2/07/2019

Lecture 07 tutorial: Routing

During tutorials prepare a short report of your activities and show it to your tutor.
Study the following **questions** and verify the correctness of the **answers** if given.
Be aware that the exam question might be directly related to the tutorial questions

Additional Instructions: Where a **group number** is indicated, please discuss this particular question with other members of your group, prepare a short written answer and email this to your tutor before the end of the day (you may wish to verify the correctness of your answer first). This will be used to produce a set of sample answers for the class for study purposes. *Note:* You should work through all questions in the tutorials, not just ones assigned to your group.

PART 1 : Questions relating to lecture slides and related materials

Question 1.
Read http://www.think-like-a-computer.com/2011/08/24/the-routing-table/
and explain what you see in your own routing table.
You need to see your configuration table first.

Answer (Group 1)

- configuration table:

```
Wireless LAN adapter WLAN:

   Connection-specific DNS Suffix  . : padavan
   Link-local IPv6 Address . . . . . : fe80::fcea:f1c4:8612:5a64%6
   IPv4 Address. . . . . . . . . . . : 192.168.6.12
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 192.168.6.1
```

Here are the TCP/IP settings of my PC:
IP Address: 192.168.6.12
Subnet mask: 255.255.255.0
Default gateway: 192.168.6.1

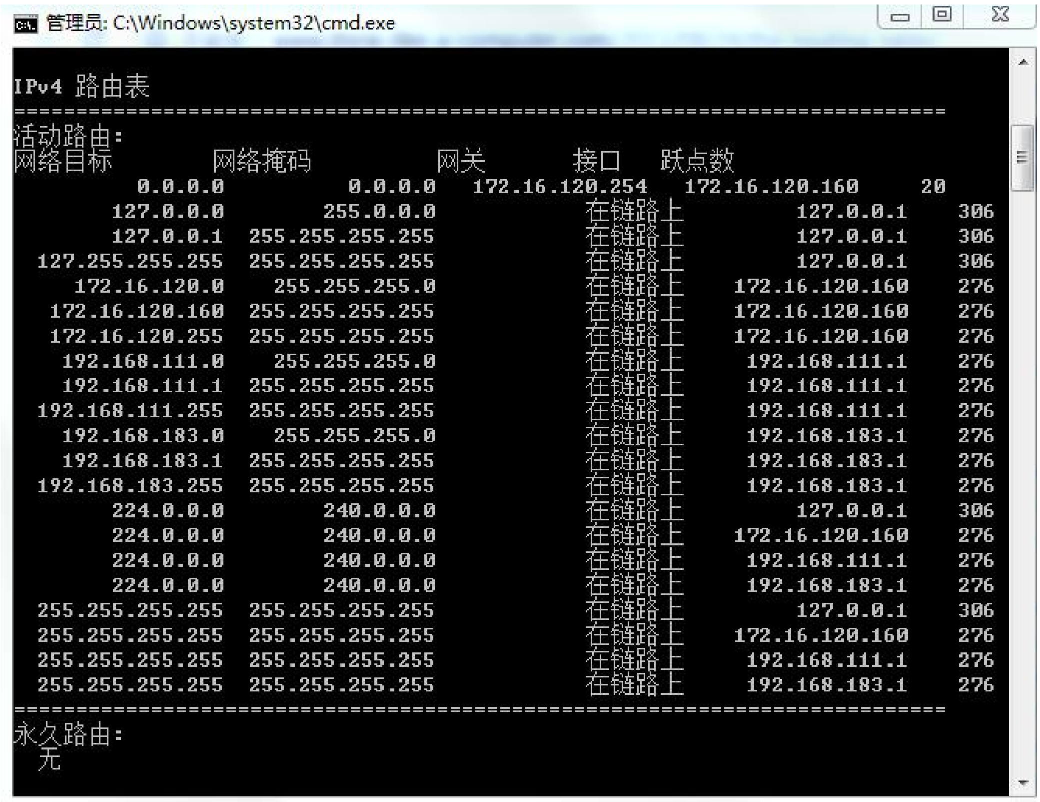
- routing table:

```
C:\Users\zerlz>route print
===========================================================================
Interface List
 57...02 00 4c 4f 4f 50 ......Npcap Loopback Adapter
 11...9e b6 d0 16 58 57 ......Microsoft Wi-Fi Direct Virtual Adapter
 14...ae b6 d0 16 58 57 ......Microsoft Wi-Fi Direct Virtual Adapter #2
  6...9c b6 d0 16 58 57 ......Killer Wireless-n/a/ac 1535 Wireless Network Adapter
  9...00 ff 71 dd 25 b0 ......Sangfor SSL VPN CS Support System VNIC
 16...9c b6 d0 16 58 58 ......Bluetooth Device (Personal Area Network)
  1...........................Software Loopback Interface 1
===========================================================================

IPv4 Route Table
===========================================================================
Active Routes:
Network Destination        Netmask          Gateway       Interface  Metric
          0.0.0.0          0.0.0.0      192.168.6.1     192.168.6.12     35
        127.0.0.0        255.0.0.0         On-link         127.0.0.1    331
        127.0.0.1  255.255.255.255         On-link         127.0.0.1    331
  127.255.255.255  255.255.255.255         On-link         127.0.0.1    331
      169.254.0.0      255.255.0.0         On-link   169.254.230.212    281
  169.254.230.212  255.255.255.255         On-link   169.254.230.212    281
  169.254.255.255  255.255.255.255         On-link   169.254.230.212    281
      192.168.6.0    255.255.255.0         On-link      192.168.6.12    291
     192.168.6.12  255.255.255.255         On-link      192.168.6.12    291
    192.168.6.255  255.255.255.255         On-link      192.168.6.12    291
        224.0.0.0        240.0.0.0         On-link         127.0.0.1    331
        224.0.0.0        240.0.0.0         On-link      192.168.6.12    291
        224.0.0.0        240.0.0.0         On-link   169.254.230.212    281
  255.255.255.255  255.255.255.255         On-link         127.0.0.1    331
  255.255.255.255  255.255.255.255         On-link      192.168.6.12    291
  255.255.255.255  255.255.255.255         On-link   169.254.230.212    281
===========================================================================
Persistent Routes:
  None
```

