Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2024, 11(1):216-221**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

IPV4 and IPV6 migration using dual-stack features and analyzing

Alliance Kingst TONY-MAYEKO

PhD-Computer of Science
Department: Electronic and Telecommunication,
Research Unit: Laboratory Electrical Engineering
Collage: Marien NGOUABI University
School: ENSP-National Higher Polytechnic School
Country: Rep of Congo
Email: mayeko2005@yahoo.fr

Abstract With IPv4 address space exhaustion fast approaching, it has become a high priority for service providers, enterprises, IP equipment manufacturers, application developers and governments to start deploying IPv6 themselves. A seamless migration from IPv4 to IPv6 is difficult to achieve. Therefore, multiple mechanisms are required to ensure a smooth, gradual, and independent transition to IPV6. Not only the transition, but also the integration of IPv6 into the existing networks is required. The solutions (or mechanisms) can be grouped into three categories: dual stack, tunneling, and translation. This white paper discusses IPV4 and IPV6 and uses manual and automatic IPV6 transition strategies and compares their performance to show how these transition strategies affect network behavior. In this project, the dual-stack transition mechanism is implemented in GNS3 (Graphical Network Simulator) using CISCO routers. The operation of this network is shown with the help of Iperf. The topology uses dual-stack technologies, which can be observed by capturing the packets in the client PC

Keywords IPv4, IPv6, dual-stack, IP, migration

1. Introduction

The internet is undergoing a complex transition to IPv6, providing long-term global and enterprise-level benefits. Various businesses and technical service providers understand the importance of moving to IPv6.

Internet Protocol Version 4 (IPv4) is the current Layer 3 protocol used on the Internet and most networks. IPv4 has survived for over 30 years and is an integral part of the Internet evolution. It was originally described in RFC 760 (January 1980) and obsolete by RFC 791 (September 1981). In the early years, even with the advent of the World Wide Web in the early 1990s, there were only about 16 million users of the Internet worldwide, compared to over 2 billion in 2011 (Reference: Internet World Statistics, www.internetworldstats.com)

The actual number of devices is increasing dramatically considering that today's users typically have multiple internet-enabled devices such as smartphones, tablets, and laptops. IPv6 was first invented by the Internet Engineering Task Force (IETF) in the mid-1990s because of the urgent need at the time to complement the rapidly shrinking IPv4 address space. It was assumed that IPv4 would be completely exhausted, so a successor was designed.149 As the majority of networks are still using IPv4, there are currently no serious motivating factors to switch to a new way of working when the current deployment is still adequate for the majority of user. The debate on whether to deploy IPv6 has been going on for years, so very few migration plans have been made in the industry [1]. This whitepaper first provides an overview of the current worldwide IPv6 deployment and compares the technical aspects of the available IPv4-to-IPv6 migration.

2. Material and Methods

IPv4 and IPv6 addresses are not compatible, so communication between a host with only IPv6 addresses and a host with only IPv4 addresses is a problem.

Two approaches are possible to enable communication: protocol translator, the double stack.

Protocol translation can take place at several levels: network (NAT-PT, NAT64), transport (TRT, RFC 3142), or application (DNS-ALG, RFC 2766). While it can be used to provide connectivity for a limited number of hosts or applications, translation introduces scaling issues (RFC 4966).

In the dual-stack approach, the first phase of the transition is to provision IPv4 hosts, and specifically servers, with both IPv6 and IPv4 addresses so that they can communicate with both IPv4 and IPv6 hosts. In the second phase, the dual stack will be generalized to most of the Internet. The use of IPv6-over-IPv4 tunnels is therefore less and less necessary.

A final phase envisages the gradual move away from IPv4 on the Internet. Some private networks continue to use it because they don't need an internet connection. The first phase of this transition has been underway since the beginning of the 21st century, with IPv6 deployment slower than originally anticipated. Since the first two phases do not help to reduce the demand for IPv4 addresses, the impending exhaustion of public IPv4 addresses leads to the development of address-sharing mechanisms.

