IPv4 to IPv6 Transition Strategies for Enterprise Networks in Developing Countries

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Abstract. Internet Protocol version 4 (IPv4) addresses have been reported to be nearing exhaustion and the next generation Internet Protocol version 6 (IPv6) is gradually being deployed in the Internet. IPv6 provides a much larger address space, better address design and greater security, among other benefits. IPv6 deployment requires thorough and careful preparation to minimize network disruption and ensure that the benefits of IPv6 are obtained. The migration from IPv4 to IPv6 cannot be achieved in a short period thus the two protocols will co-exist for some time. Unfortunately, these two protocols are incompatible; hence for them to co-exist, various IPv4-to-IPv6 transition mechanisms have been developed. In this paper, we analyse the different site-to-site tunneling mechanisms through a theoretical and experimental evaluation to study their appropriateness in IPv6 deployment for enterprise networks in developing countries. Using five performance metrics, namely: end-to-end delay, jitter, throughput, packet loss and CPU utilization, our experimental results indicate that Configured Tunneling performs better than the other tunneling mechanisms. This study is of importance to those enterprise networks which want to implement IPv6 and are concerned about which transition mechanisms to embrace depending on the performance requirements.

Keywords: IPv4-IPv6 translation, GRE tunneling, 6to4 tunneling, Configured tunneling.

1 Introduction

The Internet has continued to grow using multiple vendor equipment across all world geographical areas because of its well defined architectural standard, the TCP/IP protocol suite. Internet Protocol (IP) is one of the protocols within TCP/IP protocol suite and its current operational version in the Internet is IPv4. The IPv4 address space has been reported to be depleted in the Internet Assigned Numbers Authority (IANA) registry in February 2011 [1], while just few are remaining within the regional Internet registries, Afrinic depletion is expected by October 2014 while Apnic is already exhausted[1]. This is projected to affect the growth of the Internet greatly. The Internet Engineer Task

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Force (IETF) considered this issue and proposed a new version of Internet Protocol namely Internet Protocol Version 6 (IPv6). IPv6 is the solution to the massive growth of the Internet due to its huge address space. IPv6 addressing contains 128 bits binary value that provides 2^{128} addresses. This means that there must be a transition and that the current IPv4 should start migrating to IPv6. According to Sailan et al [2], IPv6 network penetration is still low but it is expected to grow. IPv6 is not backward compatible with IPv4. There are also performance differences between the IPv4 and IPv6 based architectures. This means that there are compatibility and interoperability issues relating to IPv4 and IPv6 during the migration period. The transition between IPv4 internet and IPv6 is a long process as they are two completely separate protocols and it is impossible to switch the entire internet over to IPv6 over night. IPv6 is not backward compatible with IPv4 and IPv4 hosts and routers will not be able to deal directly with IPv6 traffic and vice-versa. Because the IPv4 and IPv6 will co-exist for a long time, this requires the transition and inter-operation mechanisms[3]. The Next Generation Transition (NGtrans)[4] proposed three main transition mechanisms which allow IPv4 to be able to coexist with IPv6 during the migration period. These included dual stack, tunneling and translation mechanisms. Whereas there has been several mechanisms of tunneling, the main actively used tunneling mechanisms are 6to4, configured, and GRE tunneling, for site to site tunneling while ISATAP and tunnel brokers like Teredo for host tunneling.

The rest of this paper is organised as follows: Section 2 is the background to the study. Section 3 describes the experimental testbed while the experimental results are reported in Section 4. Conclusions and future works are finally given Section 5.

2 Background

This section describes the IPv6 implementation requirements of enterprise networks in developing countries as well as the theoretical underpinnings of the IPv4-to-IPv6 transition mechanisms.

2.1 Enterprise Network

An enterprise network is a network that has a clear interface with its ISP (generally by using a router or firewall) and provides internal and/or external services.Within the context of an enterprise network, the word IP addressing always brings Network Address Translation (NAT) to mind. Nearly all enterprise networks implement NAT for their IPv4 internet access, placing a clear border between the companys internal network and the internet. IPv4 NAT scales well in enterprises, as it provides enough addresses for practically any known enterprise size implementation. This NATv4 principle violates the end-to-end principle, which has been addressed in the new IPv6. Since NAT implies that there are sufficient IPv4 addresses for any enterprise network, one may wonder