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IPv4–IPv6 Network Migration: A Study of Dual-Stack, Tunnelling, and Translation Techniques

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Abstract

When considering the global situation, it is possible for network communication to be available to the whole globe, which is a system of networks that are linked. In a network, the IPv4 protocol allows for the exchange of data between two or more computers, which helps to reduce the amount of time and energy that is wasted. In February, all IPv4 addresses have been rendered obsolete, and we are presently transitioning to IPv6. In this project, a migration strategy to an IPv6 network is suggested. This approach overcomes all of the constraints that are accessible in the IPv4 network that is currently in use. In this research, many migration strategies, including dual stack migration, tunnelling, and translation migration, have been developed for the purpose of transmitting IPv6 packets across IPv4 networks. These strategies allow and accomplish complete convergence in IPv6 networks. The Graphical Network Simulator 3 (GNS 3) was used in order to model the implementation of dual stack, tunnelling, and translation strategies for the purpose of transitioning from IPv4 to IPv6 configurations. It is now possible to transport packets over the network in both static and dynamic settings. This functionality has been installed. Evaluation and analysis of the performance metrics for the transmissions have been carried out. These parameters include the success rate, as well as the lowest, average, and maximum round-trip times, and latency.

Keywords: Internet Protocol, Routers, Switches, Dual Stack, IPv4, IPv6

1. Introduction

The internet is a network of linked networks that is available to people all over the globe. The Internet Assigned Numbers Authority (IANA) is responsible for providing two versions of the Internet Protocol (IP) that are now in use [1-3]. IPv4 addresses have already been assigned to Regional Internet Registries (RIR) as a result of this protocol. There are no more IPv4 addresses available to be assigned, and the Internet Assigned Numbers Authority (IANA) has begun assigning IPv6 addresses to RIR [4-5]. Due to the fact that these protocols are not directly compatible with one another, there is a rivalry going on between them [6]. The objective of this study is to demonstrate that IPv6 packets may be sent using IPv4 without any problems. In order to enable a variety of network services, users and providers of networks are required to make a decision on whether they will support either one or both protocols [7-8].

2. System Architecture and Analysis

IPv4 (Existing System): The Internet Protocol (IP) is now in its fourth version, meaning that it is the fourth version of the protocol. A connectionless protocol, Internet Protocol version 4 (IPv4) is designed for usage on packet-switched link layer networks, such as Ethernet. It is still the case that IPv4 is the internet layer protocol that is deployed the most often. The style of distribution that it uses is known as

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"best effort." One kind of network that allows for the exchange of data between two or more computers is known as IPv4.

The addressing method used by IPv4 is known as 32-bit addressing. IPv4 has the capacity to address 232 devices, which is somewhere about 4.3 billion. The dotted decimal format is used to represent IPv4 addresses. Up to February 3, 2011, it was discovered that these addresses have been used up. Some of the factors that have contributed to the delay include changes in network addressing brought about by classful network architecture, network address translation (NAT), and classless inter-domain routing. Class A, class B, class C, class D, and class E were the five categories of addresses that were specified by the system. A rising number of public and commercial internetworks have been given the opportunity to freely distribute IPv4 addresses.IPv6, often known as IPng, or IP next generation, is the proposed system for Internet Protocol. IPv6 was designed by the Internet Engineering Task Force (IETF) in order to solve the issue of IPv4 address depletion, which had been expected for quite some time. In addition, IPv6 incorporates functionalities that are absent from the currently available IPv4 protocol. For the purpose of overcoming the constraints that are now associated with IPv4, IPv6 is required. A lower level of security, increased latency, a smaller address space, and the absence of an auto setup feature are some of the shortcomings of IPv4. Using 128-bit addresses is the method of addressing used by IPv6. These are then segregated into eight groups, which are then further subdivided into eight blocks, which are then further subdivided into four-digit hexadecimal numbers.

