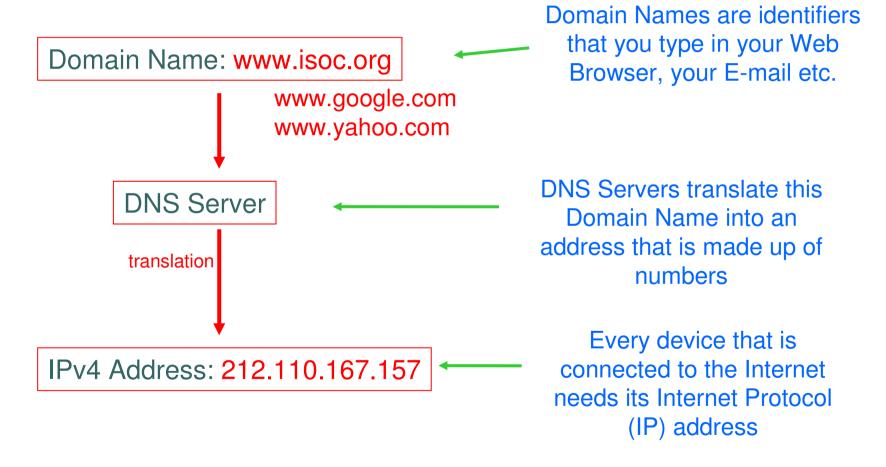
• • IPv6 Matrix Project

Tracking IPv6 connectivity Worldwide http://www.ipv6matrix.org

Dr. Olivier MJ Crépin-Leblond – ocl@gih.com
July 2011 Update for OneWebDay 22nd September 2011



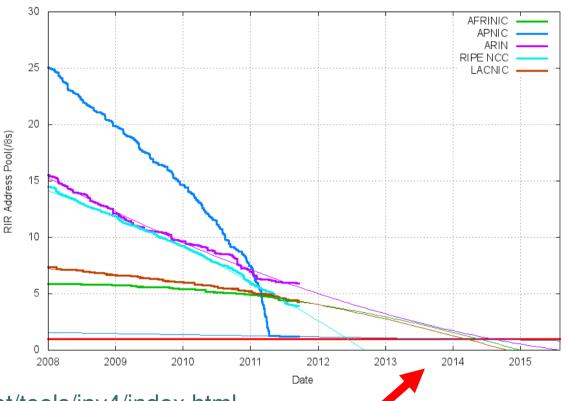
• • What is an IPv4 Address?





We are running out of IP addresses





http://www.potaroo.net/tools/ipv4/index.html

When we reach this point, it will be too late since there will be no more "free" IPv4 addresses!

Real time data collected September 2011



We are running out of IP addresses



• • IPv4 Space / December 2009

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

Reference: http://www.iana.org/assignments/ipv4-address-space/ipv4-address-space.xml



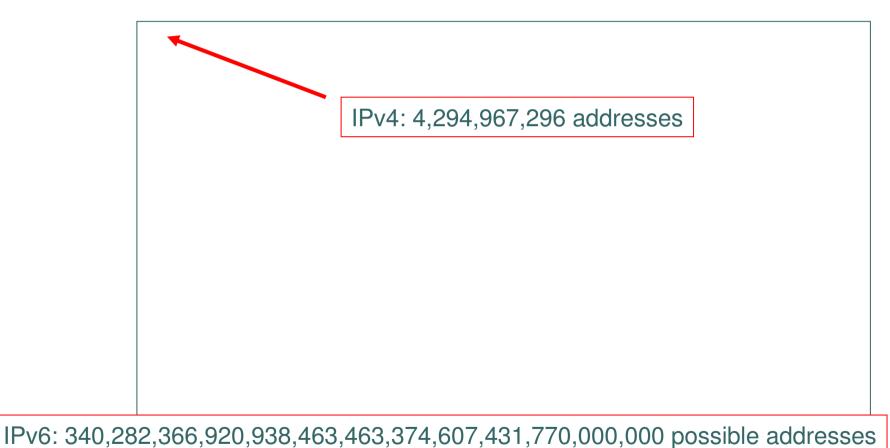
• • IPv4 Space / October 2010

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

Reference: http://www.iana.org/assignments/ipv4-address-space/ipv4-address-space.xml



