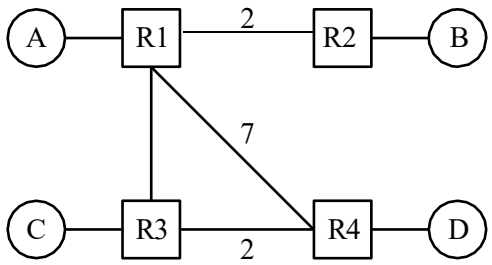
Lecture 5.2 - Distance-Vector Exercises

1 Distance Vector

Consider running the distance-vector protocol on the topology below. Unlabeled links have cost 1.



The routing tables start out initially with direct routes only:

R1′s table

Dest.	Hop, Dist.
A	Direct, 1

R2′s table

Dest.	Hop, Dist.
B	Direct, 1

R3′s table

Dest.	Hop, Dist.
C	Direct, 1

R4′s table

Dest.	Hop, Dist.
D	Direct, 1

Assumptions for this question:

- Each subpart continues on from the previous subparts. After finishing each subpart, we suggest first copying your answer to the next subpart before solving the next subpart.
- No other events occur other than the ones specified.
- We use triggered updates: a router sends out advertisements immediately after its table updates.
- We do not use incremental updates: when a router sends out advertisements, it advertises all entries in its table.
- You may not need to fill in all the rows.

1.1 EVENT: R3 advertises its routes to R1 and R4.

What do the routing tables look like after receiving R3′s routes?

R1′s table

Dest.	Hop, Dist.
A	Direct, 1

R2′s table

Dest.	Hop, Dist.
B	Direct, 1

R3′s table

Dest.	Hop, Dist.
C	Direct, 1

R4′s table

Dest.	Hop, Dist.
D	Direct, 1

1.2 Which routers will advertise their routes after receiving R3′s routes?

1.3 EVENT: R1 advertises its routes to R2, R3, and R4.

What do the routing tables look like after receiving R1′s routes?

R1′s table

Dest.	Hop, Dist.
A	Direct, 1

R2′s table

Dest.	Hop, Dist.
B	Direct, 1

R3′s table

Dest.	Hop, Dist.
C	Direct, 1

R4′s table

Dest.	Hop, Dist.
D	Direct, 1

1.4 EVENT: R4 advertises its routes to R1 and R3.

What do the routing tables look like after receiving R4′s routes?

R1′s table

Dest.	Hop, Dist.
A	Direct, 1

R2′s table

Dest.	Hop, Dist.
B	Direct, 1

R3′s table

Dest.	Hop, Dist.
C	Direct, 1

R4′s table

Dest.	Hop, Dist.
D	Direct, 1

1.5 EVENT: R1 advertises its routes to R2, R3, and R4.

What do the routing tables look like after receiving R1′s routes?

R1′s table

Dest.	Hop, Dist.
A	Direct, 1

R2′s table

Dest.	Hop, Dist.
B	Direct, 1

R3′s table

Dest.	Hop, Dist.
C	Direct, 1

R4′s table

Dest.	Hop, Dist.
D	Direct, 1

Dest.	Hop, Dist.

Dest.	Hop, Dist.

Dest.	Hop, Dist.

Dest.	Hop, Dist.

1.6 At this point, what path does R2 use to reach D, and what is the cost?

1.7 EVENT: R3 advertises its routes to R1 and R4.

What do the routing tables look like now?

R1′s table

Dest.	Hop, Dist.
A	Direct, 1

R2′s table

Dest.	Hop, Dist.
B	Direct, 1

R3′s table

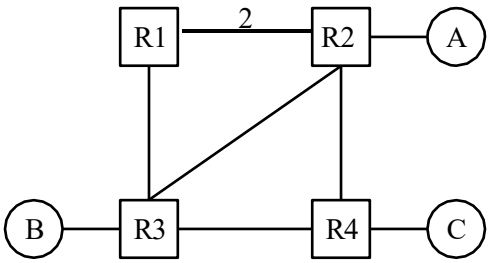
Dest.	Hop, Dist.
C	Direct, 1

R4′s table

Dest.	Hop, Dist.
D	Direct, 1

1.8 Let us now reflect on the routing state after all the advertisements in the previous subparts. In theory, under the most optimal routing state that's attainable, what is the least-cost path that R2 could use to reach D? Do the current routing tables reflect this? If not, what additional advertisement(s) could be done to allow R2 to reach D optimally? If such additional advertisement(s) must be done, express them in this form: **Router X advertises its routes to Router Y**,

2 Split Horizon and Poison



All unlabeled links have a cost of 1. The parts of the question do not build on each other.

