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A Review on Network Performance Evaluation of 6to4 Tunneling

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Abstract— **In the last decade, the number of internet users is growing rapidly. With the high demand of internet users, the use of Internet Protocol (IP) addresses is nearly overused. From this problem, an alternative to overcome the IP address problem is required. IPv6 is one of the potential implementation IP addresses to replace the use of IPv4. Currently, network implementation using IPv4 – IPv6 are used simultaneously. This method is known as the transition mechanism. In this paper, a critical review analysis is performed for network performance evaluation of 6to4 tunneling. In conclusion, some of the suggestions are given as an improvement for further study**

Keywords— **Network, performance, transition mechanism, tunneling, 6to4, IPv6, IPv4**

I. INTRODUCTION

Currently, the internet has become a global phenomenon around the world. It is because the internet is the heart of information sharing that makes the sharing more convenient and reliable. Besides, the internet also performs inter-connection networks that make all of the people around the world become connected to each other. The demand of internet users caused the use of Internet Protocol (IP) to be nearly depleted. This might happen due to the limitation of the IPv4 network especially in the lack of address space [1]. IPv4 is implementing a 32-bit addressing schema which means the upper limit of users is approximately 4.3 billion IP addresses. It becomes critical when the number of unused addresses decreases and is nearly extinct.

In order to overcome this problem, the new generation of IP addressing arose, which is the IPv6 network. It was developed by Internet Engineering Task Force (IETF). The implementation of IPv6 is believed to become a great potential replacement for the IPv4 network. It is because the main purpose of IPv6 is to grow the number of IP addresses. IPv6 may expand the IP addresses from 32-bit to 128 which may help to solve the IP address crisis. However, the migration to the new version of the internet is going very slow. Those happen due to many reasons. One of the reasons is the limitation of compatibility in the implementation of IPv6 and IPv4 [1]. Therefore, the transition mechanism of IPv4 to IPv6 is studied widely. The purpose of the transition mechanism is to provide a smooth transition from IPv4 address to IPv6 address. The transition mechanism can be categorized into three types: tunneling mechanism, dual-stack, and translation mechanism [2]. In this paper, a review based on the network performance evaluation of 6to4 tunneling is performed. This paper aims to provide a critical analysis and review of the paper regarding network performance evaluation of 6to4 tunneling.

The rest of the paper is organized as follows: Section II contains a background of internet protocols and transition mechanisms. In section 3 a review for the main paper is conducted. The discussion about the review will be described in section 4. Finally, section 5 is the conclusion from the overall critical review.

II. BACKGROUND

In this section, a comparative study related to the topic is conducted to support the importance of the research. The main focus study in this research is about internet protocol and transition mechanism that will be explained in this section.

A. Internet Protocol (IP)

TCP / IP is a data communication standard used by the internet community in the process of exchanging data from one computer to another which was built in version 4 in 1981. IPv4 has been in use on network infrastructures of all sizes and the Internet for more than 30 years. It has evolved from small experimental linkages within the IPv4 developed from a small experimental relationship and has resulted in performance, capability and led to occupy a dominant position in the growth of internet usage [2]. However, the use of IPv4 has a limitation: these usable addresses have been exhausted and nearly extinct. Due to this problem, a new generation of IPv6 is established. IPv6 is the evolutionary successor of version 4 and has been designed to address some of the major shortcomings of IPv4 network environments [3]. The main purpose of designing a new Internet Protocol (IPv6) is to grow the number of IP addresses. Basically, IPv6 addresses are designed as 128-bit (16-byte) addresses, while IPv4 only provides 32-bit (4-byte) addresses. However, IPv4 and IPv6, are used simultaneously on the Internet network. Both protocols are used simultaneously by using a transition mechanism.

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B. *Transition Mechanism*

The transition mechanism is a technique that allows the transition of IP addresses from IPv4 to IPv6. The implementation of a transition mechanism allows the IP transition to run smoothly. As stated before, there are three kinds of transition mechanisms that can be implemented in the network. Those are translation, tunneling, and dual-stack mechanism [2][4]. Each transition mechanism has its own characteristic

C. *Translation Mechanism*

The translation mechanism is one-to-one field mapping between IPv4 and IPv6. The translation mechanism enables the communication between IPv4 and IPv6 devices. This mechanism works by converting the source address type into destination address type [3]. There are many varieties of protocols standard for the translation mechanism such as bump-in-the-stack (BIS), bump-in-the-API (BIA), bump-in-the-host (BIH), Stateless translation mechanism (SIIT), classical Network Address Translation (NAT), and Port Address Translation (POT).

