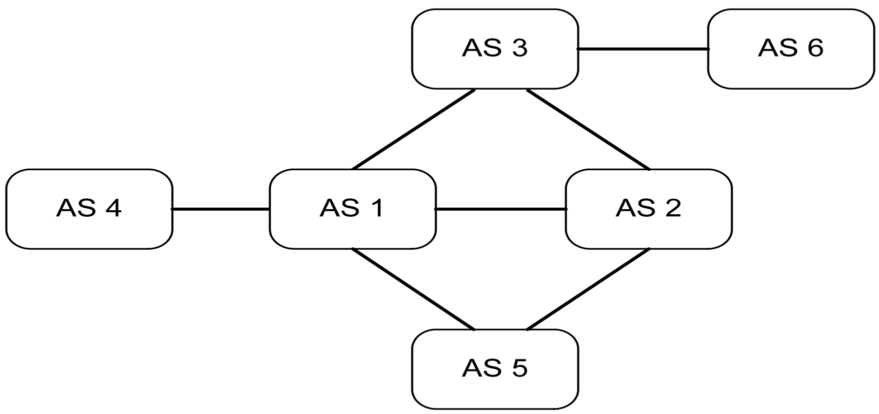
Assignment 5: Routing

Problem 1. Policy Based Routing in BGP
The figure shows a network with six autonomous systems. AS4 "owns" the prefix 10.0.1.0/24 and sends an advertisement to AS1 with the following prefix, and ORIGIN and AS-PATH attributes: *10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4}*.



a. Assume that no routing policies are employed (i.e., no advertised routes are selectively ignored and all known routes are advertised). Explain how the other autonomous systems process and disseminate the advertisement for prefix 10.0.1.0/24. Indicate which autonomous systems advertise the prefix to their neighboring autonomous systems. Provide the ORIGIN and AS-PATH attributes used in the advertisements.

b. Now consider that autonomous systems AS1, AS2, and AS3 are transit networks, and AS4, AS5, and AS6 are stub networks. For each autonomous system, explain how the processing and advertisement for prefix 10.0.1.0/24 should be changed (compared with your answer to (a)).

a.
AS-4 to AS 1: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4}

AS-1 to AS-3, AS-1 to AS-2, AS-1 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1}

AS-3 to AS-2, AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS3}
AS-2 to AS-3, AS-2 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS2}
AS-5 to AS-2: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS5}

AS-2 to AS-3: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS5,AS2}
AS-2 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS3,AS2}
AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS5,AS2,AS3}

AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1,AS2,AS3}

b. Policies are added:
AS 5 → a stub network does not advertise any network other than those originating in AS 5
AS 2 → as transit networks with peering relationships it should not advertise to AS 3 that it can carry traffic to AS 1.
AS 3 → as transit networks with peering relationships it should not advertise to AS 2 that it can carry traffic to AS 1.

AS-4 to AS 1: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4}

AS-1 to AS-3, AS-1 to AS-2, AS-1 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1}

AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS3}
AS-2 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS2}

b)
AS-4 to AS 1: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4}

AS-1 to AS-3, AS-2 and AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1}

AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS3}
AS-2 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS2}

Problem 2.
Suppose a BGP router sees the following two advertisements for destination network 10.0.1.0/8:
10.0.1.0/8, AS-PATH { 202, 101, 89, 59}
10.0.1.0/8, AS-PATH { 876, 32}
Explain how the second advertised AS-PATH could result in a longer route.

Solution:

The answer should explain that the number of AS's that are traversed is no indication of the number of IP routers that are traversed. So, the path AS876 → AS32 may have more IP routers than the path AS202→AS101→AS89→AS59.

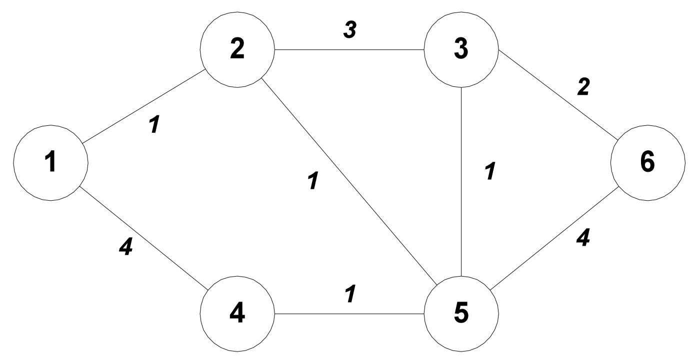


Figure 1

Consider the network shown in the figure below. The cost of each link is indicated in Figure 1.

Problem 3. Use the Dijkstra algorithm to find the least-cost path between node "1" and all other nodes.

Problem 4. Use the Distance Vector algorithm to find the least-cost paths between all nodes. (Assume that the nodes are destinations).

See scanned pages for solution to both problems.

