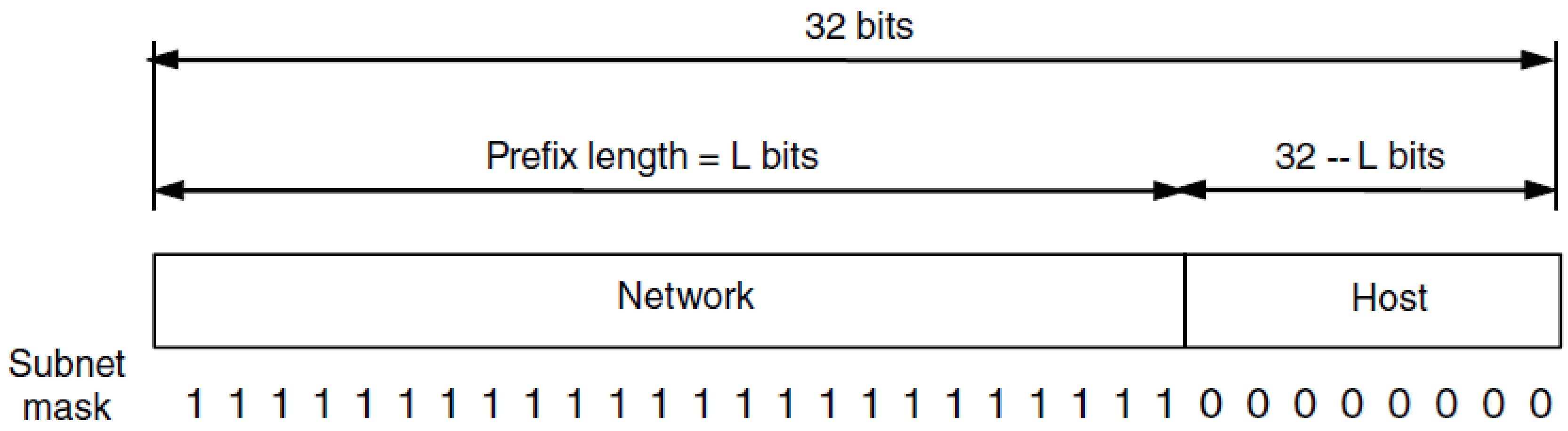
Supportive Slides from Computer Networks

By Tanenbaum and Wetherall

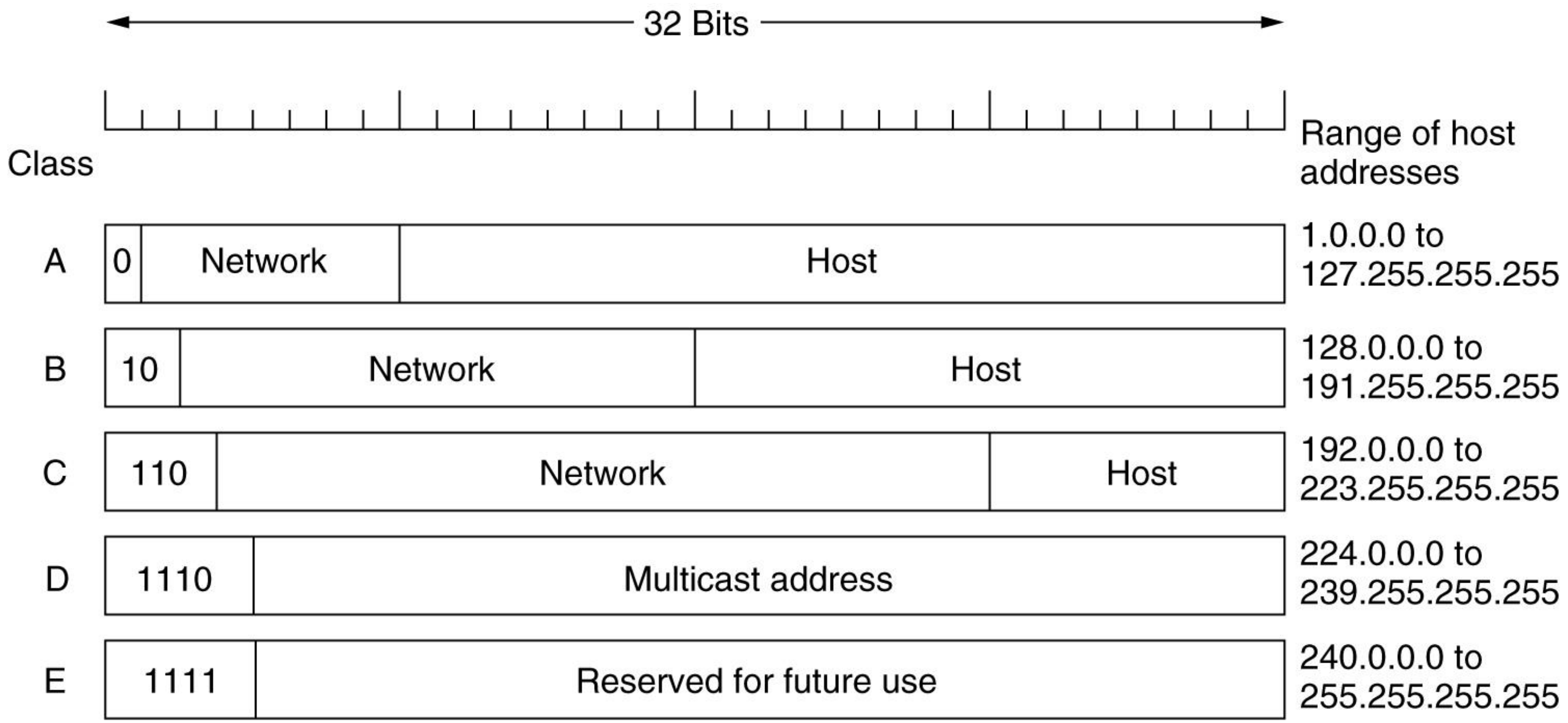
IP Addresses (1)

