

CPE348: Introduction to Computer Networks

Lecture #14: Chapter 4.2



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Outline

- IPv6
- Multicast
- Mobile IP

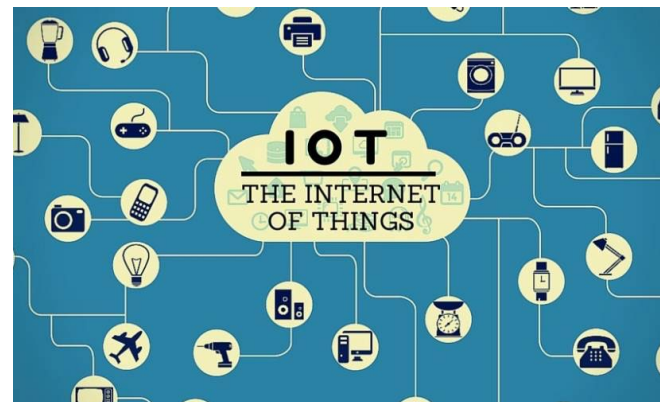
Next Generation IP (IPv6)

IPv6 Major Features

- 128-bit addresses
- Multicast
- Real-time service
- Authentication and security
- Auto-configuration – (no need for DHCP)
- Enhanced routing functionality, including support for mobile hosts

IPv6 Addresses

- Classless addressing/routing (similar to CIDR)
- Notation: x:x:x:x:x:x:x:x (x = 16-bit hex number)
 - contiguous 0s are compressed: 47CD::A456:0124
 - IPv6 compatible IPv4 address: ::FFFF:128.42.1.87
- Address assignment
 - provider-based
 - geographic



Internet Multicast

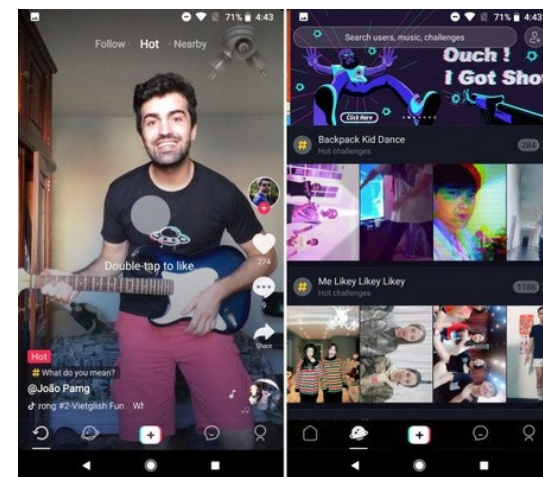
(Multicast on IP)

What is the difference between unicast,
multicast and broadcast?



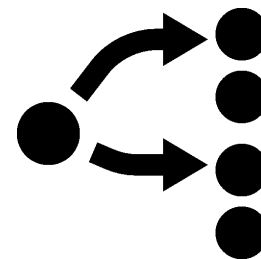
IP Multicast Overview

- One-to-many
 - Radio station broadcast
 - Transmitting news, stock-price
 - Software updates to multiple hosts
- Many-to-many
 - Multimedia teleconferencing
 - Online multi-player games
 - Distributed simulations



IP Multicast Overview

- If no support of multicast
 - A source sends a separate packet to each destination
 - More bandwidth
 - Redundant traffic, especially concentrated near the source
 - The source keeps (IP) addresses of all destinations
 - Storage overhead
 - Scalability



IP Multicast Overview – Facts

- Members of the group could be anywhere in the Internet;
- Members join and leave the group;
- A member could be in different groups;
- Senders and receivers could be distinct: a sender need not be a group member.

IP Multicast Overview – Design Objectives

- Source:
 - A host only transmits a **single copy** of data to the multicast group
- Address:
 - Use a **group address** instead of many unicast addresses
- Group Management:
 - Maintain **dynamic members** in a multicast group

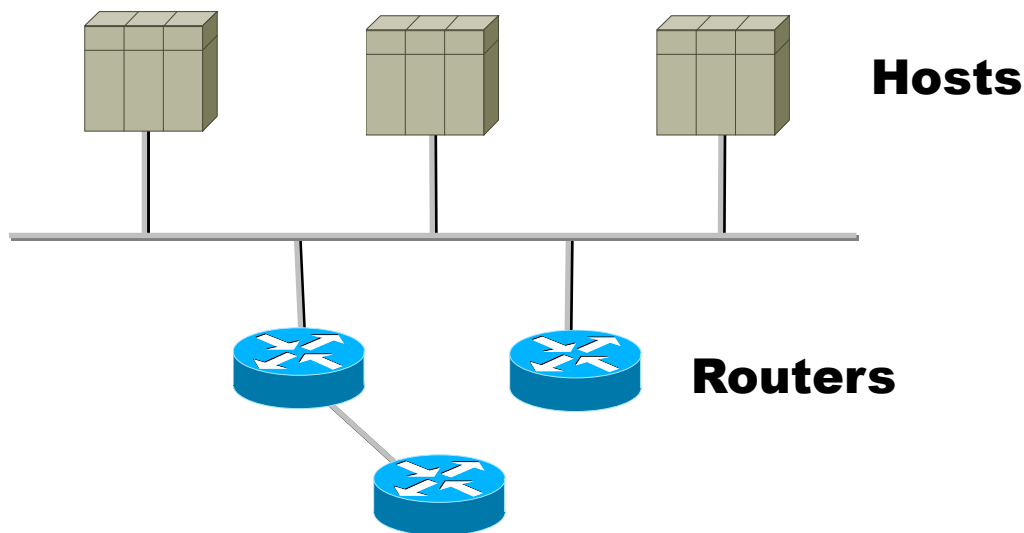
What is the design to fulfill such goals?

IP Multicast Overview

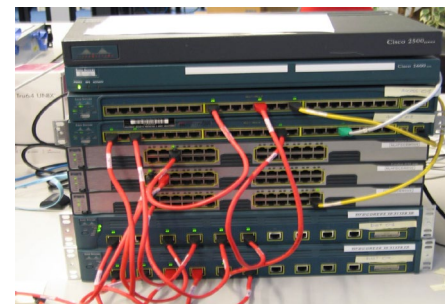
The edge router is the field of design!

Router here is **NOT** the WiFi router/access point!

Host-to-Router Protocols (IGMP)



Multicast Routing Protocols (PIM)

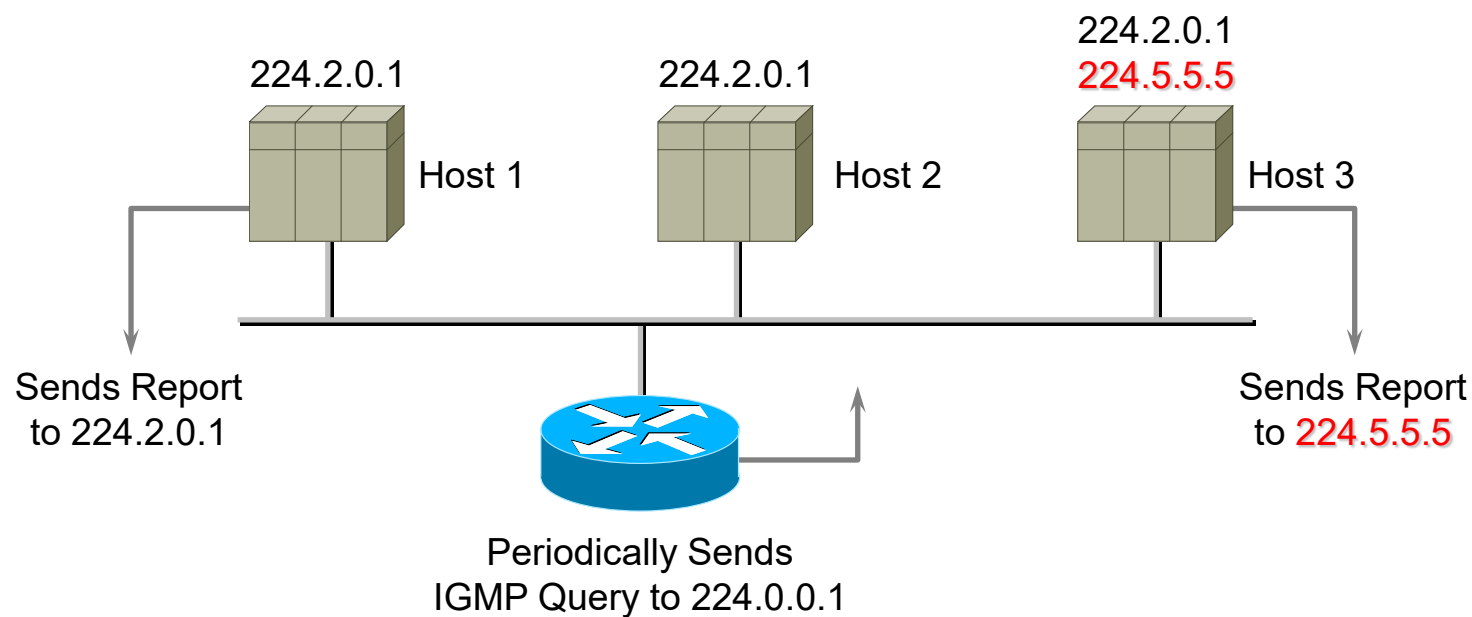


Internet Group Management Protocol (IGMP)

- IP multicast protocol used in IPv4
 - IPv6 has a similar one: Multicast Listener Discovery (MLD) protocol
- IGMP evolves from v1 to v3 for better efficiency (e.g., redundant message, latency)

