CSS2C08

COMPUTER NETWORKS

MODULE 3

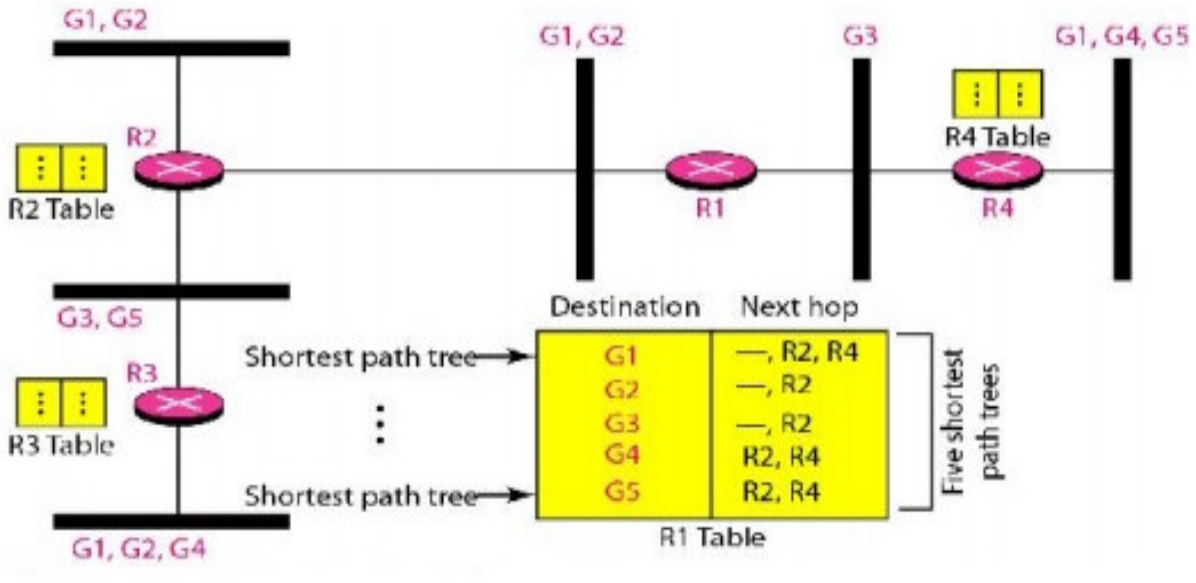
1. Network layer services
2. Routing
3. IP
4. Routing in internet
5. Router
6. IPV6
7. Multicast routing
8. Mobility

Multicast routing

- Transmitting data from one source host to a particular group of hosts having interest in receiving the data is called as multicast.
- Multicast routing is a networking method for efficient distribution of one-to-many traffic.
- A multicast packet may have destinations in more than one network. Forwarding of a single packet to members of a group requires a shortest path tree. If we have n groups, we may need *n* shortest path trees.
- We can imagine the complexity of multicast routing. Two approaches have been used to solve the problem:
  1. source-based trees and
  2. group-shared trees.