IP addresses are written in dotted decimal notation like 128.208.2.51



An IP prefix.

IP Addresses



A: 128 networks with 16 million hosts
B: 16384 networks with 64K hosts
C: 2 million networks with 256 hosts

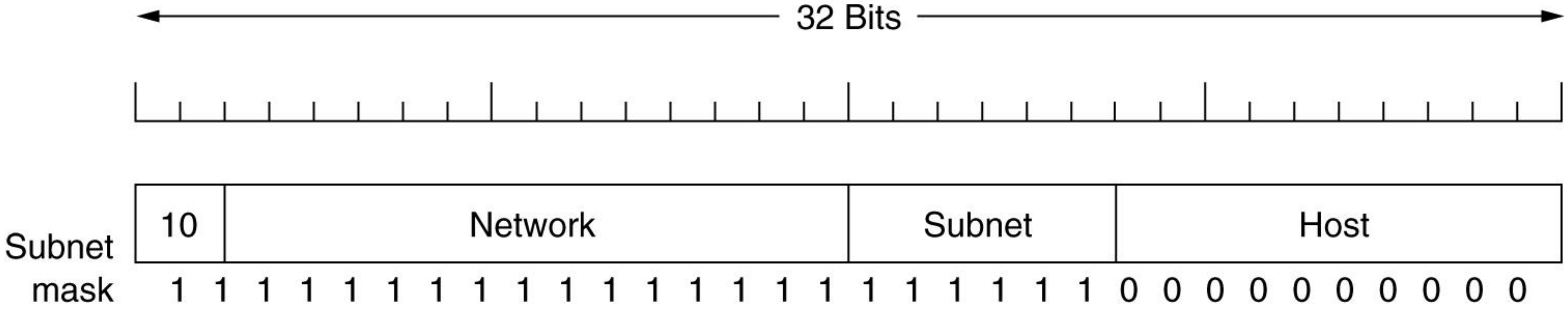
IP address formats.

Subnets

- Hard to put all hosts on a single network.
- Soln: Split a network into smaller parts (*subnets*) for internal use which still acts like a single network to the outside world
- Subnetting is not visible outside the network.

Subnets

- Host number in the IP packet is partitioned into (subnet+host)