3. Problem Definition

When an organisation wishes to install an IPv6 network in their service area, it is not practical to build the network all of a sudden over the whole region. It is necessary to migrate slowly from IPv4 to IPv6 without significantly impacting the service that is already in place. Hardware Tools Routers, switches, and hosts are the types of hardware tools that are used in the simulation process. The dual-stack protocol allows hosts and routers to interact with both IPv4 and IPv6. This protocol is also known as dual-stack. Within the context of communication with IPv6 hosts, the dual stack hosts make use of IPv6 addresses. For the purpose of interacting with IPv4 hosts, it will make use of IPv4 addresses. The tunnelling protocol is used for the purpose of ensuring the confidentiality of data transfers. Through the use of an encapsulating technique, tunnelling makes it possible for communications carried out on private networks to be sent across public networks like the internet. via the use of tunnelling, it generates a safe route via a network that is not trusted. Through the process of translating two distinct IP address families, the Translation Protocol Network (NAT) approach makes it easier for IPv4-only and IPv6-only networks to communicate with one another while facilitating communication. This technique converts IPv4 to IPv6 and provides users with a consistent internet experience by allowing them to access material on the internet that is based on IPv4 services. Manual Tunnelling: Manual tunnelling is used for the purpose of establishing stable connections between two edge routers or between an end system and edge routers in order to establish connections to distant IPv6.

3. Design of Dual Stack Network

A dual stack approach is being designed for the purpose of moving data from an IPv4 network to an IPv6 network using both static and dynamic routing. This technique will handle both types of addressing and packets while transferring data. In all, there are five routers and four switches that make up this network. Through the process of transmitting packets from one router to another router, we are able to determine the minimum, average, and maximum round trip times for both IPv4 and IPv6. With the use of this approach, we are able to determine whether IPv4 or IPv6 has the shortest round-trip time.

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4. Design of Tunneling Network

It is recommended in this study that a tunnelling mechanism be designed for the purpose of moving data from the IPv6 network of node R1 to another IPv6 network of node R5 via the IPv4 network of node R3, and vice versa. In this case, the OSPF protocol is enabled, which results in the design of both IPv6 and IPv4. When information is sent from the IPv6 network of node R1 to the dual stack of node R2, the dual stack includes an IPv4 header with the IPv6 packet and enables the data to be tunnelled via the IPv4 network to another dual stack of node R4. This dual stack of node R4 will delete the IPv4 header from the IPv6 packet that has been received, which will enable the packet to have the opportunity to reach the IPv6 network that is the destination of node R5. Using the manual tunnelling approach, we were able to successfully implement.

5. Routing Protocols

One kind of routing is known as static routing, which means that the entries in the routing table will not change. Information is inserted manually into the static routing table, which holds the information. It is not possible to do an automated update. Additionally, the administrator is responsible for manually updating the table. A kind of routing known as dynamic routing is one in which the routing protocols are responsible for automatically updating the entries in the routing table. Through the use of dynamic routing protocols such as OSPF, the dynamic routing table is updated on a regular basis. In the event that there is a change in the internet, such as the router being turned off or the connection being severed, the dynamic routing protocols should be immediately updated in all of the tables that are included inside the routers.
Open Shortest Path First: Open Shortest Path First, sometimes known as OSPF, is a protocol specifically designed for Internet Protocol (IP) networks that does adaptive routing. In addition to being a member of the group of internal routing protocols, it makes use of a link state routing algorithm and will function inside a single autonomous system.

6. Graphical Network Simulator

Graphical Network Simulator 3 (GNS 3) is a graphical network simulator that enables the modelling of complicated networks, hence giving models that are comprehensive and realistic. In addition to being a Cisco IOS emulator, it is also intimately connected with dynamics.

7. Performance Metrics for Tunneling Technique

$$\text{Latency} = \frac{\text{Average round trip time for packet}}{2}\ (\text{ms})$$

The delay that occurs between the input into a system and the output that is sought is referred to as latency.

$$\text{Throughput} = \frac{\text{Packet size}}{\text{Latency}}\ (\text{ms})$$

It is possible to define throughput as the ratio of the size of the packet to the latency.

