Year	Subject Title	Sem	Sub Code
2018 -19 Onwards	**Core: COMPUTER NETWORKS**	**IV**	**18BIT42C**

UNIT IV: The Network Layer – Network Layer Design Issues – Routing Algorithms The optimality principle, shortest path routing, flooding, and distance vector routing, routing for mobile hosts.

TEXT BOOKS

1. Andrew S. Tanenbaum, "Computer Networks", 4th Edition, Pearson Education Publ. 2014.

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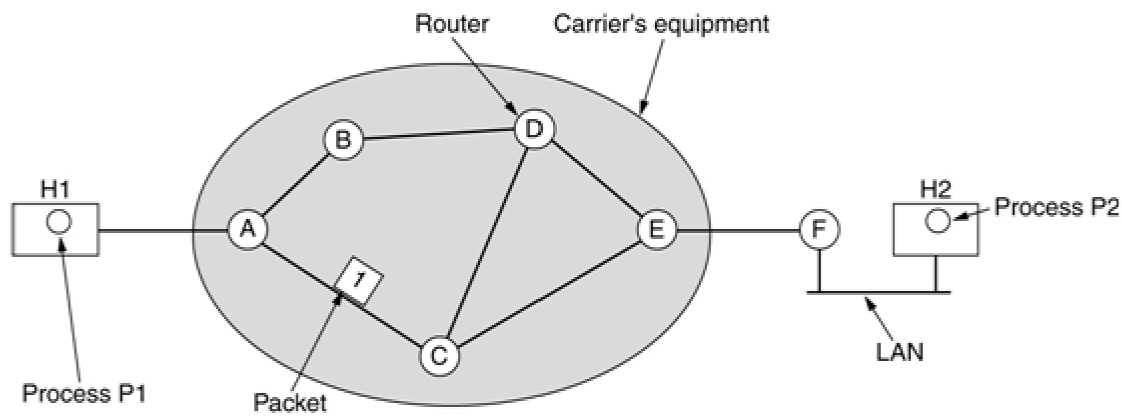
Prepared by : Mrs. G. Shashikala, Asst. prof., PG and Research Dept of InformationTechnology

Network Layer Design Isues

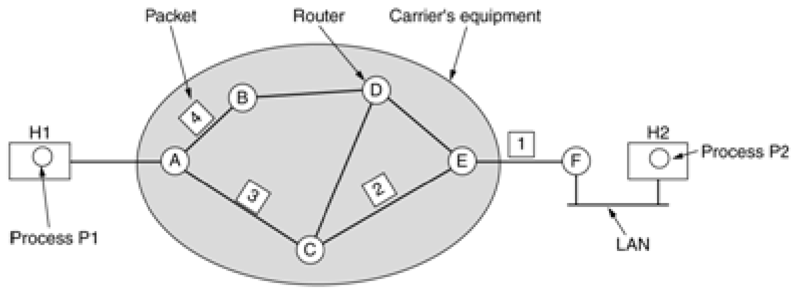
- Store-and-Forward Packet Switching
- Services Provided to the Transport Layer
- Implementation of Connectionless Service
- Implementation of Connection-Oriented Service
- Comparison of Virtual-Circuit and Datagram Subnets

Store-and-Forward Packet Switching



The environment of the network layer protocols.

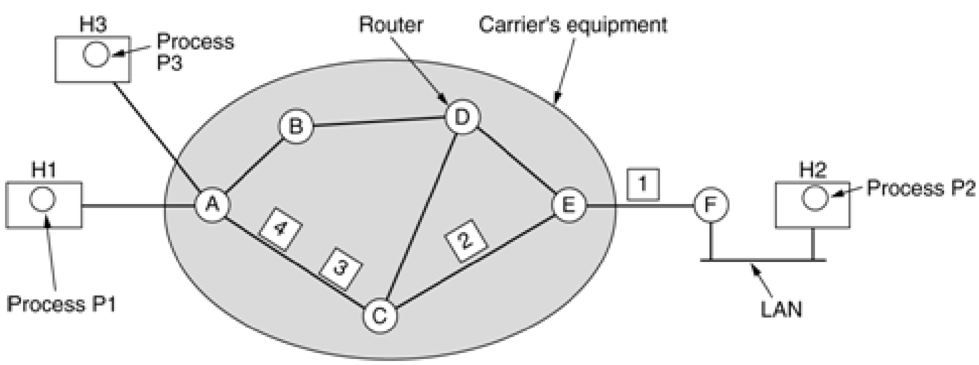
Implementation of Connectionless Service



Dest.	A's table (initially) Line	A's table (later) Line	C's table Line	E's table Line
A	–	–	A	C
B	B	B	A	D
C	C	C	–	C
D	B	B	D	D
E	C	B	E	–
F	C	B	E	F

Routing within a datagram subnet.

Implementation of Connection-Oriented Service



A's table In	A's table Out	C's table In	C's table Out	E's table In	E's table 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

Routing within a virtual-circuit subnet.

A route from source to destination is chosen as part of the connection setup. Such a route is called a virtual circuit (VC). Each router along the path puts an entry in a table, linking a VC to an outgoing line.

