January - February 2020
ISSN: 0193 - 4120 Page No. 4665 - 4671

Weight Based Transition Algorithm for IPv4 to IPv6 Inter Communications

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Abstract:
The IPv4 address space has almost exhausted with global Internet address space, which urges the community to transit into IPv6 address space. The transition from IPv4 to IPv6 is unavoidable to the community; however, this transition has not happen as anticipated. It is unavoidable to have both IPv4 and IPv6 networks during the transition period, but unfortunately they are not compatible in nature. So it is essential to maintain the IPv4 and IPv6 abilities and the inter-communication ability of IPv4 and IPv6 has to be provided. Many transition techniques are proposed in the recent years, but they obsolete by IETF due to their flaws and their technical immatureness [7]. This paper considers key difficulties in IPv4-IPv6 transition, and introduced the new transition algorithm namely weight based transition algorithm, which used the advantages of weight and tunneling translation techniques for providing inter-communication ability of IPv4 and IPv6. The proposed algorithm has simulated and the performance is discussed with the existing algorithms.

Keywords:*IPV4, IPV6, ISP, transition techniques*.

I. INTRODUCTION

The digital world is consisting of network of networks which are connected through Internet. The Internet provides platform to exchange the information among the networks. The rapid developments of digital world in the recent decades lead more demand for IP address. Today, the Interne is unavoidable connectivity to retrieve the information from one point to another in the world. In late 1960s, the IPv4 was developed without anticipating the actual need of enormous number of addresses today [8].

The IPv4 provides 4.3 billion addresses in which 3.7 billion addresses has been allocated to ordinary devices. It was anticipated that the IP address could cover all future needs. But there was a high demand for IP address due to the rapid growth of Internet in 1990s. In 2011, there was no new allocation of new block of addresses to regional Internet registry [14,15]. Hence, the IETF was given the task to develop new address space mechanisms which can be a successor to IPv4 [3]. In 1995, the IP version 6 (IPv6) were developed [7]. The IPv6 has many improvements includes 128-bit address scheme and built-in security with IPsec.

The IPv6 yielded the deployment challenges in IPv4-based infrastructures [4]. The replacement of IPv4-based infrastructure with IPv6 is costly and impractical for the small size organizations [21]. The IETF IPng Transition Working Group [24] has proposed many transition strategies to deploy IPv6 into existing networks successfully [9]. The IPv4 wraps the IPv6 and transmit it into IPv4 network. The transition strategy is an idea of using IPv6 over the IPv4. The objective of the research work is to propose a new transition mechanism and evaluate it with the other transition mechanisms in the state of the art.

II. BACKGROUND

In the early 1990s, it was identified that IPv4 address space would not be sufficient by 2000 [24]. Some temporary solutions were offered to deal with the shortage of address space [1]. The IPv6 enhanced

January - February 2020
ISSN: 0193 - 4120 Page No. 4665 - 4671

in many ways. The number of bits in the address space is increased from 32 to 128 [2]. The Flow label field of IPv6 supports payload identification to QoS handling [12]. The IPv6 has extension headers instead of option filed as in the IPv4. The DHCP (Dynamic Host Configuration Protocol) is used for IPv6 configuration and hence there is no manual configuration is required. The size of the header is increased to 40 bytes from 20 bytes of IPv4. The number of required fields is reduced and many fields are made as optional in the extension header. In the IPv4 protocol address is 32 bits long hence 2^{32} = 4,294,967,296 addresses are available theoretically. In the IPv6 protocol the addresses is 128 bit long hence 2^{128} ~ 3.4 * 1038 addresses theoretically. The dot-decimal notation used to represent the IPv4 addresses. Every byte in the address is represented by a decimal number with the dot separation. The colon notation is used to represent the IPv6 address. Every two bytes are represented by four digit hexadecimal numbers. The header length filed is removed in IPv6 as the header size is fixed as 40 bytes. Some other fields such as identification, fragment offset and options have been moved into extension header. As TOL is increase or decrease at every hop and the IPv6 relies on upper levels protocols, the header checksum filed is removed [13]. In IPv4, the length of Header Length filed is 4 bits, thus the maximum_size of the header is 60 bytes. In theory the performance over heads of IPv4 and IPv6 is minimal as the Ethernet MTU size is 1514 bytes, the 20 bytes of additional header space yields 1.3% additional overheads. The other additional overheads of encapsulating IPv6 into IPv4 cause another 1.3% additional over heads as 2.6% total additional overheads. The transition mechanism is unavoidable due to rapid increase of the size of the nodes in the Internet. Many techniques are available to transit IPv6 packets over the IPv4 network.

