MOD - 4

PAGE No.
DATE / /

* Network layer → Ip address
  - ① Design issues
  - ② Ip addressing
  - ③ Sub-netting | super-netting

* Network layer in Internet
  - ① The IP protocol
  - ② IPV4 header
  - ③ Ip V6 header
  - ④ Routing algorithms
  - ⑤ Congestion algo
  - ⑥ Quality of service.

Network layer → implements logical addressing.

⇒ Third layer in the communication model.
⇒ Translates the logical address into physical address.
⇒ Determines the route from source to destination and manages traffic.
⇒ move packets from sender to receiver.
⇒ Provides a logical connection betn different types of network.

* Design issues

1) Store and forward of packet switching:

⇒ so, host sends the packet to nearest router, now the packet is stored in router till the entire packet arrives,
⇒ once the entire packet has arrived, checksum is done and then the packet is sent to next router till destination

packet → router (stored) → till complete packet arrives → destination

PAGE No.
DATE / /

1) Services Provided to transport layer:

* services shld not be dependent on router.

- Network layer provides some services to transport layer;

→ connection less ⇒ routing and insertion of packets into subnets is done indivisually no extra setup.

packet = independent entity.

⇒ connecth oriented ⇒ all packets must be transmitted through single route. or path.

B) Implementation connection oriented:

⇒ Here a virtual circuit is setup in betn host and sender, thus the path is already decided.

⇒ Each packet follows a certain virtual circuit.

4) connechonless:

⇒ here the packet is transmitted as an independent entity

⇒ each packet has its routing info. termed as datagram.

⇒ Each datagram follows his own route from source to destination

eg: IP.

IP addressing (0.0.0.0 to 255.255.255.255) (32 bits)

⇒ Internet protocol address. ⇒ unique.

addressing

physical (mac) (logical)

IP V4 IP V6.

public private

- helps internet to distinguish betn diff. routers and components.

⇒ structure ⇒ set of 4 digits from 0.0.0.0 to 255.255.255.255

∴ x_1, x_2, x_3 = network ID

x_4 = host ID.

mac address ⇒ we cannot change
IP address ⇒ may change on restart.

PAGE No.
DATE / /

* Network ID, identifies the location where device is located.
* Host ID ⇒ identifies the specific device.

* IP V4 ⇒ 32 bits, ~~42~~ 42 hundred crores of IP, facing shortage
* IP V6. ⇒ 128 bits, hexadecimal IPaddress, 3.4×10^{38} IP

IP address types: Public, private, Fixed & Dynamic

Public ⇒ web server, email etc which are accessed by the world will have a public IP.

private ⇒ Router generates a unique IP for a device in that network.

static ⇒ (fixed) ⇒ invalid IP, a dynamic IP will be provided at that time.

Dynamic ⇒ changes over time. ISP provides Dynamic Ip instead of static.

Classfull and Classless:

* classless ⇒ in classfull size of addressing is fixed and each address range has a default subnet mask.
  ⇒ using classless, we can allocate Ip more efficiently.
⇒ used as a short soln, to the demanding IP.
⇒ Prefix data & Postfix data is attached to the IP.
⇒ classless addressing is a specific instance of classful.

PAGE No.
DATE / /

Classfull addressing:

- IP is divided into classes and each class has a specific subnet mask.

	Classes	Range.	
	A	0.0.0.0	127.255.255.255
	B	128.0.0.0	191.255.255.255
	C	192.0.0.0	223.255.255.255
multicast	D	224.0.0.0	239.255.255.255
Reserved for future.	E	240.0.0.0	255.255.255.255.

(2^{31}) (1 reserved)
- class A address can be used globally (0000 → 127 255 255 255)

  Net ID = 8 bits Host ID = 24 bits.

  used in very large networks.

(2 reserved)
- class B (2^{30})

  Net Id = 16 bits Host Id = 16 bits

  - medium sized

(2^{29}) (3 reserved)
- class C (2^{29})
  - Net Id = 24 host id = 8

(2^{28})
- class D → multicast → 1st 4 bits reserved (1110)

2^{28}
- class E ⇒ reserved ⇒ 1st 4 bits reserved (1111)

default subnet mask

A ⇒ 255.0.0.0
B ⇒ 255.255.0.0
C ⇒ 255.255.255.0
D ⇒ 255

PAGE No.
DATE / /

Classfull vs classless

⇒ Ip address are divided into 5 grps in classfull, inorder to prevent depiltion of Ip address ⇒ classless is used.

⇒ classless is more benefical than classfull.

⇒ classfull netid & hostid are properly alotted. but in classless, distinction of these does not exists.

—x—

- classless divides blocks into varying length
- Prefix suffix is given
- Block of address must have Power of 2 addresses.
  * slash notation for prefix length eg: 12.23.45.67 18.

167.199.170.82, /27

10101010 01010010

00000.

keep 1st 27 bits same & change rest to (1).

