Latency IPv4 vs IPv6
Understanding the difference

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Previous latency study

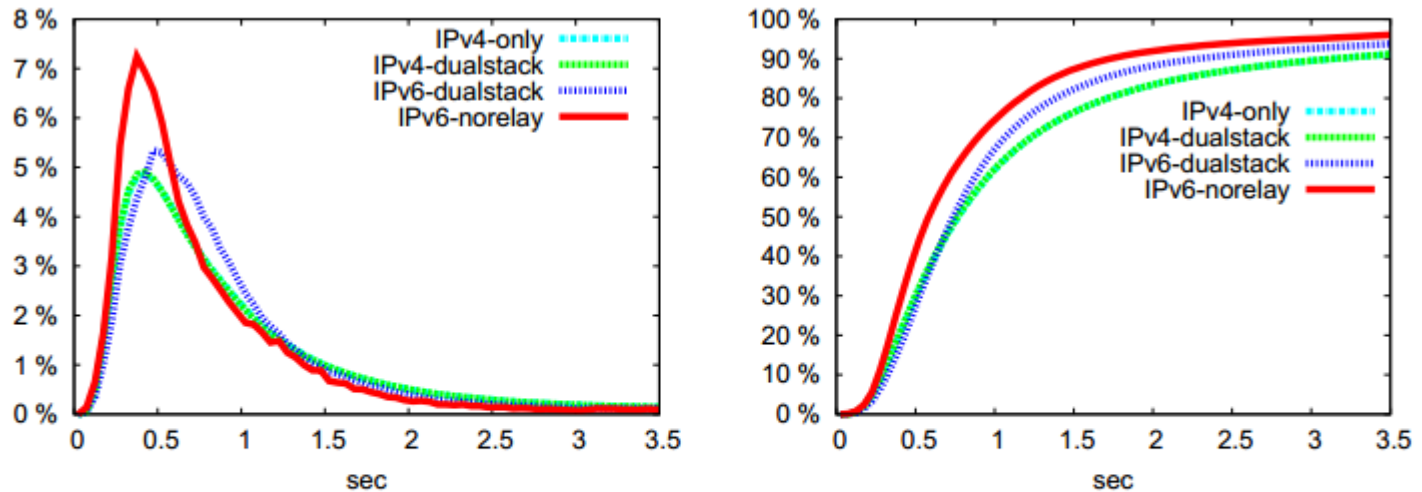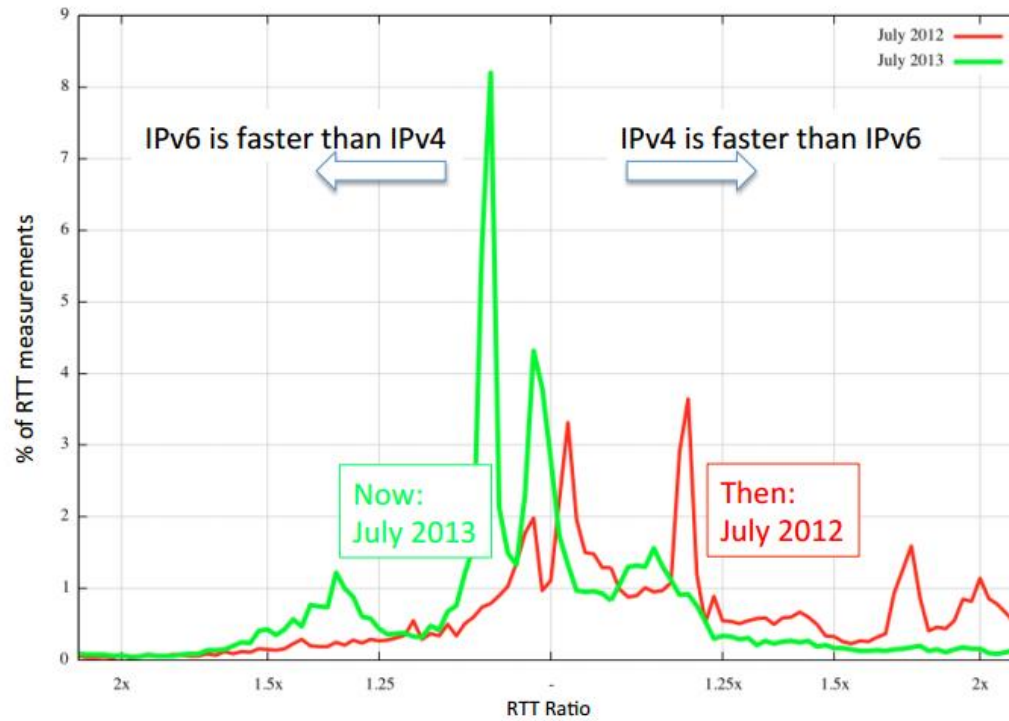## Evaluating IPv6 Adoption in the Internet