III. Transition Mechanisms

The IPv6 is deployed gradually with the existing IPv4 networks. As IPv6 is not backward compatible, it is could not send packets to IPv4 networks, hence there is need of co-existence IPv4 and IPv6 infrastructure [11]. The transition mechanism plays a compatible role in between the IPv4 networks and IPv6 networks [5,6]. The transition mechanism enables the transition in the co-existence of IPv4 and IPv6. The transition mechanisms are basically divided as follows: Dual Stack, Translation and Tunneling [16].

a) Dual Stack Transition Mechanism (DSTM)

The Dual-stack method consists of both IP stacks (IPv4 and IPv6) in a single node [10]. Both protocols run in parallel to provide the end to end service for the user as shown in figure 1. The common shared transport layer protocol is used by IPv4 and IPv6. TCP/IP model for dual stack node is shown in figure 2.

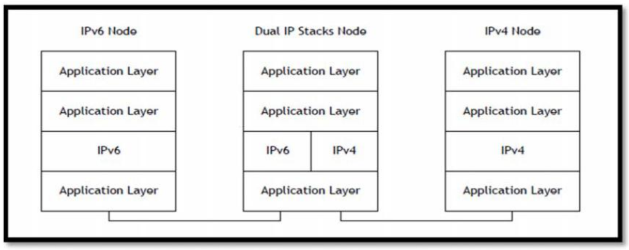

Figure 1: Dual stack TCP/IP model

The challenge in the Dual stack approach is that it required IPv4 and IPv6 are to be deployed in the same infrastructure [1]. The node should be able to understand and process both IP protocols network as required. The routing protocol decides that which IP protocol to be used based on the requirements soughed [17,18].

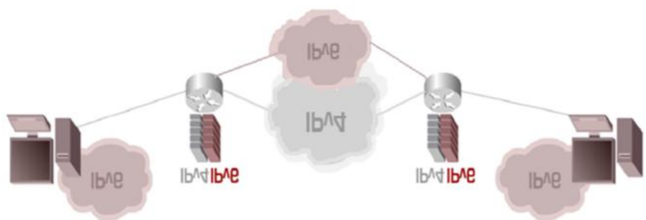

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Figure 2: Dual stack Infrastructure

January - February 2020
ISSN: 0193 - 4120 Page No. 4665 - 4671

b) Translation Mechanisms

The translations mechanism converts the IP protocols from IPV4 to IPv6 and vice versa directly. It works in the principles of transformation of header and payload of the IPV4 and IPv6 protocols. The Translation mechanisms uses translators that can translate given IPv4 address to corresponding IPv6 address as in figure 3. As this mechanism make a break in end to end network; this would not be a good choice. Some of the translation mechanisms are SIIT, BIS, BIA, NAT-PT, TRT.

c) Tunneling Mechanism

Tunneling provides the ability to deal with IPv6 traffic in IPv4 infrastructure. The IPv6 packet is encapsulated in IPv4 traffic in order to provide a tunnel for IPv6 packets to carry through IPv4 infrastructure. Tunneling is used in the where the networks infrastructure is not capable of dealing with the IPv6. The deployment of tunneling is simple and no additional management is required. Tunneling is required to be configured at the end point only. On the other hand, the Tunneling takes more CPU time and has a single point of failure. Many tunneling techniques are employed which are includes Static Tunneling, Intrusive Automatic Tunnel Addressing protocol (ISATAP), 6 to 4 Transition Mechanism.

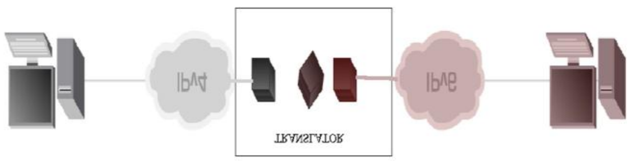

Figure 3: Translation Mechanism Infrastructure

d) Tunneling Mechanism

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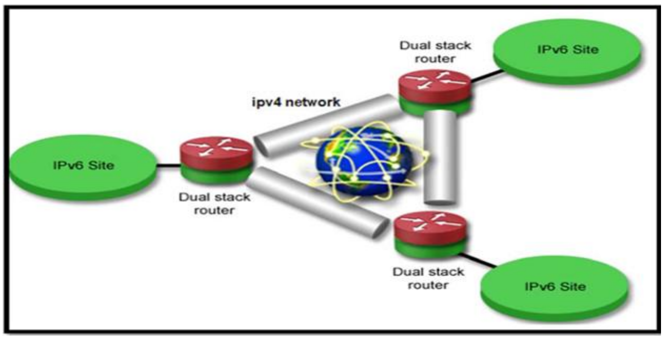

Figure 4: Static Tunneling

i. Static Tunneling

Static IPv6-in-IPv4 tunneling requires the static configuration of tunnels on dual-stack devices in order to allow IPv6 packets to be tunneled across the IPv4 network infrastructure as shown in figure 4.

