Computer Networks-Lab Exam

Instructor: Hurmat Hidayat

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IP Address

An IP (Internet Protocol) address is a numerical label assigned to the devices connected to a computer network that uses the IP for communication. IP address act as an identifier for a specific machine on a particular network. IP Version 4 (IPv4) was defined in 1981. It has not undergone much changes from that time. An IPv4 address consists of four numbers, each number contains one to three digits, with a single dot (.) separates each number or set of digits. IPv4 uses 32-bit IP address. So the maximum number of IP address is 2^{32} or 4,294,967,296. Unfortunately, there is a need of IP addresses more than IPv4 could supply.

IPv4 address: 216 . 27 . 61 . 137

Binary representation: 11011000 . 00011011 . 00111101 . 10001001

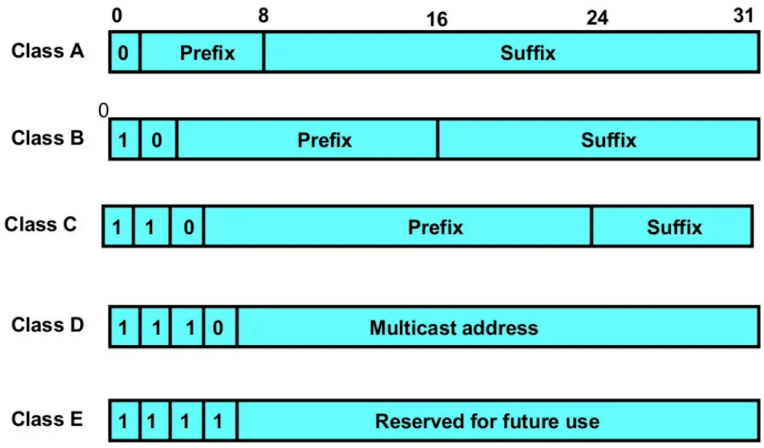
IPv4 Address is divided into two parts:

- **Prefix:** The prefix part of IP address identifies the physical network to which the computer is attached. . Prefix is also known as a **network address**.
- **Suffix:** The suffix part identifies the individual computer on the network. The suffix is also called the **host address.**

The classes of IPv4 addresses

The IP hierarchy contains many classes of the IP addresses. Broadly, the IPv4 addressing system is divided into five classes of IP address. All the five classes are identified by the first octet of the IP address. The different classes of the IPv4 address are the following:

1) Class A address
2) Class B address
3) Class C address
4) Class D address
5) Class E address



Each class has a specific range of IP addresses (and ultimately dictates the number of devices you can have on your network). Primarily, class A, B, and C are used by the majority of devices on the Internet. Class D and class E are for special uses.

Class A Address Range

Class A addresses are for networks with large number of total hosts. Class A allows for 126 i.e. (2^7 - 2) networks by using the first octet for the network ID. The first bit in this octet, is always zero. The remaining seven bits in this octet complete the network ID. The 24 bits in the remaining three octets represent the hosts ID and allows for approximately 17 million hosts per network (2^{24} -2 = 16777214). Class A network number values begin at 1 and end at 127.

Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback and diagnostic functions.

- Public IP Range: 1.0.0.0 to 127.0.0.0
    - First octet value range from 1 to 127
- Private IP Range: 10.0.0.0 to 10.255.255.255
- Subnet Mask: 255.0.0.0 (8 bits)
- Number of Networks: 126
- Number of Hosts per Network: 16,777,214

Class B Address Range

Class B addresses are for medium to large sized networks. Class B allows for 16,384 networks by using the first two octets for the network ID. The first two bits in the first octet are always 1 0. The remaining six bits, together with the second octet, complete the network ID. The 16 bits in the third and fourth octet represent host ID and allows for approximately 65,000 hosts per network. Class B network number values begin at 128 and end at 191.

- Public IP Range: 128.0.0.0 to 191.255.0.0
    - First octet value range from 128 to 191
- Private IP Range: 172.16.0.0 to 172.31.255.255
- Subnet Mask: 255.255.0.0 (16 bits)
- Number of Networks: 16,382
- Number of Hosts per Network: 65,534

Class C Address Range

Class C addresses are used in small local area networks (LANs). Class C allows for approximately 2 million networks by using the first three octets for the network ID. In a class C IP address, the first three bits of the first octet are always 1 1 0. And the remaining 21 bits of first three octets complete the network ID. The last octet (8 bits) represent the host ID and allows for 254 hosts per network. Class C network number values begins at 192 and end at 223.

- Public IP Range: 192.0.0.0 to 223.255.255.0
    - First octet value range from 192 to 223
- Private IP Range: 192.168.0.0 to 192.168.255.255

- Subnet Mask: 255.255.255.0 (24 bits)
- Number of Networks: 2,097,150
- Number of Hosts per Network: 254

Network Address

A Network Address is a logical or physical address that uniquely identifies a host or a machine in a telecommunication network. A network may also not be unique and can contain some structural and hierarchical information of the node in the network.

Broadcast Address

A broadcast address is an IP address that is used to target all systems on a specific subnet network instead of single hosts. In other words broadcast address allows information to be sent to all machines on a given subnet rather than to a specific machine

Conversion of Binary Octet to decimal

Here is how binary octets convert to decimal: The right most bit, or least significant bit, of an octet holds a value of 2^0. The bit just to the left of that holds a value of 2^1. This continues until the left-most bit, or most significant bit, which holds a value of 2^7. So if all binary bits are a one, the decimal equivalent would be 255 as shown here:

(128+64+32+16+8+4+2+1=255)

Binary	1	1	1	1	1	1	1	1
Power of 2	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
	128	64	32	16	8	4	2	1

Here is a sample octet conversion when not all of the bits are set to 1.

