Measuring IPv6 Performance

Vaibhav Bajpai
TU Munich, Germany

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Joint Work with

Jürgen Schönwälder
Jacobs University Bremen, Germany

Steffie Jacob Eravuchira | Sam Crawford
SamKnows Limited, London, UK

Saba Ahsan
Aalto University, Finland

Jörg Ott
TU Munich, Germany

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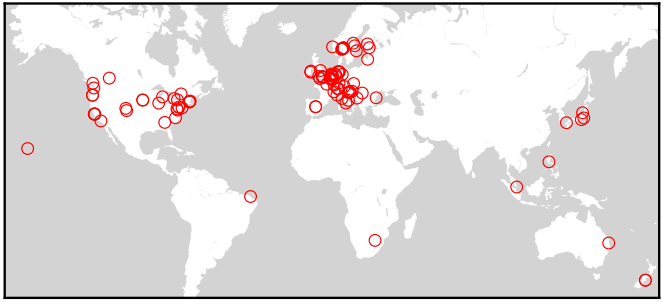
Overview | Measurement Trial



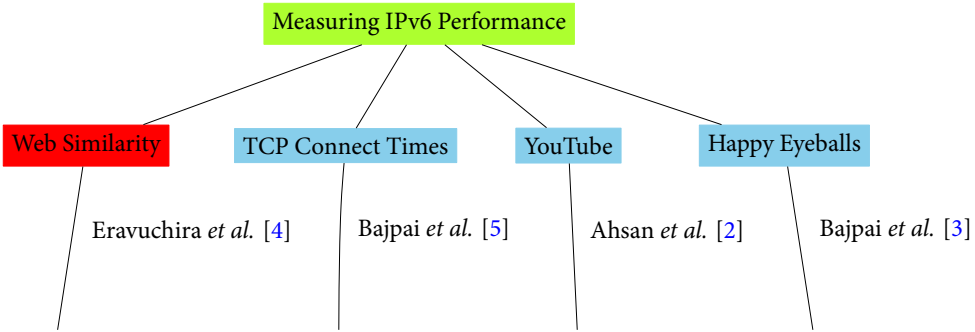
We measure from ∼100 dual-stacked SamKnows[1] probes.

NETWORK TYPE	#
RESIDENTIAL	78
NREN / RESEARCH	10
BUSINESS / DATACENTER	08
OPERATOR LAB	04
IXP	01

RIR	#
RIPE	60
ARIN	29
APNIC	10
AFRINIC	01
LACNIC	01

[1] SamKnows itself is a much larger platform, see [1]

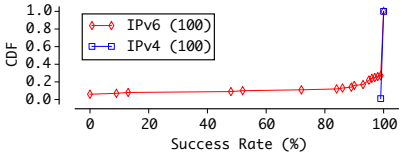
Overview | Measuring Web Similarity



Web Similarity | Success Rate

Can we fetch all webpage elements over IPv6?

- 27% of websites show some rate of failure over IPv6.
- 9% exhibit more than 50% failures over IPv6.
- 6% show complete failure (0% success) over IPv6.



#	Webpage	Success Rate (%) IPv6(↓)	Success Rate (%) IPv4	W6LD
01	www.bing.com	0	100	✓
02	www.detik.com	0	100	✓
03	www.engadget.com	0	100	✓
04	www.nifty.com	0	100	
05	www.qq.com	0	100	
06	www.sakura.ne.jp	0	100	
07	www.flipkart.com	09	99	✓
08	www.folha.uol.com.br	13	100	
09	www.aol.com	48	100	✓
10	www.comcast.net	52	100	✓
11	www.yahoo.com	72	100	✓
12	www.mozilla.org	84	100	✓
13	www.orange.fr	86	100	✓
14	www.seznam.cz	89	100	✓
15	www.mobile.de	90	100	✓
16	www.wikimedia.org	90	100	
17	www.t-online.de	93	100	✓
18	www.free.fr	95	100	
19	www.usps.com	95	100	
20	www.vk.com	95	100	✓
21	www.wikipedia.org	95	100	✓
22	www.wiktionary.org	95	100	
23	www.elmundo.es	96	100	✓
24	www.uol.com.br	96	100	✓
25	www.marca.com	97	100	✓
26	www.terra.com.br	98	100	✓
27	www.youm7.com	99	100	

