Performance Comparison Of Multi Media Application Over IPv4 and IPv6 Network

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***Abstract*— as acknowledged, the exhaustion of IP addresses by IANA (Internet Assigned Numbers Authority) is the main reason why world needs to migrate from IPv4 to IPv6. This paper analyzed a performance comparison using Dual Stack Technology based on both Simulator by GNS3 and real Cisco devices. Multimedia streaming from Host to Client scenario was set up and the streaming performance of both IPv4 and IPv6 protocol were compared and analyzed. A comprehensive quantifiers were used to measure the performance between the two such as, RTT - round trip time/delay, for TCP and UDP Result from this analysis can be a benchmark to proof that IPv6 is having a better performance compared to IPv4 based on the Dual Stack Hosts.**

Keywords—RTT; Performance; IPv4; IPv6; Dual Stack, Host, Client

I. INTRODUCTION

IPv4 has been the networking protocol of the Internet since the 1970s. The 32-bit protocol which provides 4.3 billion unique IP addresses for the Internet users for more than 30 years is nearing its expiration date [1]. The Migration of IPv4 to IPv6 is not as smooth as what we predicted. Many organisation are still hesitant to migrate. Though that we know IPv6 migration is good for business organisation to make money and save money. With the deployment of IPv6, more efficient or higher efficiently level of services can be provided by one organisation.

Dual Stack protocol is the most convenient way towards the migration of IPv4 to IPv6. This protocol allows both IPv4 and IPv6 to run simultaneously under one network. With Dual Stack, gradual migration of networks, applications and endpoints are possible. No tunneling is required for Dual Stack protocol. Figure 1 shows the Dual Stack protocol set up.

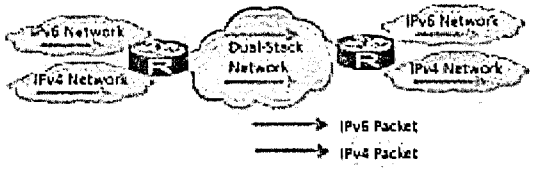


Figure 1. Dual Stack Protocol

There was also a study done on measuring TCP Connection using a Dual-Stacked Web Services [2] on why is IPv4 migration to IPv6 is facing a real challenges to be converted. Although the biggest challenges would be the cost in which that IPv4-based infrastructure needs to be replace to IPv6-based. Let alone networks operator that is still in the beginning of implementing the IPv6 migration. On the other hand, there are still many applications on the client's side that are not support IPv6 protocol. In this paper, an analysis was done using both hardware (Cisco routers) and software (GNS3) as the experimental testbed. The performance results of IPv4 and IPv6 were compared to ensure that a fair justification will be made at the end of this paper.

II. EXPERIMENTAL SETUP

A. GNS3 Simulation setup

This analysis begun with a simulation of testing the environment using a GNS3 1.3.1 software. Ping (Packet INternet Groper) test were done to verify the connection of test connection. There are two parts of setup needs to be done during GNS3 setup. i.e.: Hardware for Server using Personal Laptop and software configuration setup for Client using VM Virtual box.

Table 1: GNS3 Host and Client Specification

PC	Lenovo-PC	Oracle VM Virtual Box 5.0.10
Status	SERVER	CLIENT
Windows Edition	Windows 7 Home Premium	Windows 7 Professional
Processor	Intel® Core™ i5-3317U CPU @1.7GHz 1.7GHz	Intel® Core™ i5-3317U CPU @1.7GHz 1.7GHz
RAM	4GB	512MB
System Type	64-bit Operating System	32-bit Operating System

Test environment was set up using GNS3 software where 5 routers R1, R2, R3, R4 and R5 respectively were connected two workstations as one PC called 'server' and another end was a Virtual PC called 'client' (refer to Figure 2). During the simulation stage, the number of routers used were first being optimized based on the CPU utilization. Virtual PC were

installed using Oracle VM virtual box. Adapter for virtual PC was configured and tested. IPv4 and IPv6 addresses were manually keyed-in in the Local Area Connection properties. The setup protocol for this testing environment is using a Dual Stack protocol.

