Transport Layer Protocols
TCP/IP Protocol Suit

- Key function of the Transport Layer Protocols
- Introduction to Transport Protocols Similar to TCP
- TCP/IP Protocol Suit (part-1)
  - The Service TCP Provides to Applications
  - TCP Header Structure
  - TCP Congestion Control Algorithms
- **The Internet Protocol (IP) (part-2)**
  - **IP Addresses**
  - **IP Header Structure**

TCP/IP Protocol Suit

The TCP/IP suite includes the following protocols:

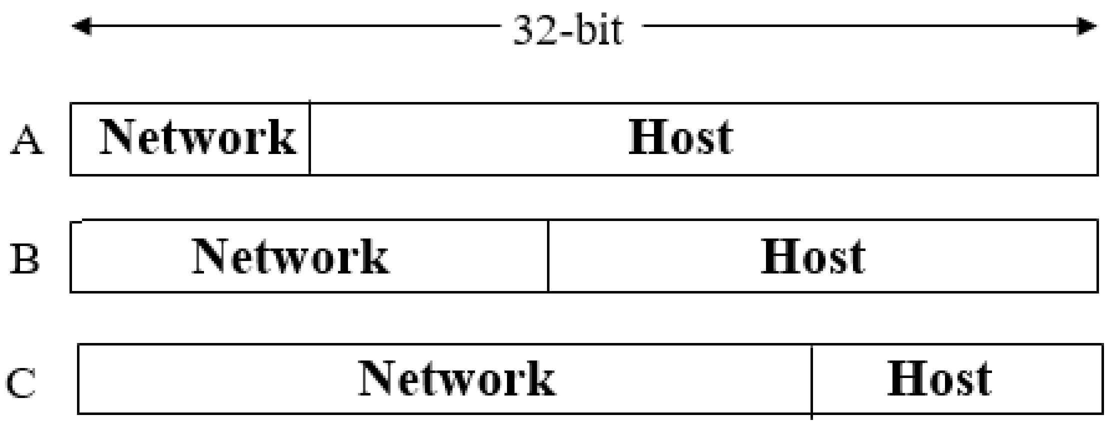
- TCP – Transmission Control Protocol
- IPv4 / IPv6 – Internet Protocol

The Internet Protocol (IP)

- The Internet Protocol (IP) is the routing layer datagram service of the TCP/IP suite.
- All other protocols within the TCP/IP suite, except ARP and RARP, use IP to route frames from host to host. The IP frame header contains routing information and control information associated with datagram delivery.
- IP provides a delivery service that is described as offering unreliable or best-effort delivery semantics, because there is no guarantee of delivery. Packets can be lost, duplicated, delayed or delivered out of order, but these errors arise only when the underlying networks fail or buffers at the destination are full.
- When an IP datagram is longer than the MTU of the underlying network, it is broken into smaller packets at the source and reassembled at its final destination.

The Internet Protocol (IP)

- **Class A.** Few networks, each with many hosts.
- **Class B.** Medium number of networks, each with a medium number of hosts.
- **Class C.** Many networks, each with a few hosts.



(126 networks with 16 millions hosts each)

(16382 networks with up to 64K hosts)

(2 millions networks with 254 hosts each)

The Internet Protocol (IP)

- Network address, which are 32-bit numbers, are usually written in dotted decimal notation
- Each of the 4 bytes is written as from 0 to 255
- The lowest IP address is 0.0.0.0 and highest is 255.255.255.255
- For example, consider the IP address 124.29.88.7

IP Header Structure

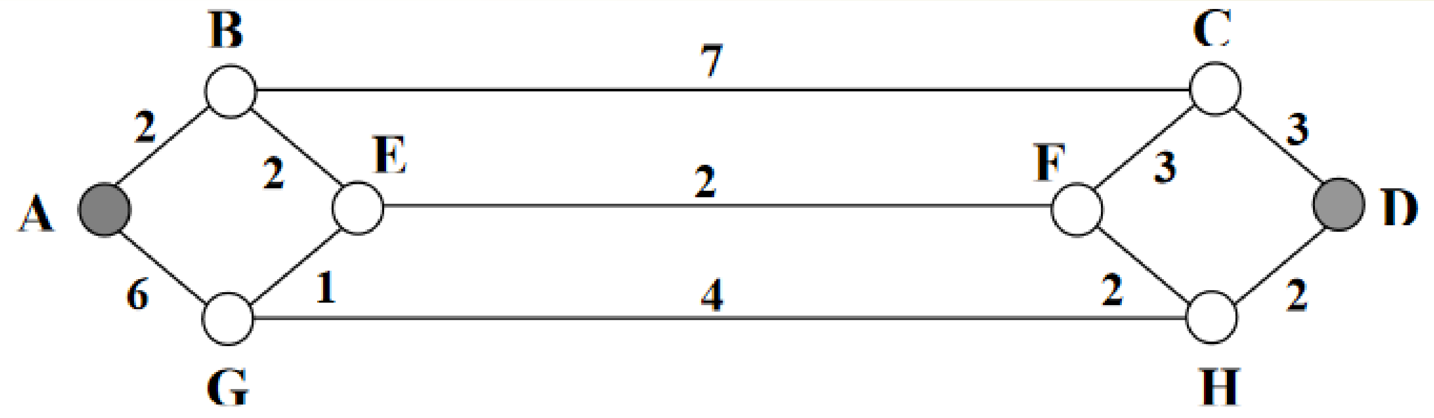
<table>
<tr><td>0</td><td></td><td>15</td><td colspan="2">31</td></tr>
<tr><td>4</td><td>8</td><td>16</td><td colspan="2">32 bits</td></tr>
<tr><td>Ver.</td><td>IHL</td><td>Type of service</td><td colspan="2">16-bit Total length</td></tr>
<tr><td colspan="3">Identification</td><td>Flags</td><td>Fragment offset</td></tr>
<tr><td colspan="2">Time to live</td><td>Protocol</td><td colspan="2">Header checksum</td></tr>
<tr><td colspan="5">32-bit Source address</td></tr>
<tr><td colspan="5">32-bit Destination address</td></tr>
<tr><td colspan="5">Option + Padding</td></tr>
<tr><td colspan="5">Data</td></tr>
</table>

