Global Journal of Computer Science and Technology
Network, Web & Security
Volume 13 Issue 11 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

IPv4 Compared to IPv6 Networks for Recital Analysis in OMNeT++ Environment

By Savita Shiwani & G.N. Purohit
Suresh GyanVihar University, India

Abstract - The broad objective of the research paper is to evaluate and compare the performance of two protocol stacks (IPv4 and IPv6) in OMNeT++ in terms of various parameters that have to be analyzed when the data is being transmitted from one client to another or to a server over a wired network. In this we have designed wired networks on basis of IPv4 and IPv6 protocols in OMNeT++, which is a network simulation platform. Simulation techniques allow us to analyze the behavior of networking protocols depending on available computing power for running the simulation experiment. The network comprises of various components like servers, routers, clients, etc. The purpose of this paper is to assess basic throughput, packet loss, latency, etc.

Keywords : *IPv4, IPv6, OMNeT++, recital, analysis, throughput, packet loss, latency.*

GJCST-E Classification : *C.2.2*

Strictly as per the compliance and regulations of:

IPv4 Compared to IPv6 Networks for Recital Analysis in OMNeT++ Environment

Savita Shiwani [α] & G.N. Purohit [σ]

Abstract - The broad objective of the research paper is to evaluate and compare the performance of two protocol stacks (IPv4 and IPv6) in OMNeT++ in terms of various parameters that have to be analyzed when the data is being transmitted from one client to another or to a server over a wired network. In this we have designed wired networks on basis of IPv4 and IPv6 protocols in OMNeT++, which is a network simulation platform. Simulation techniques allow us to analyze the behavior of networking protocols depending on available computing power for running the simulation experiment. The network comprises of various components like servers, routers, clients, etc. The purpose of this paper is to assess basic throughput, packet loss, latency, etc.

Keywords : IPv4, IPv6, OMNeT++, recital, analysis, throughput, packet loss, latency.

I. Introduction

As the technology advances, and considering the needs of the growing users of Internet each day, Internet Protocol is one of the major concerns. IPv6 is simply the upgraded version of IPv4, and makes all the attempts to overcome the drawback of the previous 4 version of Internet Protocol. Today an end to end pervasive connectivity is the need of hour. At one end revolution of Internet enabled connected devices are required because all devices have to be always connected for proper communication. Keeping this in mind, there are two networks designed, one for each- IPv4 and IPv6. Attempt has been made to bring the easy to understand comparison between both the protocols on the basis of recital analysis of IPv4 and IPv6 in OMNeT++ simulation environment.

II. Network Architecture of IPv4 and IPv6 in OMNeT++

The IPv4 and IPv6 network have been designed in the Network Editor of the OMNeT++ simulation tool. A group of parameters have been taken which illustrate the working features, performance differences between both the protocols. After preparing the respective designs which show the various wired hosts, routers, network configurator, channel controller, channel installer and servers, and various type of connections between them; the relevant .INI file is made and necessary coding is done in the C++ file which have .cc extension.

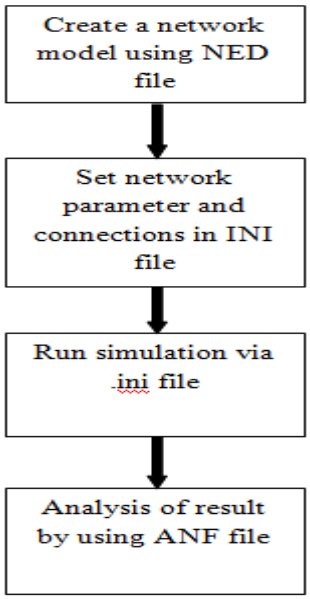


Figure 1 : Flowchart of designing steps in OMNeT++

Modules are then made to run and hence the respective simulation is performed. All the results and comparable issues are enclosed. In order to bring out the basic and foremost differences between the network protocols, both the IPv4 and IPv6, networks are designed. The different aspects in terms of parameters, featured attributes of these protocols are stated.

a) IPv4 Design and Implementation

The designed network contains at least 90 wired hosts which play an important role in bringing out the basic performance of the protocol network. Along with these hosts there is a router which has the responsibility to transfer the different packets to the different hosts aligned in the network. All the management of the protocol is done from the "channel controller" which is also laid in to the network in course of designing. This channel controller needs no connection to be established with any of the devices and it automatically governs its working. Apart from the wired hosts, as mentioned earlier, there is IPv4 Network Configurator. The basic task of this device is to configure the different devices used in the IPv4 network like the v4 wired hosts etc. The parameters of these devices like, data rate, packet size, etc are also set through this Network Configurator.

Author α : Associate Professor, Computer Science Engineering Department, Suresh GyanVihar University, Jaipur, Rajasthan, India.
E-mail : savitashiwani@gmail.com
Author σ : Dean, Apaji Institute of Mathematics & Applied Computer Technology (AIM & ACT) Banasthali Vidyapeeth, 304022 Rajasthan.
E-mail : gn_purohitjaipur@yahoo.co.in

In this network, IPv4 protocol has been used for all routers, server and host by using flat Network Configurator, which assigns IP addresses to the network devices. There is total 30 numbers of hosts comprising a LAN and connected to a server via routers. Data rate channel has been setup between host and router with parameters as delay=0.1ms and data rate=100Mbps and between router and server with the following parameters like delay is set to 10ms and data rate=100Mbps. A ThruputMeter is also connected to routers as it provides through put measurement utility with parameters set as delay=10ms and data rate=100Mbps.

Complete Network description file for IPv4 based lan network is shown in Fig. 3, which describe the whole information about the network and the connections which have been made in the network:

All the wired hosts are entitled to receive the message packet by the communication mechanism. As specified that there are 90 wired hosts assumed in the NED. The module hierarchy of each wired hosts are further described.