1. Source-Based Tree:

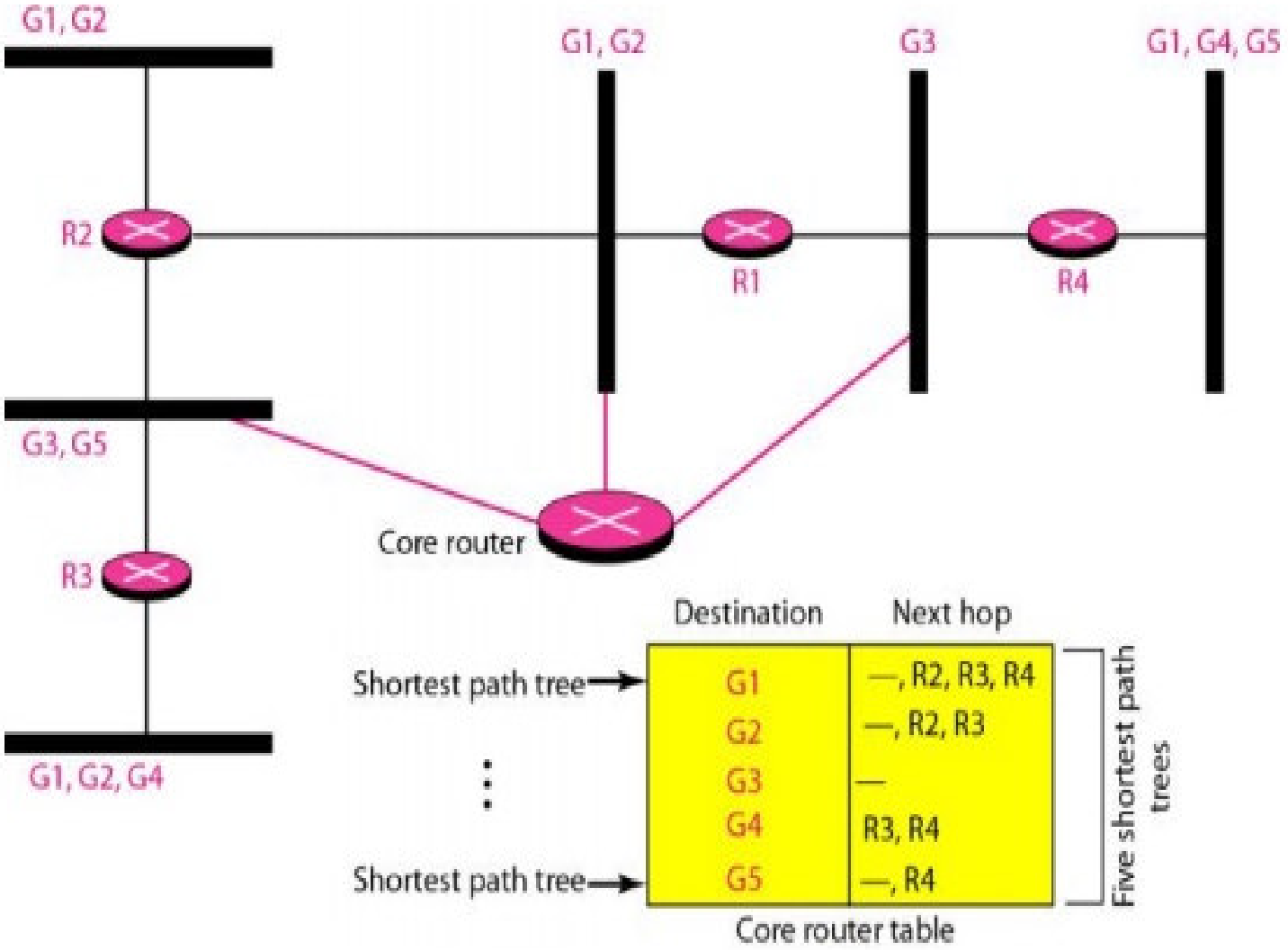
In the source-based tree approach, each router needs to have one shortest path tree for each group. The shortest path tree for a group defines the next hop for each network that has loyal member(s) for that group.



