

Lab: IPv4, Subnetting, VLSM and IPv6 Addressing

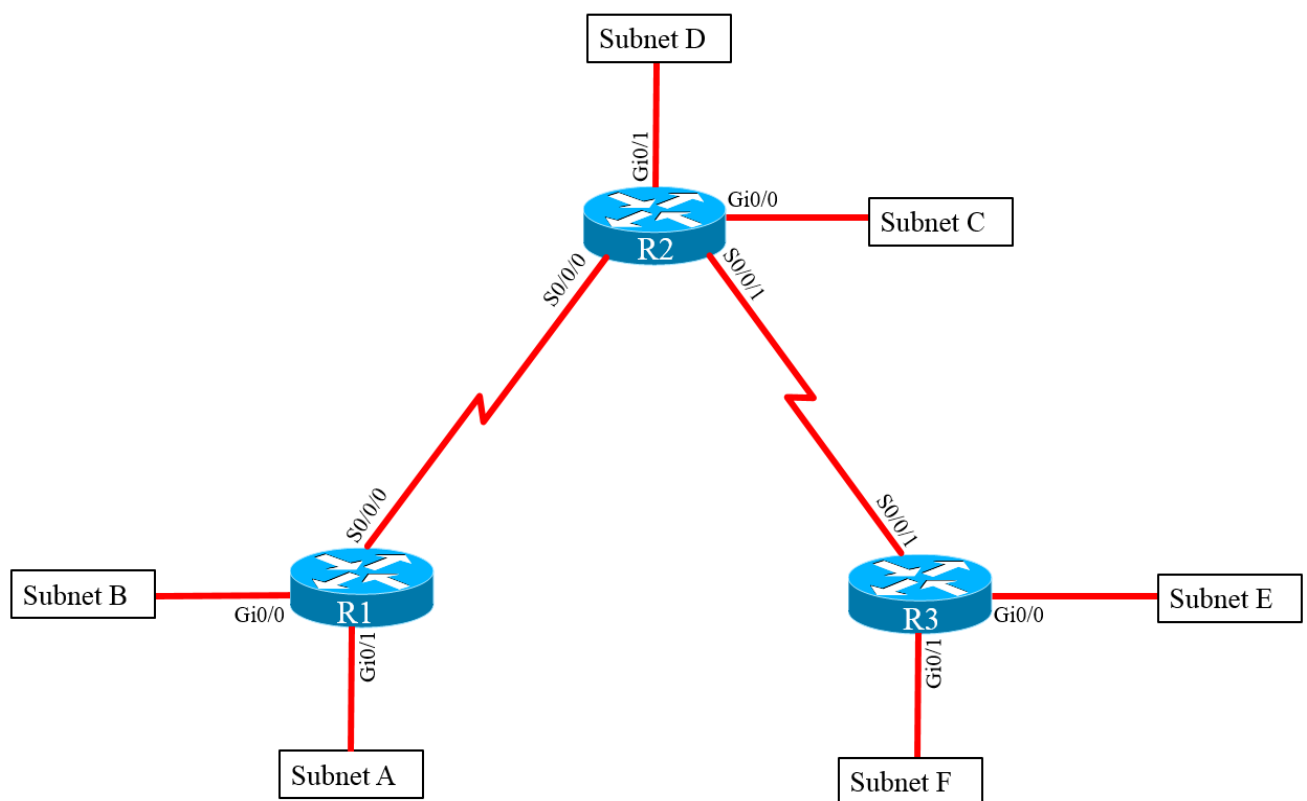
Part 1: Understanding IPv4 and IPv6 addressing (word count 1000)

This part of lab worksheet require you research and write a report on **“Features of IPv6”**. You may discuss but not limited to structure, address types, advanced functionalities and security.

Please See Appendix A for the report, titled “Features of IPv6”.

Part 2: Subnetting and VLSM

NOTE: To complete this part you would need full understanding of Lab 10 to 14.



Using the Network address 172.16.2.0/24 (ignore the /24 as noted by Lecturer), VLSM the network to support the following requirements:

Subnet A: 16 hosts

Subnet B: 2000 hosts

Subnet C: 6 hosts

Subnet D: 500 hosts

Subnet E: 60 hosts

Subnet F: 180 hosts and Serial links between routers

Table 1

Subnet	Network Address	Subnet mask	First Address	Last Address	Broadcast Address
B (2000 hosts)	172.16.2.0 /21	255.255.248.0	172.16.2.1	172.16.9.254	172.16.9.255
D (500 hosts)	172.16.10.0 /23	255.255.254.0	172.16.10.1	172.16.11.254	172.16.11.255
F (180 hosts)	172.16.12.0 /24	255.255.255.0	172.16.12.1	172.16.12.254	172.16.12.255
E (60 hosts)	172.16.13.0 /26	255.255.255.192	172.16.13.1	172.16.13.62	172.16.13.63
A (16 hosts)	172.16.13.64 /27	255.255.255.224	172.16.13.65	172.16.13.94	172.16.13.95
C (6 hosts)	172.16.13.96 /29	255.255.255.248	172.16.13.97	172.16.13.102	172.16.13.103
F Serial Link R1 to R2	172.16.13.104 /30	255.255.255.252	172.16.13.105	172.16.13.106	172.16.13.107
F Serial Link R2 to R3	172.16.13.108/30	255.255.255.252	172.16.13.109	172.16.13.110	172.16.13.111

Appendix A

Report: Features of IPv6 below.



FEATURES OF IPV6

BSc Computing Portfolio
Computer Architecture and Networks | ACCD4001

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1. Introduction

The internet protocol, or IP are a set of rules governing the routing and addressing of data packets sent over the internet, which enables internetworking and forms the basis of the internet. It has the task of delivering packets from a source host to a destination host using IP addresses [1]. The IP defines addressing methods and packet structure that encapsulate the data to be sent, in the Network (3rd) layer of the OSI model [2].

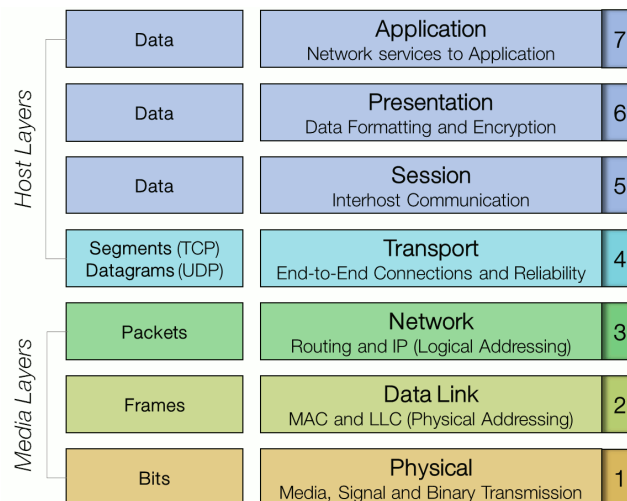


FIGURE 1. OSI MODEL - [3] [4]

IPv4, which was introduced in 1983 has been proven as a robust addressing protocol [5]. It uses 32-bit IP addresses to allow for a maximum of 4,294,967,296 addresses. However, over the years with the increased adoption of technology in everyday life through the Internet of Things, IP addresses began to run out.

According to Statistica [6], there are approximately 26.6 billion internet connected devices in 2019, and this is estimated to rise to 75.4 billion by 2025, therefore, the number of IPv4 addresses is not great enough. Although the shortage of IPv4 addresses began many years ago, the adoption of technology such as Carrier Grade Network Address Translation (CGN) has greatly increased the lifespan of IPv4. Carrier grade NAT translates private IP addresses within an ISP's network to a smaller number of public IP addresses, similarly to how individuals and organizations use NAT to translate a public IP for multiple internal private IP addresses [7].

As a result of the IPv4 address shortage, in 1998, the Internet Engineering Task Force (IETF) created Internet Protocol version 6. IPv6 has been designed to incorporate all possible future requirements of the Internet. The main improved feature of IPv6 over IPv4, is its amount of logical address space.

As of November 1st 2019, the percentage of users accessing google over IPv6 was 27%, and is growing quickly considering this number was only 5% in January 2015 [8].

2. Features of IPv6

As discussed in section 1, the creation of IPv6 was necessary due to the saturation of IPv4 addresses. Other points that have been improved on are simplification of the packet header, improved support for extensions and options, improved security and authentication and new traffic flow labelling capabilities. The core IPv6 specifications have been defined by various Request for Comments (RFCs) such as RFC 2460 [9].

2.1 IPv6 Structure

An IPv6 address is made of 128 bits, divided into 16-bit blocks and allows for approximately 3.4×10^{38} or 340 trillion, trillion, trillion addresses. Each block is converted into a 4-digit Hexadecimal number and is separated by colons. As an IPv6 address is long, rules such as omitting leading zeros and omitting blocks of consecutive zeros are used to shorten the address [10].

