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# A Comparative Study between IPv4 and IPv6

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**Abstract:** The transition between the Internet Protocol Version 4 (IPv4) and Internet Protocol Version 6 (IPv6) will be a long process during both protocol coexists and it unreasonable to expect that many millions of IPv4 nodes will be converted overnight. Mobility is becoming ubiquitous nowadays. This paper has described about a background study of IPv4 and IPv6, the needs of IPv6, transition mechanisms in the various architectures, and comparison of the IPv4 and IPv6 in two major areas; header format and transition mechanism. Then, the transformation of IPv4 to IPv6 addressing by using tunnel and dual stack protocol will be discussed.

**Keywords:** Protocol, IPv4, IPv6.

## 1. Introduction

Internet applications have been growing rapidly in recent years. The internet has been utilized and not just in academic research but also widely used in daily life. The growth of the Internet has created various impacts to end users. In nowadays, practically everyone seems to have access, through their computers, laptop, smart television, or even the car. When a device needs to communicate over the Internet with each other, it needs a unique Internet Protocol address. As there is a growing, the device will face a great problem of the depletion of Internet Protocol (IP) addresses. According to (Hossain et al., 2016) the Network Address Translation (NAT), Classless Inter Domain Routing (CIDR), Variable Length Subnet Mask (VLSM) and Port Address Translation (PAT) techniques and some others technologies have come out to solve the address limitations. However, all of these technologies able to decrease the IP address shortage's problem but they reduce robustness and security.

Due to the issue, the Internet Engineering Task Force (IETF) developed a new internet protocol (IP), which is to overcome IP shortage and to increase the number of IP address. This new version is IPv6 and also known as IP next generation (Isa & Abdulmumin, 2017). IPv6 offer new features and few improvements such as larger address space, improve security, powerful routing, multicasting, and offer network auto configuration. Internet Service Provider (ISP) slowly seeking to migrate IPv4 physical network to IPv6. However it is impossible to carry out the transition of IPv4 to IPv6 in a short period of time due to many reasons including cost, lack of technical support and lack of web content available over IPv6 (Quintero, Sans & Gamess, 2016) and also due to incompatibly issues (Ashraf, Muhammad & Aslam, 2020).

Although a new generation of IPv6 is taking place across the Internet user, it is not possible to move the entire network with IPv6. The migration of IPv4 and IPv6, involved a number of transition tools to address the various needs of different networks. In the next section, this paper will have discussed about the IPv4 and IPv6 specification based on notation rules or addressing and transition mechanism. The review will cover on two mechanisms in IPv4 and IPv6 transition, which is tunneling and dual-stalk approach.

## 2. Internet Protocol

### 2.1 Internet Protocol Version 4 (IPv4)

Internet Protocol version 4 (IPv4) is the fourth version in the development of the Internet Protocol (IP) in the year 1978 and determined in 1981. This protocol works at the network layer of the OSI Model and at the Internet layer in the TCP / IP model. Thus, this protocol has the responsibility of the routes most traffic on the Internet. IPv4 is described in IETF publication RFC 791 (September 1981), replacing an earlier definition (RFC 760, January 1980).

IPv4 is a connectionless protocol for use in packet-switched networks. It operates on a best effort delivery model; in that, it does not guarantee that packets would be delivered to the destination host, nor does it assure proper sequencing or avoidance of duplicate delivery. However, it will do the best to reach the destination. These aspects including data integrity which addressed by an upper layer transport protocol, such as the Transmission Control Protocol (TCP).

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## 2.2 Internet Protocol Version 6 (IPv6)

Internet Protocol version 6 (IPv6) is the most recent version of the Internet Protocol (IP) defined by the Internet Engineering Task Force (IETF). The development of IPv6 started in 1991 by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion. IPv6 uses a 128-bit address, allowing 2128, or approximately 3.4×1038 addresses, or more than 7.9×1028 times as many as IPv4, which uses 32-bit addresses. IPv4 provides approximately 4.3 billion addresses.

## 2.3 Comparison IPv4 and IPv6

The comparison of IPv4 and IPv6 shown in table 1. There are various comparisons in terms of addressing format, representation and a total number of addresses.

**Table 1:** Comparison IPv4 and IPV6

| | **IPv4** | **IPv6** |
|---|---|---|
| **Addressing Format** | 32 bit addressing | 128 bits |
| **Address Representation** | Decimal | Hexadecimal |
| **Total number of addresses** | 4,294,967,296 unique addresses | 340,282,366,920,938,463,463,374,607,431,7 addresses 68,211,456 unique addresses |
| **Packet Format** | 12 fields. IP header includes information about Version Number, Internet Header Length, Type of Service, Total Length, Identification, Flags, Fragment Offset, Time-to-Live, Protocol, Header Checksum, Source Address, Destination Address and Options. | 8 fields. IP Header includes information about Version, Traffic classes, Flow label, payload length, Next Header, Hop Limit, Source IPv6 Address (128 bits), Destination IPv6 Address (128 bits) |
| **Addressing Mode** | Unicast, Broadcast, Multicast | Unicast, Multicast, Anycast |
| **Style of Address** | Dotted decimal notation. Such as 192.172.10.3. | Colon hexadecimal format with suppression of leading zeros and zero compression. IPv4-compatible addresses are expressed in dotted decimal notation. For example FA90:0000:0000:0000:0301:B3EE:FE1E:80 (Tayal, Gupta, Goyal, Goyal, & Gupta, 2017) |
| **Loopback Address** | 127.0.0.1 | ::1 |
| **Network Bit Representation** | Subnet mask in dotted decimal notation or prefix length | Prefix length notation only |