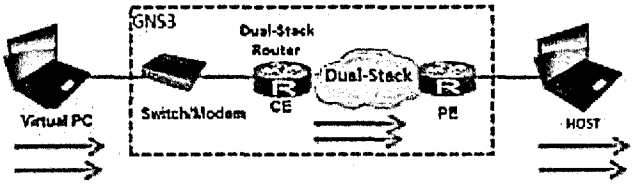


Figure 2: Dual Stack setup on GNS3

B. Hardware Setup

In this analysis, a hardware simulation using 8 cisco routers Cisco 2811 named R1, R2, R3, R4, R5, R6, R7 and R8 respectively. R1 to R4 were connected in series while R4 to R8 were connected using Fast Ethernet connection. There was also a switch SW1 connected between R1 and a Desktop which acted as SERVER. While Router R8 was connected to a laptop which acted as CLIENT (Figure 3). Since IPv4 systems is incompatible to IPv6, thus a lot of elements between the two are not possible to compromise. IPv4 address space can be mapped to IPv6 but not the other way round. Thus, Dual Stack protocol was chosen simply because it is the most convenient way for network migration [3].

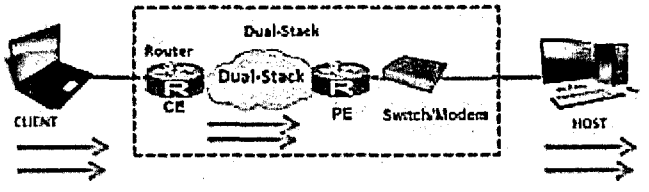


Figure 3: Dual Stack setup on Cisco Router and Hardware

During the analysis, Network analyzer tools such as:

- ICMP/PING – is a protocol used by network devices to send error messages or a requests service to indicate the availability of connection between Host and Client can be reached or not.
- FileZilla – an FTP, SFTP and FTPS is a cross platform graphical management tool for Windows, Linux, Mac OS X and others. It is a tools that helps file to be moved between a client and server.
- Tamosoft – is a software to measure wired or wireless network performances. This tool sends UDP and TCP data across the network. This tolls will provides RTT, Throughput and Packet loss for both UDP and TCP data streams. It is IPv4 and IPv6 user friendly.
- Wireshark – a network analyzer tools to measure network performance and trouble shooting.
- VLC media player – is an open source cross-platform multimedia player and framework that plays most multimedia files.

Were installed for both Server and Client. At the end of the analysis, all parameters needed to obtain the desired result will be used from the mentioned network analyzer tools.

The specifications of each hardware used in this setup were tabled in Table 2 and 3. Each Hardware were configured using Putty as the network terminal.

Table 2: Cisco Switch and Routers Specification

Hardware	Cisco 1941 Series Routers	Cisco 2960 Catalyst Switch
IOS	Universal Image 15.0(1)M for 1941	Ver: 12.2(35) SE5
Interface	Fast Ethernet: MV96340 Ethernet Serial Interface: GT96K Serial	Fast Ethernet: CPU Interface
Channel capacity	FE: 100 Mbps Serial : 1.58 Mbps	

Table 3: HARDWARE Host and Client Specification

PC	Lenovo-PC	HP A20
Status	CLIENT	SERVER
Windows Edition	Windows 7 Home Premium	Windows 7 Enterprise
Processor	Intel® Core™ i5-3317U CPU @1.7GHz 1.7GHz	AMD A10-5800B APU with Radeon ™ HD Graphics 3.8Ghz
RAM	4GB	GB
System Type	64-bit Operating System	64-bit Operating System
FTP	FileZilla Client 3.14.1	FileZilla_Server-0_9_54
VLC	VLC Media Player	VLC Media Player
TamoSoft	TamoSoft Throughtput Test	TamoSoft Throughtput Test
Jperf	jperf 2.0.2	jperf 2.0.2
Wireshark	Wireshark 1.2.1 (64-bit)	Wireshark 1.2.1 (64-bit)