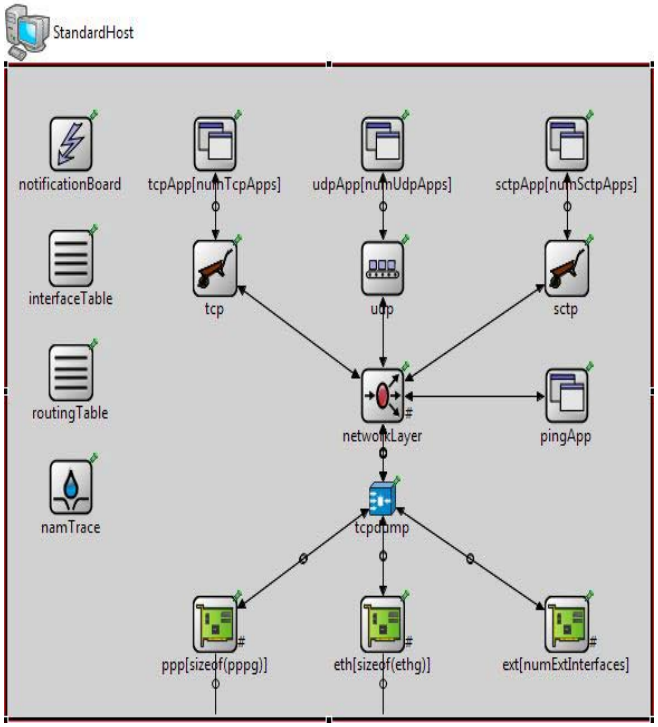


Figure 2 : IPv4 Standard Host Module Hierarchies

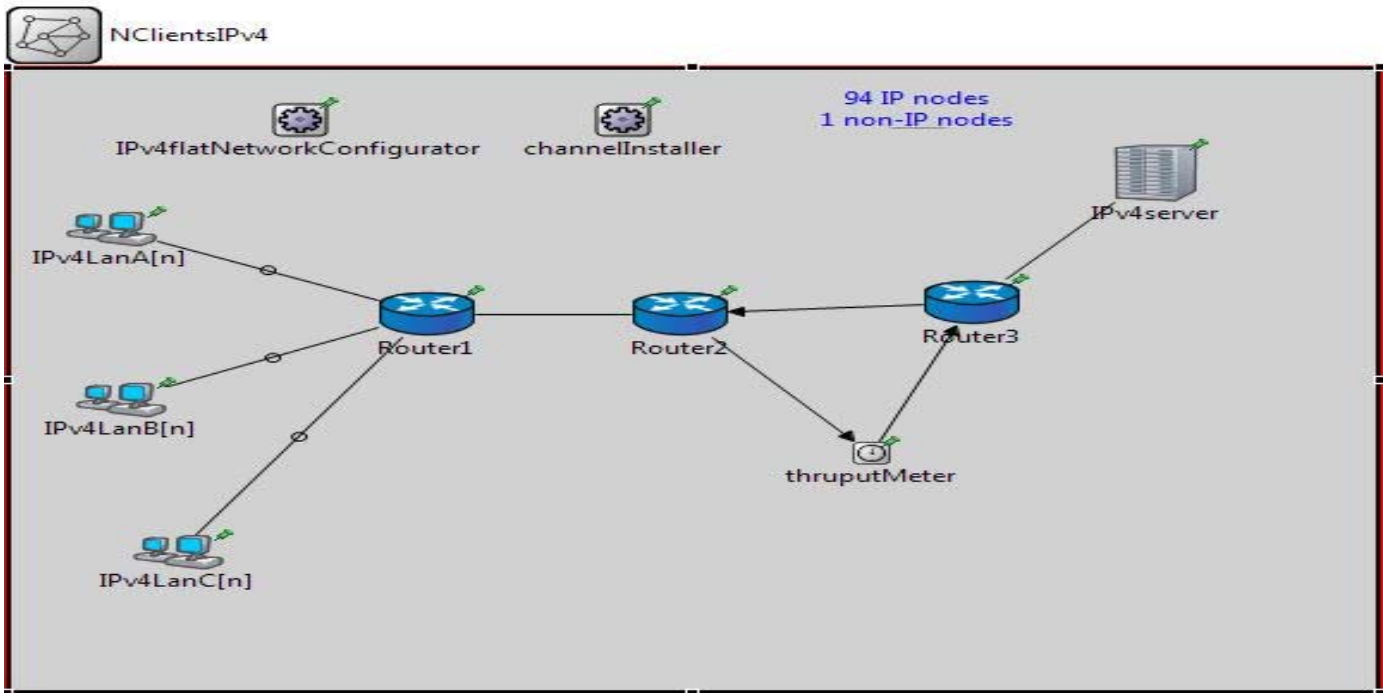


Figure 3 : IPv4 NED File

As illustrated in the Fig. 2 the Standard Host provides all the basic modules for implementing IPv4 protocol at Network Layer.

The programmer is allowed to create a new channel type which is capable to encapsulate all the data rate settings. In order to avoid the litter in global namespace, this type of channel can be defined inside the network itself. So some kind of mechanism is required to control and manage the activities of the channel created within the network. Hence Channel Installer is also placed in the designed network.

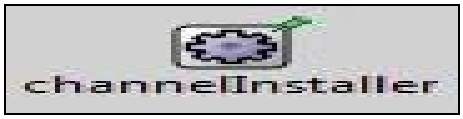


Figure 4 : The channel installer used in the ned

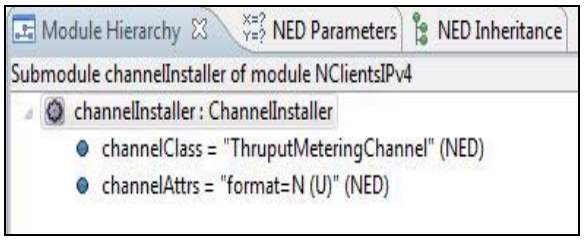


Figure 5 : Illustrating the different parameters held by sub module channel installer

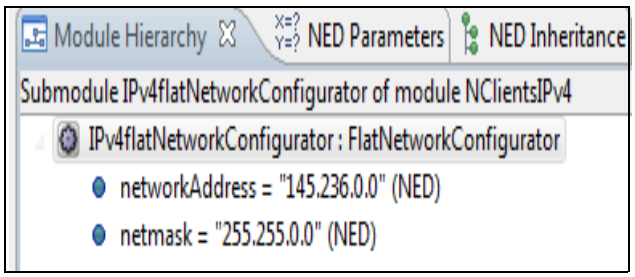


Figure 6 : Illustrating the IPv4 Network Configurator

All the configurations which are set in the designed network related to different hosts and version 4 enabled devices, are under the IPv4 Network Configurator. It provides the different v4 features which are then considered by all the devices in the network.

The next is the INI file which is used to import several packages and configure the coding. The required number of parameters can be added with the help of the INI file. All these were the description of the IPv4 network designed and its working in consideration of all the parameters.

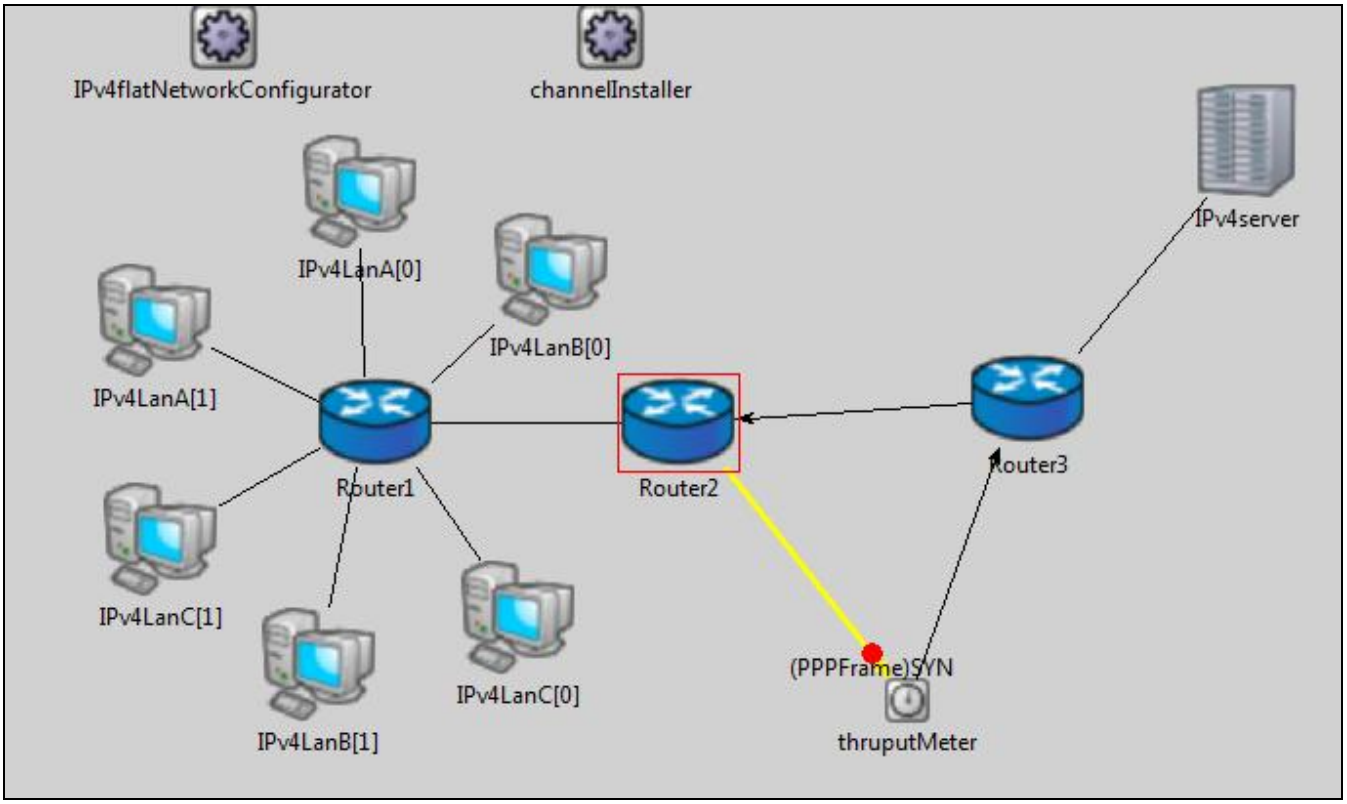


Figure 7 : IPv4 based LAN simulation model

b) IPv6 Design and Implementation

The IPv6 network is also designed using 90 wired hosts. Channel Installer and Network Configurator are similar to the IPv4 network with slight difference in the working and major difference in the performance output. Similarly in this network, IPv6 protocol has been used instead of IPv4 for all routers, server and host by using flatNetworkConfigurator6, which assigns IPv6 addresses to the network devices. There is total 30 numbers of hosts comprising a LAN and connected to a server via routers. Data rate channel has been setup between host and router with parameters as delay=0.1ms and data rate=100Mbps and between router and server with the following parameters like delay is set to 10ms and data rate=100Mbps. A ThruputMeter is also connected to routers as it provides

through put measurement utility with parameters set as delay=10ms and data rate=100Mbps.