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8. Simulation Results

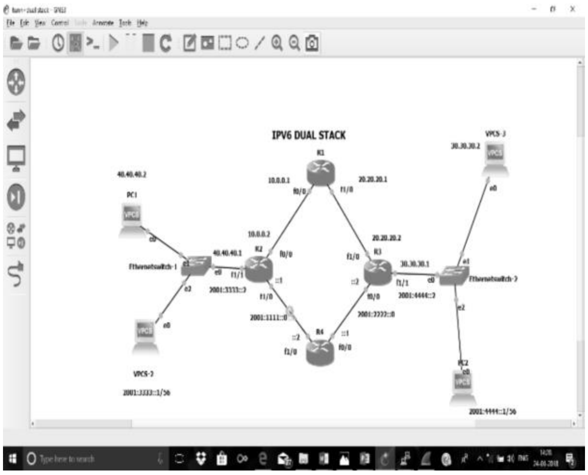

Figure 1 Dual Stack -Routing Network

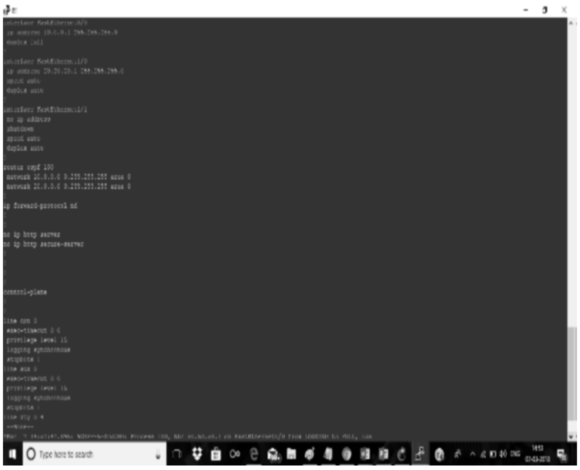

Figure 2 Router-1 Configuration

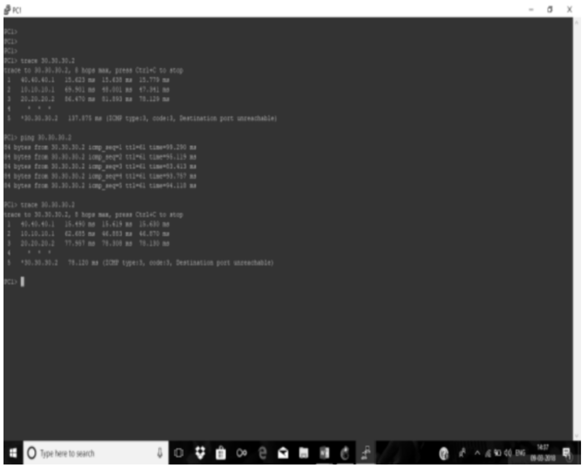

Figure 3 Router-1 Round Time Status

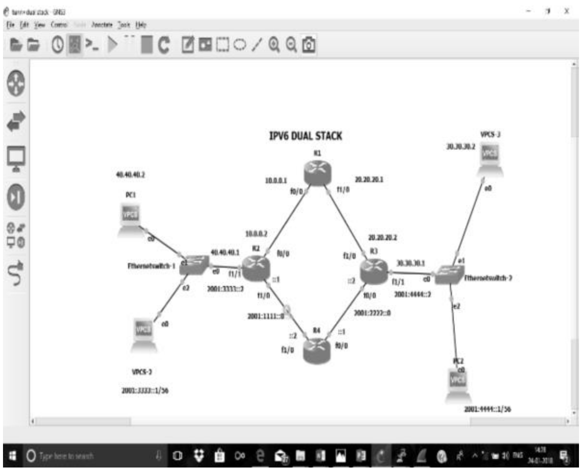

Figure 4 Dual Stack -Dynamic Routing Network

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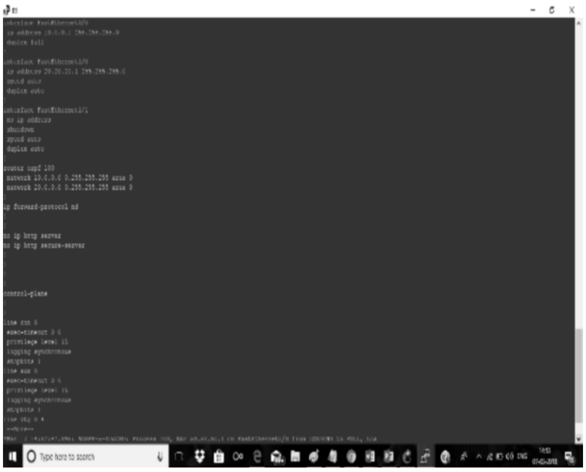