• • IPv6 Space



11 vo. 0+0,202,000,020,500,400,400,007,401,770,000,000 possible address

50,000,000,000,000,000,000,000,000 addresses per human



• • IPv6 Matrix Project

- ISOC England was awarded a Community Grants Programme award in November 2009
- Design and implementation of an "IPv6 Crawler," software on a computer that crawls through the DNS at regular intervals in order to detect and test:
 - IPv6 DNS servers
 - IPv6 compliant Web servers
 - IPv6 compliant SMTP mailers
 - IPv6 compliant NTP servers.



• • Project Rationale

- Today, more than 95% of Internet traffic is generated by a small number of data sources – i.e. the world's busiest Web Sites
- Without IPv6 accessible content, IPv6 has no chance of being used - ever.
- Take the 1 Million most popular Web site list from alexa.com as a starting point for the domains to be tested. Add more domains later.
- Test them for IPv6 connectivity
- This is equivalent to testing about 6.3 million hosts worldwide
- Use GeoIP database to estimate real host location

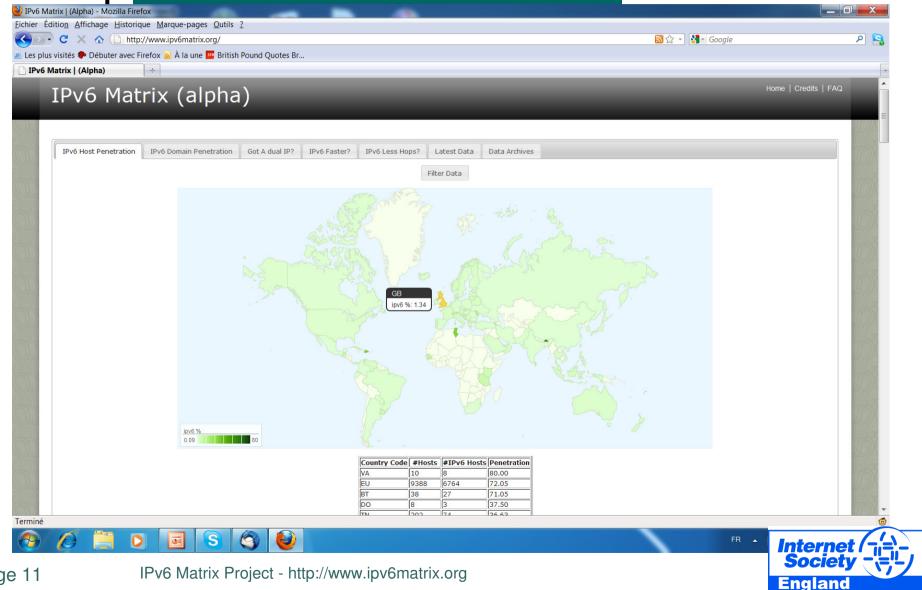


• • Project Teams

- o London, UK:
 - Project Management and support
 - Hardware supply and installation
 - Data Centre and IPv6 connectivity
- o Nile University, Egypt:
 - Software Programming



www.ipv6matrix.org Web Site



• • What are we tracking?

- Host IPv6 penetration
 - Using IPv4 Geo-location coordinates
 - Includes generic TLD (gTLDs, .com, .net, .org) and country code ccTLDs
- Two types of information:
 - Infrastructure: DNS + Web + E-mail + Time server (NTP)
 This tracks all of the infrastructure required to run IPv6 Web services
 - Web sites only (actual content)
 This tracks the Web services themselves. Usually this percentage is lower than the figure for the infrastructure



• • What are we archiving?

