CSC358H5: Principles of Computer Networking — Winter 2025

Worksheet 8 Solution: Intra-domain Routing, Distance Vector Algorithm

Q0 Knowledge Check (from Week 01-08 Lectures)

0.a Which of the following is a possible reason why a traceroute may return a path that does not exist in the actual Internet topology (*e.g.*, hop i may not be directly connected to hop $i+1$)?

- ☐ The traceroute tool is unable to resolve IP addresses correctly.
- ☐ Routers may respond with spoofed IP addresses to confuse attackers.
- ☑ Load balancing causes packets to take different paths, leading to inconsistent hop responses.
- ☐ Traceroute always shows the actual physical topology, so this situation cannot occur.

0.b Consider the partial output of the dig command given below.

```
; <<>> DiG 9.9.4-RedHat-9.9.4-18.el7_1.3 <<>>
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 47902
;; ANSWER SECTION:
harvard.edu. 1306 IN MX 100 b-00171101.pphosted.com.
harvard.edu. 1630 IN MX 100 a-00171101.pphosted.com.
;; AUTHORITY SECTION:
harvard.edu. 172100 IN NS ext-1.harvard.edu.
;; ADDITIONAL SECTION:
a-00171101.pphosted.com. 1313 IN A 67.231.148.27
b-00171101.pphosted.com. 1797 IN A 67.231.156.27
ext-1.harvard.edu. 172756 IN A 128.103.200.35
;; Query time: 1 msec
;; SERVER: 128.112.136.10#53(128.112.136.10)
;; WHEN: Mon Mar 07 12:49:47 EST 2016
;; MSG SIZE rcvd: 224
```

0.b. i List the IP address(es) of the name server(s) of harvard.edu.

Answer. We should look for NS record. "ext-1.harvard.edu" has NS record and in "Additional Section" it has IP address 128.103.200.35

0.b. ii List the IP address(es) of the mail server(s) of harvard.edu.

Answer. We should look for MX record. "b-00171101.pphosted.com" and "a-00171101.pphosted.com" have MX record and in "Additional Section" they have IP addresses 67.231.148.27 and 67.231.156.27

0.b. iii For how many seconds are the entries for the address records of the mail and name servers valid?

Answer.

- Mail server "a-00171101.pphosted.com": 1313 seconds
- Mail server "b-00171101.pphosted.com": 1797 seconds
- Name server "ext-1.harvard.edu": 172756 seconds

0.c Suppose we can access the caches of the local DNS servers of the CS department at UTM. How could we determine which websites are most popular among the users in the CS department?

Answer. If we periodically take snapshots of the DNS caches, each time we will see which websites were recently accessed. If we take many snapshots, the websites that appear in the most snapshots will be the most popular, since they are frequently accessed.

0.d Suppose the CS department has a local DNS server for all of the computers in the department. Can we tell whether or not anyone in the department recently accessed a given website?

Answer. Yes. If we use dig to query the department DNS server for that website, the query time will be low if it was recently accessed. Otherwise, it will be high since it is not cached.

0.e **(ping)** ping is a network diagnostic utility used to test the reachability of a host on a network and measure the round-trip time for messages sent from the source to the destination. It is commonly used to check network connectivity, diagnose issues, and measure packet loss. In a few sentence, explain how ping works.

Answer. ping sends ICMP (Internet Control Message Protocol) Echo Request packets to the target host. If the destination host is reachable, it responds with an ICMP Echo Reply packet. ping calculates the time taken for each packet to travel to the destination and back. If some packets do not return, ping calculates and displays the packet loss percentage.

0.f Consider the partial output of the command "ping" below.

```
PING google.com (142.251.32.78) 56(84) bytes of data.
64 bytes from yyz12s07-in-f14.1e100.net (142.251.32.78): icmp_seq=1 ttl=115 time=6.26 ms
64 bytes from yyz12s07-in-f14.1e100.net (142.251.32.78): icmp_seq=2 ttl=115 time=8.68 ms
64 bytes from yyz12s07-in-f14.1e100.net (142.251.32.78): icmp_seq=3 ttl=115 time=8.93 ms
```

Explain the fields "icmp_seq", "ttl", and "time" in the output.