Figure 5 Router-1 Configuration

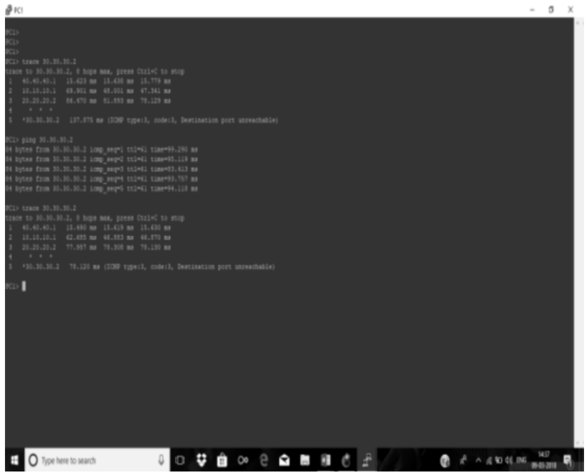

Figure 6 Router-1 Round Time Status

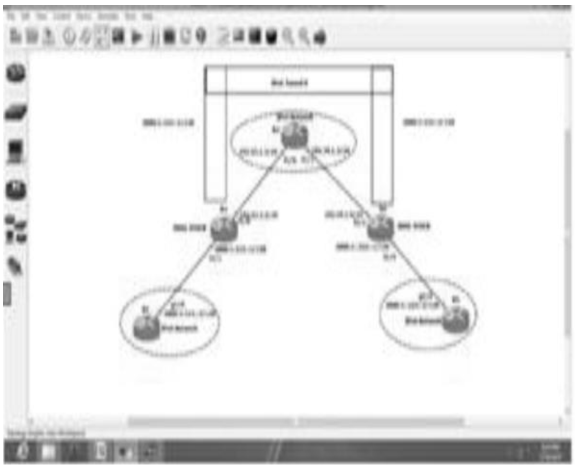

Figure 7 Architecture of Tunnelling Network

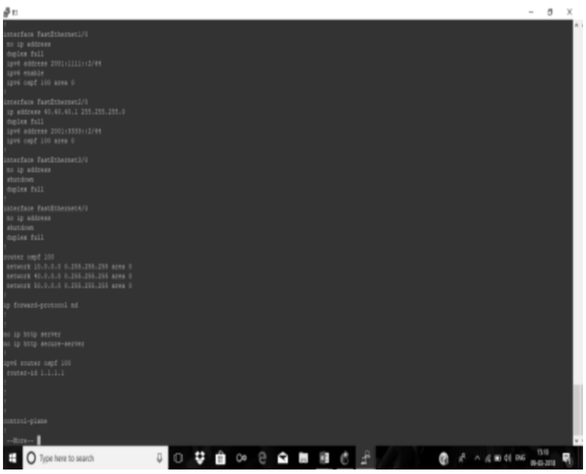

Figure 8 Configuration of Router 1 in IPv6 Network

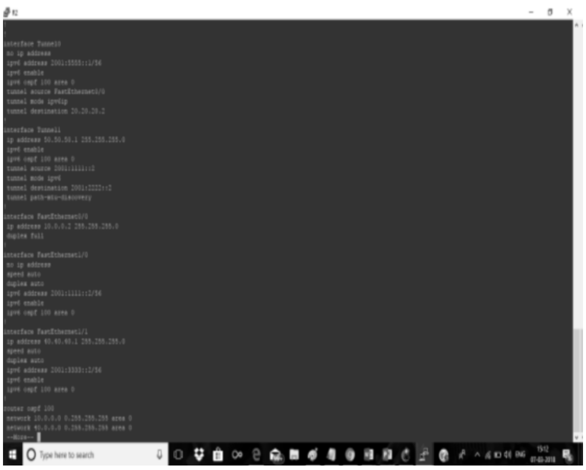

Figure 9 Configuration of Router 2 in Dual Stack

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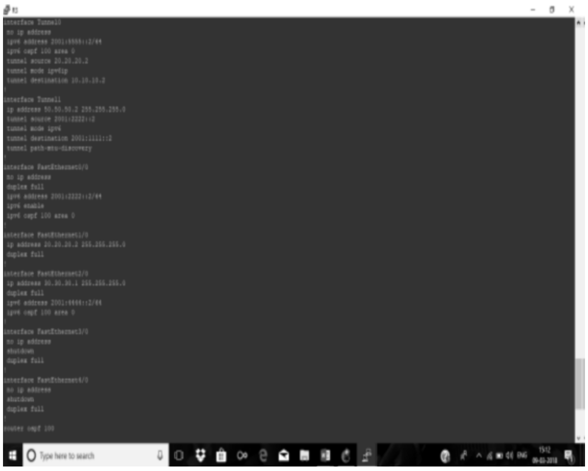