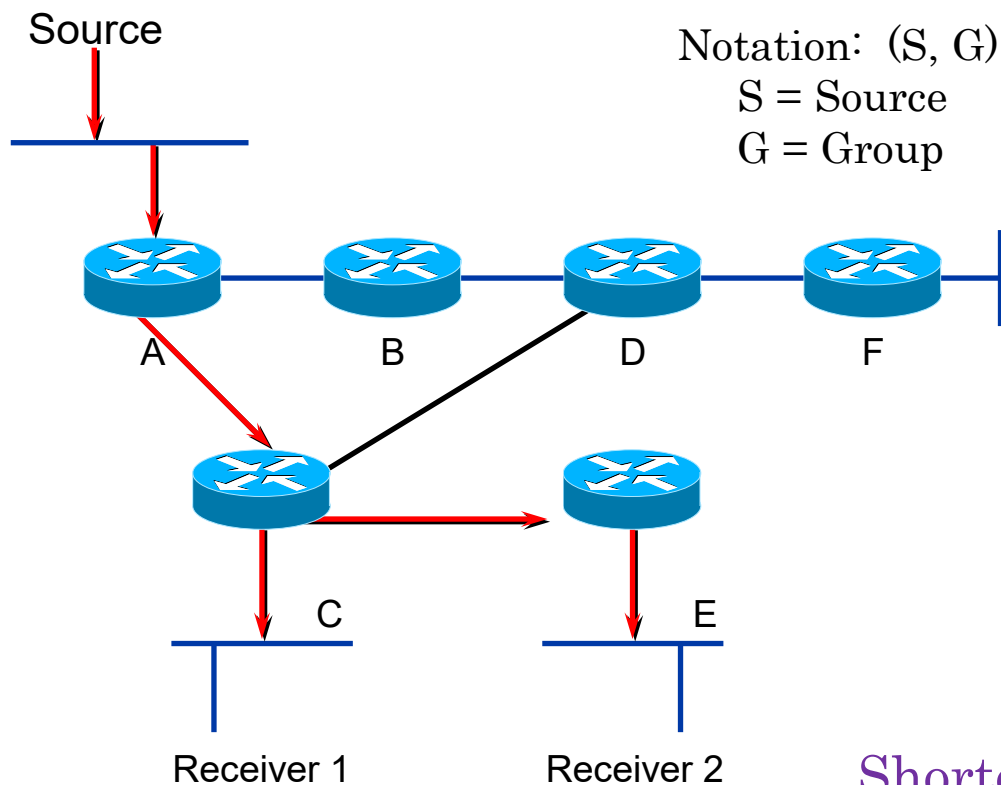
Internet Group Management Protocol (IGMP)

■ IGMP v1 Queries & Reports



Multicast Routing Protocols

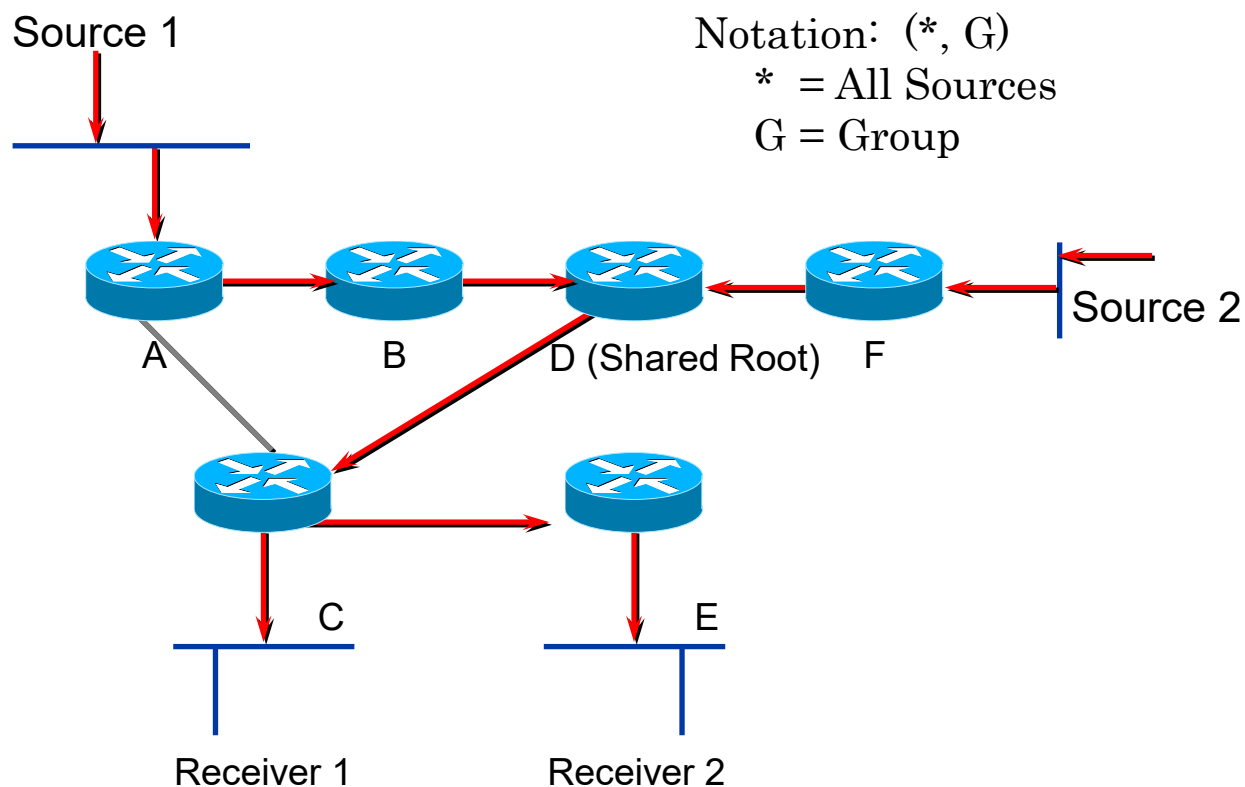
- **Goal:** forwarding multicast packets between routers



Shortest path or source
distribution tree

Multicast Routing Protocols

- Shared distribution tree (multiple sources)



Multicast Routing Protocols – analysis

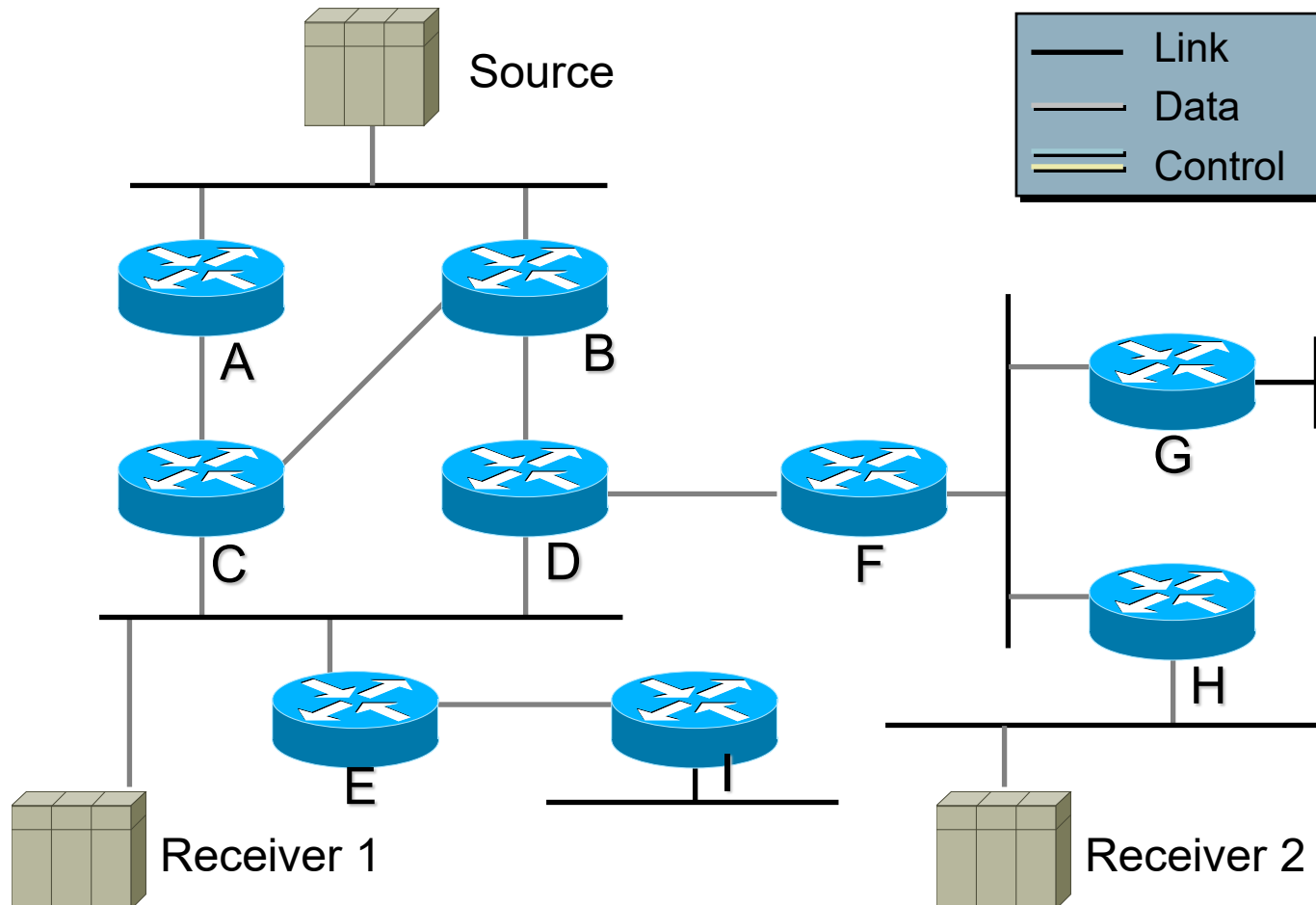
- Distribution Trees
 - Source distribution tree
 - Uses **more memory** $O(S \times G)$ but you get **optimal** paths from source to all receivers, **minimizes delay**
 - Shared distribution tree
 - Uses **less memory** $O(G)$ but you may get **suboptimal** paths from source to all receivers, may **introduce delay**
- Protocols
 - Protocol Independent Multicast (PIM)
 - Distance Vector Multicast Routing Protocol (DVMRP)

Multicast Routing Protocols – PIM

- PIM: Protocol Independent Multicast
 - Dense Mode
 - Broadcast and prune
 - Assumes dense group membership
 - Source initiated
 - Sparse Mode
 - Explicit join
 - Sparsely distributed group membership
 - Destination initiated

