CSC358 Tutorial 9

TA: Lilin Zhang

Instructor: Amir Chinaei

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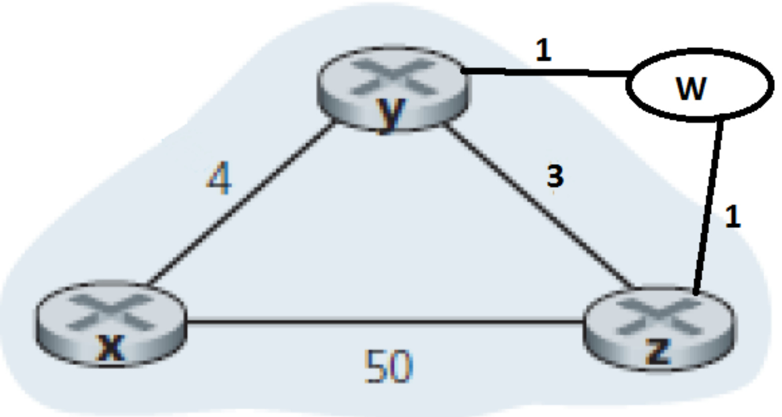
Q1 Poisoned Reverse

- Consider a figure on the right. Suppose there is another router w, connected to router y and z. The costs of all links are given as indicated.
- Suppose that **poisoned reverse** is used in the distance-vector routing algorithm.

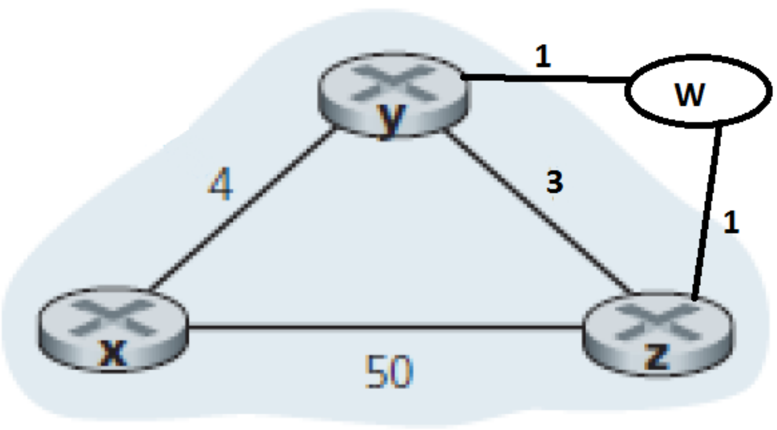


Poisoned Reverse: avoid routing loops.

Poisoned Reverse: if *z* routes through *y* to get to destination *x,* then *z* will advertise to *y* that its di stance to *x* is infinity.

Q1 Poisoned Reverse

- (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?

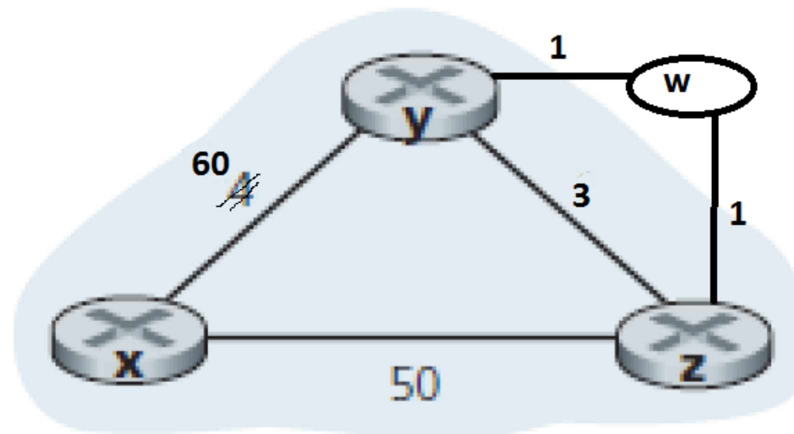


a)

Router z	Informs w, $D_z(x)=\infty$
	Informs y, $D_z(x)=6$
Router w	Informs y, $D_w(x)=\infty$
	Informs z, $D_w(x)=5$
Router y	Informs w, $D_y(x)=4$
	Informs z, $D_y(x)=4$

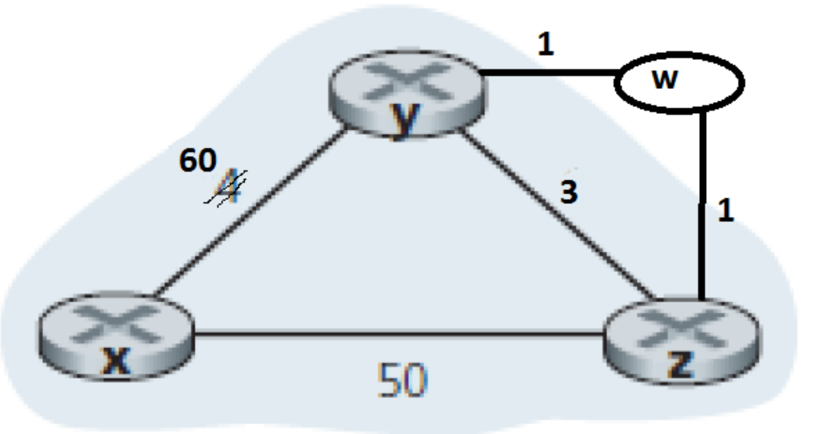
Q1 Poisoned Reverse

- (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.



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.

Q1 Poisoned Reverse



Yes, there will be a count-to-infinity problem. The following table shows the routing converging process.

