Evaluating the Composition and Performance of the IPv6 Address Space with Traceroutes and Web Requests

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Topic: Compare the speeds of IPv6 and IPv4.

"A key concern of content providers when considering IPv6 is whether it will impact performance for users. Find a set of sites that you can access using both protocols (e.g., take a look at the Alexa top sites list) and compare page load times and throughput for each protocol. You might also consider running pings and traceroute to IPv4 and IPv6 instances of the site using RIPE Atlas to understand latency and path differences between these protocols."

Background and Motivation

Initially deployed in 1983 for ARPANET, the Internet Protocol version 4 (or IPv4) is still one of the core protocols of the modern-day Internet, and continues to route most traffic in the network layer. In its earliest documentation, the Internet Protocol was described as a way of transmitting blocks of data between sources and destinations identified by a fixed length address. The initial address length was set to 32 bits, which provided for an address space of 4,294,967,296 (2^32) addresses. While this seemed an extremely large number at the time, the 90s saw a rapidly growing Internet, and Internet user-base, which began to slowly deplete the available address pool. Decades later, the number of Internet pages and users has exploded, and the common-place nature of mobile phones and laptops has necessitated many more IP address assignments than ever foreseen in the days of ARPANET. In 2011, the top-level IP addresses were exhausted, and the need for a solution became more urgent. IPv6 was proposed as the new standard, and with address lengths increased to 128 bits, the problem would effectively be dealt with.

While IPv6 seems like an effective and somewhat necessary change, there are still large parts of the Internet that have not adopted the new protocol. IPv4 continues to carry the vast majority of Internet traffic, and recent statistics show that the migration to IPv6 is occurring at a very slow pace. Some hosts may be hesitant to switch to IPv6 due to fears of slower speeds or decreased quality.

Project Scope

For our semester project, we intend to gain a better understanding of how popular websites and autonomous systems are adopting IPv6, and whether or not there are noticeable changes to the Internet experience. In particular, we are interested in finding places where IPv6 has already been implemented, and how the speed compares to IPv4.

Our work will begin with developing a script that, given a list of websites, will access the targets and produce statistics on which ones support full IPv6 connections, which ones have downgraded back to IPv4, and the various informatics associated with the connection. This will be accomplished by running an IPv6 traceroute to all targets. If we discover a resultant set of sites that support both IPv4 and IPv6, then we will request the page using both protocols to compare the access speeds.

If some sites have downgraded to IPv4, then the script will attempt to follow the traceroute in search of the point where the downgrade occurred. If we discover these points in the traceroute output, we will collect them, and attempt to find out pertinent information like the device on which the downgrade occurred, the device's AS, and the downgrading software.

Deliverables

Our final product will include an extensible script that produces the aforementioned statistics given a list of target websites, as well as a report that analyses the results of the script run on a sample of addresses. This report will include information about which sites on the list support IPv4 and/or IPv6, the access speeds, potential information on dropdown points, and which AS's have prevalent IPv6 support.

Timeline

Though it is hard to estimate when we will be able to check off the following milestones, a rough schedule of how we plan to proceed is:

By the end of October:

Have a script that can run take in the input list, run traceroutes on the sites, and report whether or not a successful IPv6 traceroute could be accomplished

By the end of November:

Add access speed evaluation capabilities to the script, and collect data on IPv4 vs IPv6 web requests of eligible sites. Be able to produce some aggregations of the data found to begin drawing conclusions

By the end of the semester:

Add AS detection and stepdown detection capabilities ot the script (if possible), and have collected a large enough dataset to produce useful visualizations and conclusions about the IPv6 internet space.

Website

https://github.com/JDowns412/IPv6-Tracer

Related Work

1. “Beyond Counting: New Perspectives on the Active IPv4 Address Space” - (https://arxiv.org/abs/1606.00360)
   This paper provides a background on the current usage of IPv4 addresses. The techniques used to measure the active IPv4 space provides a better perspective on the IPv6 adoption debate.

2. “Forming an IPv6-only Core for Today's Internet” - (http://conferences.sigcomm.org/sigcomm/2007/ipv6/1569042987.pdf)
   We plan on looking into places where IPv6 traffic needs to be converted to IPv4 and sent over some links in IPv4. This papers information on an IPv6-only core could give insight on the performance differences between completely IPv6 traffic and IPv6 traffic that has to be “tunnelled” down to IPv4.

3. “A Scalable Routing System Design for Future Internet” - (http://conferences.sigcomm.org/sigcomm/2007/ipv6/1569043163.pdf)
   While IPv6 helps with the IP address shortage issue, the huge expansion of the number of IP addresses poses scalability concerns for IPv6. The ideas mention in this paper are of interest for investigating the performance implications of IPv6.

4. “A Comparison of IPv6-over-IPv4 Tunnel Mechanisms” - (https://tools.ietf.org/html/rfc7059)
   The information on these “tunnelling” mechanisms will help us analyze the performance of traceroutes revealing a downgrade from IPv6 to IPv4. Our performance techniques can compare these techniques with an IPv6-only network.