2.1 What is the difference between IPv4 and IPv6?

Internet Protocol Version 4 (IPv4) is the fourth version of the Internet protocol used to identify IP addresses on a network. It is explicitly designed for use in networked systems. It uses a 32-bit numeric addressing scheme, separated by a period. It allows around 4 billion IP addresses for devices like smartphones, computers, and game consoles to connect to the internet.

Internet Protocol Version 6 (IPv6) is the latest and sixth version of the Internet Protocol, which is being deployed to meet the need to connect more IP addresses to the Internet. It helps identify devices on the internet for smooth communication. IPv6 is complex because it requires more address space; However, it is a widely used internet protocol. IPv6 uses 128-bit, consisting of four characters and eight sequences of numbers separated by a colon. It offers 340 million IP addresses, which is a significant number and ensures companies won't run out of IP address spaces any time soon. The benefits of IPv6 are enormous and far-reaching. However, they can vary from company to company depending on the requirements, size and structure. Let's understand the benefits of IPv4 to IPv6 migration.

2.2 IPV4 to IPV6 Communication of transition:

The transition from IPv4 to IPv6 is not a one-day step and involves many changes in network structures with the use of IP addresses. For the future success of IPv6, the next step in deploying IPv6 is to agree on the most appropriate transition methods and how to manage them. Although many types of transition mechanisms have been invented to simplify the process, implementing IPv6 is never considered easy and straightforward, even for experienced administrators. Therefore, the most difficult decision question is which method to choose for the implementation process in order to achieve a smooth and seamless transition.

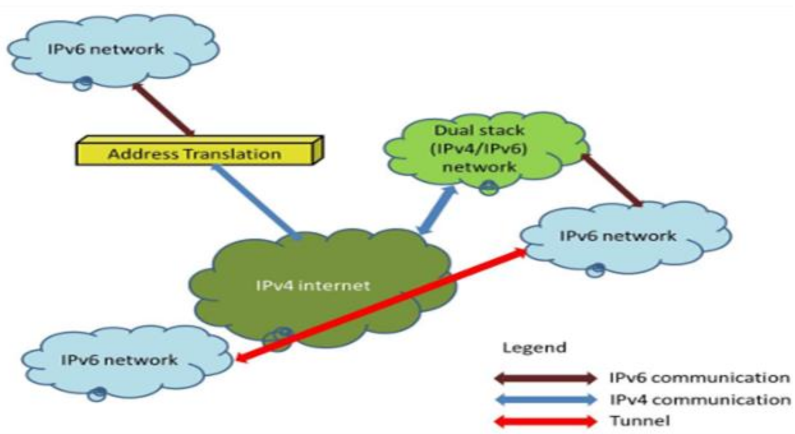


Figure 1: Transition technologies of IPV4 to IPV6

Therefore, in order to make a decision on the most suitable transition methods, it is very important to have an overview of the current IPv4 networks. In addition, companies must analyze the required functionalities, scalability and security in the company. Also, one size does not fit all, and various transition mechanisms can be applied to a network to support a fully distributed system. In this section, based on the information gathered from the research and literature review, we would like to provide an overview of some key migration methods and relevant 150 points to reject best practices for large enterprise networks.
Each technique has individual characteristics and plays an important role in the transition process.
In general, these techniques can be divided into three categories (See figure 1).

2.3 Dual Stack

However, despite the greatest flexibility, there are still some problems with this method, such as each dual stack device still needs an IPv4 address; two routing tables must be maintained in each dual-stack router; since two stacks must run simultaneously, additional memory and CPU power are required; in addition, each network requires its own routing protocol; additional security concepts and rules must be set within firewalls to match the respective stack; a DNS with the ability to resolve both IPv4 and IPv6 addresses is required; Finally, all programs must be able to choose to communicate over either IPv4 or IPv6, and separate network management commands are required

