UNIT – III NETWORK LAYER:

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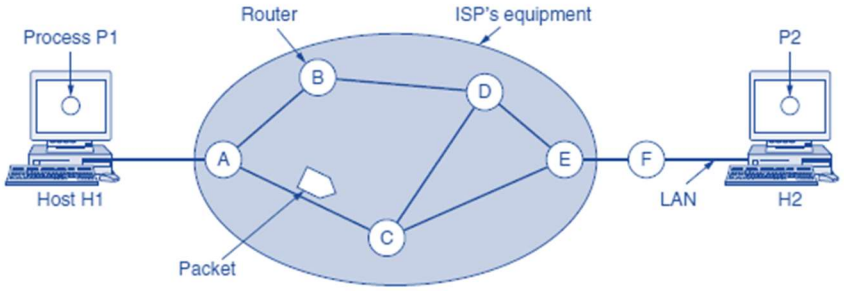
1. DESIGN ISSUES

1.1. Store and Forward Packet Switching:

- Let us understand how the Network Layer operate.
- The major components of networks are ISP's equipment i.e., Routers connected to the transmission line and then the customer equipment (Host H1 and Host H2) as shown in the figure below.



- Routers A to E forms the ISP equipment. Router F is outside ISP and not a part of ISP.
- Host H1(Home Computer) is directly connected to Router A in the ISP, consider it to be plugged to DSL modem.
- Host H2(office Computer) is a LAN through an Ethernet with router F and is on a leased line with the ISP equipment.
- But, the router F on the customer line considered to be part of the ISP's equipment as all the routers run on the same algorithm.
- The operation is as follows:
  - ✓ A Host intended to transmit the packet, sends the packet to its nearest Router
  - ✓ This packet is stored there until it is fully arrived at the router.
  - ✓ The link then processes the packet and verified it by generating the Checksum.
  - ✓ Then, the packet if forwarded to the next router until it reached the destination router.
  - ✓ This mechanism is called as ***Store-and-Forward Packet Switching***

1.2. Services provided to Transport Layer

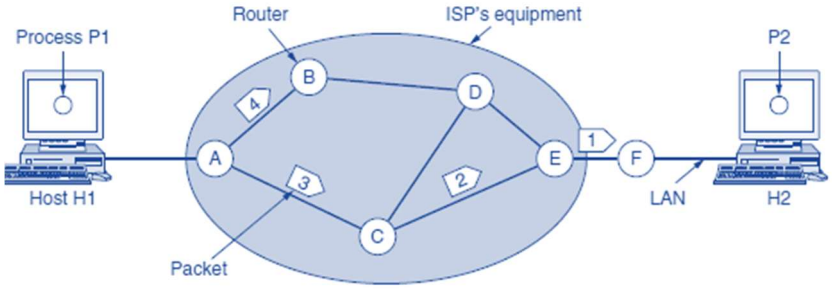
- A network layer provides services to the Transport Layer using the interface.
- These services to the transport layer are to be provided keeping in mind the following goals.
  - ✓ The services should be independent of the router technology
  - ✓ The transport layer should be shielded from the number, type, and topology of the routers present
  - ✓ The network addresses made available to the transport layer should use a uniform numbering plan, even across LANs and WANs

1.3. Implementation of Connectionless and connection –oriented Services

- We already learnt that there are two types of services. i.e., Connectionless and Connection-Oriented Services.
- In connectionless service, the packets are injected individually and routed independently. i.e., no prior setup is required. Here, the packets are called as ***datagrams and the network is called as datagram network***
- In connection-oriented service, a connection has to be established all the way from source router to the destination router before a packet is being sent. This connection is called as ***Virtual Circuit*** and the network is called as ***Virtual Circuit Network***

Datagram Network(Connectionless):

- Consider P1 from Host H1 wants to send a message to P2 on Host H2 as shown below.
- It handovers the message to the Transport layer with an instruction to deliver the message to P2
- Host H1 runs the transport layer code
- It prepends a header to the front of the message, then hands-over to network layer.