1. 0.0.0.0 network combined with the netmask (subnet mask) of 0.0.0.0 means ALL IP addresses. Because this is the only way where the gateway is 192.168.6.6, it is the default gateway of my computer.
2. The next 3 lines are entries for the loopback address and can be ignored. These are default entries but notice the gateway says “On-link”. This means that these addresses are directly accessible on the local LAN and do not need to be routed through another network.
3. 169.254.0.0 - These 3 entries are the "link local" block. As described in [RFC3927], they are allocated for communication between hosts on a single link. Hosts obtain these addresses by auto-configuration, such as when a DHCP server cannot be found.
4. 192.168.6.0 - From 8th to 11th entries are for my local network. The first one is the entire 192.168.6.x range as defined by the netmask of 255.255.255.0. Again as this network is local it says “on-link” in the gateway. These are created automatically like the others when you configure your TCP/IP settings.
5. 224.0.0.0 - These are also default entries for multicasting and can be ignored for the purpose of this article.
6. 255.255.255.255 - This is also a default entry and can be ignored.

Answer (Group 7)



```
管理员: C:\Windows\system32\cmd.exe

IPv4 路由表
===========================================================================
活动路由:
网络目标        网络掩码          网关       接口   跃点数
          0.0.0.0          0.0.0.0   172.16.120.254   172.16.120.160     20
        127.0.0.0        255.0.0.0            在链路上         127.0.0.1    306
        127.0.0.1  255.255.255.255            在链路上         127.0.0.1    306
  127.255.255.255  255.255.255.255            在链路上         127.0.0.1    306
      172.16.120.0    255.255.255.0            在链路上    172.16.120.160    276
    172.16.120.160  255.255.255.255            在链路上    172.16.120.160    276
    172.16.120.255  255.255.255.255            在链路上    172.16.120.160    276
     192.168.111.0    255.255.255.0            在链路上     192.168.111.1    276
     192.168.111.1  255.255.255.255            在链路上     192.168.111.1    276
   192.168.111.255  255.255.255.255            在链路上     192.168.111.1    276
     192.168.183.0    255.255.255.0            在链路上     192.168.183.1    276
     192.168.183.1  255.255.255.255            在链路上     192.168.183.1    276
   192.168.183.255  255.255.255.255            在链路上     192.168.183.1    276
         224.0.0.0        240.0.0.0            在链路上         127.0.0.1    306
         224.0.0.0        240.0.0.0            在链路上    172.16.120.160    276
         224.0.0.0        240.0.0.0            在链路上     192.168.111.1    276
         224.0.0.0        240.0.0.0            在链路上     192.168.183.1    276
  255.255.255.255  255.255.255.255            在链路上         127.0.0.1    306
  255.255.255.255  255.255.255.255            在链路上    172.16.120.160    276
  255.255.255.255  255.255.255.255            在链路上     192.168.111.1    276
  255.255.255.255  255.255.255.255            在链路上     192.168.183.1    276
===========================================================================
永久路由:
  无
```

Here are the TCP/IP setting of my PC:
IP Address: 172.16.120.160
Subnet mask: 255.255.255.0
Default gateway: 172.16.120.254

In above screenshot, they are 5 columns, namely Network Destination, Netmask, Gateway, Interface and Metric.

- 0.0.0.0 - The 0.0.0.0 network combined with the netmask (subnet mask) of 0.0.0.0 means ALL IP addresses. This line tells the computer that for ALL traffic no matter what the destination IP address is sends it to 172.16.120.254, which is the gateway. This is a default route created by Windows. If the computer can't find more specific match, it will work.
- 127.0.0.0 - The next 3 lines are entries for the loopback address. "On-link" means that these addresses are directly accessible on the local LAN and do not need to be routed through another network.
- 172.16.120.0 - These next 3 lines are for my local network.
- 192.168.111.0 - These next 3 lines are for my local network belonging to VMware Virtual Ethernet Adapter for VMnet1
- 192.168.183.0 - These next 3 lines are for my local network belonging to VMware Virtual Ethernet Adapter for VMnet8
- 224.0.0.0 - These are also default entries for multicasting
- 255.255.255.255 - This is also a default entry

Question 2.
What are routing tables?

Answer (Group 2)
Routing table is a routing information table stored on a router or other Internet network device. The table contains paths to specific network terminals. In some cases, there are some metrics related to these paths. The routing table is used by the router to select the best path. The information contained in the table determines the data forwarding policy.

Answer (Group 7)
All network devices that use the TCP/IP protocol have a routing table, it is used to determine where to send the packets.

Question 3.
Consider a network as in slide 4. Compile the routing table for nodes B and F. Mark the alternative paths.