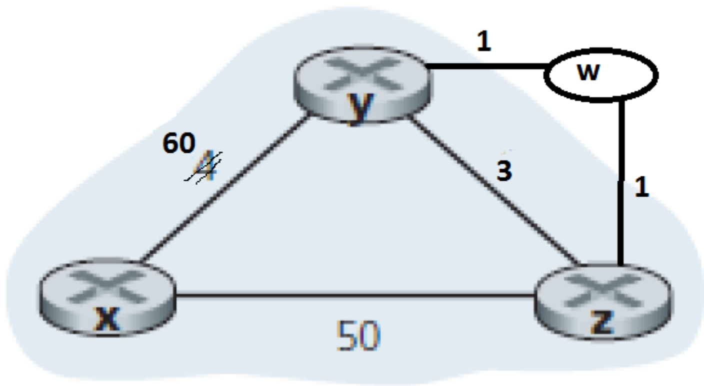
Link change occurs between t0 and t1

time	t0	t1	t2	t3	t4
Z	→ w, $D_z(x)=\infty$ → y, $D_z(x)=6$		No change	→ w, $D_z(x)=\infty$ → y, $D_z(x)=11$	
W	→ y, $D_w(x)=\infty$ → z, $D_w(x)=5$		→ y, $D_w(x)=\infty$ → z, $D_w(x)=10$		No change
Y	→ w, $D_y(x)=4$ → z, $D_y(x)=4$	→ w, $D_y(x)=9$ → z, $D_y(x)= \infty$		No change	→ w, $D_y(x)=14$ → z, $D_y(x)= \infty$

Order of updates: **Y -> W -> Z -> Y** -> W -> Z -> Y -> ....

Q1 Poisoned Reverse

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.

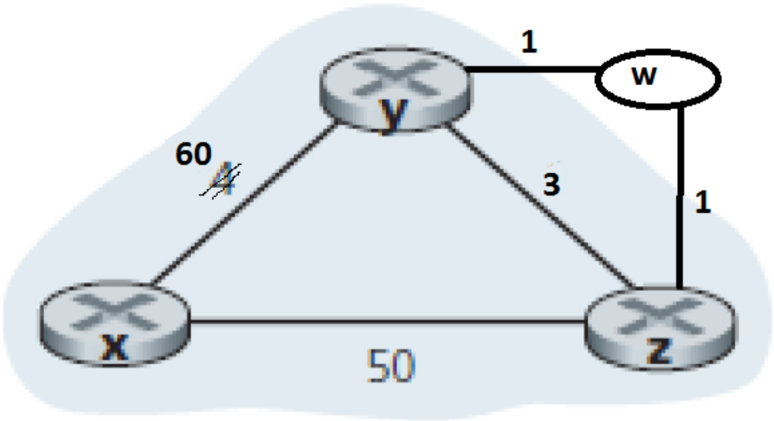


time	t27	t28	t29	t30	t31
Z	→ w, $D_z(x)=50$ → y, $D_z(x)=50$				via w, ∞ via y, 55 via z, 50
W		→ y, $D_w(x)=\infty$ → z, $D_w(x)=50$	→ y, $D_w(x)=51$ → z, $D_w(x)= \infty$		via w, ∞ via y, ∞ via z, 51
Y		→ w, $D_y(x)=53$ → z, $D_y(x)= \infty$		→ w, $D_y(x)= \infty$ → z, $D_y(x)= 52$	via w, 52 via y, 60 via z, 53

Q1 Poisoned Reverse

- (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?

  Cut the y – z link



Recall how the count-to-infinity rises:

time	t0	t1	t2	t3	t4
Z	→ w, $D_z(x)=\infty$ → y, $D_z(x)=6$		No change	→ w, $D_z(x)=\infty$ → y, $D_z(x)=11$	
W	→ y, $D_w(x)=\infty$ → z, $D_w(x)=5$		→ y, $D_w(x)=\infty$ → z, $D_w(x)=10$		No change
Y	→ w, $D_y(x)=4$ → z, $D_y(x)=4$	→ w, $D_y(x)=9$ → z, $D_y(x)=\infty$		No change	→ w, $D_y(x)=14$ → z, $D_y(x)=\infty$

Order of updates: **Y -> W -> Z -> Y** -> W -> Z -> Y -> ....