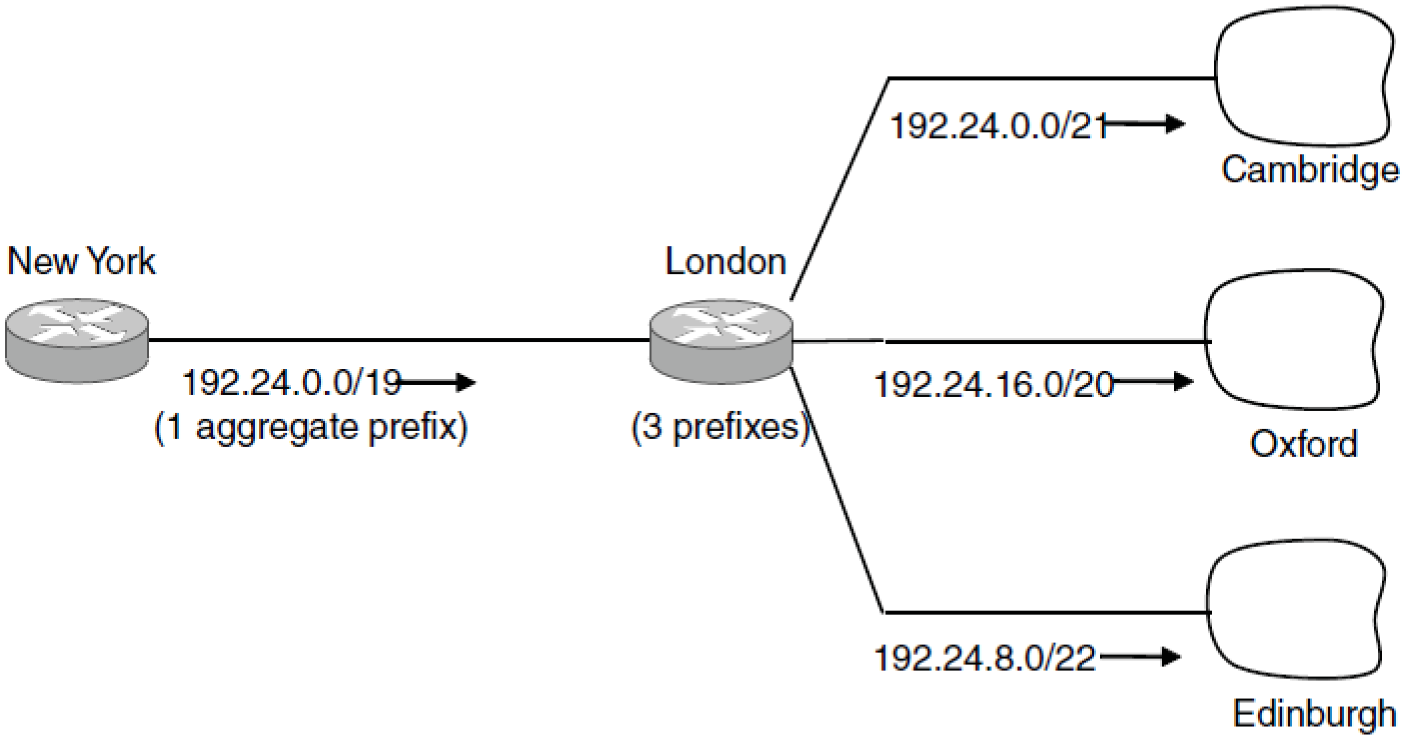
Ex: A class B network subnetted into 64 subnets.

IP Addresses (3)

University	First address	Last address	How many	Prefix
Cambridge	194.24.0.0	194.24.7.255	2048	194.24.0.0/21
Edinburgh	194.24.8.0	194.24.11.255	1024	194.24.8.0/22
(Available)	194.24.12.0	194.24.15.255	1024	194.24.12/22
Oxford	194.24.16.0	194.24.31.255	4096	194.24.16.0/20

