4.6 MULTICASTING

- In multicasting, there is one source and a group of destinations.
- Multicast supports efficient delivery to multiple destinations.
- The relationship is one to many or many-to-many.
- **One-to-Many (Source Specific Multicast)**
    1. Radio station broadcast
    2. Transmitting news, stock-price
    3. Software updates to multiple hosts
- **Many-to-Many (Any Source Multicast)**
    1. Multimedia teleconferencing
    2. Online multi-player games
    3. Distributed simulations
- In this type of communication, the source address is a unicast address, but the destination address is a group address.
- The group address defines the members of the group
- In multicasting, a multicast router may have to send out copies of the same datagram through more than one interface.
- Hosts that are members of a group receive copies of any packets sent to that group's multicast address
- A host can be in multiple groups
- A host can join and leave groups
- A host signals its desire to join or leave a multicast group by communicating with its local router using a special protocol.

MULTICAST ROUTING

- To support multicast, a router must additionally have multicast forwarding tables that indicate, based on multicast address, which links to use to forward the multicast packet.
- Unicast forwarding tables collectively specify a set of paths.
- Multicast forwarding tables collectively specify a set of trees -Multicast distribution trees.
- Multicast routing is the process by which multicast distribution trees are determined.
- To support multicasting, routers *additionally* build multicast forwarding tables.
- Multicast forwarding table is a tree structure, known as ***multicast distribution trees.***
- Internet multicast is implemented on physical networks that support broadcasting by *extending* forwarding functions.

MULTICAST ROUTING PROTOCOLS

- Internet multicast is implemented on physical networks that support broadcasting by *extending forwarding functions.*
- Major multicast routing protocols are:
  1. **Distance-Vector Multicast Routing Protocol (DVMRP)**
  2. **Protocol Independent Multicast (PIM)**

Distance Vector Multicast Routing Protocol

- The DVMRP, is a routing protocol used to share information between routers to facilitate the transportation of IP multicast packets among networks.
- It formed the basis of the Internet's historic multicast backbone.
- Distance vector routing for unicast is extended to support multicast routing.
- Each router maintains a routing table for all destination through exchange of distance vectors.
- DVMRP is also known as ***flood-and-prune protocol***.
- DVMRP consists of two major components:
- A conventional distance-vector routing protocol, like RIP
- A protocol for determining how to forward multicast packets, based on the routing table

- Multicasting is added to distance-vector routing in four stages.
  1. Flooding
  2. Reverse Path Forwarding (RPF)
  3. Reverse Path Broadcasting (RPB)
  4. Reverse Path Multicast (RPM)

Flooding

- Router on receiving a multicast packet from source *S* to a Destination from NextHop, *forwards* the packet on all out-going links.
- Packet is flooded and looped back to *S*.

The drawbacks are:

1. It floods a network, even if it has *no members* for that group.
2. Packets are forwarded by each router connected to a LAN, i.e., *duplicate flooding*

Reverse Path Forwarding (RPF)

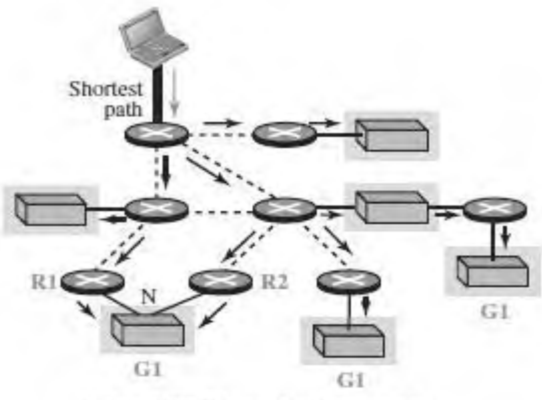
- RPF eliminates the looping problem in the flooding process.
- Only one copy is forwarded and the other copies are discarded.
- RPF forces the router to forward a multicast packet from one specific interface: the one which has come through the shortest path from the source to the router.
- Packet is flooded but not looped back to *S*.

Reverse-Path Broadcasting (RPB)

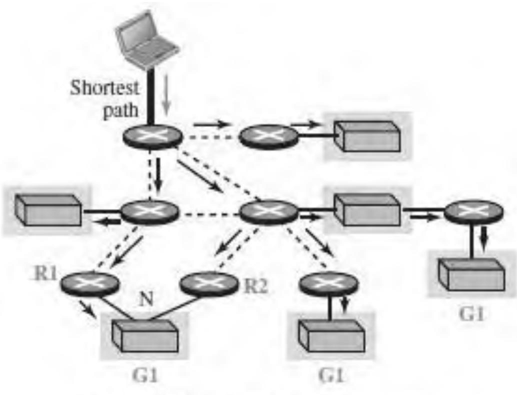
- RPB does not multicast the packet, it broadcasts it.
- RPB creates a shortest path broadcast tree from the source to each destination.
- It guarantees that each destination receives one and only one copy of the packet.
- We need to prevent each network from receiving more than one copy of the packet.
- If a network is connected to more than one router, it may receive a copy of the packet from each router.
- One router identified as parent called designated Router (DR).
- Only parent router *forwards* multicast packets from source *S to the attached network.*
- When a router that is not the parent of the attached network receives a multicast packet, it simply drops the packet

Reverse-Path Multicasting (RPM)

- To increase efficiency, the multicast packet must reach only those networks that have active members for that particular group.
- RPM adds pruning and grafting to RPB to create a multicast shortest path tree that supports dynamic membership changes



Using RPF, N receives two copies.



Using RPB, N receives only one copy.

