Chapter 13

Routing Protocols (RIP, OSPF, BGP)

- **INTERIOR AND EXTERIOR ROUTING**
- **RIP**
- **OSPF**
- **BGP**

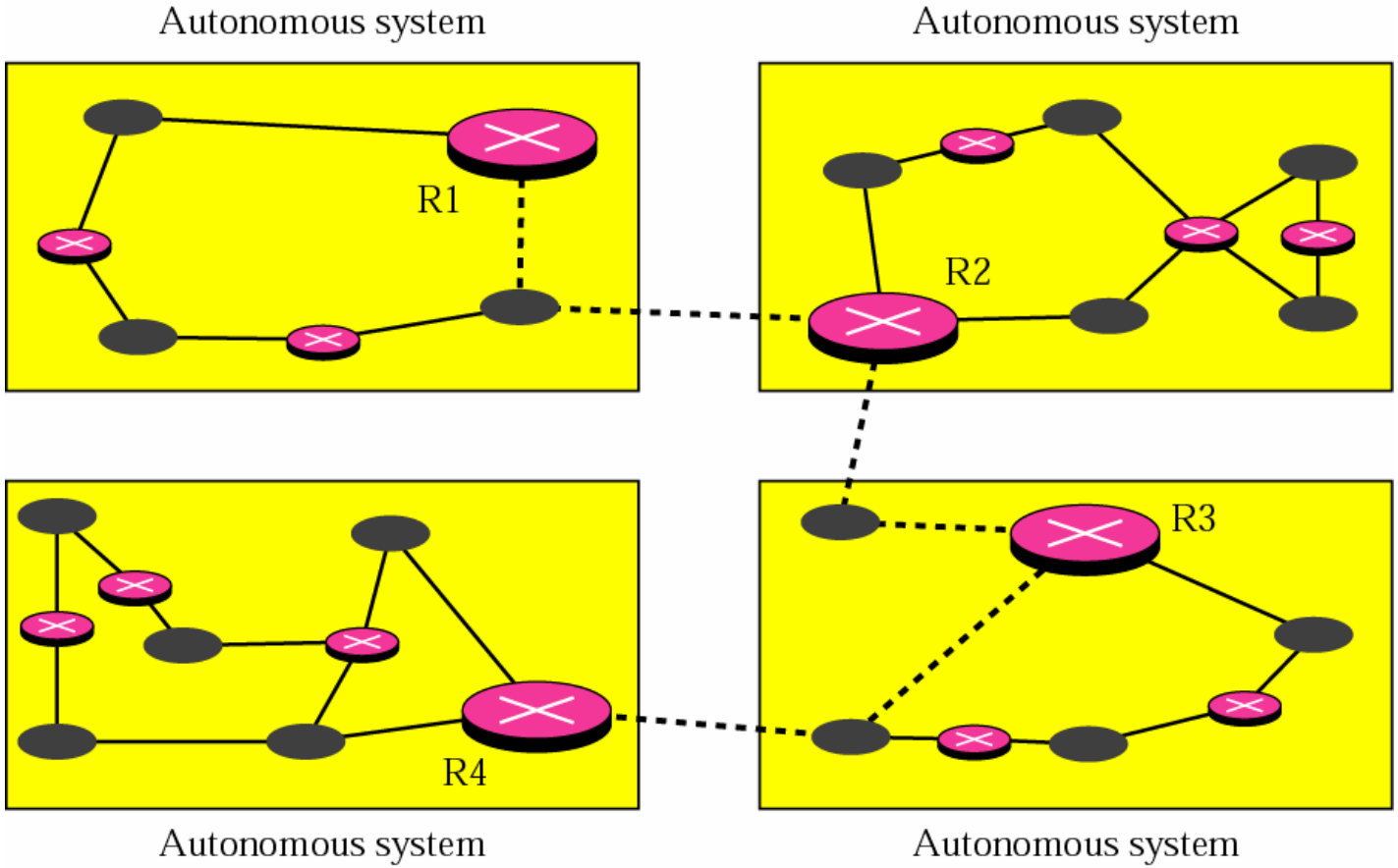
Introduction

- Packets may pass through several networks on their way to destination
- Each network carries a price tag, or a "*metric*"
- The metric of a network may be:
  - constant (i.e. each network costs one hop)
  - Service type-dependent (the cost of the network depends on what service the packet needs: e.g. throughput, delay, .. etc.)
  - Policy-dependent: a policy defines what paths should, or should not, be followed.
- The router uses a "*routing table*" to determine the path
  - Static vs. Dynamic routing tables.

