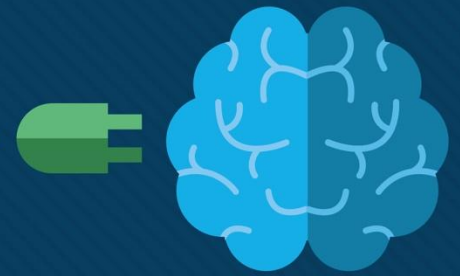
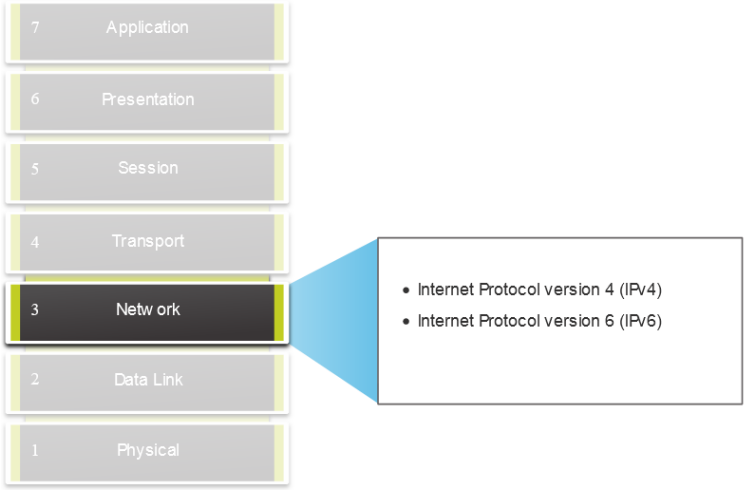


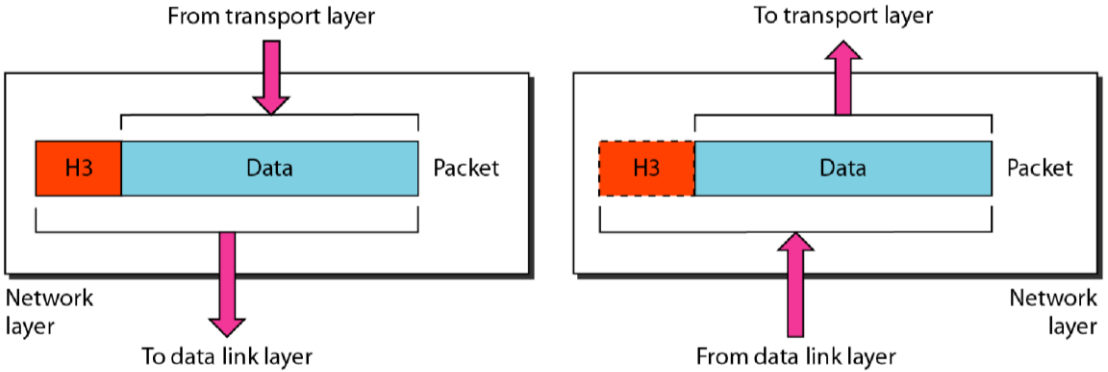
Module 5: Network Layer (Part-1)

Introduction to Networks v7.0
(ITN)

The Network Layer

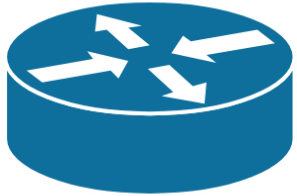
- Provides services to allow end devices to exchange data
- The network layer performs four basic operations:
  1. Logically addressing end devices (IP version 4 (IPv4) and IP version 6 (IPv6))
  2. Encapsulation
  3. Routing
  4. De-encapsulation





