Open system Interconnection (OSI)

Networking: Routing

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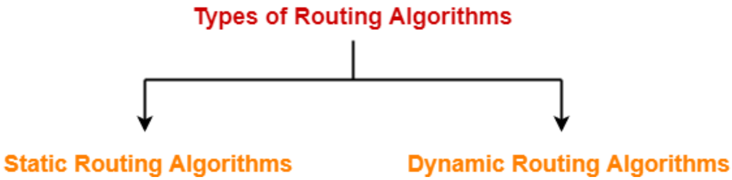
Routing Algorithms

- Routing algorithms are meant for determining the routing of packets in a node.
- Routing algorithms are classified as-



Distance Vector Routing Algorithm

- Distance Vector Routing is a dynamic routing algorithm.
  - It works in the following steps-

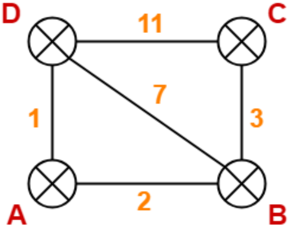
    Step-01:
    - Each router prepares its routing table.
    - By their local knowledge.
    - Each router knows about-
    - All the routers present in the network
    - Distance to its neighboring routers

    Step-02:
    - Each router exchanges its distance vector with its neighboring routers.
    - Each router prepares a new routing table using the distance vectors it has obtained from its neighbors.
    - This step is repeated for (n-2) times if there are n routers in the network.
    - After this, routing tables converge / become stable.

Distance Vector Routing Example

- Consider a network where
  - There is a network consisting of 4 routers.
  - The weights are mentioned on the edges.
  - Weights could be distances or costs or delays.

    Step-01:
  - Each router prepares its routing table using its local knowledge.
  - Routing table prepared by each router is shown below-
  - **At Router A**



Destination	Distance	Next Hop
A	0	A
B	2	B
C	∞	–
D	1	D

- **At Router B-**

Destination	Distance	Next Hop
A	2	A
B	0	B
C	3	C
D	7	D

- **At Router C-**

Destination	Distance	Next Hop
A	∞	–
B	3	B
C	0	C
D	11	D

- **At Router D-**

Destination	Distance	Next Hop
A	1	A
B	7	B
C	11	C
D	0	D

- **Step-02:**
  - Each router exchanges its distance vector obtained in Step-01 with its neighbors.
  - After exchanging the distance vectors, each router prepares a new routing table.
  - **At Router A**
    - Router A receives distance vectors from its neighbors B and D.
    - Router A prepares a new routing table as-

From B

2
0
3
7

Cost(A→B) = 2

From D

1
7
11
0

Cost(A→D) = 1

Destination	Distance	Next hop
A	0	A
B		
C		
D		

New Routing Table at Router A

  - Cost of reaching destination B from router A $= \min\ 2+0\ ,\ 1+7\ = 2$ via B.
  - Cost of reaching destination C from router A $= \min\ 2+3\ ,\ 1+11\ = 5$ via B.
  - Cost of reaching destination D from router A $= \min\ 2+7\ ,\ 1+0\ = 1$ via D.

- **Explanation For Destination B**
  - Router A can reach the destination router B via its neighbor B or neighbor D.
  - It chooses the path which gives the minimum cost.
    - Cost of reaching router B from router A via neighbor B = Cost (AB) + Cost (BB)$= 2 + 0 = 2$
    - Cost of reaching router B from router A via neighbor D = Cost (AD) + Cost (DB) $= 1 + 7 = 8$
    - Since the cost is minimum via neighbor B, so router A chooses the path via B.
    - It creates an entry (2, B) for destination B in its new routing table.
    - Similarly, we calculate the shortest path distance to each destination router at every router.
  - Thus, the new routing table at router A is-

Destination	Distance	Next Hop
A	0	A
B	2	B
C	5	B
D	1	D

At Router B

- Router B receives distance vectors from its neighbors A, C and D.
- Router B prepares a new routing table as-
  - Cost of reaching destination A from router B $=$ min $2+0$, $3+\infty$, $7+1$ $= 2$ via A.
  - Cost of reaching destination C from router B $=$ min $2+$, $3+0$, $7+11$ $= 3$ via C.
  - Cost of reaching destination D from router B $=$ min $2+1$, $3+11$, $7+0$ $= 3$ via A.
- Thus, the new routing table at router B is-

From A	From C	From D
0	∞	1
2	3	7
∞	0	11
1	11	0
Cost (B→A) = 2	Cost (B→C) = 3	Cost (B→D) = 7

Destination	Distance	Next hop
A		
B	0	B
C		
D		

New Routing Table at Router B

Destination	Distance	Next Hop
A	2	A
B	0	B
C	3	C
D	3	A

- **At Router C**
  - Router C receives distance vectors from its neighbors B and D.
  - Router C prepares a new routing table as-
    - Cost of reaching destination A from router C $=$ min $3+2$, $11+1$ $= 5$ via B.
    - Cost of reaching destination B from router C $=$ min $3+0$, $11+7$ $= 3$ via B.
    - Cost of reaching destination D from router C $=$ min $3+7$, $11+0$ $=$ 10 via B.
  - Thus, the new routing table at router C is-

From B

2
0
3
7

Cost (C→B) = 3

From D

1
7
11
0

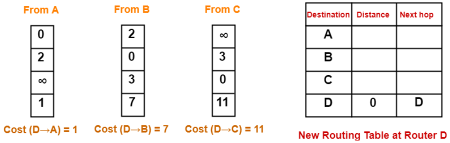
Cost (C→D) = 11

Destination	Distance	Next hop
A		
B		
C	0	C
D		

New Routing Table at Router C

Destination	Distance	Next Hop
A	5	B
B	3	B
C	0	C
D	10	B

- **At Router D**
  - Router D receives distance vectors from its neighbors A, B and C.
  - Router D prepares a new routing table as-
    - Cost of reaching destination A from router D $=$ min $1+0$, $7+2$, $11+$ $=1$ via A.
    - Cost of reaching destination B from router D $=$ min $1+2$, $7+0$, $11+3$ $=3$ via A.
    - Cost of reaching destination C from router D $=$ min $1+\infty$, $7+3$, $11+0$ $=10$ via B.
  - Thus, the new routing table at router D is-