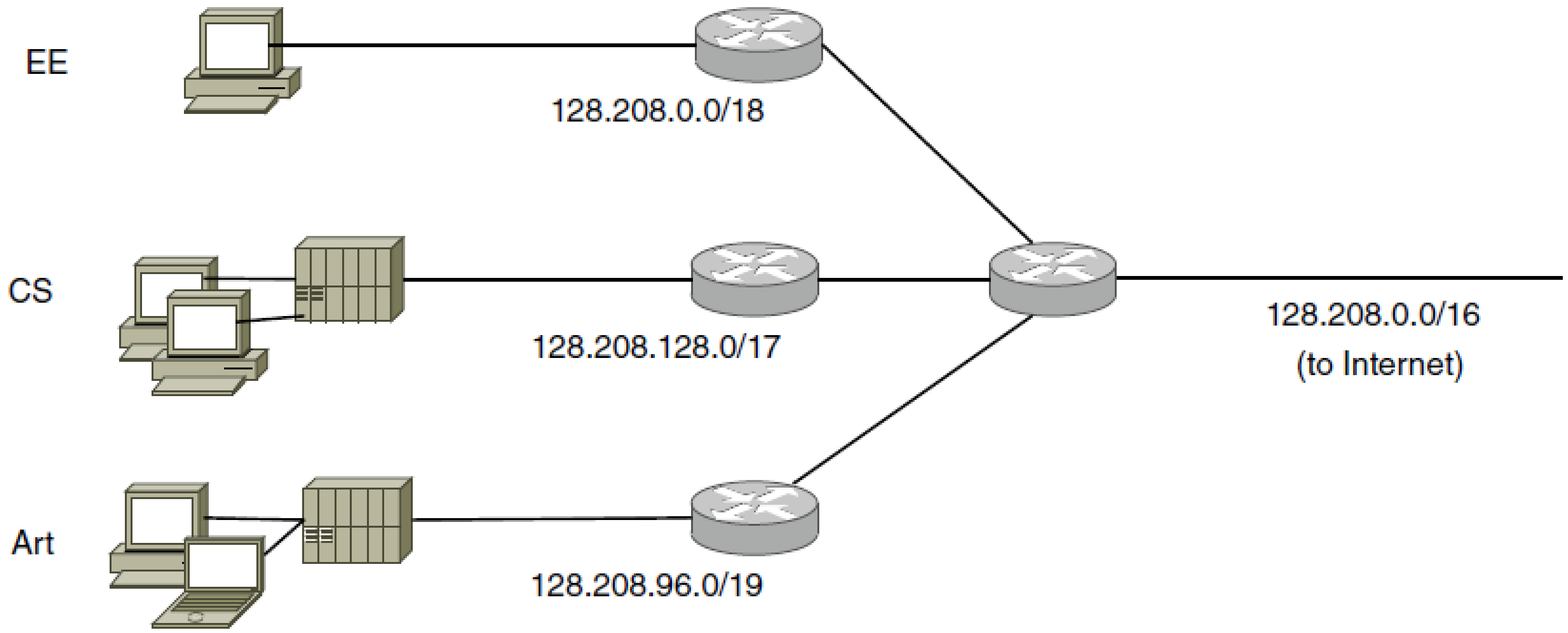
A set of IP address assignments

IP Addresses (4)



