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Performance Evaluation of Ipv4, Ipv6 Migration Techniques

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Abstract: *The Internet Protocol Version 6 (IPv6) has gained popularity with companies, organizations and Internet service providers (ISPs) due to its enhancements over IPv4 such as (IPv6 128bit compared to of ipv4(32 bit). When migrating from IPv4 to IPv6, one should be careful about interruptions of service. In this paper, three mechanisms that can be employed to provide a smooth migration process. Results are verified with the Optimized Network Engineering Tool (OPNET) version 17.5 network simulation tool.*
Keywords: *Dual Stack, Tunnelling, NAT-PT OPNET 17.5 modeller delay , packet loss, throughput*

I. Introduction

In today's communication systems, the Internet Protocol Version 4 (IPv4) has reached it limits on various front, and a transition to the new version of IPv6 is imminent[1]. J. L. Shah et. al. [2] have listed various benefits of IPv6 over the IPv4 that include, a larger address space (128 bits), inbuilt stateless auto configuration support, smaller packet header size, inbuilt support for IPSec Security, efficient Support for Mobility, better packet forwarding, support for Real Time Multimedia and QoS, and support for Multicast and Any cast Traffic. The major challenge for deployment of IPv6 systems is the migration from IPv4 based systems[1]. The cost associated with the migration for equipment as well as operational downtime cost. As discussed in [3-8], various techniques have been proposed to minimize these impacts to existing systems. In this paper, an overview of the dual stack, tunneling, and translation techniques will be provided. Moreover, the open source OPNET network simulation tool is used to investigate performance of each of the aforementioned techniques. Simulation results of the network throughput, delay, and packet loss characteristics will be presented and analyzed.

There are three main categories of transition techniques:

- **Dual-stack techniques:** This technique allows for IPv4 and IPv6 to coexist on the same network infrastructure and there's no need to encapsulate IPv6 inside IPv4 (using tunneling) or vice-versa. This technique is not suitable for large networks such as the Internet due to its difficulty and cost to cover all the network nodes. However, this technique is suitable for smaller size networks that requires low management effort. The dual stack is considered to be the basis for inventing the two other techniques for transition between IPv4 and IPv6. Fig.1 shows a diagram of such configuration.

- **Tunnelling techniques:** This technique allows transport of IPv6 traffic over the existing IPv4 network infrastructure. Tunnelling techniques can be used to deploy an IPv6 forwarding infrastructure while maintaining the basis IPv4 infrastructure such as in situations where there is no IPv6 support and can only reach IPv6 sites through encapsulating IPv6 packets within IPv4 link. Fig.2 shows a diagram of an IPv6 packets carried over an IPv4 tunnel configuration.

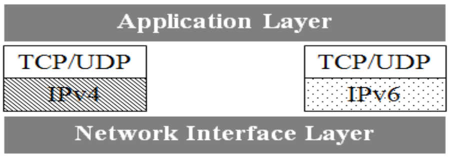

Fig. 1. The Dual Stack Architecture.

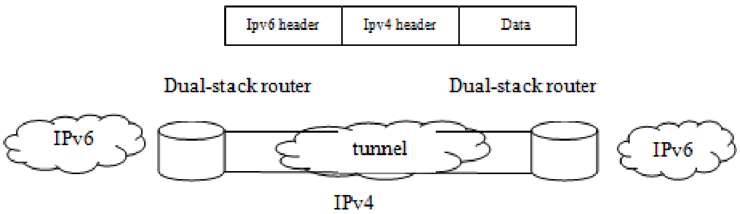

Fig. 2. The IPv6 over an IPv4 Tunnel Architecture

- **Translation techniques:** This technique allows the IPv6-only nodes to communicate with IPv4-only nodes. Translation is a way to make a connection between networks that are using different protocols; it translates IPv6 traffic to IPv4 or vice versa as needed. One translation methods is the Network Address Translation—Protocol (NAT-PT) in which translation can be configured statically or dynamically to translate IPv6 address to IPv4 or vice versa.

It can be noted that these techniques can and will likely will be used in combination with one another.

II. Simulation Setup

In this paper the Optimized Network Engineering Tool (OPNET) version 17.5 network simulation tool is used to run simulations on the three techniques mentioned earlier. The OPNET simulator tool is capable of simulating and analysing the network performance parameters such as delay, packet loss, and throughput.

