP's, small & medium ISP's and CSP's network/security/server equipment are to be replaced as the technology develops and traffic increases.

- (Domestic) For successful introduction of IPv6, let's assume that all L3 equipment (routers/switches) owned by companies surveyed in the 2013 Domestic IPv6 Preparation Status Investigation are replaced with IPv6 equipment. The resulting cost (hardware, software, labor) leads to the estimation of IPv6 transition costs. (Main ISPs: hardware 80.6%, software 10.9%, labor fees 8.5%)

  ※ The survey results in an estimate of transition costs based on the ISPs (KT, SKB, SKT, LGU+), the small & medium ISPs (77 companies) and CSPs (152 companies) surveyed.

- (USA) As the IPv6 implementation costs can affect service types, transition technologies, infrastructure configurations, security levels and transition time, so also we need to discuss with interested parties and experts to derive the IPv6 implementation costs. (Jan. 2006, US Department of Commerce report, ISPs: hardware 15%, software 15%, labor fees 70%)

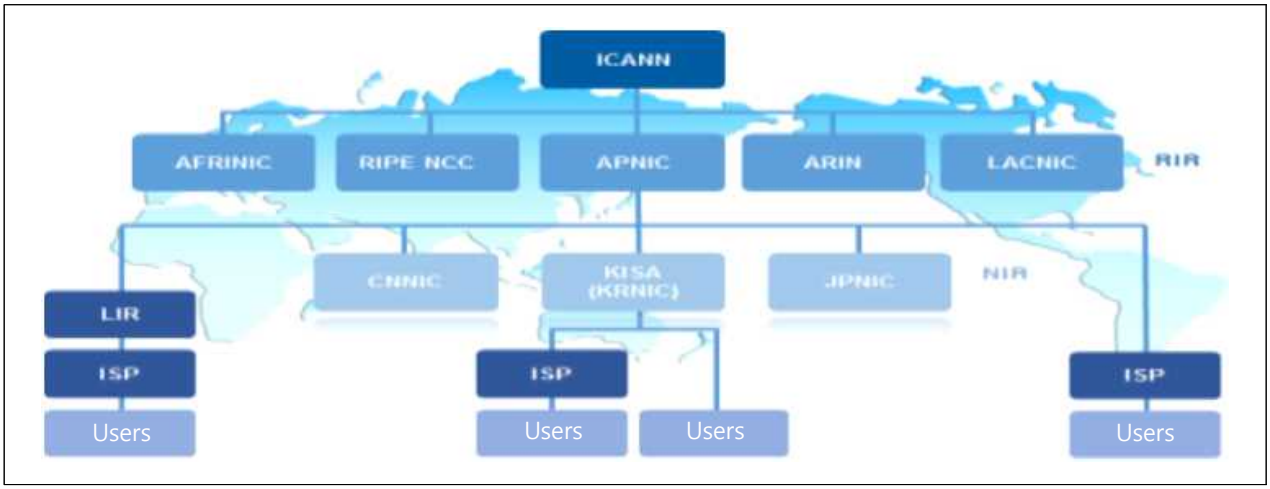
<Domestic IPv6 Transition Costs Results>

Total IPv6 Transition costs	IPv6 Preparation rate	Total transition costs		Total transition costs before 2013		Total transition costs after 2014	
	(Equipment)	Total amount	Proportion	Total amount	Proportion	Total amount	Proportion
Stakeholders	%	1 billion	%	1 billion	%	1 billion	%
Main ISPs	66.6	4,788.0	58.0	4,017.2	65.2	**770.8**	**37.1**
Small & medium ISPs	48.5	869.9	10.6	422.0	6.9	**448.0**	**21.6**
CSPs	66.5	2,557.4	31.0	1,699.6	27.6	**857.8**	**41.3**
Total		8,215.3	100.0	6,138.7	100.0	**2,076.6**	**100.0**

4 IP Address Management System

❑ IP address management system

< World's IP Address Management System >



- ICANN (Internet Corporation for Assigned Names and Numbers)
  - Comprehensively manages Internet addresses globally.
  - Non-profit organization consisting of Internet business, technology, academic and user groups.
- IANA (Internet Assigned Numbers Authority)
  - Manages the world's IP addresses provided by ICANN according to a contract with the US Department of Commerce.
  - Assigns addresses to the RIR which is an Internet address management organization of each continent.
- RIR (Regional Internet Registry)
  - The Internet address management organization for each continent. (Global total of 5)
  - Assigns addresses to each NIR who is the national Internet address management organization of the continent under the supervision of each RIR or ISP (whichever case may apply).