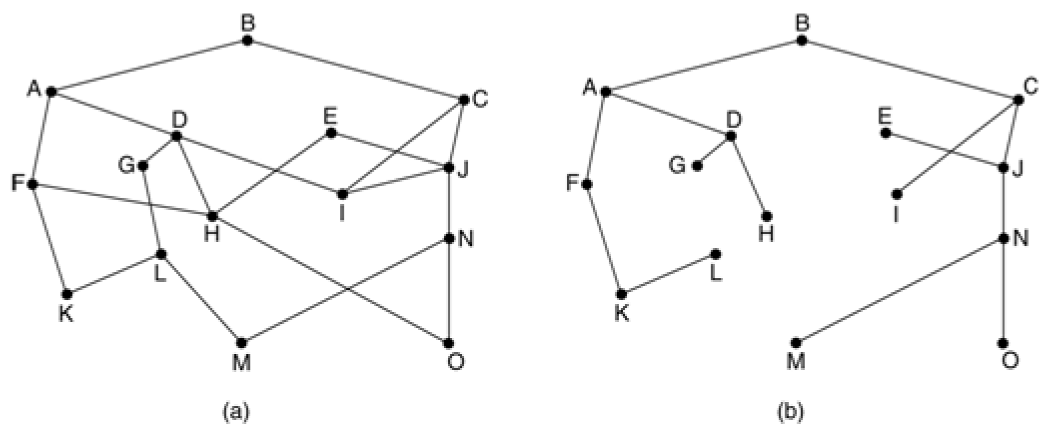
Comparison of Virtual-Circuit and Datagram Subnets

Issue	Datagram subnet	Virtual-circuit subnet
Circuit setup	Not needed	Required
Addressing	Each packet contains the full source and destination address	Each packet contains a short VC number
State information	Routers do not hold state information about connections	Each VC requires router table space per connection
Routing	Each packet is routed independently	Route chosen when VC is set up; all packets follow it
Effect of router failures	None, except for packets lost during the crash	All VCs that passed through the failed router are terminated
Quality of service	Difficult	Easy if enough resources can be allocated in advance for each VC
Congestion control	Difficult	Easy if enough resources can be allocated in advance for each VC

Routing Algorithms

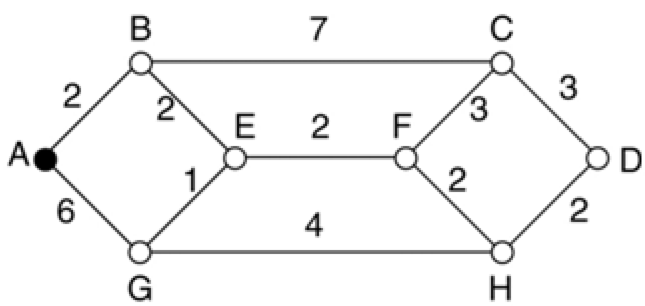
1. The optimality principle
2. shortest path routing
3. flooding
4. distance vector routing
5. routing for mobile hosts.

The Optimality Principle



(a) A subnet. (b) A sink tree for router B.

Shortest Path Routing

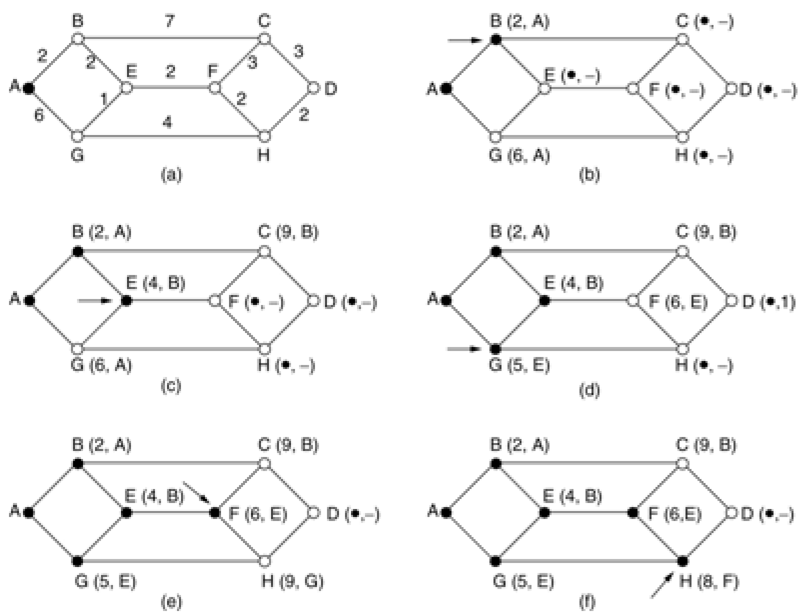


- Subnet as an undirected graph
- node: a router
- arc: a communication link
- labeled with a length.

Dijkstra's (or another) algorithm is used to compute the path with the shortest length between any two nodes.

In general the labels on the arcs can be computed as a function of distance, bandwidth, average traffic, communication costs, mean queue length, measured delay, etc.

