Shreya Sharma

Michael Sadler

EXPLORING THE REALM OF IPV6

As internet and related technologies increase in size everyday, our archaic allocation of IP addresses through IPv4 addressing scheme becomes more obsolete and difficult to handle everyday. We have long exhausted our address space using IPv4 scheme and are delaying havocs by using NATs and CIDR. There is no debate on the fact that at the time IPV4 was introduced, it was a genuinely good way of IP allocation given the number of PCs, active users, and world population at that time. But we have come a long way ever since. During the deployment of IPV4 addresses in 1989 the world population was around 4 billion, and the addressing scheme provided 2^{32} addresses, which could virtually supply one IP address to every person on the planet. It must be noted that this was just the dawn of internet and the kind of usage we have today, with every person (at least in developed countries) owning more than one internet connected devices (be it laptop, cell phone, tablets, etc) was an inconceivable idea. Naturally, at that time IPV4 seemed more than enough. But today, in the year 2017, the world population has almost doubled, reaching 7.5 billion in April. That is double the amount of address space in IPv4, with the constraint that each person gets just one IP address and ignoring the fact that there are a lot of reserved and private IP addresses in the pool too. But we somehow have managed to stretch the IPv4 life, using NATs. The basic idea behind NAT is rather simple, it just has internal and external network addresses. External addresses can be globally recognizable, whereas internal addresses need to be unique only within a network, meaning that several devices can be allocation same internal IP addresses as long as they are part of different globally identifiable networks. But even with this novel scheme of over utilizing the current IPv4 space, we will not be able to keep up the supply and demand chain in control for long. With the imminent arrival of Internet of Things, matters are bound to get worse. But we do have a solution sitting right under the rack for almost 20 years now- IPv6.

IPv6 basic protocol, also known as RFC 2460, was first published in 1998 with the introduction of a 128 bit addressing scheme (as opposed to its predecessor's 32 bit addressing scheme). It provides 2^{128} or 340 undecillion addresses, clearly more than enough for the entire human race carrying several ip-configured devices. At the first stance, IPv6 clearly looks like the immediate, effective, and long lasting solution to the IP address crisis and it should be implemented in the earliest possible manner. However, the growth of IPV6 addressing over the internet has seen a much staggering pace. The main obstacle is the hourglass structure of the OSI model with IPv4 acting as the biggest constraint at its waist. Deployment of IPv6 has been increasingly slow because of the economic overhead involved in the transition. Currently, all the components of our network are capable of utilizing IPv4 addresses and the cost of transferring them all to IPv6 is really high. Clearly, the key business players do not want to invest immediately in IPv6, at least till the point of absolute emergency. There is no pressure from the end user side either, as the very deployment of IPv6 has long been planned as a silent transition with efforts to minimize any effects the end user may feel.

In spite of this crippled growth, a lot of ISPs already started supporting IPv6 and most devices today come equipped with a MAC, which incorporates IPv6 addressing. Even though modern devices have built in these capabilities, very few of actual packet transmissions happen over

IPv6. The growth is measurable, but it still hasn't reached the magnitude desired. Very soon the deployment of IPv6 is going to become a necessity, rather than an option, and it is a good idea to actually check how far we have come in the deployment of IPv6 and what are the trends in this deployment. This brings us to the title of our project, 'Exploring the Realm of IPv6'. The approach we have chosen is strongly influenced by the previous research in the field. The aim of the project is simple, we intend to analyze the development of IPV6 over different servers, networks and countries. We intend to accomplish our goals in three main steps. First, we will take the top twenty most visited websites of the world (scored by www.alexa.com). Next, we will choose twenty geographically diverse locations (studying a few countries from every region of the world). Finally, we will measure the performance of IPv4 vs IPv6, by sending IPv4 and IPv6 requests from a host (in each of the locations) to a server (from each of the chosen websites). The performance will be measured based on two main parameters, the time taken to receive a response and number of hops in each version's route. The decision to use these particular parameters was influenced by previous research in this field and the availability of these parameters. The time taken to return a response can be a direct indicator of how many devices on the message's path were actually supportive of IPv6 as compared to IPv4. The number of hops in the route will be a strong indicator of the extent of deployment of IPv6 routing tables and their outreach.

The approach and idea of this project has been backed up by many previous research works. A notable dissertation [1] in 2016, by John B. Southworth, has explored the deployment of IPv6 in 1000 colleges and universities of the United States. After careful research, his stance has been very clear; institutions that are readily deploying IPv6 are proactively saving themselves of an impending rush hour cost of immediate IPv6 deployment at an emergency state. A related work [2], by Jakub Czyz et. Al., measures IPv6 adoption rate and has discovered significant trends. For instance, while roughly 36% of new monthly (and 12% of cumulative) allocated prefixes are IPv6, we find just 0.63% of average traffic is carried over IPv6 (a two-order-of-magnitude difference) [2]. Clearly the problem lies in the network itself and not the end hosts, which motivated our research to be focused on measuring the network directly. As shown in [3], the measurements of performance we plan use (time to return a response and number of hops in the route) are reliable measures of network adaptability. In [3], authors discuss the methods of traceroute that we intend to use in our research and provide a backbone of their reliability. In [4], authors discuss their experience in using the ATLAS Ripe platform for probing servers through different hosts over the world. The authors have vouched for the platform's unbiased data outcomes and its ability to provide a large array of host choices through largely dispensed probes. The combination of the platform and our methods of analysis, should serve as a good starting point for our project.

REFERENCES:

[1] An empirical analysis of the relationship between IPv6 readiness, IPv6 enablement, and IPv6 effectiveness at colleges and universities in the United States. Southworth, John Brooks. Indiana State University, ProQuest Dissertations Publishing, 2016. 10106058.

[2] Czyz, Jakub, et al. "Measuring ipv6 adoption." *ACM SIGCOMM Computer Communication Review*. Vol. 44. No. 4. ACM, 2014.

[3] Marchetta, Pietro, et al. "Measuring Networks Using IP Options." *IEEE Network* 31.3 (2017): 30-36.

[4] Bajpai, Vaibhav, Steffie Jacob Eravuchira, and Jürgen Schönwälder. "Lessons learned from using the ripe atlas platform for measurement research." *ACM SIGCOMM Computer Communication Review* 45.3 (2015): 35-42.