- AfriNIC(African Network Information Center) : African continent
- **APNIC(Asia Pacific Network Information Center) : Asia pacific region**
- ARIN(American Registry for Internet Numbers) : North America
- LACNIC(Latin American and Caribbean IP address Regional Registry) : Central and South America and Caribbean regions
- RIPE NCC(Reseaux IP Europeens Network Coordination Centre) : Europe

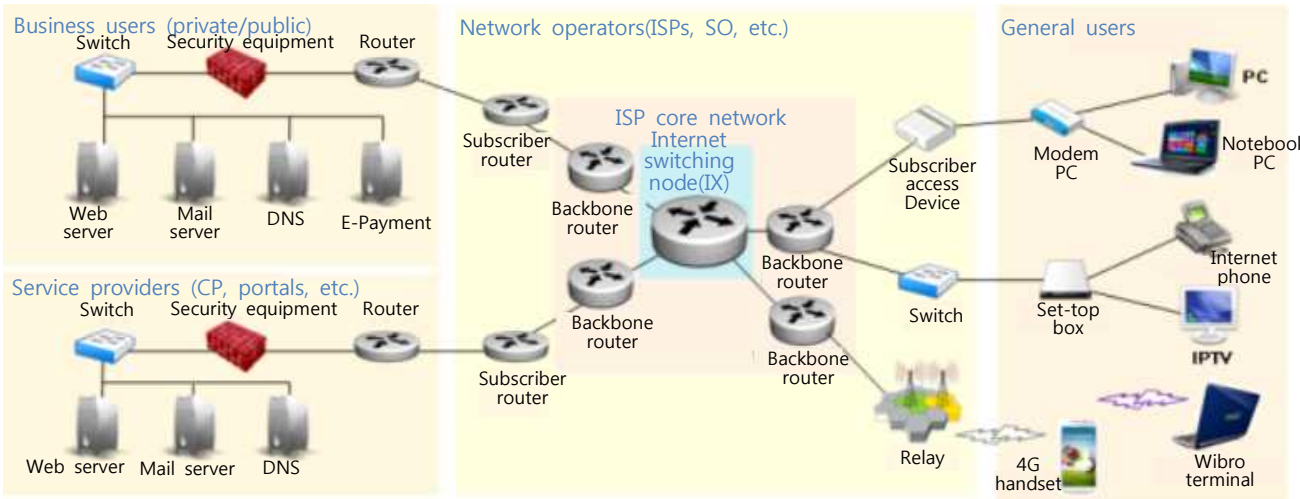
- NIR (National Internet Registry)
  - National Internet management organizations (Asian Pacific region: 7 total)

RNIC (Korea), JPNIC (Japan), CNNIC (China), VNNIC (Vietnam), TWNIC (Taiwan), APJII (Indonesia), INNIC (India)

※ KISA (KRNIC): Assigns IP addresses and AS numbers to independent users or national management agencies.

- LIR (Local Internet Registry)
  - Regional Internet address management organization. (General this means the ISPs.)

5 Status of Equipment Replacement When Introducing IPv6



Target	Service details	Substitution equipment when IPv6 is introduced
Network operators (ISPs, SO, etc)	IPv6 based Internet access service provided	(Backbone network) routers, switches (Management) DNS, DHCP, NMS (Subscriber network) ADSL, VDSL, Ethernet, HFC, FTTH, IDC, WiBro, HSDPA, VoIP, IPTV, WiFi, etc.
Business users (private/public organization)	IPv6 based self and civil service provided and external IPv6 based service used.	(Network) routers, switches (Security) firewall, IDS, IPS, web firewall, etc. (Management) DNS, DHCP, NMS, SMS (Application) web servers, mail servers, e-payments
Service providers (CPs, portals, etc)	IPv6-based content and search services	(Network) routers, switches (Security) firewall, IDS, IPS, web firewall, etc. (Management) DNS, DHCP, NMS, SMS (Application) web servers, mail servers,
General users	IPv6 based service used	PC OS
Manufacturers (hardware, software)	Considering use of IPv6 in all product groups, regardless of which product is used to configure the network, you can still provide IPv6-only service.	- Optical LAN: HDT, OLT, ONU, ONT, RN, CMTS, ENM, EAM, EMS, etc. - xDSL: IP DSLAM, Modem, IP STB, etc. - WiFi: wireless AP, etc. - Wibro/3GPP: HA, GGSN, etc. - Routers, switches, etc. - Firewall and security equipment

