Unit 3 (Part-3)

Network Layer: Routing Protocols

Forwarding

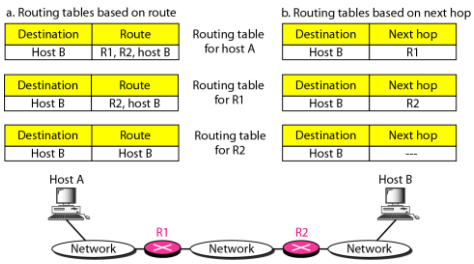
Forwarding means to place the packet in its route to its destination. Forwarding requires a host or a router to have a routing table. When a host has a packet to send or when a router has received a packet to be forwarded, it looks at this table to find the route to the final destination.

Topics discussed in this section:

Forwarding Techniques
Forwarding Process
Routing Table

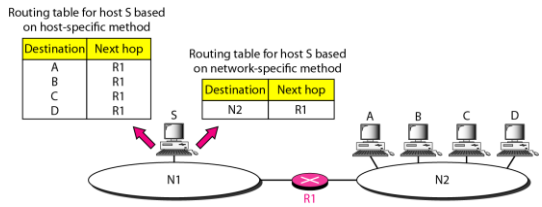
Forwarding

Figure 1 ***Route method versus next-hop method***



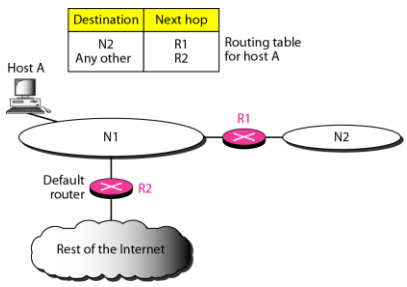
Forwarding

Figure 2 ***Host-specific versus network-specific method***



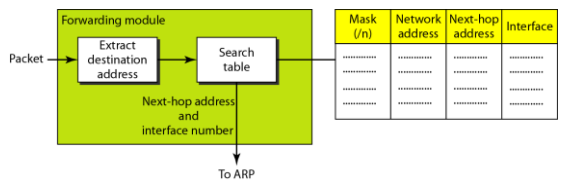
Forwarding

Figure 3 ***Default method***



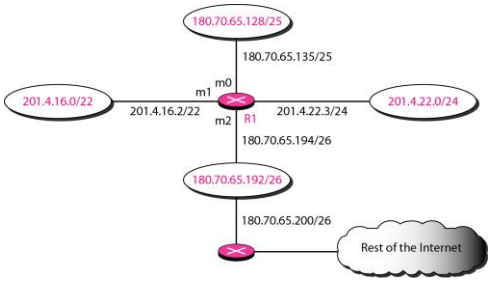
Forwarding Process

Figure 4 ***Simplified forwarding module in classless address***



Forwarding

Figure 5 *Configuration for Example 1*



Forwarding

Example 1: Make a routing table for router R1, using the configuration in Figure 5.

Solution

Table 1 *Routing table for router R1 in Figure 5*

Mask	*Network Address*	*Next Hop*	*Interface*
/26	180.70.65.192	—	m2
/25	180.70.65.128	—	m0
/24	201.4.22.0	—	m3
/22	201.4.16.0	....	m1
Any	Any	180.70.65.200	m2

Forwarding

Example 2: Show the forwarding process if a packet arrives at R1 in figure 5 with the destination address 180.70.65.140.

Solution

The router performs the following steps:

1. **The first mask (/26) is applied to the destination address. The result is 180.70.65.128.**
2. **The second mask (/25) will result 180.70.65.128 after applying on destination address. It matches with corresponding n/w address. The next-hop address and interface number m0 are passed to ARP for further processing.**

Forwarding

Example 3: Show the forwarding process if a packet arrives at R1 in figure 5 with the destination address 201.4.22.35.

Solution

The router performs the following steps:

1. **The first mask (/26) is applied to the destination address. The result is 201.4.22.0.**
2. **The second mask (/25) will result 201.4.22.0 after applying on destination address.**
3. **The third mask (/24) is applied to the destination address. The result is 201.4.22.0, which matches with corresponding n/w address. The next-hop address and interface number m3 are passed to ARP for further processing.**

Forwarding

Example 3: Show the forwarding process if a packet arrives at R1 in figure 5 with the destination address 18.24.32.78.

Solution

This time all masks are applied to the destination address., but no matching network address is found. When it reaches the end of the table, the module gives the next hop address 180.70.65.200. and interface m2 to ARP. This is probably an outgoing package that needs to be sent, via the default router, to someplace else in the internet.

Routing Table

A host and router has a routing table with an entry for each destination, or combination of destinations, to route IP packets. The routing table can be either static or dynamic.