Answer (Group 3)

Routing Table for B:

Dest.	Next
A	A
C	C
D	E
E	E
F	E
G	C

Routing Table for F:

Dest.	Next
A	E
B	E
C	C
D	E
E	E
G	C

Alternative paths:

BCF
BEF
BADEF

Question 4.
Re-write the routing table from slide 6 using the slash notation

Answer (Group 4)

Router R1's Routing Table

Network Address	Interface
10.10.51.0/24	1
10.10.52.0/24	2
10.10.53.0/24	3
10.10.20.0/24	3
10.10.43.0/24	3
10.10.1.2	3
all other addresses	0

Router R2's Routing Table

Network Address	Interface
10.10.1.1	0
10.10.53.0/24	1
10.10.20.0/24	2
10.10.43.0/24	3
all other addresses	0

Question 5.

a. How does static routing differ from dynamic routing?
b. When would you use static routing?

Answer (Group 5)

a) When the network changes, the manager need to reconfigure the static route, which the dynamic routing can change with the transformation.

b) Used on relatively simple networks with few routing options that rarely change.

Question 6.
Explain the principles of the hierarchical routing

Answer (Group 6)
Hierarchical Routing, the is-is region provides a way to Hierarchical Routing in the is-is domain. The normal is-is regions, connected with their backbone region, form a two-level routing hierarchy.

Routes within a region are called primary routes and routes between independent regions within a domain are called secondary routes.

Question 7.
Is it necessary that every autonomous system use the same intra-AS routing algorithm? Why or why not?

Answer (Group 7)
No, it's no need to use the same intra-AS routing algorithm in every autonomous. Because every area is autonomous, independent on others. As long as every Area Border Router uses the same interal-AS routing algorithm to deliver messages, it will be fine.

Question 8. Taxonomy
a) Name three most popular routing protocols.
b) Where are they used?
c) What routing algorithms the employ?

Answer?

Question 9. DV
a) Explain the concept of the distance vector routing.
b) Explain the difference between the concept and practical implementation

Answer (Group 9)
a)
Distance vector algorithm is an iterative, asynchronous, distributed algorithm that can terminate itself.

- Asynchronous: This algorithm does not require all nodes to operate and compute simultaneously with each other.
- Distributed: Each node maintains only a partial routing table, and each routing node needs to receive some link information from one or more directly adjacent adjacency nodes, perform calculation, and then distribute the calculation results to the adjacency nodes.
- Iteration: the process of exchanging information between nodes needs to continue until there is no more information to be exchanged between neighbors.
- Self-terminating: switching from the beginning to the end of the exchange is called convergence.

Each node updates its routing table by Bellman-Ford algorithm.

b)
In the DV algorithm, for simplicity, costs were defined between pairs of routers. In RIP (and also in OSPF), costs are actually from source router to a destination subnet. RIP uses the term hop, which is the number of subnets traversed along the shortest path from source router to destination subnet, including the destination subnet.

Question 10. RIP

a) Describe fundamental features of the RIP including timers used.
b) Demonstrate how the routing table in the router C is updated

Answer (Group 10)

a)

RIP is based on the Distance Vector algorithm

- distance metric/cost: number of hops (max = 15 hops)
- each link has cost 1
- neighbors exchange their DVs every 30 sec in a response message

RIP uses three timers to support its operation.

- Periodic timer controls the sending of messages
- Expiration timer governs the validity of a route
- Garbage collection timer advertises the failure of a route

b)

destination subnet	next router	# hops to dest
w	A	2
y	A	4
z	A	9
x	A	2

Question 11. OSPF

Describe OSPF routing protocol.
Improve this question by itemizing it.

Answer (Group 1)

Description:

Open Shortest Path First (OSPF) is a routing protocol for Internet Protocol (IP) networks. It uses a link state routing (LSR) algorithm and falls into the group of interior gateway protocols (IGPs), operating within a single autonomous system (AS). It is defined as OSPF Version 2 in RFC 2328 (1998) for IPv4. The updates for IPv6 are specified as OSPF Version 3 in RFC 5340 (2008). OSPF supports the Classless Inter-Domain Routing (CIDR) addressing model.

Itemization:

What is OSPF?

- OSPF uses a link state routing algorithm.
- OSPF is an interior gateway / Intra-AS routing protocol.
- OSPF provides Version 2 for IPv4 & Version 3 for IPv6.
- OSPF supports the Classless Inter-Domain Routing (CIDR) addressing model.

How does OSPF works?

- OSPF gathers link state information from available routers and constructs a topology map of the network.

- OSPF detects changes in the topology.
- OSPF computes the shortest path tree for each route using a method based on Dijkstra's algorithm, a shortest path first algorithm.
- The OSPF routing policies for constructing a route table are governed by link cost factors.

Question 12. BGP

Describe BGPF routing protocol.

Improve this question by itemizing it.

Answer (Group 2)

1.Border Gateway Protocol (BGP) is a standardized exterior gateway protocol designed to exchange routing and reachability information among autonomous systems (AS) on the Internet. The protocol is classified as a path vector protocol. The Border Gateway Protocol makes routing decisions based on paths, network policies, or rule-sets configured by a network administrator and is involved in making core routing decisions.

2.BGP offers network stability that guarantees routers can quickly adapt to send packets through another reconnection if one internet path goes down. Each BGP router maintains a standard routing table used to direct packets in transit. This table is used in conjunction with a separate routing table, known as the routing information base (RIB), which is a data table stored on a server on the BGP router. The RIB contains route information both from directly connected external peers, as well as internal peers, and continually updates the routing table as changes occur.

3.BGP is based on TCP/IP and uses client-server topology to communicate routing information, with the client-server initiating a BGP session by sending a request to the server.

<u>PART 2 : Additional Text Book Problems</u>

P l. Looking at Figure 5.3, enumerate the paths from y to u that do not contain any loops.