Q1 Poisoned Reverse

	X
Y	4

	X
Y	60

	X
Y	52

	X
W	5

	X
W	61

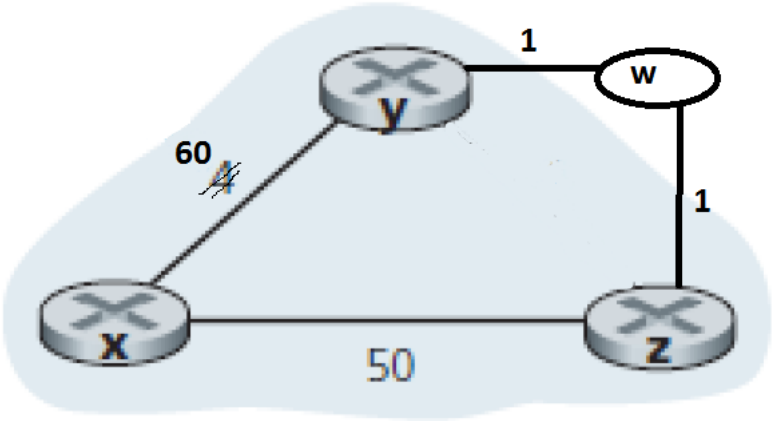
	X
W	51

	X
Z	6

	X
Z	50

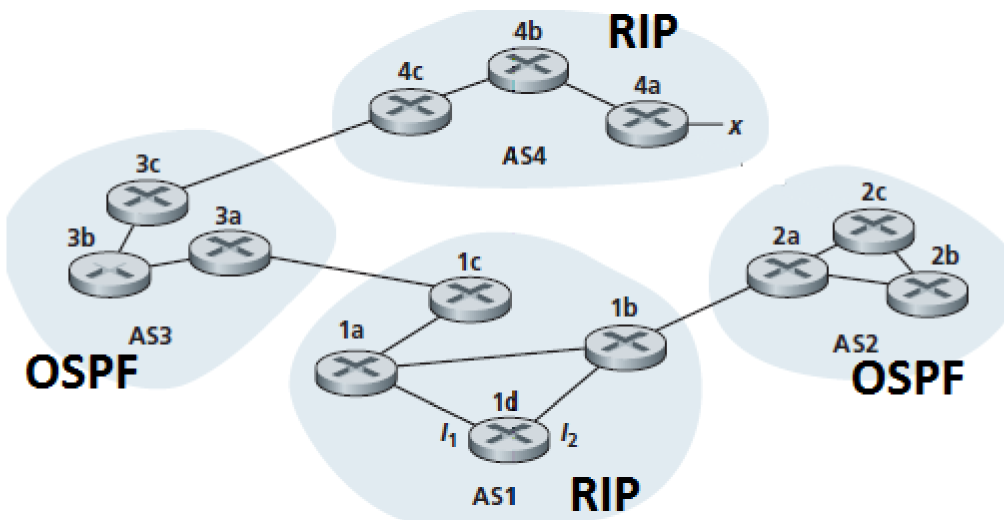
	X
Z	50

Link change occurs



Q2 RIP, OSPF, BGP

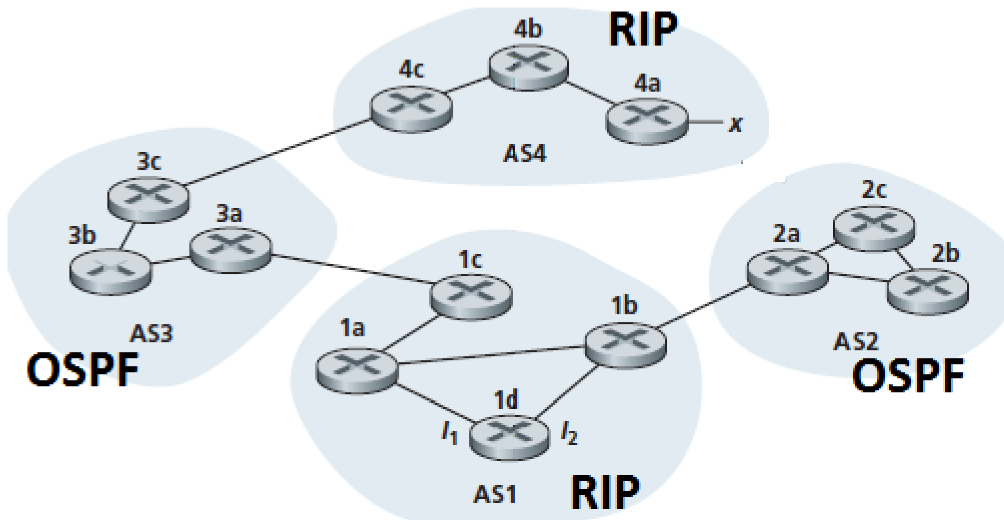
- Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Initially suppose there is *no* physical link between AS2 and AS4.



Open Shortest Path First: intra-domain routing, Link state
Routing Information Protocol: intra-domain routing, distance vector

Q2 RIP, OSPF, BGP

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

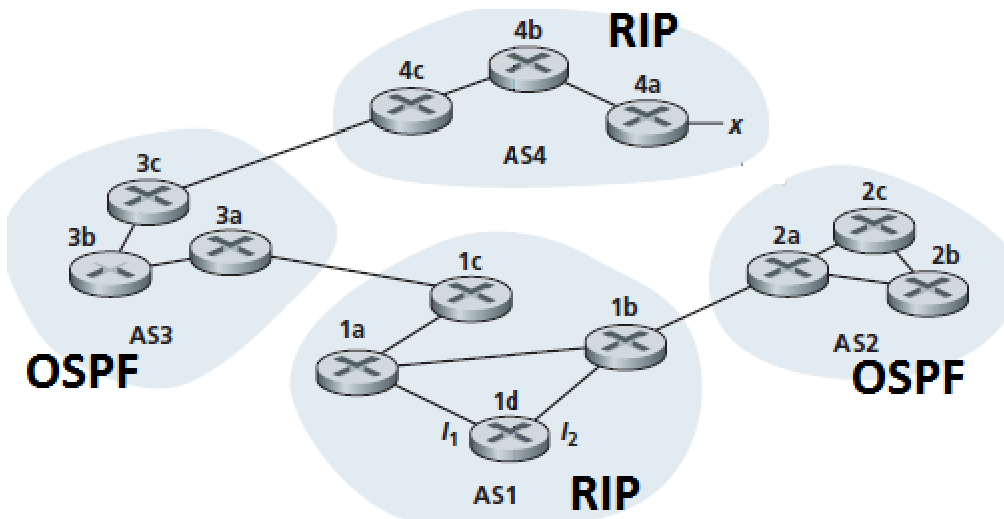


EBGP: external BGP runs between routers in different ASs
IBGP: internal BGP runs between routers in the same AS

Router 3c learns about x from eBGP

Q2 RIP, OSPF, BGP

- (b) Router 3a learns about *x* from which routing protocol ?

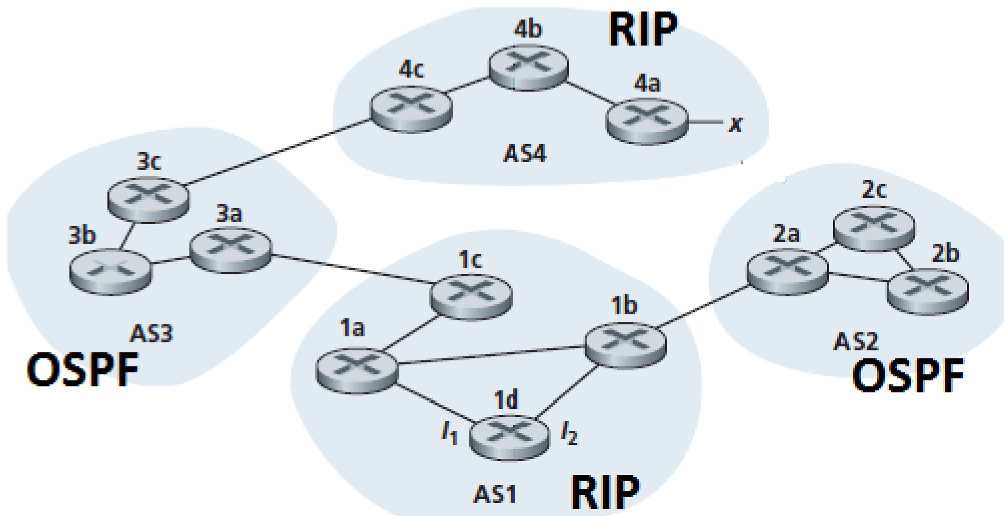


EBGP: external BGP runs between routers in different ASs
IBGP: internal BGP runs between routers in the same AS

