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The Effect of IPv4 and IPv6 over Network and Application Servers Load and Delay

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***Abstract*— The paper presents the simulation results of the comparison of the two Internet Protocols, Internet Protocol version 4 and Internet Protocol version 6. The comparison criteria are the affect of each on the Ethernet load and Ethernet delay over four networks services http service, DB service, Video conference service and IP telephony service.**

***Index Terms*— IPv4, IPv6, Network Delay, Network Load.**

I. INTRODUCTION

IP internet protocol is the set of technical rules or standards which set forth that how computer communicates over a network. Internet protocol version 4 IPV4 has been introduced in 1981. But the growth of internet applications causes space exhausting . Moreover, IPV4 based internet causes problems of IP addressing space depletion and routing overhead[1] . Some temporary solutions were offered, such as NAT (Network Address Translator) or CIDR (Classless InterDomain Routing) , however work began on a new Internet Protocol, namely IPv6[2]. IPv6 is a new version of internet protocol designed as a successor to the current ipv4[1]. The main reason for a new version of the Internet Protocol was to increase the address space; IPv6 was designed with a 128 bit address scheme, enough to label every molecule on the surface of the earth with a unique address [2]. IPv6 - originally known as IPng- has been selected from several proposed alternatives as a suitable successor of the existing Internet Protocol (IPv4) [3]. Most of the existing protocol stacks, systems and applications run on IPv4-based systems. Changes to these systems can have significant impact on existing applications and must therefore be carefully implemented. While a principal design objective of IPv6 was to ease the transition from and coexistence with IPv4, the migration of IPv4-based systems to IPv6 will be a major challenge despite IPv6's built-in features that are backward-compatible with IPv4[4]. It is envisioned that the transition from IPv4 to universal IPv6 will not happen in the near future.[3]

II. IPv4

The Internet Protocol version 4 (IPv4) was developed in the early 1980s. Since then, it has established itself as a primary protocol which enables internetworking thereby allowing a vast array of client/server or peer-to-peer applications to communicate[4]. IPv4 was the first version of the Internet protocol that was widely deployed in order to provide unique global computer addressing to make sure that two computers (or any two network devices) can uniquely identify one another. Due to the fast growth of the network as well asInternet devices, a huge amount of unique addresses are needed. To overcome the limitations of the existing IP (IPv4) in terms of addresses, routing, and security a new version of Internet protocol was designed by the Internet Engineering Task Force (IETF) known as IPv6 [3].

III. IPV4 HEADER

IPv4 uses 32bit (4byte) addresses to uniquely identify nodes within the global internet so the number of addresses in the ipv4 is 2^32. An IPv4 datagram header is shown in figure 1. If option field is set to empty, the length of header comes out to be 20 bytes. These 20 bytes includes 32 bit source address, 32 bit destination address, header checksum and some other fields [1].

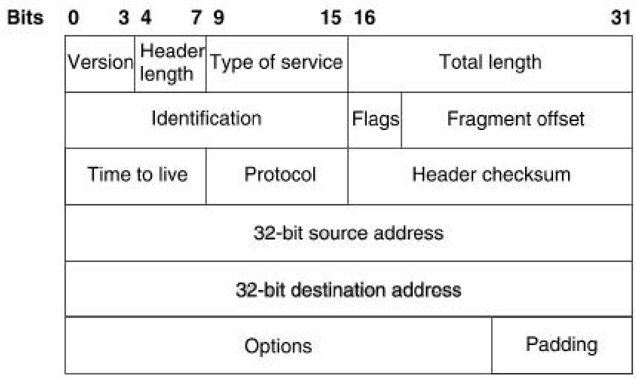

Figure 1. IPv4 Datagram header

IV. IPV6

IPv6 is the next generation network layer protocol that was designed as a replacement for the current IPv4 protocol The primary advantages of IPv6 over IPv4 are its large address space (128-bit addresses) and potential to better support (via the traffic class field) the quality of service requirements of applications including real-time voice and video that are increasingly used on the Internet today. The increase in IPv6 packet size due to the larger addresses is partly offset by a streamlined header with optional extension headers (the header fields in IPv4 for fragmentation support and checksum are eliminated in IPv6)[5].