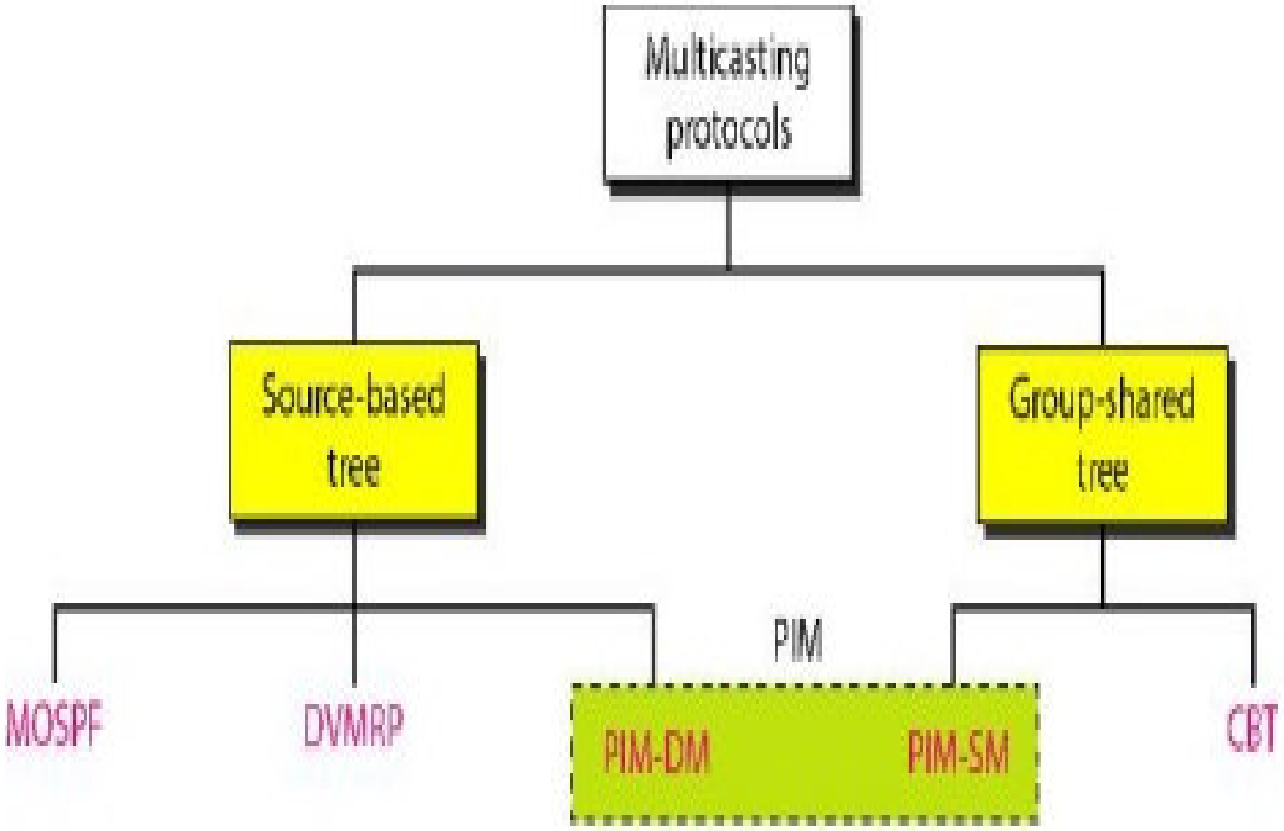
- we assume that we have only five groups in the domain: GI, G2, G3, G4, and G5.At the moment GI has loyal members in four networks, G2 in three, G3 in two, G4 in two, and G5 in two. We have shown the names of the groups with loyal members on each network.
- There is one shortest path tree for each group; therefore there are five shortest path trees for five groups. In this approach, if the number of groups is m, each router needs to have m shortest path trees, one for each group.

2. Group-Shared Tree:

In the group-shared tree approach, instead of each router having m shortest path trees, only one designated router, called the center core, or rendezvous router, takes the responsibility of distributing multicast traffic. The core has m shortest path trees in its routing table. The rest of the routers in the domain have none. If a router receives a multicast packet, it encapsulates the packet in a unicast packet and sends it to the core router. The core router removes the multicast packet from its capsule, and consults its routing table to route the packet.


G1, G2
G1, G2
G3
G1, G4, G5
R2
R1
R4
G3, G5
Core router
R3
G1, G2, G4
Destination
Next hop
Shortest path tree
G1
—, R2, R3, R4
G2
—, R2, R3
G3
—
G4
R3, R4
Shortest path tree
G5
—, R4
Five shortest path trees
Core router table

Multicast Routing Protocols



1. Multicast Link State Routing: MOSPF

- Multicast link state routing uses the source-based tree approach. links. For multicast routing, a node needs to revise the interpretation of *state.* A node advertises every group which has any loyal member on the link. Here the meaning of state is "what groups are active on this link." The information about the group comes from IGMP. Each router running IGMP solicits the hosts on the link to find out the membership status.

- **Multicast Open Shortest Path First (MOSPF) protocol** is an extension of the OSPF protocol that uses multicast link state routing to create source-based trees. The protocol requires a new link state update packet to associate the unicast address of a host with the group address or addresses the host is sponsoring. This packet is called the group-membership LSA.

2. Multicast Distance Vector Routing:DVMRP

- Unicast distance vector routing is very simple; extending it to support multicast routing is complicated. Multicast routing does not allow a router to send its routing table to its neighbors. The idea is to create a table from scratch by using the information from the unicast distance vector tables.
- Multicast distance vector routing uses source-based trees, but the router never actually makes a routing table. When a router receives a multicast packet, it forwards the packet as though it is consulting a routing table.

