Panel 1

Last Time:

Network Layer

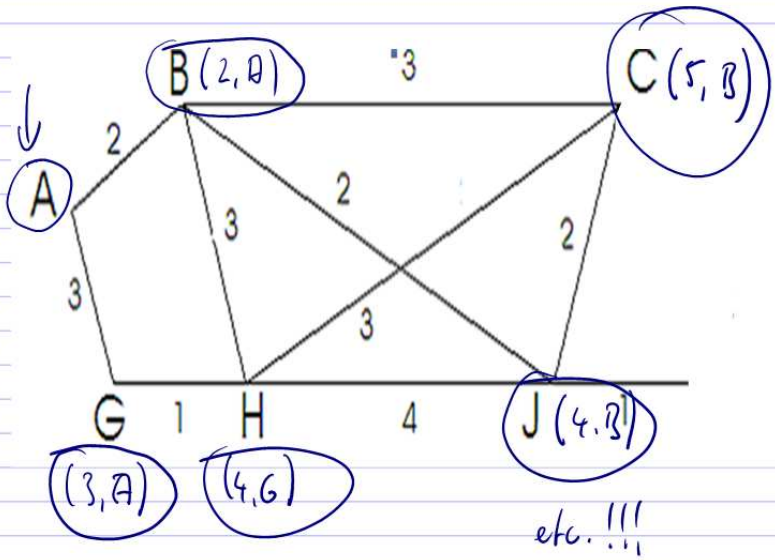
Routing
- Optimality Principle
- Sink tree
- Dijkstra's Shortest Path Routing
- Flooding

Quiz on Monday!

1

Panel 2

Apply "Shortest Path" starting at node A



2

Panel 3

Adaptive Routing: Distance Vector Routing

Bellman-Ford ≈1957

Ford-Fulkerson ≈62

Original ARPANET routing alg.
was used by AppleTalk, Cisco Routers, Novel IPX

Setup: Each router maintains table with one entry per router on network. Each entry has two parts:

- preferred outgoing line to that dest.
- delay estimate for packets to it

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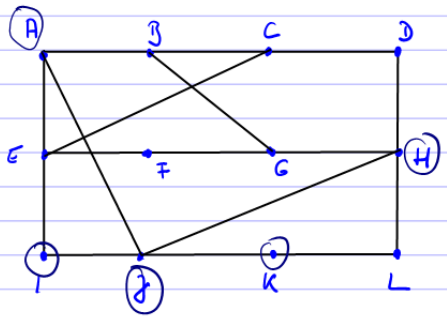
Panel 4



Routing table for J

to	delay	line
A	8	A
B	26	A
C	28	I
D	20	H
E	17	I ←
F	30	I
G	18	H
H	12	H
I	10	I
J	0	–
K	6	K
L	15	K

Each router maintains a table with $n = 12$ rows, indexed by router label.

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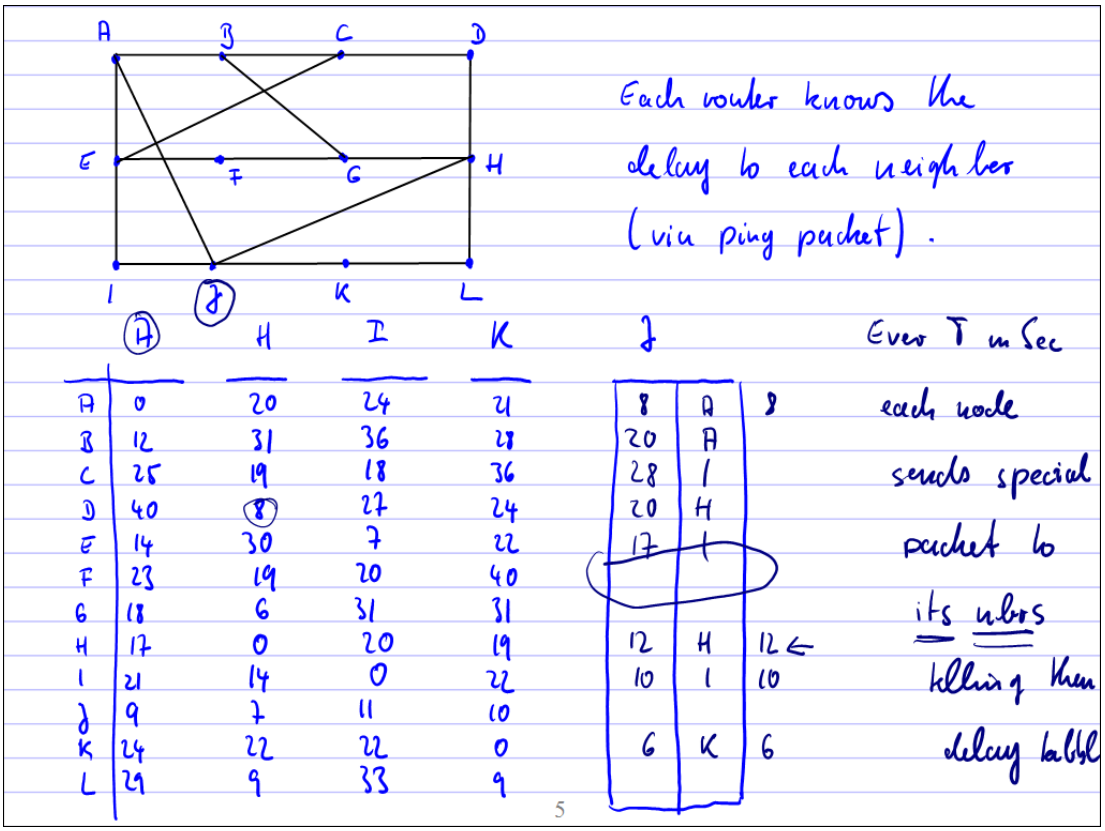
Panel 5