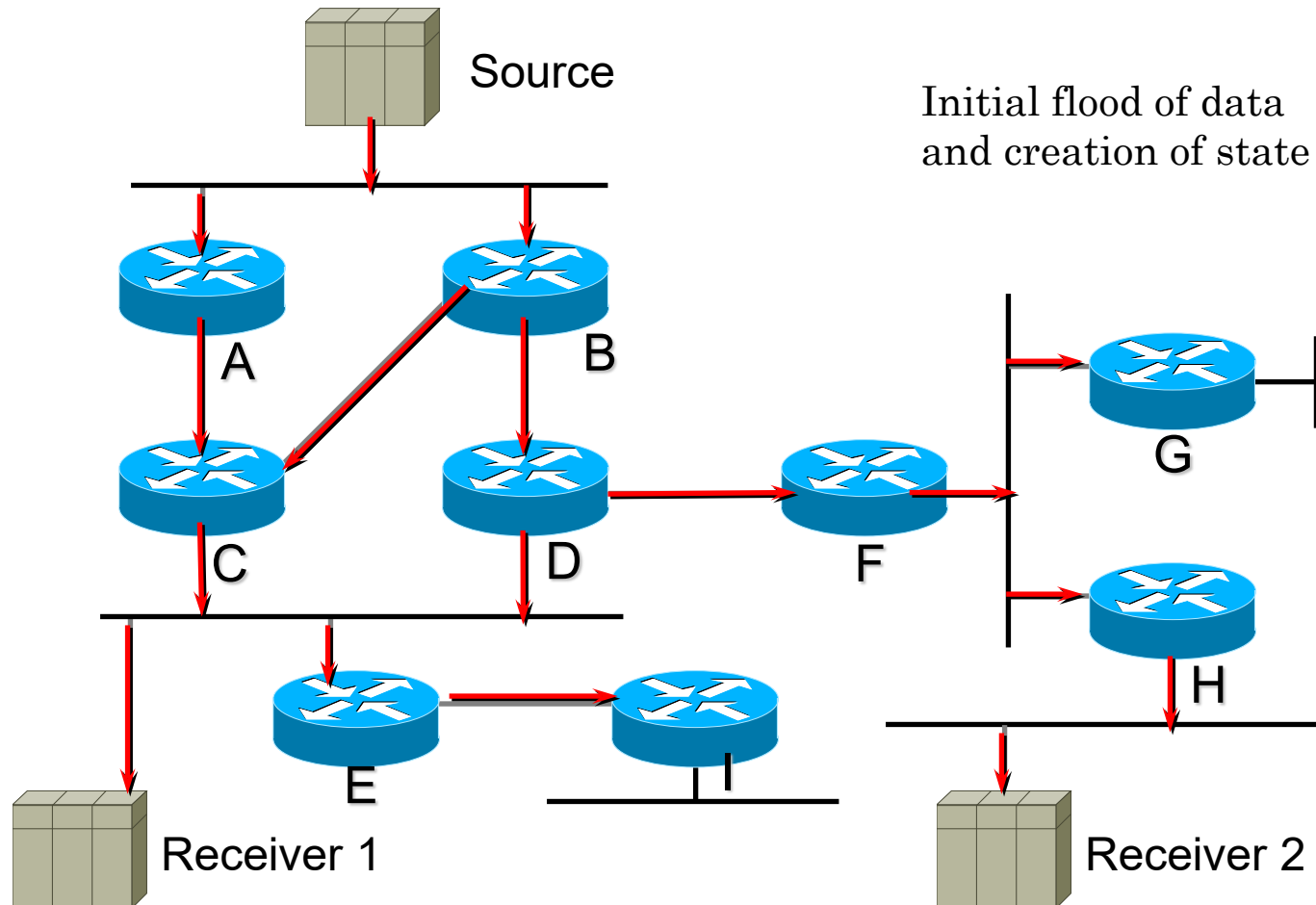
Multicast Routing Protocols – PIM

■ PIM – Dense Mode



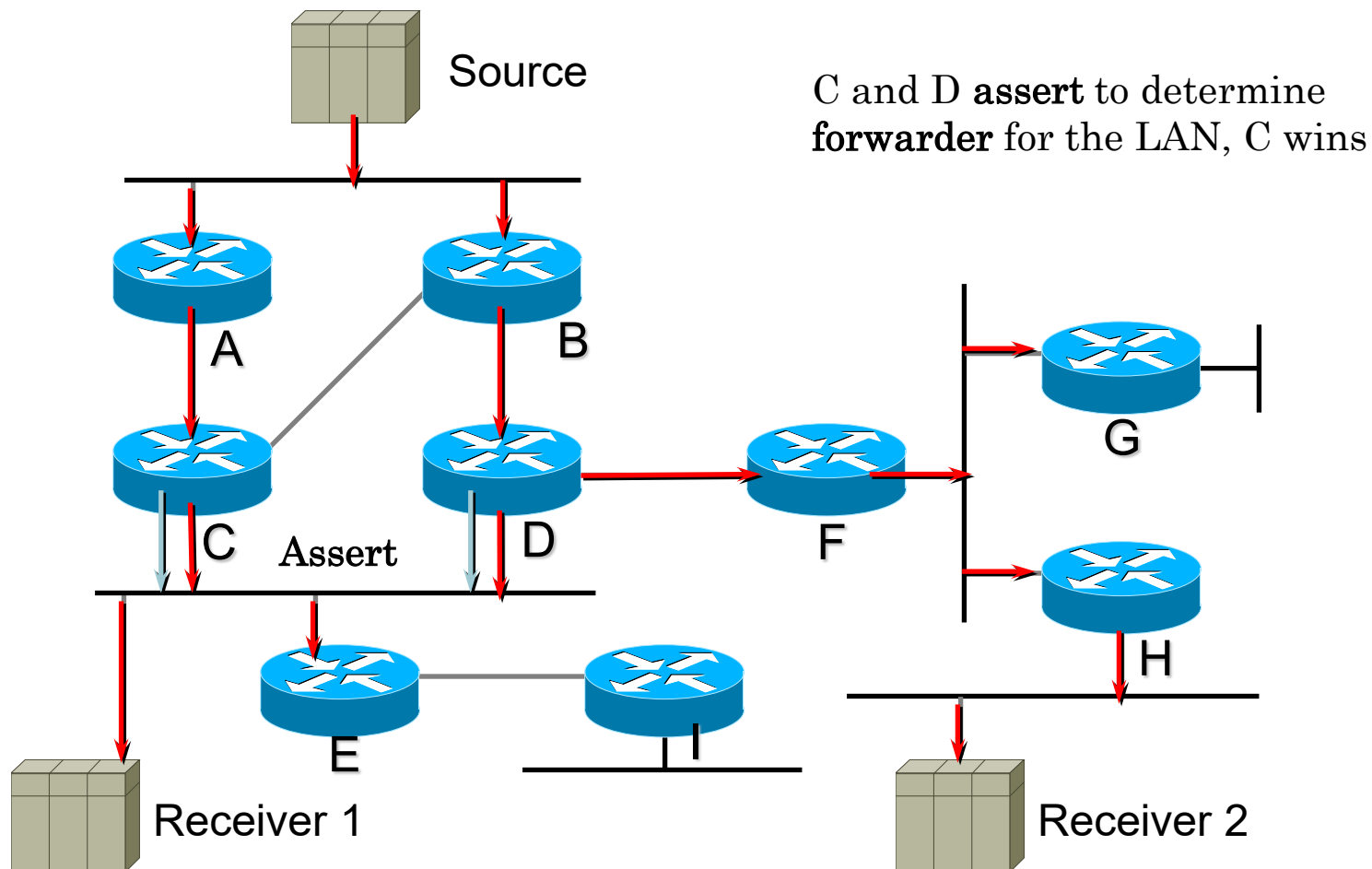
Multicast Routing Protocols – PIM

- PIM – Dense Mode



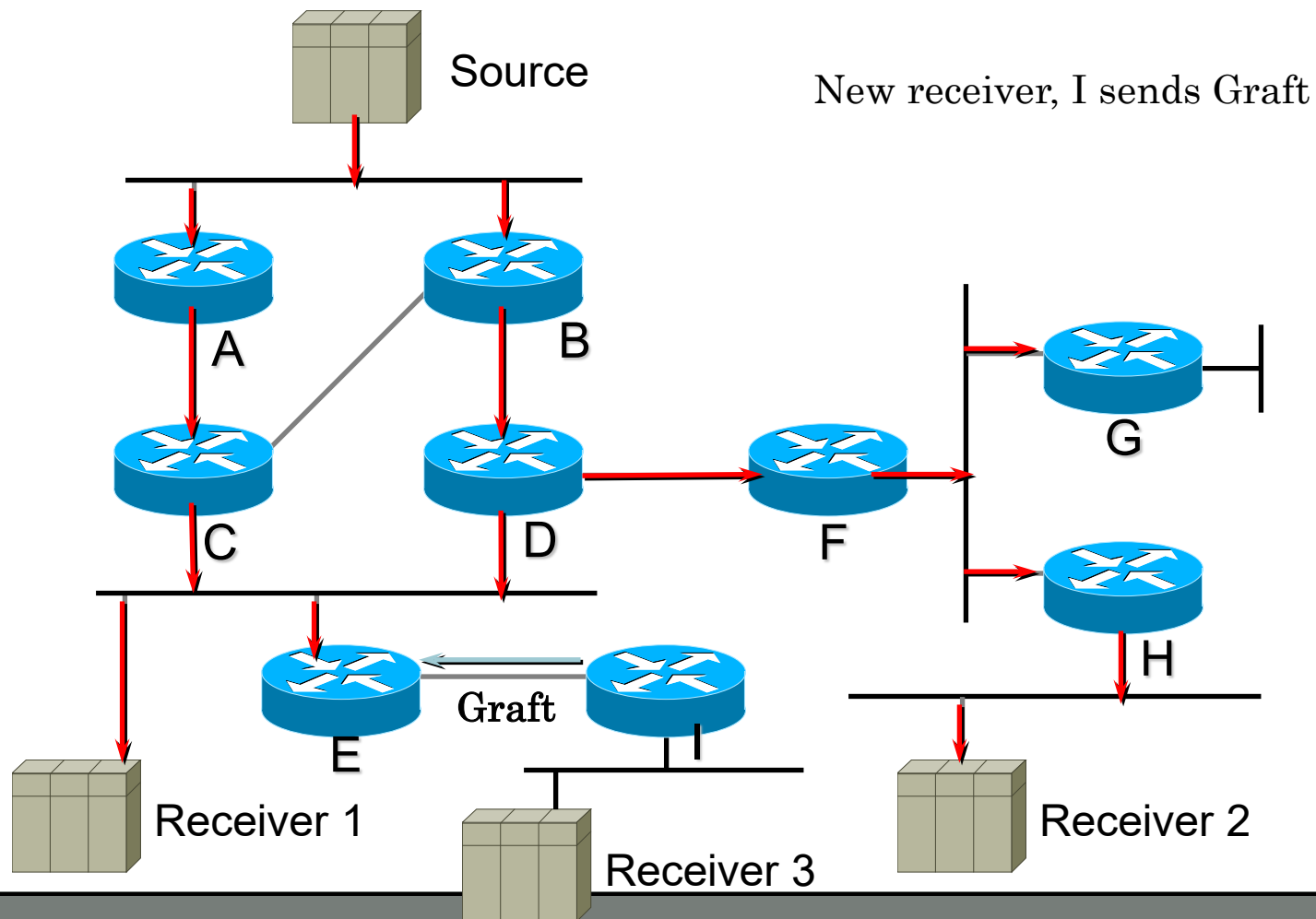
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- PIM – Dense Mode