Equipment type	Minimum OS requirements for IPv6
General PCs	Windows Vista (Windows XP after installing SP2), MAC OS 10x , OS2 z/OS 1.4 or higher
Smartphones/ PDAs	IOS 4.0, Google Android 2.3, Windows CE/NET 4.1 or higher
Servers	Windows Server 2003, OpenBSD 2.7, Linux Kernel 2.0, Solaris 5.8 HP-UX 11i, FreeBSD 4, AIX 4.3 or higher
Network equipment	IOS 12.2 (2)T (enterprise class), JUNOS 5.1 or higher
Web/DNS/mail/ DB	Apache 2.0, Tomcat 5.5, IIS 7.0, BIND 9.0, Sendmail 8.8.x, Exchange 2007 SP1, Oracle 11g, MS-SQL 2005, Mysql 5.5 or higher
Web browsers	Internet Explorer 7.0, Chrome 11, Firefox 3.6, Safari 5.0, Opera 11.5 or higher

6 IPv6 Transition Plans and Outcomes

<IPv6 Distribution Promotion Plans and Outcomes>

<table>
<tr><th>Classification</th><th>IPv6 distribution promotion plan ('04)</th><th>Basic IPv6 distribution promotion plan ('07)</th><th>IPv6 transition plan ('10)</th></tr>
<tr><td>Goals</td><td>• IPv6-based wireless/wired integration technology development and test service.</td><td>• Apply IPv6 to government/public/research areas to cover the market early.</td><td>• Strengthen private/public collaboration to promote the basis for commercial IPv6 service.</td></tr>
<tr><td rowspan="4">Main Tasks outcomes</td><td>IPv6-based wireless/wired integration technology development</td><td>Application of IPv6 to public and research organizations.</td><td>Private/government collaboration for successful implementation of the basis for supporting commercial IPv6 service</td></tr>
<tr><td>• Leverage a successful business by supporting development of equipment essential to IPv6 distribution.

- Equipment and technology development for successful IPv6 infrastructure implementation.
※ Develop a total of seven types of equipment such as IPv4/IPv6 gateways, mobility technologies and network management servers usable in the integrated wireless/wired communication environment ('04-'05).

- Develop IPv6-based integrated equipment and services for service interconnection in the BCN such as mobile communication networks, wifi LAN and WiBro.

- Next generation IP router technology development.
※ Small & medium IPv6 routers and technology development (five cases) ('03-'05), Development of integrated security equipment prototypes ('06).</td><td>• Apply IPv6 to self governing local organizations and research institutions.

- IPv6 equipment support for public organizations, IPv6 cluster implementation for Daedok research complex

<table><tr><th>Area</th><th>Organizations</th></tr><tr><td>Self governing local organizations</td><td>Gangneung city hall, Samchuck city hall, Gongju city hall, Gyeongsangnam-do office, Gyeongsangbuk-do office, Gwangju city hall, Busan city hall (total of seven)</td></tr><tr><td>Daeduck research institutions</td><td>KBSI, KARI, KASI, NFRI, KIGAM, KIOM, KISTI, ETRI (total of 8)</td></tr></table></td><td>• Implement an environment to introduce commercial IPv6 service.

- Apply IPv6 to the three main Korean service provider backbone networks and link IPv6 over the IX to secure a foundation for the IPv6 environment.

- Collaborate with SKT to implement the IPv6-based wireless network (3G, LTE, WiFi) and provide relevant services (2012).

- Collaborate with web hosting companies to apply IPv6 to websites (2012).

- Collaborate with cable service providers to acquire 250 subscribers to IPv6 services and develop the latest IPv6 transition technologies to attract IPv6 subscribers (6RD) (2011).</td></tr>
<tr><td>IPv6 applied service development and distribution promotion</td><td>Implementation of the foundation for distribution and expansion of IPv6 and improvement of a system to introduce IPv6</td><td>Implementation of a private/government collaboration system and support for the socially vulnerable</td></tr>
<tr><td>• Develop advanced applications to ignite the early IPv6 market.
- IPv6-based P2P application development and applications
※P2P applications, VoIP, telematics, educational applied services, etc.