- Everything that we are tracking on the previous page, plus:
- Testing of connectivity to the above services in case IPv6 addresses are advertised but no service runs on them
- Tracing of route from London Docklands to each one of these hosts both using IPv4 and IPv6 – and archiving all of this information in text format
- A lot more data, accessible from the Web site archive
- In April 2011, the size of this database in text format is approx 60Gb and continually increasing (the testing software runs 24/7)



Europe Data snapshot

IPv6 Host Penetration

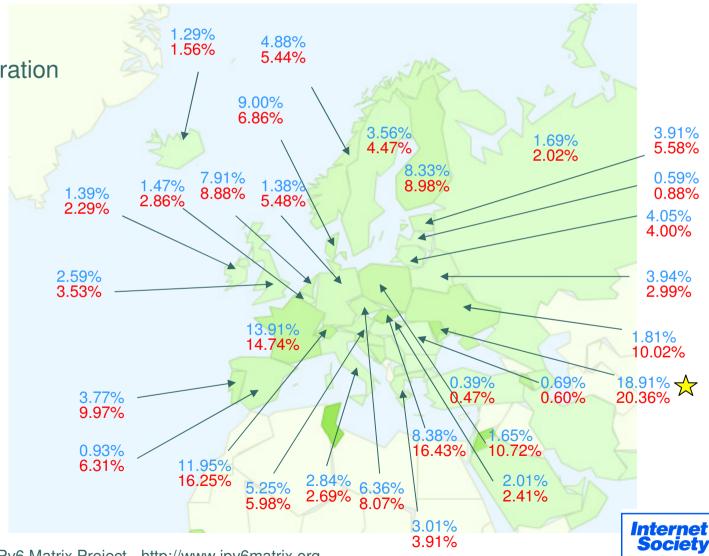
Infrastructure

- DNS
- Web
- E-mail
- NTP

★ Low Sample Low accuracy

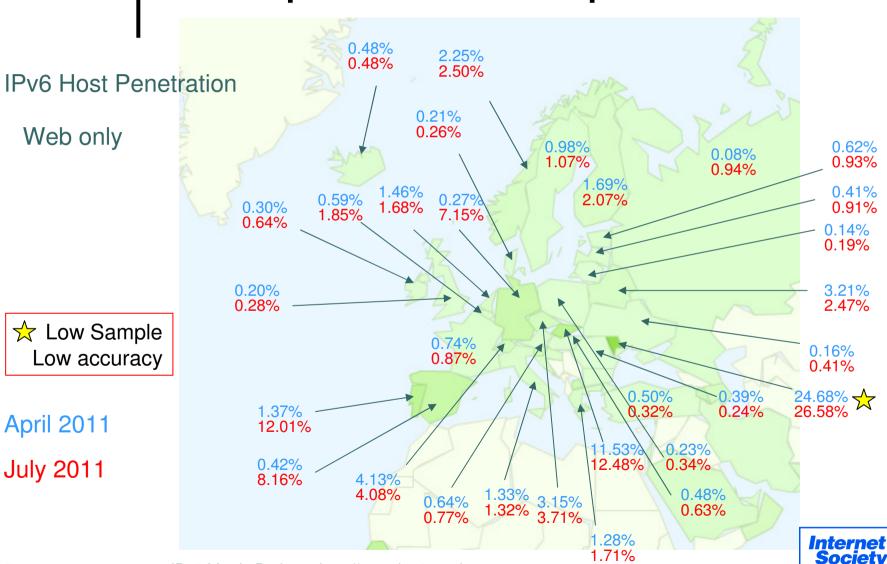
April 2011

July 2011



England

Europe Data snapshot



England

IPv6 Matrix Project - http://www.ipv6matrix.org

Page 15



IPv6 Host Penetration

Infrastructure

- DNS or
- Web or
- E-mail or
- NTP

(*) Low Sample Low accuracy

Country	DNS+WEB+	% change	
	April 2011	July 2011	
Moldova (*)	18.91%	20.36%	1.45%
Slovakia	8.38%	16.43%	8.05%
Switzerland	11.95%	16.25%	4.30%
France	13.91%	14.74%	0.83%
Slovenia	6.52%	10.93%	4.41%
Poland	1.65%	10.72%	9.07%
Ukraine	1.81%	10.02%	8.21%
Portugal	3.77%	9.97%	6.20%
Finland	8.33%	8.98%	0.65%
Netherlands	7.91%	8.88%	0.97%
Czech Republic	6.36%	8.07%	1.71%
Bosnia and Herzegovina (*)	7.73%	7.66%	-0.07%
Denmark	9.00%	6.86%	-2.14%
Spain	0.93%	6.31%	5.38%
Austria	5.25%	5.98%	0.73%
Croatia	6.36%	5.68%	-0.68%
Estonia	3.91%	5.58%	1.67%
Germany	1.38%	5.48%	4.10%
Norway	4.88%	5.44%	0.56%
Sweden	3.56%	5.44%	1.88%
Macedonia	2.92%	4.04%	1.12%
Lithuania	4.05%	4.00%	-0.05%
Greece	3.01%	3.91%	0.90%
United Kingdom	2.59%	3.53%	0.94%
Serbia (*)	2.61%	3.09%	0.48%
