Explores how the multiple networks are interconnected to form the Internet

6.7.1 Learning Outcomes:

Learning Outcomes:

- Explains the role of a gateway device in inter connecting two LANs
- Explain the need for a uniform, MAC protocol independent addressing scheme and how
- IP addresses play that role
- Describes the role of subnet masks
- Calculates subnet masks and IP address ranges given a block of IP addresses and
- network sizes
- Describes the how DHCP is used to dynamically assign IP addresses
- Describes the role of routers in finding a suitable path from the sender to the receiver
- Explains packet switching and best effort delivery in IP networks

Contents:

- A device connected two or more networks – gateway
- Need for globally unique uniform addressing independent of MAC addresses and LAN technology
  - IPv4 addresses
  - Assigning IPs to networks
    - ❖ Sub-netting
    - ❖ Subnet masks
    - ❖ CIDR notation
    - ❖ Private IP addresses
    - ❖ DHCP
  - Scarcity of IPv4 addresses and IPv6 as a solution (an overview)
  - Finding the path to the destination
    - Routing and routers
    - Packet switching
- Best effort delivery

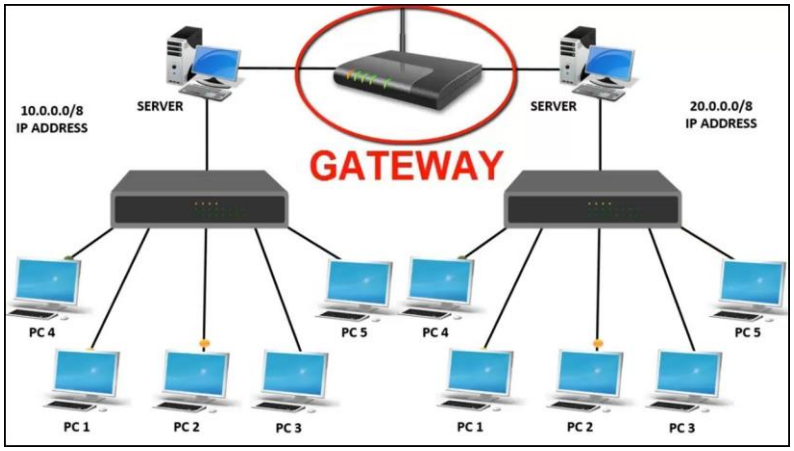
Devices to connect two or more networks

A gateway

- A gateway is a node (router) in a computer network, a key stopping point for data on its way to or from other networks.
- It is to communicate and send data back and forth.
- The Internet wouldn't be any use to us without gateways
- Gateway is a network device used to connect two or more dissimilar networks.
- In networking parlance, networks that use different protocols are dissimilar networks.
- A gateway usually is a computer with multiple NICs connected to different networks.

Default gateway

- A default gateway in Internet jargon is a term for a hardware node or point that will provide outgoing access to data packets to a destination in some other discrete network.
- Default simply means that this gateway is used by default, unless an application specifies another gateway. The default server does not even need to be a router; it may be a computer with two network adapters, where one is connected to the local subnet and the other is connected to an outside network.
- In a traditional physical network, the default gateway is going to point to the IP address of piece of hardware that acts as the gateway.
- The IP address specified is the IP address for the router.
- If IP address cannot be found in the packet (frame) ,such occasions that data is being transmitted by a device available in TCP/IP



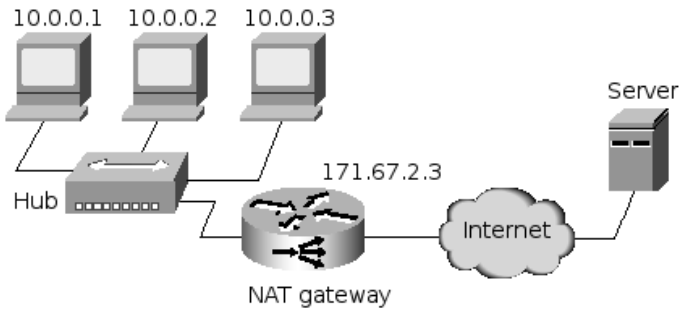
Need for globally unique uniform addressing independent of MAC addresses and LAN technology

To identity of a network is identified by the MAC address .in a network the MAC address has to be used to transmit data from one computer to another but it is cannot practically done. Because you cannot find the mac address of other computer.