C. Routing Protocol

To name a few of routing protocol that we can use to route all routers i.e.: OSPF, BGP, RIP, EIGRP, IS-IS and others. RIPv2 routing protocol were used during this analysis for both GNS3 simulation and Cisco hardware routers. RIP is the oldest protocols which make use of hop count as a routing metric. It is also allows major numbers of Class A, B or C to be specified in the command network. Also known as the simplest routing protocol and its ability to support almost all operating systems and routers [4]. By implementing limit on the number of hops from source to destination, routing loops can be prevented. For RIP, the number of hops allowed are 15hops. RIP protocol sends broadcast its routing table every 30secs [5].

This analysis using RIPv2. RIPv2 has its own multicast MAC address. RIPv2 also supports security between RIP routers using message-digest or clear-text authentication.

Routing Configuration needs to be done on each routers for both hardware Cisco routers and GNS3 simulator. Then, RIPv2 configuration needs to be configured to each routers in order to make the routers connect between each other. The connection of each will finally tested using PING test.

Step 1: Configure each Routers for both Hardware and GNS3 simulator

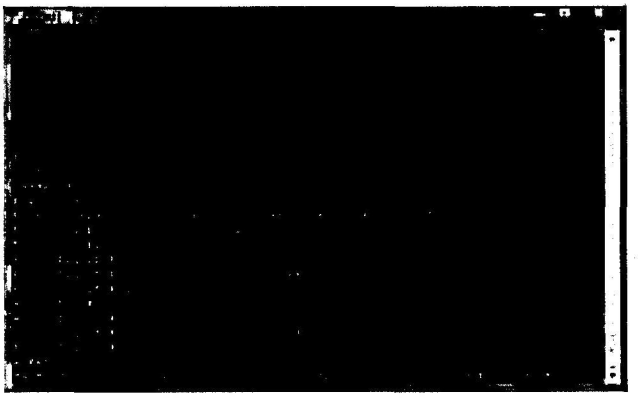


Figure 4: Example of Routers configuration for IPv6

Step 2: Configure each Routers using RIP routing protocol

Figure 5: Example of Routers configuration for IPv4 and IPv6 using RIP

Step 3: Ping test to ensure connection from SERVER to CLIENT

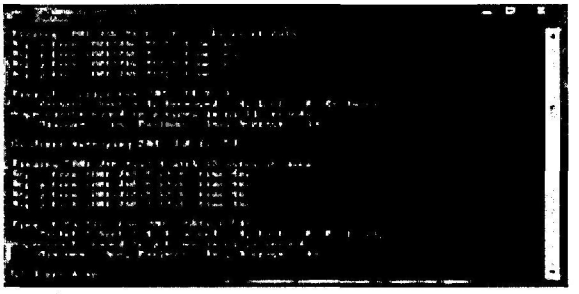


Figure 6: IPv6 PING from SERVER to CLIENT

D. Video Streaming

The connection between server and client were also tested using a video streaming from SERVER to CLIENT using a VLC Media Player. A few of multimedia type such as MP3 and MP4 were tested using HTTP protocol. VLC setup for both SERVER and CLIENT in order to allow streaming multimedia file from source to destination. All Multimedia streamed at or from SERVER can be played at CLIENT side.

E. FTP File transfer

FTP software were used for FTP file transfer protocol. In this analysis, FileZilla Client 3.14.1 and FileZilla Server FileZilla_Server-0_9_54 software were both installed in each respectively. A few file sizes and type were transferred from source and destination. Result from this transfer activity were analyzed for both IPv4 and IPv6. Performance between the two were then be concluded at the end of this paper.

III. MEASUREMENT TRIALS AND DATA ANALYSIS

In this paper, a few sets of results were obtained from each experimental done. A few parameters were measured during this analysis.