Figure 10 Configuration of Router 3 in IPv4 Network

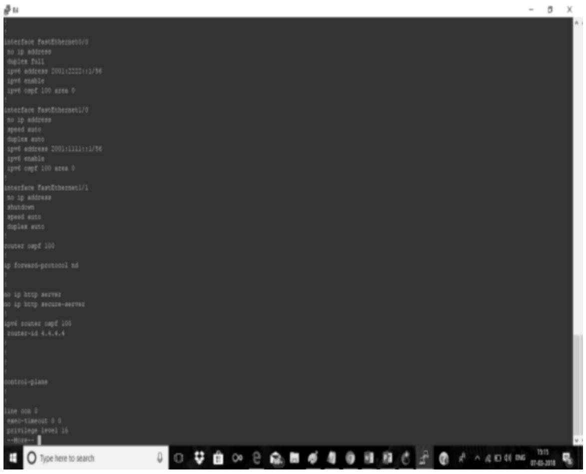

Figure 11 Configuration of Router 4 in Dual Stack

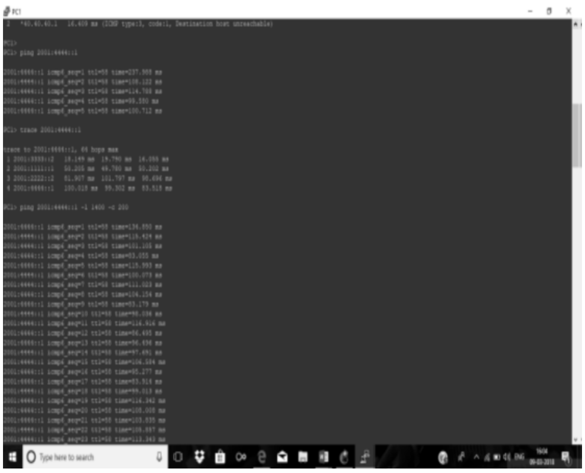

Figure 12 Router R1 Round Trip Time

Time Dual Stack

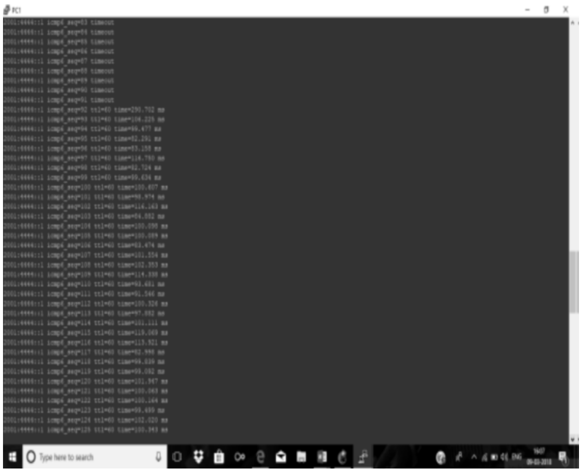

Figure 13 Router R1 to R5 Round Trip

Via Tunneling Path

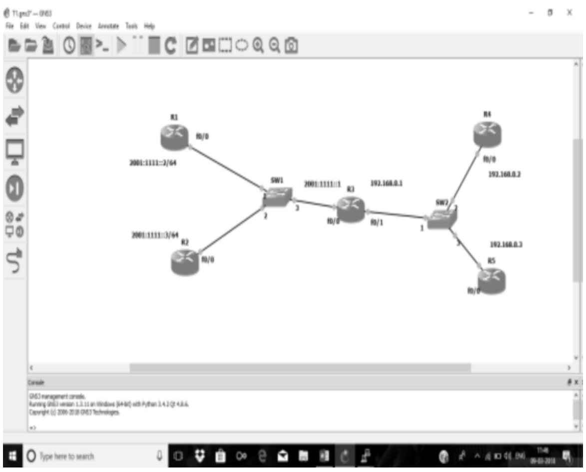

Figure 14 Architecture of Translation

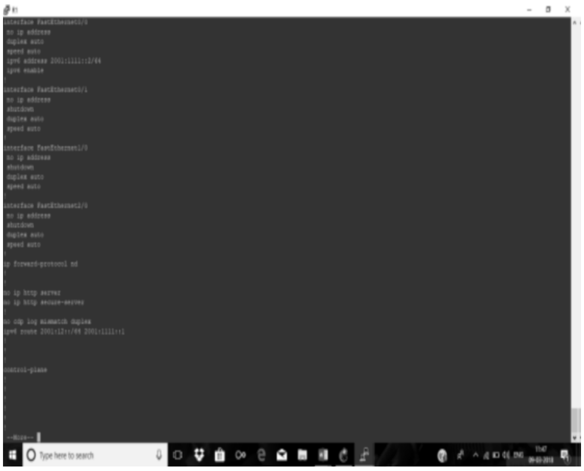

Figure 15 Router 1 Configuration

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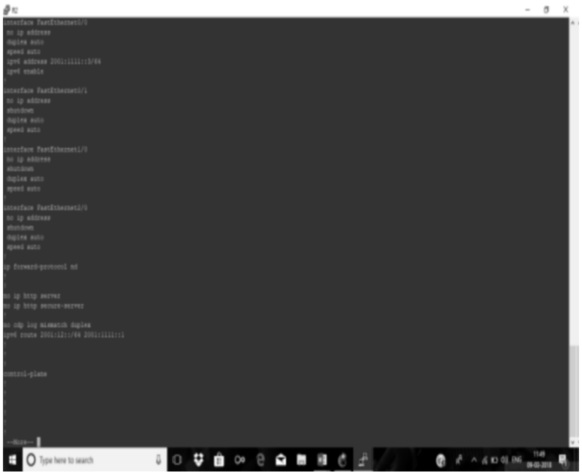