Fig. 8. PDF and CDF of hit latency. Time granularity of 50 ms. The IPv4-only and IPv4-dualstack plots are indistinguishable. The latency data are not indicative of ordinary Google service latency.

2010 - IPv6 is faster.

Previous latency study

Launch+365 (2012)

Paired RTT Distribution

2012 - IPv6 is faster. Again.

How it could be?

IPv6 Internet graph is subset of

IPv4 Internet graph

$$G_{IPv6} \subseteq G_{IPv4}$$

$$\downarrow$$

$$latency(G_{IPv6}) \geq latency(G_{IPv4})$$

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Incorrect

?

Comparing IP Graphs

	IPv4	IPv6
Number of AS	50157	9616
Number of links	193466	54425
Number of c2p links	90386	16051
Number of p2p links	103047	38372

Density of p2p is slightly higher in IPv6 then in IPv4.
But still no clear evidence.

But we don't see all paths…

Possible Paths

But we could make assumption about possible paths!
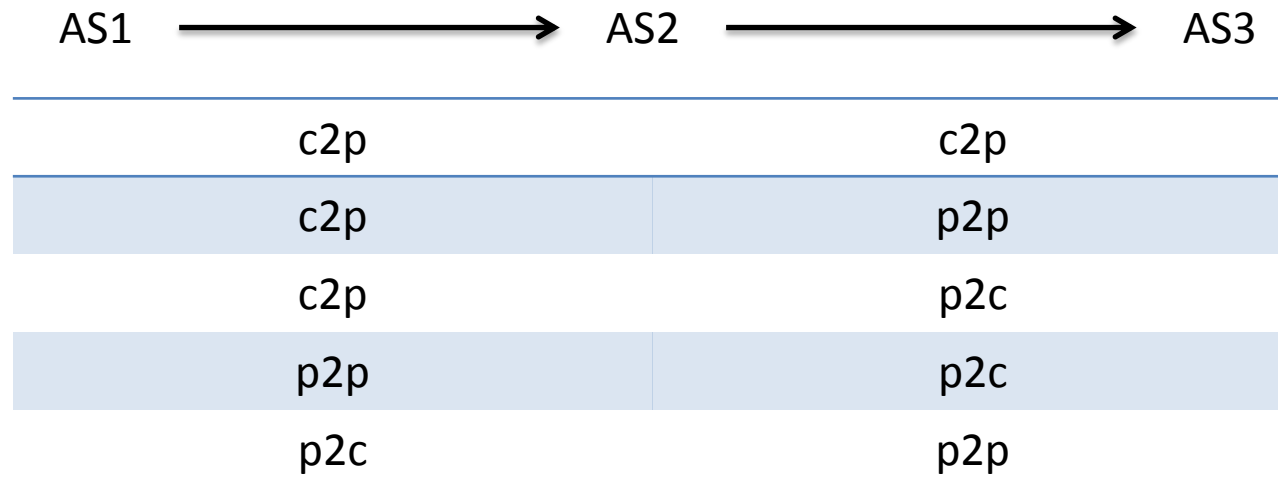
AS1 ⟶	AS2 ⟶	AS3

c2p		c2p
c2p		p2p
c2p		p2c
p2p		p2c
p2c		p2p

Comparing IP Graphs

	IPv4	IPv6
Number of AS	50157	9616
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Possible Paths	96 x 10^6	12 x 10^6