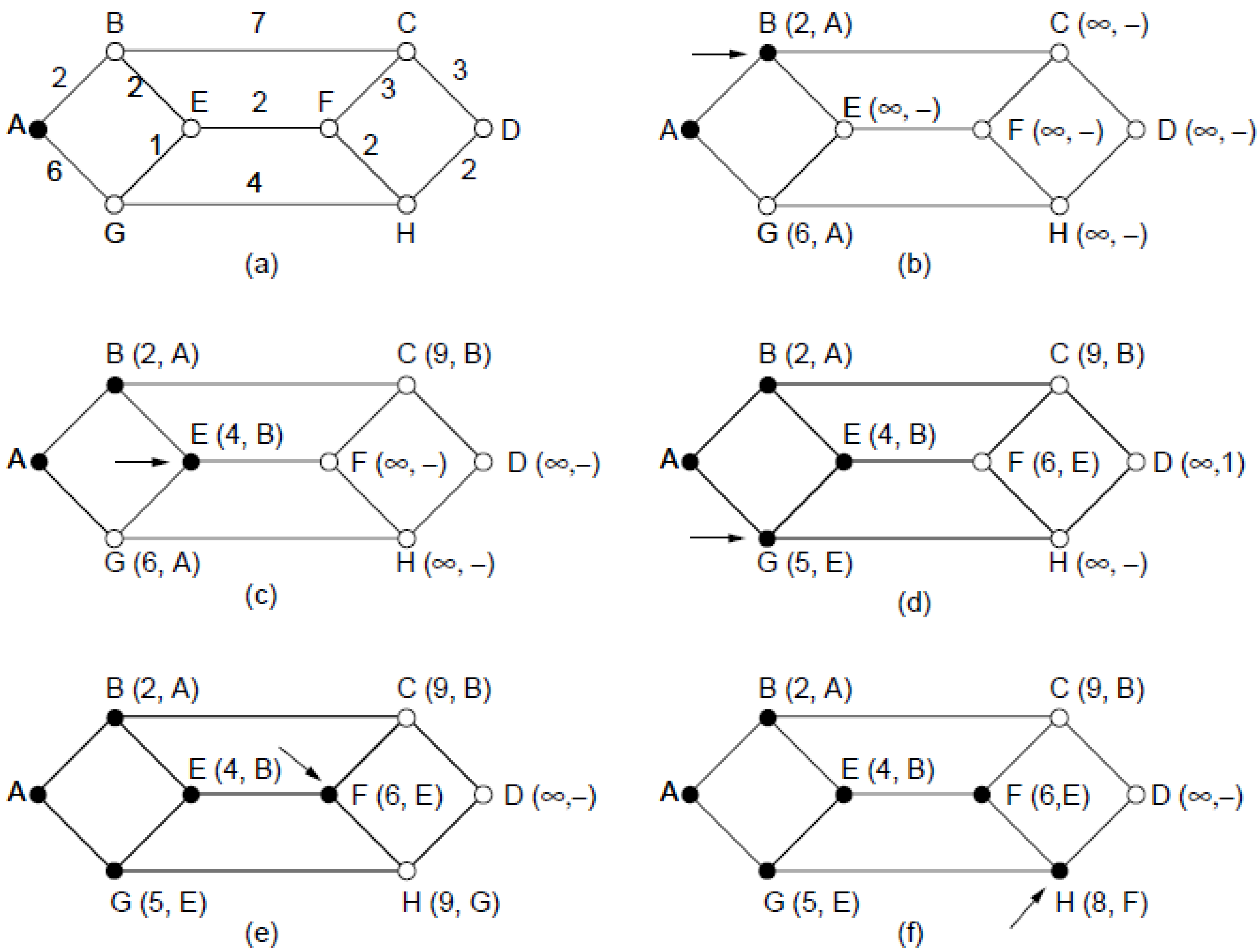
Aggregation of IP prefixes

IP Addresses (2)



Splitting an IP prefix into separate networks with subnetting.
Outside the network, subnetting is not visible.

Shortest Path Algorithm (1)

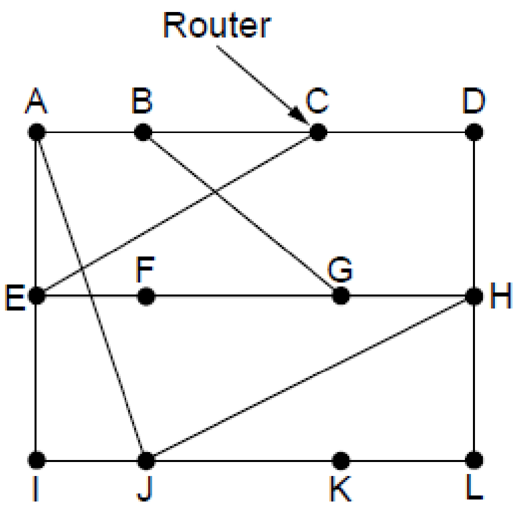


The first five steps used in computing the shortest path from *A to D.* The arrows indicate the working node

Flooding (Taşkın)

- Every incoming packet is sent out on every outgoing link except the one it arrived on
- It generates vast number of duplicate packets
- A hop counter is kept at the header of each packet which is decremented at each hop, with the packet being discarded when the counter reaches to zero
- Keeping track of floooding packet could be an alternative technique to avoid sending them out second time
- Selective flooding could be another alternative solution
- It is very robust
- It finds the shortest path

Distance Vector Routing



(a)

