

IPv6 Measurement in Korea

Feb 2017 Dong-wook Shim dwshim@kisa.or.kr



Current status of Korea

• 3 years have been passed after the 1st commercialized IPv6 service

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- ISPs deployed IPv6, firstly on mobile
- IPv6 on LTE, 9.8M among 61M subscribers (16%)
- IPv6 residential internet, 60,000 subscribers
- Contents providers don't need IPv6
- Nearly no contents

IP allocation



- 112M of IPv4 addresses (world 6th)
- 5,249 x /32 of IPv6 (world 9th)
- 79M number of Internet connectable devices
- 142% compared to IPv4

Country	IPv4 Allocated	Share%	Internet devices (fixed+mobile) - ITU	IPv4 addresses Devices
China	338,146,816	7.87%	1,565,883,000	21.59%
Japan	203,122,432	4.73%	197,253,242	102.98%
South Korea	112,425,984	2.62%	78,959,500	142.38%
Australia	48,520,448	1.13%	38,433,000	126.25%
India	40,794,880	0.95%	1,028,174,000	3.97%
Taiwan	35,503,360	0.83%	35,337,820	100.47%
Indonesia	17,948,672	0.42%	341,211,000	5.26%
Vietnam	15,846,144	0.37%	129,600,000	12.23%
Iran	12,399,104	0.29%	82,852,676	14.97%

IPv6 Usage Rate

• We are monitoring IPv6 statistics of Google, APNIC and Akamai

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(2016.12.)

- 4.2% (33rd) on Google stats 0.16% (37th) On APNIC stats
- 1.3% (39th) on Akamai stats



Infra Readiness

- 30~35 ASNs available over IPv6 among all ASNs (more than 800)
- Cisco statistics : 63% of Transit ASNs available over IPv6
- Majors ISPs in Korea are preparing to exchange IPv6 commercial traffic with each other

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 They only exchanged IPv4 traffic so far, and it caused worse performance of IPv6 vs IPv4

Contents Compatibility

- So far we're getting nearly no websites available over IPv6
- 183 of all 108M .kr websites (0.017%) registered IPv6 address (AAAA) on DNS

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- Among 200 popular websites preferred by Korean users, 10 are IPv6 available, but 9 of them are not Korean contents
- It's natural because basically Korean ISPs don't provide IPv6 connection to Business customers yet
- most of IPv6 enabled websites tend to go (IPv6-enabled) CDN (Akamai, Cloudflare)

Indices of Korea

- ICT development Index : 8.78 (1st)
- Average Internet speed: 26.33Mbps (1st)
- GDP per Capita : 27,633usd (29th)
- Number of IPv4 : 112M
- Number of Internet devices : 79M
- n(IPv4) / n(devices) = 142%
- IPv6 usage rate : 4.2% (33rd) Google stats

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The motivation of IPv6 deployment?

 We wanted to figure out the variables which have influence on IPv6 deployment (IPv6 usage rate)

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- Is it 'increasing demands of IP addresses' ?
- or, economic indices such as GDP per Capita
- ICT indices such as ICT dev index
- We took a look into numbers of 171 countries and calculated **correlation coefficient** between IPv6 usage rate and other variables
- With correlation coefficient (-1<n<1) you can see the relationship between 2 variables
- When the number is close to -1 or 1 it indicates that the factor has a strong influence on the variable(IPv6 usage rate%)

Result

Variable A	Variable B	Correlation Coefficient		
IPv6 usage rate	IPv4 addresses Devices	<u>+0.62</u>		
IPv6 usage rate	IPv6 usage rate of 3 biggest ASNs	<u>+0.85</u>		
IPv6 usage rate	Rate of increase in internet connectable devices (2013 to 2015)	-0.13		
IPv6 usage rate	ICT development index	+0.47		
IPv6 usage rate	GDP per Capita	<u>+0.53</u>		
IPv4 addresses Devices	ICT development index	<u>+0.70</u>		

- IPv6 usage rate and its needs have a very weak relationship
- Countries have higher number of IPv4, GDP per Capita, ICT indices tend to have higher rate of IPv6 deployment as well

IPv6 usage rate vs demands for IP

IPv6 was developed basically because of IPv4 exhaustion

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- So we expected a positive correlation between IPv6 usage rate and the demand for IP addresses
- However, what we found was IPv6 usage rate has a positive correlation with IPv4 stock instead.
- When a country has more IPv4 allocated, it tend to have higher IPv6 usage rate with a correlation coefficient : +0.62

