Internet Protocol Version 6 over Multiprotocol Label Switching

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Abstract: ***This paper presents a study of performance of voice and FTP traffic based on simulative and analytical methods in IPv4/IPv6 over Multiprotocol Label Switching (MPLS) networks. The research aims to find out what Internet protocol performs better in MPLS networks. Will analyze a series of IPv6 and IPv4 over the MPLS backbone using a simulation tool (OPNET) and will evaluate and compare their performances. The analysis will include comparing the traffic sent and traffic receives, FTP upload response time, FTP download response time and voice delay variations. The simulation is set up and configured to obtain results based on OPNET simulator. The experiment includes two scenarios: the first scenario is IPv4 over MPLS and the second scenario is IPv6 over MPLS.***

Keywords: IPv4, IPv6, MPLS, OPNET

1. Introduction

The current version of Internet Protocol, IPv4 is widely used. It is easy to implement, robust, and supports a wide range of applications. However, the growth of the Internet and address-hungry Internet services and applications has depleted the IPv4 addresses. As more devices require connectivity to the Internet, IPv4 addresses will not be able to address this increased demand. IPv6 is the next-generation Internet Protocol that offers more IP addresses and overcomes the address exhaustion of IPv4. For latecomers to the Internet explosion, IPv6 is their only solution. Therefore, IPv6 is expected to be widely used. The transition between IPv4 and IPv6 will be a long process because the two protocols are not backward compatible [1].

Multiprotocol Label Switching (MPLS) is a high performance technology that enables a much faster „switching" of packets making up a data stream. Main MPLS processing and sorting of packets takes place only once – at the beginning of a connection. MPLS has turned out to be the most efficient technology for efficiently managing and operating IP networks. Common areas of application of the protocol could include:

- Switching of connections for real time data streams (such as video, multimedia or Voice over IP [VoIP])
- Creation of virtual private networks (VPNs). [3]

All packets are labelled before being forwarded and consequently, at down-stream routers, analysis of the packet"s network layer header is not required [2]. In this paper, we have analyzed the performance of two virtual core network environments:

a. MPLS over core IPv4 network.
b. MPLS over core IPv6 network.

This paper is organized as follows: section 2 presents basic concept of MPLS. In Section 3 gives the details of simulation environment. Section 4 discusses the results obtained gives the analysis of results. Finally, conclusion is given in Section 5.

2. Basic Concept of MPLS

1. Forwarding equivalence class (FEC): As forwarding technology based on classification, MPLS groups packet to be forwarding in the same manner into a class called the forwarding equivalence class (FCE) , where packets of the same FEC are handed and treated in the same way. The classification of FECs is very flexible. It can be based on any combination of source address, destination address, source port, destination port, protocol type and VPN. For example, in the traditional IP forwarding using longest match, all packets to the same destination belongs to the same FEC.
2. Label: A label is a short fixed length identifying a FEC.A FEC may correspond to multiple labels in scenarios. Label is carried in the header of a packet, it is local significant, does not contain any topology information and consist of four octets or 32 bits in length.
3. Label switching routers (LSRs): is high-speed router device in the core of an MPLS network that participates the establishment of LSPs using the appropriate label signaling protocol and high-speed switching of the data traffic based on the established paths.
4. Labe edge routers (LERs): is a device that operates at the edge of the access network and MPLS network. The LER plays a very important role in the assignment and removal of labels when traffic enters or exits an MPLS network. LERs support multiple ports connected to dissimilar network (such as frame relay, ATM and Ethernet) and forwards this traffic on the MPLs network after establishing LSPs, using the label signaling protocol the ingress and distributing the traffic back to the access network at the egress.
5. Label switching path (LSP): A collection devices represent an MPLS domain, within this domain a path is set up for a given packet to travel based on an FEC. The LSP setup for an FEC is unidirectional in nature that means, the return traffic must take another LSP.
6. Label distribution protocol (LDP): Label distribution protocol (LD) means the protocol used by MPLS for control. It has the same function as a signaling protocol on a traditional network. It classifies FECs, established between LDP peers in the MPLS network.

3. Simulation Environment

OPNET simulator was used to compare MPLS over core IPV4 network with MPLS over core IPV6 network. OPNET is a real-time simulator designed mainly for the design and analysis of network models. The network topology used to carry out this research consists of 6 routers, out of these 6 routers 2 routers are LER and 4 routers are LSR. Besides these routers two applications have been simulated over these networks namely voice and ftp. One server is used for FTP. The links used for connection are PPP_DS1 links. MPLS has been implemented over the network. In addition to all this background traffic is running in the network. Figure 1 below shows the IPv4 over MPLS network for this research and the same network is used for IPv6 over MPLS simulation as shown in Figure 1. In order to be able to control flows of traffic, label-switching paths (LSPs) had to be installed. static LSPs were established, in order to have a more precise control over the path a flow was to use. Flow specifications governed by the ingress router (PE_1) for traffics injected into the network were also specified. Four FECs are configured each for voice, and ftp applications, also traffic trunks are configured for each running applications.