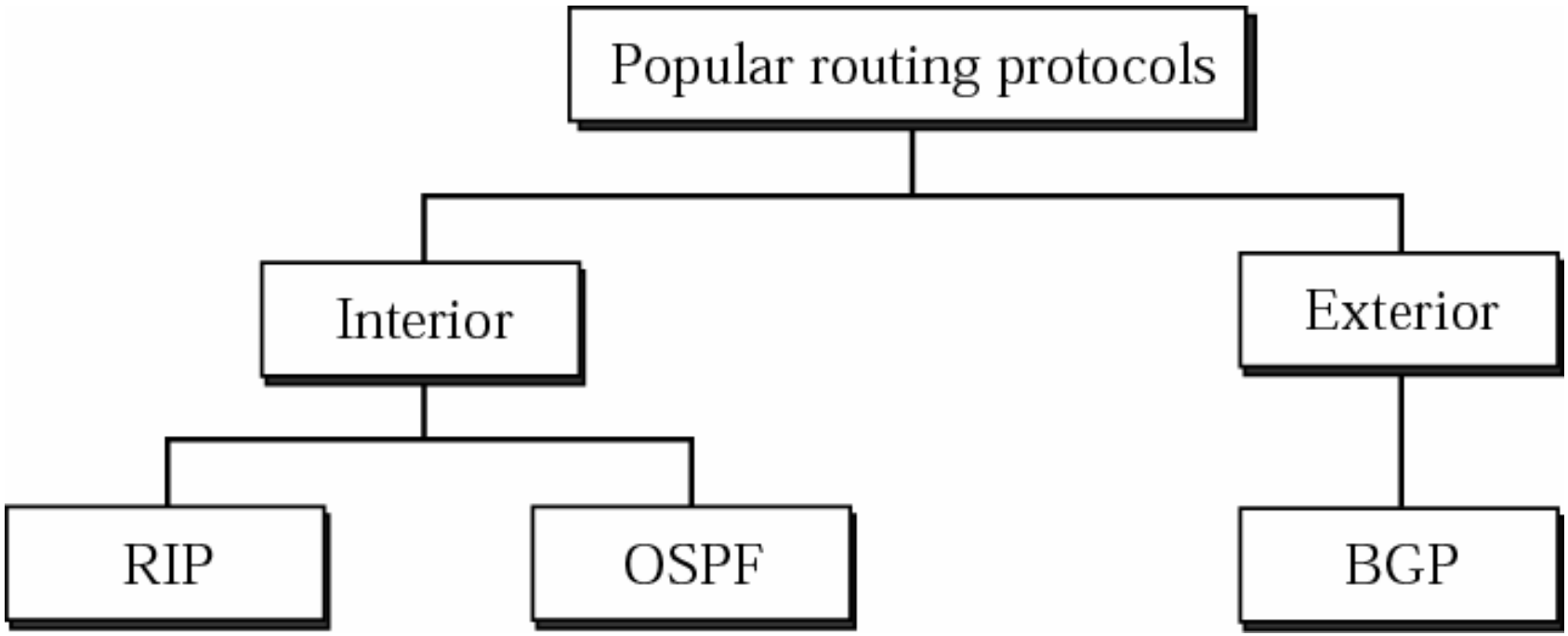
13.1 Interior & Exterior Routing

Autonomous system:

a group of networks and routers under authority of a single administrator



Popular routing protocols



13.2 RIP: Routing Information Protocol

- Distance Vector Routing
  - Share the most you know about the entire autonomous system
  - Share with all your direct neighbors, and them only
  - Share periodically, e.g. every 30 seconds

Destination	Hop Count	Next Hop	Other Info
163.5.0.0	7	172.6.23.4	
197.5.13.0	5	176.3.6.17	
189.45.0.0	4	200.5.1.6	