While the tunnel is assigned an IPv6 address, the tunnel source and destination addresses are configured using the IPv4 addresses of the two end-point routers. The tunnel destination address is the address that is included in the IPv4 packet header, which allows other intermediate devices that are only running IPv4 to know where to send these packets. The static tunneling from IPv4 to IPv6 is shown in figure 4.

ii. ISATAP

ISATAP is used in the local site to enable the IPv6 communications over the IPv4 networks infrastructure. A special dual stack ISATAP router is required to perform the tunneling over the IPv6 networks. The tunneling has established by using the Dual stack routers and hosts over IPv4 networks as shown in figure 5.

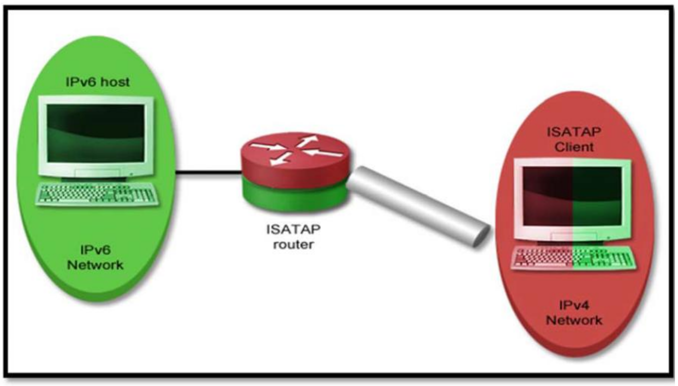

Figure 5: ISATAP Tunneling

iii. 6 to 4 tunneling

In 6-to-4 tunneling is established by configuring the routers at different sites. The endpoints are configured by default between devices. The dual stack router supports as the tunnel endpoints. Only IPv6 Hosts can make 6-to-4 tunneling through NAT. The IPv6 site is associated with the IPv4 address at the tunnel end point as shown in figure 6. For example, a router with the IPv4 address of 207.142.131.202 would converted with the prefix of 2002: CF8E:83CA: :/48. The 6-to-4 tunneling used dynamic configuration hence the 6-to-4 tunneling deployment is simple. The 6-to-4 tunneling is shown in figure 6.

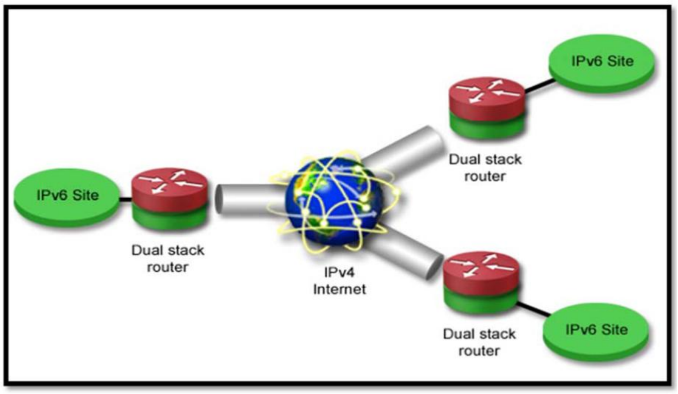

Figure 6: 6-to-4 Tunneling

IV. WEIGHT BASED TRANSITION ALGORITHM

The proposed weight based Transition algorithm is designed using the router-to-router tunneling mechanism. The Weight vector "w" is computed empirically using the past history of the transmission [19,20]. The Weight vector "w" is re-determined for particular interval of time "T" based on the recent past transmission history. The Weight Vector "w" represents the priority of the transmission by considering the importance factors of the IPv4 to IPv6 conversion [7].

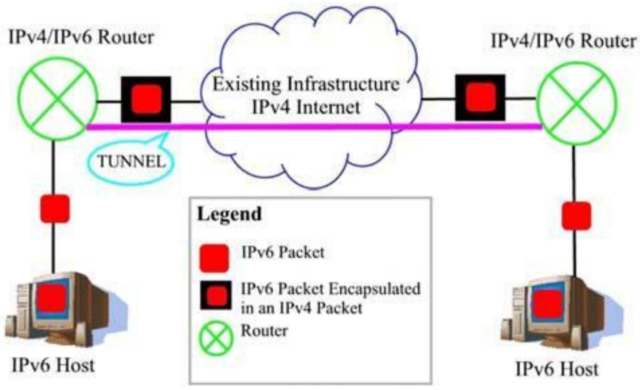

Figure 8: Weight Based Router – Router Tunneling

The packets are encapsulated with its weight value w[i] at the IPV4/IPv6 source and used at the IPv4/IPv6 destination.