Complete Network description file for IPv6 based lan network is shown below, which describe the whole information about the network and the connections which have been made in the network:

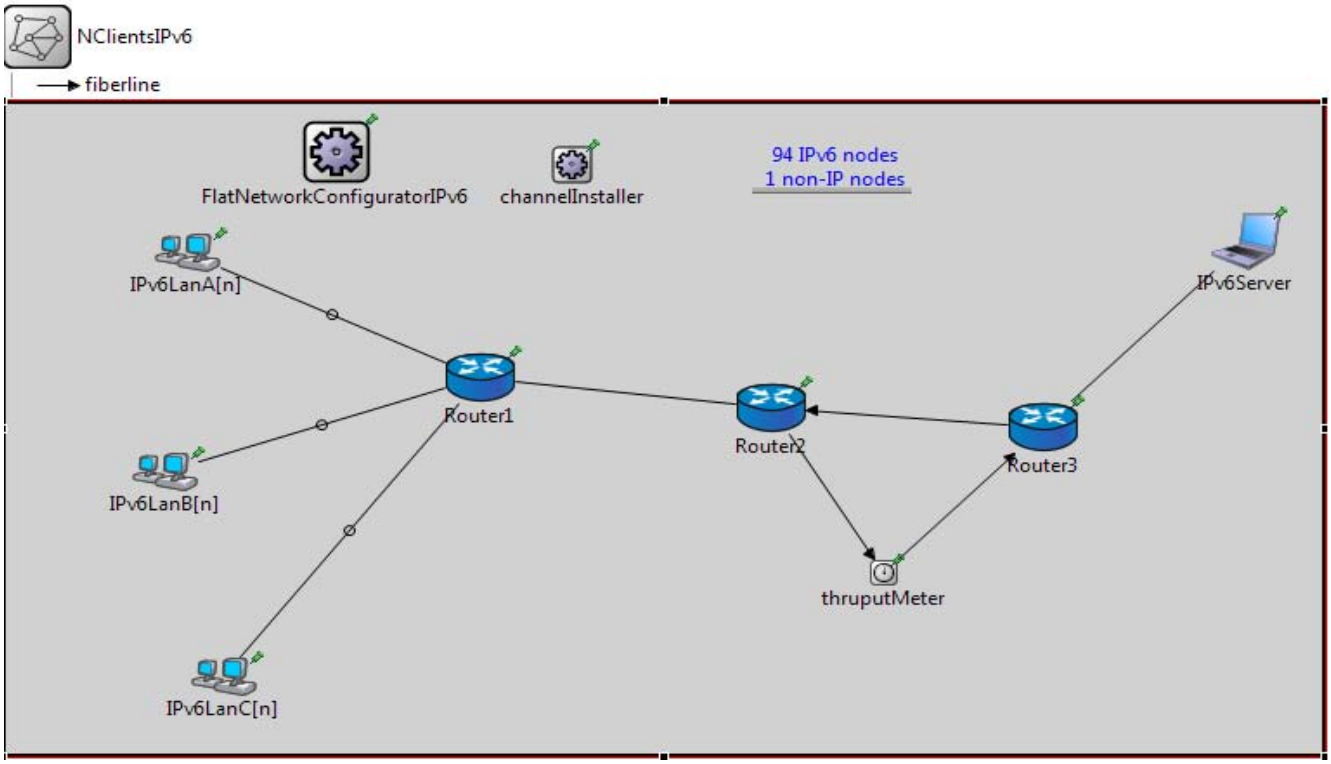


Figure 8 : Proposed Network of IPv6 Protocol

The Fig. 8 illustrates the designed network of the IPv6 Protocol. This design may look a little similar to that of IPv4. But still there are several differences in the structure and the execution flow of both the protocols.

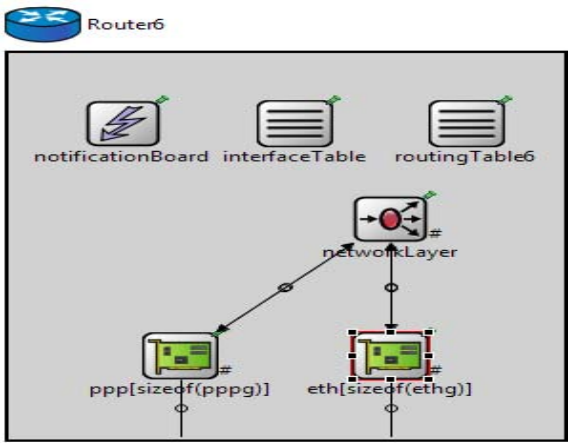


Figure 9 : Illustrating the basic module hierarchy of the routers used in the IPv6 network design

After performing the basic design of both the protocols, they were individually run for different time span and thereby simulated for a couple of hours.

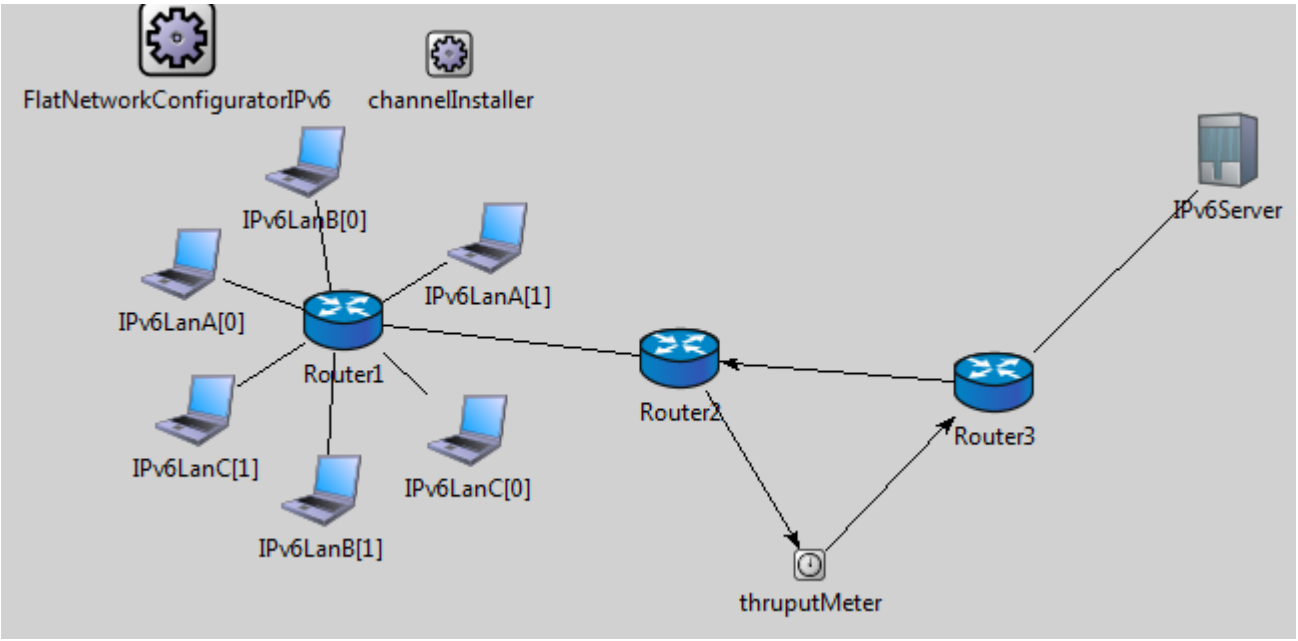


Figure 10 : IPv6 based LAN simulation model

III. IPv4 and IPv6 Simulation Results Under OMNeT++

Both the IPv4 and IPv6 networks are loaded with FTP traffic beginning at 50 bytes up to 100 MB with an inter-request time of 2000 seconds. The performance metrics for both IP networks are then measured and analyzed.

