Defining the Impact of the Edge Using The SamKnows Internet Measurement Platform

PREPARED FOR
EdgeConneX

Contents

1 Executive Summary

SamKnows has performed an independent study of measurement data published by the FCC to ascertain the real world benefits of an ISP connecting to content providers at an EdgeConneX location.

Measurement data relevant to two such deployments were analyzed, one in Norfolk, Virginia and the other in San Diego, California.

In Norfolk, a cable ISP, Cox Communications, established connectivity with a leading content provider in early February 2015. Soon after, the page load time for a major search engine improved by an average of 15.4% for users in that area. Some users saw page load time improvements of more than 40%.

In San Diego, Cox again established connectivity with a CDN, Akamai Technologies, in March 2015. This CDN serves a major online shopping website, which was used as a proxy to study the performance improvement of Akamai connecting at this EdgeConneX location. On average, a 9.2% improvement in page load time was observed following the change. Moreover, further analysis of the results showed that while Akamai still only served a fairly small fraction of the shopping website's requests; if they served all of the site's traffic then the performance improvements to the shopping website's loading time could be as high as 65%.

With web page size growing and Internet traffic increasing, page load time becomes critical to content providers and ISPs. The sensitivity of load times to engagement and revenue can be seen from some of the top Internet destinations:

- Amazon has Estimated that 100 ms increase in load time can decrease sales by 1%.
- Google found that moving from 10 search results to 30 increased the average page load time from 400 ms to 900 ms. This, in turn, reduced traffic and ad revenue by 20%.
- For Linkedin, a 1 Second Median Latency Increase causes a 15% engagement drop and 5% bounce rate increase.
- Facebook pages that are 500 ms slower result in a 3% drop-off in traffic, and 1 second causes a 6% drop-off.

The results presented here demonstrate a tangible benefit of "localization" to end user experience from an ISP connecting to content providers at an EdgeConneX location.

1.1 About EdgeConneX

EdgeConneX provides space, power and connectivity to a variety of clients at more than 20 edge data centers around the US. These locations are typically in metropolitan areas with large residential and business populations that are not well served by other data center operators. This affords EdgeConneX the opportunity to act as the meet point between ISPs and major content providers. Content providers are able to hand-off traffic to the ISP's far closer to the edge than would otherwise be possible. This in turn means reduced transit volumes for the ISPs and content providers, a shorter network path for the users' traffic, and a better end user experience.

Further information about EdgeConneX can be found at

http://www.EdgeConneX.com

1.2 About SamKnows

SamKnows provides fixed-line and mobile broadband performance measurement services to ISPs and telecommunications regulators worldwide. Their regulatory clients include the FCC (USA), Ofcom (UK), IDA (Singapore), CRTC (Canada), Anatel (Brazil) and the European Commission. The SamKnows fixed-line measurement work relies upon "Whiteboxes," small hardware probes deployed in consumers' homes running active measurements, to build a robust and long-term picture of broadband performance. To date, around 100,000 Whiteboxes have been deployed across five continents, measuring every aspect of the consumer's broadband performance.

Further information about SamKnows can be found at
http://www.samknows.com

2 Introduction

EdgeConneX commissioned SamKnows to perform analysis of the publicly available FCC Measuring Broadband America data to determine whether an ISP establishing connectivity with a content provider at new "edge" locations would lead to a measurable and meaningful change in end user performance.

EdgeConneX provided SamKnows with installation dates. Based on this, SamKnows estimated approximate dates for when the EdgeConneX-enabled ISP established connectivity with content providers in each of its locations.

The hypothesis EdgeConneX wished to test was that ISPs connecting to a content provider at one of their locations would lead to a shorter network path, yielding reduced latency and, associated performance improvements. SamKnows has attempted to prove this hypothesis by studying performance data already collected around the time of an EdgeConneX deployment by an ISP.

