Performance Evaluation of IPV6 Transition Technologies

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***Abstract*—Presently, IPv6 is highly renowned with organizations, companies and Internet service suppliers because of the deficiencies in IPv4. For preventing a sudden change from IPv4 to IPv6, three mechanisms will be employed to offer a smooth migration from IPv4 to IPv6 with least impact on the network. These mechanisms are Tunnel, Dual-Stack and Translation. This research will beam the light on IPv4 and IPv6 and assess the manual and automatic transition schemes of the IPv6 by comparing their performances for indicating how the transition scheme influences the network behaviour. The experiment will be done by employing OPNET Simulator that models a network consisting a Wide Area Network (WAN), Local Area Network (LAN), a servers and hosts. The results will be represented in tables and graphs. The experiment will utilize different measurements i.e. latency (delay), throughput, TCP delay and queuing delay.**

Keywords: IPv6, IPv4, 6to4 Tunnel, Manual Tunnel, Dual-Stack, Opnet Modeler, Delay and Throughput

I. INTRODUCTION

The connection between computing nodes needs a protocol, number or a name, for identifying every node, and for the source and destination of every packet to be known. The Internet based on protocol that is called as Internet Protocol version 4 (IPv4), which utilizes 32 bit and Classless Inter domain Routing (CIDR): this protocol can deal with 4.3 billion nodes across the world. Because the technology is developing, and various different services and devices utilize 3G and 4G, IPv4 is arriving at its limit: there is not sufficient IPs available from internet service suppliers to fulfill customer needs. Thus, the new version of IP is vital in keeping the pace of the Internet's development as depicted in the picture. IPv6, developed by IETF, is taken more effective as compared to IPv4 in terms of reliability, scalability, protection and speed. Furthermore, the size is more than IPv4, as it utilizes 128 bit that will be capable to cover all of the nodes and any services that might need the IP, both in present and in the future. Countries i.e. India, China and Japan have initiated to utilize the next generation IP [1]. IPv6 can deal with 340 trillion, trillion, trillion nodes while IPv4 is only capable to deal with 4.3 billion nodes. This will add to constructing the essential infrastructure for future development. IPv6 will not need NAT as IPv4 does, as security will be constructed in. IPv4 utilized NAT as security, but its function is not mainly for security. The flow control offers high importance for particular traffic to neglect congestion, and the connection with IPv6 will be as end to end. In summation, the IPv6 header is simpler as compared to IPv4. It consists fewer fields which suports data to be processed quicker, which will in turn be mirrored in a higher performance.

II. TRANSITION STRATEGIES

Transition strategies are mechanisms that offer a means of connection between IPv6 and IPv4, as these two protocols cannot understand each other. Thus, for transferring data, a particular method is required. The three strategies are:

2.1. Dual-Stack

The Dual Stack method utilizes IPv6 and IPv4 within the same stack parallel. The selection of protocol is determined by the administrator policies, along with what type of service is needed and which kind of network is utilized. This technology does not build any change to the packet header and at the same time does not perform encapsulation between IPv4 and IPv6. This technology is called Dual IP layer or native dual stack.

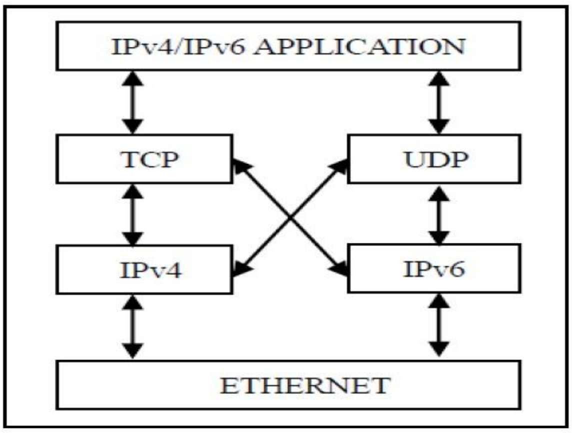

Figure 1 Dual-Stack

2.2. Tunnelling

Tunnelling could be either automatic or manual. The manual connection is a point to point mode which is allocated the source address and the destination address of the tunnel by the operator while the automatic connection is a point to multipoint where the destination address is determined automatically and the source address is allocated by the operator. The tunnel idea functions as a bridge to transport packets between two similar networks over unsuited network. In other way we can say that, the IPv6 will be as a part of IPv4, and the IPv6 data will flow by utilizing IPv4 infrastructure, which will route it to the destination (IPv6) node for processing; the tunnel is a virtual connection between the two points to transport data.