The components used in the suggested network models running on OPNET 17.5 device used in the network are six clients, two switches, and three routers. To represent an IP-based gateway running and supporting up to two Ethernet interfaces at a selectable data rate, the label switch (ethernet16_layer4) and label router (tr2_slip8_gtwy_adv_6upgarte) are used. The IP packets arriving on the input interface are routed to the appropriate output interface based on packet destination IP address. The setup uses the following models and configurations and for the purpose described below:

- **The ethernet16_switch node model** is used to represent a switch that is supporting up to 16 Ethernet interfaces.
- **The Ethernet wkstn _adv node model** is used to represent a workstation with client-server applications running over TCP/IP and UDP/IP.
- **The Application_ Config** includes a name and a description table that specifies various parameters for the different applications (i.e. web browser HTTP Heavy and FTP heavy applications). The specified application name is used while creating user profiles on "Profile_ Config" object.
- **The Profile_ Config** is used to create user profiles. These user profiles can be specified on different nodes in the network to generate application layer traffic. The applications defined in the Application_ Config are used by this object to configure profiles. Traffic patterns can be specified followed by the configured profiles and the applications.

Fig 3. shows the network topologies used in the current study as modelled within OPNET simulator.

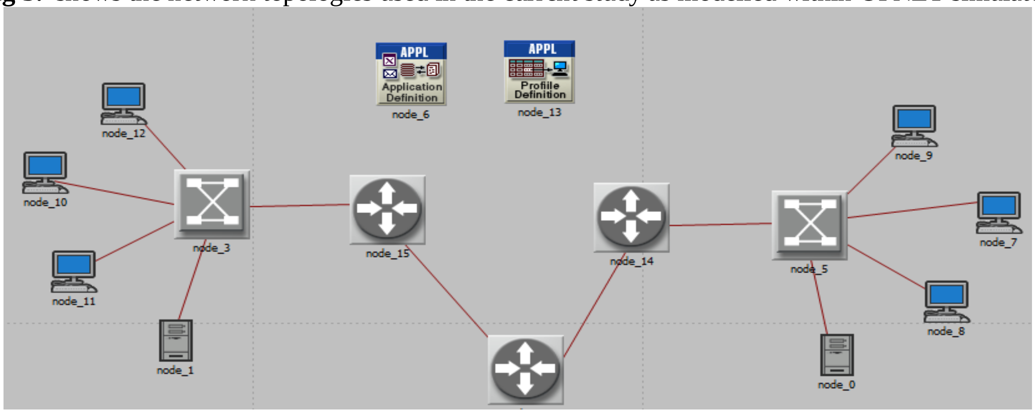

Fig. 3. Network Architecture (Dual-Stack, NAT-PT, and Tunnel).

III. Results And Analysis

A simulation period of 1 min (60 sec) is chosen to demonstrate the network performance.

A. Ethernet delay Performance:

Fig. 4 shows a plot of Ethernet delay against time for the dual stack, NAT-PT, and tunneling configurations. The graph shows that all of the three configuration exhibits transient state that roll off into steady state for simulation time that is more than 20s or (30%). The tunneling configuration has depicted the lowest delay values of approximately 75ms towards the end of simulation period. Both dual-stack and NAT-PT exhibited longer delay time of approximately 85-90ms

B. Throughput Performance:

The throughput is defined as the amount of data packet successfully received by the destination node and it is usually measured in bits per second (bits/sec). Fig.5 shows the throughput results between dual stack, NAT-PT, and tunnelling techniques. The simulation results exhibits a transient behaviour for a short period of time at the beginning of the simulation period (~5ms). This is followed by a steady state behaviour where throughput values settles to about 100bits/sec for dual-stack and NAT-PT techniques, while tunnelling throughput settles at about 200bis/sec. It can be also be noted that as the simulation time approaches the end, the throughput values of all techniques become comparable.