Shortest Path Routing



The first 5 steps used in computing the shortest path from A to D.
The arrows indicate the working node.

Flooding

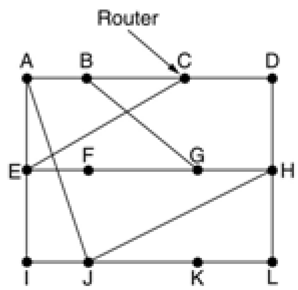
A simple static algorithm is **flooding**, in which every incoming packet is sent out on every outgoing line except the one it arrived on.

It generates a vast number of duplicate packets, an infinite number unless some measures are taken to damp the process. E.g. a hop counter in the header of each packet, which is decremented at each hop, and the packet is discarded when the counter reaches 0.

In **selective flooding** the packets are only sent out on those lines that are going approximately in the right direction.

Flooding might be usable in military applications, large numbers of routers may be blown to pieces at any instant, as it is very robust.

Distance Vector Routing



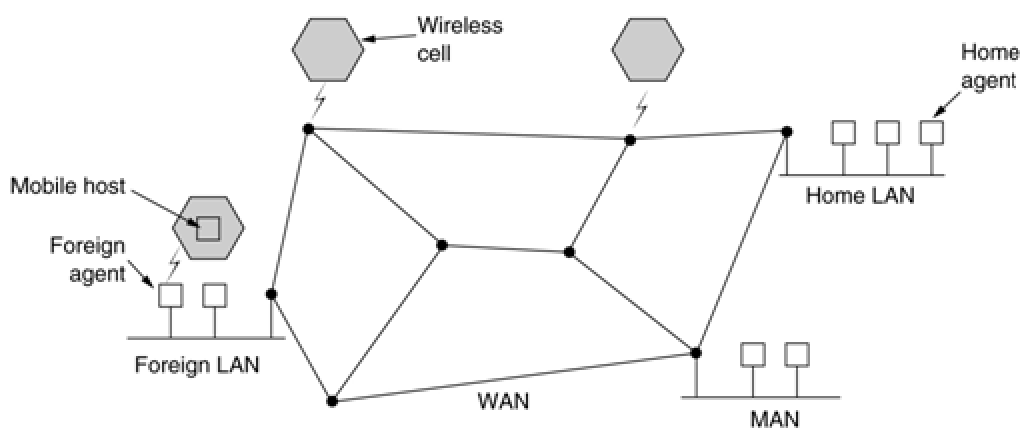
To	A	I	H	K	New estimated delay from J	Line
A	0	24	20	21	8	A
B	12	36	31	28	20	A
C	25	18	19	36	28	I
D	40	27	8	24	20	H
E	14	7	30	22	17	I
F	23	20	19	40	30	I
G	18	31	6	31	18	H
H	17	20	0	19	12	H
I	21	0	14	22	10	I
J	9	11	7	10	0	–
K	24	22	22	0	6	K
L	29	33	9	9	15	K
Vectors received from J's four neighbors	JA delay is 8	JI delay is 10	JH delay is 12	JK delay is 6	New routing table for J	

A routing table in each router contains for each router the preferred outgoing line for that router and an estimate for the "cost" to that destination.

The cost metric might be number of hops, queue length, time delay, etc. Time delay is measured by periodically sending ECHO packets.

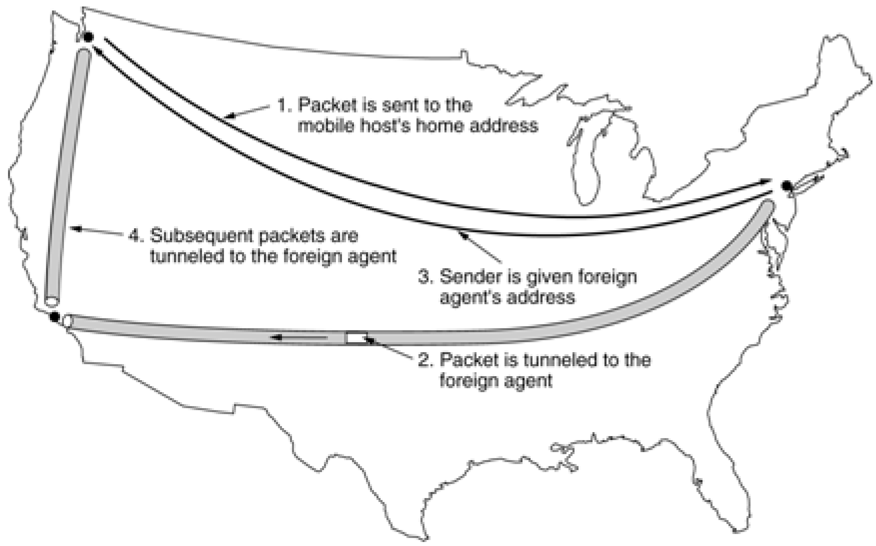
Once every T msec each router sends to its neighbors a list of estimated "costs" to each destination.

Routing for Mobile Hosts



A WAN to which LANs, MANs, and wireless cells are attached.

Routing for Mobile Hosts (2)



Packet routing for mobile users.