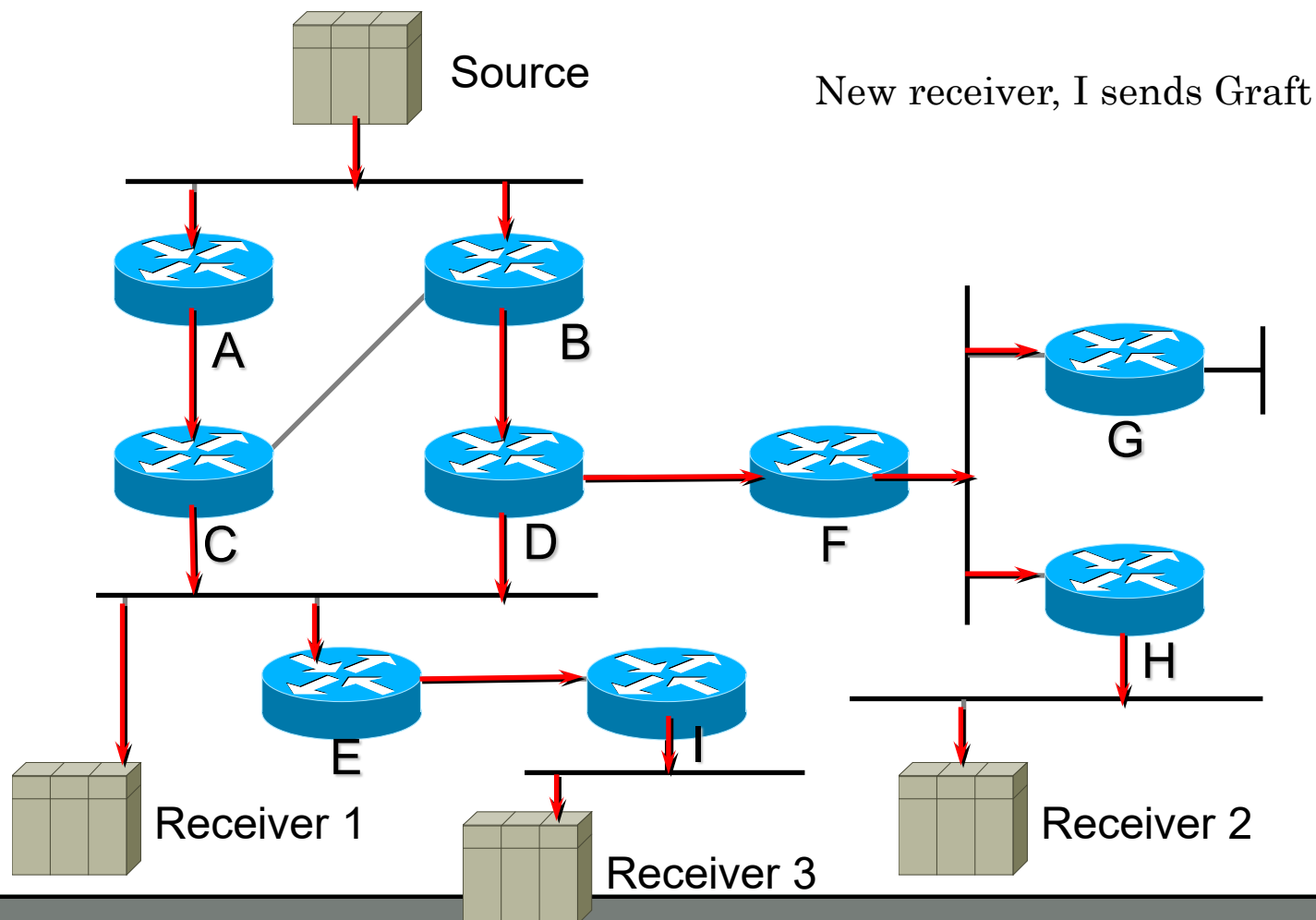
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■ PIM – Dense Mode



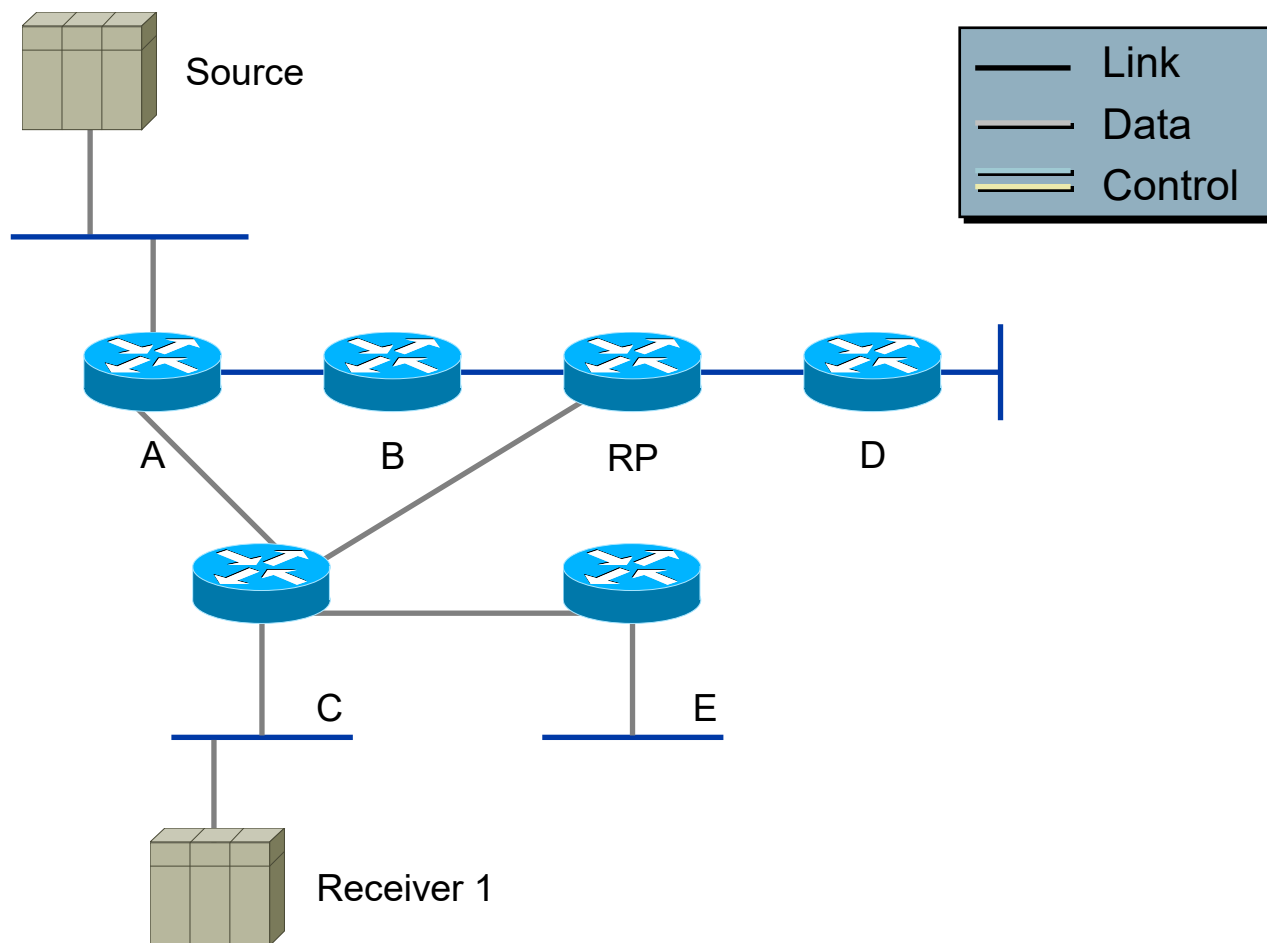
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- PIM – Dense Mode



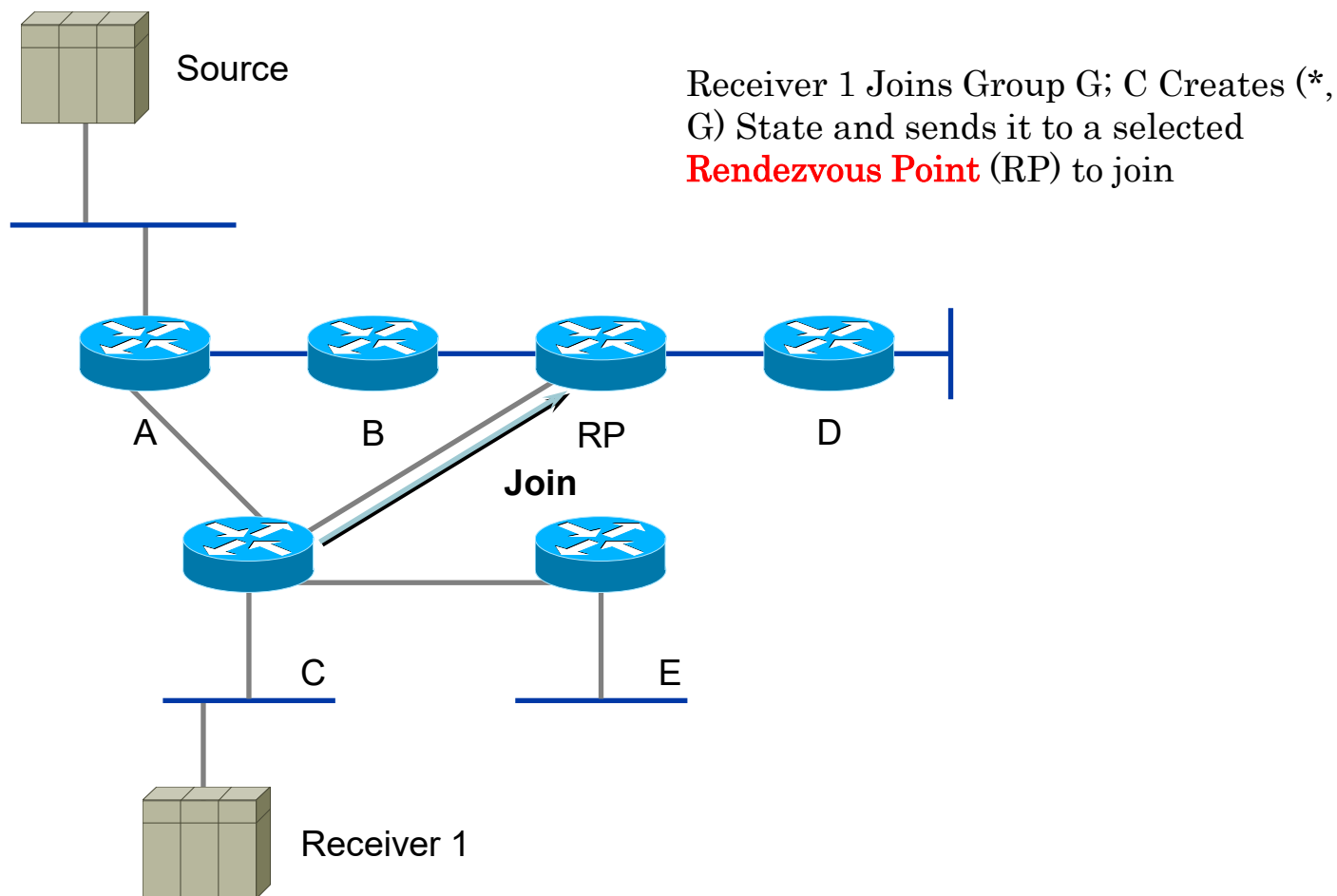
Multicast Routing Protocols – PIM

■ PIM – Sparse Mode



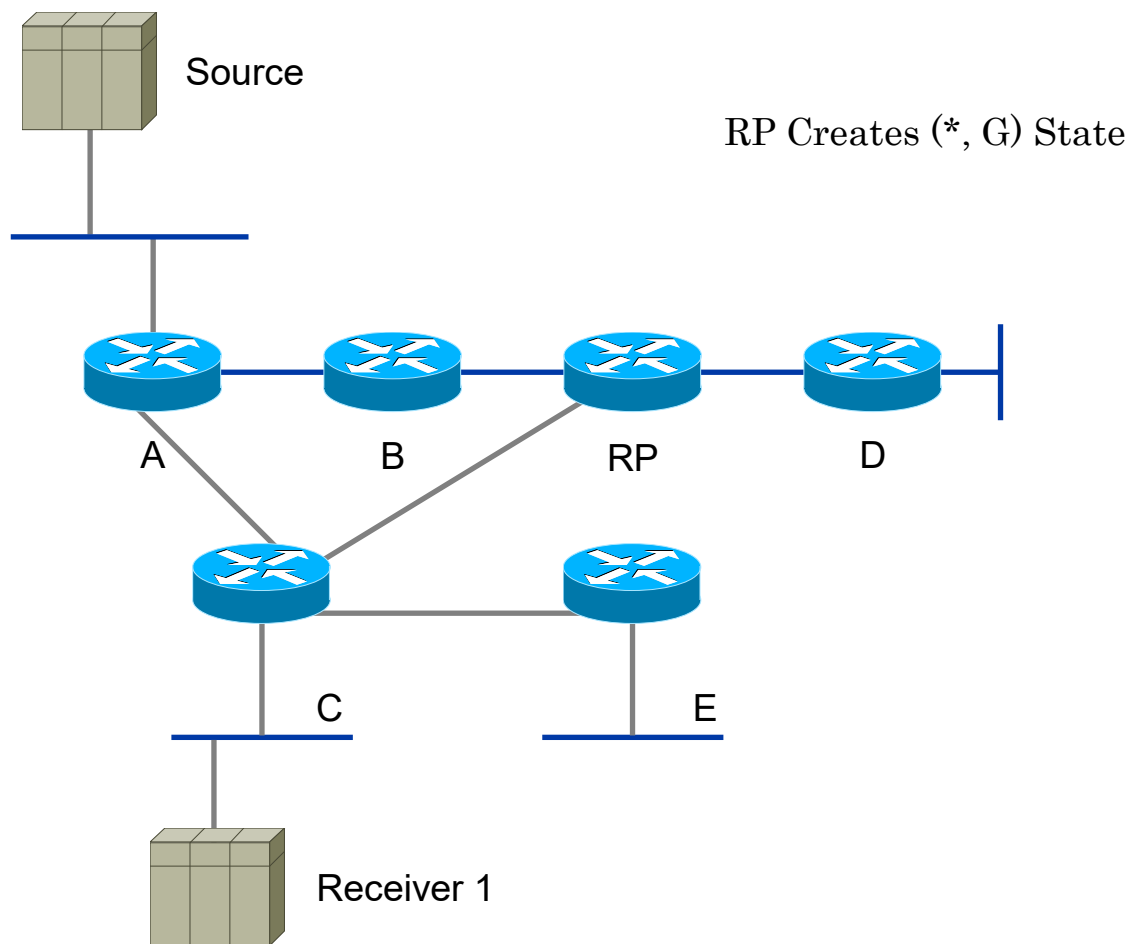
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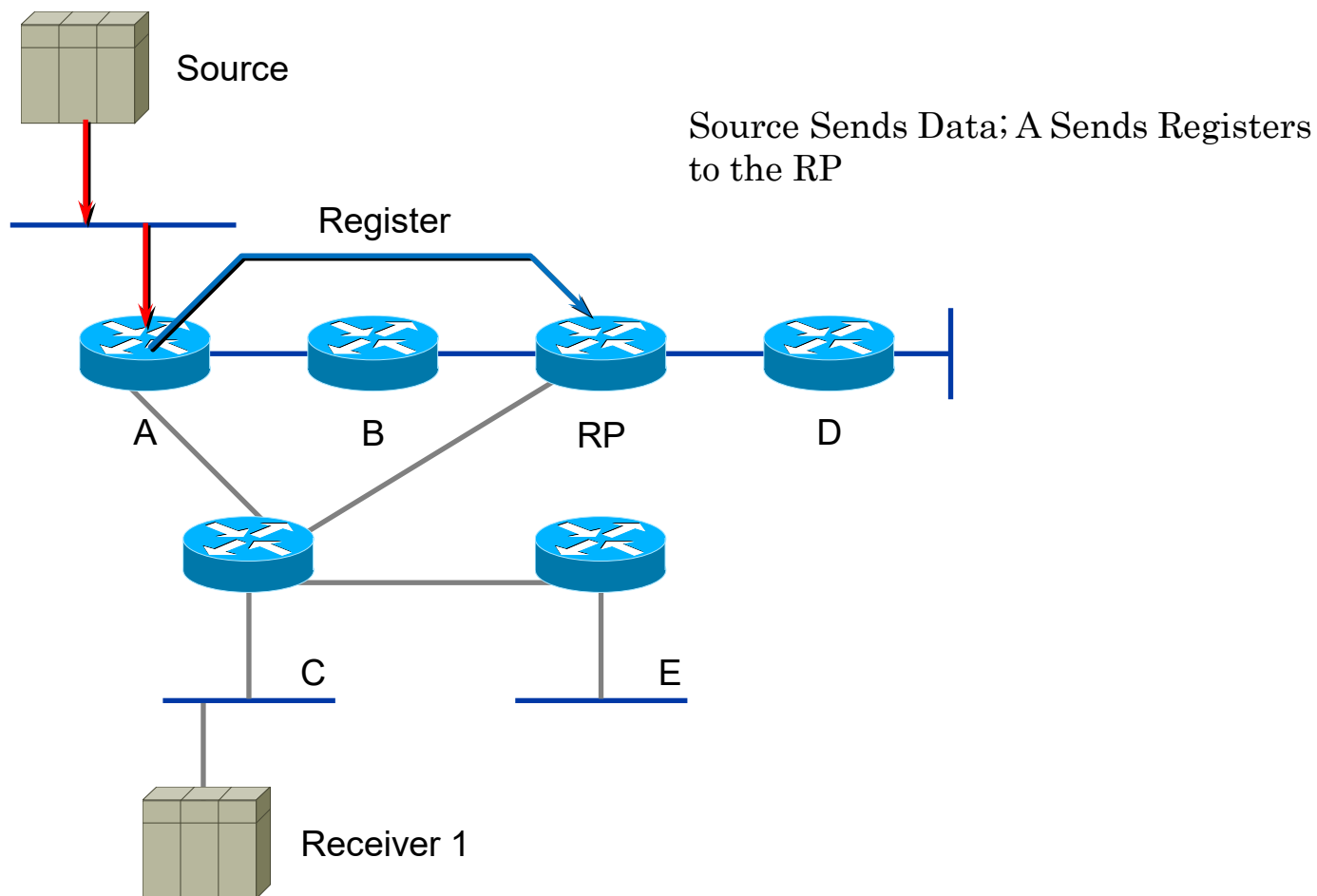
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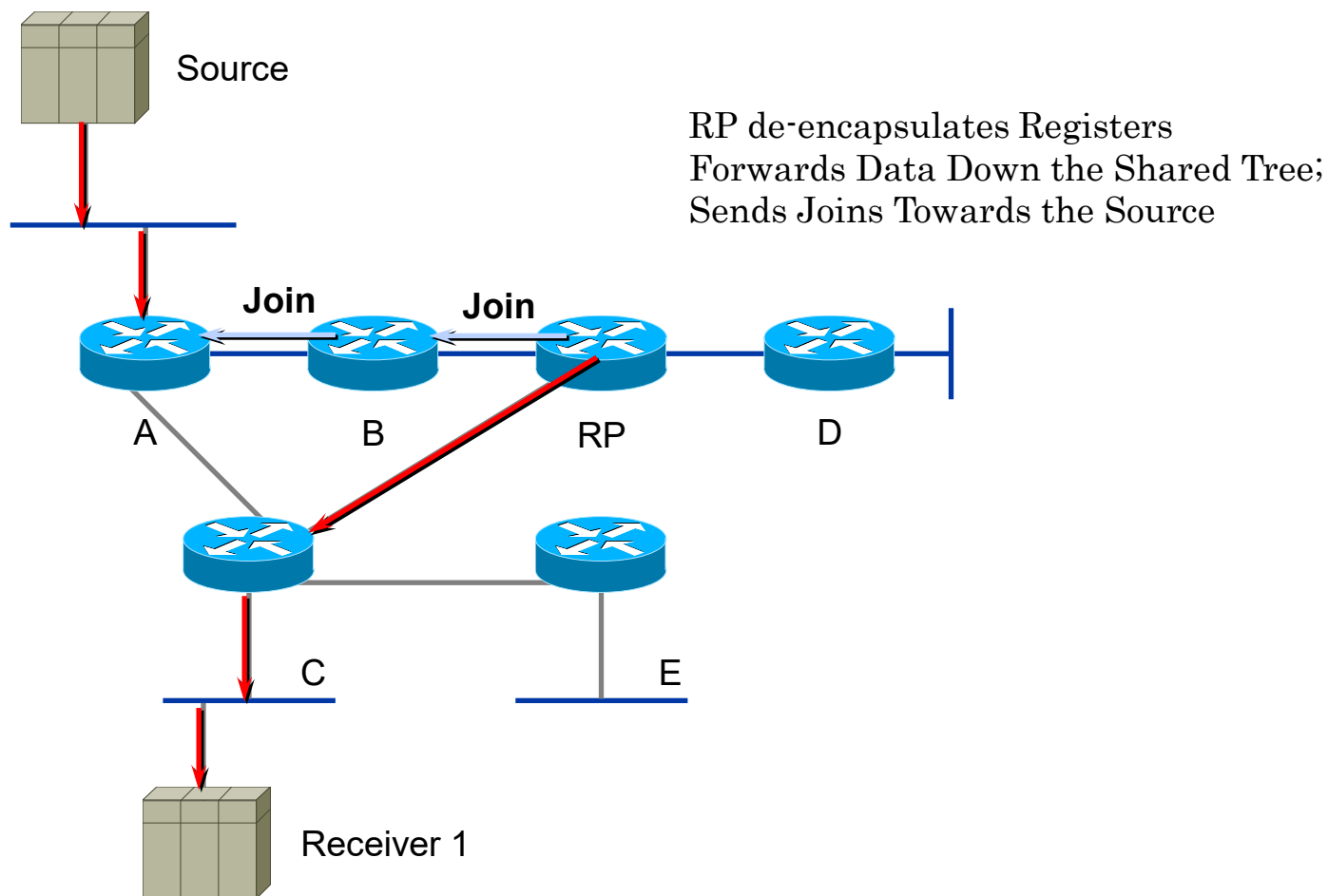