0 1 0 0 0 0 0 1

0 64 0 0 0 0 0 1 (0+64+0+0+0+0+0+1=65)

And this sample shows an IP address represented in both binary and decimal.

10. 1. 23. 19 (decimal)

00001010.00000001.00010111.00010011 (binary)

These octets are broken down to provide an addressing scheme that can accommodate large and small networks. There are five different classes of networks, A to E. This document focuses on classes A to C, since classes D and E are reserved and discussion of them is beyond the scope of this document.

Default Gateway

When a host wants to reach a destination that is **outside of its own network**, it has to use a default gateway. We use a router or multilayer switch (that's a switch that can do routing) as a default gateway.

A default gateway makes it possible for devices in one network to communicate with devices in another network. If a computer, for example, requests a web page, the request goes through the default gateway before exiting the local network (LAN) to reach the internet.

Think of a default gateway as an intermediate device between the local network and the internet. The default gateway transfers internal data to the internet and back again.

Routing

Routing is the process of selecting and defining paths for IP-packet traffic within or between networks as well as the process of managing network traffic overall.

Static Routing

Network administrators use static routing, or *nonadaptive routing*, to define a route when there is a single route or a preferred route for traffic to reach a destination. Static routing uses small routing tables with only one entry for each destination. It also requires less computation time than dynamic routing because each route is preconfigured.

Because static routes are preconfigured, administrators must manually reconfigure routes to adapt to changes in the network when they occur. Static routes are generally used in networks where administrators don't expect any changes.

Command

Router(config)#

ip route <Destination Network ID> <Destination Subnet Mask> <Next-hop IP address>

Router>	- User EXEC mode
Router#	- Privileged EXEC mode
Router(config)#	- Configuration mode (notice the # sign indicates this is accessible only at privileged EXEC mode)
Router(config-if)#	- Interface level within configuration mode
Router(config-router)#	- Routing engine level within configuration mode
Router(config-line)#	- Line level (vty, tty, async) within configuration mode

Configuring DHCP server on a Router

To configure DHCP server on router we will define a DHCP pool of IP addresses to be assigned to hosts, a Default gateway for the LAN and a DNS Server.

Configuring DHCP server

To configure the DHCP service, we have to click on the DHCP tab and turn on the DHCP service. We can change the default name of the pool which is serverpool. We can set up the default gateway and DNS if required as per our network design.

The *ip helper-address* configuration command allows the router to forward local DHCP requests to one or more centralized DHCP servers

File Transfer Protocol (FTP)

The File Transfer Protocol (FTP) is a standard network protocol used for the transfer of computer files between a client and server on a computer network.

Command: ftp ip_address

To check other FTP commands supported by the FTP client running on the Laptop(or PC), you can use a question mark (?) on the Laptop's command prompt as shown below:

Understand Subnetting

Subnetting allows you to create multiple logical networks that exist within a single Class A, B, or C network. If you do not subnet, you are only able to use one network from your Class A, B, or C network, which is unrealistic.

Possible Number of Subnets

To calculate the number of possible subnets, use the formula 2^n , where n equals the number of host bits borrowed. For example, if three host bits are borrowed, then n=3. $2^3 = 8$, so eight subnets are possible if three host bits are borrowed.

The table below lists the powers of 2.

Bits Borrowed	Formula	Possible Subnets	Bits Borrowed	Formula	Possible Subnets
1	2^1	2	12	2^{12}	4,096
2	2^2	4	13	2^{13}	8,192
3	2^3	8	14	2^{14}	16,384
4	2^4	16	15	2^{15}	32,268
5	2^5	32	16	2^{16}	65,536
6	2^6	64	17	2^{17}	131,072
7	2^7	128	18	2^{18}	262,144
8	2^8	256	19	2^{19}	524,288
9	2^9	512	20	2^{20}	1,048,576
10	2^{10}	1,024	21	2^{21}	2,097,152
11	2^{11}	2,048	22	2^{22}	4,194,304

Network Address Translation

For a device configured with a private address to access the internet or a remote network, the address must be translated into a public routable address.

This translation takes place on a NAT-enabled router which typically operates on the border of a sub network.

Types of NAT

Network address translation can be classified into three types. They are:

1. Static Network Translation (Static NAT)
2. Dynamic Network Address Translation (Dynamic NAT)
3. Port Address Translation (PAT)

Static NAT

Following command is used to map the inside local IP address with inside global IP address.

```
Router(config)#ip nat inside source static [inside local ip
address] [inside global IP address]
```

Following command will define interface Fa0/0 as inside/outside local.

```
Router(config-if)#ip nat inside/outside
```

Dynamic NAT

To create a standard numbered ACL following global configuration mode command is used:-

```
Router(config)# access-list ACL_Identifier_number permit/deny
matching-parameters
```

Following command is used to define the NAT pool.

```
Router(config)#ip nat pool [Pool Name] [Start IP address] [End
IP address] netmask [Subnet mask]
```

To configure a dynamic NAT with these options we will use following command.

```
R1(config)#ip nat inside source list ACL_Identifier_number pool
[Pool Name]
```