Router 3a learns about x from iBGP

Q2 RIP, OSPF, BGP

- (c) Router 1c learns about *x* from which routing protocol?

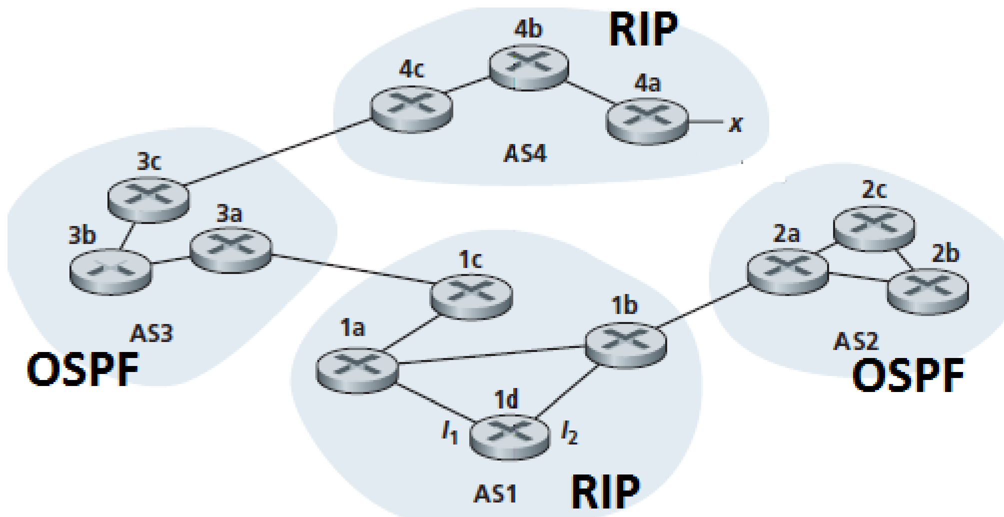


EBGP: external BGP runs between routers in different ASs
IBGP: internal BGP runs between routers in the same AS

Router 1c learns about x from eBGP

Q2 RIP, OSPF, BGP

- (d) Router 1d learns about *x* from which routing protocol ?

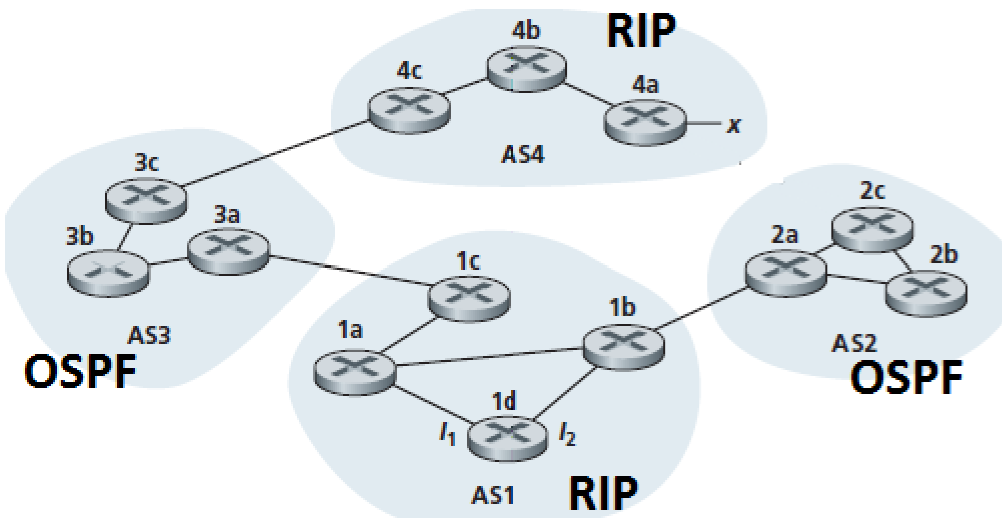


EBGP: external BGP runs between routers in different ASs
IBGP: internal BGP runs between routers in the same AS

Router 1d learns about x from iBGP

Q3 BGP

- Referring to the previous problem, once router 1d learns about *x* it will put an entry (*x*, *I*) in its forwarding table.

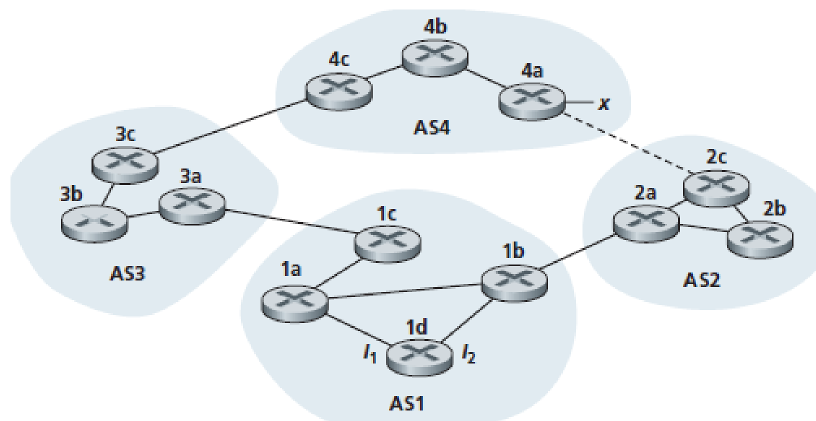


(a) Will *I* be equal to *I*1 or *I*2 for this entry? Explain why in one sentence

I1 because this interface begins the least cost path from 1d towards the gateway router 1c.