2.1 Measurement Methodology

SamKnows operates a network of approximately 6,500 Whiteboxes in the USA on behalf of the FCC. These are deployed across the largest ISPs and most popular service tiers. These Whiteboxes run a suite of measurements every hour of every day, gathering a very robust, long-term dataset of broadband performance.

Some of these measurements test to servers that are dedicated for the purpose of the testing project, while other measurements test to real content providers (e.g. Google, Facebook). The tests that are conducted to real content providers include web browsing and video streaming measurements.

SamKnows performed some preliminary analysis of the FCC measurement data coupled with the EdgeConneX deployment schedules in order to determine what measurement data was available around the time of the deployments. SamKnows identified two ISPs with sufficiently large sample sizes of Whiteboxes in municipalities where EdgeConneX facilitated connectivity.

In both of these instances, page load time is the metric being focused on. Full details of the page load time metric are available at https://www.samknows.com/broadband/uploads/methodology/SQ301-005-EN-Test-Suite-Whitepaper-4.pdf. Video streaming measurements to live

content providers had not been widely deployed at the time of the study, so data was not available for analysis, but these would be included in future reports.

Web browsing measurements are conducted on the FCC network every two hours to popular websites. These include various websites including YouTube, Wikipedia, Amazon and others.

Two of the content providers that interconnect at EdgeConneX locations serve popular websites included in the SamKnows analysis. The measurement results from these websites formed the basis for the analysis below.

The FCC measurement data used in this report is available at http://www.fcc.gov/measuring-broadband-america.

3 Results

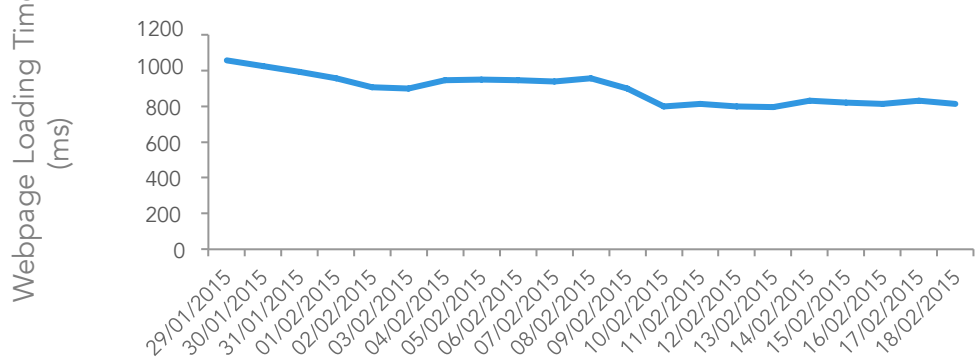
3.1 Norfolk, Virginia

Cox Communications established connectivity with a major search engine at EdgeConnex's Norfolk datacentre on 6th February 2015. SamKnows identified a statistically significant number of Whiteboxes using Cox in Virginia which were collecting web page loading time measurements for the search engine. These homes were the ones most likely to benefit from the geographic redirection used by this content provider to direct users to the nearest set of webservers, in order to deliver optimal performance.

Although the CDN established presence on 6th February, it is unknown exactly when the content provider and the cable ISP agreed to begin exchanging traffic at that location. However, on the assumption that it would be relatively soon after 6th February, analysis was performed over the surrounding period to try to identify a step change in performance.

Figure 1, below, shows a clear step change in page load time on the 9th February 2015. For the 11 days prior to this, average page load time for the major search engine across the whiteboxes was 961ms. For the subsequent 9 days, this value decreased to 813ms. This represents a 15.4% improvement in page load time.

Figure 1: Average major search engine page load time for homes in Virginia



It is important to stress that one or two homes seeing a big change did not drive improvements to the average. Half of the homes saw an improvement in page load time of at least 20%, and a third of the homes saw an improvement of at least 40%. No homes saw their performance degrade following the change.