Routing

- The Network layer is responsible for routing packets across a network.
- For packets to be correctly routed there needs to be a table setup to show the shortest routes between two networks.
- These tables can either be *dynamic* or *static*: Static routing tables are set up manually by administrators.
- Dynamic routing protocols use one of two methods to define the shortest route without administrator support: *i) Distance Vector, ii) Link State*

Shortest Path Routing

- The idea is to build a graph of the subnet, with each node of the graph representing a router and each arc of the graph representing a communication line.
- To choose a route between a given pair of routers, the algorithm just finds the shortest path between them on the graph. One-way of measuring path length is the number of hops.
- There are also other metrics to find out the shortest path Routing. Physical distance and time delay in milliseconds.

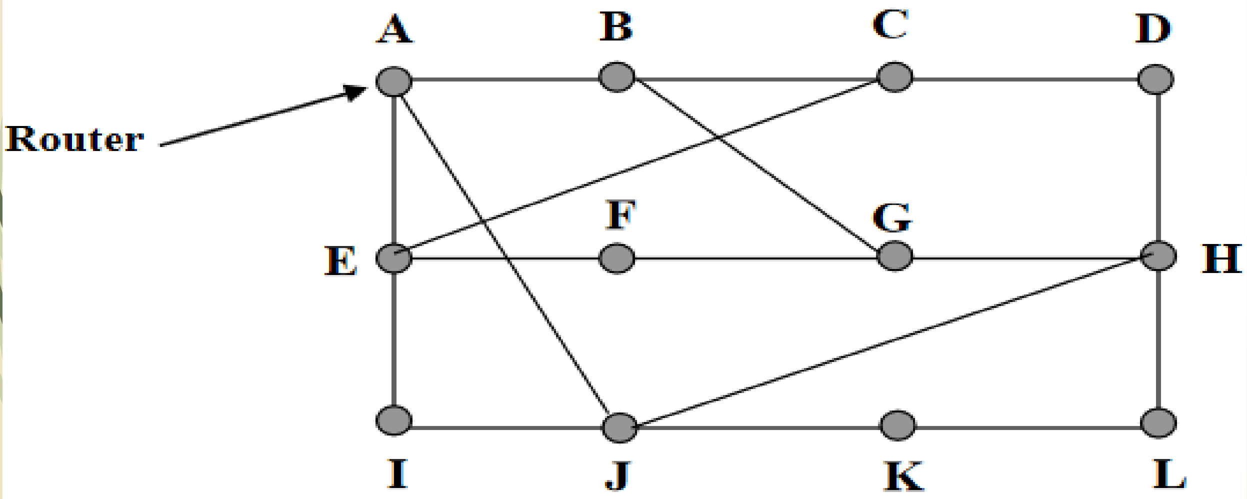


Distance Vector Routing

- Modern computer networks generally use dynamic routing algorithms. Two dynamic algorithms in particular, distance vector routing and link state routing, are the most popular.
- Distance Vector Routing algorithms operate by having each router maintain a table giving the best-known distance to each destination and which line to use to get there.
- These tables are updated by exchanging information with the neighbors. Each router maintains a routing table indexed by, and containing one entry for each router in the subnet. If the metric is delay, the router can measure it directly with special ECHO packets that the receiver just timestamps and sends back as fast as it can.

Distance Vector Routing

- Figure shows the delay vectors received from the neighbors of router *J*. A claims to have a 12-msec delay to *B*, a 25-msec delay to *C* etc. Suppose that *J* has measured or estimated its delay to its neighbors, *A, I, H* and *K* as 8, 10, 12 and 6-msec. Consider how *J* computes its new route to router *G*.



	A	I	H	K	New Routing table for J	Line
A	0	24	20	21	8	A
B	12	36	31	28	20	A
C	25	18	19	36	28	I
D	40	27	8	24	20	H
E	14	7	30	22	17	I
F	23	20	19	40	30	I
G	18	31	6	31	18	H
H	17	20	0	19	12	H
I	21	0	14	22	10	I
J	9	11	7	10	0	-
K	24	22	22	0	6	K
L	29	33	9	9	15	K
	JA delay is 8	JI delay is 10	JH delay is 12	JK delay is 6		

Vector Table received from J's four neighbors.

Thank You

Q & A