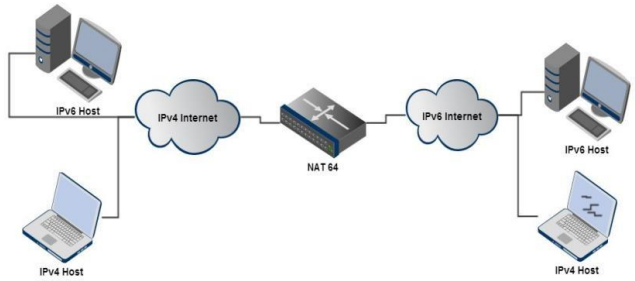

Figure 1. Translation mechanism [3]

D. *Dual-stack Mechanism*

Dual stack mechanism is the mechanism where all hosts/routers maintain both protocol IPv4 and IPv6 stack. This mechanism is able to communicate both IPv6 and IPv4 systems. When communicating with IPv6 host dual-stack use IPv6 address and vice versa for IPv4 host and IPv4 address. Dual stack mechanism use application selection to choose the correct address based on the type of IP traffic and particular requirement of the communication [1]. In a real-world implementation, dual-stack protocol on IPv4 and IPv6 networks has used both protocols simultaneously.

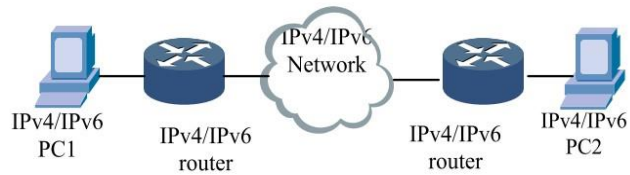

Figure 2. Dual-Stack Mechanism [1]

E. *Tunnel Mechanism*

The tunneling mechanism is a kind of transition mechanism that encapsulates IPv6 packets in IPv4 packets. This mechanism allows carrying data for transmission over incompatible networks so that the tunneling mechanism allows IPv6 to process and maintain the IPv4 network infrastructure. [2]. In other words, this mechanism provides a safe route under an insecure network. There are several tunneling mechanism protocols that can be implemented. Those are Generic Routing Encapsulation (GRE) IPv6 tunnels, 6to4 tunnels, IPv6 rapid deployment (6th), and Intra-Site Automatic Tunnel Addressing Protocol (ISATAP) tunnels [3][4].

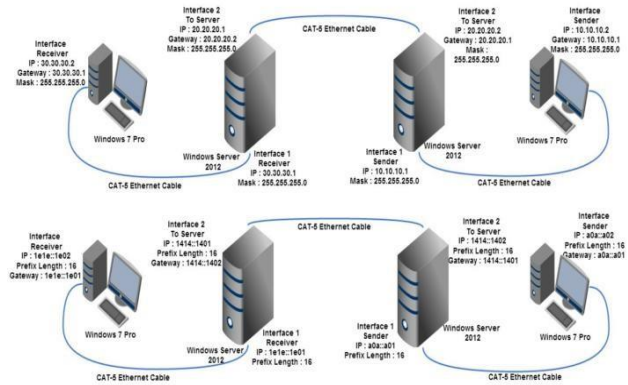

Figure 3. Tunneling mechanism [3]

III. RELATED WORK: REVIEW

In this section, the author will provide a critical review in the performance evaluation of 6to4 tunneling by Bahaman et al [2]. It will discuss connectivity and Packet Flow tests which aimed to monitor traffics activity. Besides that, there are also other procedures described to achieve research objectives, those are Throughput, Round Trip Time (RTT), Tunneling Overhead.

A. *Connectivity*

Testing connectivity in the study was conducted by using the ping command and ping6 in the both of two end nodes. The purpose of this testing is to ensure multiplatform operation.

B. *Packet Flow*

The exposure of packet flow in this paper is clearly presented. This was reinforced by the packet viewer. The packet viewer illustrates an example of the packet flow activities gathered, where a represents source IP address, b represents destination IP address, c represents packet type, and represents protocol type and e represents load size.

C. *Throughput*

In this paper, Throughput is the basic Transfer File Protocol (FTP). It is used to calculate the process of downloading files across the networks. Formula 1 is used to calculate the throughput (T), where P represents the transferred data size, and L is for the time cost during transfer.

$$T = \frac{P}{\mathrm{L}} \quad (1)$$

D. Round Trip Time (RTT)

It is the identification process from results of the quality-of-service experienced by nodes in the IPv6 and IPv4 networks. The way to determine the RTT is by calculating a value between 1 and 0 (the smoothing factor) [5][7].