• Promote IPv6 through test services.</td><td>• Aggressively establish IPv6 introduction requirements and relevant systems.
- Mandatory use of IPv6 products when the government purchases equipment.
- Develop guidelines such as the 'Public Organizations' IPv6 Application Guides.'
- Establish the IPv6 address allocation system in the public</td><td>• Operate a comprehensive IPv6 transition support system for the socially vulnerable.
- IPv6 application and implementation/operation experts trained. (2008-, 3,185 persons)
- IPv6 transition technology consulting. (2011-, 35 times)
※ Provide consulting for small & medium companies having difficulties in technology and</td></tr>
</table>

Classification	IPv6 distribution promotion plan ('04)	Basic IPv6 distribution promotion plan ('07)	IPv6 transition plan ('10)
	- FTTH digital home service ('04) - VoIPv6 test service ('04, '06) - IPv6 based remote university lecture test service ('04) - IPv6 disaster prevention management service ('05) - Unattended night-watch service (2006) • Encourage application of IPv6 to the home network service and promote the development of the wireless/wired integrated network and the relevant industry.	sector. • Implement an IPv6 training and cooperation system to promote awareness of IPv6 transitions. - IPv6 training (17 times, 612 persons) and technical consulting (20 times) - Operate an academic/industry discussion board (11 times) - Technical consulting (20 times) - Global IPv6 Summit and events hosting (12 times) - Policy research (2 cases), journals and standardizations, press releases.	investments. • Expand the private/government cooperation system and host events to secure a foundation for actual service. - Operate the IPv6 transition discussion boards (4 times) and working group (7 times). - Participated in the World IPv6 Day (May 2011.) event. ※ 12 domestic sites including Naver and Daum participated. - Hosted the Korea IPv6 Day event. (2012.5) ※ 22 organizations including Naver, Daum, KT and SKB participated.
	Introducing IPv6 DNS test services and standardization certification systems	**IPv6 network, portal service operation and promotion research**	**Strengthening the inspection system for each area of IPv6 transition and promoting awareness.**
	• IPv6 .kr DNS application studies and test services - Make sure five out of eleven .kr DNS operating in Korea and overseas support both IPv4 and IPv6. (2008) • Standardize IPv6 in Korea and overseas. - Adopt IETF international standards, ITU-T international standards proposal and domestic standards. • IPv6 test certification to guarantee interoperability among equipment. - "IPv6 Ready"logo certificates, IPv6 related TTA Verified certificates.	• IPv6 website renewals for advertising IPv6. • Research for promoting IPv6 applications and contents for public organizations. (2 cases) • IPv6 link network (6NGIX/6KANet) operation.	• Newly develop a preparation/usability index to examine the level of IPv6 use in Korea. ※ Investigate the current status of preparation and transition of IPv6 in Korea (2010-2012). • IPv6 awareness promotion - According to the domestic IPv4 address final allocation policy enforcement (2011April), provide information sessions and distribute the press release materials. - Check the current status of IPv6 and attend international meetings to present pioneering cases of IPv6 in Korea. - In the environment of mutual IPv4/IPv6 survival, to guarantee reliable transition to IPv6, prepare and distribute 'Success Cases of IPv6 Introduction' and 'Practical IPv6 for the Interested Parties.'

7 Terminology

A

- ADSL : Asymmetric Digital Subscriber Line
- AfriNIC : African Network Information Center
- AP : Access Point, wireless LAN access point
- APNIC : Asia Pacific Network Information Center
- APJII : Asosiasi Penyelenggara Jasa Internet Indonesia
- ARIN : American Registry for Internet Numbers, regional Internet Registry for North America

C

- CGN : Carrier-Grade NAT, address converter that can handle large size traffic in the backbone network.
- CC certificates : Common Criteria, set of international standards to evaluate information security products according to international standards.
- CP : Content Provider (portals, etc.)
- CNNIC :China Internet Network Information Center
- CMTS : Cable Modem Terminal Service
- CIO : Federal Chief Information Officers Council

D

- DSLAM : Digital Subscriber Line Access Multiplexer
- DSTM : Dual Stack Transition Mechanism, server/gateway based IPv4/IPv6 dual stack transition.
- DTV : Digital Television,
- DNS : Domain Name Server, device to convert a domain name to an IP address.
- DHCP : Dynamic Host Configuration Protocol, communication protocol for IP allocation and management

E

- EU : European Union
- EC : European Commission
- EAM : End Amplifier Modem, Internet signal amplifier at the end of an optical

network.

- Ethernet : Most popular bus structured short range communication network.
- ENM : Ethernet Node Modem
- EMS : Element Management Systems

F

- FTTH : Fiber to the Home, optical network service at home.

G

- GEN6: Governments Enabled with6, IPv6 protocol for implementation of e-government in EU.
- GGSN : Gateway GPRS Support Node in the mobile communication network.