5.1 Network Layer Connecting devices

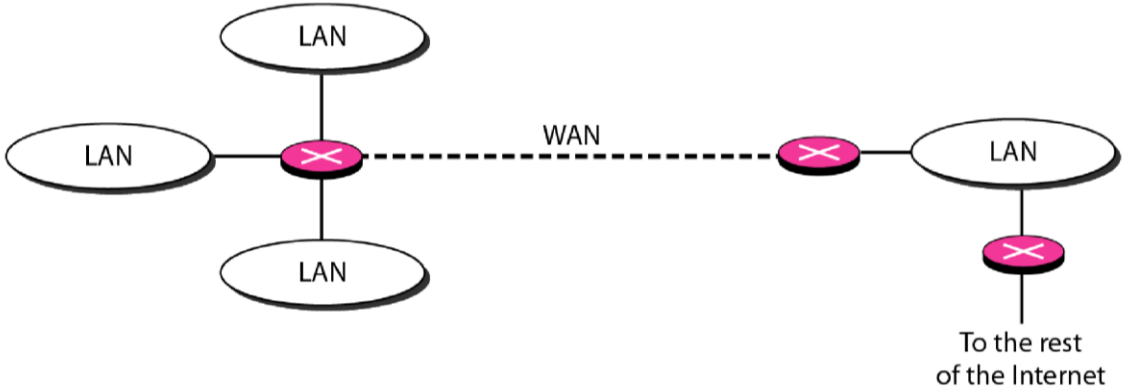
Routers



1- Routers

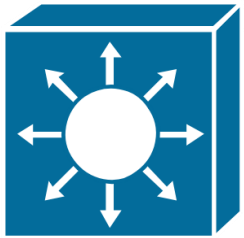
- Operates at network layer (deals with packets not frames).
- Connect LANs and WANs with similar or different protocols together.
- Routers **isolate both collision domains and broadcast domains**.
- Performs logical addressing (IP address).
- Routers communicate with each other and exchange routing information.
- Determine best route using routing algorithm by special software installed on them.

Routers (contd.)



Routers connects independent LANs and WANs

Layer-3 Switch



2- Multilayer Switch (Layer-3 Switch)

- It operates on two OSI layers: layer 2 and layer 3.
- a Layer 3 switch combines the functionality of a switch and a router
- It comes with 24 Ethernet ports, but no WAN interface.
- It acts as a switch to connect devices within the same subnet.
- It can support routing protocols, inspect incoming packets, and may even make routing decisions supporting source and destination addresses

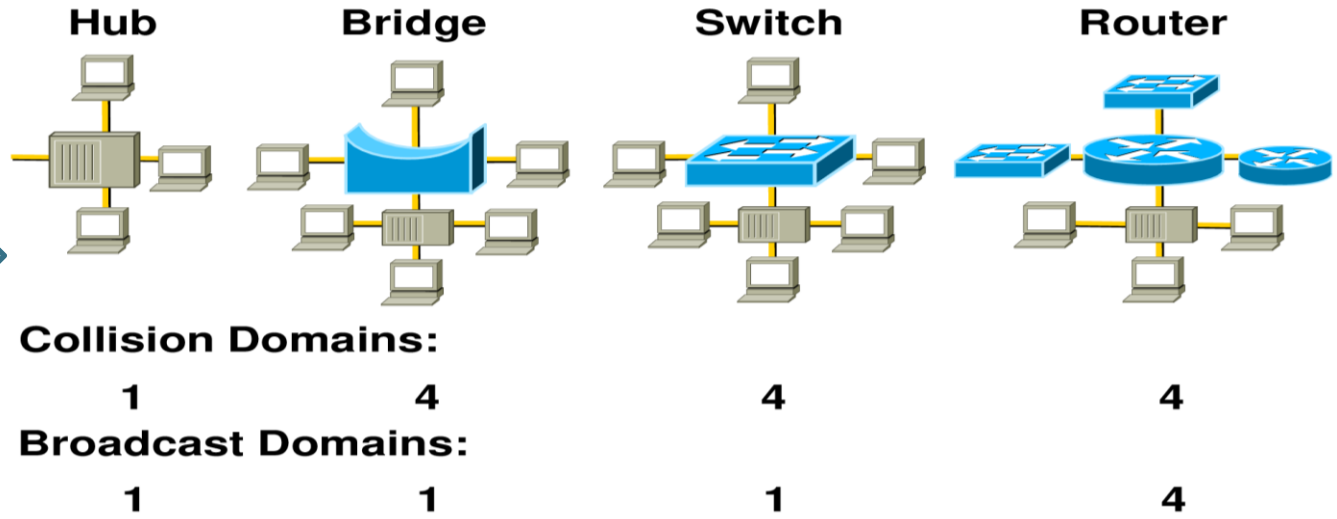
5.2 Collision Domain & Broadcast domain

Routers (contd.)