The first step to see the results of the simulation of the network is to build the entire network. Because every time any changes are made in the design or the code then the network is required to be reconfigured every time. As the constructions of the project will register all the functions built into the system tool and necessary updating of the INI files is done so that results obtained are according to the changes. The simulation time can be from few seconds to many hours. More is the simulation time, better are the obtained results, and the simulation time chosen was 6 hours.

Server is providing FTP services to the three LANs: LANA, LANB and LANC. It supports one Ethernet connection at 10 Mbps and 100 Mbps. Client workstations in these LANs are requesting for FTP services from the server. The workstation supports one underlying Ethernet connection at 10 Mbps and 100 Mbps. Packets are routed on the first come first serve basis and speed of client depends on the transmission rate of output interface.

Based on the IPv4 or IPv6 network, Address attribute is set. Subnet Mask in mentioned as given in Fig. given below. Maximum transmission unit (MTU) is set to 4470 bytes. Based on IPv4 and IPv6 networks the value of MTU will vary.

```
network NClientsIPv4
{
   parameters:
      int n;
      @display("bgb=571,432");
   submodules:
      IPv4flatNetworkConfigurator:
FlatNetworkConfigurator {
         parameters:
            networkAddress = "145.236.0.0";
            netmask = "255.255.0.0";
            @display("p=121,35");
      }     ……
```

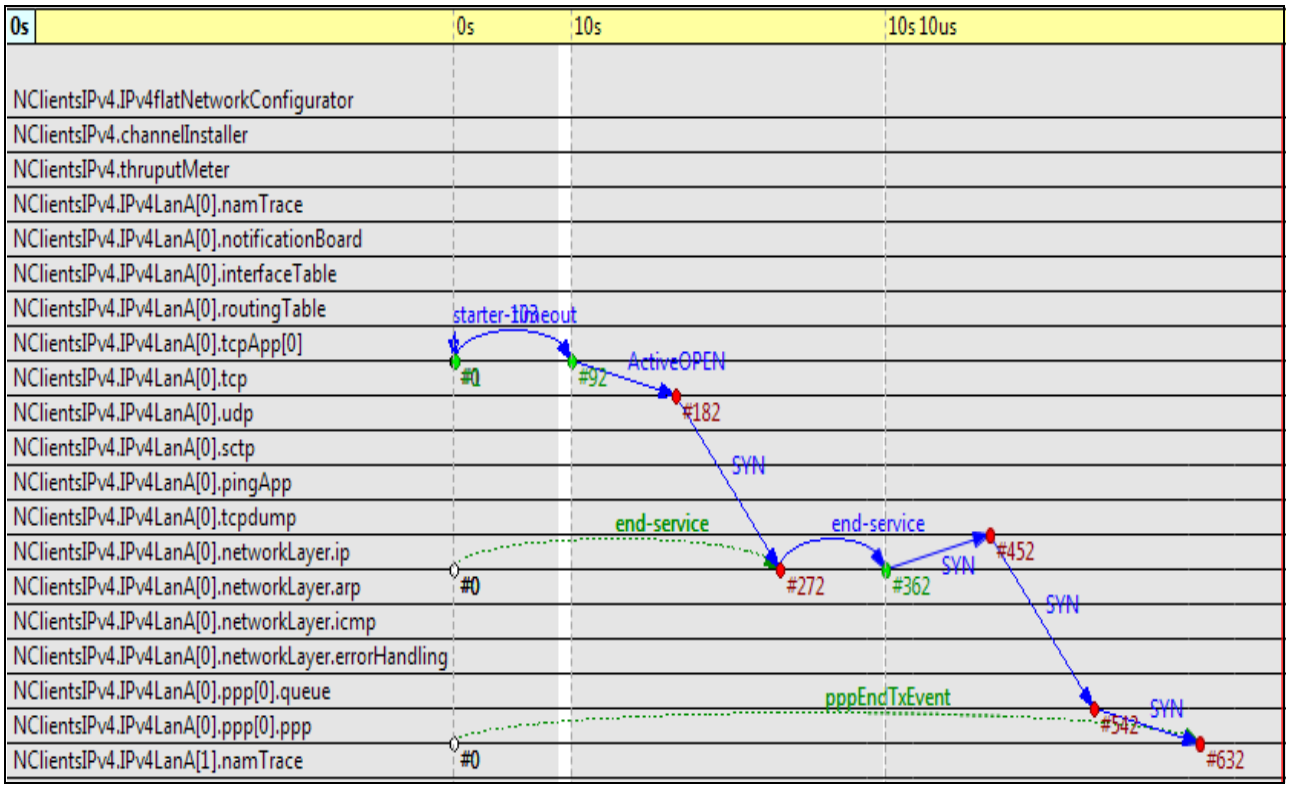
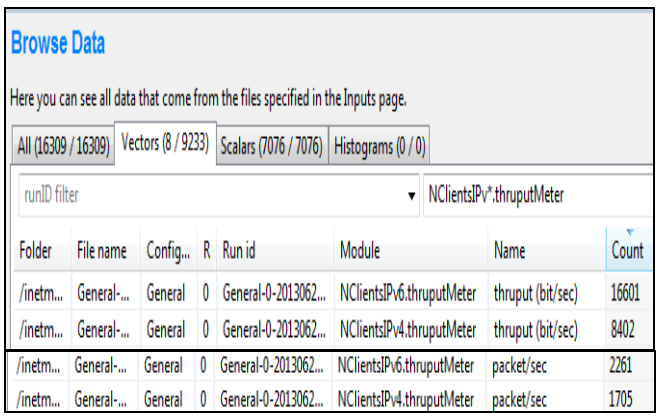


Figure 11 : Illustrating the message transmission in IPv4 network

This .elog file describes the basic functionality of the entire network designed for the simulation. This particular portion of the simulation file explores the flow of message transmission. It explains how the other components are connected, when they receive the events to send the messages and the relevant information.



Folder	File name	Config...	R	Run id	Module	Name	Count
/inetm...	General-...	General	0	General-0-2013062...	NClientsIPv6.thruputMeter	thruput (bit/sec)	16601
/inetm...	General-...	General	0	General-0-2013062...	NClientsIPv4.thruputMeter	thruput (bit/sec)	8402
/inetm...	General-...	General	0	General-0-2013062...	NClientsIPv6.thruputMeter	packet/sec	2261
/inetm...	General-...	General	0	General-0-2013062...	NClientsIPv4.thruputMeter	packet/sec	1705

Figure 12 : Showing thruput values for IPv4 and IPv6 Networks

The total numbers of packets sent per second in IPv4 networks are much less as compared to IPv6, similarly throuput achieved is also much higher in IPv6 as compared to IPv4 as depicted in the simulation data.