Belarus	3.94%	2.99%	-0.95%
Belgium	1.47%	2.86%	1.39%
Italy	2.84%	2.69%	-0.15%
Hungary	2.01%	2.41%	0.40%
Ireland	1.39%	2.29%	0.90%
Russia	1.69%	2.02%	0.33%
Iceland	1.29%	1.56%	0.27%
Latvia	0.59%	0.88%	0.29%
Bulgaria	0.46%	0.71%	0.25%
Romania	0.69%	0.60%	-0.09%





IPv6 Host Penetration

Web only

(*) Low Sample Low accuracy

Country	WEB		% change
-	April 2011	July 2011	_
	_	_	
Moldova (*)	24.68%	26.58%	1.90%
Slovakia	11.53%	12.48%	0.95%
Portugal	1.37%	12.01%	10.64%
Estonia	0.62%	8.16%	7.54%
Spain	0.42%	8.16%	7.74%
Germany	0.27%	7.15%	6.88%
Macedonia	2.11%	5.43%	3.32%
Switzerland	4.13%	4.08%	-0.05%
Slovenia	1.28%	3.96%	2.68%
Czech Republic	3.15%	3.71%	0.56%
Norway	2.25%	2.50%	0.25%
Belarus	3.21%	2.47%	-0.74%
Finland	1.69%	2.07%	0.38%
Belgium	0.59%	1.85%	1.26%
Greece	1.28%	1.71%	0.43%
Netherlands	1.46%	1.68%	0.22%
Croatia	1.53%	1.55%	0.02%
Italy	1.33%	1.32%	-0.01%
Sweden	0.98%	1.07%	0.09%
Russia	0.08%	0.94%	0.86%
Latvia	0.41%	0.91%	0.50%
France	0.74%	0.87%	0.13%
Austria	0.64%	0.77%	0.13%
Ireland	0.30%	0.64%	0.34%
Hungary	0.48%	0.63%	0.15%
Iceland	0.48%	0.48%	0.00%
Ukraine	0.16%	0.41%	0.25%
Poland	0.23%	0.34%	0.11%
Bulgaria	0.26%	0.31%	0.05%
United Kingdom	0.20%	0.28%	0.08%
Denmark	0.21%	0.26%	0.05%
Romania	0.39%	0.24%	-0.15%
Lithuania	0.14%	0.19%	0.05%
Bosnia and Herzegovina (*	0.00%	0.00%	0.00%
Serbia (*)	0.00%	0.00%	0.00%



• • Europe Trends

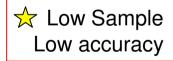
- Many countries see a significant rise in infrastructure
 - Likely to be caused by a main hosting provider, installing dual-stack Nameservers
- Slovakia joined by Portugal in leading with dual-stack Web sites
- IPv6 Day in June 2011 might have generated positive results