## 2.4 Comparison IPv4 and IPv6 Header

Refer to IPv4 header in figure 1, the Options field leads to an IPv4 header of variable length with minimum 20 bytes. By contrast, IPv6 has the main header length fixed at 40 bytes, a benefit to fast header processing because routers do not have to implement lookup processes that account for variable-length header. The fixed length makes the Header Length field obsolete. The functionality provided by the options delivered through extension headers, a concept described later in the section. The options and padding is also removed from the main packet header.

The fragmentation is only done by the traffic source. Before sending IPv6 traffic, the source does Path MTU (PMTU) Discovery. It then sends packets at the discovered PMTU, thus freeing the routers from having to fragment them. For this reason, the three IPv4 header fields related to fragmentation (Identification, Flags, and Fragment Offset) become irrelevant in IPv6. A contrast from IPv4, Packet Header Checksum was eliminated in IPv6 and is in turn enforced at the upper layers.

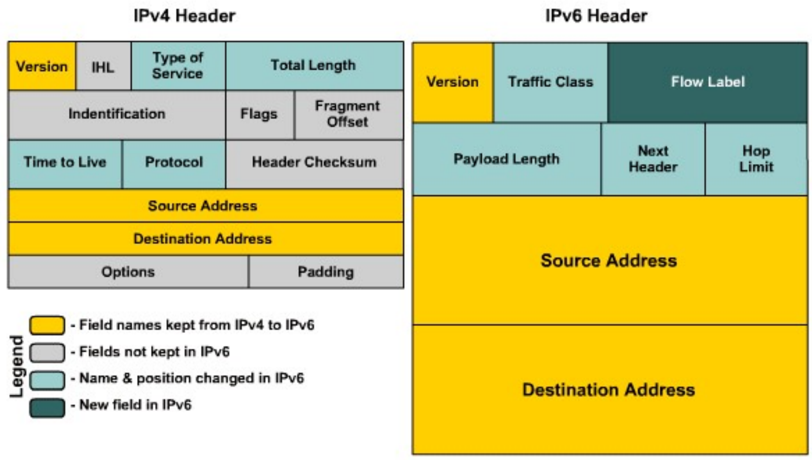


**Figure 1.** IPv4 vs IPv6 Header

## 3. Transition Mechanism from Ipv4 to Ipv6

Transition process from IPv4 and IPv6 is not a straightforward and in the meantime, its take a long time since both protocol is still coexisting and interoperate. To enable the network interoperable, the Internet Engineering Task Force (IETF) have been proposed three kinds of transition mechanisms. This paper will review a dual stack and tunneling approach.

### 3.1 Dual-Stack

A dual stack approach is a simple transition mechanism where its make available for both protocol IPv4 and IPv6 working in parallel. This approach as discussed by (Khannah & Alsa'deh, 2017) can be implement at the end system or at the network node. By using this approach, if the destination's host and router used IPv4, so that the IPV4 protocol stack is used. While, if the destination's host and router used IPv6 so the IPv6 protocol stack is used.

The dual stack approach offers a few advantages where it allowing the previous network services to be used (El Khadiri et al., 2018) said that this approach also offers better performance and can be applied in a small network. However, the disadvantages are the implementation cost is quite high. Figure 2 represented a topology for dual stack approach. In a dual stack approach, a server having dual configuration which is IPv4 and IPv6 can communicate with hosts using IPv4 or IPv6 with the implementation of dual stack router.

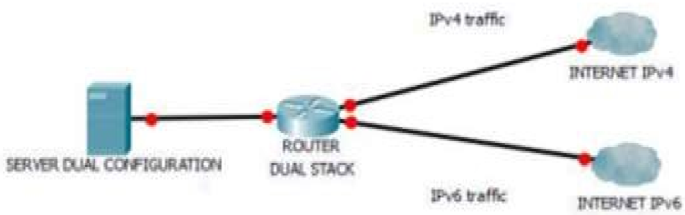


**Figure 2.** Dual Stack Approach Diagram (Enache & Alexandru, 2016)

In dual stack approach, the format of IPv4 and IPv6 influence each other and operate at the same time without any bother to another. But, in the real dual stack interfaces is hard to certify that IPv4 and IPv6 are completely isolated and need to be implemented to separate gateway for lowering their reciprocal influence.

### 3.2 Tunnel Technology

Tunneling Mechanism allows the usage of IPv4 networks in order to carry IPv6 traffic and the basic principle is shown in figure 3. The process can be completed either in a manual or in an automatic way. The manual configuration involves definite specification of the IPv4 or IPv6 source and the tunnel destination. When the number of tunnels increases, managing this technique becomes a major problem (Enache & Alexandru, 2016).