2.3 Translation

The translation mechanism modifies the payload of the IP and the header from version 4 to version 6 and vice versa. There are two methods for translation: stateful and stateless. The stateless translation, there is no address for the prior packet at the time of translation while the stateful translation is related with the prior packets.

III. OPNET MODELER

The Optimized Network Engineering Tools (OPNET) Simulator is an effective method to offer a whole study for the network analysis. The graphical user interface (GUI) is very easy to employ and the result is displayed as graphical and static. Moreover, it does not need a programming knowledge, and this can be easily utilized. The OPNET examines the network as a real life network which provides entire view prior to constructing the network in a real life and also consists a number of models and protocols which can be employed as instances.

There are four simulation techniques supported by Opnet:

Discrete-event Simulation (DES): The DES offers a simulation similar to a real network; it will guide the study by examining the performance and behaviour of the protocols and packets.

Hybrid Simulation: Hybrid simulations are supported by DES, the results based on analysis and the DES to be accurate; by utilizing the two, accurate results can be produced with sensible runtimes.

Flow Analysis: Analytical algorithms and techniques are utilized with flow analysis. It employs detailed topology information to reconstruct the routing table to assure high efficiency for device. Flow analysis is utilized to study and understand the routing and arrivability over the network.

ACE Quickpredict: The packet loss, bandwidths and latency impact time will be studied by ACE quick predict, which is served within the OPNET Application Characterization Environment (ACE) [19].

IV. SIMULATION EXPERIMENT

This experiment will be performed by employing the OPNET Simulator 17.5 for simulation. OPNET was selected as it is assumed as highly effective simulation software and will be suitable in fulfilling the objective of the experiment. It also involves most of the network techniques i.e. switches and routers, as well as other appliances i.e. the filters, which help to examine the traffic. The experiment contains of various steps: firstly, the network model is generated; secondly, the most appropriate statistical analysis is determined; thirdly, the simulation is perfromed for obtaining results; fourthly, the results are examined and compared to each other.

V. RESULT AND DISCUSSION

The simulation time considered for experiment is 5min (300 sec): this simulation time is sufficient to obtain a summary of the network behaviour.

5.1 Delay

Fig 2 displays the LAN TCP delay within the web server: 6 to 4 is shown by green, blue for the IPv4, manual transition by red and purple for IPv6.

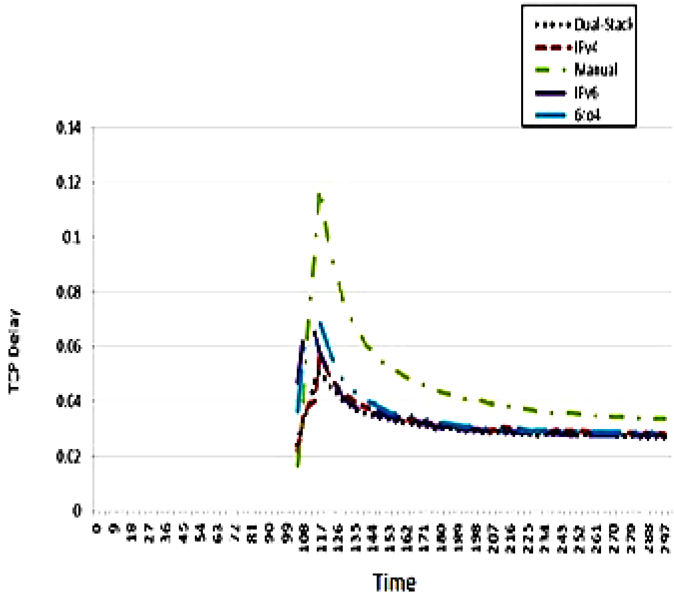

Figure 2. TCP network delay

Queuing delay: The packets reaching at the switch or the router will stay in the queue for processing and the waiting time will produce a delay. Fig 3 displays the point to point delay between the IPv4 switch site and the dual stack router. The fig displays IPv4 has less queue delay because the packet size is smaller in comparison of other types.

