International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 03 | Mar 2020 www.irjet.net p-ISSN: 2395-0072

Evaluating the impact of IPv4 to IPv6 tunneling with MPLS on VOIP

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Abstract - *Internet Protocol version 6 [IPv6] is replacing Internet Protocol version 4 [IPv4] due to the ever-increasing needs of the internet and the shortcomings of the latter. Tunneling is an effective mechanism that will facilitate the transition from IPv4 to IPv6 and ensure connectivity between the migrated and migrating networks. The last few years have been a witness to the rapid deployment of real-time applications on the internet that focus on Quality of Service (QoS). Multi-Protocol Label Switching (MPLS) plays a key role in networks dealing with realtime traffic, thus ensuring QoS for users which in turn provides better performance than the traditional IP.*

***Key Words*: IPv4, IPv6, Tunneling, MPLS, VOIP.**

1. INTRODUCTION

Every end device and node within a network needs an IP(internet protocol) address to ensure communication within the network. Internet Protocol version 4 i.e. IPv4 has been the backbone of the internet since the last few decades. But as the number of users increased, the demand for IP addresses increased. IPv4 addresses were facing a severe threat of getting exhausted. The number of Addresses currently provided by IP version 4 is too limited to handle the new demand of IP addresses. There are some techniques developed to handle this address space problem, they are Network Address Translation (NAT), Variable Length Subnet Mask (VLSM), Classless Interdomain Routing (CIDR), port address translation (PAT) and so on. But these all technology are not able to save the IP address shortage's problem. This led to the introduction of the new version of Internet Protocol (IPv6). 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. While most of the networks have transitioned and now operate on IPv6, there are still many networks around the globe that are in the state of transition.

However, there exist some networks that prefer operating still on IPv4 due to convenience or owing to some constraints. So, in a global scenario, there are networks that are working on either IPv6 or IPv4. To ensure compatibility and connectivity between two networks operating on different Internet Protocol versions, different transition mechanisms exist. Tunneling, Dual-Stack, and 6-to-4 translation are considered to be the preferred transition mechanisms. As per requirement, the users can select the most favorable transition mechanism. As the internet is rapidly advancing, it led to the development of many real-time applications worldwide. A few years back, the only kind of data that existed on the network was elastic traffic i.e. emails and file transfers. However, in recent times inelastic traffic i.e. video, voice has become popular. These inelastic traffic demand certain performance standards, which if not met turns the application futile. Multiprotocol label switching [MPLS] is the next generation protocol that employs label switching mechanisms to support the inelastic traffic exchanged within the network, which guarantees the performance standards required by the real-time applications.

2. LITERATURE SURVEY

Internet Protocol Version 6 i.e. IPv6 is the latest version of Internet Protocol developed for satisfying the ever-changing needs of Internet users. A Lot of focus has shifted over IPv6 due to its advantageous factors such as large address space, scalability, security features, multimedia transmission, and mobility. Organizations around the globe have been primarily operating on IPv4 for years before the introduction of IPv6. The major part of network infrastructure is available on IPv4 and it is relatively impossible to migrate from the current infrastructure to IPv6 in a single day. However, the demand for IP addresses has risen greatly o+9-*9ver the last decade. But the number of addresses provided by IPv4 is not sufficient to meet the demand. IPv6 is the solution to this dilemma. While most of the organizations are already using IPv6 and some are in the state of transition due to the advantages IPv6 offers, there are still some organizations that prefer to operate on IPv4 only due to constraints. These existing IPv4 networks need not be completely opted out, it could co-exist with the IPv6 networks. To ensure interoperability between organizations operating on different Internet Protocol versions, the Transition mechanisms are adopted to ensure compatibility. According to [1], a comparative analysis of three different networks operating on IPv4, IPv6, and 6-to-4 tunneling networks was performed based on the Application layer protocol i.e. Voice Over Internet Protocol (VOIP). VoIP was compared on LAN using the background User Datagram Protocol(UDP). From the analysis, it was observed that the throughput of 6-to-4 tunneling is thrice of that in IPv4 and almost equal with IPv6. The delay provided in IPv6 is least as compared to IPv4 and hence IPv6 performs better than IPv4. Packet end-to-end delay and throughput is stable and well in limits. IPv6 has more packet loss than IPv4 in high congestion and has poor voice quality. IPv4 performs better than IPv6 in low traffic mode. VoIP has better performance

over IPv6 networks than IPv4 networks. The 6-to-4 tunneling performs better than IPv4 networks in throughput, queuing delay tests and the overall end-to-end delay is reduced to a significant level in the heterogeneous network. Jitter and packet endto- end delay proves that IPv6 has better performance than IPv4 enabled networks. Based on the observations, 6-to-4 tunneling provides performance parameters that are almost as good as IPv6. Hence, it provides an alternative and ensures compatibility between IPv4 and IPv6. The deployment of IPv6 will be a gradual process and for the time being IPv4 and IPv6 have to co-exist for a long time. In order, for both IPv4 and IPv6 to co-exist, several transition mechanisms can be used. The three significant transition mechanisms from IPv4 to IPv6 used are Dual-Stack, Tunneling, and Translation. Dual-Stack permits users to operate both IPv6 and IPv4 simultaneously on the same router on separate interfaces. Tunneling encapsulates the IPv6 packet into an IPv4 packet and transfers it securely over the IPv4 network. The topologies for the mechanism have been developed in Packet Tracer 6.2 and their respective performances analyzed. According to [2],ICMP packets of various sizes and durations have been exchanged between the hosts. Some complex Protocol Data Unit has also been exchanged between the hosts. The analysis has been done based on latency, throughput and packet loss. The observations state that all three mechanisms have some advantages as well as disadvantages. The mechanism chosen for the network should be based on different parameters. Based on Latency, throughput and packet loss, the tunneling mechanism is the best choice while Translation is the worst. However, the tunneling method has some security issues. But the comparisons were limited to few application layer services which show Tunneling to be the best option.

In [3], two transition mechanisms, 6-over-4, and IPv6 in IPv4 tunneling relate to the performance of IPv6 were evaluated. Based on the extent of tunneling, there are two tunneling mechanisms i.e. Host-to-Host and Router-to-Router tunneling. Host-to-Host tunneling performs encapsulation at the source host and decapsulation at the destination host. Router-to- Router tunneling performs encapsulation at the router next to the originating host i.e. Edge Router and decapsulation at the Edge Router of the Destination host. The impact of these approaches was evaluated on end-to-end user application performance based on parameters such as throughput, latency, host CPU utilization, TCP connection time, and the number of TCP connections per second that a client can establish with a remote server. According to, [3], The host-to-host encapsulation transition mechanism performs slightly better than the router-to-router tunneling. However, the router-to-router tunneling requires less CPU utilization, whereas host-to-host tunneling has a 66 percent increase in CPU utilization. Since the task of encapsulation/decapsulation is performed by the Routers in the case of Router-to-Router Tunneling, the processor limitation of hosts is overcome.

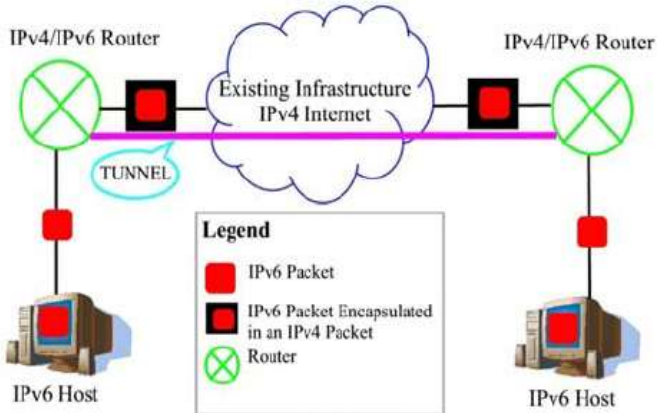

Fig. 1: Router-to-Router Tunneling

As stated in [4], The performance analysis of three transition mechanisms i.e. Dual Stack, Manual Tunnel, 6-to-4 tunnel was performed based on real-time application (Video Conferencing) based on Optimized Network Engineering Tool (OPNET) Modeler in two different Scenarios. Dual Stack includes stacks of IPv4 and IPv6 protocol working simultaneously on the same infrastructure. According to [4], The comparative analysis was performed based on delay, delay variation, and packet loss. Observations obtained from the results indicated that the Dual-stack mechanism performed better than the Tunneling mechanism. Due to the constant Encapsulation and Decapsulation process, the performance of the Tunneling mechanism was reduced when the background traffic was real-time video conferencing data.

In recent times, Organizations across the globe require services for their network which are more reliable, efficient, scalable and with a reduced amount of cost for their Infrastructure. Many real-time applications have been deployed on the Internet over the last few decades. These applications require the network parameters to be within an acceptable range to achieve a better Quality of Service. This has given rise to a new protocol i.e. MPLS. Multi-Protocol Label Switching (MPLS) plays a vital role in these applications by delivering Quality of Service (QoS) which helps in managing the ever-increasing traffic when paths are over/underutilized. Multiprotocol Label Switching (MPLS) is a label switching mechanism that assigns labels to packets and then forwards packets solely based on labels. The performance of MPLS and traditional IP networks were compared based on VOIP traffic. The voice and data traffic exchanged across the networks are analyzed in two simulation scenarios. MPLS performed better than the IP model for voice traffic and had better measurement factors. The dropping of packets in IP mode started earlier as compared to the MPLS model. According to [5], The performance analysis of the two models was based on voice metrics such as voice end-to-end delay, voice jitter, voice packet delay variation, voice packet send and received which helps to calculate the number of calls to help network

managers with implementing such challenging tasks like VOIP deployment over LAN and WAN. MPLS has better performance for voice traffic in terms of jitter, end-to-end delay, packet drops and no. of calls supported with acceptable quality. MPLS model had a better overall performance as compared to the IP model.

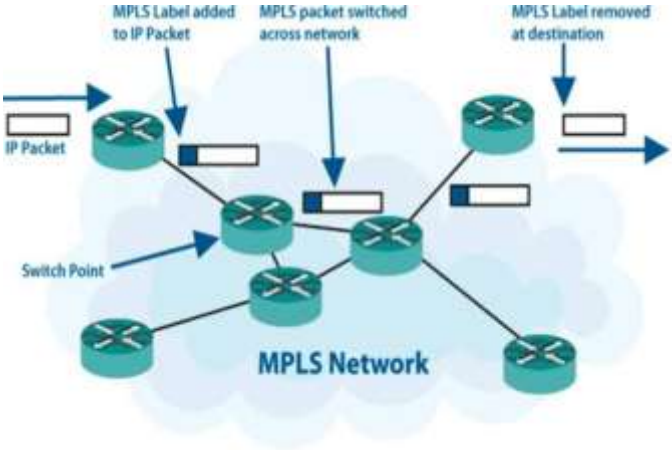

Fig. 2: Multiprotocol label switching

The performance of MPLS is compared over IPv4 and IPv6 using the OPNET simulator in [6]. OSPF and OSPFv3 are used as the routing protocol in IPv4 over MPLS and IPv6 over MPLS respectively. According to [6], FTP, Voice, Video Conferencing and Database are the applications used for the performance analysis of the two networks. IPv6 over MPLS network has high throughput and link utilization than IPv4 over the MPLS network. Also, MPLS keeps more number of packets in the network due to which there is less packet drop. However, the delay is higher in IPv6 over MPLS as compared to IPv4 over MPLS. Due to more delays in IPv6 over MPLS, the jitter is also higher. Hence, the parameters that are vital to the network performance and the application to be used should be considered before selecting between IPv4 over MPLS and IPv6 over MPLS as both have certain advantages as well as disadvantages. MPLS VPN has proved to be extremely reliable in terms of security, quality of service and optimization of performance over the last few years. It provided certain advantages over the IP and MPLS networks. The performance evaluation of MPLS, MPLS VPN, MPLS IPSec VPNs, and IP network was performed using Graphical Network Simulator (GNS3) and VOIP traffic was used as background traffic. The VOIP traffic was analyzed to determine the impact of the mechanisms used on the performance of VOIP. 64 scenarios were used to determine the impact. Also, the IP SLA method was used to generate test traffic between the different network devices used in the simulation. According to [7], the IP network is affected by high latency and a bad MOS score. When there is more traffic exchanged within the network, the MPLS protocol is the faster transfer technique as compared to the IP transmission. MPLS VPN offers similar results as the MPLS technology alone in terms of latency, jitter and MOS score. IPsec in MPLS VPN leads to degradation of performance with the rising traffic. Hence, MPLS has a low loss rate, low latency and acceptable MOS score for VOIP traffic.

3. CONCLUSION

IPv4 has been the IP version that ran the internet for years. As advancements kept taking place and needs increased IPv4 showed a lot of shortcomings. IPv6 is the latest version of the internet protocol. IPv6 offers many advantages over IPv4.To ensure compatibility and interoperability between IPv4 and IPv6 there are three transition mechanisms. Tunneling proves to be the best option of all the mechanisms. Router-to-Router tunneling overcomes the processor limitations of host-to-host tunneling. However, tunneling also has its own set of disadvantages with IP. MPLS is based on label switching. MPLS proves to have better performance than IP in the case of VOIP packets. Hence MPLS overcomes the shortcomings of tunneling with IP. MPLS on an IPv6 network has more delay as compared to MPLS on an IPv4 network. When there is more traffic in the network MPLS technique is faster than the traditional IP. In a scenario where two IPv6 networks need to communicate with each through an existing IPv4 network, the 6-4 tunneling proves to be efficient with MPLS protocol running on the IPv4 network.

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