Protocol Independent Multicast (PIM)

- PIM divides multicast routing problem into *sparse* and *dense* mode.
- PIM sparse mode (PIM-SM) is widely used.
- PIM does not rely on any type of unicast routing protocol, hence protocol independent.
- Routers explicitly join and leave multicast group using ***Join and Prune messages***.
- One of the router is designated as *rendezvous point* (RP) for each group in a domain to receive PIM messages.
- Multicast forwarding *tree* is built as a result of routers sending Join messages to RP.

  Two types of trees to be constructed:

  Shared tree **-** used by all senders

  Source-specific **tree -** used only by a specific sending host
- The normal mode of operation creates the shared tree first, followed by one or more source-specific trees

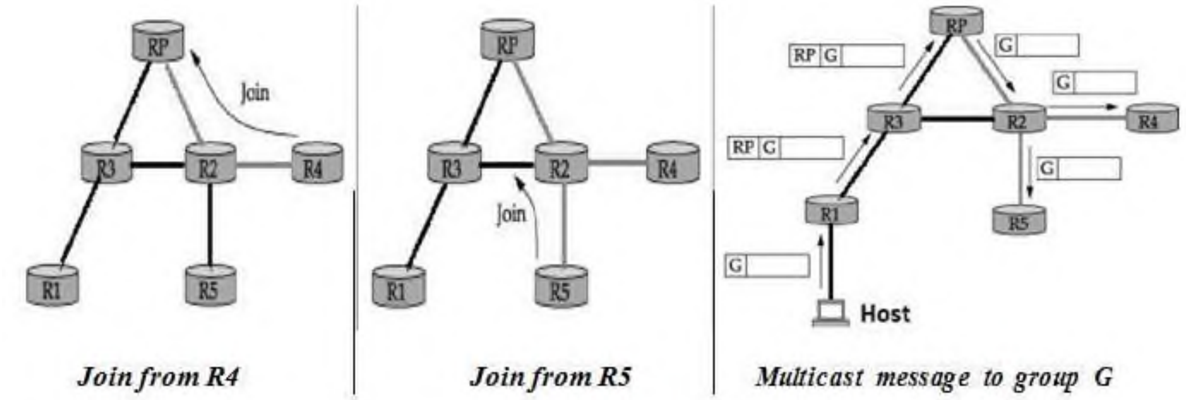
Shared Tree

- When a router sends Join message for group *G* to RP, it goes through a set of routers.
- Join message is *wildcarded* (*), i.e., it is applicable to all senders.
- Routers create an *entry* (*, *G*) in its forwarding table for the shared tree.
- *Interface* on which the Join arrived is marked to forward packets for that group.
- *Forwards* Join towards rendezvous router RP.
- Eventually, the message arrives at RP. Thus a shared tree with RP as *root* is formed.

Example

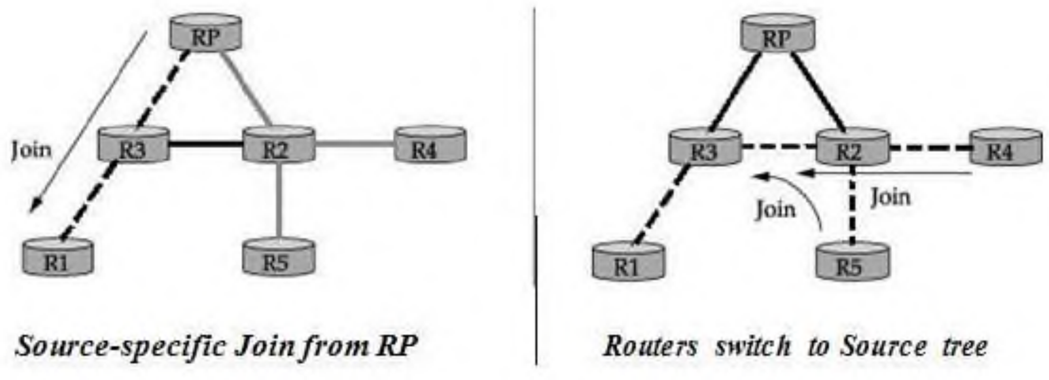
- Router *R4* sends Join message for group *G* to rendezvous router RP.
- Join message is received by router *R2*. It makes an entry (*, *G*) in its table and forwards the message to *RP*.
- When *R5* sends Join message for group *G*, *R2* does not forwards the Join. It *adds* an outgoing interface to the forwarding table created for that group.
- Suppose route R1 receives a message to group *G*. o*R1* has no state for group *G.*
- Encapsulates the multicast packet in a Register message.
- Multicast packet is tunneled along the way to RP.
- RP decapsulates the packet and sends multicast packet onto the shared tree, towards *R2*.

➢ *R2* forwards the multicast packet to routers *R4* and *R5* that have members for group *G*



Source-Specific Tree

➢ RP can force routers to know about group *G*, by sending Join message to the sending host, so that tunneling can be avoided.
➢ Intermediary routers create *sender-specific* entry (*S*, *G*) in their tables. Thus a source-specific route from *R1* to RP is formed.
➢ If there is high rate of packets sent from a sender to a group *G*, then shared-tree is *replaced* by source-specific tree with sender as root.



➢ Rendezvous router RP sends a Join message to the host router *R1*.
➢ Router *R3* learns about group *G* through the message sent by RP.
➢ Router *R4* send a source-specific Join due to high rate of packets from sender.
➢ Router *R2* learns about group *G* through the message sent by *R4*.
➢ Eventually a source-specific tree is formed with *R1* as root.