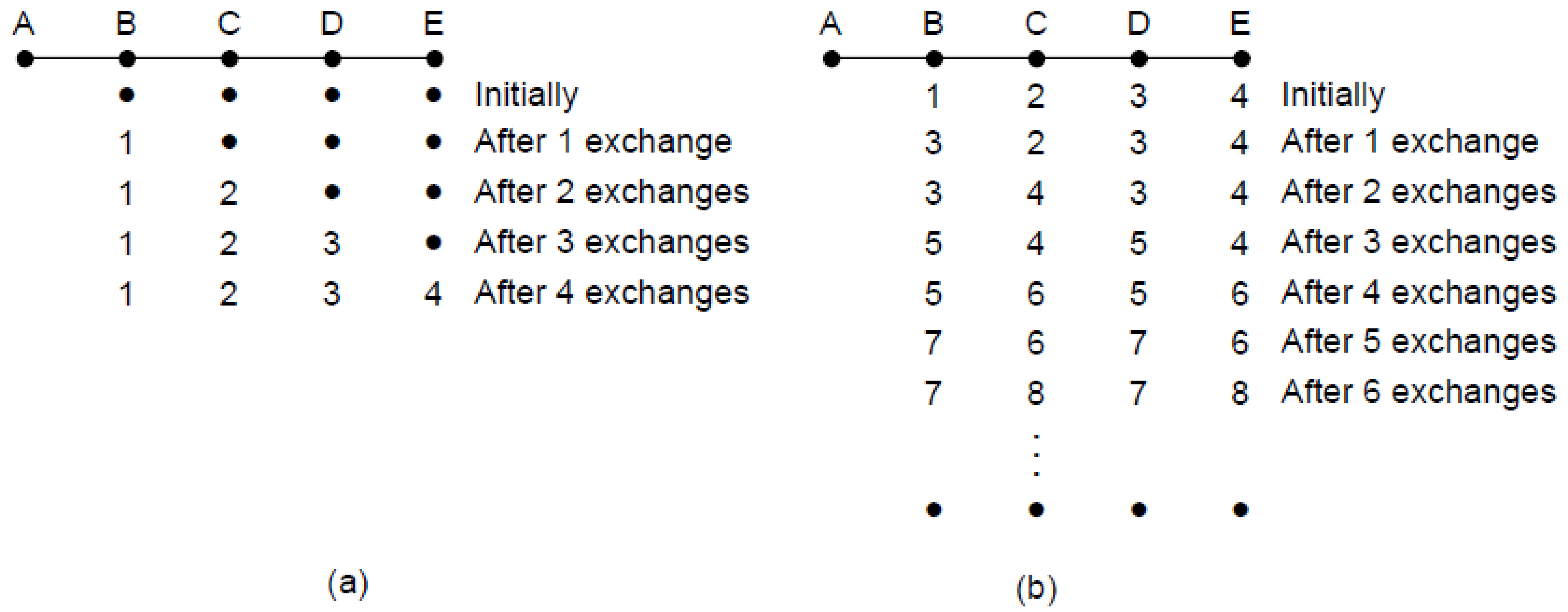
To	A	I	H	K	New estimated delay from J	Line
A	0	24	20	21	8	A
B	12	36	31	28	20	A
C	25	18	19	36	28	I
D	40	27	8	24	20	H
E	14	7	30	22	17	I
F	23	20	19	40	30	I
G	18	31	6	31	18	H
H	17	20	0	19	12	H
I	21	0	14	22	10	I
J	9	11	7	10	0	–
K	24	22	22	0	6	K
L	29	33	9	9	15	K
	JA delay is 8	JI delay is 10	JH delay is 12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

Vectors received from J's four neighbors

(b)

(a) A network.
(b) Input from *A, I, H, K, and the new routing table* for *J.*

The Count-to-Infinity Problem



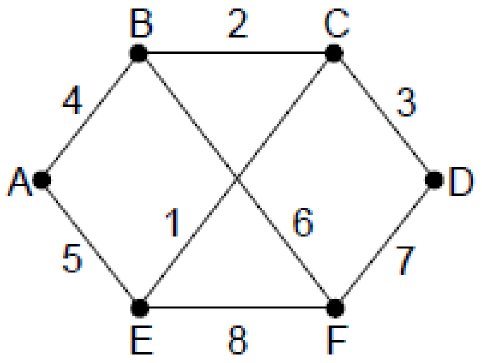
The **core of the problem** is that when X tells Y that it has a path somewhere, Y has no way of knowing whether it itself is on the path.

The count-to-infinity problem

Link State Routing

1. Discover neighbors, learn network addresses.
2. Set distance/cost metric to each neighbor.
3. Construct packet telling all learned.
4. Send packet to, receive packets from other routers.
5. Compute shortest path to every other router.

Building Link State Packets



(a)

Link State Packets

A		B		C		D		E		F	
Seq.		Seq.		Seq.		Seq.		Seq.		Seq.	
Age		Age		Age		Age		Age		Age	
B	4	A	4	B	2	C	3	A	5	B	6
E	5	C	2	D	3	F	7	C	1	D	7
		F	6	E	1			F	8	E	8

(b)

(a) A network. (b) The link state packets for this network.

Possible problems

- Sequence numbers wrap around
- If a router crashes, it will start with seq no 0!
- If a sequence number gets corrupted

Solution: Age field which is decremented once per second while being kept in a router. If it gets zero, the packet will be discarded.

+ Some refinements: holding area and ACK

Distributing the Link State Packets

			Send flags			ACK flags			
Source	Seq.	Age	A	C	F	A	C	F	Data
A	21	60	0	1	1	1	0	0	
F	21	60	1	1	0	0	0	1	
E	21	59	0	1	0	1	0	1	
C	20	60	1	0	1	0	1	0	
D	21	59	1	0	0	0	1	1	

The packet buffer for router *B* in previous slide