NETWORK LAYER

FUNCTIONS

1. **Routing :** When a packet reaches the routers input link, the router will move the packets to the routers output link

2. **Logical Addressing** The data link layer implements the physical addressing. and network layer implements logical addressing. The network layer adds a header to the packet which includes addresses of both sender and reciever.

3. **InterNetworking :** This is the main role of network layer that it provides logical connection between different types of networks

4. **Fragmentation :** It is the process of breaking the packets into smallest individual data units that travel through different networks.

SWITCHING TECHNIQUES

1.] **CIRCUIT SWITCHING**
   circuit switching is a switching technique that establishes a dedicated path between sender and reciever.
   In circuit switching Technique, once the connection is terminated only then the connection path is termi cease to exist
   - Space division
   In this the path is seperated by physical seperators called cross points.

2.] **MESSAGE SWITCHING**
   In message switching no dedicated path is created, it is transported to intermediate nodes which route it according to the information in the message which has destination address.
   This is called dynamic routing.

3.] **PACKET SWITCHING**
   In the Packet switching the message is sent in one go but is divided into smaller parts known as packets.

IP Addressing.

IPv4 :

32 bit long.
address are unique and universal.

Classes:

Class A : 1.0.0.0 – 127.0.0.0
Class B : 128.0.0.0 – 191.255.0.0
Class C : 192.0.0.0 – 223.255.255.0
Class D : 224.0.0.0 – 239.255.255.255 (multicast address)
Class E : 240.0.0.0 – 254.255.255.255 (reserved for future)

NOTATIONS

1. Doted decimal Notation :
   Denoted decimal format where each part seperated by
   a dot.
   Mostly used for human configurations.
2. Binary notations:
   In binary format (32 bits)
   Mostly used by devices for processing.

CLASSLESS ADDRESSING

1. Subnetting :
   It is the process of converting host bits to network bits
   As a result it increases the network
2. Super netting :
   It is the process of converting network bits to host bits
   As a result it decreases the network size

VLSM (Variable Length Subnet Mask) ↑↑

NAT [Network address translation]

IP address has public range & private range

To connect to network globally public range must be used
with unique IP globally.

To connect to network within organization private range
must be used with unique IP within org.

The NAT router consist public IP at exit interface and
Private IP at internal interface.

Private IP	Private port	External IP (Public)	External port (Public)	Transport Protocol

IPv6 :

ADDRESS STRUCTURE

An IPv6 address is made of 128 bits divided into eight 16 bit blocks. each block is converted into 4 digit Hex number seperated by colon symbol

example : 2001 : 0000 : 3238 : DFE1 : 0063 : 0000 : 0000 : FEFB

It can be shortened by following rules
- remove leading zeroes.

   2001 : 0000 : 3238 : DFE1 : 63 : 0000 : 0000 : FEFB

If two or more block contain 0000's then replace with ::

   2001 : 0000 : 3238 : DFE1 : 63 :: FEFB

DIFFERENCE BETWEEN

Category	IPV4	IPV6
Address length	32 - bits	128 - bits
Available IP	2^{32}	2^{128}
Fragmentation	Done by sender & router	Done only by sender
Packet Flow Identification	Not available	Available in header using flow label field.
Checksum field.	Available	Not Available
Options field	Available	Not Available but extention field present
Broadcast Message	Available	Not Available
ARP protocol	Available to map IPV4 to MAC	Replaced by Neighbor Discovery Protocol
Configuration	Manual Configuration & Dynamic Configuration is required to configure IP	Auto configuration of IP is available

ROUTING ALGORITHM

DISTANCE VECTOR ~~PROTOCOL~~ ROUTING

In this each link node updates the distance matrix of other node with its distance to that node.
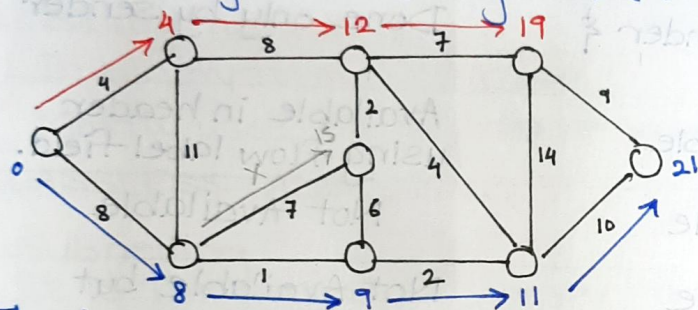
example
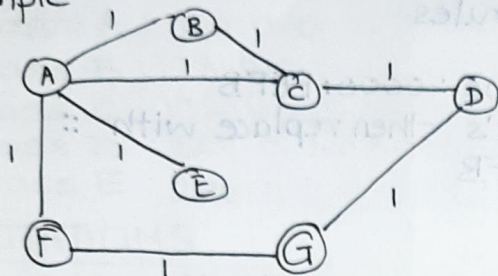
	A	B	C	D	E	F	G
A	.0	1	1	2	1	1	2
B	1	0	1	2	2	2	3
C	1	1	0	1	2	2	2
D	2	2	1	0	3	2	1
E	1	2	2	3	0	2	3
F	1	2	2	2	2	0	1
G	2	3	2	1	3	1	0

LINK STATE ROUTING

It uses Dijkastra's Algorithm to solve/route.

It also has

Link state packet – small packet with routing info
Link state database – A collection information gathered from link state packet.
Routing table – List of known paths and interface.

ADAPTIVE ROUTING

- called as Dynamic
- makes decisions based on network topology & traffic
- parameters related are hop count, distance, estimated time.
- They are complex

NON ADAPTIVE ROUTING

- called as static
- when booting up network routing info stored in router
- doesnt consider topology or traffic
- They are simple

INTERNET CONTROL PROTOCOL

ARP [Address Resolution Protocol]

It is a communication protocol used for resolving physical address associated with given network address

Typically ARP is network layer to Datalink layer mapping process which is used to discover the MAC of given IP

To send a message the destination IP is not enough we also need the MAC of destination machine. Here ARP is used.

RARP [Reverse Address Resolution Protocol]

In this the machine in LAN requests its IP from the gateway-router's ARP table

The network Admin makes a ARP table which maps MAC address to IP
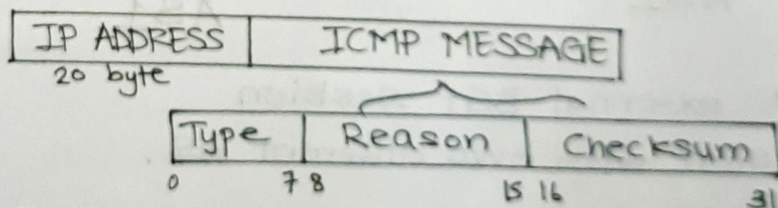
DIAGRAM

ARP

RARP
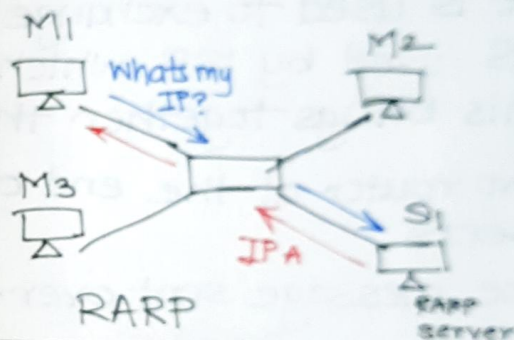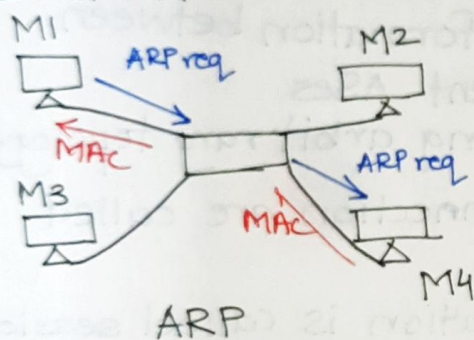
ICMP [Internet Control Message Protocol]

ICMP is used to check if destination is reachable and responding.

It is used by host and reports back to sender if an error occurs [doesn't correct the error]

IP DATAGRAM

IP ADDRESS 20 byte	ICMP MESSAGE

Type	Reason	Checksum
0	7 8	15 16	31

IGMP [Internet Group MANAGEMENT PROTOCOL

It is used to route Multicast messages from sender to hosts that have registered through IGMP to recieve them.

ROUTING PROTOCOLS

They are used to determine the path taken by a datgram between source and destination.

An Autonomous system (AS) is a collection of router under the same administrative control.

OSPF - Open Shortest Path First

Its a link state routing protocol which uses the best path calculation between source and destination.

It constructs a topological graph of network (AS)
It runs Dijkastra algorithm to determine shortest path.
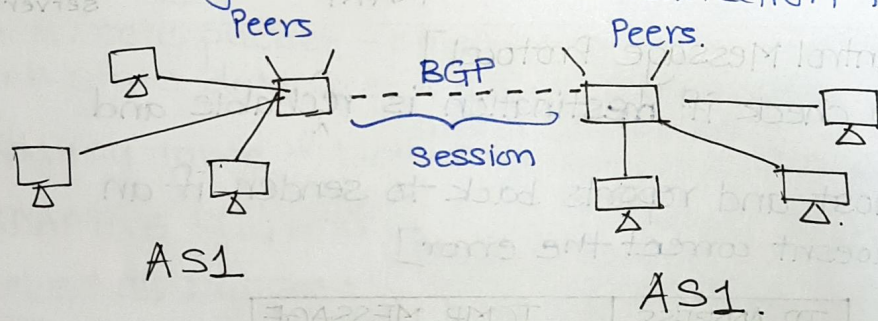Finally it broadcasts link state info to all other routers in AS

BGP - Border Gateway Protocol

It is used to exchange routing information between AS used by ISP which are different ASes
This brings together the AS using arbitrary topology
Two router at the end of each connection are called peers
The message sent over this connection is called session

eBGP external BGP session
  session with two different AS.
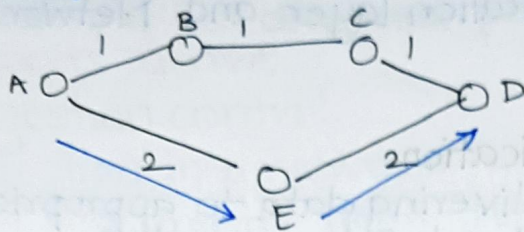
iBGP internal BGP session.
  session within a AS

RIP :- Routing Information Protocol.

It is a distance vector protocol used for routing
It focuses on hop count as metric for routing
It works towards minimizing the number of
hops required to reach destination.

✗ A − B − C − D : hop − 3
dist − 3

✓ A − E − D : hop − 2
dist − 4.

MPLS − Multi protocol Label Switching.

It is a routing technique in which it direct data
from one node to other based on lables rather than
network addresses