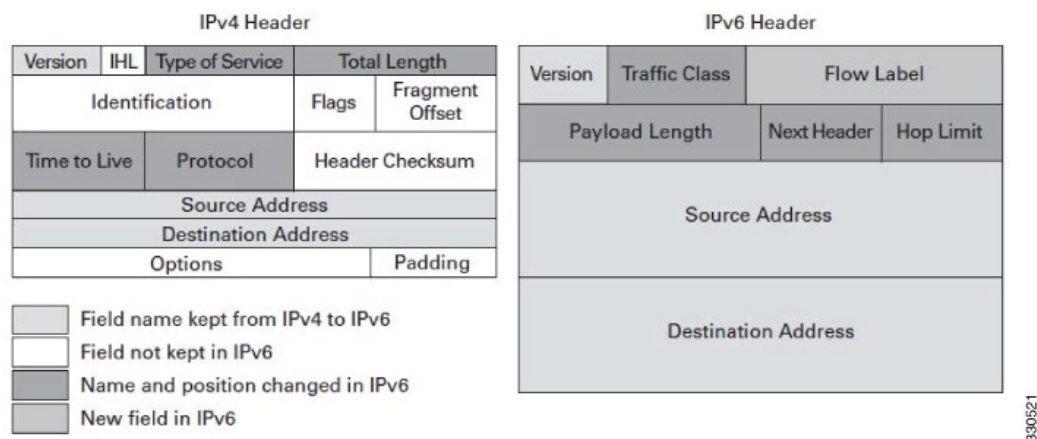


FIGURE 2. COMPARISON OF IPV4 AND IPV6 HEADERS [11].

IPv6's headers have been highly simplified and have removed unnecessary information and options present in previous version's headers. Unlike variable length IPv4 headers which range from 20 to 60 bytes, IPv6 headers are a fixed length of 40 bytes meaning that fields such as total length (IPv4) are redundant, and instead now only payload length must be used [9]. IPv6 headers can include optional extension headers. The extension header may contain information that can help routers understand how to handle the given packet or flow. IPv4 provides only 40-bytes for options however IPv6 is extensible to allow as much options as the size of the packet itself [10].

2.2 Security Improvements

The enormous address space covered by IPv6 makes port scanning far more difficult than IPv4 for attackers that may want to scan the ports of a victim's network in order to gather information on it [12].

In IPv4, the only security feature offered is a security option field as IP Security or IPSec was an optional aspect of IPv4 that is now mandatory. IPSec provides authenticity, confidentiality, integrity and access control to each IP packet through both Encapsulating Security Payload (ESP) and Authentication Header (AH) [13].

Address Resolution Protocol has been replaced in IPv6 by Neighbor Discovery (ND) Protocol. ARP suffers from vulnerabilities such as ARP Spoofing, where an attacker exploits the interaction of IP and ethernet protocols by sending forged ARP reply packets to the victim [14]. ARP attacks can allow attackers to the system which can then leave it vulnerable to other attacks including Man-in-the-Middle attacks and session hijacking [14]. In the IPv6 protocol, the ID portion of a layer 3 address is directly derived from a device's layer 2 MAC address and therefore ARP is redundant.

IPv6 has also introduced the possibility of binding a public signature key to an IPv6 address resulting in a Cryptographically Generated Address (CGA), which provides additional security by allowing the user to provide a 'proof of ownership' for a particular IPv6 address and aims to prevent spoofing attacks.

Despite improved security, IPv6 cannot prevent attacks on layers above the network layer [12].

2.3 Addressing Modes

IPv6 supports three different addressing modes. Firstly, Unicast. A unique unicast address acts as an identifier for a single host. The IP packet contains both source and destination addresses, and the packet is delivered to the interface identified by that address [15].

Next, a multicast address acts as an identifier for a pre-defined group of interfaces. An IP packet destined for a multicast address is delivered to the multiple interfaces of that group [15].

Finally, new to IPv6 are anycast addresses. In this addressing mode, multiple hosts are assigned the same Anycast IP address. When a host wants to communicate with another host with an Anycast IP, it sends a Unicast message. With the help of complex routing mechanisms, the Unicast message is delivered to the host closest to the Sender in terms of Routing cost [16].

2.3 Transition from IPv4 to IPv6

Currently, there is a main barrier preventing the complete transitioning from IPv4 to IPv6, which is that IPv6 is not backward compatible. This is unlike most other technologies which allow backward compatibility to ensure a smooth transition and means that multiple technologies must be used, such as Dual Stack Routers.

Dual Stack Routers can be configured with both IPv4 and IPv6 addresses to provide a medium for hosts to access the server without changing their respective IP versions [17].

Where different IP versions exist on transit networks, tunneling provides a solution where a user's data can pass through a non-supported IP version, such as from IPv4 to IPv6 or vice versa [18].