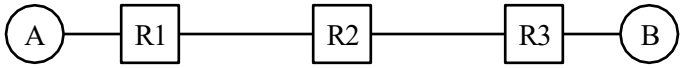
2.1 Assume that the routers use split horizon. Say that R4 advertises (A: 2, C : 1) to R3. Assuming that R3 has received no other advertisements, what does R3 now tell R4 about R3′s path to A?

2.2 Assume that the routers use poisoned reverse. Routing tables have not converged and R3 believes its shortest path to A is through R1 (this path is R3-R1-R2 of length 4). R3 advertises its routes to R4. Now, R4 advertises to R3. R4 bases this advertisement off of its routing table which has: (B: 2, A: 2, C : 1). After recomputing its routes, R3 advertises its routes to R4. What is the advertised distance to A?

2.3 Consider the simple topology (A-R1-R2-R3). Assume that routing tables have converged, with R1 believing its shortest path to A is through R2 (this path is R1-R2-A of length 3). Then, suppose that link R1-R2 goes down. When R1 advertises to R3 (A: ∞), is this an act of poisoning a route or poisoned reverse?

2.4 Poisoning a route and poisoned reverse might sound similar, but actually we can think of one of them as being "honest" while the other one is "lying." Which one tells the truth, and which one tells a white lie to keep the network functioning?

3 Count to Infinity



For part 1 of this question there is no split-horizon or poisoned reverse, and advertisements are only sent periodically (aka when it is explicitly stated).

3.1 What do the routing tables look like once R1, R2 and R3 converge?

R1′s table

Dest.	Hop, Dist.
A	Direct, 1

R2′s table

Dest.	Hop, Dist.

R3′s table

Dest.	Hop, Dist.
B	Direct, 1

3.2 What periodic advertisement will R1 and R2 send to each other? (One such message is given as an example)

From	To	(Destination, Distance)
R1	R2	(A, 1)

3.3 EVENT: Re link between R2 and R3 goes down.

What will R1 and R2 send to each other?

From	To	(Destination, Distance)

3.4 EVENT: R2′s route to *B* finally expires.

After R1 and R2 exchange advertisements again, what will their routing tables look like?

R1′s table

R2′s table

R3′s table

Dest.	Hop, Dist.
A	Direct, 1

Dest.	Hop, Dist.

Dest.	Hop, Dist.
B	Direct, 1
A	R2, 3

3.5 EVENT: R1′s route to B expires.

After R1 and R2 exchange advertisements again, what will their routing tables look like?

R1′s table

Dest.	Hop, Dist.
A	Direct, 1

R2′s table

Dest.	Hop, Dist.

R3′s table

Dest.	Hop, Dist.
B	Direct, 1
A	R2, 3

3.6 Is this good?

For the remainder of this question, there is split-horizon, but no poisoned reverse, and advertisements are only sent periodically (i.e., when it is explicitly stated). Also, all dropped links are back up, and the routing state starts out converged!

3.7 What will R1 and R2 send to each other after everything has converged?

From	To	(Destination, Distance)

3.8 EVENT: The link between R2 and R3 goes down.

What will R1 and R2 send to each other?

From	To	(Destination, Distance)

(Question 3 continued…)

3.9 EVENT: R2′s route to *B* finally expires.

After R1 and R2 exchange advertisements again, what will their routing tables look like?

Dest.	Hop, Dist.
A	Direct, 1

R1′s table

Dest.	Hop, Dist.