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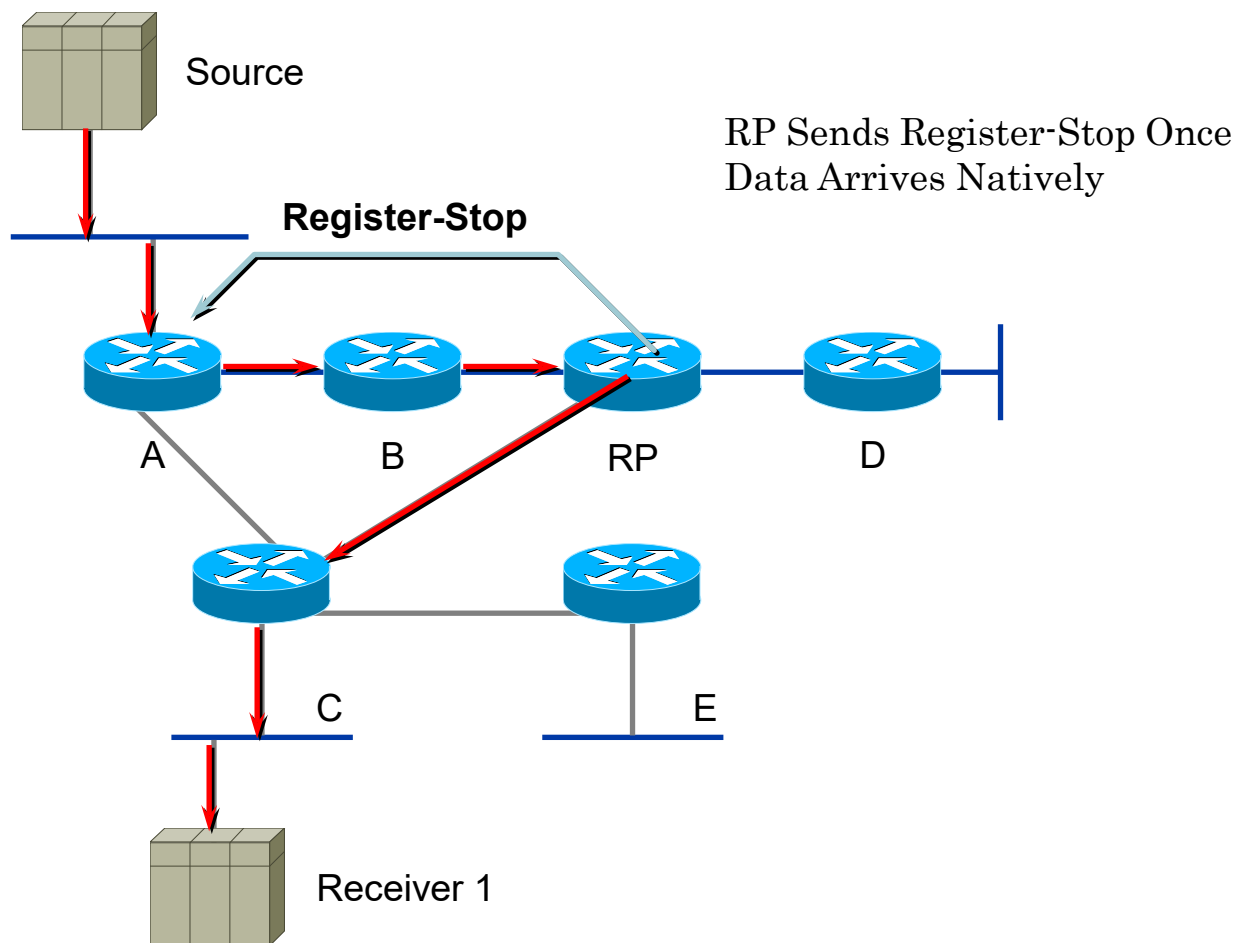
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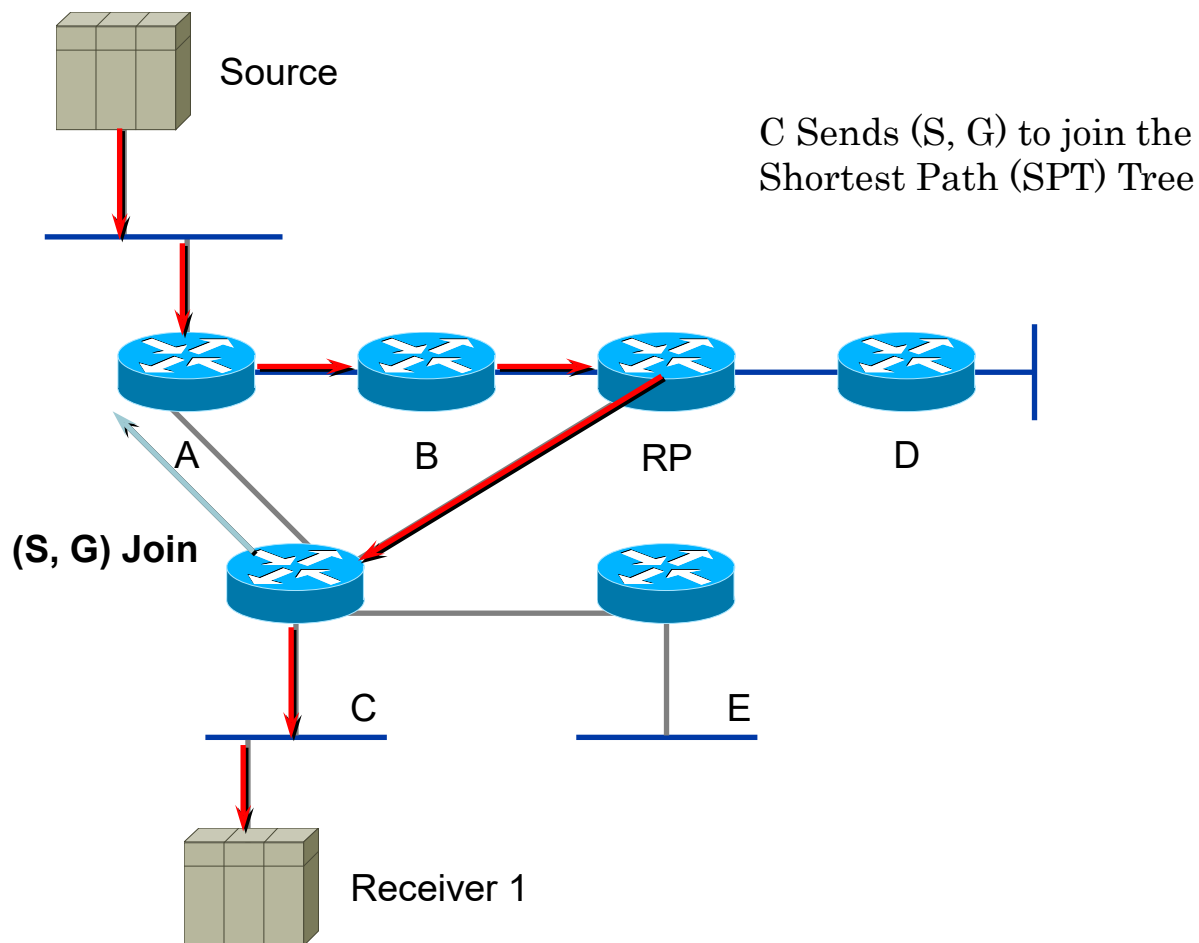
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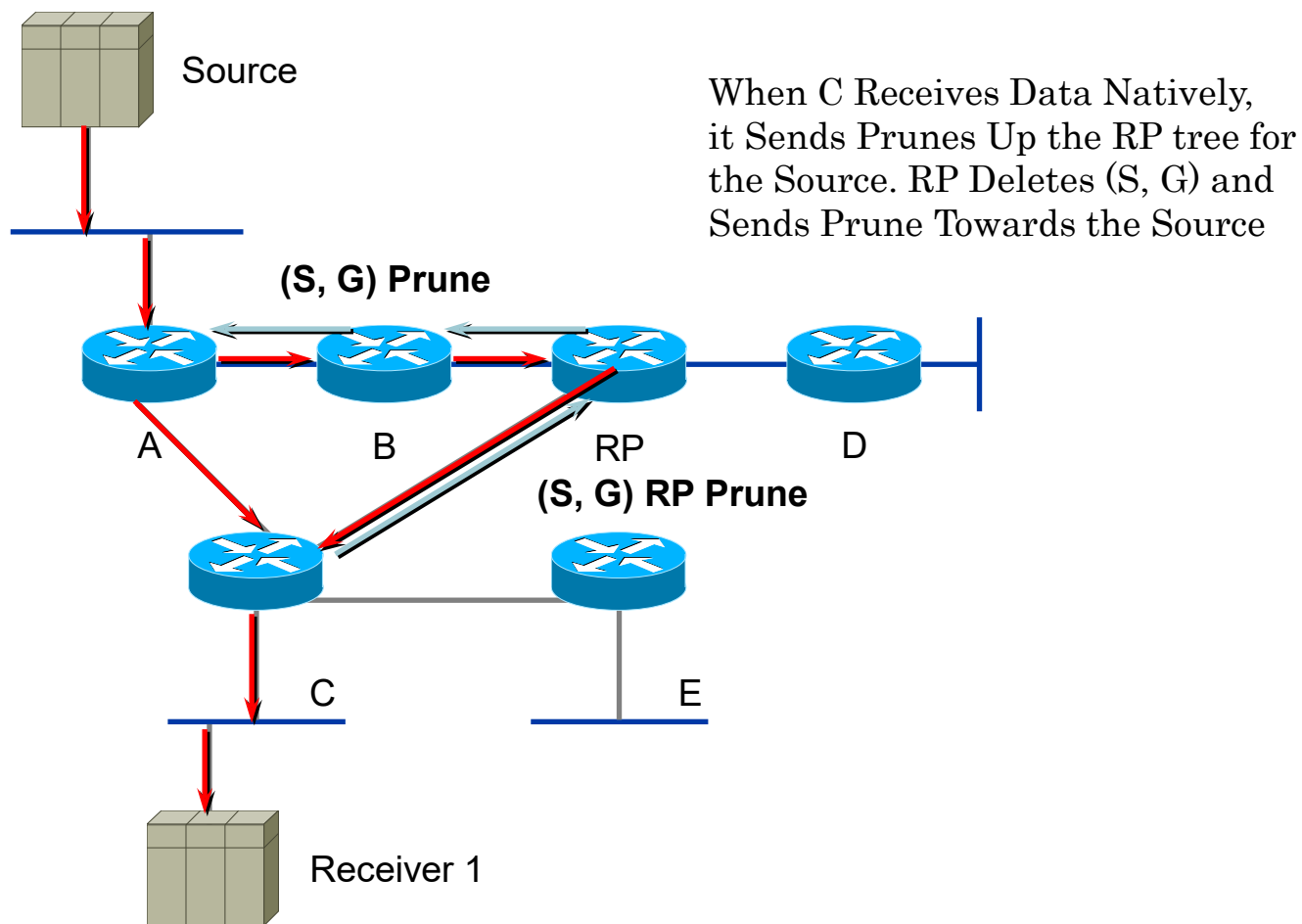
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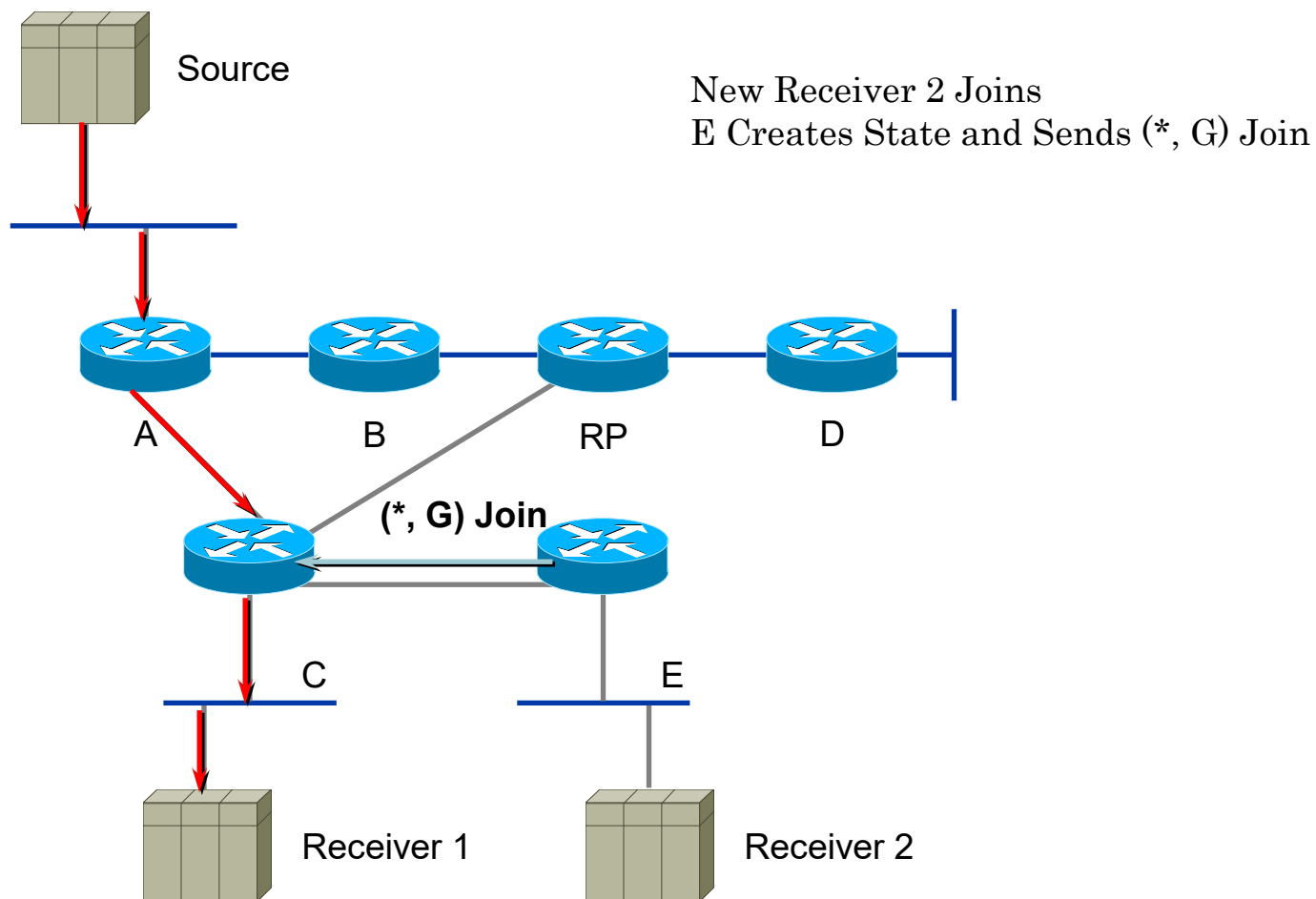