P2. Repeat Problem Pl for paths from x to z, z to u, and z to w.

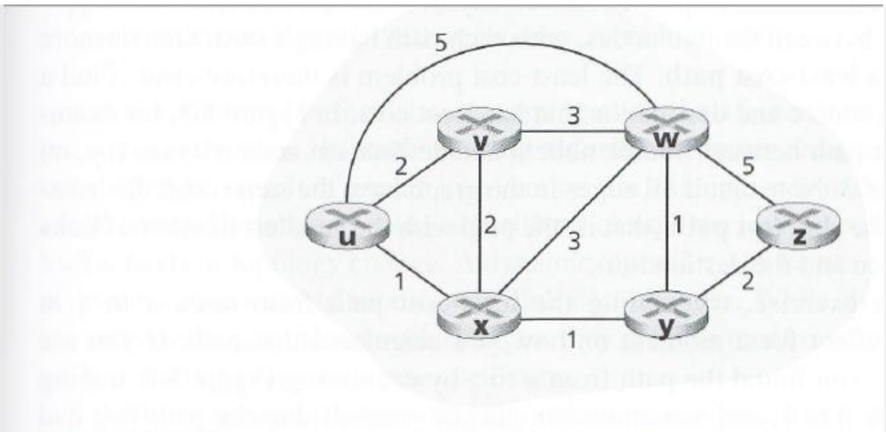


Figure 5.3 ♦ Abstract graph model of a computer network

Answer (Group 3)

A Python program based on DFS for P1 and P2:

```
v=['x','y','z','u','v','w']
e={'x':['u','v','w','y'],
      'y':['x','w','z'],
      'z':['y','w'],
      'u':['w','x','v'],
      'v':['u','w','x'],
      'w':['u','v','x','y','z']}
s='x'
r='u'
def dfs(cur):
      if cur[-1]==r:
            print(cur)
            return
      for i in e[cur[-1]]:
            if i not in cur:
                  dfs(cur+i)
s=input("start:")
r=input("end:")
dfs(s)
```

Y to U:

yxu
yxvu
yxvwu
yxwvu
yxwu

ywu
ywxu
ywxvu
ywvxu
ywvu

yzwu
yzwxu
yzwxvu
yzwvxu
yzwvu

X to Z:

xyz
xywz

xwz
xwyz

xvwz

xvwyz
xvuwyz
xvuwz

xuwz
xuwyz
xuvwz
xuvwyz

Z to U:

zyxu
zyxvu
zyxvwu
zyxwu
zyxwvu
zywu
zywxu
zywvu
zywxvu
zywvxu

zwu
zwvu
zwvxu
zwxu
zwxvu
zwyxu
zwyxvu

Z to W:

zw

zyw
zyxw
zyxvw
zyxuw
zyxuvw
zyxvuw

Answer (Group 2)

P1
y-z-w-v-u y-z-w-x-y y-z-w-v-x-u
y-w-v-u y-w-x-u y-w-v-x-u
y-x-w-v-u y-x-v-u

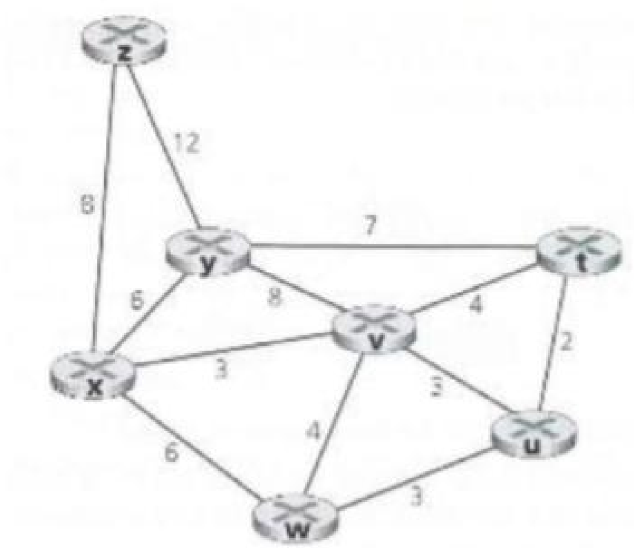
P2
X TO Z

x-y-z x-y-w-z
x-v-w-z x-v-w-y-z
x-u-v-w-y-z x-u-v-w-z

Z to U
z-w-v-y z-w-v-x-u z-w-x-u z-w-x-v-u z-w-y-x-u z-w-y-x-v-u
z-y-x-y z-y-x-v-u z-y-x-w-v-u z-y-w-v-u z-y-w-v-x-y z-y-w-x-u z-y-w-x-v-y

Z TO W
z-w
z-y-w z-y-x-w z-y-x-v-w z-y-x-u-v-w

P3. Consider the following network.



With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from x to all network nodes. Show how the algorithm works by computing a table similar to Table 5. I .

Answer (Group 4)

STEP	N	D(v), P(v)	D(w), P(w)	D(u), P(u)	D(y), P(y)	D(z), P(z)
0	x	2, x	3, x	1, x	1, x	∞
1	xu	2, x	3, x		1, x	∞
2	xuy	2, x	2, y			3, y
3	xuyw	2, x				3, y
4	xuywv					3, y
5	xuywvz					

P4. Consider the network shown in Problem P3. Using Dijkstra' s algorithm, and showing your work using a table similar to Table 5.1, do the following: a. Compute the shortest path from t to all network nodes. b. Compute the shortest path from u to all network nodes. c. Compute the shortest path from v to all network nodes. d. Compute the shortest path from w to all network nodes. e.

Compute the shortest path from y to all network nodes. f. Compute the shortest path from z to all network nodes.

Answer (Group 5)

a. Compute the shortest path from t to all network nodes.

Step	N'	D(u),p(u)	D(v),p(v)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0	t	2, t	4, t	∞	∞	7, t	∞
1	tu		4, t	5, u	∞	7, t	∞
2	tuv			5, u	7, v	7, t	∞
3	tuvw				7, v	7, t	∞
4	tuvwx					7, t	15, x
5	tuvwxy						15, x
6	tuvwxyz						

b Compute the shortest path from u to all network nodes.

Step	N'	D(t),p(t)	D(v),p(v)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0	u	2, u	3, u	3, u	∞	∞	∞
1	ut		3, u	3, u	∞	9, t	∞
2	utv			3, u	6, v	9, t	∞
3	utvw				6, v	9, t	∞
4	utvwx					9, t	14, z
5	utvwxy						14, z
6	utvwxyz						

c. Compute the shortest path from v to all network nodes.

Step	N'	D(u),p(u)	D(t),p(t)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0	v	3, v	4, v	4, v	3, v	8, v	∞
1	vu		4, v	4, v	3, v	8, v	∞
2	vux		4, v	4, v		8, v	11, x
3	vuxt			4, v		8, v	11, x
4	vuxtw					8, v	11, x
5	vuxtwy						11, x
6							

d. Compute the shortest path from w to all network nodes.

Step	N'	D(u),p(u)	D(v),p(v)	D(t),p(t)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0	w	3, w	4, v	∞	6, w	∞	∞
1	wu		4, v	5, u	6, w	∞	∞
2	wuv			5, u	6, w	∞	∞
3	wuvt				6, w	12, t	∞
4	wuvtx					12, t	14, x
5	wuvtxy						14, x
6							

e. Compute the shortest path from y to all network nodes.

Step	N'	D(u),p(u)	D(v),p(v)	D(w),p(w)	D(x),p(x)	D(t),p(t)	D(z),p(z)
0	y	∞	8, y	∞	6, y	7, y	12, y
1	yx	∞	8, y	12, x		7, y	12, y

2	yxt	9, t	8, y	12, x			12, y
3	yxtv	9, t		12, x			12, y
4	yxtvu			12, x			12, y
5	yxtvuw						12, y
6							

f. Compute the shortest path from z to all network nodes.

Step	N'	D(u),p(u)	D(v),p(v)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(t),p(t)
0	z	∞	∞	∞	8, z	12, z	∞
1	zx	∞	11, x	14, x		12, z	∞
2	zxv	14, v		14, x		12, z	15, v
3	zxvy	14, v		14, x			15, v
4	zxvyu			14, x			15, v
5	zxvyuw						15, v
6	zxvyuwt						

P5. Consider the network shown below, and assume that each node initially knows the costs to each of its neighbors. Consider the distance-vector algorithm and show the distance table entries at node z.

Answer (Group 5)

Problem 5

Network	Entries	Distance
X	D(z, x)	2
V	D(z, v)	6
U	D(z, x)+D(x, v)+D(v, u)	6
Y	D(z, x)+D(x, y)	5

P6. Consider a general topology (that is, not the specific network shown above) and a synchronous version of the distance-vector algorithm. Suppose that at each iteration, a node exchanges its distance vectors with its neighbors and receives their distance vectors. Assuming that the algorithm begins with each node knowing only the costs to its immediate neighbors, what is the maximum number of iterations required before the dist1ibuted algorithm converges? Justify your answer.

Note 1

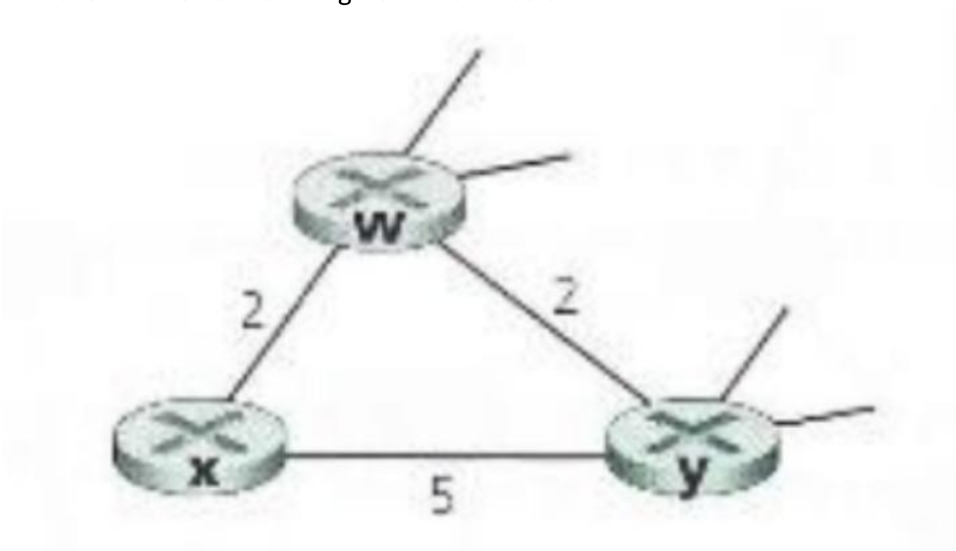
The wording of this question is a bit ambiguous. We meant this to mean, "the number of iterations from when the algorithm is run for the first time" (that is, assuming the only information the nodes initially have is the cost to their nearest neighbors). We assume that the algorithm runs synchronously (that is, in one step, all nodes compute their distance tables at the same time and then exchange tables).