Asia Data snapshot

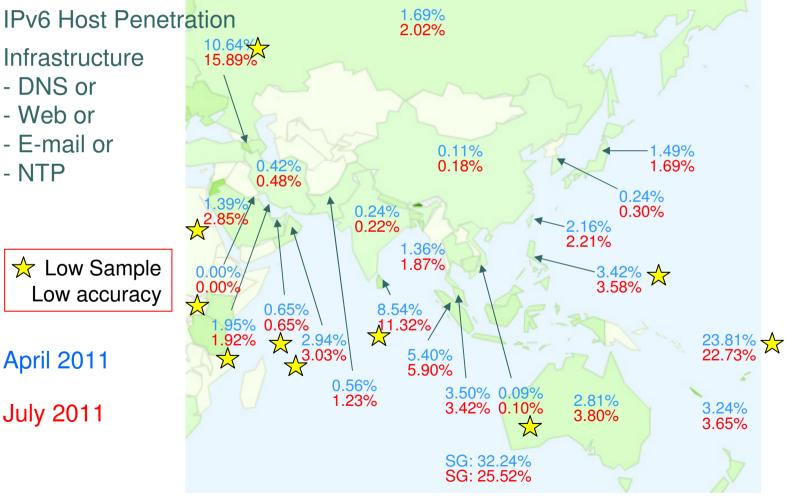
Infrastructure

- DNS or
- Web or
- E-mail or
- NTP



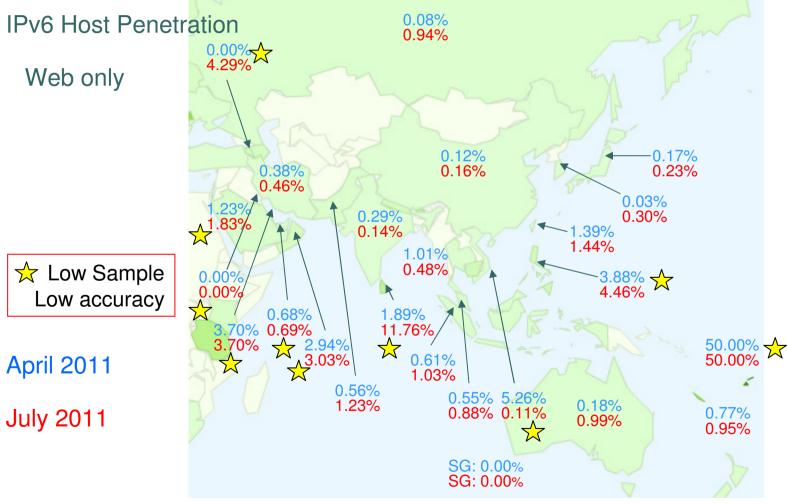
April 2011

July 2011





Asia Data snapshot







IPv6 Host Penetration

Infrastructure

- DNS or
- Web or
- E-mail or
- NTP

(*) Low Sample Low accuracy

Country	DNS+WEB+	E-mail+NTP	% change
	April 2011	July 2011	
Singapore	32.24%	25.52%	-6.72%
Armenia (*)	10.64%	15.89%	5.25%
Sri Lanka (*)	8.54%	11.32%	2.78%
Indonesia	5.40%	5.90%	0.50%
Australia	2.81%	3.80%	0.99%
New Zealand	3.24%	3.65%	0.41%
Philippines (*)	3.42%	3.58%	0.16%
Malaysia	3.50%	3.42%	-0.08%
Oman (*)	2.94%	3.03%	0.09%
Saudi Arabia	1.39%	2.85%	1.46%
Taiwan	2.16%	2.21%	0.05%
Russia	1.69%	2.02%	0.33%
Qatar (*)	1.95%	1.92%	-0.03%
Thailand	1.36%	1.87%	0.51%
Japan	1.49%	1.69%	0.20%
Pakistan	0.56%	1.23%	0.67%
United Arab E	0.65%	0.65%	0.00%
Iran	0.42%	0.48%	0.06%
South Korea	0.24%	0.30%	0.06%
India	0.24%	0.22%	-0.02%
China	0.11%	0.18%	0.07%
Vietnam (*)	0.09%	0.10%	0.01%
Kuwait (*)	0.00%	0.00%	0.00%





