

Measured trends in IPv6 adoption

Sandvine and World IPv6 Day

- 24-hour live test day for IPv6
 - June 8, 2011; Who: Google, Facebook, Yahoo!, Akamai, Limelight, and many others...
- Sandvine helped North America carriers to understand behaviour before/during/after this day
- Detailed reports expanded to IP Version awareness
- 🕨 Goals
 - Application trends and adoption
 - Performance benchmark: IPv6 x IPv4



Public report available on www.sandvine.com



IPv6 volume (native+transitional) increased slightly (4%)

- From 0.135% of average daily downstream to 0.141%;
- Peaked at 0.415% of downstream



IPv6 Protocol Summary

- Teredo represents the bulk (80%) of IPv6
- Largest relative increase was 6to4,
 - Rose to account for more than 11% of IPv6 traffic



6to4 application breakdown

Early adopters...

IpVersion: SixToFour

Protocol	Distribution
BitTorrent UTP	24.33%
BitTorrent Encrypted	22.60%
BitTorrent	20.05%
Other TCP Protocol	15.21%
UDP	7.12%
BitTorrent UDP	5.15%
YouTube	3.64%
ICMP	1.14%
YouTube HD	0.34%
HTTP	0.17%
Outside Top 10	0.25%

Application Summary

- Normally P2P Filesharing accounts more than 97% of IPv6 traffic (clients like uTorrent support Teredo)
 - P2P Filesharing dipped in relative share due to surges in Real-Time Entertainment (rising to 6% of IPv6 traffic, driven by YouTube support), Web Browsing (1.33%), and E-mail (0.34%)
- When measured in bytes, YouTube is the big winner out of the major participants, accounting for more than 97% (Teredo)

	Share of IPv6 Traffic		Domain	Distribution	
Category	Before	During	youtube.com		97.75%
P2P Filesharing	97.32%	92.30%	cnn.com googleapis.com	0.42%	
Real-Time Entertainment	2.15%	6.02%	facebook.com	0.07%	
Web Browsing	0.48%	1.33%	google.com gstatic.com	0.05%	
All Others	0.05%	0.35%	yahoo.com	0.03%	



IpVersion: IPv4

IpVersion	NbiClientDevice	Distribution
IPv4	Macintosh	42.39%
IPv4	PC	27.40%
IPv4	PlayStation 3	5.69%
IPv4	Xbox	5.24%
IPv4	iPad	5.22%
IPv4	Apple TV	3.96%
IPv4	iPhone	2.47%
IPv4	Roku	2.36%
IPv4	Wii	1.83%
IPv4	TiVo	0.83%
IPv4	Outside Top 10	2.60%

Units measured in bytes.



HTTP device access

- Larger regional representation of Macintosh
- PC is the largest IPv6 device
 - Early adopters? Large P2P user sample?

OS and Browser Type Summary



Units measured in bytes.

IpVersion: IPv4

IpVersion	NbiBrowser	Distribution
IPv4	Chrome/11.0	20.60%
IPv4	Firefox/4.0	17.24%
IPv4	Safari/533.21	14.75%
IPv4	Firefox/3.6	13.84%
IPv4	MSIE 8.0	6.50%
IPv4	Outside Top 5	27.07%

Units measured in bytes.





IpVersion: NativeIPv6

IpVersion	NbiBrowser	Distribution
NativeIPv6	Chrome/12.0	65.57%
NativeIPv6	Safari/6533.18	8.29%
NativeIPv6	Chrome/11.0	7.44%
NativeIPv6	Safari/533.20	6.83%
NativeIPv6	Safari/533.21	5.84%
NativeIPv6	Outside Top 5	6.04%

Units measured in bytes.

- IPv4 shows more traditional Windows 7 (NT6.1) and Mac OS and Chrome/Firefox/Safari regular browser versions
- IPv6 indicates early adopters: Linux OS & Beta Chrome Version

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access Round Trip Time (aRTT)

- Critical metric for QoE analysis
- aRTT defined in the study as
 Client = {T2 T1}
- Subscriber's experience decreases as aRTT increases

Sandvine Policy Traffic Switch calculates aRTT per group of subscribers, location or application type



aRTT summary: Native IPv6 x IPv4

- Native IPv6 experienced lower latency: 80% of IPv6 subscribers experienced an aRTT lower than 16ms; versus 24ms on native IPv4
- May be due to NAT in the home and even (?) differences in the TCP stack based on Operating Systems



aRTT summary: Tunnelled IPv6

- IPv6 via tunnels: higher latencies than native
- 6to4: 80% of flows at 85ms
- Teredo: 80% of flows at 120ms
- Impact of relays and NATs like home routers



Subscriber Client RTT

Native IPv4				
User	aRTT	Deviation		
ABC1234	686.79	42.48%		
ABC1235	680.24	41.12%		
ABC1236	640.12	32.80%		
ABC1237	609.17	26.38%		
ABC1238	606.89	25.90%		
ABC1239	606.21	25.76%		
ABC1240	567	17.63%		
ABC1241	549.47	13.99%		
ABC1242	543.27	12.70%		
ABC1243	507.08	5.20%		
ABC1244	502.65	4.28%		
ABC1245	476.82	-1.08%		
ABC1246	476.43	-1.16%		
ABC1247	473.92	-1.68%		
ABC1248	439.17	-8.89%		
ABC1249	433.05	-10.16%		
ABC1250	404.57	-16.07%		
ABC1251	399.53	-17.12%		
ABC1252	383.21	-20.50%		
ABC1253	361.21	-25.07%		
ABC1254	356.48	-26.05%		
ABC1255	351.1	-27.16%		
ABC1256	339.58	-29.55%		
ABC1257	336.94	-30.10%		
ABC1258	319.94	-33.63%		
Average	482.03			
Std Dev	114.02			

Teredo				
User	aRTT	Deviation		
YYZ1234	1089.58	325.84%		
YYZ1235	845.59	230.48%		
YYZ1236	613.69	139.85%		
YYZ1237	399.1	55.98%		
YYZ1238	314.31	22.84%		
YYZ1239	261.47	2.19%		
YYZ1240	232.14	-9.27%		
YYZ1241	223.13	-12.79%		
YYZ1242	205.5	-19.68%		
YYZ1243	182.36	-28.73%		
YYZ1244	179.79	-29.73%		
YYZ1245	170.8	-33.25%		
YYZ1246	169.35	-33.81%		
YYZ1247	165.7	-35.24%		
YYZ1248	152.54	-40.38%		
YYZ1249	145.85	-43.00%		
YYZ1250	144.96	-43.34%		
YYZ1251	136.2	-46.77%		
YYZ1252	126.08	-50.72%		
YYZ1253	125.68	-50.88%		
YYZ1254	111.13	-56.57%		
YYZ1255	108.8	-57.48%		
YYZ1256	100.66	-60.66%		
YYZ1257	99	-61.31%		
YYZ1258	93.19	-63.58%		
Average	255.86			
Std Dou	244.44			

Top 25 users ranked by the highest average aRTT

Top Teredo client > 1,000 ms

Smaller Teredo sample may influence



Payload Bytes

Retransmitted Bytes



- Efficiency = % of traffic requiring retransmission
- {Efficiency = Payload / (Payload + Re-transmission)}
- Currently IPv6 is notably lower

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Future benchmarks

What will be the impacts of IPv6 on Video QoE?

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tettigent broadband Ne	tworks					_
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uality of Experie	nce Analysis 🛛	isplay: Content Provi	ider 🔍 Stre	am Type: Progressi	ve I 🔻	2011-08-11
sandvine			Filter by Region: Ca	anada	CDN: Total	
Content Provider	QoE Score	Jitter Time (ms)	Buffer Stalls	Buffer Stall Duration (ms)	Server Latency Time (ms)	Bitrate Changes
otal	3.0	0	1.2	5736	224	0.0
ther	3.3	0	1.0	3036	178	0.0
ouTube	3.3	0	1.3	8351	209	0.0
oyala	5.0		0.0	17	1	0.0
legavideo	4.5	— Deep analy	sis of QoE. Why is	0	1072	0.0
SN Video	3.7	the OoE sc	ore for one region/	3769	113	0.0
unes	4.9	provider/C	provider/CDN worse than	429	81	0.0
ornhub.com	2.2	provider/C		15/29	//	0.0
videos.com	3.8	another		9013	27	0.0
gncdn.com	5.0		00.0	0	59	0.0
utiocker.com	2.5	0	23.3	45996	361	0.0
ustin.tv	5.0	0	0.0	4227	9	0.0
ouborn.com	4.4	0	0.8	1337	15	0.0 L
3.2	vider		Time of Day - Cont	ent Provider	QoE Score	
2.8	~~		4.0 2.0 W	MM	MmM	mm
2.8 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4	-term trending of metrics above	any	4.0 2.0 0.0 Histogram for QoE 8,000 6,000 5 4,000 5 4,000	- Qo	Show the distrib and show the da to help understa Experience	ution of samples ata over the day and Quality of
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Thank You!