Note 2
At each iteration, a node exchanges distance tables with its neighbors. Thus, if you are node A, and your neighbor is B, all of B's neighbors (which will all be one or two hops from you) will know the shortest cost path of one or two hops to you after one iteration (i.e., after B tells them its cost to you).

Answer (Group 6)

Suppose that the length of the longest path without loop between any two nodes in the network is d, the maximum number of the iterations required is d - 1. Given that the only information a node initially has is the cost of its nearest neighbor and all nodes compute their distance tables at the same time, all nodes, after d - 1 iterations, can know the shortest path cost of d or fewer hops to all other nodes.

P7. Consider the network fragment shown below.



x has only two attached neighbors, w and y. w has a minimum-cost path to destination u (not shown) of 5 , and y has a minimum-cost path to u of 6. The complete paths from wand y to u (and between wand y) are not shown. AU link costs in the network have strictly positive integer values. a. Give x's distance vector for destinations w, y, and u. b. Give a link-cost change for either c(x, w) or c(x,y) such that x will inform its neighbors of a new minimum-cost path to u as a result of executing the distance-vector algorithm. c. Give a link-cost change for either c(x, w) or c(x,y) such that x will not inform its neighbors of a new minimum-cost path to u as a result of executing the distance-vector algorithm.

Answer (Group 7)

a. x’s distance vector
d(x,w)=2;
d(x,y)=min{d(x,y), c(x,w)+d(w,y)}=min{5, 4}=4;

Because d(w,u)=5, d(y,u)=6,
d(x,u)=min{c(x,w)+d(w,u), c(x,y)+d(y,u)}=min{7, 10}=7

b. If we change c(x,w) from 2 to 7,
So d(x,y)=min{d(x,y), c(x,w)+d(w,y)}=min{5, 9}=5;
d(x,u)=min{c(x,w)+d(w,u), c(x,y)+d(y,u)}=min{12, 11}=11,
then, it will inform its neighbors of a new minimum-cost path to u through y not w.

c. If we change c(x,w) from 2 to 5,
So d(x,y)=min{d(x,y), c(x,w)+d(w,y)}=min{5, 7}=5;
d(x,u)=min{c(x,w)+d(w,u), c(x,y)+d(y,u)}=min{10, 11}=10,
It will not inform its neighbors because the minimum-cost path keeps the same, namely going to u through w.

P8. Consider the three-node topology shown in Figure 5.6. Rather than having the link costs shown in Figure 5.6, the link costs are c(x,y) = 3, c(y,z) = 6, c(z,x) = 4. Compute the distance tables after the initialization step and after each iteration of a synchronous version of the distance-vector algorithm (as we did in our earlier discussion of Figure 5.6).

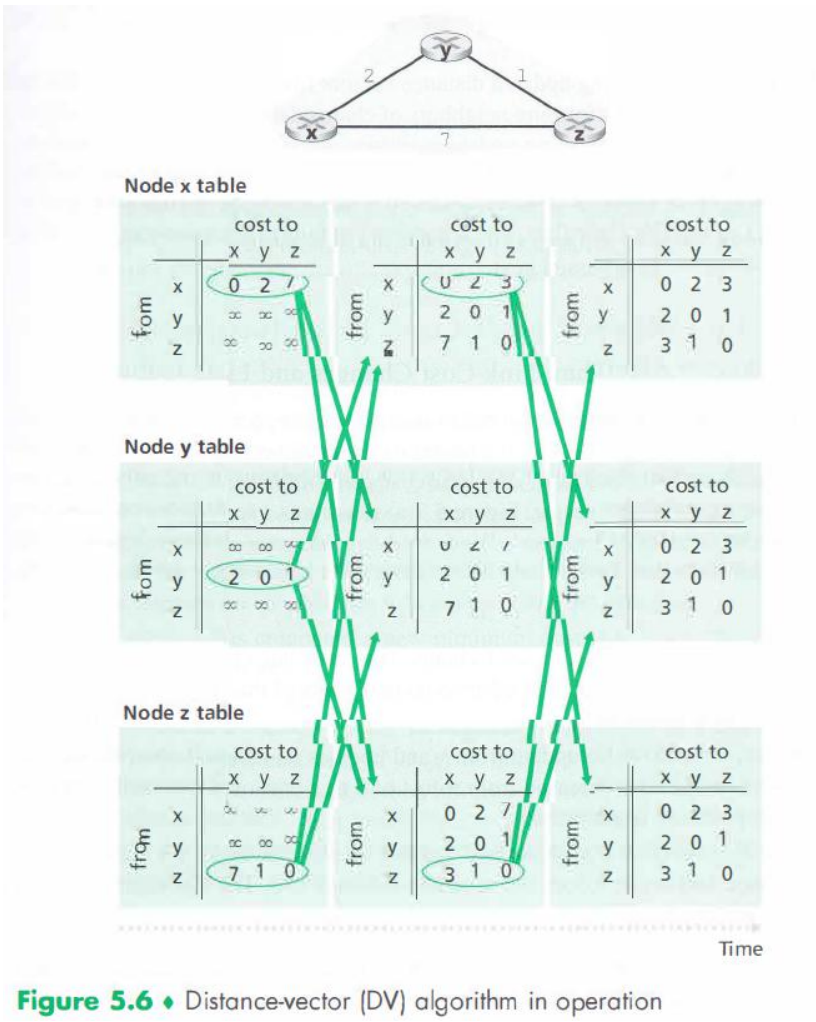


Figure 5.6 • Distance-vector (DV) algorithm in operation

Missing answer

P9. Can the poisoned reverse solve the general count-to-infinity problem? Justify your answer.