The encapsulation is carried out at edge router carried out. Tunneling is established between the routers of the edge with the ability to analyze the weight vector "w". It emphasis the importance of the conversion and those packets will be treated as specified to reduce the conversion overheads. The weight Vector is obtained as W = (0.5, 0.3, 0.2) on Throughput, RTT, Packet Loss empirically by doing the trail experiments. The Throughput, RTT and Packet Loss were considered with respect to the nature of the packets pattern. The packets are queued in the waiting queue for conversion transition, a packet is selected for conversion based on the weight value of the packet. The packet with greatest weight

January - February 2020
ISSN: 0193 - 4120 Page No. 4665 - 4671

is selected for conversion and hence RTT latency and loss rate are expected to be improved.

V. Experimental Setup

Due to space and equipment limitations, a virtual network was simulating the real one using VMware ESX 5.1. The Graphical Network Simulator-3(GNS3) was used as emulator. A Virtual Machine (VM) running CentOS was used to implement GNS3. Our testbed consisted of two dual stacks, two identical workstations configured as separate networks with the 100Mb/s link. The experiments were executed for a sufficiently long period of time and results are taken for the exchange of 32B packets to 1,024B packet size. The empirical measurement was conducted based on the results obtained. The round-trip latency and the Loss Rate were considered as the performance metrics for comparative analysis [22]. The latency is identified as the round-trip latency (RTT) [23]. The Loss Rate (LR) is defined as "the ratio between numbers of packets lost to the total number of packets sent".

VI. Results and Discussion

The results were obtained by sending 32MB, 64MB, 128MB, 256MB, 512MB and 1024MB bytes' size packets using in GNS3 simulator.

Table 1: Results obtained for the various file size

Size (MB)	Tunneling		6to4		Weight Based Transition	
	RTT(ms)	LR(%)	RTT(ms)	LR (%)	RTT(ms)	LR(%)
32	68	0	49	30	39	5
64	69	2	50	30	40	5
128	71	2	51	30	42	5
256	73	2	54	32	45	5
512	76	2	58	32	48	6
1024	81	2	62	32	51	6

The simulation results showed that Weight Based Transition algorithm performed better in RTT latency while comparing with the tunneling and 6to4 transition algorithms. The graphical illustration is shown in figure 9. The Weight Based Transition algorithm yielded the better Loss Rate compare than 6to4 transition algorithm, but the Loss Rate is higher than Tunneling transition algorithm as illustrated in the figure 10.

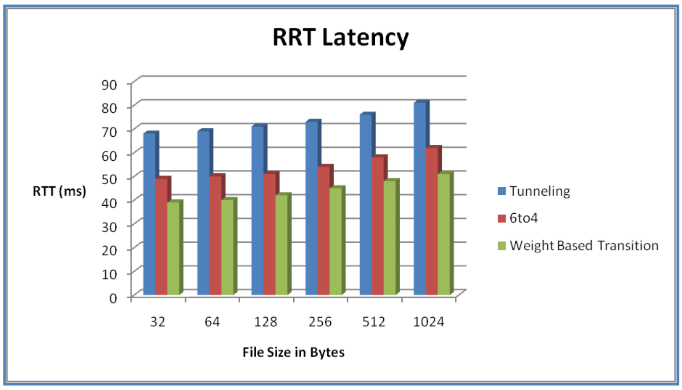

Figure 9: RTT latency in various Transition algorithms

Figure 10: Loss Rate in various Transition algorithms

VII. Conclusion and Future work

IPv6 overcomes many of the limitations over IPv4 with new features and functionalities with the ability to support IPv4. The large address space of IPv6 is able to provide the larger address space globally. But the environment is to be upgraded from the existing

January - February 2020
ISSN: 0193 - 4120 Page No. 4665 - 4671

facilities to use IPv6. The organizations are to be prepared for these changes in terms of technical, hardware/software support and economical terms. It may take 5-10 years time with respect to their ability. It was found that the proposed Weight Based Transition algorithm yielded the better performance in RTT latency compare than tunneling and 6 to4 algorithms. The proposed Weight Based Transition is outperformed in RTT as 42.65%, 42.03%, 40.85%, 38.36%, 36.84% and 37.04% than Tunneling for 32MB, 64MB, 128MB, 256MB, 512MB and 1024MB size of the packets. The proposed Weight Based Transition is outperformed in RTT as 27.94%, 27.54%, 28.17%, 26.03%, 23.68% and 23.46% than 6-to-4 transition for 32MB, 64MB, 128MB, 256MB, 512MB and 1024MB size of the packets. However the proposed Weight Based Transition algorithm under performed in Loss Rate while compare than tunneling, but outperformed than 6-to-4 conversion transition. The proposed algorithm has reduced the Loss Rate as 83.33%, 83.33%, 83.33%, 84.38%, 81.25% and 81.25% for 32MB, 64MB, 128MB, 256MB, 512MB and 1024MB size of the packets . The future work of the proposed algorithm will be carried in the different configuration setup and additional performance parameters will be considered for quantifying the performance of the proposed algorithm.

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