E. Tunneling Overhead

Tunneling involves allowing private network communications to be sent across a public network. Several tunneling there is a combination involving tunneling matter resulting in tunneling overhead. Tunneling overhead occurs because there is a reduction in the round trip time of each protocol against the round trip time of non-tunnel/direct traffic. By calculating tunneling overheads, it will get the maximum results for the round trip time IPv6 network by tunneling and RTT native IPv6 network [6].

IV. DISCUSSION

In this section, the discussion about the main paper review regarding the methodology and result is conducted. Regarding [2], network performance assessment is conducted under a controlled environment with basic network components. The network components are including users (sender and receiver), protocols (IPv4, IPv6, and IPv6 in IPv4), transmission device (router and switch), packet monitor (packet viewer), and packet generator (D-ITG). The experiment was conducted in 3 different environments which are the environment in full IPv4, an IPv6 environment entirely, and an environment using tunneling methods.

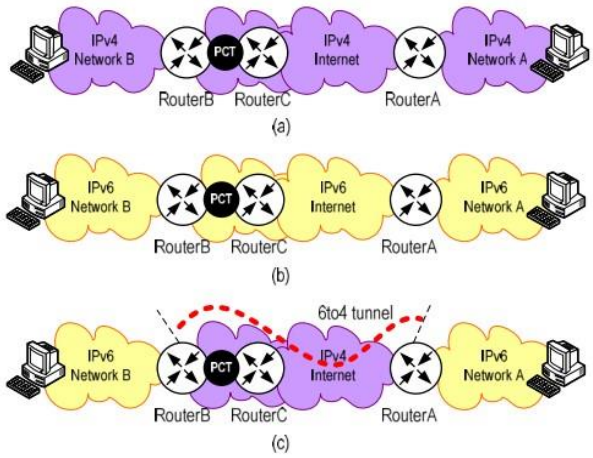

Figure 4. (a) IPv4 (b) IPv6 (c) IPv6 with 6to4 tunneling [2]

Each experiment is repeated 20 times to gain high data accuracy. From the experiment, the results achieved are no effect of the UDP data transmission on each protocol via the selected tunneling. The first one is packet generator simulation which is a simulation of TCP and UDP traffic. The second one is the performance evaluation of UDP and TCP traffic. Thus, the third is the comparison of transmission data between IPv4 and IPv6 networks.

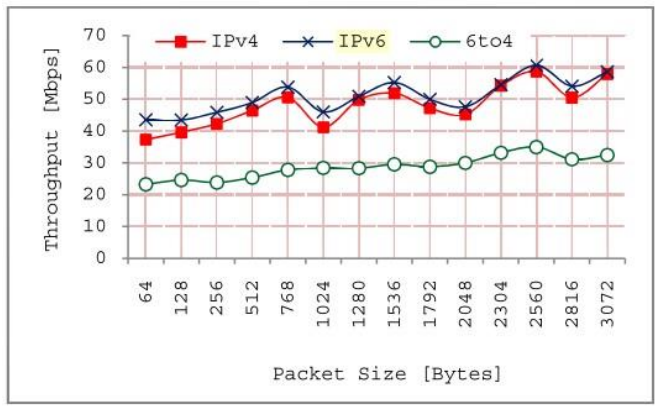

Figure 5. TCP Throughput [2]

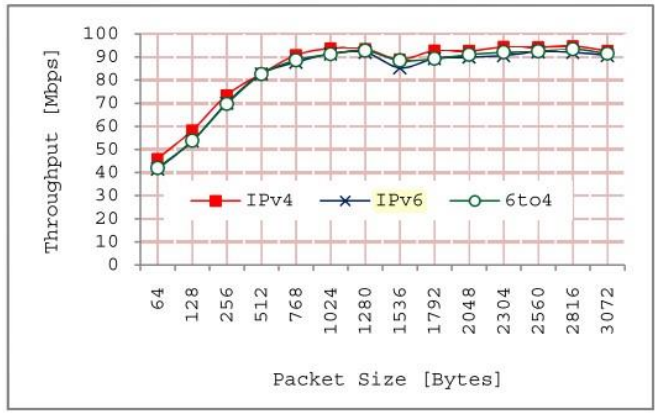

Figure 6. UDP Throughput [2]

Based on the TCP throughput, the internet protocol for IPv4 and IPv6 are producing the same pattern for each packet size. However, 6to4 tunneling provides a throughput result by half of the other internet protocol. Meanwhile, in UDP throughput all of the internet protocols whether IPv4, IPv6, and also 6to4 tunneling are provide a similar line. It can be indicated that it is difficult to differentiate the throughput value between the scenario given.