IPv6 Host Penetration

Web only

(*) Low Sample Low accuracy

Country	WEB		% change
	April 2011	July 2011	
Sri Lanka (*)	1.89%	11.76%	9.87%
Philippines (*)	3.88%	4.46%	0.58%
Armenia (*)	0.00%	4.29%	4.29%
Qatar (*)	3.70%	3.70%	0.00%
Oman (*)	2.94%	3.03%	0.09%
Saudi Arabia	1.23%	1.83%	0.60%
Taiwan	1.39%	1.44%	0.05%
Pakistan	0.56%	1.23%	0.67%
Indonesia	0.61%	1.03%	0.42%
Australia	0.18%	0.99%	0.81%
New Zealand	0.77%	0.95%	0.18%
Russia	0.08%	0.94%	0.86%
Malaysia	0.55%	0.88%	0.33%
United Arab E	0.68%	0.69%	0.01%
Thailand	1.01%	0.48%	-0.53%
Iran	0.38%	0.46%	0.08%
South Korea	0.03%	0.30%	0.27%
Japan	0.17%	0.23%	0.06%
China	0.12%	0.16%	0.04%
India	0.29%	0.14%	-0.15%
Vietnam (*)	5.26%	0.11%	-5.15%
Singapore	0.00%	0.00%	0.00%
Kuwait (*)	0.00%	0.00%	0.00%



• • Asia Trends

- Singapore still leading by far in infrastructure but trailing in dual-stack Web Site content
- China results abnormally very low content not dual stacked or IPv6 behind firewall?
- Less reliability of results due to smaller sample size in many countries of the region

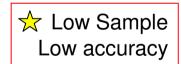


• • Africa Data snapshot

IPv6 Host Penetration

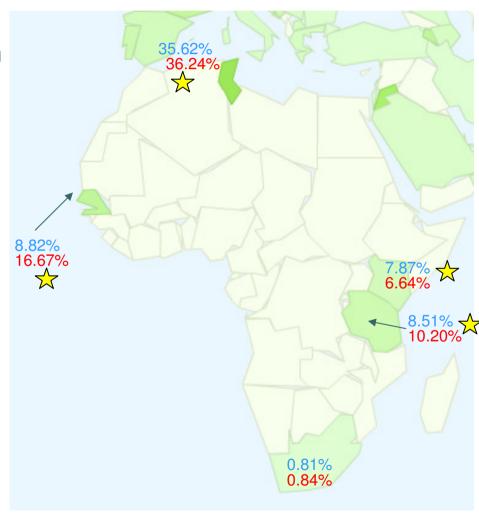
Infrastructure

- DNS or
- Web or
- E-mail or
- NTP



April 2011

July 2011

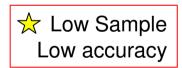




• • Africa Data snapshot

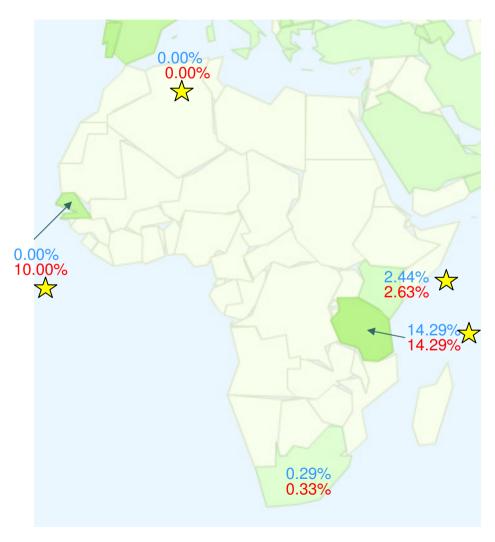
IPv6 Host Penetration

Web only



April 2011

July 2011







Infrastructure

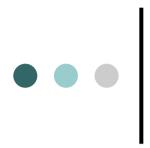
- DNS or
- Web or
- E-mail or
- NTP

(*) Low Sample Low accuracy

Country	DNS+WEB+	% change	
	April 2011	July 2011	
Tunisia (*)	35.62%	36.24%	0.62%
Senegal (*)	8.82%	16.67%	7.85%
Tanzania (*)	8.51%	10.20%	1.69%
Kenya (*)	7.87%	6.64%	-1.23%
South Africa	0.81%	0.84%	0.03%