IPv6 despite its host of advantages over Ethernet results in big overhead due to its large header size. Its header size has increased to 40 bytes when compared to IPv4 whose header size is 20 bytes (with no options). The increased header size with IPv6 packets would be costly in terms of poor bandwidth utilization, throughput and roundtrip latency especially for

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small sized packets. TCP/IP was originally designed and is usually implemented for wide area networks (WAN). While TCP/IP can be used on a LAN it is not optimized for this domain . In IPv6 there are certain fields in the header such as Flow label and Hop limit which are only relevant in a WAN. Moreover the IPv6 header has certain information such as the Interface Identifier, payload length and the IP version that are redundant as they are present in layer-2 as well. It is possible to significantly increase communication performance for IPv6 packet transmission over Ethernet LAN by handling these functionalities efficiently[6].

V. IPV6 HEADER

The customized IPv6 header is constructed by exploiting some of the enhanced features of IPv6 such as address auto-configuration, the redundancy found between layer-2 and layer-3 functionalities and fields in the IPv6 header that are irrelevant for local traffic in a LAN. The methodology described here limits its focus to an Ethernet LAN. Fig. 3 and Fig. 4 show the typical Ethernet frame header and the standard IPv6 packet header[7]. The shaded portion of the header denotes those fields that is redundantly present for local area communication.

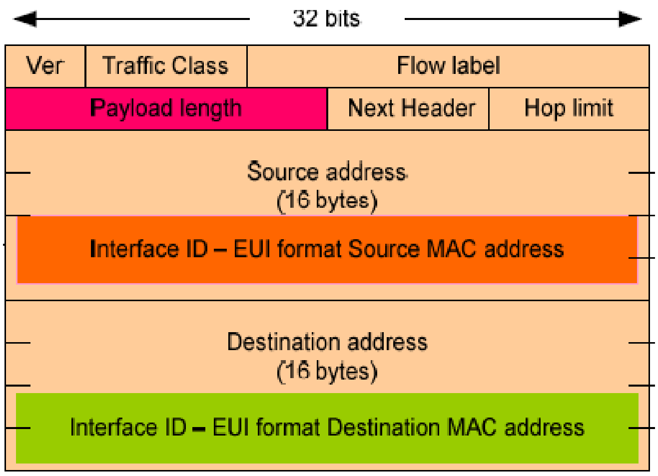

Figure 2 IPv6 Datagram header

VI. IPCV4 VS IPV6

IPv4 and IPv6 have different structures, for example the header format. Some fields header format in IPv4 are no longer available or being replaced in IPv6 header, such as the 6-bit DSCP field and 2-bit ECN field replace the historical 8-bit traffic class field, the 16-bit payload length is not included in IPv6, etc. It aims to increase the speed of forwarding data and reduce the delay[8]. The major difference in layout between the IPv4 and IPv6 packages is that IPv4 has a 20 byte header while IPv6 has a 40 byte header. Even though the IPv6 address space is four times larger than IPv4 but it has reduced the number of required fields and also introduced header connection[9]. The large IPv6 header size will be detrimental to the network transmission efficiency in terms of increased bandwidth utilization, increased latency and reduced throughput. Further the inclusion of IPSec which was optional in IPv4 as a mandatory component for IPv6 adds to the overhead[7].

Table I below highlights 12 key distinctions between IPv4 and IPv6. From that table, address features is the main changes between IPv4 and IPv6. The 128bits addressing space in IPv6 was built to overcome the address space shortage in IPv4 [10].

Features	IPv4	IPv6
Address	32 bits	128 bits
Checksum in header	Included	No checksum
Header includes options	Required	Moved to IPv6 extension headers
Quality of Services (QoS)	Differentiated Services	Use traffic classes & flow labels
Fragmentation	Done by routers & source node	Only by the source node
IP configuration	Manually or DHCP	Auto-configuration or DHCP
IPSec support	Optional	Required
Unicast, multicast and broadcast	Use all	Uses unicast, multicast and anycast
Address Resolution Protocol (ARP)	Use to resolve an IPv4 address	replaced by Neighbor Discovery
Internet Group Management Protocol (IGMP)	Use to manage local subnet group	Replaced with Multicast Listener Discovery (MLD)
Domain Name System (DNS)	Use host address (A) resource records	Use host address (AAAA) resource Record
Mobility	Use Mobile IPv4 (MIPv4)	MIPv6 with faster handover, routing and hierarchical mobility