For this purpose new mechanism was introduce. It is called IP address

IP address

- It is a numerical label assigned to each device connected to a computer network that uses the Internet Protocol for communication.
- All devices that are connected to an internet connection have a unique IP address which means there's a need of billions of IP addresses
- When connected to the internet, the IP address allows the computers to send and receive information
- There are four different types of IP addresses: public, private, static, and dynamic. While the public and private are indicative of the location of the network—private being used inside a network while the public is used outside of a network—static and dynamic indicate permanency.
- It allows a system to be recognized by other systems connected via the Internet protocol. There are two primary types of IP address formats used today



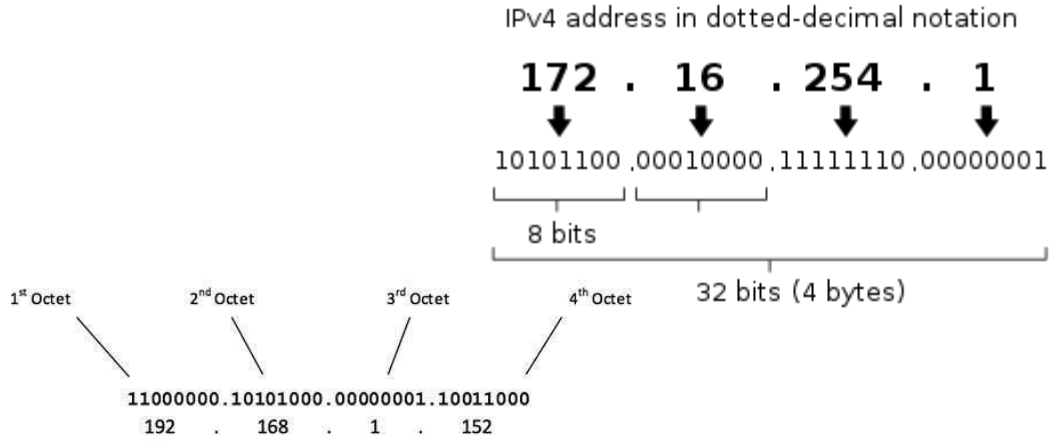
IANA

- The **Internet Assigned Numbers Authority** (**IANA**) is a standards organization that oversees global IP address allocation, autonomous system number allocation, DNS root zone management in the Domain Name System (DNS), media types, and other Internet Protocol-related symbols and **Internet numbers**
  .
- Since 1997, this role has been performed by ICANN
- **IANA introduce two IP versions named as IPV4 and IPV6**
- IP Version 4 (IPv4) is 32 bits long and can address up to 4 billion devices. IP Version 6 (IPv6) is 128 bits long and is plenty enough to address a huge number of networkable devices.

IPV4

- Internet Protocol version 4 (IPv4) is the fourth version of the Internet Protocol (IP). It is one of the core protocols of standards-based internetworking methods in the Internet and other packet-switched networks.
- IPv4 was the first version deployed for production on SATNET in 1982 and on the ARPANET in January 1983.
- An IPv4 address consist of four sets of numbers from 0 to 255, separated by three dots. For example, the IP address of www.ikman.lk is 104.17.253.46. This number is used to identify the www.ikman.lk website on the Internet.

- When you visit http:// www.ikman.lk in your web browser, the DNS system automatically translates the domain name "techterms.com" to the IP address "104.17.253.46"



- IP (version 4) addresses are 32-bit integers that can be expressed in hexadecimal notation. The more common format, known as dotted quad or dotted decimal, is x.x.x.x, where each x can be any value between 0 and 255.