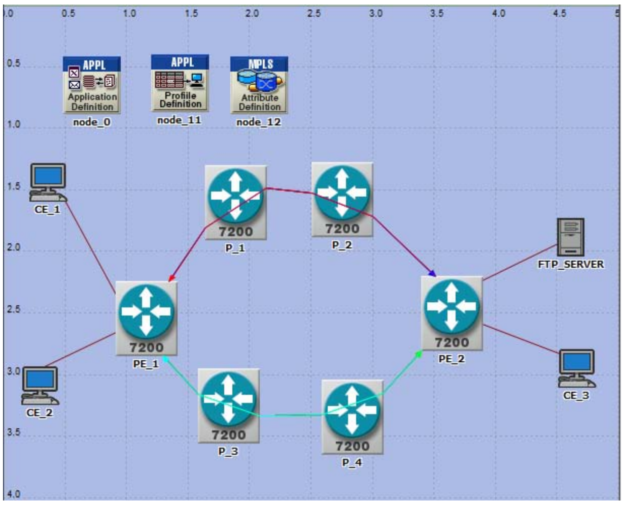

Figure 1: IPv4 and IPv6 over MPLS Network

4. SIMULATION RESULTS

1. FTP traffic sent

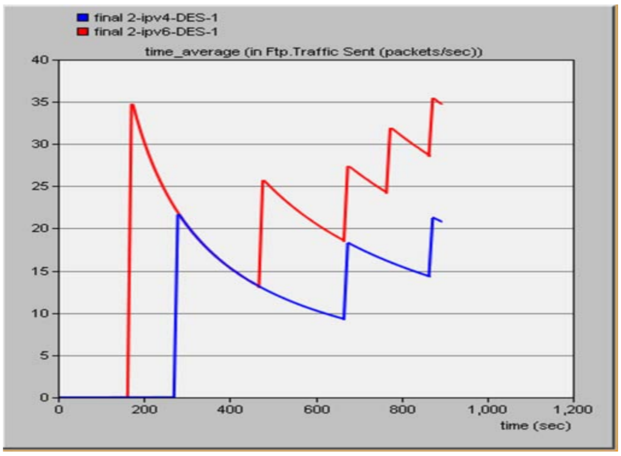

Figure 2: FTP traffic sent for IPv4 and IPv6 over MPLS

From Figure 2, it can be seen that the traffic sent for IPv4 and IPv6 over MPLS network. The traffic sent for the IPv4 over MPLS network is 21 packets at the time of simulation is 270 sec. It can also be seen that the traffic sent for the IPv6 over MPLS network increases to 34.7 packets at the time of simulation is 162 second.

2. FTP traffic received

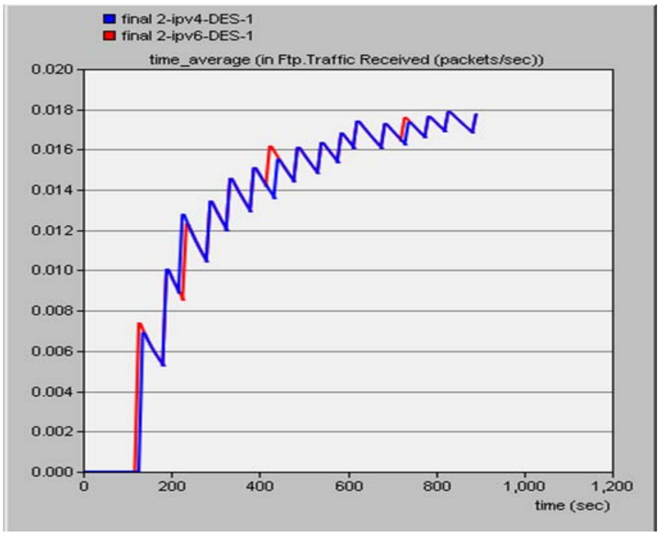

Figure 3: FTP traffic received for IPv4 and IPv6 over MPLS

From Figure 3, it can be seen that the traffic received for IPv4 and IPv6 over MPLS network. The traffic received for the IPv4 over MPLS network is 0.0067 packets at the time of simulation is 126 sec. It can also be seen that the traffic received for the IPv6 over MPLS network is 0.0074 packets at the time of simulation is 177 second.