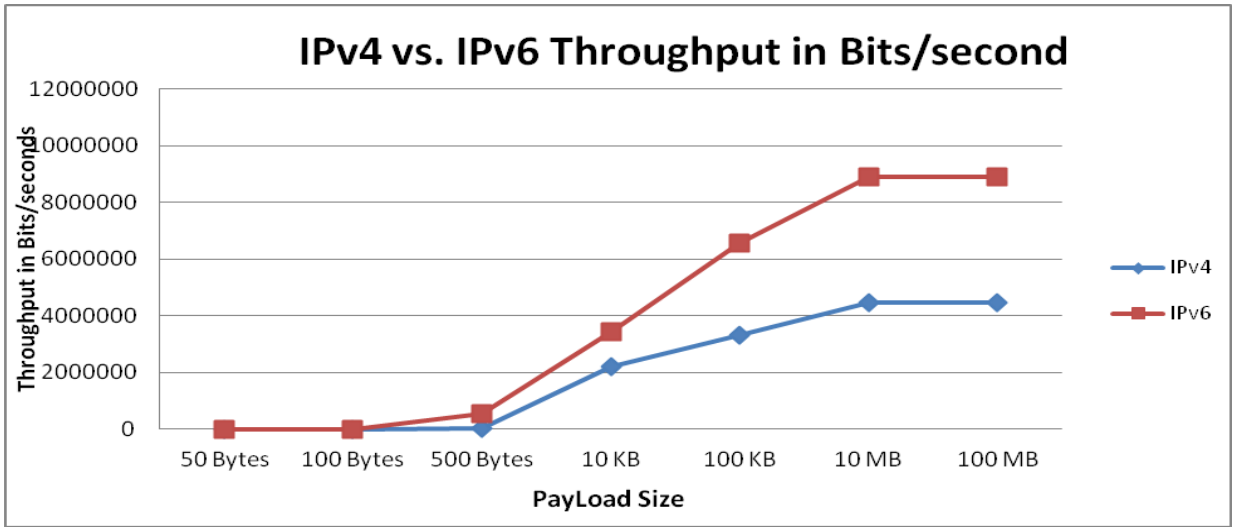


Figure 13 : Throughput in Bits/Second for IPv4 and IPv6 Networks

Fig. 13 shows the two graphs which compares the throughput statistics of IPv4 and IPv6 over both the networks. FTP is the data traffic used for simulating the network. The network is loaded with FTP traffic beginning at 50 bytes up to 100 MB with an inter-request time of 2000 seconds. The difference in throughput of an IPv4 and IPv6 network is small when the FTP traffic is low. As the volume of the FTP data traffic crosses 500 Bytes with an inter-request time of 2000 seconds, throughput of the IPv6 network increases in comparison to the IPv4 network. Any increase in the FTP data traffic from 10 MB per 2000 seconds onward will not affect the throughput of IPv4 and IPv6 network due to the bandwidth limitation of the link. At this point the buffers in the switch are full and additional packets are dropped.

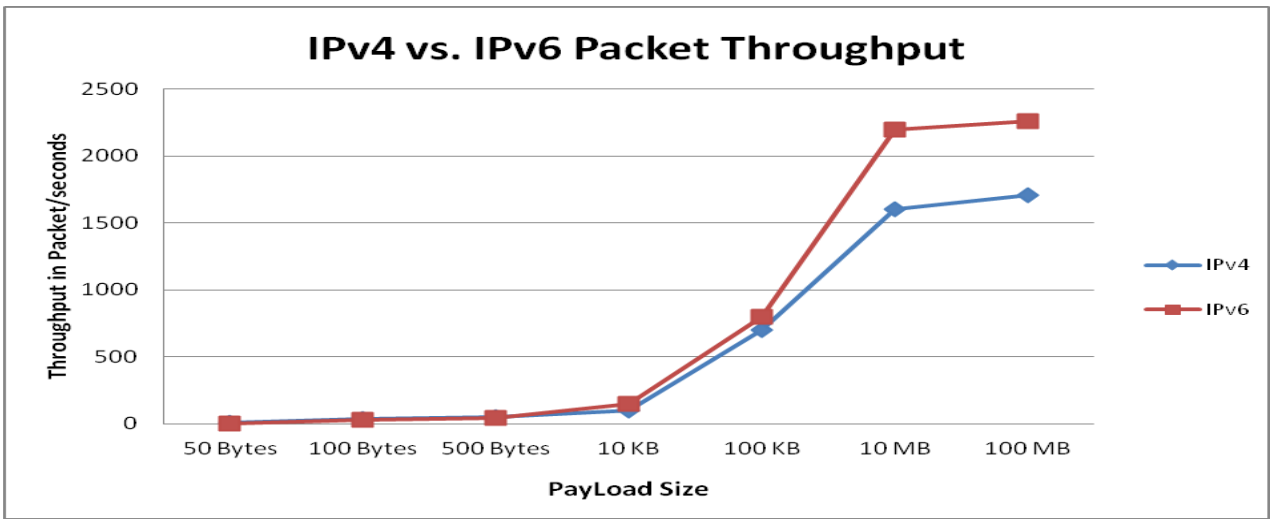


Figure 14 : Throughput in Packet/Second for IPv4 and IPv6 Networks

Fig. 14 gives the simulation results between IPv4 and IPv6 networks in terms of packet throughput. Packet throughput is similar for both the protocols when FTP data is sent between 50bytes through 500 bytes with an inter-request time of 2000 seconds. Again, the difference is very low, but as the FTP traffic crosses 100 KB with an inter-request time of 2000 seconds, IPv6 packet throughput almost doubles in comparison to IPv4 packet throughput after 10 MB payload. The packet throughput remains constant as it reaches the limit of the link bandwidth.

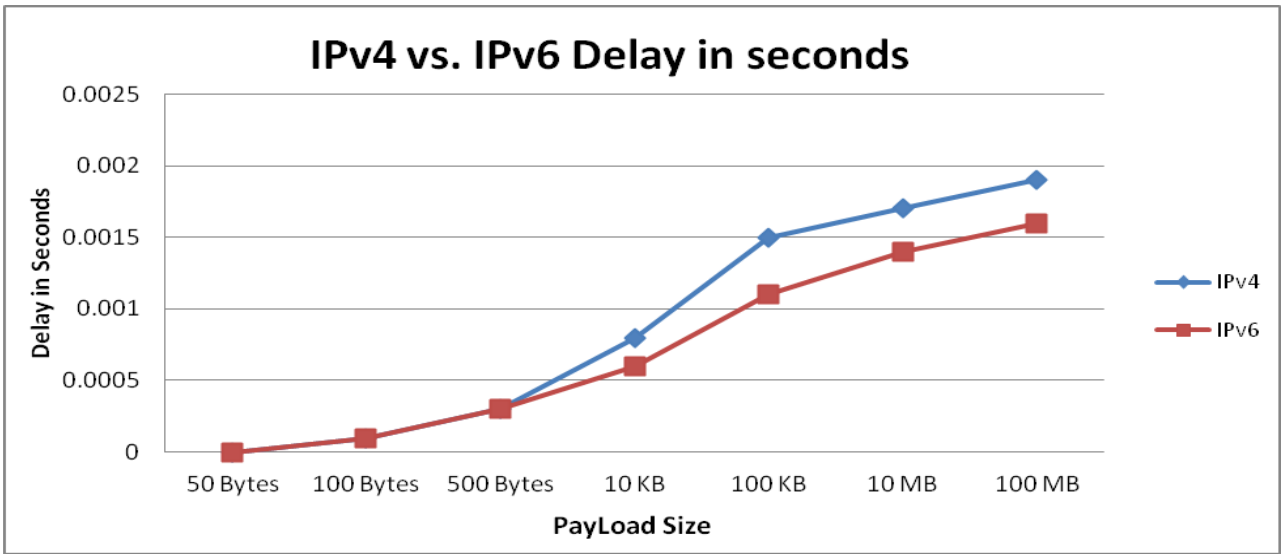


Figure 15 : Delay in IPv4 and IPv6 Networks

Fig. 15 presents IPv4 and IPv6 delay on an Ethernet cable. The graph shows the end-to-end delay of all packets received by all the stations in the network. Increase in the FTP traffic increases the number of packets thereby increasing the delay of the network. Delay is 0.19 ms and 0.16 ms for IPv4 and IPv6 network respectively. When the FTP data volume increases, the number of packets in IPv4 increases, which results in further delay in the IPv4 network. Delay in IPv6 network is lower than IPv4 due to lesser number of packets in the network. Delay on an Ethernet cable of both IPv4 and IPv6 network increases with increase in data.