C. Packet loss (traffic drop) Performance:

The packet loss which represent the traffic drop results are shown in Fig. 6 for the dual-stack, NAT-PT, and tunneling configurations. All the configuration exhibits a zero packet drop for initially (~5ms), then the drop amount increases sharply with an overshoot behavior. As time progresses, the drop settles to a steady values. The tunneling techniques exhibited smaller drop packet values of about 1(packet/sec) when compared to the dual-stack and NAT-PT techniques that shows about a drop of about 1.4(packet/sec)

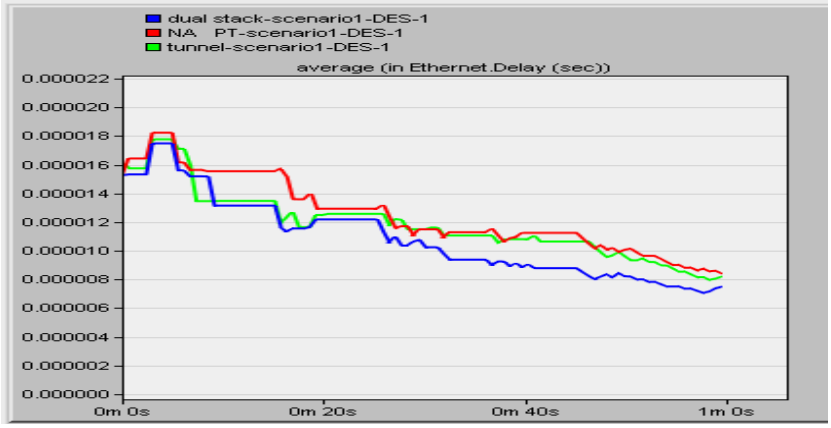

Fig. 4 Ethernet delay for the three techniques.

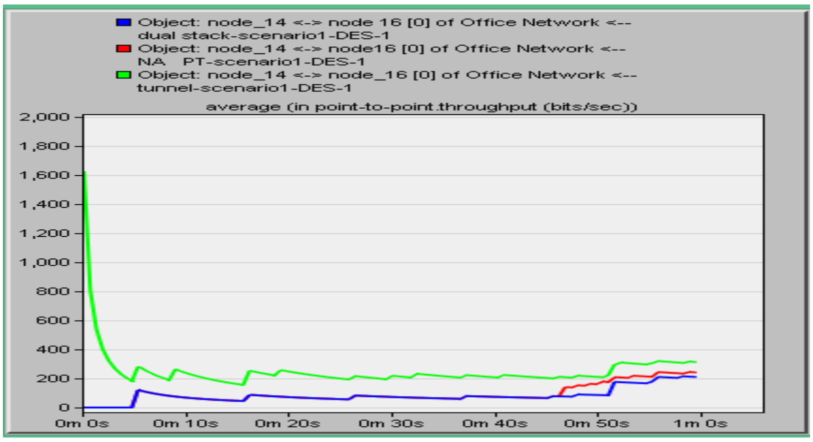

Fig. 5 Throughput performance of Dual-stack, NAT-PT, and Tunneling configurations.

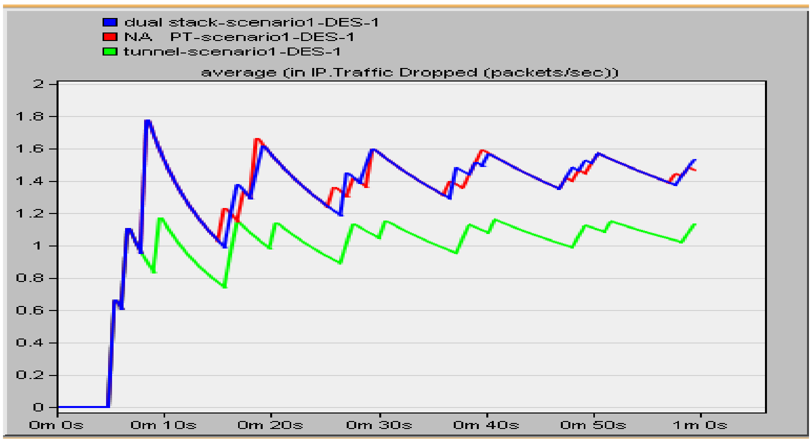

Fig. 6 packet drop (packet loss) for the dual-stack, tunneling and NAT-PT techinques.

IV. Conclusions

An investigation of network performance on dual-stack, NAT-PT translation, and tunnelling techniques as part of migration investigation of IPv4 to IPv6 infrastructure. The open source network modeller OPNET V17.5 is used in the study to simulation for Ethernet delay, throughput, and drop packet for each techniques. A transient behaviour is observed on all of the network performance quantities initially and they settle to steady state. Simulation of throughput shows values of 100bits/sec for the dual-stack and NAT-PT techniques and 200bit/sec for the tunnelling. For the packet drop, it was observed that the tunneling techniques exhibited a packet drop about 1.0(packet/sec) while the dual-stack and NAT-PT techniques exhibited a packet drop of about 1.4(packet/sec)

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