RIP Updating Algorithm

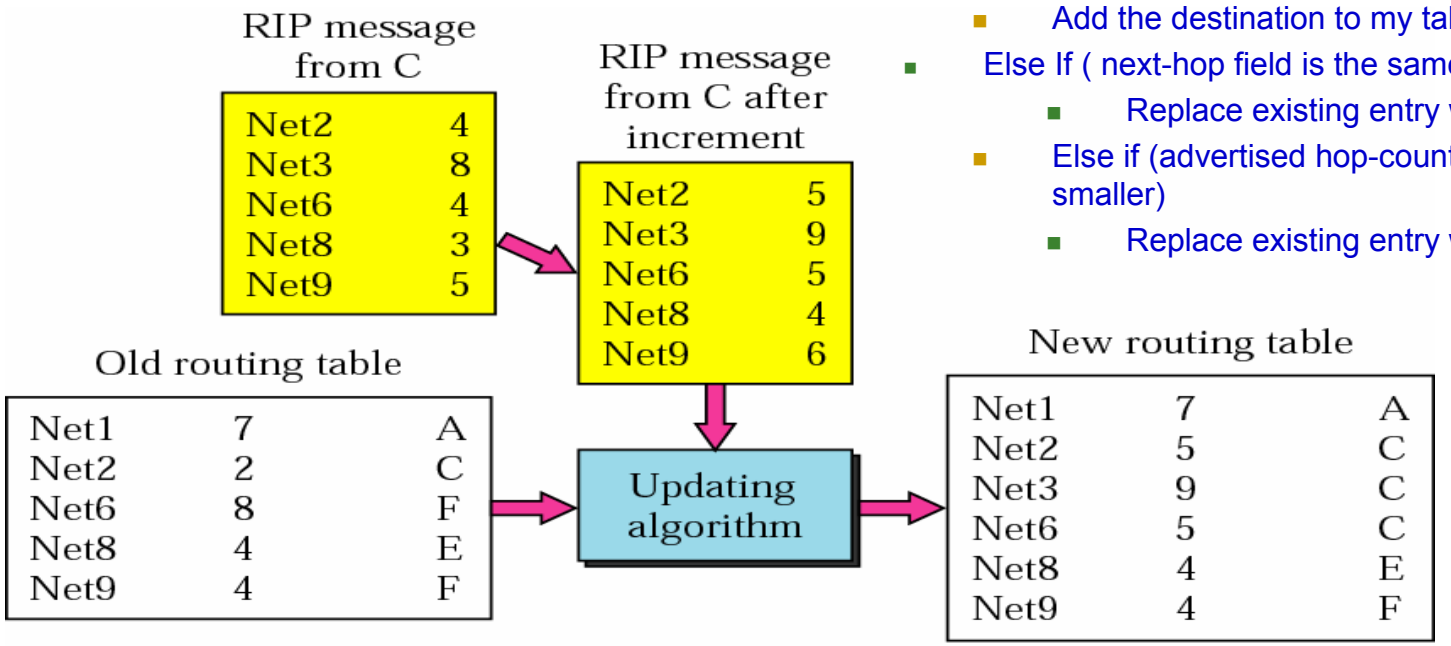
Receive: a response RIP message

1. Add one to the hop count for each advertised destination
2. Repeat for each advertised destination
   - If (destination is not in my routing table)
     - Add the destination to my table
   - Else If (next-hop field is the same)
     - Replace existing entry with the new advertised one
     - Else if (advertised hop-count –after incrementing- is smaller)
       - Replace existing entry with the new advertised one