H

- HA : Home Agent
- HDT : Host Digital Terminal, a type of Internet traffic switching/handling equipment
- HFC : Hybrid Fiber Coax
- HSDPA : High Speed Downlink Packet Access

I

- IANA : Internet Assigned Numbers Authority, global IP address allocation authority
- ICANN : Internet Corporation for Assigned Names and Numbers, global Internet address management organization
- IDC : Internet Data Center
- IDS : Intrusion Detection System
- IETF : Internet Engineering Task Force
- IoT : Internet of Things
- IP : Internet Protocol
- IPv4 : Internet Protocol version 4, IP ver. 4 (RFC 791)
- IPv6 : Internet Protocol version 6, IP ver. 6 (RFC 2460)
- IPv6 Forum : International IPv6 forum to promote introduction of IPv6.
- IPv6 Ready Logo : Certificate logo provided for all the IPv6 products verified by

IPv6 forum.

- IPS : Intrusion Prevention System
- IPTV : Internet Protocol Television
- ISATAP : Intra-Site Automatic Tunnel Addressing Protocol, Technology used to communicate between IPv6 only handsets isolated in the IPv4 network and the IPv6 network. (RFC 5214)
- ISP : Internet Service Provider
- ITU: International Telecommunication Union
- IVI : Prefix-specific and Stateless Address Mapping (IVI) for IPv4/IPv6 Coexistence and Transition, IPv4/IPv6 address transition technology proposed by China.
- IX(IXP) : Internet Exchange Node

J

- JPNIC : Japan Network Information Center

K

- KRNIC : Korea Internet Network Information Center

L

- LACNIC : Latin American and Caribbean Internet Addresses Registry
- LIR : Local Internet Registry, (ISP and etc.)
- LTE : Long term Evolution, 4G mobile communication protocol.

M

- MIIT : Ministry of Industry and Information Technology, China
- Modem : MOdulation DEModulation, computer accessing device using telephone lines.

N

- NAT : Network Address Translation, IP address transition mechanism (device)
- NAT-PT : Network Address Translation-Protocol Translation, IPv4/IPv6 address transition mechanism (RFC 2766)
- NIR : National Internet Registry

- NTT : Nippon Telegraph and Telephone Corporation
- NTT Docomo : Japanese mobile communication company that separated from NTT.
- NMS : Network Management System

O

- OLT : Optical Line Terminal
- ONU : Optical Network Unit
- ONT : Optical Network Terminal
- OECD : Organisation for Economic Co-operation and Development
- OMB : Office of Management and Budget, U.S

R

- RIPE-NCC : Reseaux IP Europeens Network Coordination Centre
- RIR : Regional Internet Registry, Internet address management organization within a defined region.
- RN : Remote Node

S

- SO : Service Operator, cable service provider who provides Internet service.
- Socks Gateway : One of the transport layer methods. IPv4/IPv6 low speed transition technology(RFC3089)
- STB : Set-top Box
- SMS : Short Message Service
- SQUID : The Source Quench Introduced Delay, IPv6 address transition technology which uses applied layer gateway methods.(RFC1016)

T

- Teredo : Technology to connect IPv6 hosts in the IPv4 NAT service area to another IPv6 hosts ouside by using the UDP protocol. (RFC 4380)
- Tunnel Broker : Methodfor the tunnel broker server to set the tunneling when more than one IPv6 networks are communicating via the IPv4 network. (RFC 3053)
- TF : Task Force

- TRT : An IPv6-to-IPv4 Transport Relay Translator, transport layer IPv4/IPv6 address transition(RFC 5214)
- TTA : Telecommunications Technology Association
- TWNIC : Taiwan Network Information Center

U

- UN : United Nations

V

- v6ops WG : IPv6 Operations Working Group
- VDSL : Very high-data rate Digital Subscriber Line
- VNNIC : Vietnam Network Information Center
- VoIP : Voice over Internet Protocol

W

- WiBro : Wireless Broadband
- WIFI : Wireless-Fidelity, WiFi technology to achieve high performance mobile communication.

X

- xDSL : x Digital Subscriber Line

NUM

- 3G : 3Generation, 3G mobile communication protocol by ITU.
- 464XLAT : IPv6 transition next generation technology. (RFC6877)
- 6NGIX : IPv6 Next Generation Internet Exchange, IPv6 Internet exchange node operated by KISA.
- 6KANet : IPv6 Korea Advanced Network, IPv6 based Internet subscriber network operated by KISA.
- 6RD : 6Rapid Deployment, Technology to provide IPv6 based Internet service after installing one 6RD terminal in the household. (RFC 5969)
- 6to4 : Method for communicating with more than one IPv6 networks via IPv4 networks without explicitly setting the tunnel. (RFC 6343)