A. Lantency (delay) – A time taken by a multimedia transmission to from source to destination.

$$Latency = \frac{\text{Ave RTT for packets}}{2} (ms) \qquad [6]$$

B. Throughput - Rate of data transfer from source to destination can be tramsmitted over a sufficiently long period of time; the performance is measured in Mbit/s

$$Throughput = \frac{Packet\ Size}{Latency} (Mbits/s) \qquad [6]$$

C. *Packet Loss* - dropped packet

D. *CPU Utilization* – CPU utilization was monitored during the setup of GNS3 simulation.For Windows 7, at the Windows Task Manager under the performance tab. The optimum CPU utilization is important to ensure the performance of PC during the simulation.

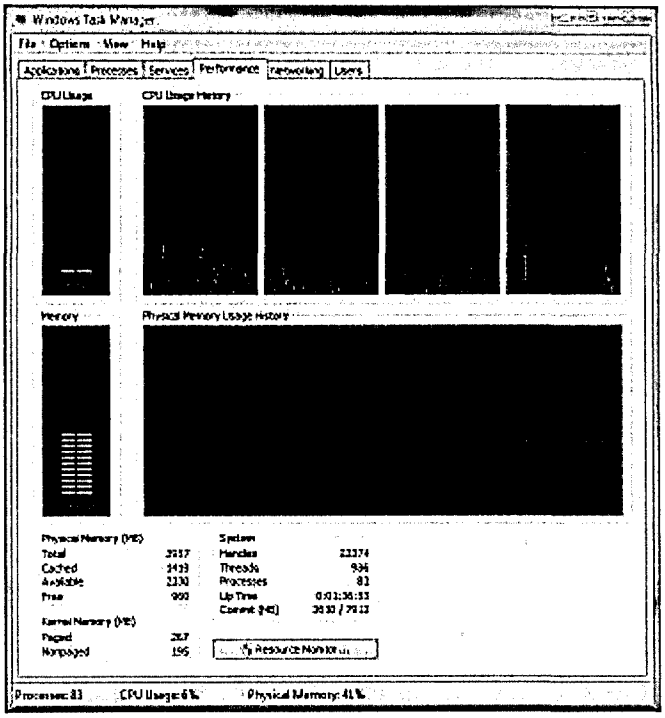


Figure 7: CPU Utilization optimized

IV. RESULT

This paper presented a set of results from various tests done such as: ICMP, FTP and HTTP protocols. All results were captured using difference tools analyzer. However, at the end of the analysis desired up-shot can be concluded accordingly and results will be compared with previous research or analysis done in this area.

A. ICMP PROTOCOL TEST.

ICMP/Ping test were implemented to ensure connection between SERVER and CLIENT. This is the basic test that needs to be done on each networking construction. ICMP/PING measures RTT (max, min and average) from source to destination. Along the line, errors and packet loss will be reported (if any). There was a study done on ICMP protocol. Stated that, this protocols is an OS recognition. There are three levels in networking scanning. To identify target host status whether it is still alive, to identify OS of targeted Host and finally to acknowledge the details of the specified service [7].

Table 4: ICMP test for IPv4 vs. IPv6 on GNS3 Simulator and Cisco Hardware Setup

TESTBED	RTT Ave (*ms*)	
	IPv4	IPv6
GNS3	19	0
Cisco Hardware	4	3

Table 4 shows that using GNS3 simulator the RTT average for IPv6 is 0ms. Which indicates that there are no delay in sending the signal through the network with 100% signal sent and received. Looking at the Cisco Hardware setup, the RTT average of IPv6 compared to IPv4 is 1ms. Proven that IPv6 is having faster of signal return compared to IPv4.