Example of updating a routing table

Receive: a response RIP message

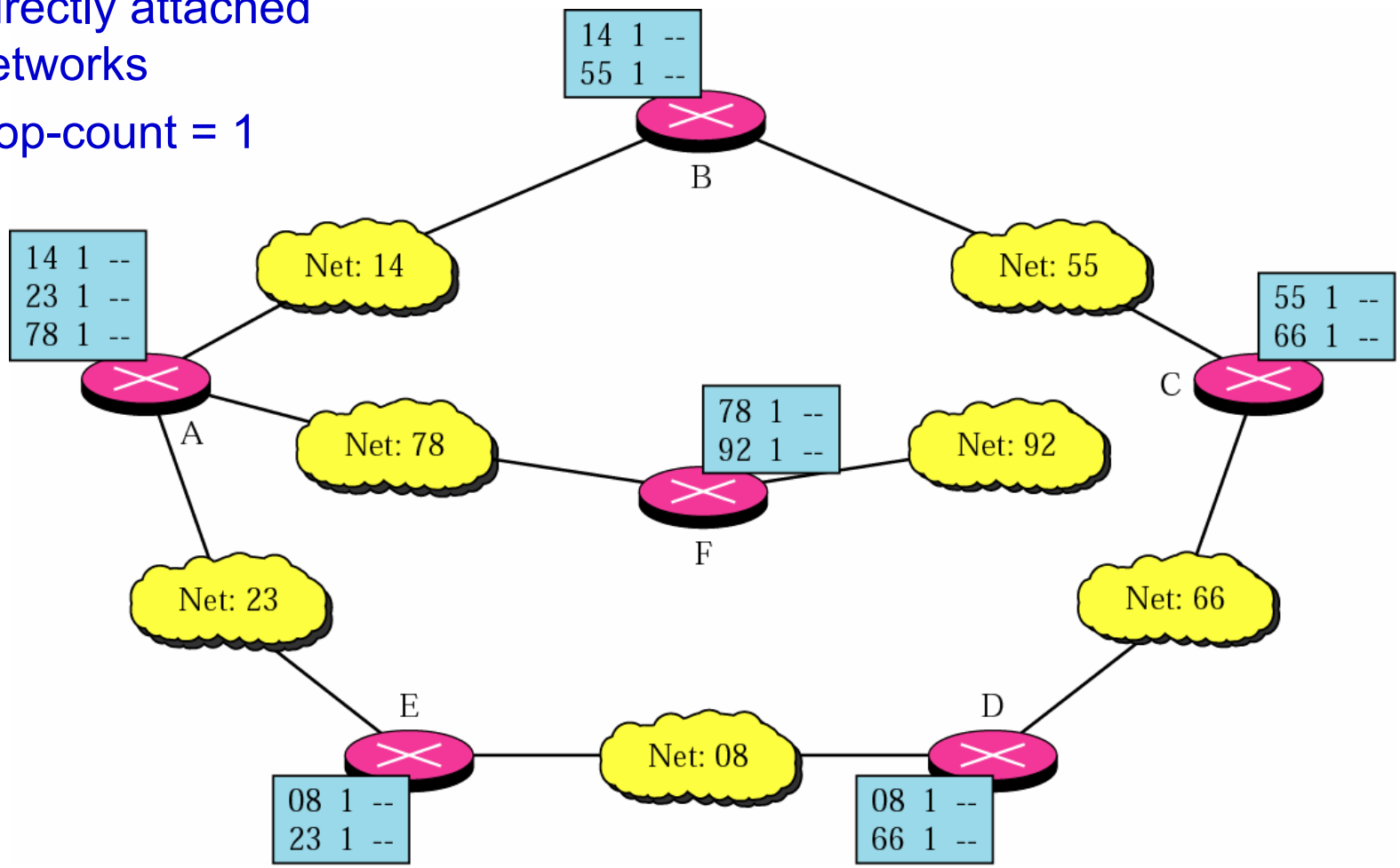
1. Add one to the hop count for each advertised destination
2. Repeat for each advertised destination
   - If (destination is not in my routing table)
     - Add the destination to my table
   - Else If (next-hop field is the same)
     - Replace existing entry with the new advertised one
     - Else if (advertised hop-count –after incrementing- is smaller)
       - Replace existing entry with the new advertised one



Net1: No news, do not change
Net2: Same next hop, replace
Net3: A new router, add
Net6: Different next hop, new hop count smaller, replace
Net8: Different next hop, new hop count the same, do not change
Net9: Different next hop, new hop count larger, do not change