Figure 6. *Common fields in routing table.*

Mask	Network address	Next-hop address	Interface	Flags	Reference count	Use
.....	.....	.....	.....	.....	.....	.....

Flags-> U, G, H, D, M

ROUTING PROTOCOLS

A routing protocol is a combination of rules and procedures that lets routers in the Internet inform each other of changes.

Topics discussed in this section:

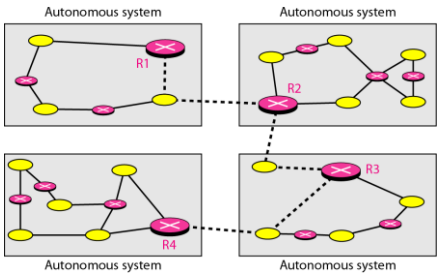
Optimization
Intra- and Inter-domain Routing
Distance Vector Routing and RIP
Link State Routing and OSPF
Path Vector Routing and BGP

ROUTING PROTOCOLS

- Optimization
  - Decision taken by router is based on the optimization.
  - Which of the available path is optimum pathway.
  - The cost assigned to calculate optimum pathway is referred as ***metric***.
- For example:
  - RIP treats a network as 1-hop (metric)
  - OSPF works based on type of service.

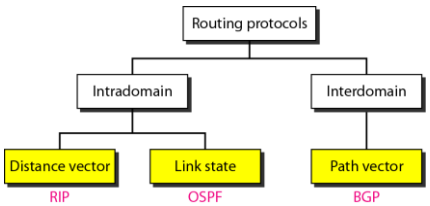
ROUTING PROTOCOLS

Figure 6 ***Autonomous systems***



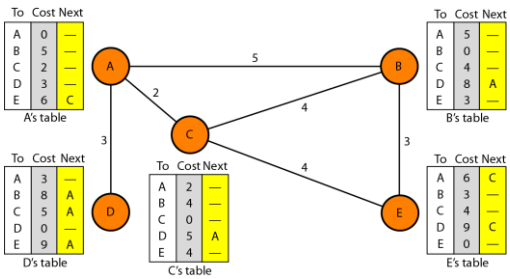
ROUTING PROTOCOLS

Figure 7 ***Popular routing protocols***



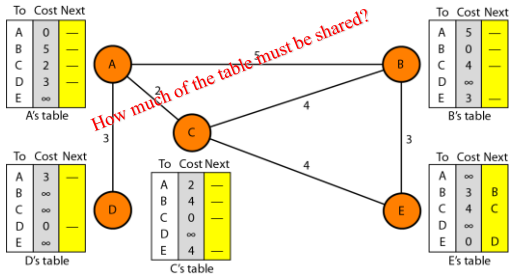
Distance Vector Routing (DVR)

Figure 8 ***Distance vector routing tables***



Distance Vector Routing (DVR)

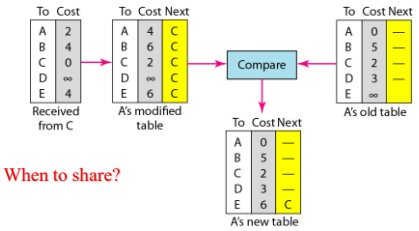
Figure 9 ***Initialization of tables in distance vector routing***



Distance Vector Routing (DVR)

In distance vector routing, each node shares its routing table with its immediate neighbors periodically and when there is a change.

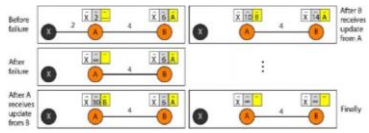
Figure 10 *Updating in distance vector routing*



When to share?

Distance Vector Routing (DVR)

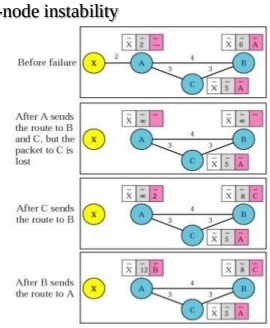
- Two-node instability



- Defining infinity
- Split horizon

Distance Vector Routing (DVR)

- Three-node instability

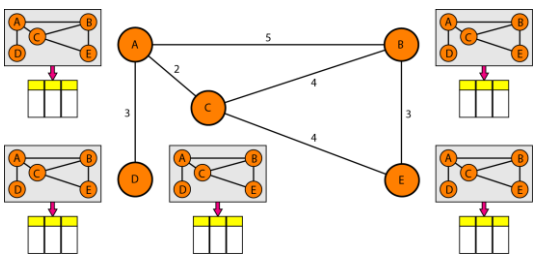


Link State Routing (LSR)

- Each node has the entire topology of the network to guide the packets. It includes:
  - List of nodes
  - How they are connected (Unidirectional or bidirectional)
  - Cost
  - Condition of links (up or down)
- It uses ***Dijkstra algorithm.***

Link State Routing (LSR)

Figure 11 *Concept of link state routing*

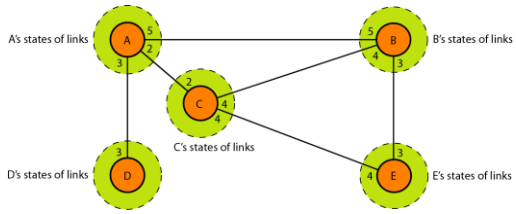


Link State Routing (LSR)

How can a common topology be dynamic and stored in each node?