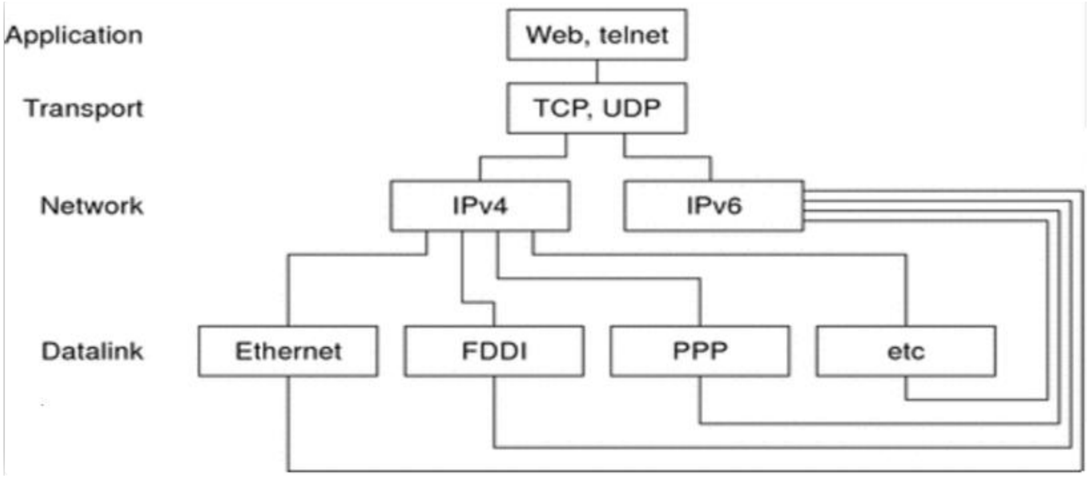


Figure 2: The structure of dual stack model

The dual-stack model is implemented in the network layer for both IPv4 and IPv6. Before transferring the packet to the next layer, the network layer chooses which one to use based on information from the data link layer. Large enterprise networks that have decided to transition to IPv6 can adopt the dual-stack method as the basic strategy that includes device configuration to deploy IPv4 and IPv6 simultaneously on the core routers, perimeter routers, firewalls, server farm routers and desktop access routers. Depending on the response to DNS requests, applications can choose which protocol to use and that choice can be made in accordance with the nature of the IP traffic. In addition, hosts can retrieve both available IPv4 content and IPv6 content. Accordingly, the dual-stack mechanism offers a flexible transition strategy.

2.4 Tunneling Transition

The IPv6 transition process is tunneling as shown in Figure 3 below. This is used to transfer data between compatible network nodes over incompatible networks. There are two common scenarios for using tunneling: 1- Allowing end systems to deploy off-link transition devices on a distributed network, and 2- Allowing edge devices on networks to connect across incompatible networks. Technically, the tunneling technique uses a protocol whose function is to encapsulate the payload between two nodes or end systems. This encapsulation is performed at the tunnel entrance and the payload is decapsulated at the tunnel exit. This process is called tunnel definition. There are currently various tunneling methods such as **6to4**, ISATAP, Teredo, DSTM and 6over4. Tunnels can be configured manually or configured automatically.

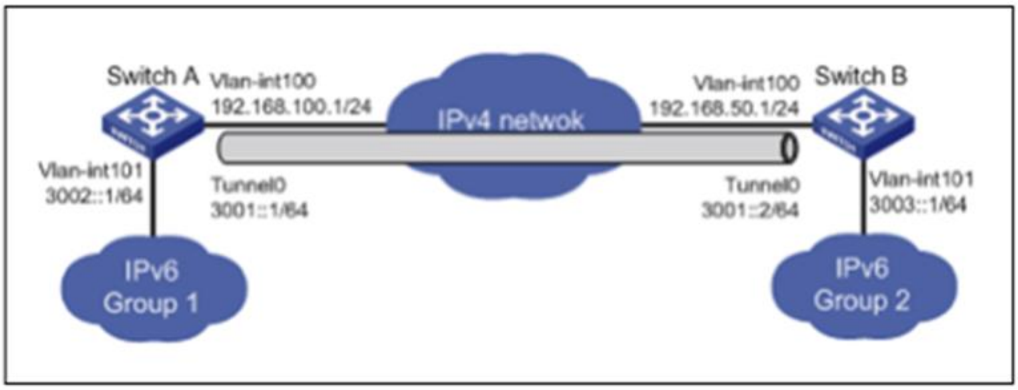


Figure 3: Model of tunneling transition

2.5 Translation model

Network Address Translation (NAT) is a well-known method in IPv4 that is commonly used to translate between private (RFC 1918) addresses and the public IPv4 address space. NAT64 provides transparent access between pure IPv6 and pure IPv4 networks. Address Family Translation (AFT), or simply translation, enables communication between pure IPv6 and pure IPv4 hosts and networks. AFT performs IP header and address translations between these two network layer protocols. The translation model is shown in figure 4