Collision domain: is a network segment where data transmitted by devices belonging to it can collide with each other.

Broadcast domain: is a logical network segment on which a device is able to communicate directly with another device on the same segment without the need for routing.

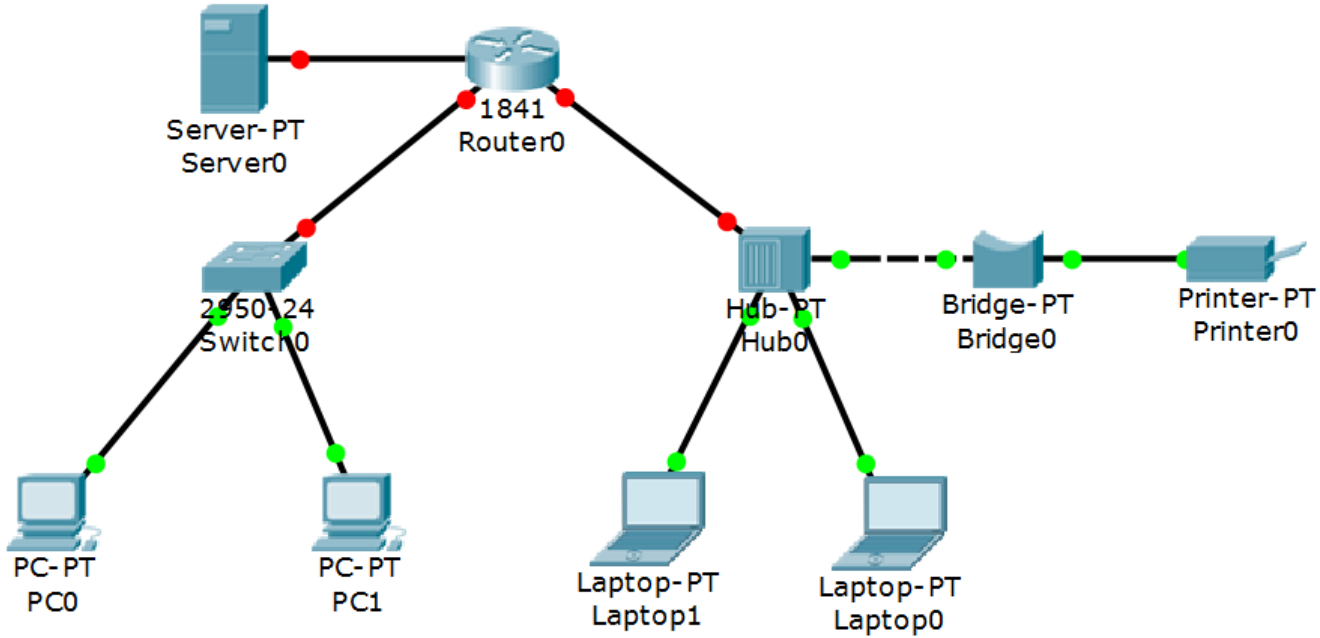
collision domain and broadcast domain for 4-port connecting devices