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Problem Set 4: Solutions for Problems 2 + 3

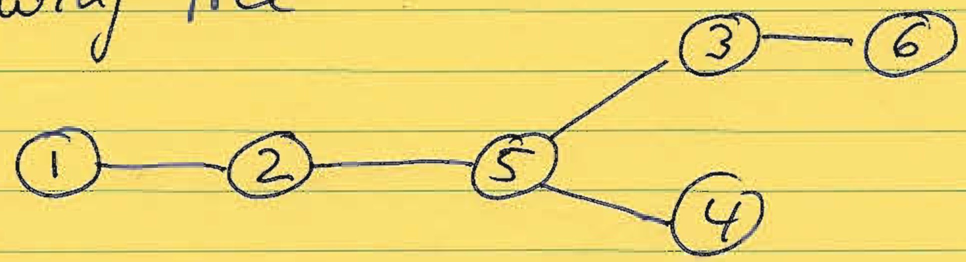
(2) Dijkstra: Apply algorithm on slides (p. 7) using tableau of slide 9

$S = 1$

Iteration	M	D_1	D_2	D_3	D_4	D_5	D_6
Init	{1}	0	1	∞	4	∞	∞
1	{1,2}	–	–	4	4	2	∞
2	{1,2,5}	–	–	3	3	–	6
3	{1,2,5,3}	–	–	–	3	–	5
4	{1,2,5,3,4}	–	–	–	–	–	5
5	{1,2,5,3,4,6}	–	–	–	–	–	–

Note: selection in Iteration 2 is a tie for nodes 3 and 4

shortest path are branches of the following tree



Problem 3:

- For distance vector, we need to indicate exchanged messages
- Assume (see slide 21 of RIP lecture):
  - all updates occur simultaneously
  - initially all nodes know cost to neighbors

t=0:

node 1

dest	via	cost
2	–	1
4	–	4

sends: (2,1)
(4,4)

node 2

dest	via	cost
1	–	1
3	–	3
5	–	1

sends: (1,1)
(3,3)
(5,1)

node 3

dest	via	cost
2	–	3
5	–	1
6	–	2

sends: (2,3)
(5,1)
(6,2)

node 4

dest	via	cost
1	–	4
5	–	1

sends: (1,4)
(5,1)

node 5

dest	via	cost
2	–	1
3	–	1
4	–	1
6	–	4

sends: (2,1),(3,1),(4,1)
(6,4)

node 6

dest	via	cost
3	–	2
5	–	4

sends: (3,2)
(5,4)

Problem 3 (con't):

t = 1

node 1

dest	via	cost
2	–	1
3	2	4
4	–	4
5	2	2

sends: (3,4)
(5,2)

node 2

dest	via	cost
1	–	1
3	5	2
4	5	2
5	–	1
6	3	5

sends: (3,2), (4,2)
(6,5)

node 3

dest	via	cost
1	2	4
2	5	2
4	5	2
5	–	1
6	–	2

sends: (1,4)
(2,2)
(4,2)

node 4

dest	via	cost
1	–	4
2	5	2
3	5	2
5	–	1
6	5	5

sends: (2,2)
(3,2)
(6,5)

node 5

dest	via	cost
1	2	2
2	–	1
3	–	1
4	–	1
6	3	3

sends: (1,2)
(6,3)

node 6

dest	via	cost
2	3	5
4	5	5
5	3	3
3	–	2

sends: (2,5)
(4,5)

Problem 3 (cont'd)

t = 2

node 1

dest	via	cost
2	–	1
3	2	3
4	2	3
5	2	2
6	2	6

sends (3, 3)
(4, 3)
(6, 6)

node 2

dest	via	cost
1	–	1
3	5	2
4	5	2
5	–	1
6	5	4

sends: (6, 4)

node 3

dest	via	cost
1	5	3
2	5	2
4	5	2
5	–	1
6	–	2

sends: (1, 3)

node 4

dest	via	cost
1	5	3
2	5	2
3	5	2
5	–	1
6	5	4

sends: (1, 3)
(6, 4)

node 5

dest	via	cost
1	2	2
2	–	1
3	–	1
4	–	1
6	3	3

sends: X

node 6

dest	via	cost
1	3	6
2	3	4
3	–	2
4	3	4
5	3	3

sends: (1, 6)
(2, 4)
(4, 4)

Problem 3 (cont'd)

t = 3

node 1

dest	via	cost
2	–	1
3	2	3
4	2	3
5	2	2
6	2	5

sends: (6, 5)

node 2

dest	via	cost
1	–	1
3	5	2
4	5	2
5	–	1
6	5	4

sends: X

node 3

dest	via	cost
1	5	3
2	5	2
4	5	2
5	–	1
6	–	2

sends: X

node 4

dest	via	cost
1	5	3
2	5	2
3	5	2
5	–	1
6	5	4

sends: X

node 5

dest	via	cost
1	2	2
2	–	1
3	–	1
4	–	1
6	3	3

sends: X

node 6

dest	via	cost
1	3	6
2	3	4
3	–	2
4	3	4
5	3	3

sends: X

after this: - no changes to routing tables
- no more messages.