3. FTP Download response time

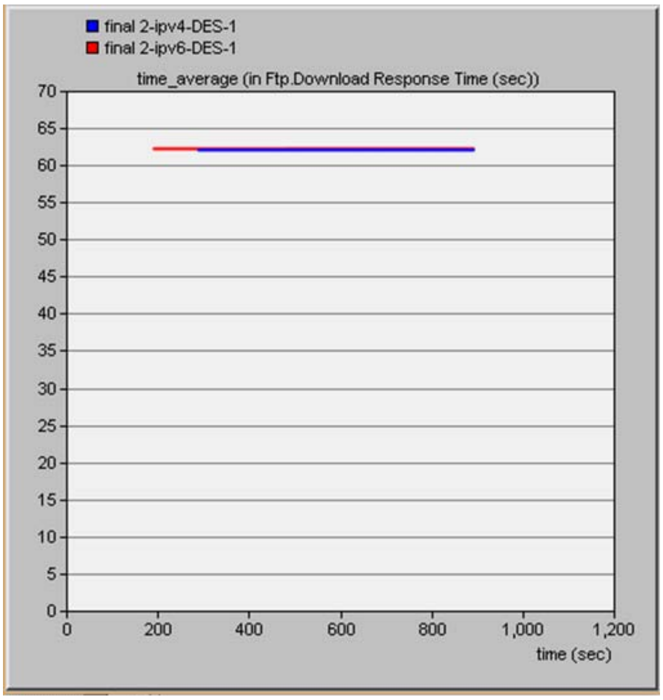

Figure 4: FTP Download response time for IPv4 and IPv6 over MPLS

From Figure 3, it can be seen that the FTP download response time for IPv6 over MPLS network was 62.195107 sec at the time of simulation is 189 sec. It can also be seen that the FTP download response time for the IPv4 over MPLS network was 62.030136 sec at the time simulation was 288 sec.

4. FTP upload response time

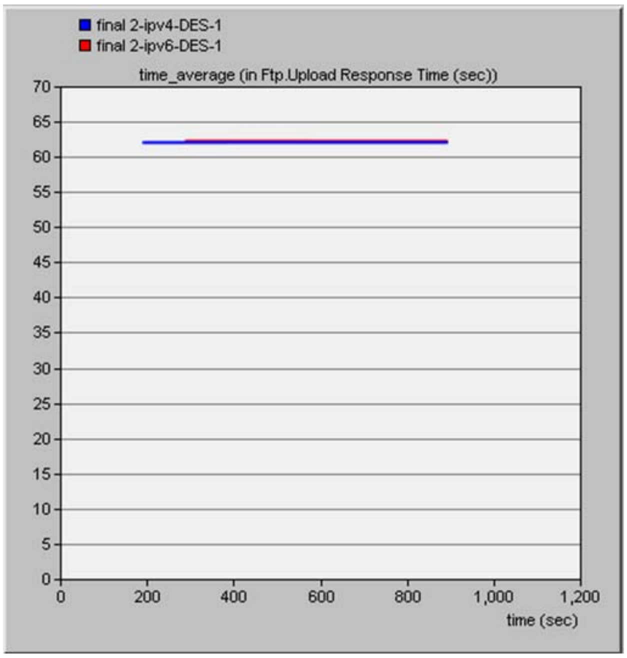

Figure 5: FTP upload response time for IPv4 and IPv6 over MPLS

From Figure 5, it can be seen that the FTP upload response time for IPv4 and IPv6 over MPLS network was 62 second at the time of simulation is 288 sec. It can also be seen that the FTP upload response time for the IPv4 over MPLS network was 62.030136 second at the time simulation was 198 sec.

5. Voice Traffic Sent

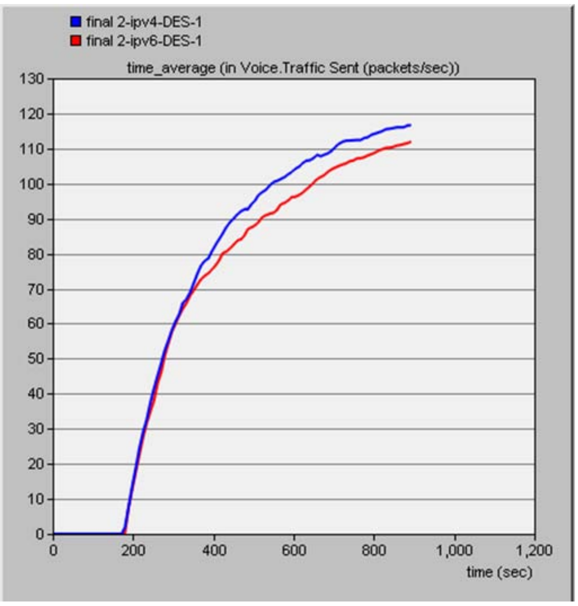

Figure 6: voice traffic sent for IPv4 and IPv6 over MPLS

From Figure 6, it can be seen that the voice traffic sent for IPv6 over MPLS network was 111.8 packets at the time of simulation is 891 sec. It can also be seen that the voice traffic sent for the IPv4 over MPLS network was 116 packets at the time simulation was 891 sec.