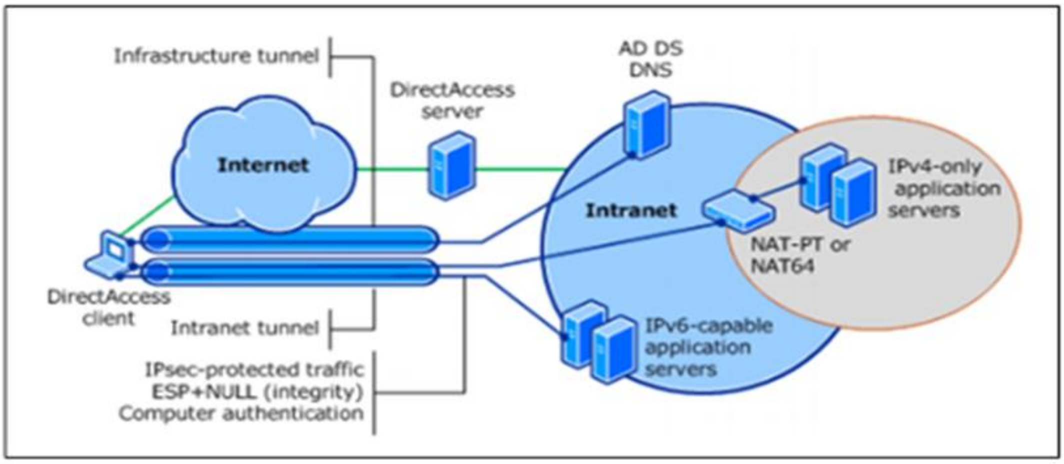


Figure 4: Model of translation

2.6 ISP usage

Carrier Grade NAT, designed to facilitate carrier transition with customers in various phases of transition

Enables service:

IPv6 /48 or longer general prefix to customer

Equivalent of IPv4 /24 or longer to customer in IPv6 form for access by remote IPv4-only hosts with 1:1 stateless translation

Requires advertisement of /64 by edge network for IPv4-mapped IPv6 addresses

IPv6-only service with

Remote IPv4 hosts accessing local mapped IPv6-only servers and

Local IPv6 hosts accessing remote IPv4-only server

3. Results & Discussion:

Migration to IPv6 is a long-term necessity, but IPv6 isn't just about IP address space. There are a few other benefits, including long-term cost savings and better performance. Although transitional approaches are the short-term solution for IP protocol evolution, a network implemented with a single routing policy is more agile and flexible in responding to network status. If it is difficult for operators to switch directly to native IPv6, they can implement transition technologies. In terms of IPv6 migration, small countries are currently ahead of the IPv6 deployment schedule compared to larger or more developed countries. Problems arise with hardware differences around the world and it would not be feasible to recommend a change in a short period of time. Awareness rising is required prior to implementation. A difficulty with this approach is that there is no clear understanding of how long IPv4 will last. Some of the companies and countries plan to do the migration in their network and then switch to native IPv6 when all applications and content are available on IPv6. The network diagram in Figure 5 shows the dual-stack implemented topology, where R1, R2, and R3 are three dual-stack routers.

Let see the below and discuss what have been done:

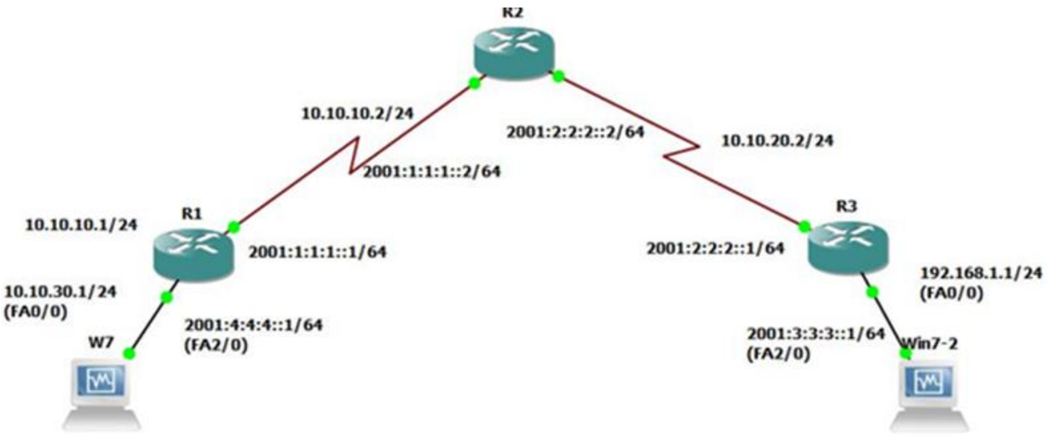


Figure 5: Network dual-stack enabled

A dual stack is needed when we need to connect IPv6 over IPv4. Dual stack is implemented on this network to provide direct connectivity between the IPv6 and IPv4 networks. In this topology, both IPv4 and IPv6 are used by side devices to know the impact on QoS. Iperf and result in figure 6 shows the Iperf capture performed in the Ethernet connection between client (IPv4) and server (IPv6). Iperf worked like PING which uses ICMP message containing both IPv4 and IPv6 fields in its packet

The explanation of the commands is:

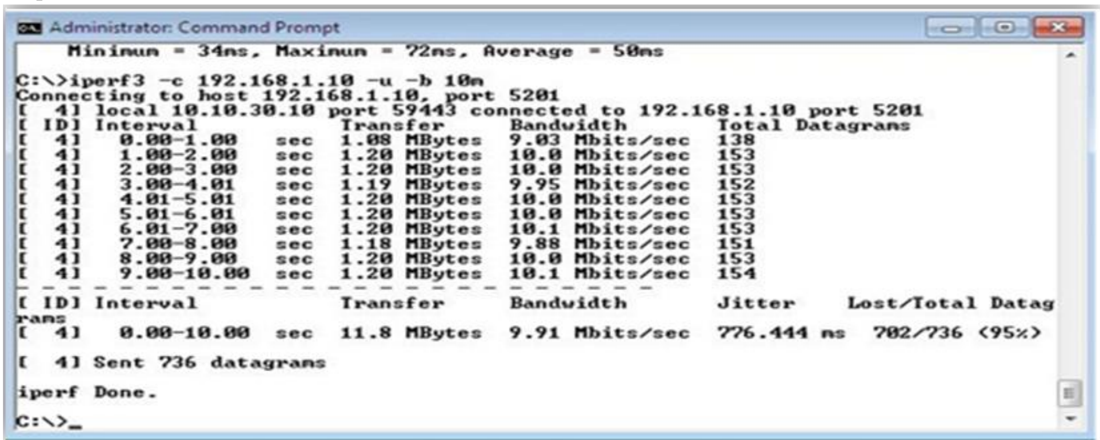
c means as a client PC, 192.168.1.10 its (IPv4) destination to the server,

u for packet type UDP,

b for bandwidth and 10m for size 10 megabytes.

Figure 7 shows Iperf capture in the Ethernet connection between client (IPv6) and server (IPv4).