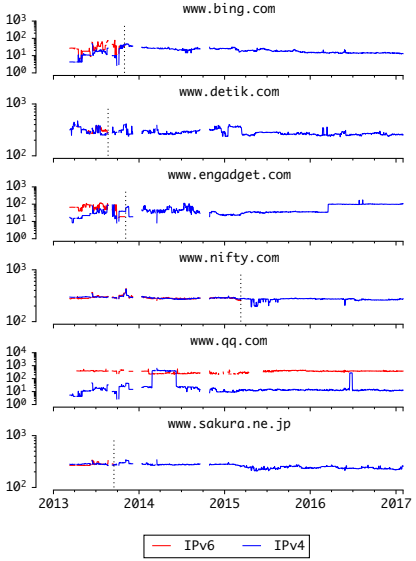
Web Similarity | Success Rate

ALEXA top 100 dual-stacked websites:

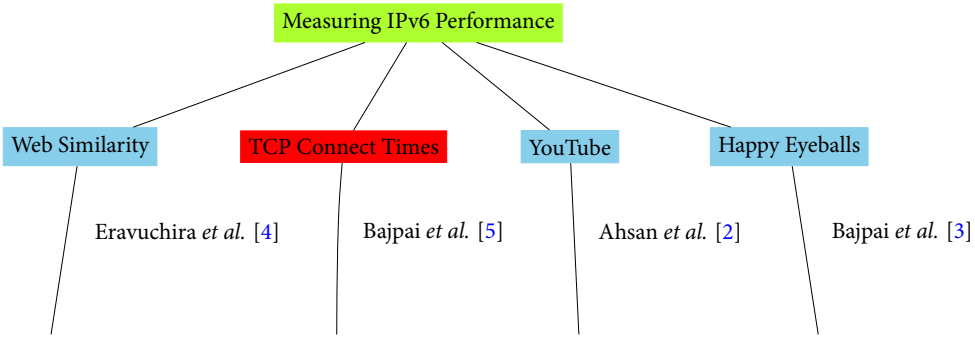
- 6% show complete failure over IPv6.

#	Webpage	Success Rate (%) IPv6(↓)	IPv4	W6LD
01	www.bing.com	0	100	✓
02	www.detik.com	0	100	✓
03	www.engadget.com	0	100	✓
04	www.nifty.com	0	100	
05	www.qq.com	0	100	
06	www.sakura.ne.jp	0	100	

- Metrics that measure IPv6 adoption should account for *changes* in IPv6-readiness.



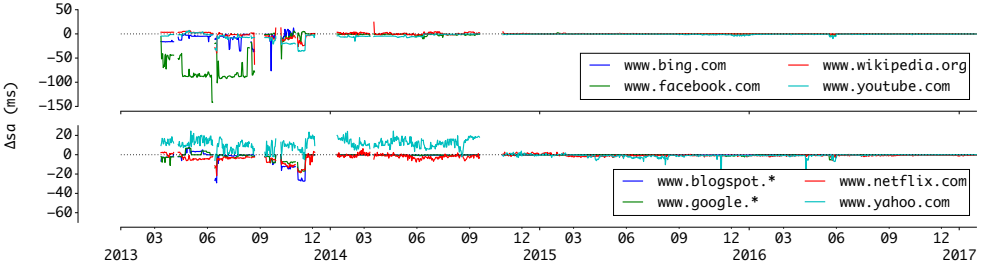
Overview | TCP Connect Times



TCP Connect Times | Trends (2013 - 2017)

$$\Delta s_a(u) = t_4(u) - t_6(u)$$

where $t(u)$ is the time taken to establish TCP connection to website u.