Destination	Distance	Next Hop
A	1	A
B	3	A
C	10	B
D	0	D

- **Step-03:**
  - Each router exchanges its distance vector obtained in Step-02 with its neighboring routers.
  - After exchanging the distance vectors, each router prepares a new routing table.
- **At Router A-**
  - Router A receives distance vectors from its neighbors B and D.
  - Router A prepares a new routing table as-
    - Cost of reaching destination B from router A $= \min \; 2+0 \, , 1+3 \; = 2$ via B.
    - Cost of reaching destination C from router A $= \min \; 2+3 \, , 1+10 \; = 5$ via B.
    - Cost of reaching destination D from router A $= \min \; 2+3 \, , 1+0 \; = 1$ via D.

From B

2
0
3
3

Cost(A→B) = 2

From D

1
3
10
0

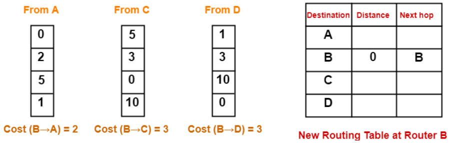
Cost(A→D) = 1

Destination	Distance	Next hop
A	0	A
B		
C		
D		

New Routing Table at Router A

Destination	Distance	Next Hop
A	0	A
B	2	B
C	5	B
D	1	D

- **At Router B**
  - Router B receives distance vectors from its neighbors A, C and D.
  - Router B prepares a new routing table as-
    - Cost of reaching destination A from router B $= \min\ 2+0\ ,\ 3+5\ ,\ 3+1 = 2$ via A.
    - Cost of reaching destination C from router B $= \min\ 2+5\ ,\ 3+0\ ,\ 3+10\ = 3$ via C.
    - Cost of reaching destination D from router B $= \min\ 2+1\ ,\ 3+10\ ,\ 3+0\ = 3$ via A.
  - Thus, the new routing table at router B is-



Destination	Distance	Next Hop
A	2	A
B	0	B
C	3	C
D	3	A

- **At Router C**
  - Router C receives distance vectors from its neighbors B and D.
  - Router C prepares a new routing table as-
    - Cost of reaching destination A from router C $= \min \ 3+2 \ , \ 10+1 \ = 5$ via B.
    - Cost of reaching destination B from router C $= \min \ 3+0 \ , \ 10+3 \ = 3$ via B.
    - Cost of reaching destination D from router C $= \min \ 3+3 \ , \ 10+0 \ = 6$ via B.
  - Thus, the new routing table at router C is-

From B

2
0
3
3

Cost (C→B) = 3

From D

1
3
10
0

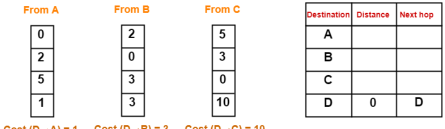
Cost (C→D) = 10

Destination	Distance	Next hop
A		
B		
C	0	C
D		

New Routing Table at Router C

Destination	Distance	Next Hop
A	5	B
B	3	B
C	0	C
D	6	B

- **At Router D**
  - Router D receives distance vectors from its neighbors A, B and C.
  - Router D prepares a new routing table as-
    - Cost of reaching destination A from router D $= \min \; 1+0 , 3+2 , 10+5 \; = 1$ via A.
    - Cost of reaching destination B from router D $= \min \; 1+2 , 3+0 , 10+3 \; = 3$ via A.
    - Cost of reaching destination C from router D $= \min \; 1+5 , 3+3 , 10+0 \; = 6$ via A
  - Thus, the new routing table at router D is-



New Routing Table at Router D

Destination	Distance	Next Hop
A	1	A
B	3	A
C	6	A
D	0	D

- These will be the final routing tables at each router.

Identifying Unused Links

- After routing tables converge (becomes stable),
  - Some of the links connecting the routers may never be used.
  - In the above example, we can identify the unused links as-
    - The value of next hop in the final routing table of router A suggests that only edges AB and AD are used.
    - The value of next hop in the final routing table of router B suggests that only edges BA and BC are used.
    - The value of next hop in the final routing table of router C suggests that only edge CB is used.
    - The value of next hop in the final routing table of router D suggests that only edge DA is used.
  - Thus, edges BD and CD are never used

Point to Note

- Note-01: In distance vector routing
  - Only distance vectors are exchanged.
  - Next hopvalues are not exchanged.
  - This is because it results in exchanging the large amount of data which consumes more bandwidth.
- Note-02:While preparing a new routing table-
  - A router takes into consideration only the distance vectors it has obtained from its neighboring routers.
  - It does not take into consideration its old routing table.
- Note-03:The algorithm is called so because-
  - It involves exchanging of distance vectors between the routers.
  - Distance vector is nothing but an array of distances.
- Note-04:
  - The algorithm keeps on repeating periodically and never stops. This is to update the shortest path in case any link goes down or topology changes.

Point to Note Cont...

- Note-05:
  - Routing tables are prepared total (n-1) times if there are n routers in the given network.
  - This is because shortest path between any 2 nodes contains at most n-1 edges if there are n nodes in the graph.
- Note-06:
  - Distance Vector Routing suffers from count to infinity problem.
  - Distance Vector Routing uses UDP at transport layer.

Thank You