6. Voice Traffic Received

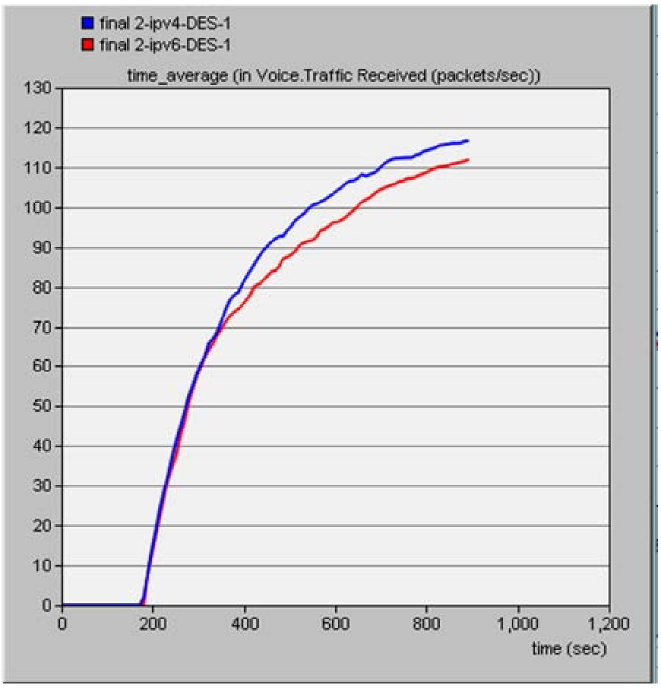

Figure 7: voice traffic received for IPv4 and IPv6 over MPLS

From Figure 7, it can be seen that the voice traffic received for IPv6 over MPLS network was 111.8 packets at the time of simulation is 891 sec. It can also be seen that the voice traffic received for the IPv4 over MPLS network was 116 packets at the time simulation was 891 sec.

7. Voice Packets Delay Variation

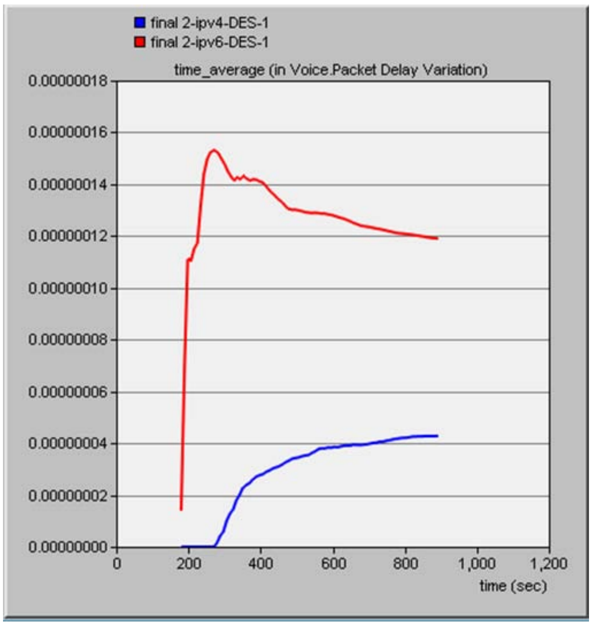

Figure 8: voice packets Delay variation for IPv4 and IPv6 over MPLS.

From Figure 8, it can be seen that the voice packets Delay variation for IPv6 over MPLS network was 0.000000018 at the time of simulation is 180 sec. goes on increasing until it was 0.0000001190 at the time of simulation is 891 sec. It can also be seen that the voice packets Delay variation for the IPv4 over MPLS network was 0.0000000 at the time of simulation is 180 sec. goes on increasing until it was 0.000000427 at the time of simulation is 891 sec.

5. Conclusion

This paper evaluated the performance of IPV4 and IPV6 over MPLS. The simulation results show that the IPv6 over MPLS network has higher upload response time and download response time than IPv4 over MPLS network. It was also observed that the delay variation in case of IPv6 over MPLS network is higher than that of IPv4 over MPLS network. Finally, the simulation results show's that the IPv6 over MPLS network performs better than IPv4 over MPLS network in terms of upload response time and download response while the IPv4 over MPLS has slightly lesser delay variation than IPv6 over MPLS.

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