B. FTP PROTOCOL TEST.

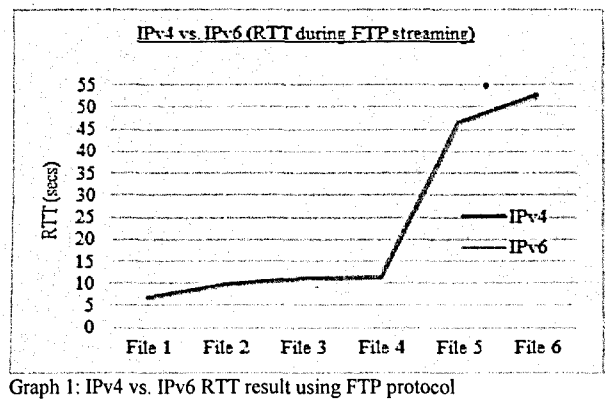
It has to be built on a Client and server architecture. It is believe to be the most reliable tool for file transport with a very less delay compared to others [8]. By using this tools we can simply upload, download, rename, delete, copy and move files from a server. The RTT and throughput can also be obtained during this file transfer.

In this paper, throughput and RTT were also measured between IPv4 and IPv6 using FTP protocols. Various file sizes and file type were streamed using FTP protocols and the RTT and Throughput results were compared.

- RTT of IPv6 is proven to be faster than IPv4 based on Graph 1 and Table 5. Showing that the average RTT differences between both IPv4 and IPv6 is 0.35secs

Table 5: IPv4 vs. IPv6 RTT Streaming Results

File Name	File Type	File Size	RTT Ave (*ms*)	
			IPv4	IPv6
File 1	.pdf	1.95	6.64	6.58
File 2	.MP3	2.06	9.81	9.23
File 3	.JPEG	2.49	11.04	10.89
File 4	.Zip	2.59	11.51	11.39
File 5	.docx	10.5	46.64	46.07
File 6	.PNG	11.9	52.70	52.06

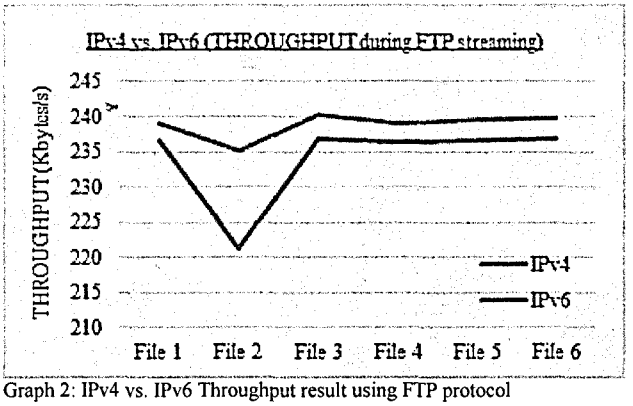


Graph 1: IPv4 vs. IPv6 RTT result using FTP protocol

- Throughput result were compared during FTP file transferred. IPv6 shows that the rate of data transferred using FTP protocol on Dual Stack network architecture are higher than Ipv4 by average of 4.65kbytes/secs. Table 5 shows the side by side of transferred data rate for both IPv4 and IPv6.

Table 5: IPv4 vs. IPv6 RTT Streaming Results

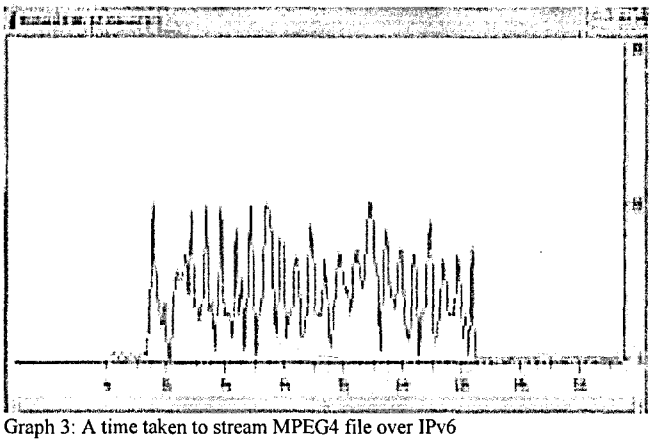
File Name	File Type	File Size	Throughput (Kbytes/s)	
			IPv4	IPv6
File 1	.pdf	1.95	236.71	238.94
File 2	.MP3	2.06	221.24	235.07
File 3	.JPEG	2.49	236.78	240.15
File 4	.Zip	2.59	236.48	239.06
File 5	.docx	10.5	236.66	239.62
File 6	.PNG	11.9	236.93	239.84