Top 18 countries Which have enough IPv4 addresses

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Na	Country	IPv4 addresses					ICT Development
NO		Devices	Number of IPv4	Share%	IPv6 usage rate	GDP per Capita\$	Index
1	United States	332.72%	1,613,090,560	37.56%	28.90%	57,294	8.06
2	Norway	202.65%	15,895,440	0.37%	8.00%	71,497	8.35
3	Sweden	185.81%	29,980,520	0.70%	3.15%	51,604	8.47
4	Netherlands	168.82%	46,997,472	1.09%	8.27%	45,210	8.36
5	Belgium	166.87%	28,466,816	0.66%	47.24%	41,491	7.69
6	Canada	165.53%	70,267,136	1.64%	15.80%	42,319	7.55
7	Finland	148.96%	13,599,744	0.32%	11.76%	43,492	8.11
8	South Korea	142.38%	112,425,984	2.62%	4.20%	27,633	8.78
9	Luxembourg	140.20%	1,409,024	0.03%	21.20%	105,829	8.34
10	Denmark	131.40%	12,710,248	0.30%	2.02%	53,243	8.77
11	Swiss	129.54%	19,935,928	0.46%	26.72%	79,578	8.50
12	Australia	126.25%	48,520,448	1.13%	6.54%	51,593	8.18
13	United Kingdom	116.84%	121,940,248	2.84%	15.85%	40,412	8.54
14	Irelands	105.61%	6,560,080	0.15%	8.16%	65,871	7.73
15	Japan	102.98%	203,122,432	4.73%	13.65%	37,304	8.28
16	Taiwan	100.47%	35,503,360	0.83%	0.56%	22,044	-
17	New Zealand	97.47%	6,871,808	0.16%	5.92%	38,066	8.05
18	Germany	93.84%	119,244,928	2.78%	26.84%	42,326	8.13
	Average	147.69%	140,429,250	3.24%	13.41%	50,933	8.23

- Countries have higher ICT index, higher GDP per Capita tend to have enough IPv4 stock (Except Top 16, all countries are short of IPv4 addresses)
- Demands for IP doesn't seem like a direct motivation for IPv6 deployment

Top 10 Countries showed a sharp increase in number of internet connectable devices

No	Change rate Country in number of internet de for 2 yrs ('13->'15)		IPv4 addresses Devices	IPv6 Usage rate	ICT Development Index
1	Myanmar (Asia)	602.20%	0.27%	0.00%	1.95
2	East Timor (Asia)	211.73%	0.98%	0.07%	2.92
3	Burundi (Africa)	197.03%	0.72%	0.00%	1.16
4	Cuba (Middle America)	167.09%	7.69%	0.33%	2.64
5	Ethiopia (Africa)	165.97%	0.84%	0.02%	1.29
6	Mozambique (Africa)	162.29%	2.13%	0.00%	1.60
7	Guinea (Africa)	144.74%	0.23%	0.00%	1.57
8	Tanzania (Africa)	144.63%	2.63%	0.07%	1.54
9	Liberia (Africa)	143.16%	0.74%	0.00%	1.73
10	Sierra Leone (Africa)	141.43%	0.92%	0.00%	-
	Average	208.03%	1.71%	0.05%	1.82
	Cf) South Korea	107.55%	142.38%	4.20%	8.78

- Countries in need of more IP addresses have less IPv4 addresses, are not likely to deploy IPv6 either, have lower ICT index
- Correlation Coefficient : -0.13

When Big ISPs move to IPv6 it directly influences the country's IPv6 usage rate

Correlation Coefficient

between IPv6 usage rate (Google stats) and IPv6 usage rate of 3 biggest ASNs (APNIC stats) : +0.85



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- Each column indicates 171 countries have been searched, has 3 rows each which indicate 3 biggest ASNs within each country
 (ex. South Korea (33rd column) KT(AS4766), SKB(AS9318), LGU+(AS17858)
 Belgium (1st column from the right) AS2647, AS5432, AS6848)
- Each row is colored with each ASN's IPv6 rate data
- Sorted by country IPv6 usage rate ascending

Internet On, Security In!

Thank you! 감사합니다.

Should you have any questions, please contact us anytime





Appendix: Examples of Asia Pacific

Country	IPv4 addresses Devices	Number of IP v4	Number of internet devices	Rate of increas ing internet de vices ('13 to '15)	IPv6 usage rate	ICT Dev. Index	GDP per Capita
South Korea	142%	112M	79M	7.55%	4.20%	8.78	27,633
Australia	126%	48M	39M	24.29%	6.54%	8.18	51,593
Japan	103%	203M	197M	6.85%	13.65%	8.28	37,304
Taiwan	100%	36M	35M	-3.77%	0.56%	-	22,044
New Zealand	97%	7M	7M	15.92%	5.92%	8.05	38,066
Singapore	69%	7M	10M	-2.36%	4.43%	7.88	53,053
Hong Kong	61%	12M	19M	-1.36%	0.28%	8.4	42,963
China	22%	338M	1566M	10.43%	0.14%	4.8	8,261
Iran	15%	12M	83M	17.68%	0.05%	4.66	5,124
Malaysia	14%	7M	47M	1.98%	12.04%	5.64	9,546
Vietnam	12%	16M	130M	0.55%	4.67%	4.02	2,164
Philippines	4%	5M	124M	17.38%	0.09%	3.97	2,991
India	4%	41M	1028M	-1.29%	10.35%	2.15	1,719
Sri Lanka	2%	0.5M	25M	14.09%	2.58%	2.5	3,870