Table 1 highlights 12 key distinctions between IPv4 and IPv6

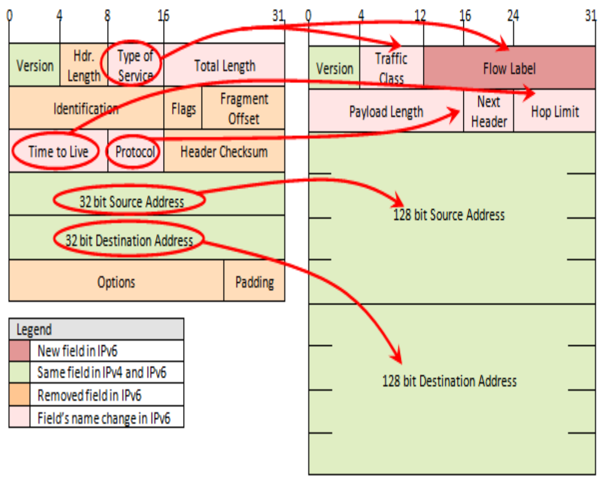

Figure 3 shows changes and relationship between IPv4 and IPv6 header.

VII. Simulation Methodology

Network is simulated using OPNET® Modeler. OPNET® is extensive and powerful simulation software tool with wide variety of capabilities. It enables the possibility to simulate entire heterogeneous networks with various protocols [11]. The simulated network designed with http server provide http service to 12 clients, DB server provide DB service to 12 clients, Video server provide Video conference service to 12 clients and Voice server provide IP telephone service to 12 clients , as shown in the Fig 4.

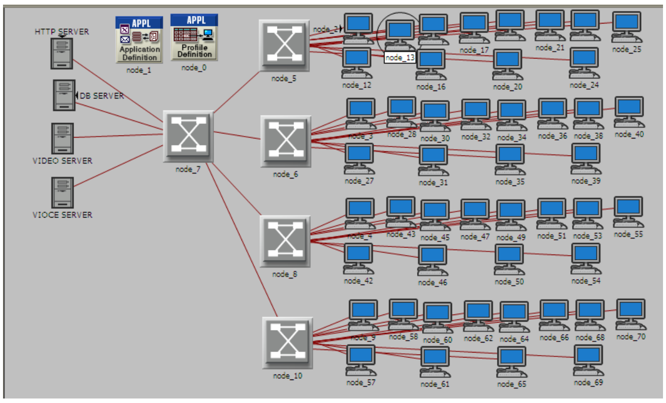

Fig 4 the network diagram

VIII. Scenarios

Two scenarios are proposed in this paper, the initial scenario used IP address version 4 and The second scenario used IP address version 4.

IX. Results

Because some fields header format in IPv4 are no longer available or being replaced in IPv6 header as shown in figures 5,6,7,8,9. The applications when it used IPv4 the delay is larger than when it used IPv6, that mean the changes in the IPv6 header fields comparing with IPv4 header fields increased the speed of forwarding data and reduced the delay.

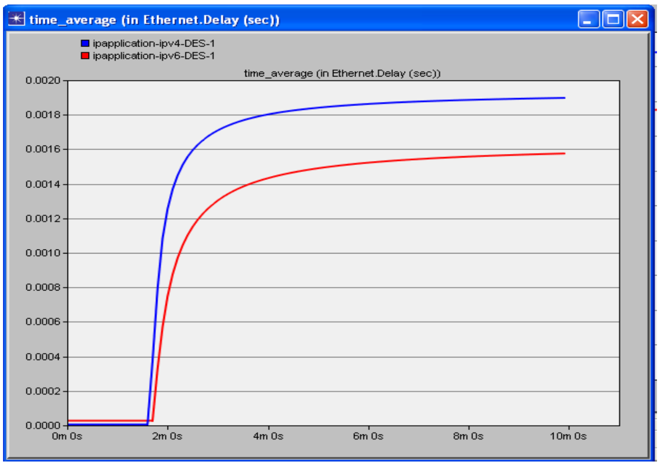

Fig 5 shows LAN Ethernet Delay

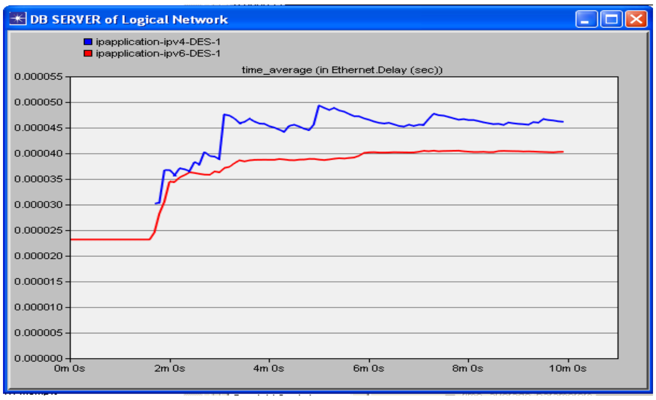

Fig 6 shows DB server Ethernet Delay

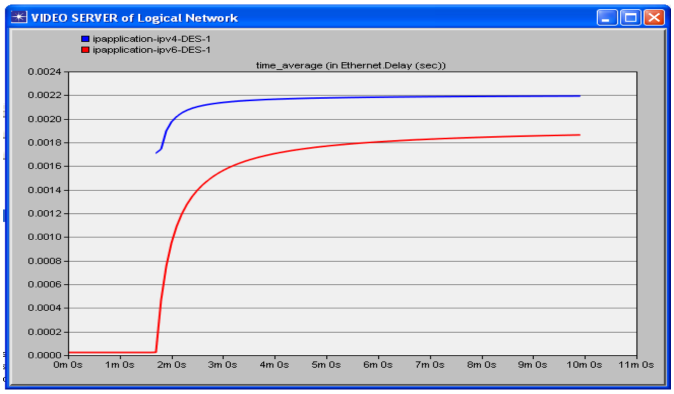

Fig 7 shows Video Conference server Ethernet Delay

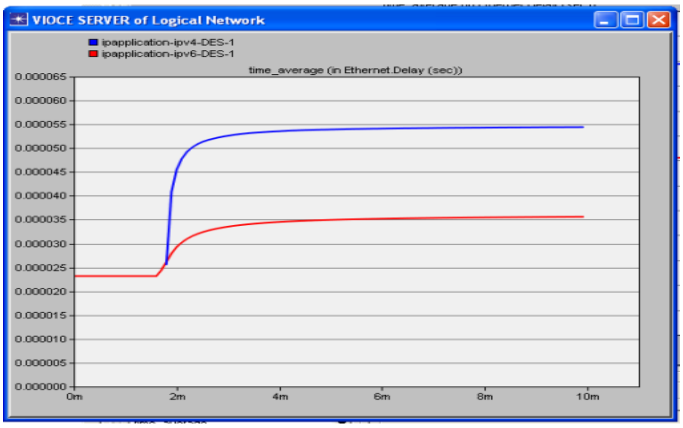

Fig 8 shows Voice server Ethernet Delay

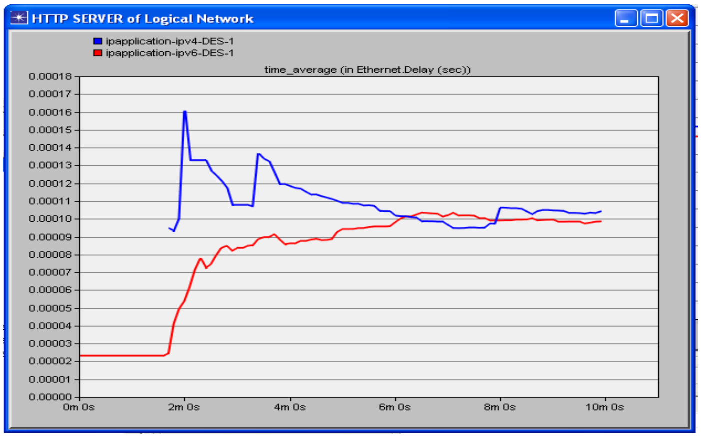

Fig 9 shows http server Ethernet Delay

The large IPv6 header size increased the load over http server , DB server Video Conference server, Voice server and over the all network as shown in figures 10,11,12,13. That mean when IPv6 is used the bandwidth and the network devices have to be upgraded .

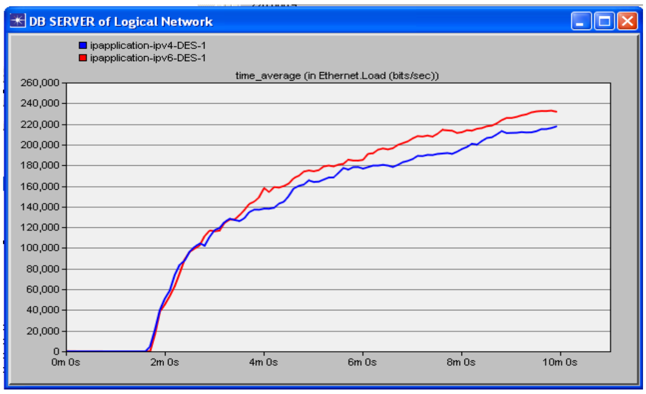

Fig 10 shows DB server Load

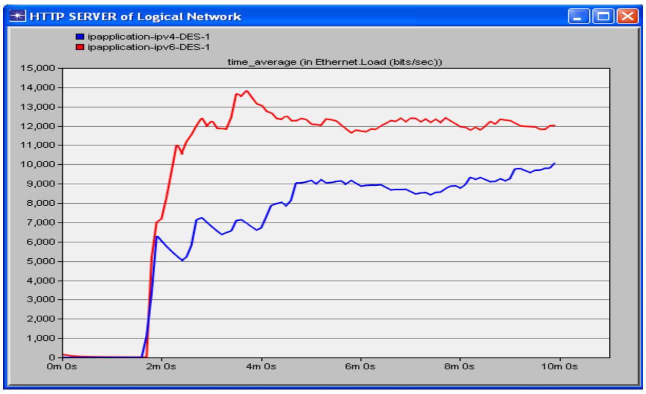

Fig 11 shows http server Load

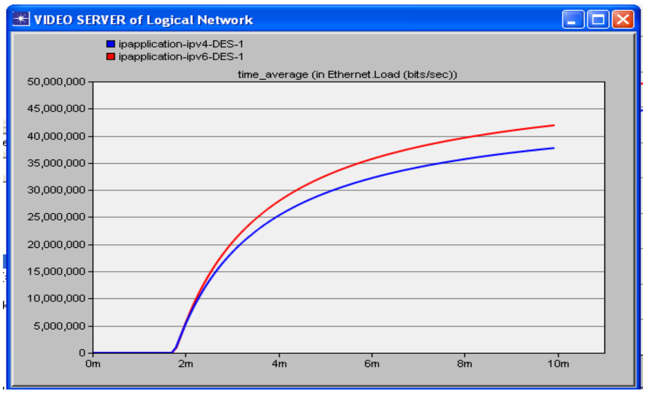

Fig 12 shows Video server Load

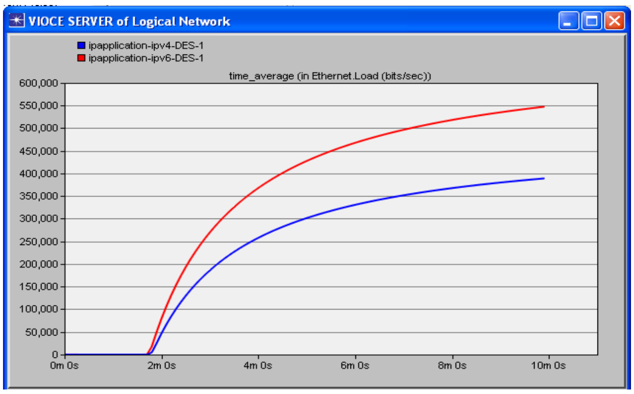

Fig 13 shows Voice server Load

X. Conclusion

- When the network used IPv6 as addressing protocol there have to be more IP addresses rather than it used IPv4 .
- The delay over the network severs when it used IPv6 less than IPv4.
- On the other hand the network load increased when the network used IPv6 rather than IPv4.

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