Examples

Example

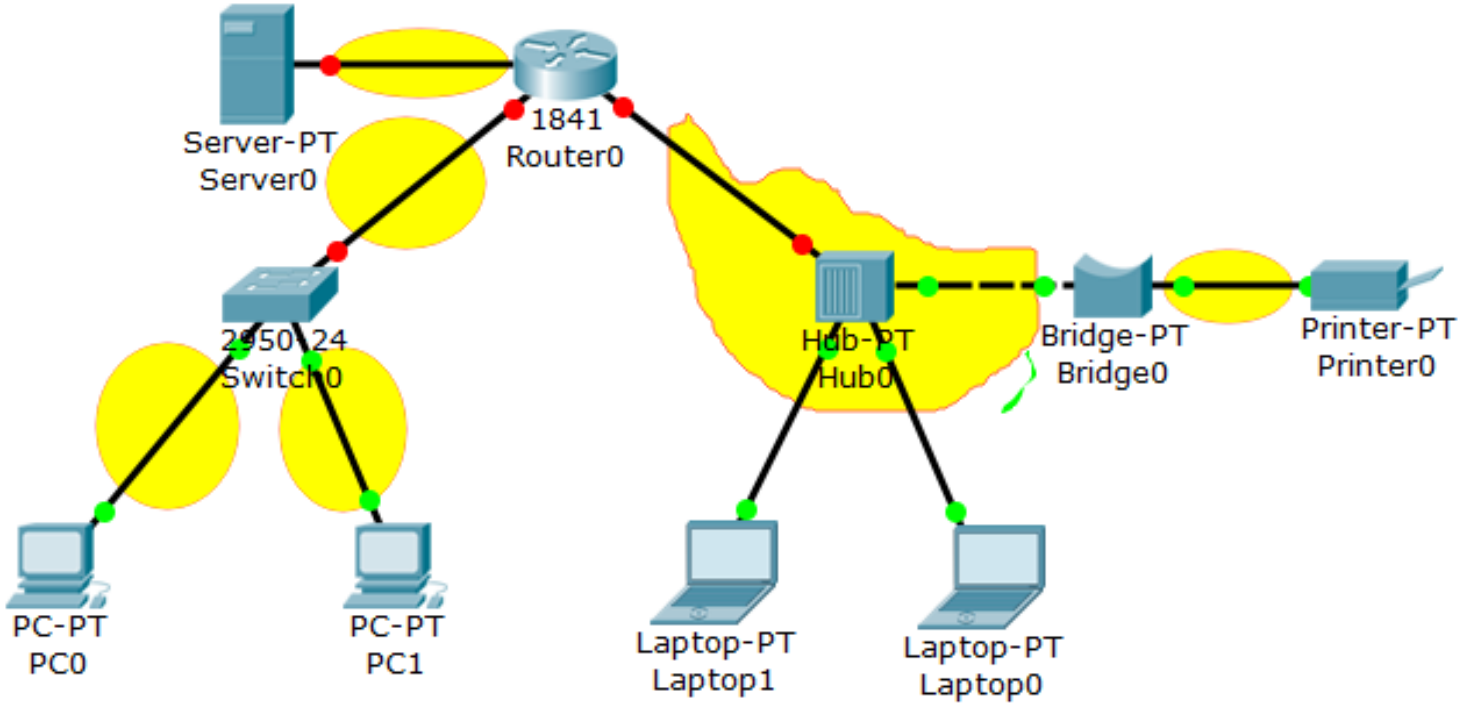
For the network shown below, find number of collision domains and number of broadcast domains