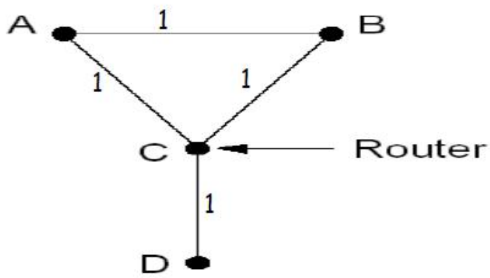
Answer (Group 9)

No. Loops involving three or more nodes (not just two directly connected neighbors) will not be detected by the toxicity reversal technique.

When the connection between C and D is broken, the following events occur in sequence:

- A receives bad news from C and will choose to go from B to D
- A sends an update message to C
- C sends an update message to B

The problem arises because A and B cannot simultaneously receive an update message from C and update their distance vectors.



P 10. Argue that for the distance-vector algorithm in Figure 5.6, each value in the distance vector D(x) is non-increasing and will eventually stabilize in a finite number of steps.

Answer (Group 10)

- Distance Vector routing protocols are based on the BellmanFord dynamic programming algorithm. The algorithm will calculate the shortest distance of node by using the fomule.

$$d(x,y) = \min_k(c(x,k) + d(k,y))$$

At each step, each updating of a node's distance vectors is based on the Bellman-Ford equation, only decreasing those values in its distance vector. There is no increasing in values. If no updating, then no message will be sent out. Thus, D(x) is non-increasing. Since those costs are finite, then eventually distance vectors will be stabilized in finite steps.

P 11. Consider Figure 5. 7. Suppose there is another router w, connected to router y and z. The costs of all links are given as follows: c(x,y) = 4, c(x,z) = SO, c(y, w) = l , c(z, w) = 1, c(y,z) = 3. Suppose that poisoned reverse is used in the distance-vector routing algorithm. a. When the distance vector routing is stabilized, router w, y, and z inform their distances to x to each other. What distance values do they tell each other? b. Now suppose that the link cost between x and y increases to 60.

Will there be a count-to-infinity problem even if poisoned reverse is used? Why or why not? If there is a count-to-infinity problem, then how many iterations are needed for the distance-vector routing to reach a stable state again? Justify your answer. c. How do you modify c(y,z) such that there is no count-to-infinity problem at all if c(y,x) changes from 4 to 60?

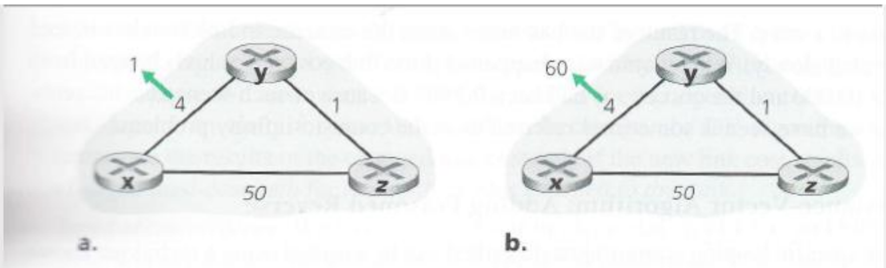
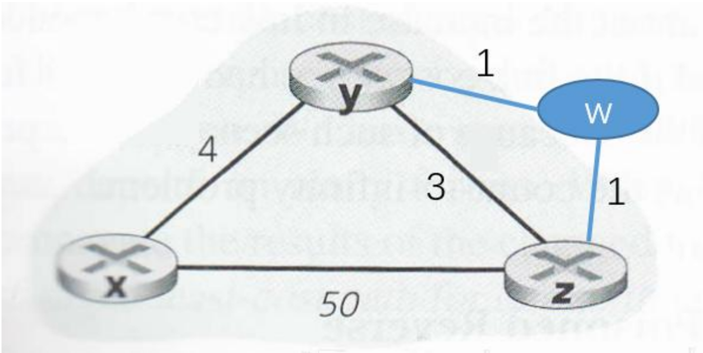


Figure 5.7 ♦ Changes in link cost

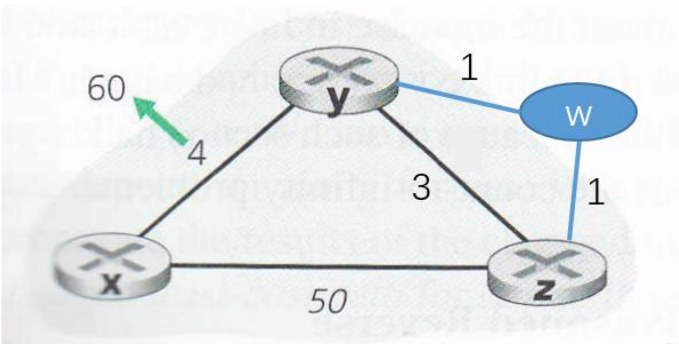
Answer (Group 1)

a.



w reports c(w,x)=5
y reports c(y,x)=4
z reports c(z,x)=6

b.