Q3 BGP

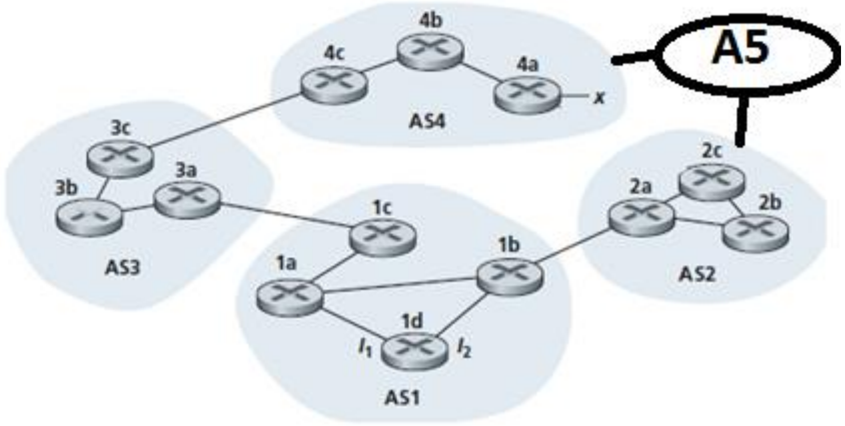
- (b) Now suppose that there is a physical link between AS2 and AS4, shown by the dotted line. Suppose router 1d learns that *x* is accessible via AS2 as well as via AS3. Will *I* be set to *I*1 or *I*2? Explain why in one sentence.



I2. Both routes have equal AS-PATH length, but I2 begins the path that has the closest NEXT-HOP router.

Q3 BGP

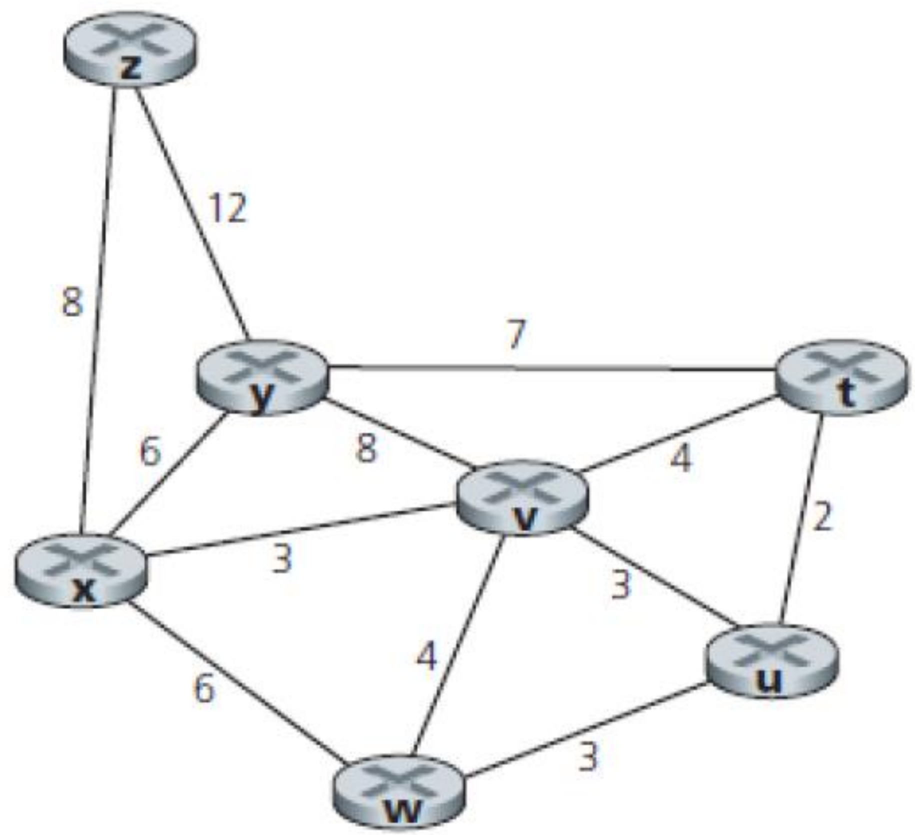
- (C) Now suppose there is another AS, called AS5, which lies on the path between AS2 and AS4. Suppose router 1d learns that *x* is accessible via AS2 AS5 AS4 as well as via AS3 AS4. Will *I* be set to *I*1 or *I*2? Explain why in one sentence



I1. I1 begins the path that has the shortest AS-PATH.