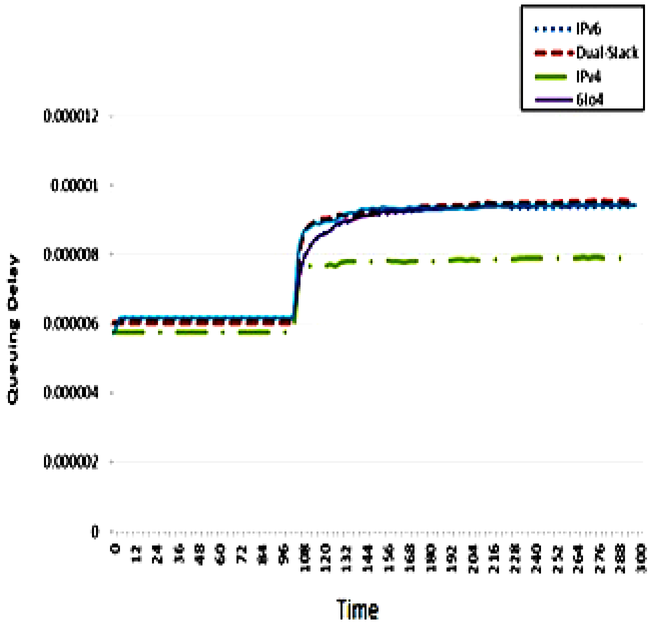

Figure 3. Queuing delay between point to point

CPU Utilizations: The router consists a CPU, and the use becomes highly high when there is a greater level of traffic that requires to be processed rapidly. The 6to4 and manual transitions produce more stress on the CPU as compared to IPv4, Dual-Stack and IPv6 because the manual and 6to4 need the encapsulation and De capsulation operations on every packet cross from IPv6 to Ipv4 and vice versa; fig 4 displays the impact of the five levels on the router.

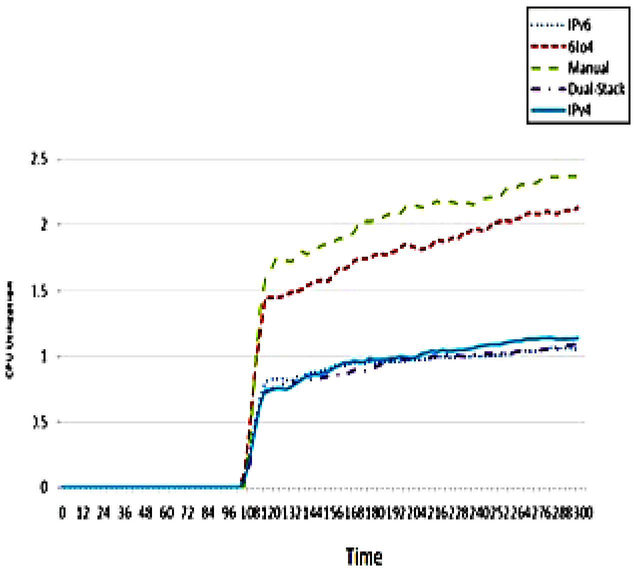

Figure 4. CPU utilization on the middle router

Page response time: The response time for the page is concerned to the delay, as delay can affect the time it considers for the server to react the host request. Fig 5 displays the responses times for every phase. The response times for IPv6, IPv4 and Dual-Stack are less than those of 6to4 and manual as they produced less router overhead and thus the processing time is quicker. The manual transition had a slower response time as compared to 6to4, that is why the TCP delay is higher.