The small number of hosts tested make the results for most of Africa appear higher than they really are





IPv6 Host Penetration

Web only

Country	WEB		% change
	April 2011	July 2011	
Tanzania (*)	14.29%	14.29%	0.00%
Senegal (*)	0.00%	10.00%	10.00%
Kenya (*)	2.44%	2.63%	0.19%
South Africa	0.29%	0.33%	0.04%
Tunisia (*)	0.00%	0.00%	0.00%

(*) Low Sample Low accuracy The small number of hosts tested make the results for most of Africa appear higher than they really are

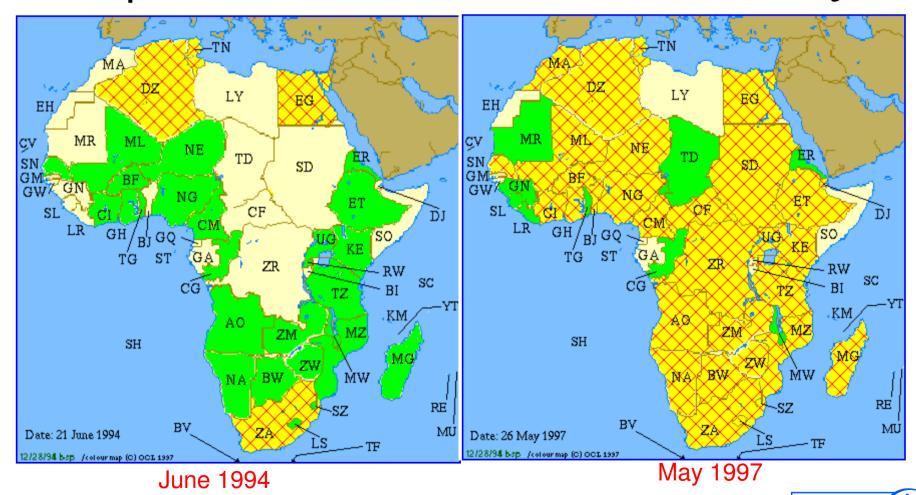


• • Africa Trends

- Very few countries with IPv6 connectivity
- Dual Stack Islands starting to appear
- Can be compared with the growth of Internet connectivity in the nineties



Compare Historical data on African Internet Connectivity



England

Source: Internetology - http://www.nsrc.org/codes/bymap/ntlgy/ntlgy.htm Page 29 IPv6 Matrix Project - http://www.ipv6matrix.org