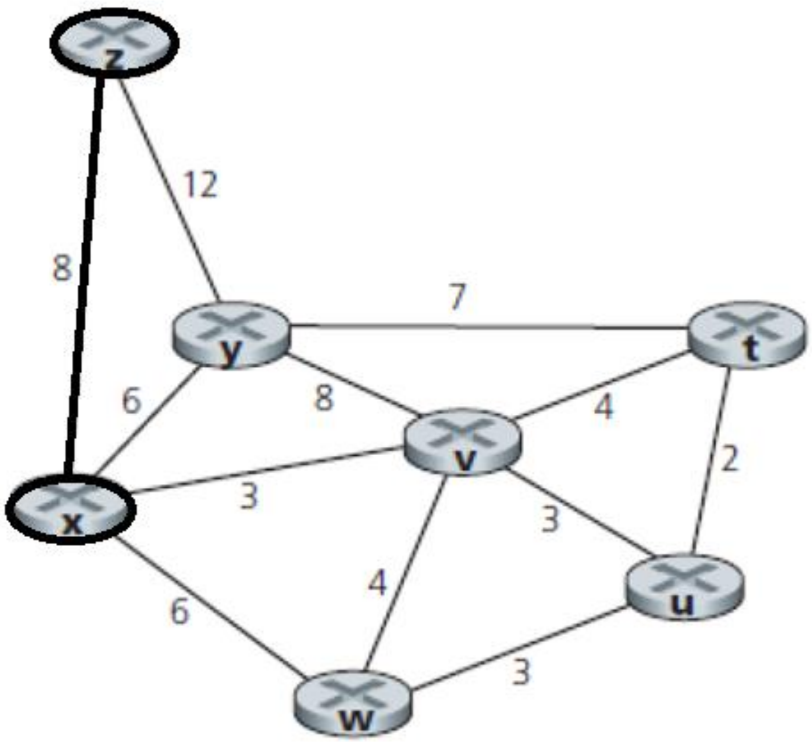
Q4 Minimal cost tree

- Consider the network. Show the minimal-cost tree rooted at *z* that includes (as end hosts) nodes *u*, *v*, *w*, and *y*.

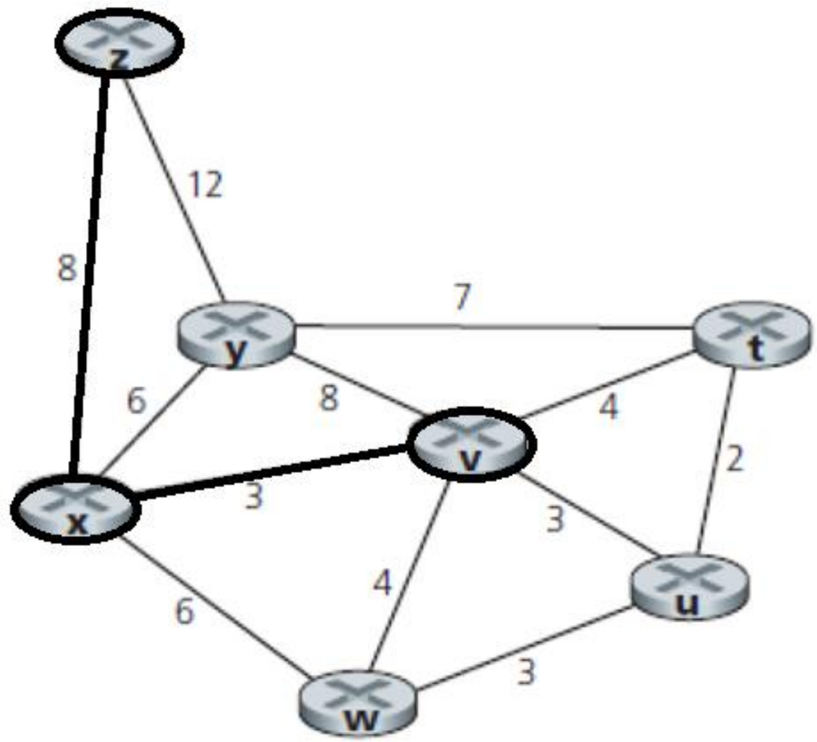


Prim's algorithm:
let T contain a single vertex *root*
while (T has fewer than n vertices) {
    find the smallest edge connecting T to G-T
    add it to T
}