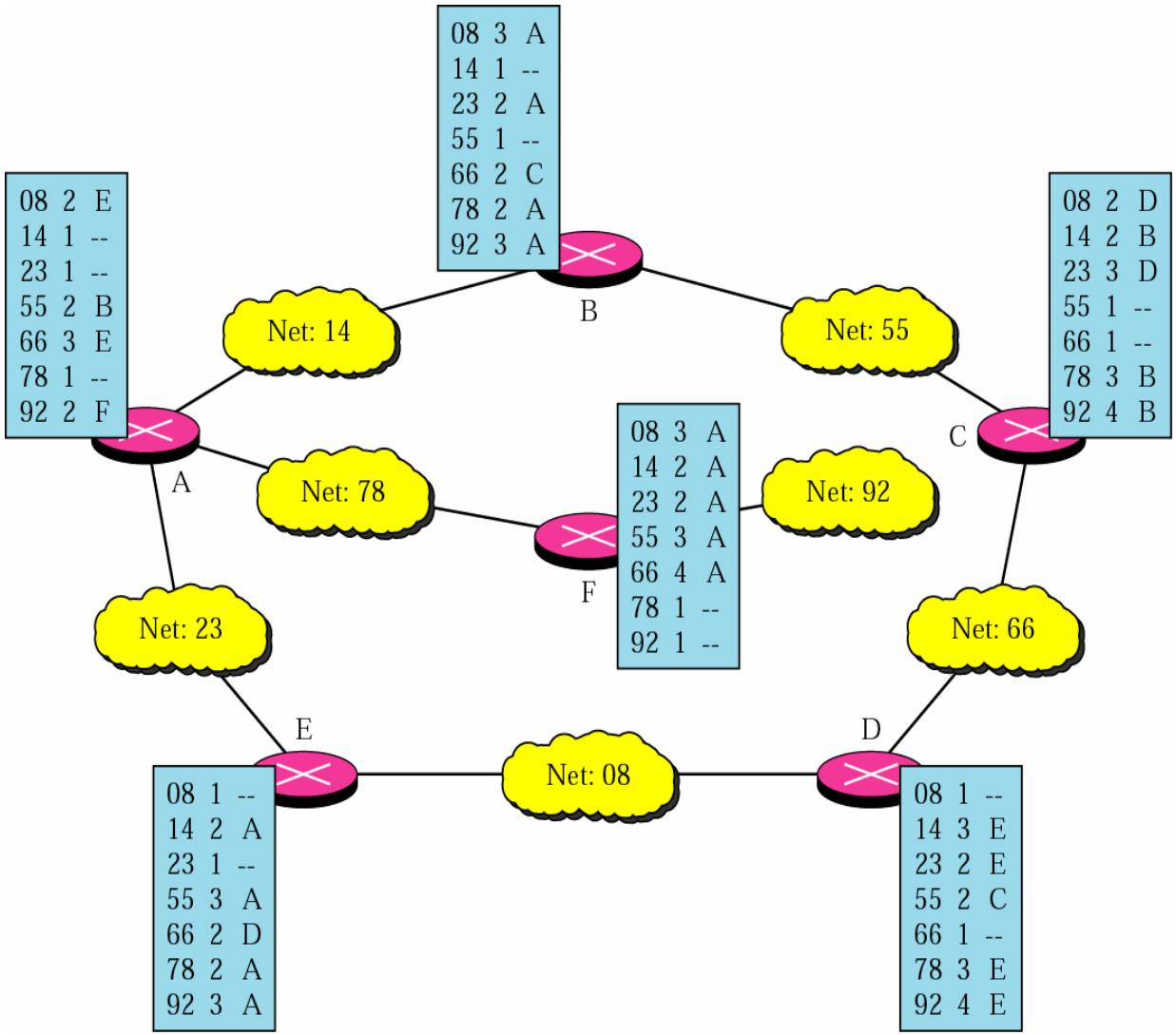
Initial routing tables in a small autonomous system