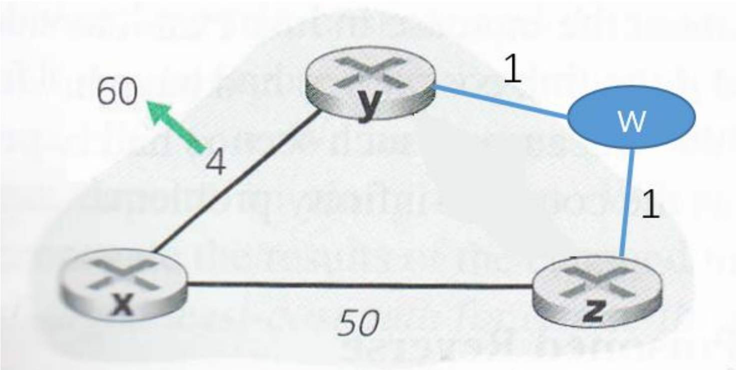
1. Yes, there is a count-to-infinity problem. **The core of the count-to-infinity problem is that if A tells B that it has a path somewhere, there is no way for B to know if the path has B as a part of it.**

2. The following table shows the routing converging process: (Suppose the change of the link loss between x and y from 4 to 60 happens between t0 and t1.)

time	t0	t1	t2	t3	t4
Z	➩ w, c(z,x) = ∞ ➩ y, c(z,x) = 6		No change	➩ w, c(z,x) = ∞ ➩ y, c(z,x) = 11	
W	➩ y, c(w,x) = ∞ ➩ z, c(w,x) = 5		➩ y, c(w,x) = ∞ ➩ z, c(w,x) = 10		No change
Y	➩ w, c(y,x) = 4 ➩ z, c(y,x) = 4	➩ w, c(y,x) = 9 ➩ z, c(y,x) = ∞		No change	➩ w, c(y,x) = 14 ➩ z, c(y,x) = ∞

order of updates: **y**➩ **w**➩ **z**➩ **y**➩ w➩ z➩ y➩ … (there is a loop)
Loops continue, messages exchange between w,y,z.
At t27, z detects that its least cost to x is 50, via its direct link with x.
At t29, w learns its least cost to x is 51 via z.
At t30, y updates its least cost to x to be 52 (via w).
Finally, at time t31, no updating, and the routing is stabilized.

c. Cut the y – z link



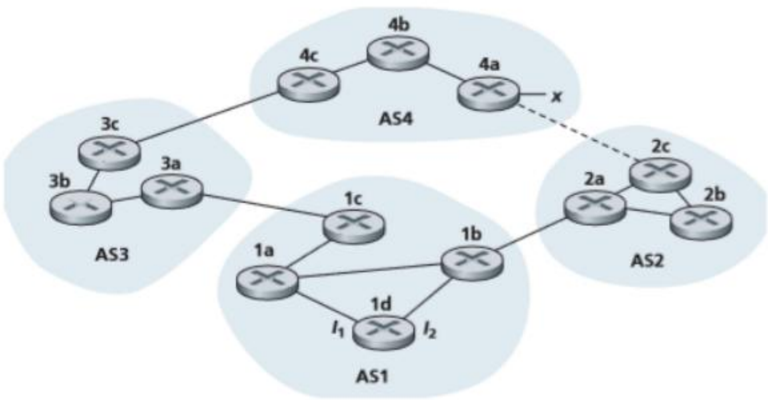
P 12. What is the message complexity of LS routing algorithm?

Missing answer

P 13. Will a BGP router always choose the loop-free route with the shortest AS path length? Justify your answer.

Answer (Group 3):
No. Every router is assigned a local preference value. When there are two or more routes, the routes with the highest local preference values are selected. If all these values are the same, then the shortest AS path will be considered.

P 14. Consider the network shown below.



Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS l and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Initially suppose there is no physical link between AS2 and AS4. a) Router 3c learns about prefix x from which routing protocol: OSPF, RIP, eBGP, or iBGP? b) Router 3a learns about x from which routing protocol? c) Router learns about x from which routing protocol? d) Router Id learns about x from which routing protocol? 4b X 2c AS3 AS1

Answer (Group 4)

a. Router 3c learns about prefix x from which routing protocol: OSPF, RIP, eBGP, or iBGP? **eBGP**

b. Router 3a learns about x from which routing protocol? **iBGP**

c. Router 1c learns about x from which routing protocol? **eBGP**

d. Router Id learns about x from which routing protocol? **iBGP**

PI5. Referring to the previous problem, once router learns about x it will put an entry (x, I) in its forwarding table. a. Will I be equal to /1 or h for this entry? Explain why in one sentence. b. Now suppose that there is a physical link between AS2 and AS4, shown by the dotted line. Suppose router learns that xis accessible via AS2 as well as via AS3. Will be set to /1 or 12? Explain why in one sentence. c. Now suppose there is another AS, called ASS, which lies on the path between AS2 and AS4 (not shown in diagram). Suppose router learns that is accessible via AS2 ASS AS4 as well as via AS3 AS4. Will/ be set to 11 or 12? Explain why in one sentence.

Answer (Group 5)

a) I1. It can get to x just by AS3
b) I2. Through AS2 and AS3 has same as path, so using hot potato, the closest next-hop.
c) I1. AS4 to AS3 is closer than AS5, AS2, and AS3.

P16. Consider the following network. ISP B provides national backbone service to regional ISP A . ISP C provides national backbone service to regional ISP D. Each ISP consists of one AS. B and C peer with each other in two places using BGP. Consider traffic going from A to D. B would prefer to hand that traffic over to Con the West Coast (so that C would have to absorb the cost of carrying the traffic cross-country), while C would prefer to get the traffic via its East Coast peering point with B (so that B would have carried the traffic across the country). What BGP mechanism might C use, so that B would hand over A-to-D traffic at its East Coast peering point? To answer this question, you will need to dig into the BGP specification.

Answer (Group 6)

Because of the BGP routing notification principle. The BGP Speaker(C) only notifies neighbors of its own route (optimal route), so it can only inform D of the route on the east coast.