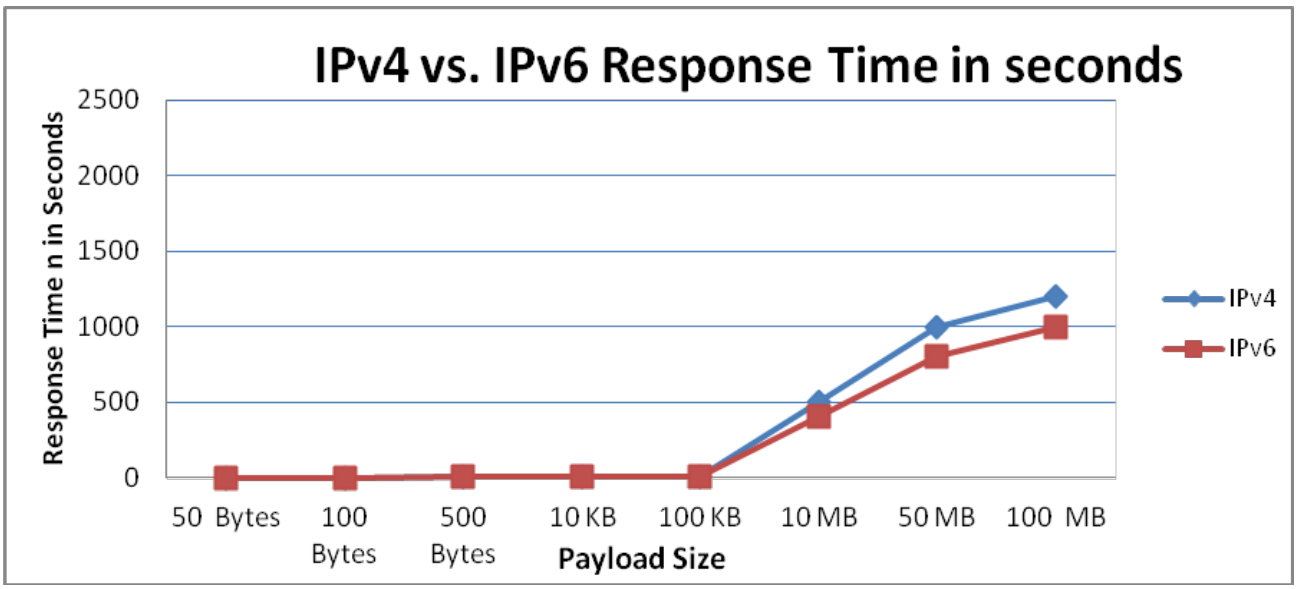


Figure 16 : Response Time in IPv4 and IP6 Networks

Fig. 16 shows the statistics of the IPv4 and IPv6 Response time. The Response time is measured from the time a client application sends a request to the server, to the time it receives a response packet. When the FTP traffic sent is between 50 bytes to 10 KB with an inter-request time of 500 seconds, the response time is low for the both the protocols. However, an increase in data traffic gradually increases the response time for IPv4 network. The difference in response time of an IPv4 and an IPv6 network is small.

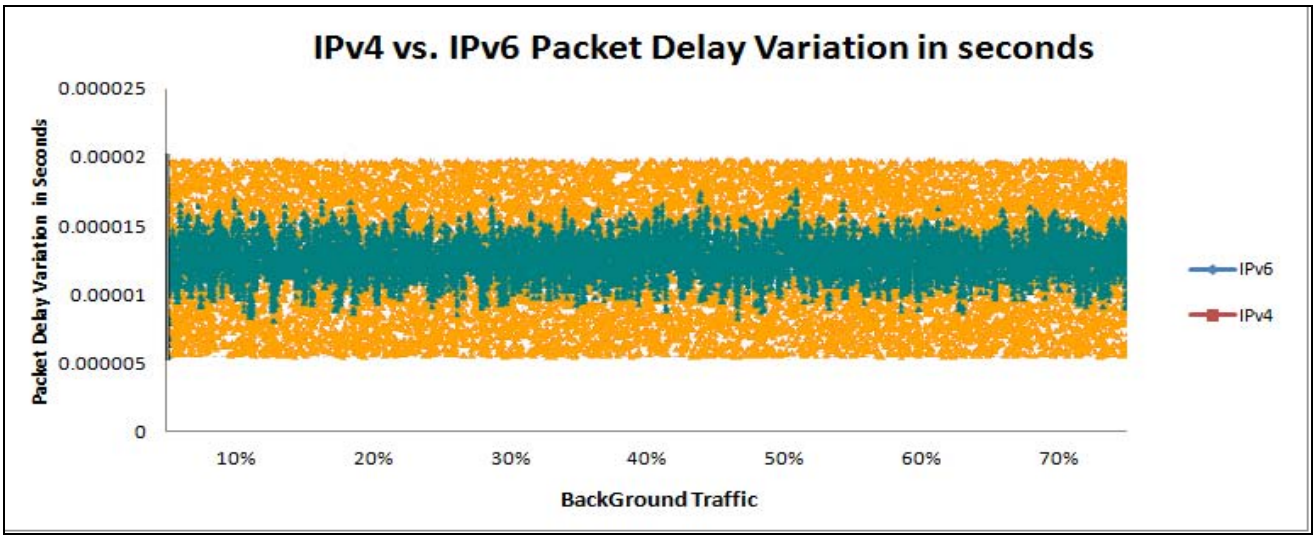


Figure 17 : Packet Delay Variation in Seconds for IPv4 and IPv6 Networks

Here background traffic is varied from 10% to 70% of the link bandwidth. Ipv6 network shows less variation compared to IPv4 network. All the above Figures vividly illustrates the obtained results and the parameters on the basis of which, these values were calculated by the simulation tool.