**Figure 3.** Tunneling

To implement IPV4 over IPV6 tunnelling, various type of tunnelling technologies has been conducted. For example, (Meena & Bundele, 2015) surveyed some burrowing concept. Burrowing of IPV6 packets by an IPV4 arrange incorporate prefixing each IPV6 parcels with IPV4 headers. The path of endpoint or leave hub perform encapsulation to peel off IPV4 header and send the parcel to target by IPV6 (Meena & Bundele, 2015).

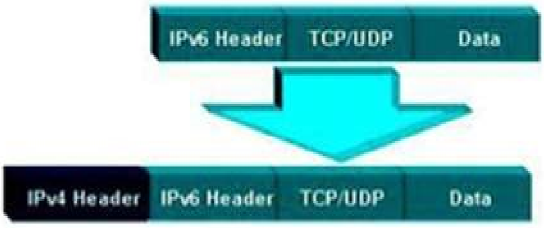


**Figure 4.** IPv6 over IPv4 Tunnelling (Meena & Bundele, 2015)

(Raad Al-ani & Raad Al-Ani, 2018) said that in tunnelling, when it travels from one type of protocol to another the header of the packet will also change. Therefore, an IPv6 packet will be able to migrate to IPv4 packet in order to communicate IPv6 network hosts through IPv4 backbone by using IPv6 tunnels. This mechanism is relevant when one IPv6 site connected with other IPv6 site over an IPv4 infrastructure by producing a tunnel interface among two IPv6 networks. Tunneling approaches is a solution to reduce the cost for connecting IPv6 networks. It is because to support both IPv4 and IPv6 protocols only the gateway routers should be upgraded. It allows toestablish the communication among IPv6 networks over an IPv4 network.

Nowadays, a few types of tunneling are applicable such as manual tunneling, Generic Routing Encapsulation tunnelling. Intra-Site Automatic Tunnel Addressing, Tunnel broker and 6to4 tunneling (Poussy & Abdelbaki, 2014). The tunneling networks have two phase which the first phase of use IPv4 protocol in a small part of IPv6. While in second phase IPv4 remains and encapsulated with IPv6 tunnel which migrate IPv4-to-IPv6, makes IPv6 network capable to interconnect with IPv4 networks (Fawad et al., 2016). Figure 5 shows two different networks of IPv6 hosts are connecting each other over IPv4 network infrastructure. In order to complete the transmission, the IPv6 packets are encapsulated in IPv4 packets exclusively within IPv4 network. (Coonjah, Catherine & Soyjaudah, 2015).

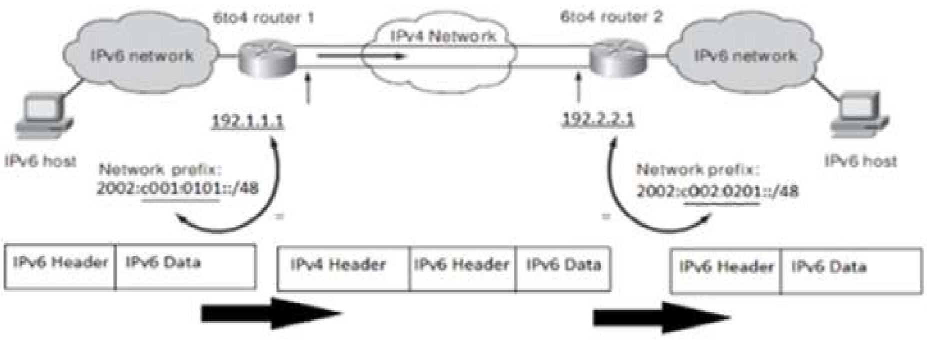


**Figure 5.** 6to4 Tunneling

Besides, this is a tunneling technique that allows dual-stack hosts in IPv4 to connect with remote IPv6 devices which call Intra-Site Automatic Tunnel Addressing Protocol (ISATAP). The ISATAP address is designed with a changed of EUI-64 format by using the value of 8-bit hexadecimal and the address of the node is 32-bit IPv4. In this system, the node forms an initial link of local address, which allows it to communicate with other ISATAP nodes that are in the same virtual local link. ISATAP is applied in a few platforms such as Windows XP/Vista/7/8/10 and Linux because it is easy to configure (Quintero, Sans & Gamess, 2016).

## 4. Conclusion

In this paper several works have been reviewed starts from the background study of IPv4 and IPv6, the needs of IPv6 and comparison of the IPv4 and IPv6 in two major areas which header format and transition mechanism. The understanding on the transformation of IPv4 to IPv6 addressing by using tunneling and dual stack protocol is important. It can be seen from the above review and the comparative study in the dual-stack environment and tunneling techniques. As a transition way, dual stack is not difficult to implement and it also reliable because has high support rate from the current network equipment. Dual stack also won't affect the function of the network and is one of the best solutions which provide better reliability. However, the contribution of tunnel technology can't be denied. The existing tunneling technology has a different impact to the key performance indicators of IPv6 network when it is widely used in IPv6 network. More review and analysis should be done to complete the evolution of internet addressing itself. In evolution phase many elements must be considered.

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