Q4 Minimal cost tree

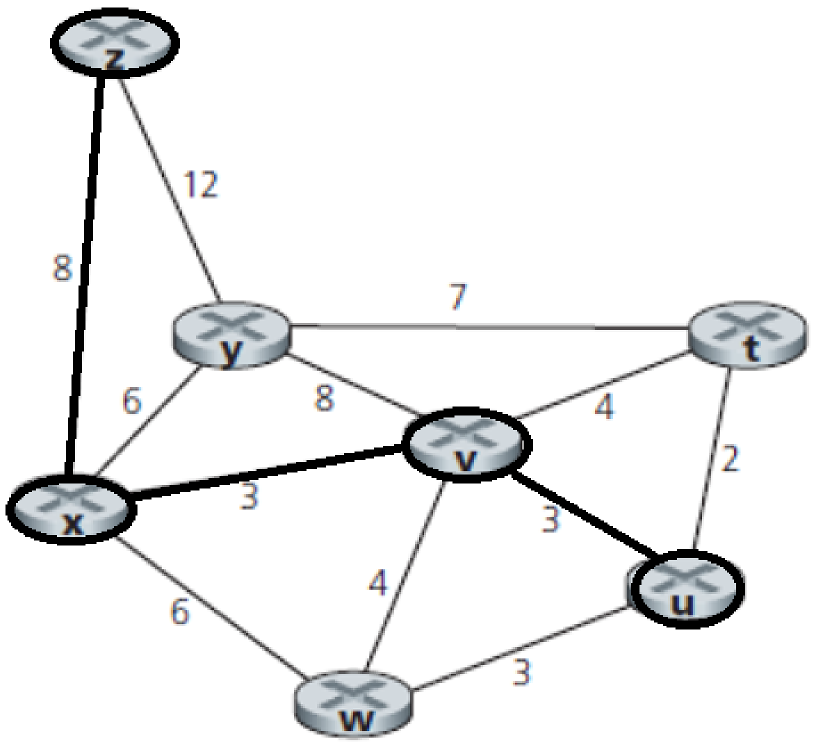


Visited: z, x

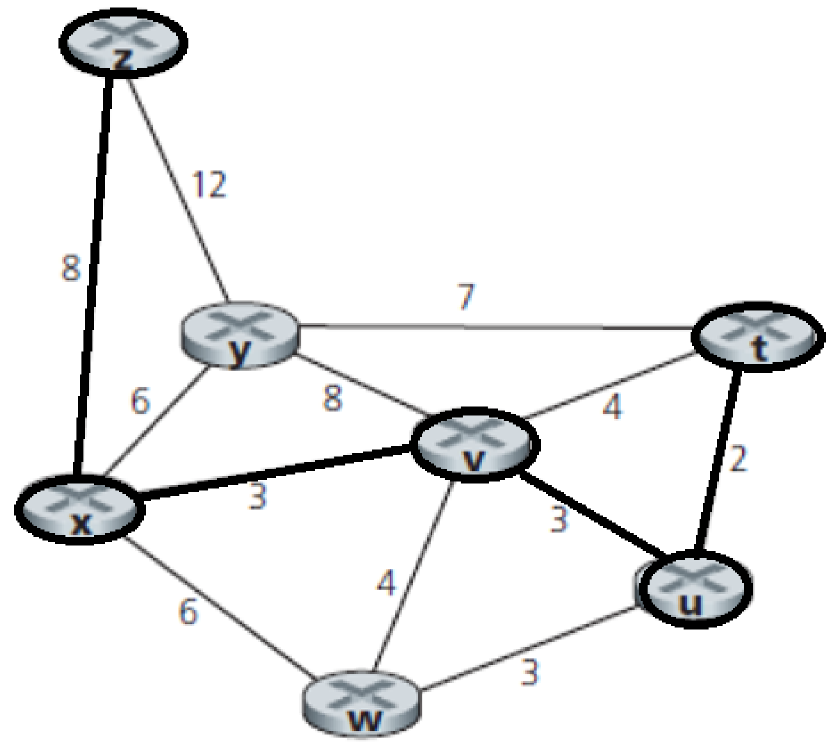


Visited: z, x, v
Distance(z,v) = 11

Q4 Minimal cost tree

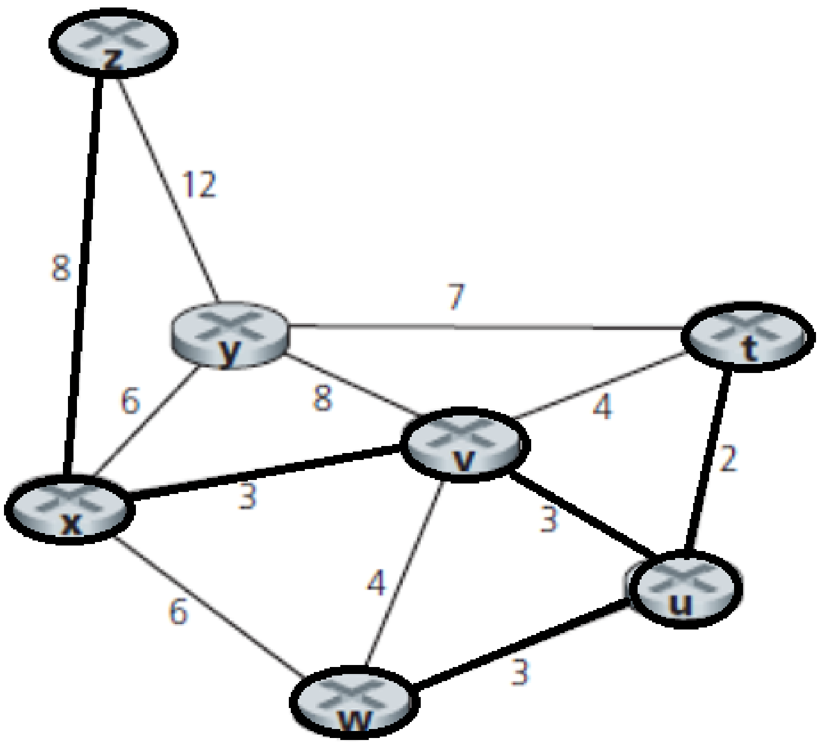


Visited: z, x, v, u
Distance(z,u) = 14

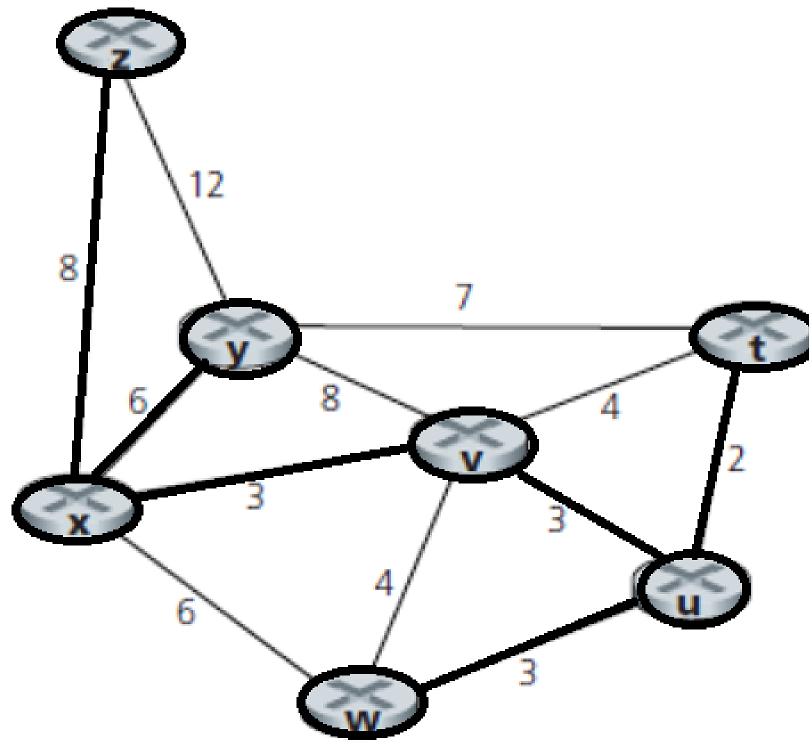


Visited: z, x, v, u, t

Q4 Minimal cost tree



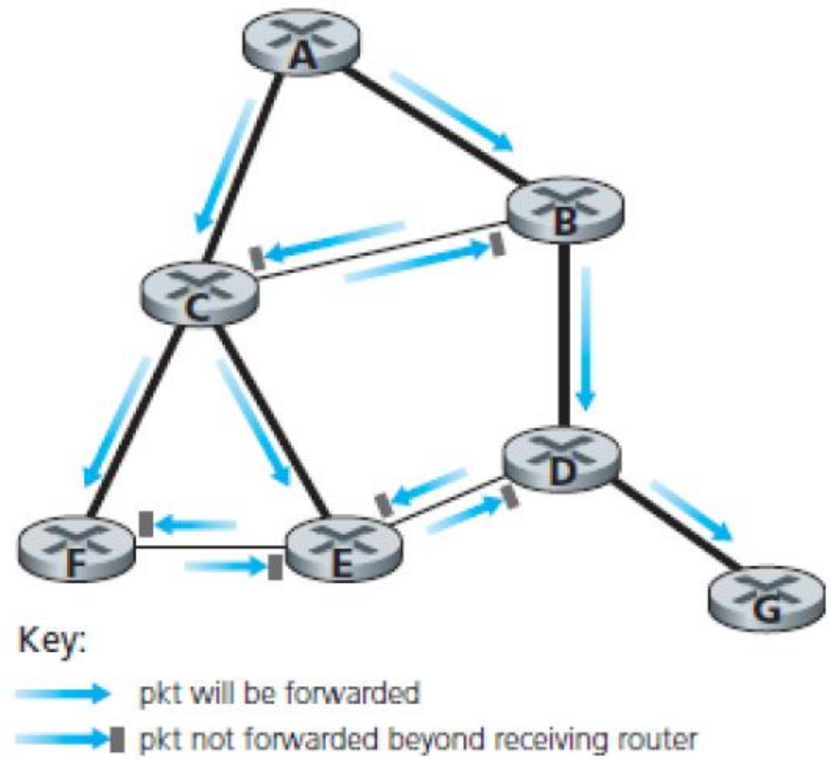
Visited: z, x, v, u, t, w
Distance(z,w) = 17



Visited: z, x, v, u, t, w, y
Distance(z,y) = 11

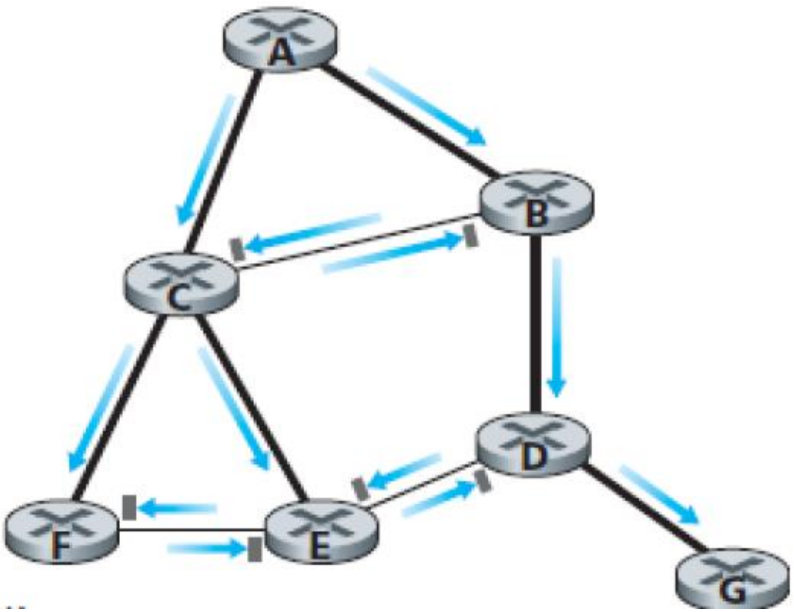
Q5 Reverse Path Forwarding (RPF)

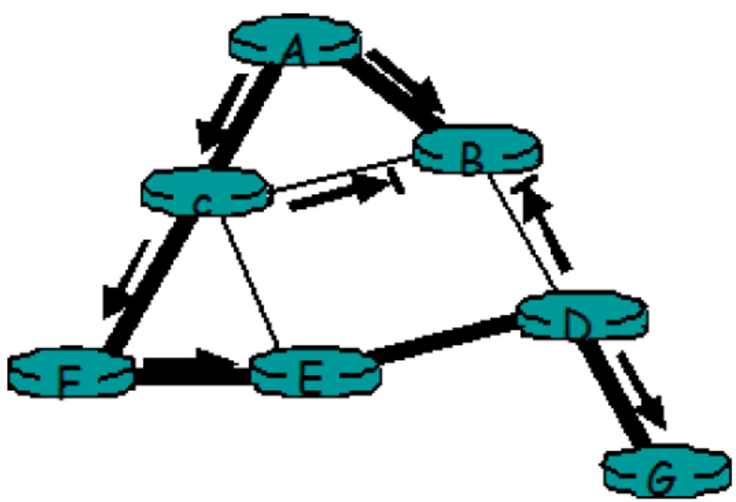
- Using the topology, find a set of paths from all nodes to the source node *A* (and indicate these paths in a graph using thicker-shaded lines) such that if these paths were the least-cost paths, then node *B* would receive a copy of *A*'s broadcast message from nodes *A*, *C*, and *D* under RPF.



RPF: When a router receives a broadcast packet with a given source address, it transmits the packet on all of its outgoing links (except the one on which it was received) **only if the packet arrived on the link that is on its own shortest unicast path back to the source.**

Q5 Reverse Path Forwarding (RPF)





- In order to have A's broadcast message sent to B from A, Link A-B should be the least-cost path from B to A.
- In order to have A's broadcast message sent to B from C, Link B-C should NOT be on the least cost path from C to A.
- In order to have A's broadcast message sent to B from D, Link B-D should NOT be on the least cost path from D to A.

Office hours

- Instructor office hours:
  - Tuesday 17:00-18:00 and
  - Thursday 9:00-10:00 in BA4222
- TAs office hours:
  - Wednesday 15:00-16:00 in BA3201 and
  - Friday 10:00-11:00 in BA7172

Thanks!