North/South America

IPv6 Host Penetration

Infrastructure

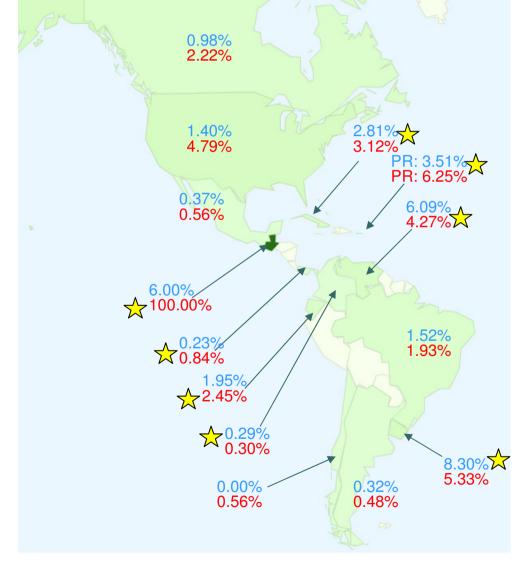
- DNS or
- Web or
- E-mail or
- NTP

★ Low Sample

Low accuracy

April 2011

July 2011





North/South America

IPv6 Host Penetration

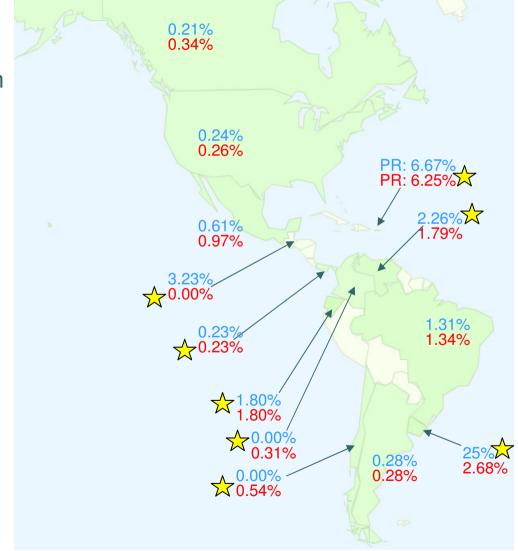
Web only

★ Low Sample

Low accuracy

April 2011

July 2011







IPv6 Host Penetration

Infrastructure

- DNS or
- Web or
- E-mail or
- NTP

(*)	Low Sample
L	ow accuracy

Country	DNS+WEB+	% change	
	April 2011	July 2011	
Guatemala (*)	6.00%	100.00%	94.00%
Puerto Rico (*)	3.51%	6.25%	2.74%
Uruguay (*)	8.30%	5.33%	-2.97%
United States	1.40%	4.79%	3.39%
Venezuela (*)	6.09%	4.27%	-1.82%
Cuba (*)	2.81%	3.12%	0.31%
Ecuador (*)	1.95%	2.45%	0.50%
Canada	0.98%	2.22%	1.24%
Brasil	1.52%	1.93%	0.41%
Panama (*)	0.23%	0.84%	0.61%
Mexico	0.37%	0.56%	0.19%
Chile	0.00%	0.56%	0.56%
Argentina	0.32%	0.48%	0.16%
Colombia (*)	0.29%	0.30%	0.01%

For (*) the small number of hosts tested make the results in many countries appear higher than they really are





IPv6 Host Penetration

Web only

(*) Low Sample Low accuracy

Country	WEB		% change
	April 2011	July 2011	
Puerto Rico (*)	6.67%	6.25%	-0.42%
Uruguay (*)	25.00%	2.68%	-22.32%
Ecuador (*)	1.80%	1.80%	0.00%
Venezuela (*)	2.26%	1.79%	-0.47%
Brasil	1.31%	1.34%	0.03%
Mexico	0.61%	0.97%	0.36%
Chile	0.00%	0.54%	0.54%
Canada	0.21%	0.34%	0.13%
Colombia (*)	0.00%	0.31%	0.31%
Argentina	0.28%	0.28%	0.00%
United States	0.24%	0.26%	0.02%
Panama (*)	0.23%	0.23%	0.00%
Guatemala (*)	3.23%	0.00%	-3.23%
Cuba (*)	0.00%	0.00%	0.00%

For (*) the small number of hosts tested make the results in many countries appear higher than they really are



• • America Trends

- North America trailing behind Europe but sees significant rise in IPv6 infrastructure. Results of IPv6 Day on infrastructure itself?
- On the other hand, low percentage of IPv6 Web Sites across the region shows little impact of IPv6 day (June 8)
- Elsewhere, data based on low number of Web sites, needs to be taken in moderation (the restricted number of hosting providers can make figures jump several percentage points)



• • Worldwide Trends

- We are seeing a slow growth in dual stack IPv4-IPv6 implementation
- The June 8th IPv6 Day appears to have had more impact in several European Countries than elsewhere
- A decrease in percentage in some countries, points to unstable peering agreements (the IPv6 network is less closely meshed than the IPv4 network)
- Bearing in mind the Asia Pacific Regional Internet Registry has run out of IPv4 addresses, it is alarming to see so few Web sites up and running IPv6 in that region.



• • Future work / funding required

- Add more domains to be tested
- Add more features to be tested
- Current front end Web Pages are only an example of possible analysis
 - Develop new data visualisation
 - Perform further analysis
 - Perform historical/time analysis from archives
 - Develop an engine to write automated reports
- Duplicate Crawler to other regions



Thank you

Contact: ISOC England – contact@isoc-e.org