Examples

Solution

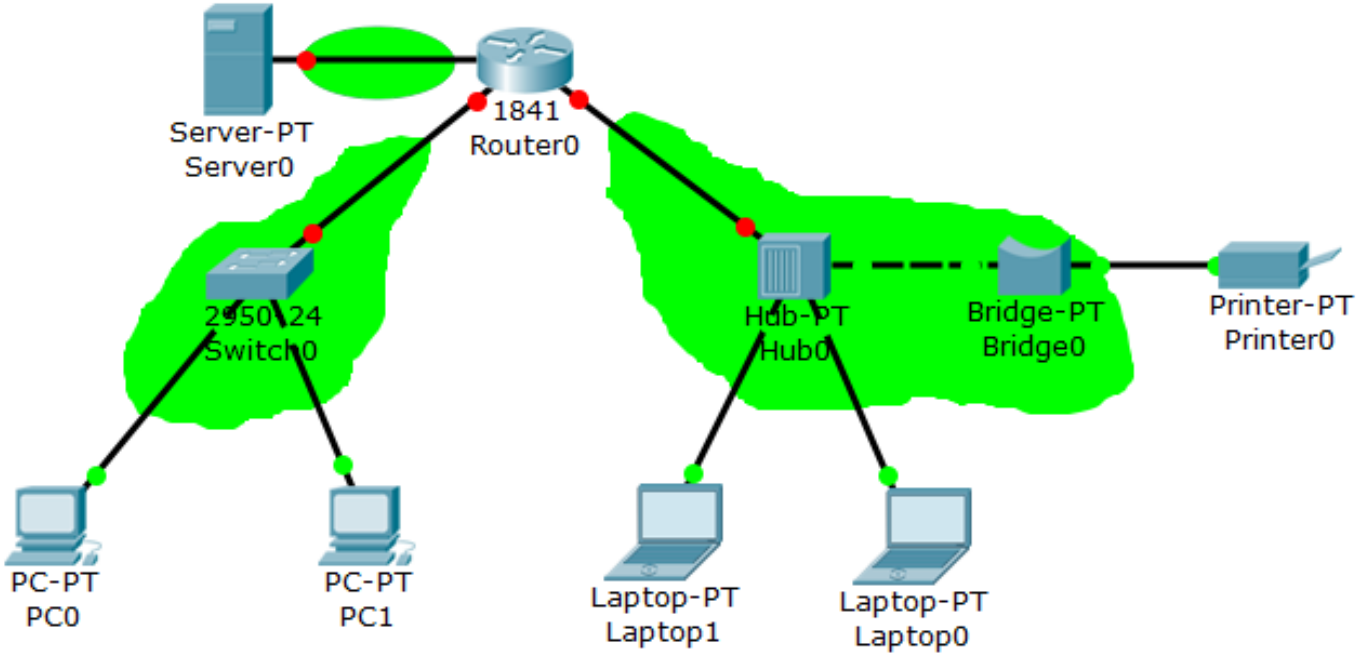
Number of collision domain = 6 (as shown in the yellow areas)



Examples

Solution (contd.)

Number of broadcast domain = 3 (as shown in the green areas)

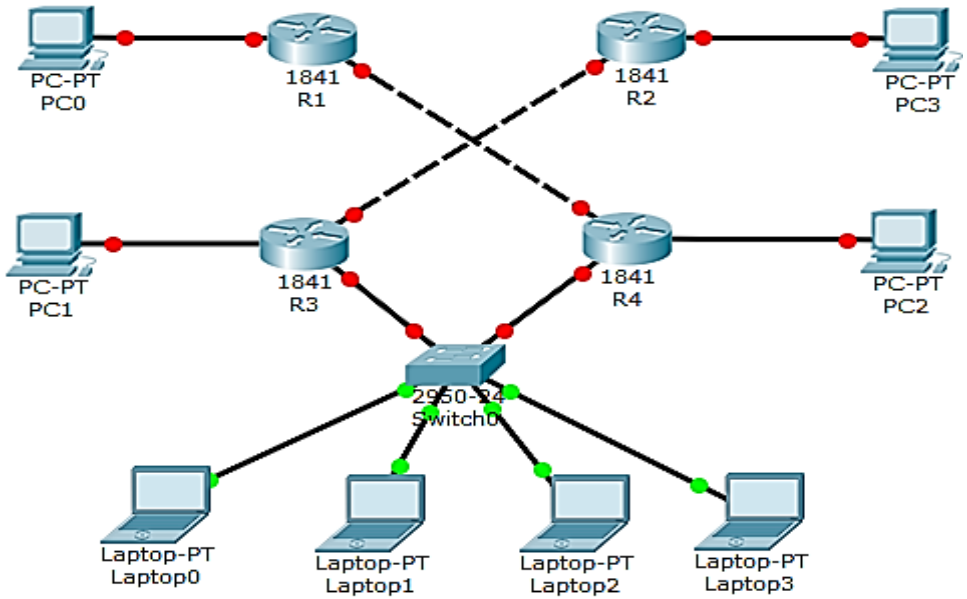


Examples

Homework:

For the network shown below, find:

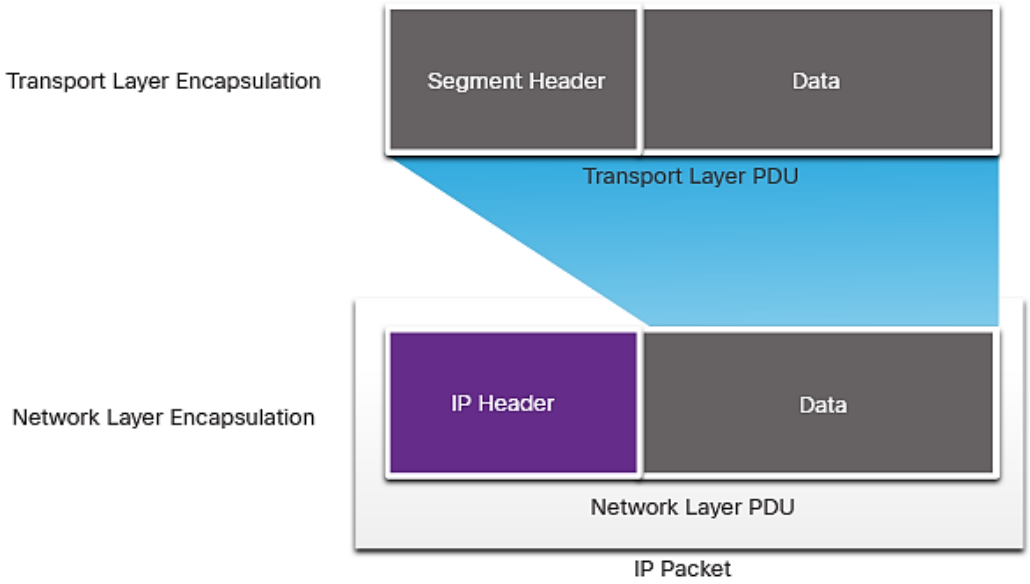
a. Number of collision domains
b. Number of broadcast domains
c. If we replace R2 with Switch, what is the broadcast domain.
d. If we replace the Switch with Router, what is the collision domain.



5.3 IP Encapsulation Frame

IP Encapsulation

- IP encapsulates the transport layer segment.
- IP can use either an IPv4 or IPv6 packet and do not effect the layer 4 segment.
- IP packet will be examined by all layer 3 devices as it traverses the network.



IPv4 Packet Header

IPv4 is the primary communication protocol for the network layer.

The network header has many purposes:

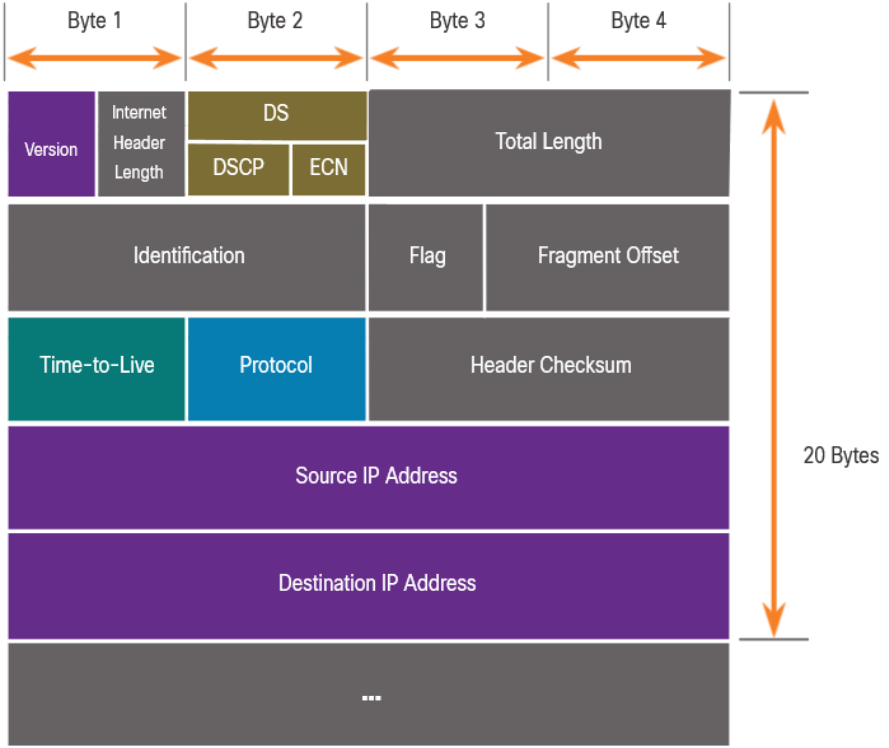
- It ensures the packet sent in the correct direction (to the destination).
- It contains information for network layer processing in various fields.
- The information in the header is used by all layer 3 devices that handle the packet

The IPv4 network header characteristics:

- It is in binary.
- Contains several fields of information
- Diagram is read from left to right, 4 bytes per line
- The two most important fields are the source and destination.