Density in IPv6 is less then IPv4.
Still no evidence… ☹

Difference between IP Graphs

	IPv4	IPv6
Number of AS	50157	9616
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Possible Paths	96 x 10^6	12 x 10^6

	IPv4/IPv6	IPv6/IPv4
Number of links	139438	9578
Number of c2p links	77028	1211
Number of p2p links	62094	8360
Possible Paths	89 x 10^6	5.8 x 10^6

The difference ratio IPv6/IPv4 > 45%
Interesting!

Connectivity

AS prefixes

Speakers that export BGP views to RIPE or RouteViews
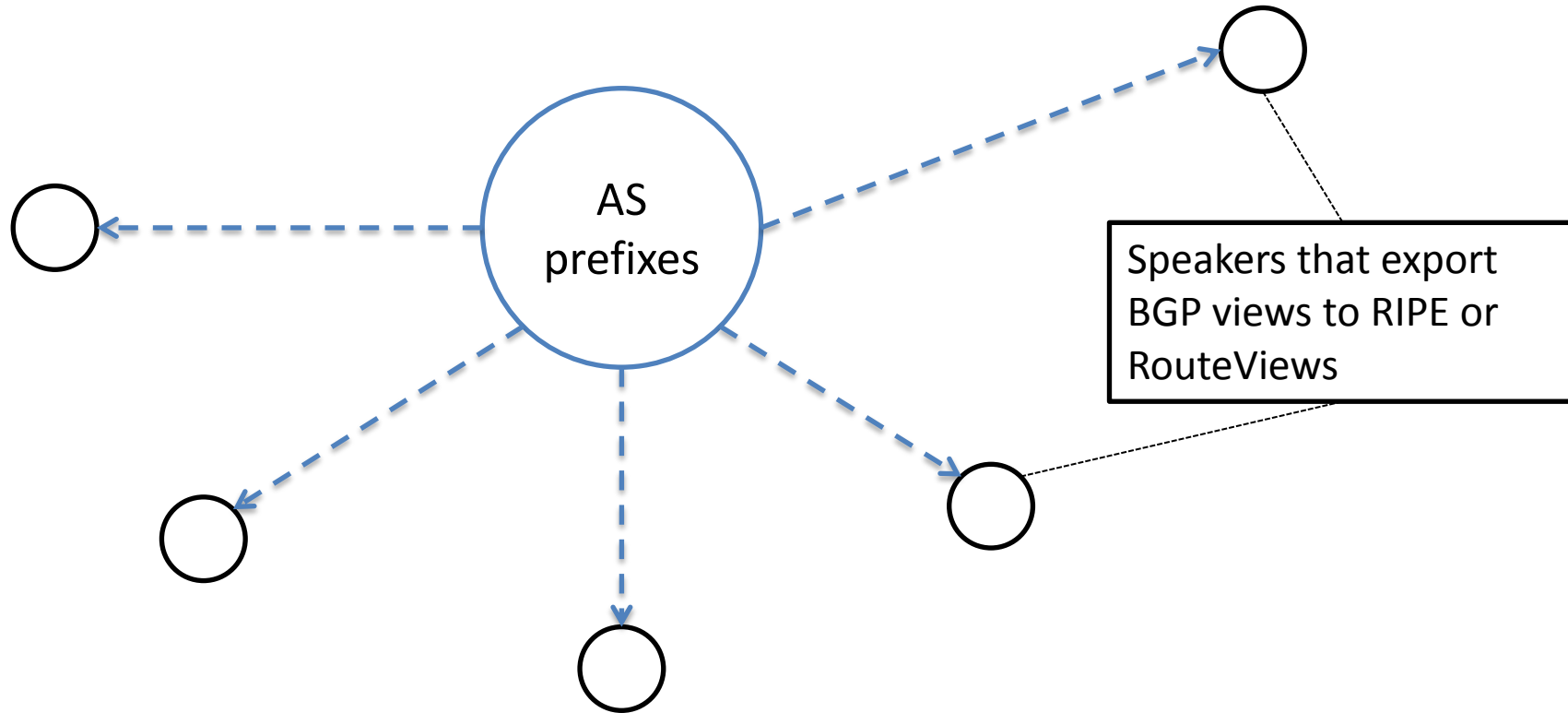
$$Connectivity(AS) = \frac{\sum_{prefixes}\sum_{speakers} distance(prefix, speaker)}{|speakers| \times |prefixes|}$$