- Let us now understand how the message is sent from Host H1 to Host H2
- Consider that the message is 4 times the packet size. Message now has to be split to 4 packet P1, P2, P3, P4
- Each packet is sent in-turns to Router A.
- The packet now enters ISP and ISP takes over the operations.
- Packets can be sent only on the directly connected lines. Router A has to two outgoing lines and the packets should be sent over these lines.
- Every router has its own internal table that tells where to send the packets to reach destination.
- Let the initial table of A is

A	-
B	B
C	C
D	B
E	C
F	C

And let, Packets P1, P2, P3 arrive at A. after the evaluation of checksum, these packets are forwarded to the routers based on the A's table. P1 is sent to C and then forwarded to E and F.

After reaching F (outside ISP), it is sent over LAN to reach P2 on Host H2. Also, P2 and P3 follows the same route.

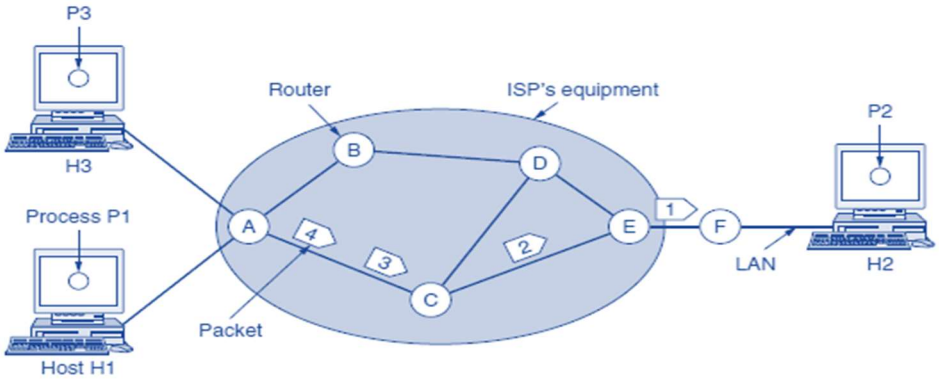
When P4 reached router A, it might have sensed a traffic-congestion in the previous path
(A-C-E) and P4 is sent over different route and it updates the table as below

A	-
B	B
C	C
D	B
E	B
F	B

- The algorithm that manages the tables and makes the routing decisions is called the **ROUTING ALGORITHM**

Virtual Circuit Network (Connection Oriented Service):

- The idea behind virtual circuits is to avoid having to choose a new route for every packet sent.
- when a connection is established, a route from the source machine to the destination machine is chosen as part of the connection setup and stored in tables inside the routers.
- That route is used for all traffic flowing over the connection
- When the connection is released, the virtual circuit is also terminated.
- With connection-oriented service, each packet carries an identifier telling which virtual circuit it belongs to.
- Let us understand with an example shown below.



Here, Host *H1* has established connection-1 with Host *H2*. This connection is remembered as the first entry in each of the routing tables. The A's table be

A's Table					C's Table					E's Table			
IN		OUT			IN		OUT			IN		OUT	
H1	1	C	1		A	1	E	1		C	1	F	1
H3	1	C	2		A	2	E	2		C	2	F	2

The first line of *A*'s table says that if a packet bearing connection identifier 1 comes in from *H1*, it is to be sent to router *C* and given connection identifier 1. Similarly, the first entry at *C* routes the packet to *E*, also with connection identifier 1.

Now, let H3 also wants to establish the connection with H2. It chooses connection identifier 1 (because it is initiating the connection and this is its only connection) and tells the network to establish the virtual circuit. This leads to the second row in the tables.

Note that we have a conflict here because although *A* can easily distinguish connection 1 packets from *H1* from connection 1 packets from *H3*, *C* cannot do this. For this reason, *A* assigns a different connection identifier to the outgoing traffic for the second connection.

Avoiding conflicts of this kind is why routers need the ability to replace connection identifiers in outgoing packets.

This process is called as ***LABEL SWITCHING.***