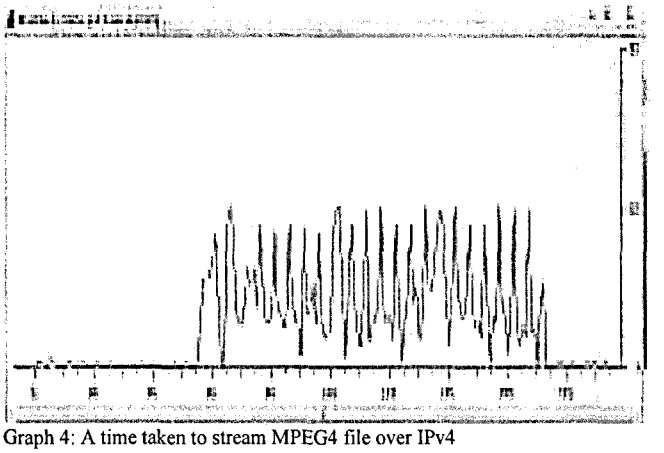


Graph 2: IPv4 vs. IPv6 Throughput result using FTP protocol

C. *HTPP PROTOCOL VIDEO STREAMING*

This paper also run an analysis using HTTP protocols and the result obtained for this video streaming were compared. An MPEG4 file was streamed using VLC media player from a server and the video was played on client site. During this activity, the traffic info were captured using wireshark. Since the file streamed was short in duration, Throughput and RTT graph were not able to be accurately captures by wireshark. Thus, in this comparison the IO graph were used to compare the time taken for MPEG video during streaming.


Graph 3: A time taken to stream MPEG4 file over IPv6


Graph 4: A time taken to stream MPEG4 file over IPv4

Comparing Graph 3 and Graph 4 the time taken for same MPEG4 video streamed over IPv6 and IPv4 with a dual stack protocol network, show a very significant result in term of streaming time. IPv6 proved that streaming time for tested video took only approximately 120s which was 40s faster than IPv4. The percentage of 32% for IPv6 to stream faster than IPv4.

D. *RTT, THROUGHPUT and LOSS using TAMOSOFT THROUGHPUT TEST software*

In this paper, another free software was used to measure the hardware topology established using Cisco routers. TAMOSOFT was a simple throughput software to measure RTT, Throughput and Loss on the topology establish using dual stack protocol. This analysis can simply be run at both SERVER and CLIENT. TCP protocol was measured in this analysis because of majority internet connection were using TCP due to its robustness and efficiency in sending and receive data. Best of effort network was chose during this test as, in a best-effort network all users obtain best-effort service, meaning that they obtain unspecified variable bit rate and delivery time, depending on the current traffic load.

Figure 8 shows that average throughput of 1.9Mbps for a TCP on Dual stack protocol over IPv6 is better compared to IPv4 with only 1.8Mbps.