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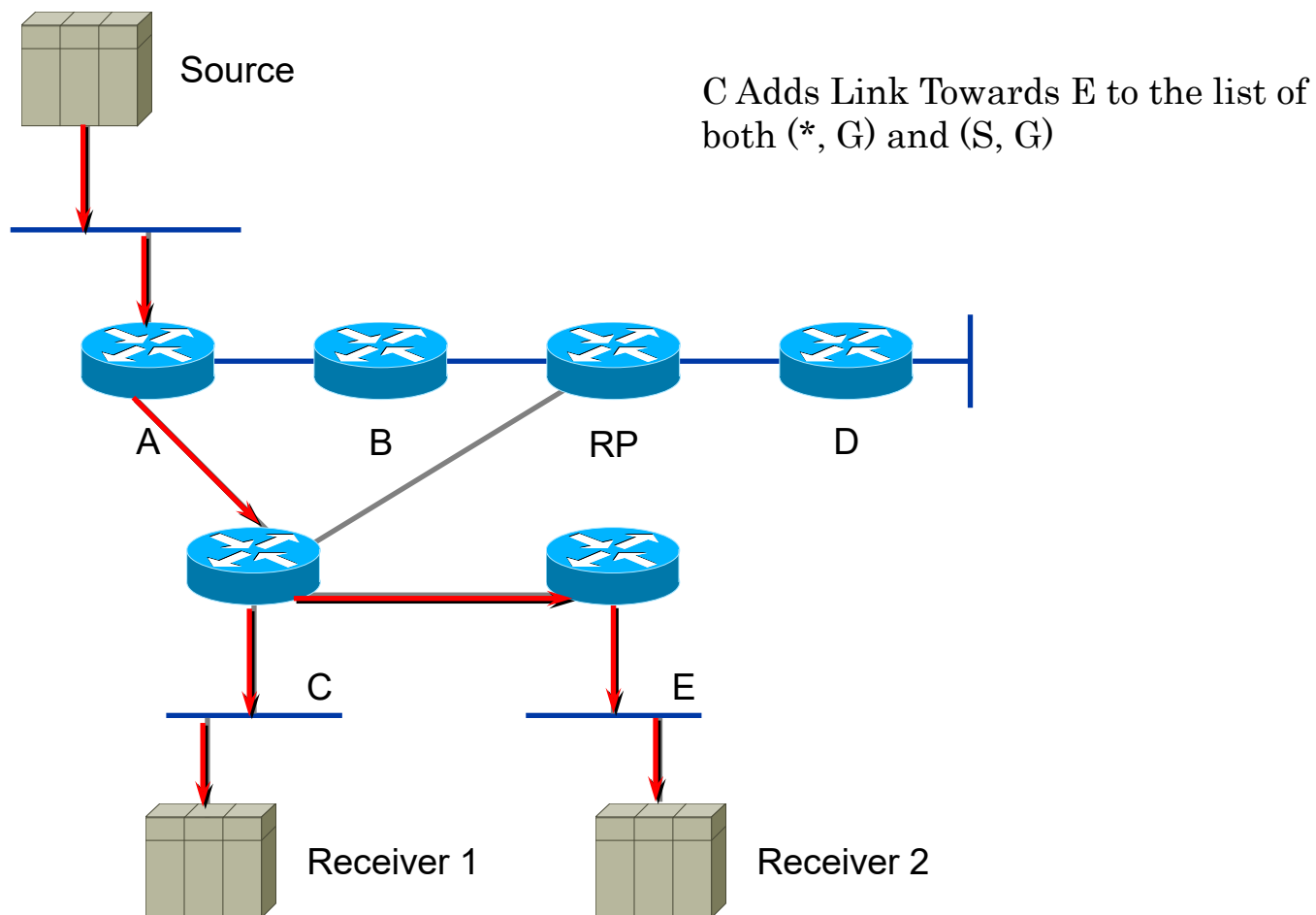
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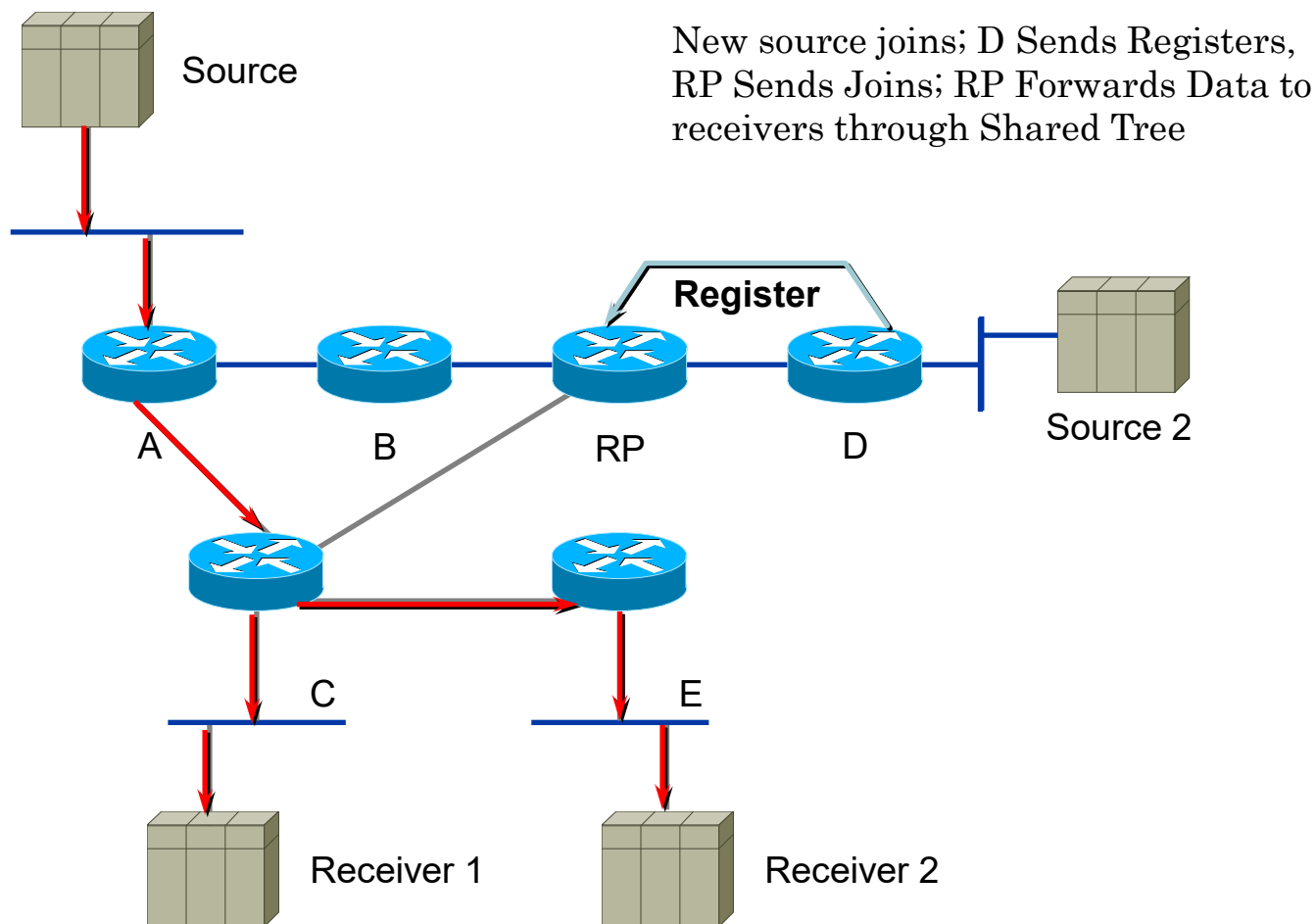
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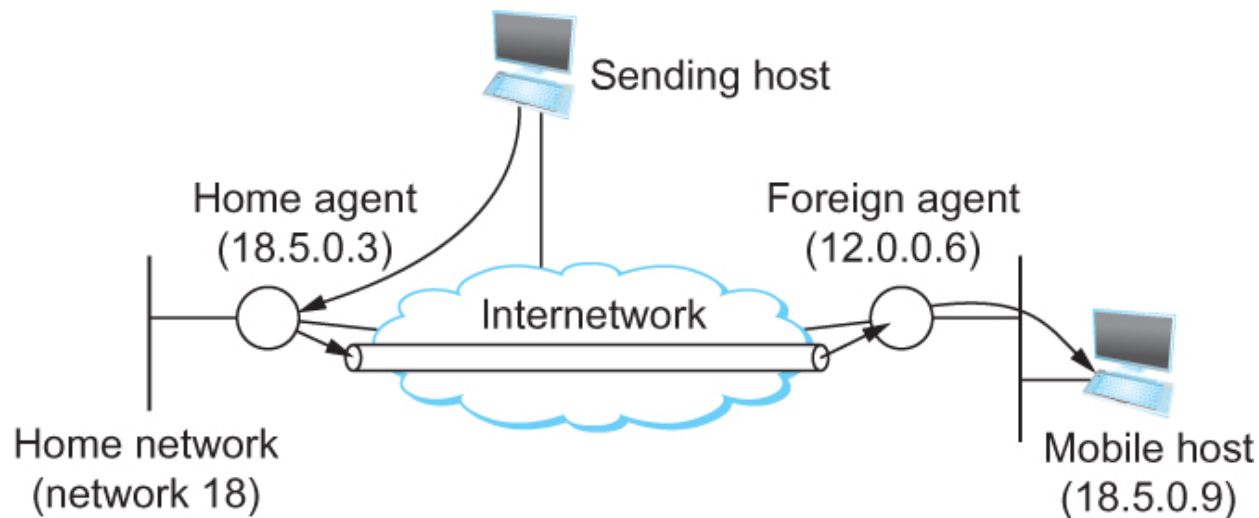
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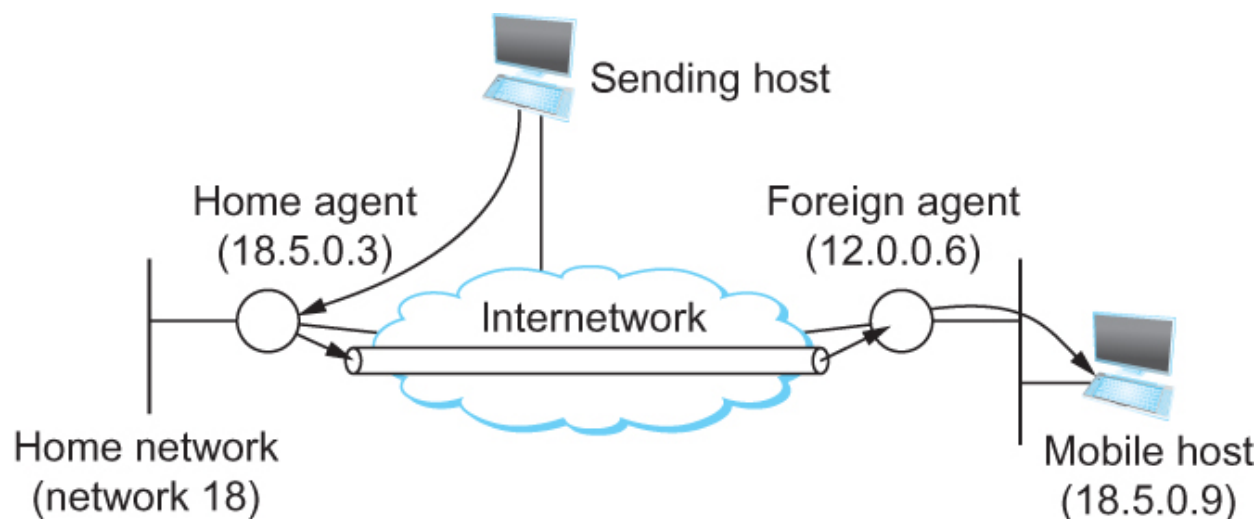
Routing for Mobile Hosts