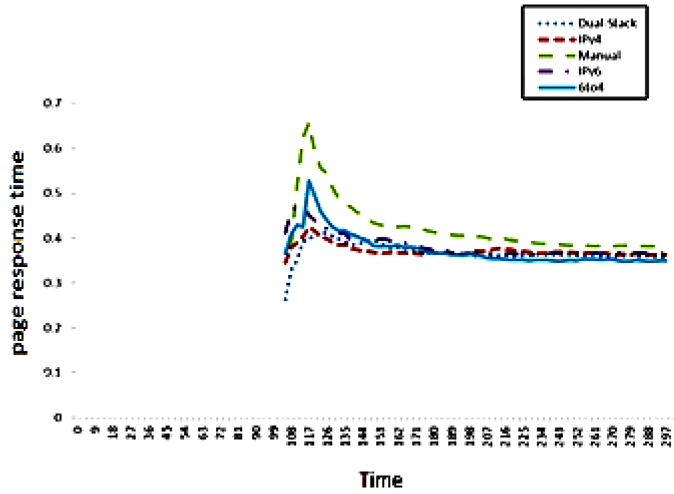

Figure 5. Server response time

The table 1 displays the difference in delays between IPv4, IPv6, manual and 6to4 tunnelling. Table 1displays the mean network performances

Table1. Average Network Performances

	Page response Time	TCP delay	Queue Delay	CPU Utiliz-ation
Dual-Stack	0.3380	0.0376	7.7896	0.5454
IPv4	0.3852	0.0393	6.8322	0.5706
Manual Tunnel	0.5185	0.0667	7.6015	1.1846
IPv6	0.4165	0.0462	7.5913	0.5349
6to4 Tunnel	0.4380	0.0484	7.596	1.0650

5.2 Throughput

Throughput is the rate of transferring data across a network and is estimated in terms of bits/second. The table displays the throughput between the LAN, which consist 100 users, and a FTP server. There are three data rates for this test: 1Mbps, 2 Mbps and 5 Mbps.

Table 2. Average Networks Throughput

Phase	Data rate	*Through put* (byte/sec)	Data rate	*Through put* (byte/sec)	*Data Rate*	*Throughput*
IPv6	1 Mbps	19523.5	2 Mbps	36707.4	5 Mbps	83014
IPv4	1 Mbps	13697.5	2 Mbps	28552.5	5 Mbps	74279.4
Dual-Stack	1 Mbps	17774	2 Mbps	32631.6	5 Mbps	74275
Manual Tunnel	1 Mbps	18357	2 Mbps	33795	5 Mbps	61166.5
6to4 Tunnel	1 Mbps	15736.5	2 Mbps	33214.5	5 Mbps	75730

CONCLUSION

In the prior years IPv4 has shown its worth in offering enough internet addresses. When the Internet continuously extend, it started to arrive IPv4's limit in offering various services and applications. Thus, a new version of IP (called IPv6) was formulated for serving to all user's needs. In this paper, some networks were planned and modelled by employing OPNET Simulator to study various translation strategies. The design contained several network devices for capturing a real network environment. The network configuration was configured in five phases as – Ipv6, IPv4, Dual-Stack, 6to4, and manual tunnel. The statistical analysis was performed to offer appropriate results and to display that the network's performance changed across different mechanisms. For instance, the CPU utilization for manual and 6to4 is greater as compared to IPv6, IPv4 and Dual-Stack because the transition strategy creates more effort to encapsulate. The Dual-Stack detected less delay with TCP, but the delay is higher with 6to4 and manual because the packets are not transported directly, as usual. The network throughput simulations were examined by employing three different data rates: 1, 2 and 5 Mbps. The results display that IPv6 has greater throughput in comparison of the other four, and for manual it is greatre than 6to4 till 5 Mbps. The 6to4 and manual schemes needed manual configurations to determine the source, and the manual tunnel is needed to have the destination determined for building the point to point mechanism.

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