- The multicast distance vector algorithm uses a process based on four decision-making strategies. Each strategy is built on its predecessor.

  a) **Flooding:** Flooding broadcasts packets, but creates loops in the systems.

  b) Reverse Path Forwarding (RPF)

  c) Reverse Path Broadcasting (RPB)

  d) Reverse Path Multicasting (RPM)

b) Reverse Path Forwarding (RPF)

- In this strategy, the router only forwards those packets that have traveled the shortest path from source to destination.
- To achieve this, the router pretends that it has a packet to send to the source from where the packet has arrived.
- In this way, the shortest path to the sender of the packet is computed.
- If the same route is followed by the received packet, it is forwarded to the next router and it is discarded otherwise.

- The reverse path forwarding ensures that the network receives a copy of the packet without formation of loops. A loop occurs when a packet that has left the router may come back again from another interface or the same interface and be forwarded again.
- RPF does not guarantee that there would be no duplicate packets in the network *i.e.* the network may receive two or more copies.
- The reason for this is that the routing is based on the source address and not on the destination address.

c) Reverse Path Broadcasting (RPB)

- In this method, one parent router is defined for each network.
- The network could accept the multicast packets from this parent router only.
- This router sends packets to those ports for which it is designated as parent.
- Thus, RPB principle' allows a router to broadcast the packet in the network.
- This creates duplicate packets on the network and reduces the network efficiency.

d) Reverse Path Multicasting (RPM)

- To overcome the problem of broadcasting in RPB, Reverse Path Multicasting in used.
- In this the desired multicast network tree is created by using two different methods: Pruning and grafting.
- A router can send a prune message to its upstream router whenever it finds that its network is not interested in a multicast packet. In this way a router prunes (cuts) its network from multicasting.
- If a router receives prune message from all the downstream routers, it in turn, sends a prune message to its upstream router.
- A router can also send a graft message to its upstream router if it finds that its network is again interested in receiving the multicast packet. In this way, graft message forces the upstream router to resume sending the multicast message. The network is again grafted (joined).

- **DVMRP** The Distance Vector Multicast Routing Protocol (DVMRP) is an implementation of multicast distance vector routing. It is a source-based routing protocol, based on RIP.

3. Core-Based Tree (CBT)

- The Core-Based Tree (CBT) protocol is a group-shared protocol that uses a core as the root of the tree. The autonomous system is divided into regions, and a core (center router or rendezvous router) is chosen for each region.
- The Core-Based Tree (CBT) is a group-shared tree, center-based protocol using one tree per group. One of the routers in the tree is called the core.

- A packet is sent from the source to members of the group following this procedure:

  a) The source, which may or may not be part of the tree, encapsulates the multicast packet inside a unicast packet with the unicast destination address of the core and sends it to the core. This part of delivery is done using a unicast address; the only recipient is the core router.

  b) The core decapsulates the unicast packet and forwards it to all interested interfaces.

  c) Each router that receives the multicast packet, in turn, forwards it to all interested interfaces.

4. Protocol Independent Multicast (PIM)

- **Protocol Independent Multicast (PIM)** is the name given to two independent multicast routing protocols:
  - Protocol Independent Multicast-Dense Mode (PIM-DM) (based on source-based tree)
  - Protocol Independent Multicast-Sparse Mode (PIM-SM). (based on group-shared tree)

- **PIM-DM**

  PIM-DM is used when there is a possibility that each router is involved in multicasting (dense mode). In this environment, the use of a protocol that broadcasts the packet is justified because almost all routers are involved in the process. PIM-DM is a source-based tree routing protocol that uses RPF and pruning and grafting strategies for multicasting. Its operation is like that of DVMRP.

- **PIM-SM**

  PIM-SM is used when there is a slight possibility that each router is involved in multicasting (sparse mode). In this environment, the use of a protocol that broadcasts the packet is not justified; a protocol such as CBT that uses a group-shared tree is more appropriate. PIM-SM is used in a sparse multicast environment such as a WAN. PIM-SM is a group-shared tree routing protocol that has a rendezvous point (RP) as the source of the tree.