R2′s table

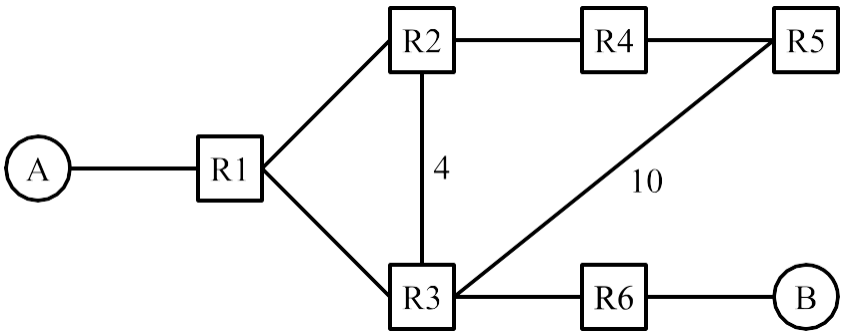
Dest.	Hop, Dist.
B	Direct, 1
A	R2, 3

R3′s table

3.10 Will this end well?

Q4. Distance-Vector

Consider running the distance-vector protocol from lecture on the topology below. All unlabeled links cost 1.w



At time $t = 0$, all forwarding tables are empty. At time $t = 1$, static routes are installed. At each subsequent time step starting at t=2, every router advertises all of its routes to all of its neighbors. Assume that advertisements are sent, received, and processed on the same time step. For example, if R3 sends an advertisement at $t = 10$, then R1 receives the advertisement and updates its table entry at $t = 10$. R1 can then advertise this updated entry at $t = 11$. Each subpart is independent unless otherwise stated.

Q4.1 What is the first time step t where R5 will have a table entry for destination B?
ANS:

Q4.2 What is the first time step t where R5 will have a table entry with the least-cost route for destination B?

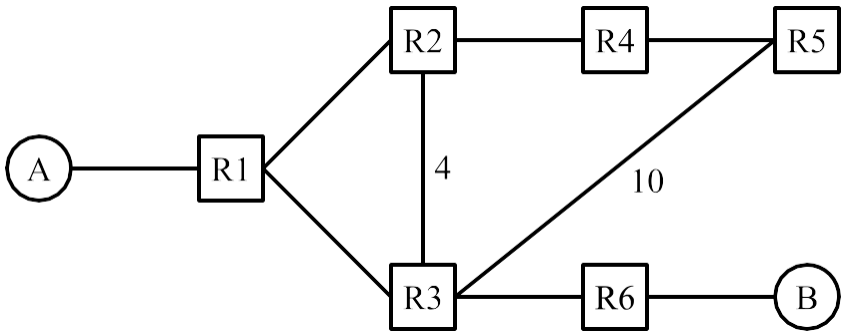
ANS: t = 6.

Q4.3 For this subpart only, assume split horizon and poison reverse are disabled. A long time later, the network has converged. At this time, the R3-to-R6 link goes down. R3 learns about this change and updates its table entry for B. Which routers will R3 advertise this change to?
ANS:

In the rest of the question, consider this scenario:

- Split horizon is enabled.
- No poison is ever sent.
- A long time later, the network has converged. After convergence, host A leaves the network.
- At time $t = 100$, R2 still has its (stale) entry for destination A (the same entry that it had at convergence). All other routers have had their entries for destination A expired and deleted. The topology, reprinted for your convenience:

(Question 3 continued…)



Q4.4 At time $t = 103$, what table entry does each router have for destination A?

Note: $t = 103$ means you should consider three rounds of sending advertisements, receiving advertisements, and updating tables. The first round ($t = 101$) starts with R2 advertising its entry for A.

Some entries are filled in for you. For example, the bottom-right row says that R6′s forwarding table has the entry "I can reach A with cost 7, via R3."

In the Cost column, write an integer, or ∞, or "N/A" (if the table has no entry for destination A).

In the Next-Hop column, write a router (e.g. "R1"), or "N/A" (if the entry has cost infinity, or if the table has no entry for destination A).

Router	Cost to A	Next-Hop to A
R1		
R2		
R3		

Router	Cost to A	Next-Hop to A
R4	3	R2
R5		
R6	7	R3

Q4.5 Many time steps later, what happens to the routers' table entries for destination A? (Reminder: All costs 16 or greater are infinite, and all costs 15 or less are finite.)

ANS: