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Research on the Effective Interoperability between Heterogeneous Data Communication Networks Based on Dual-Protocol Stack and Tunnel Transition

G. Saranyadevi
Assistant Professor, ECE Department, SRM University, Tamil Nadu, India
K. Tamizhelakkiya
Assistant Professor, ECE Department, SRM University, Tamil Nadu, India
G. Annapoorani
Assistant Professor, ECE Department, SRM University, Tamil Nadu, India
E. Anusha
Assistant Professor, ECE Department, SRM University, Tamil Nadu, India

Abstract:
Based on the effective interoperability between Heterogeneous data communication networks, IPv4 and IPv6, the performance of two kinds of mechanism options, double-stack protocol and tunneling techniques (manual and auto) are analyzed and tested. The result shows that there are some performance advantages on dual stack and tunneling protocol mechanisms as compared to the reference IPv6 network. The result was analyzed using the parameters- Latency, Throughput and RTT (round trip time).

1. Introduction

IPv4 is the oldest and widely used network. But the IPv4 network has many disadvantages, especially the lack of address space as well as the network security flaws, the next generation IPv6 network has solved many of these issues. The IPv6 has solved IP address crisis, which expands IP addresses from 32-bit to 128-bit. But all the networks are not upgraded to ipv6. There is limitation of compatibility between IPv6 and IPv4, hence it was essential to create an interoperability between ipv4 and ipv6. So, transition mechanism from IPv4 to IPv6 is studied widely, mainly focuses on dual stack mechanism and the tunnel mechanism. This paper describes the principle of transitional mechanism, makes a comparison and analysis by testing the performance of IPv6 based on commonly used transition mechanism.

2. Transition Mechanism

2.1. Dual-stack Protocol

The dual stack approach consists of providing all hosts/routers with both the IPv4 and IPv6 protocol stacks. Dual stack hosts/routers are able to communicate with both the IPv4 and IPv6 systems simultaneously. The following is a simple description of how dual stack operates:

- If the destination address used by the application is an IPv4 address, then the IPv4 protocol stack is used.
- If the destination address used by the application is an IPv6 address, then the IPv6 protocol stack is used.

Applications choose between using IPv6 or IPv4 with the application selecting the correct address based on the type of IP traffic and particular requirements of the communication.

2.2. Tunnel Mechanism

Another transition mechanism used to create the interoperability between the IPv4 and IPv6 network is the 6to4 tunneling mechanism. The basic concept of this mechanism is to encapsulate an ipv6 datagram into an IPv4 datagram to make the IPv6 packet become part of IPv4 packet and send it to the destination host/router supporting the dual stack protocols through the IPv4 tunnel. At the point where IPv4 datagram leaves the tunnel of IPv4 network, the dual-stack routers will forward data, the original IPv6 packet, to the IPv6 protocol stack. The two types of tunneling discussed in this paper are auto tunneling and manual tunneling.

2.2.1. Auto Tunneling

An automatic tunnel allows isolated IPv6 domains to be connected over an IPv4 network to remote IPv6 networks. In automatic tunneling the routers are not configured in pairs because they treat the IPv4 infrastructure as a virtual non broadcast multi access (NBMA) link. The IPv4 address embedded in the IPv6 address is used to find the other end of the automatic tunnel.

2.2.2. Manual Tunneling

In the manual tunneling both the source and destination address are assigned to the tunnel. It is a simple point-to-point tunnel that can be used within a sight or between sights. It is equivalent to a permanent link between to IPv6 domains over an IPv4 backbone.
The hosts/routers at both the ends of the tunnels should support dual stack protocols. The major difference between auto and manual tunnel is the former is a point to multipoint tunnel whereas the latter is a point to point tunnel.

3. Performance Test Design and Analysis

The parameters that have been analyzed in this paper are latency, throughput and round-trip time by comparing the performance of reference IPv6 network with none of the above mechanism to the performance of the IPv6 network enabled with the above discussed mechanisms. The results prove that these mechanisms provide an effective interoperability between the IPv4 and IPv6 networks.

3.1. Testing Structure

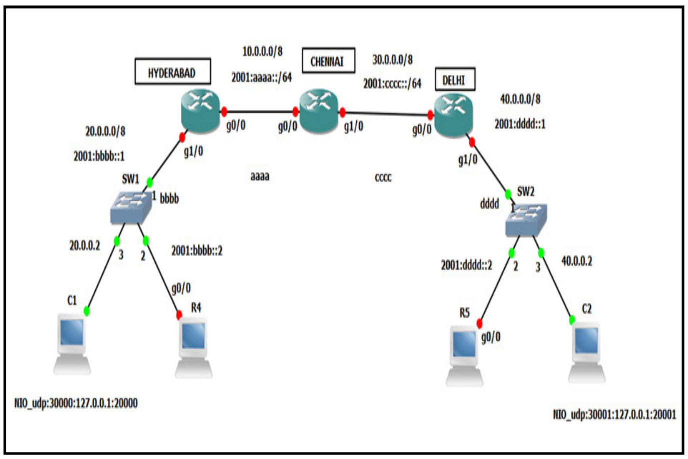

Figure 1: Dual stack protocol

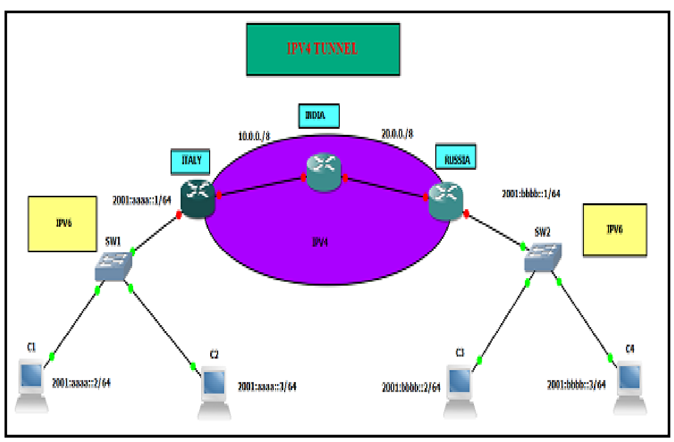

Figure 2: Tunnel mechanism

3.2. Test Analysis

3.2.1. Round-Trip Delay Time Test

It is defined as the length of time it takes for a packet to be sent plus the length of time it takes for an acknowledgement of the signal to be received. This time delay consists of propagation time between the two points of a signal. The graph is plotted by sending 5 sequence of packet for each packet size and the RTT values in ms are averaged on y-axis and on the x-axis the packet size is taken in bytes. For a system to work efficiently the RTT value should be less.

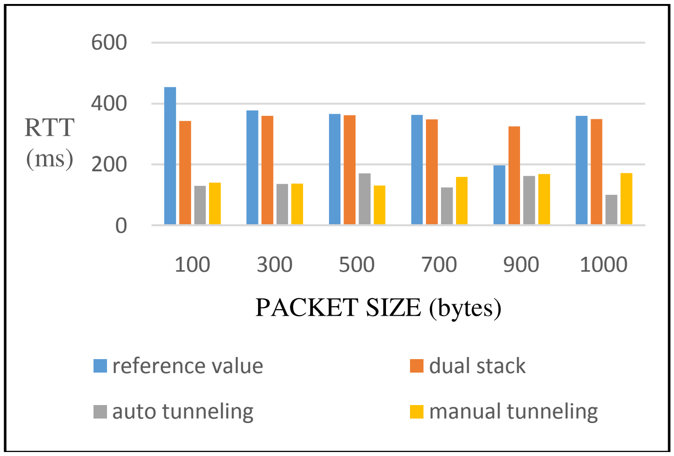

Figure 3: RTT graph

3.2.2. Latency Test

The amount of time it takes a packet to travel from source to destination is defined as latency. The formula used for calculating latency is L= (RTT)/2 where L=latency and RTT= average value of round trip time. The graph is plotted by taking the x-axis as the packet size in bytes and the y-axis as the latency in ms. For a system to work efficiently the latency value should be less.

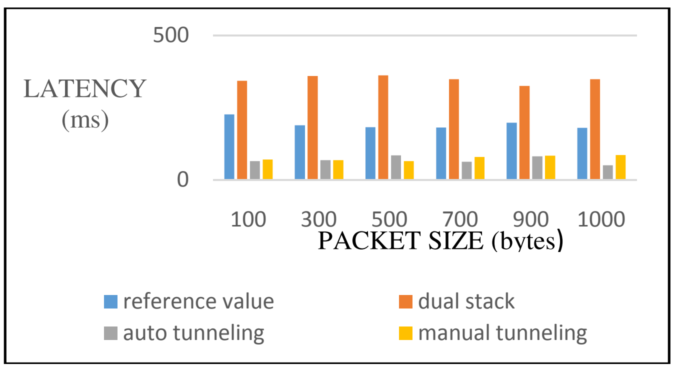

Figure 4: Latency graph

3.2.3. Throughput Test

The amount of packet data that is transmitted over the entire path per unit time is called throughput. The throughput is calculated from the formula T=P/L where T represents the throughput, P represents the packet size and L represents the latency. The packet size is considered from 100 to 1000 bytes and each group's result takes the average value of 5 times test. The following figure shows comparison result of IPv6 network with and without dual stack and tunneling transition mechanisms. The x-axis is taken as packet size in bytes and the y axis is taken as throughput in kbps. For a system to work efficiently the throughput value should be more.

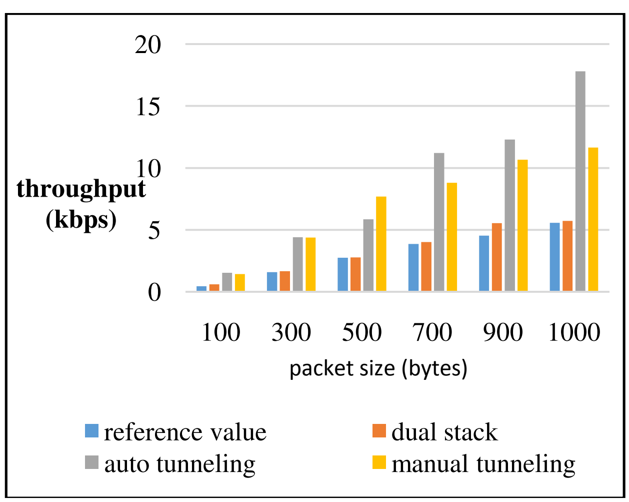

Figure 5: Throughput graph

4. Conclusion

The transition mechanisms of IPv6, the dual stack protocol, auto tunneling mechanism, and manual tunnel network performance are studied and tested based on program implemented by our group. In general, results indicate that the tunneling and dual stack mechanisms have better performance which provide effective interoperability between IPv4 and IPv6 data communication networks compared to a normal IPv4/IPv6 network and it can be clearly observed from low latency and high throughput from the graphs

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