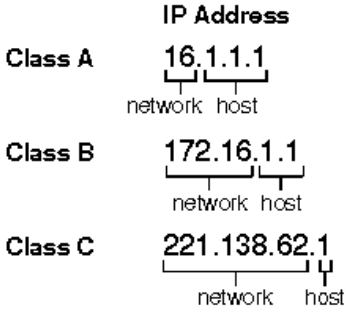
  For example, 192.0.2.146 is a valid IPv4 address.

Loopback address in IPv4

- IPv4 has special reserved addresses called as loopback addresses.
- When any program/protocol sends data from a computer with any IPv4 loopback address as the destination address, the TCP/IP protocol stack on that computer process the traffic within itself without sending it to the network.
- if you ping to a loopback address, you get the reply from the TCP/IP protocol stack running on the same computer.
- Any data traffic sent to IPv4 loopback addresses from 127.0.0.1 to 127.255.255.254 as the destination IPv4 address will never appear on network.

IPv4 - Address Classes

- Using the first number of the given IP address should be used for identify the class of the network
- Internet Protocol hierarchy contains several classes of IP Addresses to be used efficiently in various situations as per the requirement of hosts per network.
- The IPv4 Addressing system is divided into five classes of IP Addresses.
- All the five classes are identified by the first octet of IP Address.



Class A Address

- The first bit of the first octet is always set to 0 (zero).
- the first octet ranges from **1 – 127**
- Class A addresses only include IP starting from 1.x.x.x to 126.x.x.x only.
- **The IP range 127.x.x.x is reserved for loopback IP addresses.**
- Class A has 16777214 hosts (2^{24-2}).

Class B Address

- An IP address which belongs to class B has the first two bits in the first octet set to 10
- Class B IP Addresses range from **128.0.x.x to 191.255.x.x.**
- Class B has 65534 (2^{16-2}) Host addresses.

Class C Address

- The first octet of Class C IP address has its first 3 bits set to 110
- Class C IP addresses range from **192.0.0.x to 223.255.255.x.**
- Class C has 254 (2^{8-2}) Host addresses.

Class D Address

- Very first four bits of the first octet in Class D IP addresses are set to 1110,
- Class D has IP address range from **224.0.0.0 to 239.255.255.255.**
- Class D is reserved for Multicasting. In multicasting data is not destined for a particular host, that is why there is no need to extract host address from the IP address, and Class D does not have any subnet mask.

Class E Address

- This IP Class is reserved for experimental purposes only or Study. IP addresses in this class ranges from **240.0.0.0 to 255.255.255.254.**

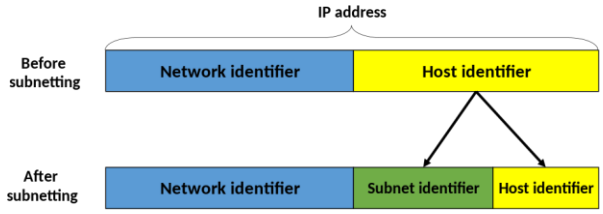
Address Class	RANGE	Default Subnet Mask
A	1.0.0.0 to 126.255.255.255	255.0.0.0
B	128.0.0.0 to 191.255.255.255	255.255.0.0
C	192.0.0.0 to 223.255.255.255	255.255.255.0
D	224.0.0.0 to 239.255.255.255	Reserved for Multicasting
E	240.0.0.0 to 254.255.255.255	Experimental
Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback testing.		

Assignment of IP addresses:

- All hosts in the same network are assigned the same address prefix.
- Address prefixes are assigned by central authority and are obtained from ISPs. Within a network each host is assigned a unique suffix locally by the network administrator.

Sub network

- A sub network or subnet is a logical subdivision of an IP network
- The practice of dividing a network into two or more networks is called sub netting.