- Mobile IP
 - *home agent*
 - Router located on the home network of the mobile hosts
 - *home address*
 - The permanent IP address of the mobile host.
 - Has a network number equal to that of the home network and thus of the home agent
 - *foreign agent*
 - Router located on a network to which the mobile node attaches itself when it is away from its home network



Routing for Mobile Hosts

- Mobile host connects to Foreign Agent
- Mobile host provides the address of the Home Agent
- Foreign Agent sends a care-of-address to the Home Agent



Routing for Mobile Hosts

- Problem of delivering a packet to the mobile node
- How does the home agent intercept a packet that is destined for the mobile node?
 - Proxy ARP –
 - same as ARP, except Home Agent inserts the Mobile Hosts IP address
 - Nodes on the network associate the MAC address of the Home Agent with the Mobile Hosts IP address
- How does the home agent then deliver the packet to the foreign agent?
 - IP tunnel
 - Care-of-address

Routing for Mobile Hosts

- Problem of delivering a packet to the mobile node
 - How does the foreign agent deliver the packet to the mobile node?
 - Foreign Agent receives the IP packet for the Mobile Host with the IP address of the Mobile Host
 - Foreign Agent recognizes the IP address as a registered mobile node and delivers the packet to the hardware address of the Mobile Node

Routing for Mobile Hosts

- Route optimization in Mobile IP
 - The route from the sending node to mobile node can be significantly sub-optimal – want to avoid the Home Agent
 - One extreme example
 - The mobile node and the sending node are on the same network, but the home network for the mobile node is on the far side of the Internet
 - Triangle Routing Problem

Routing for Mobile Hosts

- Route optimization in Mobile IP - solution
 - Let the sending node know the care-of-address of the mobile node. The sending node can create its own tunnel to the foreign agent
 - Home agent sends binding update message
 - The sending node creates an entry in the binding cache
 - The binding cache may become out-of-date
 - The mobile node moved to a different network
 - Foreign agent sends a binding warning message

Chapter Summary – Advanced Networking

- BGP
- IPv6: addressing
- Multicast: IGMP and PIM
- Mobile IP