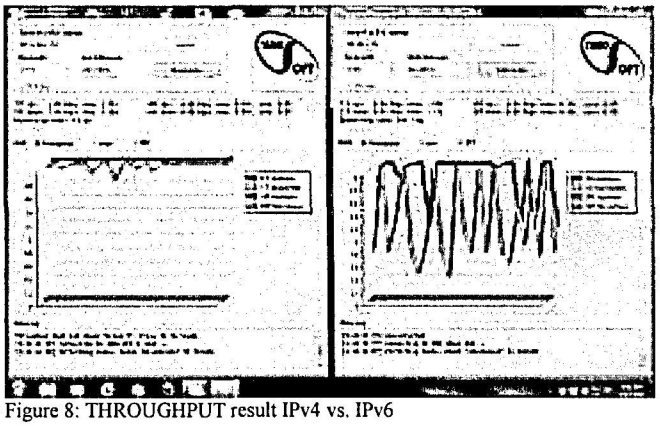


Figure 8: THROUGHPUT result IPv4 vs. IPv6

This analysis was based on TCP protocol. Thus, no loss observed for both IPv4 and IPv6 since we know that one of the characteristic of TCP is to re-transmit all data that loss during transmission. In other word, all the data delivery is managed and loss free ensured

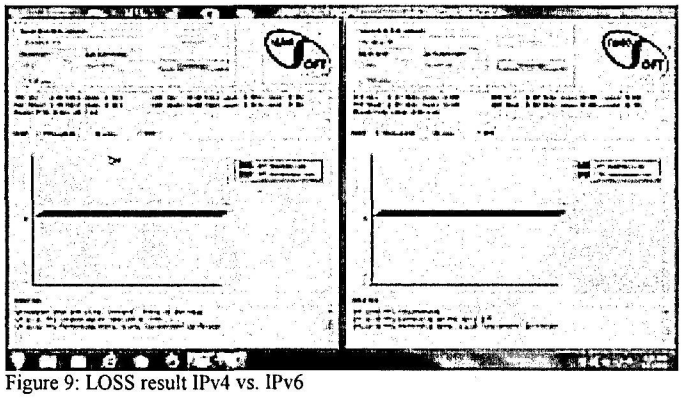


Figure 9: LOSS result IPv4 vs. IPv6

RTT for both IPv6 and IPv4 showing 25times higher for IPv4 to return the signal sent earlier. This shows that IPv6 is behaving good compared to IPv4 in terms of RTT.

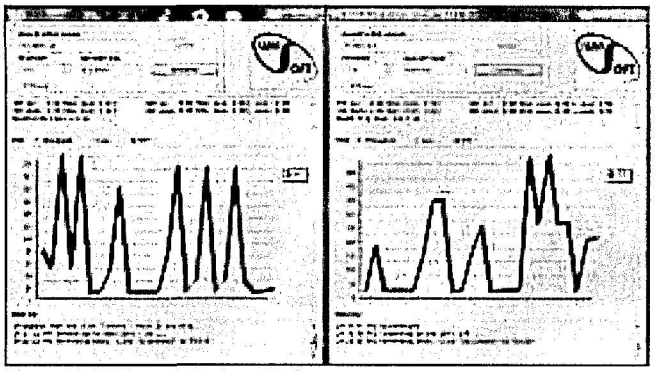


Figure 10: RTT result IPv4 vs. IPv6

V. CONCLUSION

Results shown from each network tools or parameters that IPv6 is better compared to IPv4 through Dual Stack protocol. Multimedia streaming proven to be faster over IPv6 with Dual stack protocol. TCP used as one parameter tested on RTT and Throughput for both IPv4 and IPv6 but still IPv6 is showing better performance than IPv4. Although IPv6 adoption is still in early stage, with result shown in this paper, it can be a benchmark of future investigation. On the other hand, multiple research and analysis done on the performance of IPv4 and IPv6. Some even proof otherwise [15]. However, the performance of Dual Stack protocol over IPv4 and IPv6 seems to be the most ideal combination to achieved optimum Throughput and RTT [16]

In future, multiple size of multimedia files with various length of time can be tested using multimedia streaming method and the result significant RTT, Packet Loss and Throughput can be analyzed using Wireshark.

Another testbed architecture can also be used in order to determine the performance of the two, IPv4 and IPv6. The performance can also be compared between wired and wireless environment using various routing protocol. There are also an analysis to study the same performance comparison with a difference network architecture such as tunneling and translation technique [3] [17].

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