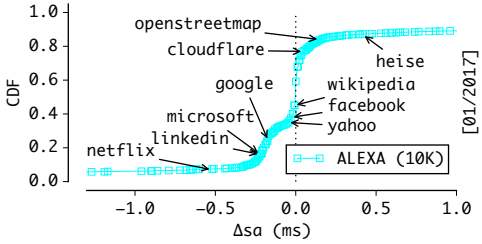


- TCP connect times to popular websites over IPv6 have *considerably* improved over time.

TCP Connect Times | Who connects faster?

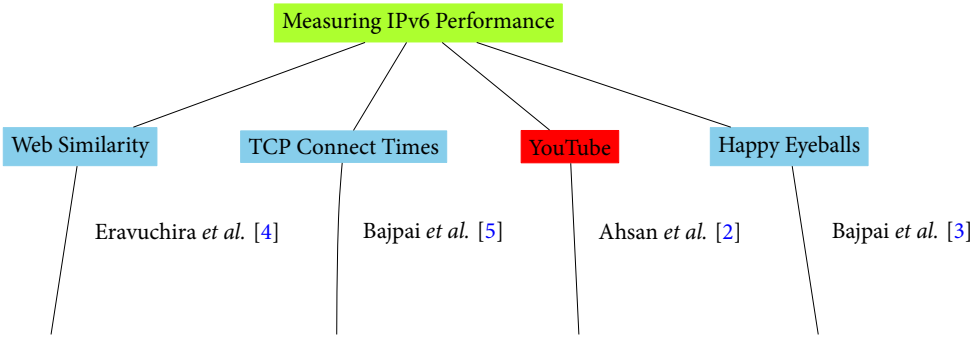
ALEXA top 10K websites (as of Jan 2017):

- 40% are *faster* over IPv6.
- 94% of the rest are at most 1 ms slower.
- 3% are at least 10 ms slower.
- 1% are at least 100 ms slower.



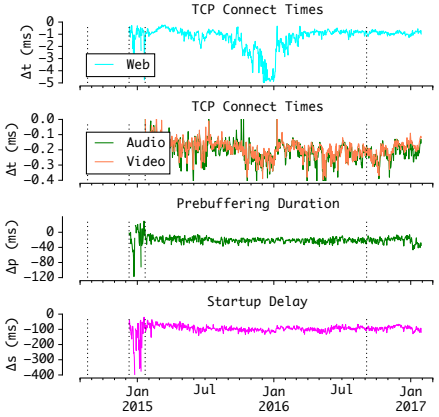
$$\Delta s_a(u) = t_4(u) - t_6(u)$$

Overview | Measuring YouTube



YouTube | Latency

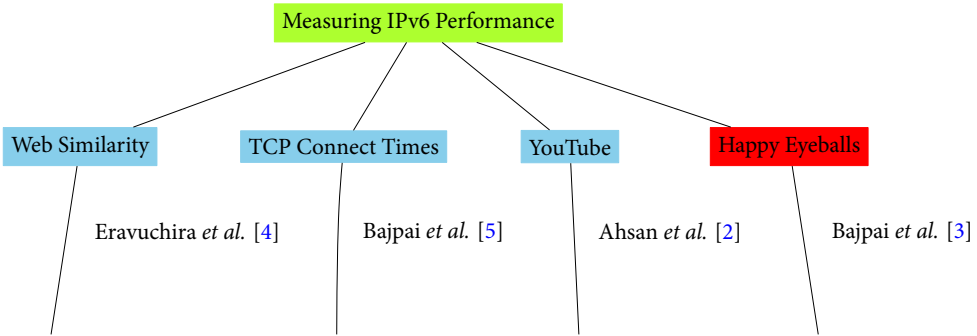
- TCP connect times
  - < 1 ms slower over IPv6
  - Higher towards webpages
- Prebuffering durations
  - > 25 ms slower over IPv6
- Startup delay
  - > 100 ms slower over IPv6



$$\Delta t(y) = tc_4(y) - tc_6(y)$$
$$\Delta p(y) = pd_4(y) - pd_6(y)$$
$$\Delta s(y) = sd_4(y) - sd_6(y)$$

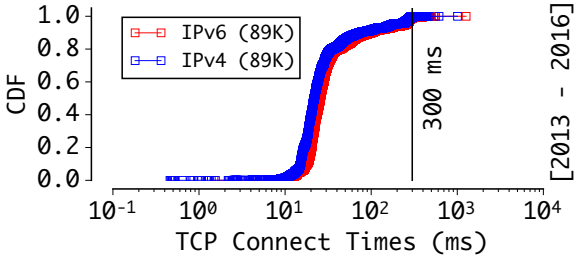
Latency is consistently *higher* over IPv6.

Overview | Measuring Effects of Happy Eyeballs



* entries are papers currently under review.

Happy Eyeballs

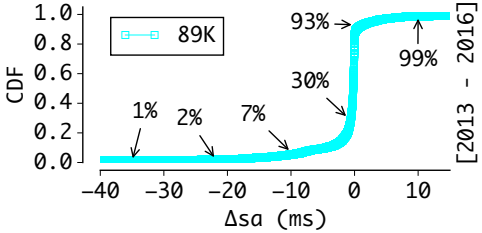


- Only ∼1% of samples above HE timer value > 300 ms

Happy Eyeballs | Slowness

Samples where HE *prefers* IPv6 —

- HE prefers slower IPv6 connections 90% of the time.
- Absolute difference is not that far apart from IPv4
  - 30% — at least 1 ms slower.
  - 7% — at least 10 ms slower.



$$\Delta s_a(u) = t_4(u) - t_6(u)$$

$$\Delta s_r(u) = \frac{t_4(u) - t_6(u)}{t_4(u)}$$

We show in [3] that lowering HE timer to 150 ms maintains same IPv6 preference levels.

Impact

- Measuring IPv6 Performance
  - Measuring TCP Connect Times [5] [NETWORKING '15]
  - Measuring YouTube Performance [2] [PAM '15]
  - Measuring Effects of Happy Eyeballs [3] [ANRW '16]
  - Measuring Web Similarity [4] [CNSM '16]

- Relevance:
  - Network operators in *early* stages of IPv6 deployment.
  - Content providers to see how their *service delivery* over IPv6 compares to IPv4.
  - Drive related *standards* work in the IETF.

www.vaibhavbajpai.com

bajpaiv@in.tum.de | @bajpaivaibhav

References

[1] V. Bajpai and J. Schönwälder, "A survey on internet performance measurement platforms and related standardization efforts," *IEEE Communications Surveys and Tutorials*, vol. 17, no. 3, pp. 1313–1341, 2015. [Online]. Available: http://dx.doi.org/10.1109/COMST.2015.2418435

[2] S. Ahsan, V. Bajpai, J. Ott, and J. Schönwälder, "Measuring YouTube from Dual-Stacked Hosts," in *Passive and Active Measurement - 16th International Conference, PAM 2015, New York, NY, USA, March 19-20, 2015, Proceedings*, 2015, pp. 249–261. [Online]. Available: http://dx.doi.org/10.1007/978-3-319-15509-8_19

[3] V. Bajpai and J. Schönwälder, "Measuring the effects of happy eyeballs," in *Proceedings of the 2016 Applied Networking Research Workshop*, ser. ANRW '16. New York, NY, USA: ACM, 2016, pp. 38–44. [Online]. Available: http://doi.acm.org/10.1145/2959424.2959429

[4] S. J. Eravuchira, V. Bajpai, J. Schönwälder, and S. Crawford, "Measuring web similarity from dual-stacked hosts," in *12th International Conference on Network and Service Management, CNSM 2016*, 2016.

[5] V. Bajpai and J. Schönwälder, "IPv4 versus IPv6 - who connects faster?" in *Proceedings of the 14th IFIP Networking Conference, Networking 2015, Toulouse, France, 20-22 May, 2015*, 2015, pp. 1–9. [Online]. Available: http://dx.doi.org/10.1109/IFIPNetworking.2015.7145323