Another method of transitioning to IPv6 is by the use of NAT-PT, or Network Address Translation – Protocol Translation enabled device. A NAT-PT device takes an IPv4 packet, removes the IPv4 header and adds an IPv6 header, then passes it through the internet. When a response from an IPv6 server comes for the IPv4 host, the router does the opposite [19].

3. Conclusion

IPv6 aims to provide enough addresses for the foreseeable future and also incorporates new and improved features as discussed in this report such as IPSec and improved performance.

IPv4 is still used in the large majority of the internet however due to the issues with IPv4 outlined above IPv6 adoption is increasing at a fast pace. On 6th June 2012, all major ISP's were shifted to IPv6 during "World IPv6 Launch" however others are still to follow [20].

For a full transition over to IPv6, it must be implemented end to end, meaning it must be enabled by network hardware vendors, transit providers, access providers, content providers and endpoint hardware makers [21], which is still likely to take many years.

4. References

- [1] H. Frystyk, "The Internet Protocol Stack," 1994. [Online]. Available: <https://www.w3.org/People/Frystyk/thesis/TcpIp.html>. [Accessed: 01-Dec-2019].
- [2] W. R. Parkhurst, *Routing first-step*. Cisco, 2004.
- [3] Cisco, "Cisco Networking Fundamentals," 2006.
- [4] C. Goedegebure, "The OSI Model." [Online]. Available: <https://www.coengoedegebure.com/osi-model/>. [Accessed: 01-Dec-2019].
- [5] Cloudflare, "What is the Internet Protocol? | Cloudflare." [Online]. Available: <https://www.cloudflare.com/learning/ddos/glossary/internet-protocol/>. [Accessed: 01-Dec-2019].
- [6] Statistica, "IoT: number of connected devices worldwide 2012-2025." [Online]. Available: <https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/>. [Accessed: 01-Dec-2019].
- [7] Lee Schlesinger, "Whatever happened to the IPv4 address crisis?," 2014. [Online]. Available: <https://www.networkworld.com/article/2174297/whatever-happened-to-the-ipv4-address-crisis-.html>. [Accessed: 01-Dec-2019].
- [8] Google, "IPv6 – Google." [Online]. Available: <https://www.google.com/intl/en/ipv6/statistics.html>. [Accessed: 01-Dec-2019].
- [9] S. E. Deering, "Internet Protocol, Version 6 (IPv6) Specification."
- [10] Tutorials Point, "Learn Internet Protocol Version 6," 2014.
- [11] Cisco, "Routing and Bridging Guide vA5(1.0), Cisco ACE Application Control Engine - Overview of IPv6 [Cisco Services Modules] - Cisco." [Online]. Available: https://www.cisco.com/c/en/us/td/docs/interfaces_modules/services_modules/ace/vA5_1_0/configuration/rtg_brdg/guide/rtrbrgdgd/ipv6.html. [Accessed: 01-Dec-2019].
- [12] Government of the Hong Kong Special Administration, "IPv6 SECURITY," 2011.
- [13] E. Durdađi and A. Buldu, "IPV4/IPV6 security and threat comparisons," in *Procedia - Social and Behavioral Sciences*, 2010, vol. 2, no. 2, pp. 5285–5291.
- [14] A. Shrivastava, "Security Issues With Address Resolution Protocol," 2008.
- [15] "IPv6 Addressing | IPv6.com." [Online]. Available: <https://www.ipv6.com/general/ipv6-addressing/>. [Accessed: 01-Dec-2019].
- [16] Tutorials Point, "IPv6 - Addressing Modes." [Online]. Available: https://www.tutorialspoint.com/ipv6/ipv6_addressing_modes.htm. [Accessed: 01-Dec-2019].
- [17] Cisco, "Dual Stack IPv4/IPv6 Devices," 2010.
- [18] IBM, "IPv6 tunneling." [Online]. Available: https://www.ibm.com/support/knowledgecenter/en/ssw_aix_72/network/tcpip_ipv6_tunnel.html. [Accessed: 01-Dec-2019].
- [19] T. Point, "Transition From IPv4 to IPv6 - Tutorialspoint." [Online]. Available: https://www.tutorialspoint.com/ipv6/ipv6_ipv4_to_ipv6.htm. [Accessed: 01-Dec-2019].
- [20] "World IPv6 Launch." [Online]. Available: <https://www.worldipv6launch.org/>. [Accessed: 02-Dec-2019].
- [21] J. Streebel, "IPv4 vs IPv6," 2019. [Online]. Available: <https://pagely.com/blog/ipv4-vs-ipv6/>. [Accessed: 02-Dec-2019].