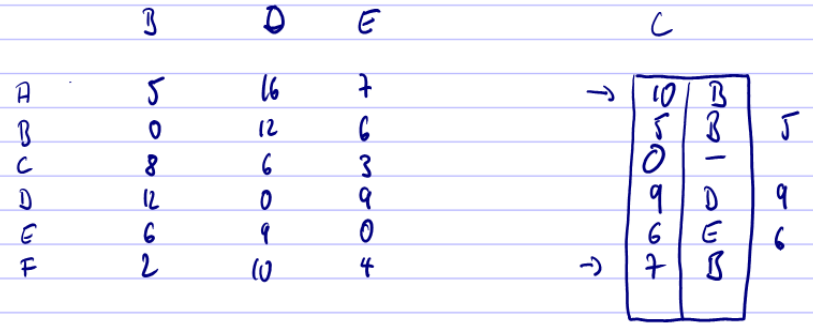


Panel 6

Consider a subnet with 6 routes named A, B, C, D, E, and F. Suppose that for distance vector routing the following vectors have just arrived at router C.

- from B: (5, 0, 8, 12, 6, 2) (i.e the distance B-A is 5, B-B is 0, B-C is 8, B-D is 12, B-E is 6, and B-F is 2),
- from D: (16, 12, 6, 0, 9, 10); and
- from E: (7, 6, 3, 9, 0, 4);

The measured delays from C to its neighbors B, D, and E are 5, 9, and 6, respectively. What is C's new routing table? Give both the outgoing line to use and the expected delay.

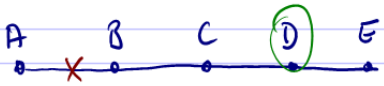


Panel 7

Distance vector routing problem:

Count-to-Infinity problem

Dist. vector routing reacts fast to good news but slow to bad news



∞	∞	∞	∞
1	∞	∞	∞
1	2	∞	∞
1	2	3	∞
1	2	3	4

measure is # hops

A is down

A goes up

all know the good news in 4-5 iterations

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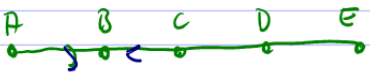
Panel 8



1	2	3	4
3	2	3	4
3	4	3	4
5	4	5	4
5	6	5	6
7	6	7	6
⋮	⋮	⋮	⋮
∞	∞	∞	∞

A goes down

Bad news take infinitely long to propagate

⇒ Solution: "Split Horizon Hack"

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Panel 9

Shortest Path Routing ✓

Flooding ✓

Distance Vector Routing

used ~ 1979 but replaced because of "count-to-infinity" problem

Replaced by

Link State Routing

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Panel 10

Link State Routing

Each router must:

1. Discover each neighbor + network address
2. Measure delay to each neighbor
3. Construct packet with this info
4. Send packet out to every router on network
5. Construct shortest path to every other router

Monday more details...

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