Byte Values								
Base Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Weight	128	64	32	16	8	4	2	1
Byte and Network Mask Values								
128	1	0	0	0	0	0	0	0
192	1	1	0	0	0	0	0	0
224	1	1	1	0	0	0	0	0
240	1	1	1	1	0	0	0	0
248	1	1	1	1	1	0	0	0
252	1	1	1	1	1	1	0	0
254	1	1	1	1	1	1	1	0
255	1	1	1	1	1	1	1	1

Sub-netting

- Sub-netting is a technique used to overcome the problem of depletion of network address of a 32 bit addressing scheme.
- In sub-netting each physical network is assigned 32-bit address mask, which is used to identify networks among other networks.
- All machines in the subnet should have the same subnet mask.
- Each IP class is equipped with its own default subnet mask which bounds that IP class to have prefixed number of Networks and prefixed number of Hosts per network

Network class	IP range	Subnet mask	bit value	No of bits in binary
A	1-126	255.0.0.0	11111111.00000000.00000000.00000000	0'S-24
B	128-191	255.255.0.0	11111111.11111111.00000000.00000000	0'S-16
C	192-233	255.255.255.0	11111111.11111111.11111111.00000000	0'S-8

Sub network

255 . 255 . 255 . 192

1111111.11111111.11111111.**11**000000

(2^n) No networks Hosts (2^n) useable 2^n-2

How to find subnet

IP value	-192.168.1.15
Class of the network	-C
Subnet mask number according to class	-255.255.255.0
Number of networks need	- 4
Number of networks	-2x2=2^2
Subnet mask	-
	11111111.11111111.11111111.11000000
	255 . 255 . 255 . 192

- **We cannot use all the host in the network there are 2 address are used for network address and broadcast address**
  We use 2^n-2 for find useable hosts

Total host bits (n)	=6
No of useable host can connect	=**2^n-2=** 2^6 -2 = 2x2x2x2x2x2=64-2=62

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For the IP value **192.168.1.15** sub network is **255. 255. 255. 192** & no of **host can connect 62**

Question 1

A new computer lab has to be established with 13 computers. With 12 networks. Public IP address 192.150.100.2 is given for this lab to access the Internet. You are requested to propose a subnet mask for this network and assign suitable IP address for each device attached to it. The network should be secured from the threats coming from outside.

Identifying the required devices, draw a network diagram with the relevant IP addresses for the proposed network

IP value	-192.150.100.2
Class of the network	-C
Subnet mask number according to class	-255.255.255.0
Number of networks need	-12
Number of networks	-2x2x2x2=16=2^4
Subnet mask	-11111111.11111111.11111111.11110000
	255 . 255 . 255 . 240
Total host bits (n)	=2^4 =16
No of useable host can connect	=**2^n-2=** 2^4 -2 = 2x2x2x2=16-2=14

For the IP value 192.150.100.2 sub network is **255. 255. 255. 240** & no of **host can connect 14**

Obtaining network range

192.150.100.0----------network address

192.150.100.16(0+16)

192.150.100.32(16+16)

192.150.100.48(32+16)

192.150.100.63(48+16)

192.150.100.79(63+16)

192.150.100.95(75+16)

192.150.100.111(95+16)

192.150.100.127(111+16) Valid Host address

192.150.100.143(127+16)

192.150.100.159(143+16)

192.150.100.175(159+16)

192.150.100.191(175+16)

192.150.100.207(191+16)

192.150.100.223(207+16)

192.150.100.239(223+16)

192.150.100.255(239+16) ----------Broadcast address

subnet	**Ip address**	**Useable address**
1 subnet	192.150.100.0	192.150.100.1---192.150.100.15
2 subnet	192.150.100.16	192.150.100.17--192.150.100.31
3 subnet	192.150.100.32	192.150.100.33--192.150.100.47
4 subnet	192.150.100.48	192.150.100.49--192.150.100.62
5 subnet	192.150.100.63	192.150.100.64--192.150.100.78
6 subnet		
7 subnet		
8 subnet		
9 subnet		
10 subnet		