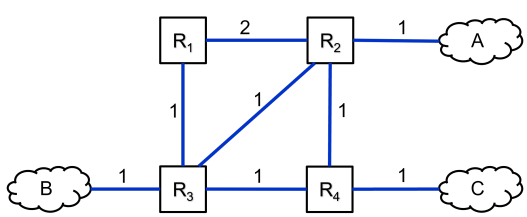
Answer.

- icmp_seq: Sequence number of the ICMP request.
- ttl (Time-To-Live): Maximum number of network hops before a packet is discarded.
- time: The round-trip time in milliseconds.

0.g **Poisoning a route** and **poisoned reverse** 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?

Answer. Poisoned reverse encourages routers to tell a white lie. With poisoned reverse, we tell a neighbor that we have no path to a certain destination if our path goes through that neighbor. Since we actually do have a path, our message is not strictly true. On the other hand, poisoning a route happens when a link goes down, and we actually lose our path to some destination. Thus, we're telling the truth when we advertise a distance of float.inf to this destination (given that an infinitely long path is equivalent to no path).

0.h Consider the illustrated network topology. Assume that the routers **use poisoned reverse**. Routing tables have not converged and R_3 believes its shortest path to A is through R_1 (this path is R_3-R_1-R_2 of cost 4). R_3 advertises its distance vector to R_4. Now, R_4 advertises to R_3. R_4 bases this advertisement off of its distance vector $(B:2, A:2, C:1)$. After receiving the advertisement from R_4, R_3 recomputes its routes and then advertises its distance vector to R_4. What is the advertised distance to A? [**NOTE:** Assume that during the described process, routers R_1 and R_2 did not advertise their distance vectors.]

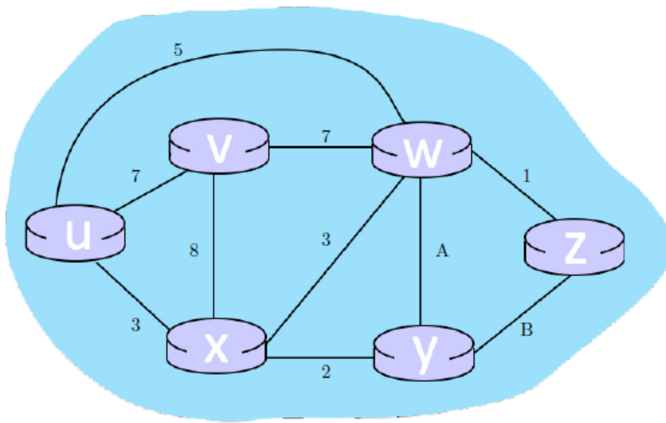


Answer. R_3 will tell R_4 that its distance to A is infinitely long, because R_3's new shortest route goes through R_4.

0.i Consider the simple topology (A-R1-R2-R3). After the routing tables have converged, link R1-R2 goes down. When R2 advertises to R3 (A: ∞), is this an act of poisoning a route or poisoned reverse?

Answer. R2 is poisoning a route. Namely, it tells R3 that its distance is float.inf, not because R2's new path goes through R3, but because R2 actually has no route now.

Q1 **(Reviewing Graph Basics – CSC358 Final, Winter 2022)** Consider the 6-node graph shown below, with the given positive link costs. The cost of the links connecting node w to y and y to z are unknown and are represented by **A** and **B**, respectively. The table below shows the shortest distance to all nodes from **u**, and



the node that has to be visited right before the destination when traversing along the shortest path to the destination.

Destination	least cost from u	Previous Node
u	0	n/a
x	3	u
y	5	x
w	5	u
z	6	y
v	7	u

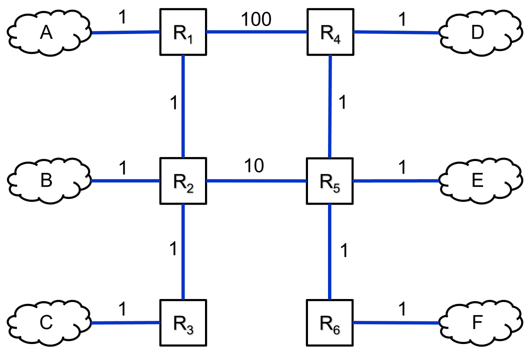
1.a Using the information provided in the above table, find the value of **A**? If the answer can't be determined given the information, respond with "n/a".