Latency should linearly depend on connectivity

When IPv4 is faster IPv6?

	Connectivity v4	Connectivity v6	AS Relations v4	AS Relations v6
AS38064	4.0574	7.9215	c2p AS4770 c2p AS9560 c2p AS24192	c2p AS9560
AS132043	3.557	5.8953	c2p AS9583 c2p AS18101 c2p AS55824	c2p 55824
AS39537	2.27792	4.5904	c2p AS8553 c2p AS174 c2p 6777 c2p 41847 +p2p	c2p AS8553
AS41401	2.8269	5.0108	c2p AS3292 c2p AS35121 c2p 41943	c2p 41943

When IPv6 graph is subgraph of IPv4 graph. As it should be.

When IPv6 is faster IPv4?

	Connectivity v4	Connectivity v6	AS Relations v4	AS Relations v6
AS262934	6.0239	2.1081	c2p AS52324 c2p AS52465	c2p AS6939
AS52465	5.9786	2.1189	c2p AS262770	c2p AS6939
AS27912	5.27355	2.1129	c2p AS23383 c2p AS27696	c2p AS6939
AS42772	5.26224	2.1075	c2p AS6697 c2p AS12406	c2p AS6939

When in IPv6 you become client of AS6939!

AS6939 in IPv6 is smart choice

TOP 5 connectivity in IPv4		TOP 5 connectivity in IPv6	
AS	Connectivity	AS	Connectivity
8075/Microsoft	1.18545	6939/HE	1.17805
15169/Google	1.29763	8075/Microsoft	1.20592
6939/HE	1.35115	15169/Google	1.38314
3856/PCH	1.3598	9002/RETN	1.4785
12989/Eweka	1.42068	36351/Softlayer	1.49182

Closer Look at 6939

TOP 5 direct customers in IPv4		TOP 5 direct customers in IPv6	
AS	Connectivity	AS	Customers
174/Cogent	4349	6939/HE	2245
3356/Level3	4034	174/Cogent	1129
7018/ATT	2222	3356/Level3	1009
4323/TW	1862	1299/Telia	562
209/Qwest	1564	2914/NTT	553

Closer Look at 6939

	IPv4	IPv6
701→6939	--	p2p
3356←→6939	--	p2p
3549←→6939	--	p2p
6453←→6939	--	p2p
2914←→6939	--	p2p
3257←→6939	--	p2p
209←→6939	--	c2p

And every third triple (AS1->AS2->AS3) in IPv6
goes through AS6939!

Conclusions

- When you compare IPv4 and IPv6 latency you compare latency in two different Internets;

- The result greatly differs from one AS to another;

- The routing policy of your AS could affect global latency if you are Hurricane Electric ☺

- With growth of IPv6 traffic the IPv4 and IPv6 graphs should become less different.

Questions?

Thank you for listening!