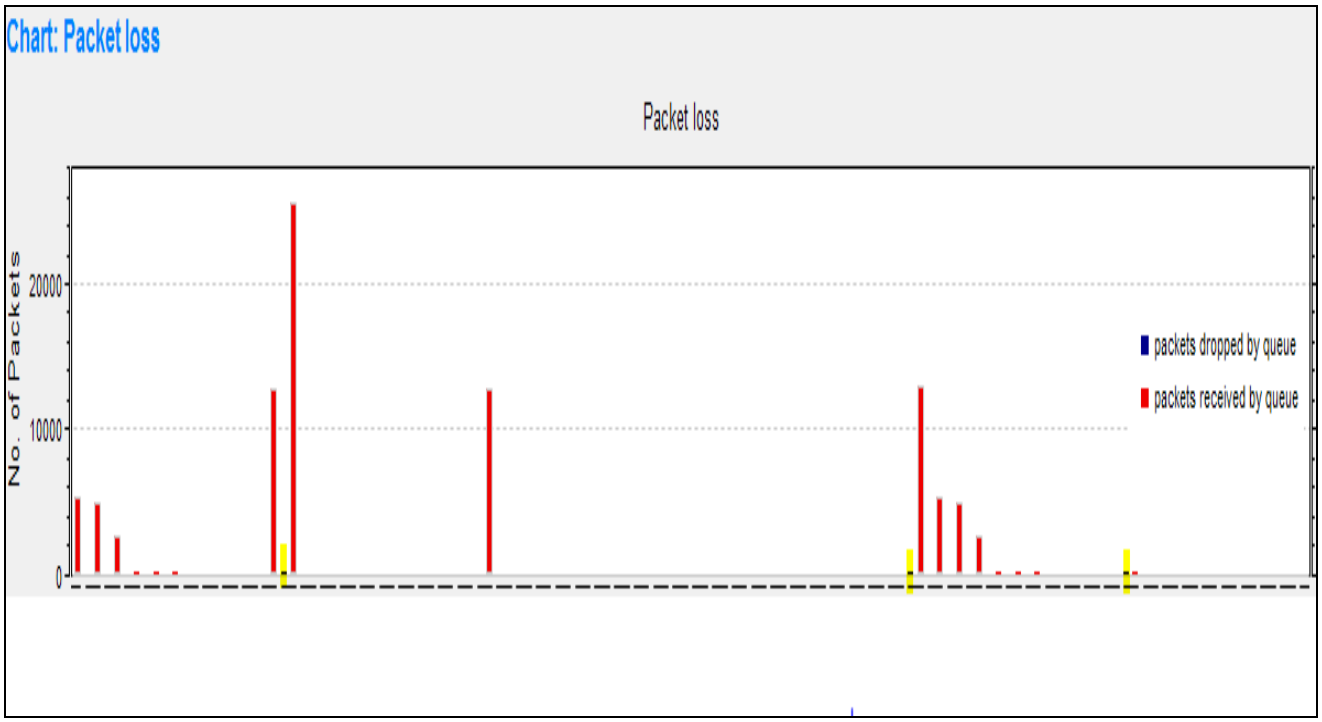


Figure 18 : Packet dropped by queue at router1 in IPv4 LAN

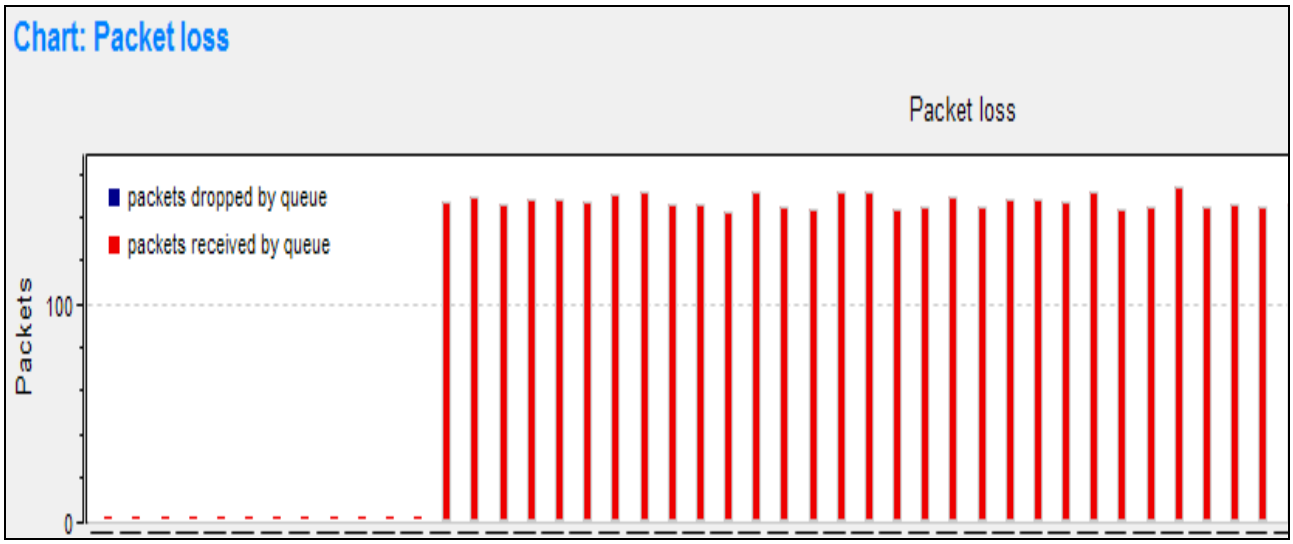


Figure 19 : Packet dropped by queue at router1 in IPv6 LAN

Fig. 18 and 19 shows number of packets dropped by queue in IPv4 and IPv6 based LAN respectively. It is observed that there is no packet loss in case of IPv6 but in IPv4 some packets were dropped by queue represented by purple and highlighted using yellow color, as it's very small in number that's why we can't visualize clearly in graph. At about 50 Mbps there is no packet loss but if load on network exceed, packet loss increases, it is clearly visualize from table given below where highlights shows the no. of packets dropped.

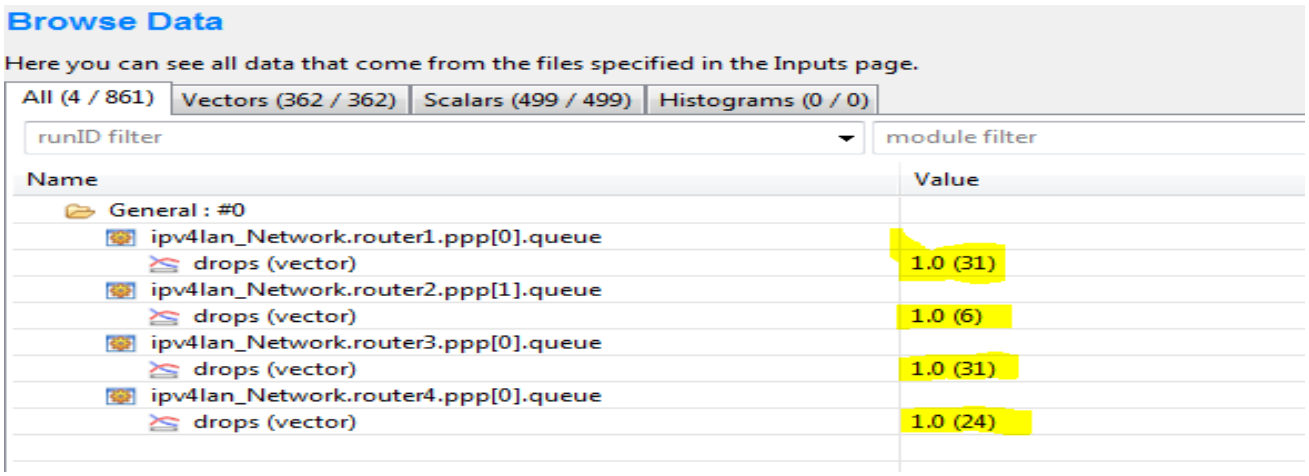


Figure 20 : Number of packets loss in IPv4

Latency can be measured as time taken by the packet while transmitting over the network that is Round trip time (RTT). When compared, it is found that latency values for both the protocol are nearly equal. Very little variation is found depending upon the size of packet.