IPv4 Packet Header Fields

Function	Description
Version	Version 4 or version 6
Header Checksum	Detect corruption
Time to Live (TTL)	When it becomes zero the router will discard the packet.
Protocol	Next level protocol: ICMP, TCP, UDP, etc.
Source IPv4 Address	32 bit source address
Destination IPV4 Address	32 bit destination address

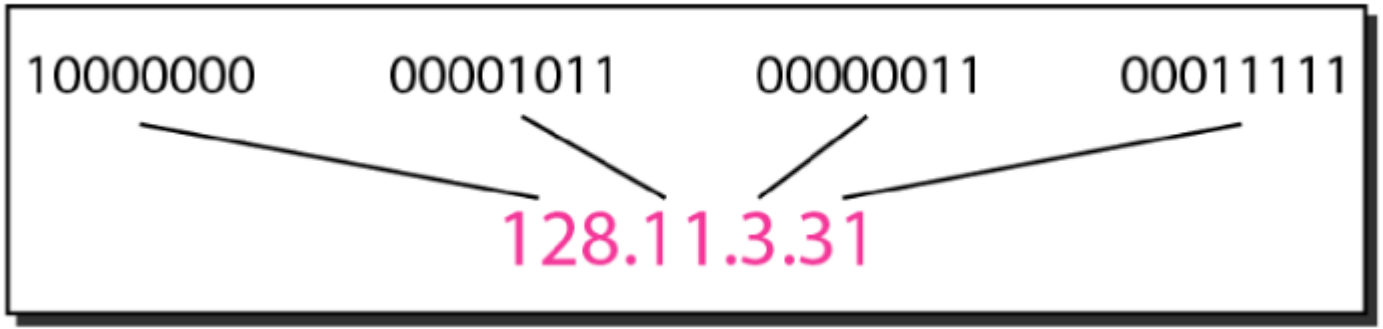


Note: The IPv6 header is simplified, but not smaller (40 Byte long), some fields in IPv6 were removed to improve performance, and addresses long are 128 bit

5.4 IPv4 Address Structure

Network and Host Portions

- An IPv4 address is a 32-bit hierarchical address that is made up of a network portion and a host portion.
- An IPv4 addresses are unique and universal.
- The address space of IPv4 is **2^{32} = 4,294,967,295**



Dotted-decimal notation and binary notation for an IPv4 address

Example 5.1

Change the following IPv4 addresses from binary notation to dotted-decimal notation.

a. 10000001 00001011 00001011 11101111

b. 11000001 10000011 00011011 11111111

Solution

We replace each group of 8 bits with its equivalent decimal number and add dots for separation.

a. 129.11.11.239

b. 193.131.27.255

Example 5.2

Change the following IPv4 addresses from dotted-decimal notation to binary notation.

a. 111.56.45.78

b. 221.34.7.82

Solution

We replace each decimal number with its binary equivalent

.

a. 01101111 00111000 00101101 01001110

b. 11011101 00100010 00000111 01010010

Example 5.3

Find the error, if any, in the following IPv4 addresses.

a. 111.56.045.78

b. 221.34.7.8.20

c. 75.45.301.14

d. 11100010.23.14.67

Solution

a. There must be no leading zero (045).

b. There can be no more than four numbers.

c. Each number needs to be less than or equal to 255.

d. A mixture of binary notation and dotted-decimal notation is not allowed.

Public and Private IPv4 Addresses

- As defined in in RFC 1981, public IPv4 addresses are globally routed between internet service provider (ISP) routers.
- Private addresses are common blocks of addresses used by most organizations to assign IPv4 addresses to internal hosts.
- Network Address Translation (NAT) translates private IPv4 addresses to public IPv4 addresses.
- NAT translates the internal private address to a public global IP address