Subnetting Supernetting

* Subnetting ⇒

Subnet ⇒ • logical division or partition of Ip ~~address~~ network
• Segmented piece of larger network into small networks

⇒ The practice of dividing larger network in smaller = subnetting small logical networks.

* computers belonging to a single subnet, addressed with identical most significant bit group.

eg: 192.168.14.0 to 192.168.14.255

(12 ... 244) = subnets.

Subnet mask = 32 bit address used to distinguish.
betn netid & host id.

0000 = network address | 255255... = broadcast reserved

PAGE No. DATE / /

* ① identify class & default subnet mask.
② convert default subnet mask into binary.
③ note the no of host required per subnet
④ generate new subnet mask.
⑤ make network rangers.

* 255.255.0.0
these say that group of IP should have same value for 1st & 2nd pos.
→ these say that the IP can have any value, group of IP can have any value at 3rd & 4th pos.

eg: 11.11.14.12. & 11.11.13.11
both belong to same group

* 216.21.5.0 in-to 30 host in each subnet.
net → host id.

216.21.5.0 ⇒ class C.

∴ default subnet mask of C.
255.255.255.0.

⇒ 11111111.11111111.11111111.00000000
8 bits reserved

no. of host = 30 (11110) - 5 bits

now reserve 5 bits & fill remaing with 1.

⇒ 11111111.11111111.11111111.11100000 & 5 reserved

subnet generator = 1st 1 from right
$= 2^5 = 32$
in octet 4
= 255.255.255.224 /27

PAGE No.
DATE / /

⇒ 216.21.5.0 + 32

⇒ 216.21.5.32. Keep adding 32 for 30 times.

216.21.5.0 - 216.21.5.31.

supernetting = opposite of subnetting.,

⇒ multiple networks are combined into 1 single network.
e. supernetworking / supernet

⇒ used in route summarization.
where routes to multiple network with same network prefixes are sent through same single route.

⇒ reduces traffic and size of routing.

⇒ aggregating small networks into one big.

~~Internet~~ Internet Protocol

* main task of Ip is to deliver packets from source to ~~be~~ destination, based on Ip address available in the packets.

* Provides a connectionless service accompanied by either TCP/IP or udp/IP.

* main function is also to provide addressing to hosts, and encapsulating data and routing data from source to destination.

* Ip has its Packet ⇒ Ip header + date.

* And Ip addressing ⇒ private & Public.

* IP addr unique identifier assigned to comp. which is connected to Internet

PAGE No.
DATE / /

* Public address ⇒ external address, they are grouped under WAN. addresses used to access the internet, available on our comp.

* with public address we can setup home server to access internet.

⇒ scope is global.

* Private address ⇒ Internal address, grouped under LAN

- used in communicating within the network.
- not routed on internet, thus no internet traffic.

- Private address are those comp, printer that are placed in house.

⇒ scope is local, only in network communication.

* IP routing: process of determining the path of data.

* the path that each packet follows is done by routing algorithms.
* routing algo. considers various, constraints, size, header for efficient route

* router forwards the packets & it works on network layer.

* Constraints & measures on routing:

(1) Hop count ⇒ path with least hops, least routers is to be selected
(2) Delay ⇒ time taken by router to process data, hence path with less delay is used.

PAGE No.
DATE / /

③ Bandwidth ⇒ higher the capacity to transfer data measured in bits/sec. higher bandwidth more data transferred.

④ load ⑤ reliability

* static routing ⇒ give the route manually.
* Default ⇒ used when router has to send data to single hop. (single exit point).
* Dynamic ⇒ adaptive, discover new routes, can change routes.

* Routing Algorithms:

- to determine the route of transferring we use routing algo.
- We know, we have 2 points in Ip. i.e. connectionless (UDP) & connection oriented (TCP)
- Routing algo help in calculating least cost path.

* Types of Routing algo.

① Adaptive Routing algo.
② Non-adaptive routing algo.

* 1] Adaptive Routing algorithms:

- also are the dynamic routing algorithms, able to change the path and discover new path.
- Makes own decisions based on topology & traffic.
- main parameters are hop count, distance, delay.

* They are of 8 types ⓐ centralized
ⓑ isolated (CID)
ⓒ distributive decentralized.

Routing →

adaptive — nonadaptive

(global) • centralized
(local) • Isolated
• distributive.

PAGE No.
DATE / /

ⓐ centralized ⇒

- computes the least cost path by using the complete and global data about the network
- takes the data first ~~and~~ before performing the routing, and does the calc. of routing.

* Link state algorithm = centralized.

ⓑ Isolation ⇒

- It takes in the information for routing from the local information or from nodes.

ⓒ distributed ⇒ also called decentralized, computes the shortest path in iterative, repeated manner.

- here no node has knowledge about other nodes.
- It has info about only is directly attached link. and from that it calculates least cost path.
- never knows the complete path.