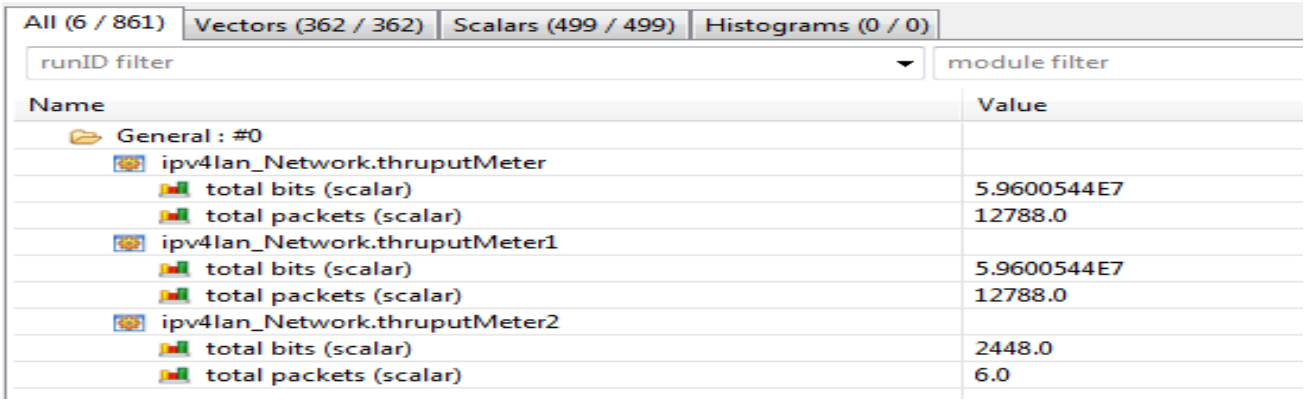


Figure 21 : Total no of bits and packets transferred in IPv4 based network

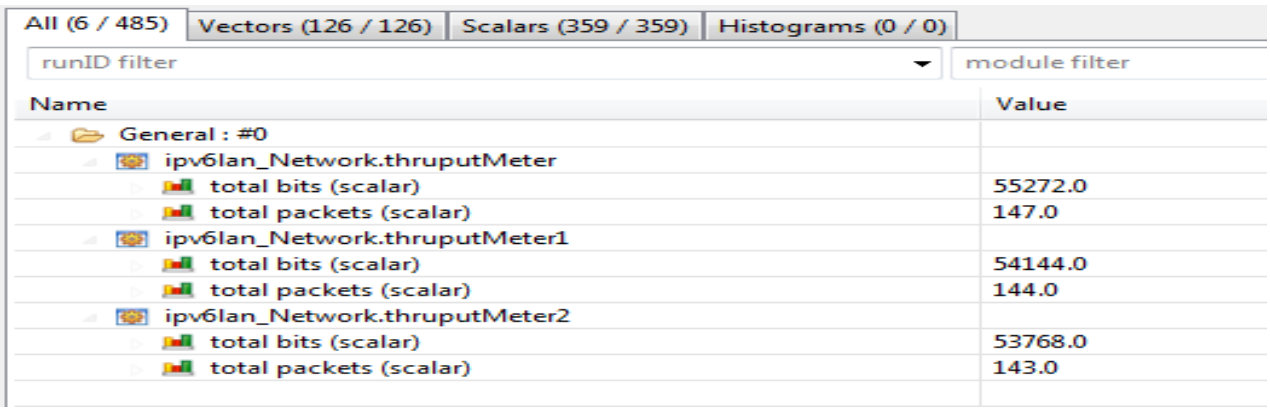


Figure 22 : Total no of bits and packets transferred in IPv6 based network

By comparing Fig. 21 and 22 it can be concluded that IPv6 is better as its total no of bits is more in less no of packets as compared to IPv4.

Comparison Parameter	IPv4	IPv6
Send Bit Rate	15868.578 bps	33977.568 bps
Receive Bit Rate	13450.509 bps	33425.290 bps

Table 1 : Comparison of various parameters for IPv4 and IPv6 simulation

So the above description clearly states the working concept and technical aspect of both Internet Protocols. Basically five vital comparisons were considered and traced down while running this simulation on the OMNeT++ tool.

First thing is the bit rate, the bit rate, which is the total number of bits transmitted in some unit time (second). The receive bit rate for IPv4 was 13450.5094235678 bps and send bit rate for the same IPv4 was 15868.578533435bps. When it is compared with the IPv6 bit rate, it was less. The bit rate observed in IPv6 case was 36291.2904392990 bps.

Another very important key point in the wired transmission of the packets considered is the time in which the data packets are being delivered. Total messages created in case of IPv4 are 3219, and the total number of messages created in IPv6 protocol was 11073. The time at which these critical values were observed was 2.0159 minutes. It clearly explains the better output results in case of IPv6 protocol.

These were some of the major things which were observed during the simulation of both the networks.

Altogether it contributed to the better performance of the Ipv6 protocol over IPv4.

IV. Conclusion

In this research work various performance parameters like throughput, packet loss, latency, etc. for both the protocols IPv4 and IPv6 based on wired networks were evaluated. Baseline IPv4 network, baseline IPv6 network have been simulated. The simulation has been done by using OMNeT++, which is a disceret event simulator. A comparative study of parameters was carried out in two different networks based on IPv4 and IPv6 respectively.

This thesis analyses the performance of IPv4 and IPv6 Networks in OMNeT++. The network consists of 100Mbp links. The networks are loaded with FTP

traffic to analyze their throughput, packet throughput, Delay, and response time. When network is loaded with FTP traffic the throughput is low for IPv4 compared to IPv6 during the low load and the difference is very small. When the FTP traffic increases throughput of both IPv4 and IPv6 increases, But Ipv6 shows a better result. The throughput for IPv4 and IPv6 is constant when the FTP traffic reaches the link bandwidth. Packet throughput is initially low for IPv4 than for IPv6, due to low FTP traffic. As the volume of data increases the number of packets in the IPv4 network is more than the IPv6 network. When the volume of FTP traffic is increased the delay in the IPv4 network is more than that of IPv6 because the IPv4 network has a higher number of packets to be processed than the IPv6 network.

In case of packet loss it was found that it is more in IPv4 as compared with IPv6. It was also found that IPv4 and IPv6 versions of IP protocol behave roughly the same in terms of Latency, with difference in overhead due to large header format of IPv6 may be because IPv6 is still in developing phase.

Thus, the analysis of IPv4 and IPv6 networks presents us with their performance characteristics through statistical analysis. The statistics obtained from simulation tells us that the performance of IPv6 is much better than IPv4. IPv6 performs better under specific circumstances.

So far the performance is concerned; the IPv6 protocol has better transmission efficiency despite the larger size of the header and the packet frame. Another key aspect is the jitter. Jitter is basically a slight irregular directional flow of the electrical signals, which are actually the data packets. When the simulation was in a running state, then more or less there was no major difference observed in the jitter values of both the protocols. Although in a comparison, IPv6 showed less jitter than IPv4 protocol.

With the extinct of the address spaces in IPv4, there is an immediate need to adopt IPv6 protocol as early as possible, so as to avoid future impediments in the Internet network.

V. Future Work

Future work can be done on satellite and wireless IPv4 and IPv6 networks. In future more research can be done on various aspects like study of IPsec as to observe the increase in overhead due to use of encryption and decryption concept using OMNeT++.

References Références Referencias

1. Narayan, S. Lutui, P.R. Vijayakumar, K. Sodhi, S. [2010] "Performance analysis of networks with IPv4 and IPv6", Computational Intelligence and Computing Research (ICCIC), IEEE International Conference.
2. Svec, P. Munk, M. [2011] "IPv4/IPv6 Performance Analysis: Transport Layer Protocol Impact to Transmission Time", Internet Technology and Applications (iTAP), International Conference, Nitra, Slovakia.
3. OMNeT++ Discrete Event Simulation System Version 4.2.2 User Manual by András Varga.
4. Lai, J. Wu, E. Varga, A. Ahmet S, Y., Egan, G.[2008] "A Simulation Suite for Accurate Modeling of IPv6 Protocols", Centre for Telecommunication and Information Engineering, Monash University, Melbourne, Australia.
5. Lai, J. Wu, E. Varga, A. Ahmet Sekercioglu, Y. Egan, K. [2002] "A Simulation Suite for Accurate Modeling of IPv6Protocols", 2nd International OMNeT++ Workshop. January 2002, Berlin, Germany Centre for Telecommunication and Information Engineering Monash University, Melbourne, Australia.
6. S. Hagen (July 2006), "IPv6 Essentials", O'Reilly.
7. Khan, M.A. Saeed, Y. Asif, N. Abdullah, T. Nazeer, S. Hussain, A.[2012] "Network Migration And Performance Analysis Of Ipv4 And Ipv6", M GC. University Faisalabad, Pakistan, European Scientific Journal March edition vol. 8, No.5 ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431.
8. Wang, Y. Ye, S. Li, X. [2005] "Understanding current IPv6 performance: a measurement study", Proceedings of 10th IEEE Symposium on Computers and Communications (ISCC'05), Cartagena, Murcia, Spain, June 2005; 71–76. DOI: 10.1109/ISCC.151.
9. Deering, S.; Hinden, R. [December 1998]. Internet Protocol, version 6 (IPv6) Specification. IETF. RFC 2460.