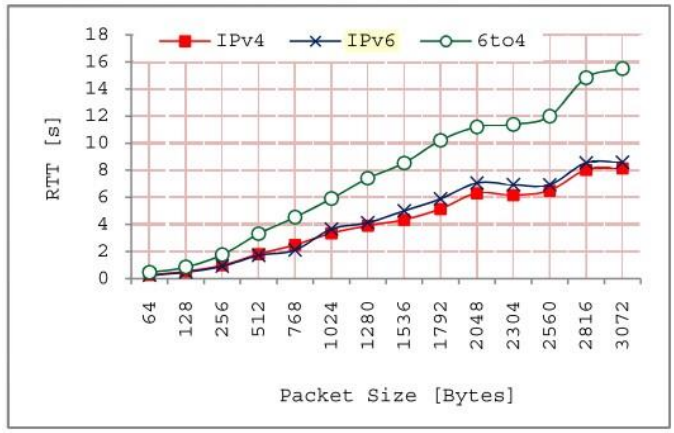

Figure 7. RTT on TCP [2]

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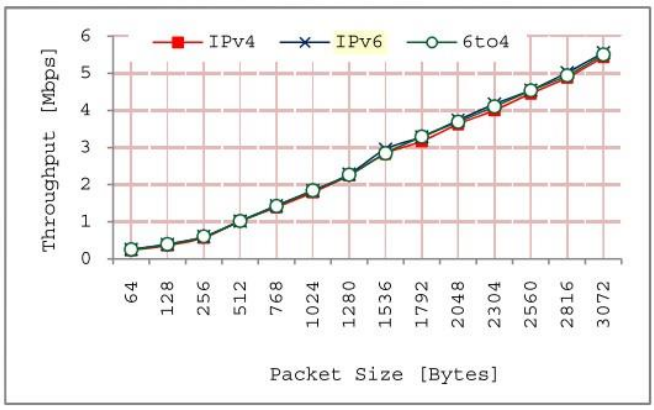

Figure 8. RTT on UDP [2]

For the second evaluation, the result of RTT for TCP and UDP provides a different result. In TCP, IPv4 and IPv6 provide the same graph result. However, for the 6to4 tunnel when the packet size becomes higher the difference with both of IP are become great different. Meanwhile, in UDP all of the RTT results provide the same graph.

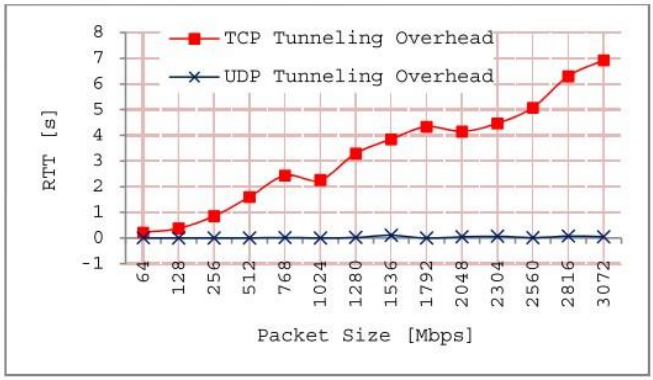

Figure 9. Tunneling overhead [2]

V. Conclusion

The increase of internet users leads to a new problem regarding the availability of internet protocol (IP). This problem arises since the availability of unused IP in the IPv4 address is nearly depleted. Thus, a new version of IP which is IPv6 established to overcome this problem. However, the implementation of IPv6 in the network becomes slower. The compatibility between IPv4 and IPv6 becomes a new problem in the implementation. Thus, the transition mechanism becomes a solution to provide a smooth transition between IPv4 and IPv6 networks. One of the transition techniques is the tunneling mechanism that allows IPv6 packets to come across in the IPv4 network. In this paper, a critical review of network performance evaluation of 6to4 tunneling is conducted. The experiment that has been conducted, shows that 6to4 tunneling is an improper tool since it provides high tunneling overhead for TCP. This is because TCP is the largest contributor to traffic network communication. For further research, testing for another transition mechanism must be conducted in order to analyze the performance of the mechanism.

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