Nonadaptive algorithms :

- also known as static routing algorithms
- do not take routing decisions.

We have 2 types ⓐ Flooding
ⓑ Random walks.

PAGE No.
DATE / /

(node based)

a) Flooding ⇒

- every incoming packet, sent to all other links connected or all other outgoing links.
- several copies of some data may be generated.

b) Random walks ⇒

- the received packet is sent to one of the neighbours randomly.
- It uses alternative routes very efficiently.

Distance vector algo (distributed) · (Dynamic)

↳ This is ① distributed ⇒ each nodes receives info from one or more of directly attached nodes.

② Iterative ⇒ process continues

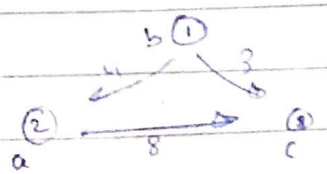
③ Async ⇒ does not require all nodes.

* each router maintains a distance table = vector
* routing only to neighbours / connected to main.
* cost for distance vector routing is based on hop count

* Routing table ⇒ net id, cost, next hop.
  - net id → Final destination
  - cost → no. of hops
  - next hop → next router

∴ all these data is stored in all routers, and that basis the distance vector is seen and data is transmitted to router

* after each transmission, we update data



1 → 8 = 4	table -
2 → 8 = 8	1 → 3 = 3
1 → 3 = 3	3 → 2 = 8.

PAGE No.
DATE / /

Link state Routing : (Centralized)

Based on tech. in which each router shares knowledge about its neighbour to all other routers.

Flooding ⇒ • Instead of sending the routing table, router sends the information about its ~~neg~~ neighbour

• Each router does send info to all other routers except neighbours. and now every router that receives the data, sends that to other routers.

* 2 ~~tot~~ states

1] Reliable flooding

a) initial stage ⇒ each node knows the cost of neighbour

b) Final stage ⇒ each node knows entire graph.

2] Route calc. ⇒

• uses Dijkstra. to calc. node.

↳ iterative algo. known for finding least cost path.

* uses dijkstra to find closest path & share info

* heavy traffic is created. due to flooding.

PAGE No.
DATE / /

Congestion ⇒ heavy traffic.
• delay in performance.

Congestion algorithm:

- cong. control algo is a mechanism that controls entry of data packets in network
- congestion Avoidance algo is used in TCP.

Two types ① Leaky bucket
② Token bucket.

① Leaky bucket

- allows to control, the rate at which data is given to network.
- used in traffic shaping.
- assume as a bucket
- any input to the bucket is not affected but at a constant rate the packets are released
- basically bucket leaks some data at const rate.
- means data input is higher than output.
- But this helps in making the data in a ordered sequence manner. ⇒ makes data regular flowed.

* leak rate is fix so bit inefficient, uses some buffer to control the data
* During large traffic, this causes issues.
* in huge traffic info bigger than bucket may be lost

PAGE No.
DATE / /

(2) Token bucket: (bucket ⇒ buffer)

- When traffic is high, output is allowed to speed up. Thus making it more efficient and flexible.
- Generally no data is lost.
- The output of bucket is based on the tokens (data in the bucket)

- token bucket algo adds token to bucket at every 1/r sec
- If new token appears and bucket is full, then the new token is discarded.

- when not enough spaces available, then either the token is considered in non-conformant. they may be dropped

* the space available in Token bucket only that no. of packets will be allowed
∴ no scope of overflow.

IPV4 vs IPV6

- IPV4
  - current version — 32 bits.
  - a set of 4, 8 bit octets.
  - IPV4 is depleting, no more left-, khatam ho gaye.

- IPV6
  - next gen of IP. (hexadecimal value),
  - 128 bit address. has larger scopes & small headers

PAGE No.
DATE / /

* transition strategy's IPV4 to V6

① Dual stacking ⇒ both version of V4 & V6 on same device
② Tunneling ⇒ IP V6 communicates with V4.
③ Network addr. translation ⇒ allows communicat' with diff IP version

* V4 has 4 octets, V6 has 16 octets.

• numeric seperated by dot	• alphanumeric seperated by colon
• class → 5 classes are used	• does not have any classes.
• supports Virtual length subnet mask	• Does not support VLSM
• Manual & DHCP config	• manual, DHCP, auto config, renumbering.
• end to end integrity is impossible.	• end to end integrity possible.
• lower security	• Higher security.
• Fragmentation is done by sender and routers	• Fragmentation done by sender only.
• uses checksum	• has no checksum
• does not have encryption & decryption.	• provides encryption & decryption.

Quality of service: set of tech. that work on network to give its best performance.

B
D
L
J.

- Bandwidth — high
- delay — less
- loss rate — less
- error rate — med.
- jitter — dk.
  - Irregular speed of packet resulting congestion.

Based on router as we are checking the network layer data transmission.

Router Adv
- prioritize, queue, traffic marking,
- latency reduction, enhanced user exp. • Prevent loss