Answer. n/a

1.b Using the information provided in the above table, find the value of **B**? If the answer can't be determined given the information, respond with "n/a".

Answer. Observe that for destination z, the previous node is y. Thus, the cost of the least-cost path to reach z (*i.e.*, 6) is equal to the cost of the least-cost path to reach y (*i.e.*, 5) plus B. Thus, B is equal to 1.

Q2 **(Distance Vector Routing)** Consider the illustrated network topology. Assume all links are full-duplex and the routers use distance vector routing protocol. Furthermore, assume that routers synchronously advertise their distance vector every 3 seconds, starting at $t = 1$ (*i.e.*, they advertise their distance vector at $t = 1, 4, 7, 10, 13, 16, \ldots$). Assume that at $t = 0$, each router only knows about the subnet that is directly connected to it.



2.a Show R_1 and R_4's routing tables at $t = 0$. Please ignore the TTL field.

Answer.

R_1's Routing Table		
Destination	**Cost**	**Next Hop**
A	1	direct

R_4's Routing Table		
Destination	**Cost**	**Next Hop**
D	1	direct

2.b Show R_1 and R_4's routing tables at $t = 3$. Please ignore the TTL field.

Answer.

R_1's Routing Table		
Destination	**Cost**	**Next Hop**
A	1	direct
B	2	R_2
D	101	R_4

R_4's Routing Table		
Destination	**Cost**	**Next Hop**
D	1	direct
A	101	R_1
E	2	R_5

2.c Show R_1 and R_4's routing tables at $t = 6$. Please ignore the TTL field.

Answer.

R_1's Routing Table		
Destination	**Cost**	**Next Hop**
A	1	direct
B	2	R_2
D	101	R_4
C	3	R_2
E	12	R_2

R_4's Routing Table		
Destination	**Cost**	**Next Hop**
D	1	direct
A	101	R_1
E	2	R_5
F	3	R_5
B	12	R_5

2.d Show R_1 and R_4's routing tables at $t = 9$. Please ignore the TTL field.

Answer.

R_1's Routing Table		
Destination	**Cost**	**Next Hop**
A	1	direct
B	2	R_2
D	13	R_2
C	3	R_2
E	12	R_2
F	13	R_2

R_4's Routing Table		
Destination	**Cost**	**Next Hop**
D	1	direct
A	13	R_5
E	2	R_5
F	3	R_5
B	12	R_5
C	13	R_5

2.e Assume that the distance vector algorithms had already converged. At $t = 99$ the link between R_2 and R_5 fails. Similar to the previous parts, routers synchronously advertise their distance vector every 3 seconds, starting at $t = 101$ (*i.e.*, they advertise their distance vector at $t = 101, 104, 107, 110, 113, 116, \ldots$). Assume that the routing protocol uses **poison reverse**.

2.e. i Show R_1 and R_4's routing tables at $t = 100$. Please ignore the TTL field.

Answer.

R_1's Routing Table		
Destination	**Cost**	**Next Hop**
A	1	direct
B	2	R_2
D	13	R_2
C	3	R_2
E	12	R_2
F	13	R_2

R_4's Routing Table		
Destination	**Cost**	**Next Hop**
D	1	direct
A	13	R_5
E	2	R_5
F	3	R_5
B	12	R_5
C	13	R_5

2.e. ii Show R_1 and R_4's routing tables at $t = 103$. Please ignore the TTL field.

Answer.

R_1's Routing Table		
Destination	**Cost**	**Next Hop**
A	1	direct
B	2	R_2
D	∞	R_2
C	3	R_2
E	∞	R_2
F	∞	R_2

R_4's Routing Table		
Destination	**Cost**	**Next Hop**
D	1	direct
A	∞	R_5
E	2	R_5
F	3	R_5
B	∞	R_5
C	∞	R_5

2.e. iii Show R_1 and R_4's routing tables at $t = 106$. Please ignore the TTL field.

Answer.

R_1's Routing Table		
Destination	**Cost**	**Next Hop**
A	1	direct
B	2	R_2
D	101	R_4
C	3	R_2
E	102	R_4
F	103	R_4

R_4's Routing Table		
Destination	**Cost**	**Next Hop**
D	1	direct
A	101	R_1
E	2	R_5
F	3	R_5
B	102	R_1
C	103	R_1