Additionally, it can be observed from the raw data that prior to February 9th, the search engine was served from a range of IP addresses registered in Dallas, TX for the homes being tested. On February 9th, this IP address range ceased to be used for hits to the search engine and a new IP range began being used. This new IP range is almost certainly being served from the Norfolk data center, although it is registered generically to that content provider's California headquarters.

3.2 San Diego, California

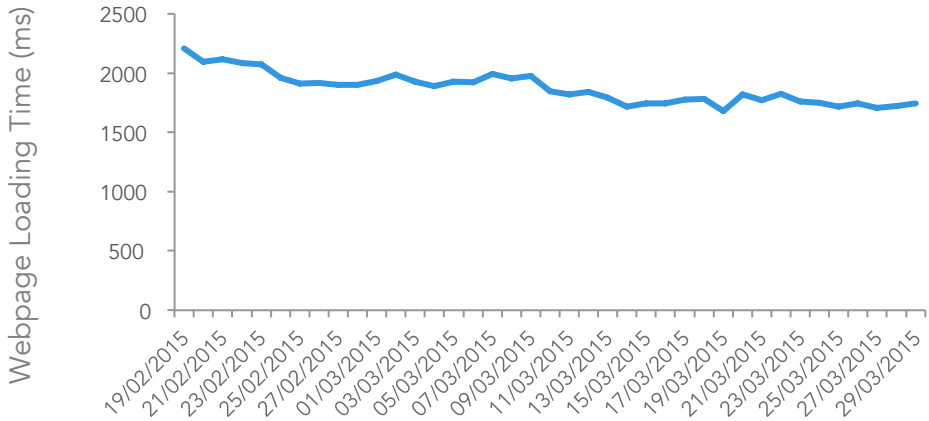
Cox established connectivity with a CDN, Akamai, at EdgeConnex's San Diego datacentre on 5th March 2015. SamKnows again identified a statistically significant number of Whiteboxes using Cox in this metro area that were actively running web browsing measurements during this period.

As with the Norfolk case, it is unknown exactly when Cox and Akamai began exchanging production network traffic at this location, so data analysis looked at the surrounding weeks.

Akamai provides hosting for many of the world's largest websites. One of the websites they provide services for is a leading online shopping website, which is included in the FCC's Measuring Broadband America dataset. The results from web site measurements are therefore being used as a proxy to study the CDN's performance.

Figure 2, below, shows a small but noticeable improvement in web page load times for the online shopping website from 10th March 2015 onwards.

Figure 2: Average online shopping website load time for homes in California



For the 5 days leading up to the change the homes averaged 1.95 seconds to load, and for the 5 days after they averaged 1.77 seconds. This represents a 9.2% improvement in page load time for the major online shopping website.

This is a noticeably smaller improvement than was observed in the Norfolk case. If anything, we would actually expect to see a bigger improvement here, as the online shopping website's home page is far larger than that of the major search engine, so the benefits from the reduction in latency should yield more significant page load time improvements.

Further analysis of the raw measurement data identified the cause of this unexpectedly small improvement. While the online shopping website uses Akamai for serving its home page, it appears to only do so intermittently. When it does not use it, it instead uses its own servers that it hosts independently of Akamai. The reasons for this are unknown, and there is no clear pattern to when traffic is sent to one versus the other.

Starting on 10th March 2015, the number of Whiteboxes sending requests to Akamai's IP addresses rather than the online shopping website's IP addresses increased significantly.
However, study of the raw measurement results showed that even after the change Akamai still only served 15-20% of the online shopping site's homepage requests. This helps explain why the overall performance improvement is so small in Figure 2 above.

In light of this, it is interesting to explore further the difference between the online shopping site's page load time when Akamai is used versus when the major online shopping website's own web servers are used. Figures 4 and 5 below show the results from two individual Whiteboxes in California.

Figure 3: Online shopping website page load time
(Whitebox #207352)

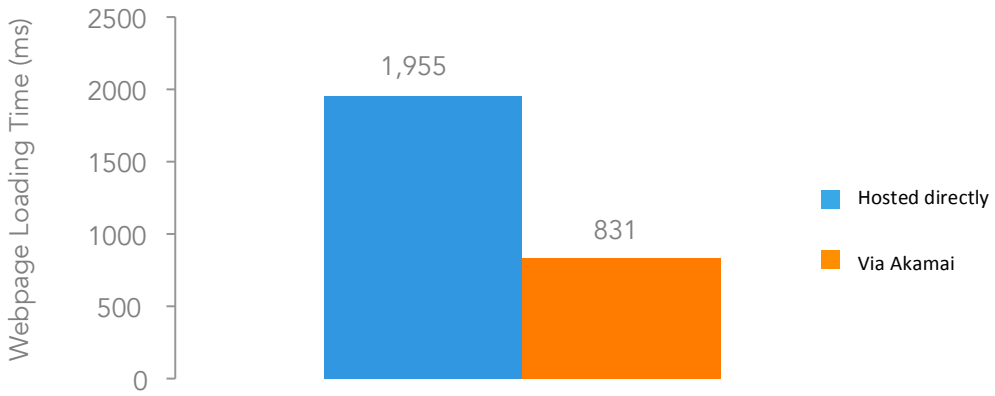
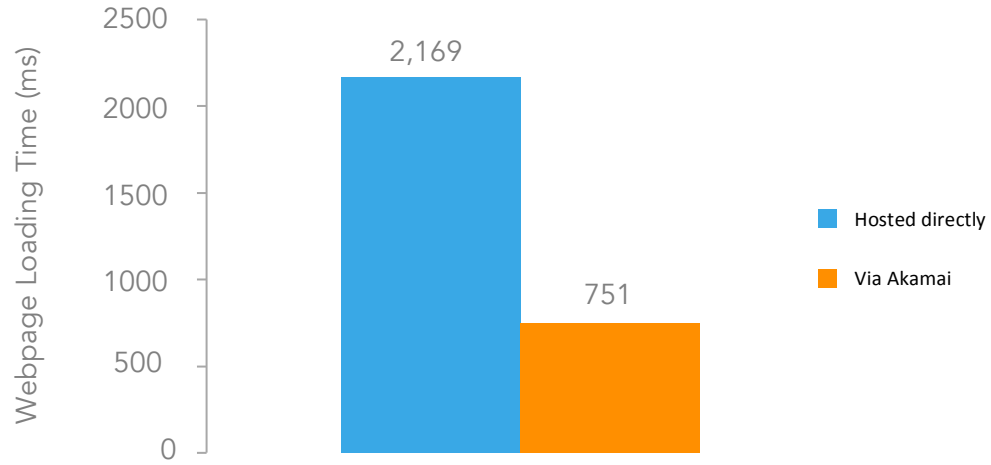


Figure 4: Online shopping website page load time
(Whitebox #599910)



The two Whiteboxes depicted above see a 58-65% page load time improvement when using Akamai versus the online shopping website's own web infrastructure. If this website were to switch to using Akamai for all of their requests, it would be reasonable to expect to see similar improvements across all users (at least in the Southern California area).

4 Conclusion

The results presented in this report demonstrate a tangible improvement in web browsing performance from two real-world deployments of an ISP connecting to major content providers at an EdgeConneX data center. This improvement is driven predominantly by a reduction in latency between the client and the content provider, made possible by a hand-off between the client's ISP and the content provider at a location closer to the edge of the network. Aside from improving a client's quality of experience, this will have the added significant benefit to ISPs and content providers of reducing the volume of traffic transiting other parts of their network.

While this report only looks at two EdgeConneX locations and two content providers, it is reasonable to expect similar improvements would be observable in other locations and with other content providers.

It is anticipated that a future report will focus on the quality of experience improvements that can be observed in video streaming when an EdgeConneX location is used to exchange video traffic. With video consuming huge percentages of US Internet traffic and the traffic volumes increasing continually, it is reasonable to expect significant improvements will be observable here too.

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