The two figures shown differ in bandwidth and transmission at a size of 10 megabytes in the same dual-stack topology. Need time to process header when different protocol IPs communicate from source to destination. The most important contents to consider in the field of IPv4 are



```
Administrator: Command Prompt
    Minimum = 34ms, Maximum = 72ms, Average = 50ms

C:\>iperf3 -c 192.168.1.10 -u -b 10m
Connecting to host 192.168.1.10, port 5201
[  4] local 10.10.30.10 port 59443 connected to 192.168.1.10 port 5201
[ ID] Interval           Transfer     Bandwidth       Total Datagrams
[  4]   0.00-1.00   sec  1.08 MBytes  9.03 Mbits/sec  138
[  4]   1.00-2.00   sec  1.20 MBytes  10.0 Mbits/sec  153
[  4]   2.00-3.00   sec  1.20 MBytes  10.0 Mbits/sec  153
[  4]   3.00-4.01   sec  1.19 MBytes  9.95 Mbits/sec  152
[  4]   4.01-5.01   sec  1.20 MBytes  10.0 Mbits/sec  153
[  4]   5.01-6.01   sec  1.20 MBytes  10.0 Mbits/sec  153
[  4]   6.01-7.00   sec  1.20 MBytes  10.1 Mbits/sec  153
[  4]   7.00-8.00   sec  1.18 MBytes  9.88 Mbits/sec  151
[  4]   8.00-9.00   sec  1.20 MBytes  10.0 Mbits/sec  153
[  4]   9.00-10.00  sec  1.20 MBytes  10.1 Mbits/sec  154
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datag
rams
[  4]   0.00-10.00  sec  11.8 MBytes  9.91 Mbits/sec  776.444 ms  702/736 (95%)

[  4] Sent 736 datagrams

iperf Done.

C:\>_
```

Figure 6: Capture IPV6 as server and IPV4 as client on Ethernet link Iperf

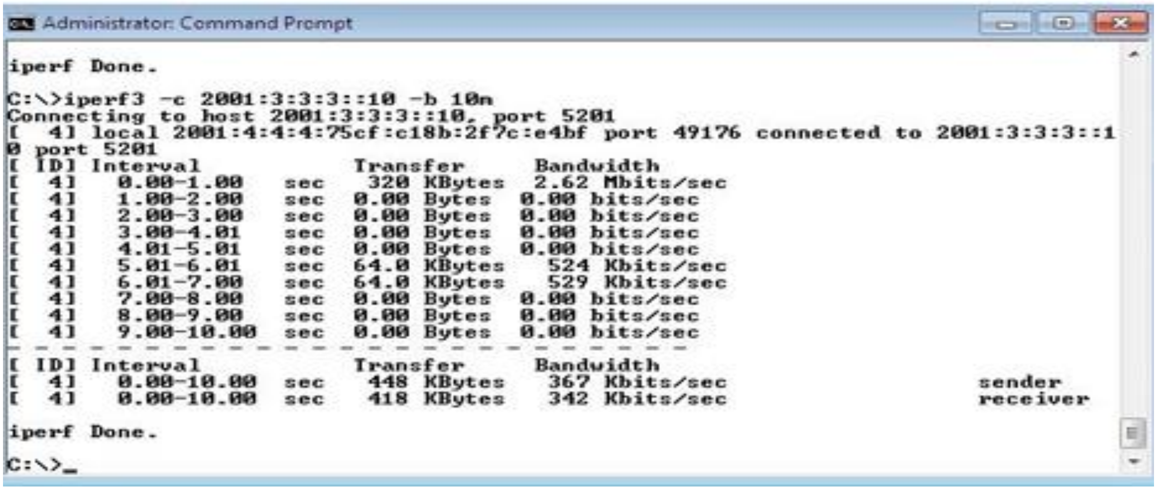


Figure 7: Capture IPV6 as server and IPV4 as client on Ethernet link Iperf

The protocol type use the source and destination addresses. The protocol field in the IPv4 header tells the network layer on the destination host which protocol this packet belongs to. The protocol represents that we know the encapsulation and de-capsulation process of IPv6 packets inside or outside of IPv4.

4. IPv4 to IPv6: Advantages of migration

Larger address space: In contrast to IPv4, IPv6 uses 4 times more bits to address a device on the Internet; Header simplified; end-to-end connectivity; auto-configuration; faster forwarding/Routing.
IPSec; no broadcast

Acknowledgements

We thank to the journal team, for their valuable comments and suggestions which have led to an improvement of the manuscript.

References

[1]. [T, 2020] Tek TOOLS, 'Computer Paperback, May11, 2020, page 1-3

[2]. Oracle Docs. (2001). The structure of Dual stack model. Available: http://docs.oracle.com/cd/E19455-01/806-0916/images/dual.epsi.gif

[3]. [I. Raicu and S. Zeadall], "Evaluating IPv4 to IPv6 transition mechanisms," in Telecommunications, 2003. ICT 2003. 10th International Conference on, 2003, pp. 1091-1098