Figure 16 Router 2 Configuration

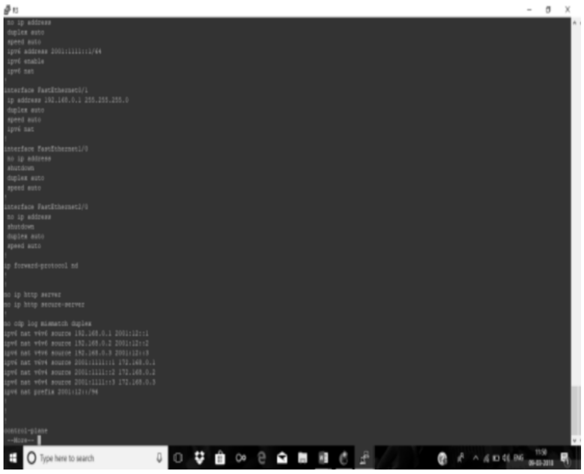

Figure 17 Router 3 Configuration

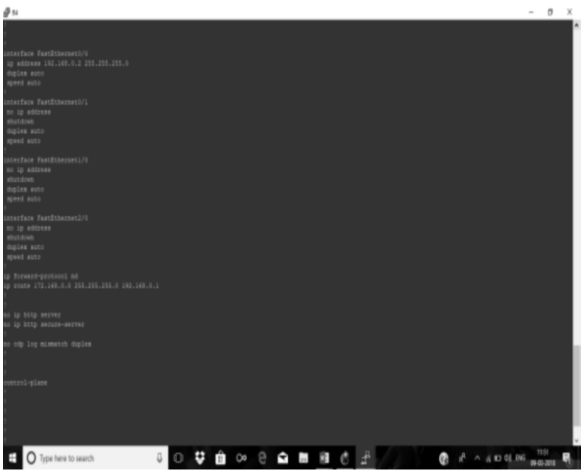

Figure 18 Router 4 Configuration

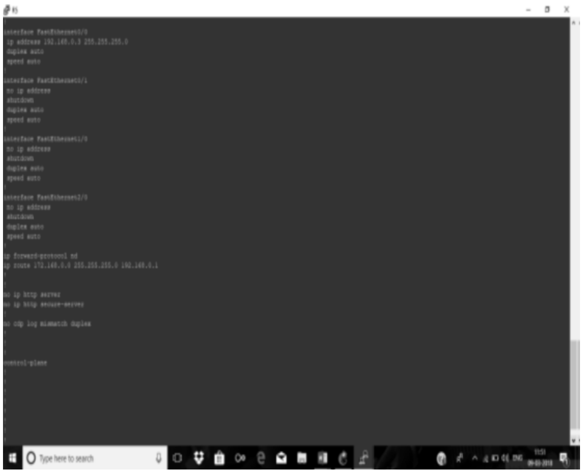

Figure 19 Router 5 Configuration

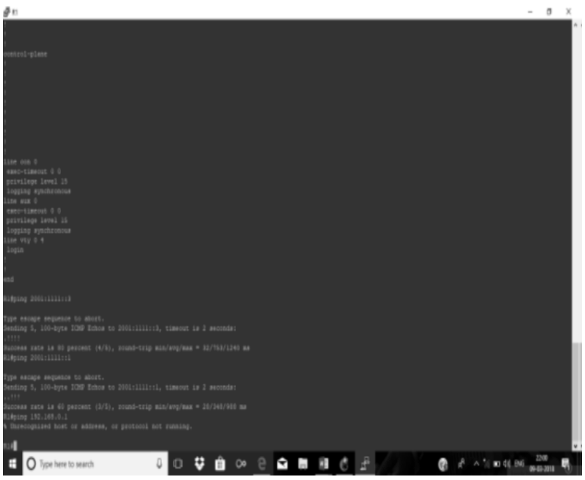

Figure 20 Router 1 Round Trip Time

Figure 21 Router 5 Round Trip Time

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9. Performance Comparisons

Table 1 Performance Comparison of Static and Dynamic Dual Stack

Dual Stack Techniques	Success Rate	Round Trip Time (ms)		
		Minimum	Average	Maximum
Static IPv4	100	268	316	376
Static IPv6	100	280	381	464
Dynamic IPv4	100	172	230	448
Dynamic IPv6	100	224	307	344

Table 2 Performance Comparison for Latency between IPV6 and IPV4 in Tunneling Technique

Pocket Size	IPv6		IPv4	
	Latency (ms)	Throughput (M bits/s)	Latency (ms)	Throughput (M bits/s)
100	22	4.54	56	1.78
100	27	3.70	30	3.33
100	37	2.70	62	1.61
100	32	3.12	67	1.49

10. Conclusion

The investigation on the use of the dual stack technology for the purpose of transitioning from IPv4 to IPv6 has been implemented. There has been research done on the process of packet transmission over the network, taking into account both static and dynamic settings. Through the use of the dual stack approach, the determination of the success rate as well as the minimum, average, and maximum round-trip times for the transmissions has been carried out. The lowest and average round trip delays encountered by Dynamic IPv4 are the least, whereas the maximum round trip delay encountered by Dynamic IPv6 is the least. Studies have been conducted on the use of tunnelling as a method for transitioning from IPv4 to IPv6 architecture. It has been accomplished that the packets have been transferred over the network that uses manual tunnelling. The transmissions that were carried out using the manual tunnelling approach were subjected to an analysis that included the success rate, the size of the packets, as well as the lowest, average, and maximum round-trip times. When calculating and analysing latency and throughput, both IPv6 and IPv4 are taken into consideration. Due to the fact that the throughput is dependent on the latency, IPv6 has the lowest latency when compared to the latency of IPv4. Consequently, we are transitioning from an IPv4 network to an IPv6 network.

11. References

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