Link State Routing (LSR)

Figure 12 ***Link state knowledge***

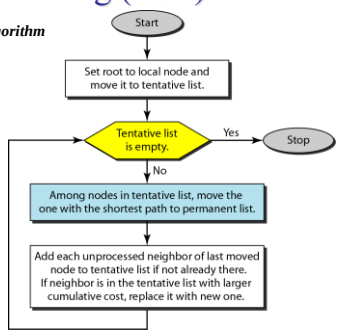


Link State Routing (LSR)

- Building Routing Table
  - Link state packet (LSP)
  - Dissemination of LSP(i.e. Flooding)
  - Formation of shortest path tree (SPT) for each node
  - Calculation of routing table based on SPT.

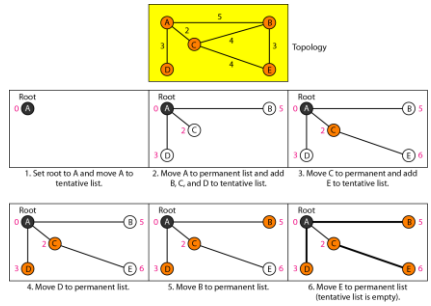
Link State Routing (LSR)

Figure 13 ***Dijkstra algorithm***



Link State Routing (LSR)

Figure 14 ***Example of formation of shortest path tree***

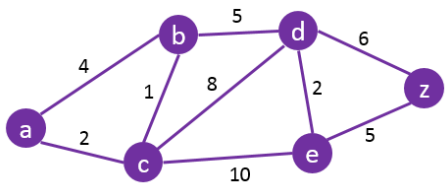


Link State Routing (LSR)

Table 2 ***Routing table for node A***

Node	*Cost*	*Next Router*
A	0	—
B	5	—
C	2	—
D	3	—
E	6	C

Example: ***Create a shortest path tree for the following network for node a. Also show the steps for the same.***

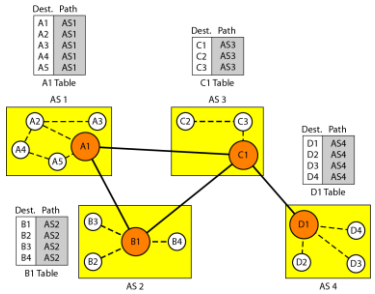


Path Vector Routing (PVR)

- Path vector routing is inter-domain routing
- Speaker Node
- Reachability of nodes inside Autonomous Systems (AS).

Path Vector Routing (PVR)

Figure 15 *Initial routing tables in path vector routing*



Path Vector Routing (PVR)

Figure 16 *Stabilized tables for three autonomous systems*

Dest.	Path
A1	AS1
A5	AS1
B1	AS1-AS2
B4	AS1-AS2
C1	AS1-AS3
C3	AS1-AS3
D1	AS1-AS2-AS4
D4	AS1-AS2-AS4

A1 Table

Dest.	Path
A1	AS2-AS1
A5	AS2-AS1
B1	AS2
B4	AS2
C1	AS2-AS3
C3	AS2-AS3
D1	AS2-AS3-AS4
D4	AS2-AS3-AS4

B1 Table

Dest.	Path
A1	AS3-AS1
A5	AS3-AS1
B1	AS3-AS2
B4	AS3-AS2
C1	AS3
C3	AS3
D1	AS3-AS4
D4	AS3-AS4

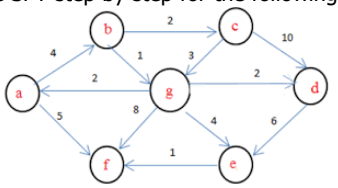
C1 Table

Dest.	Path
A1	AS4-AS3-AS1
A5	AS4-AS3-AS1
B1	AS4-AS3-AS2
B4	AS4-AS3-AS2
C1	AS4-AS3
C3	AS4-AS3
D1	AS4
D4	AS4

D1 Table

Assignment-2

- Write short notes on the followings:
  - RIP
  - OSPF
  - BGP
- Create SPT step by step for the following figure



Thank You