- Configuration File
  - Directly attached networks
  - Hop-count = 1

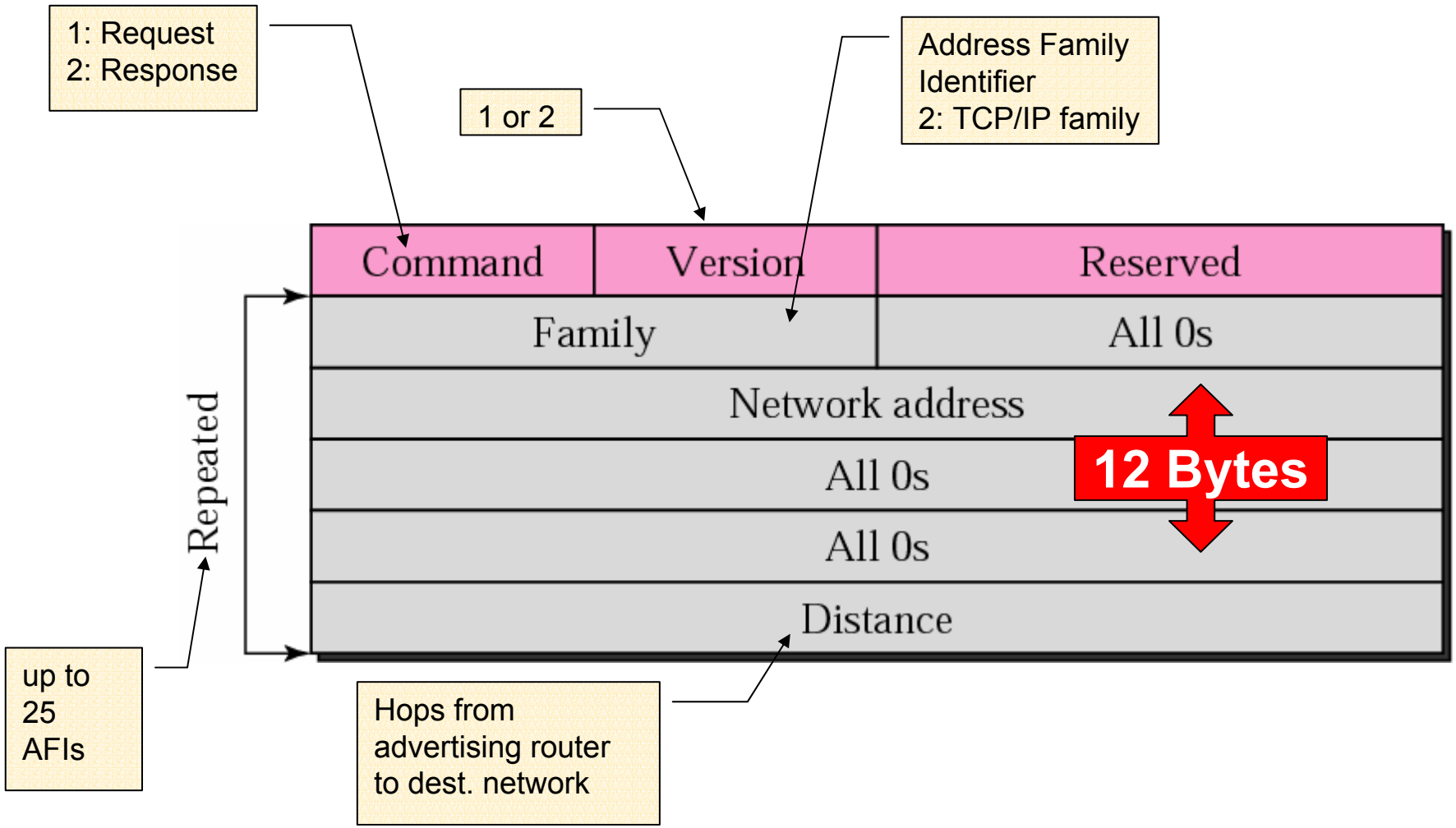


Final routing tables for the previous autonomous system

- RIP messages are exchanged
- Routing tables are updated

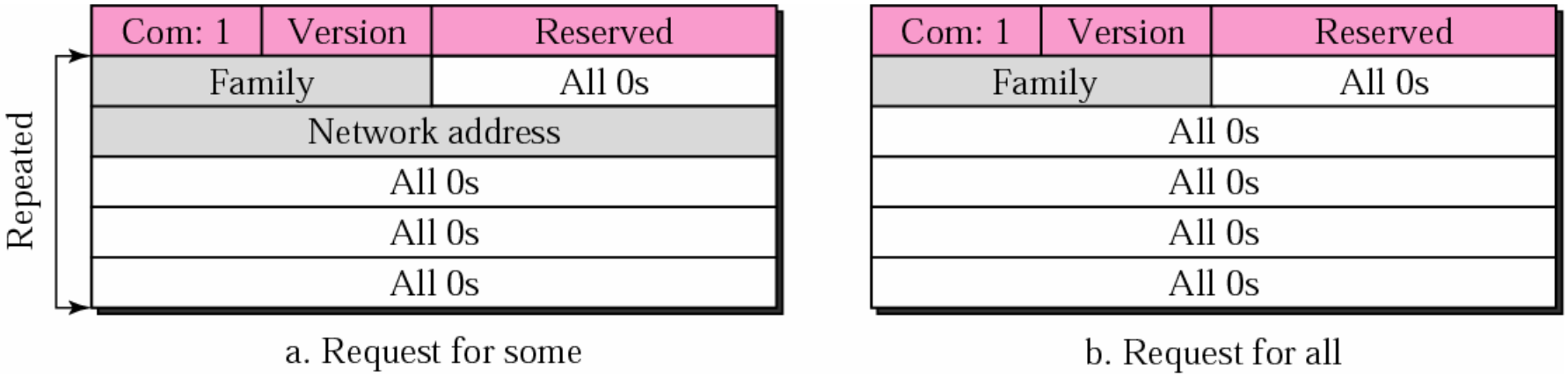


RIP message format



RIP Request Messages

- Sent by a router when booted, or when an entry times-out
- May request updates for ALL networks, or specific one(s)



RIP Response Messages

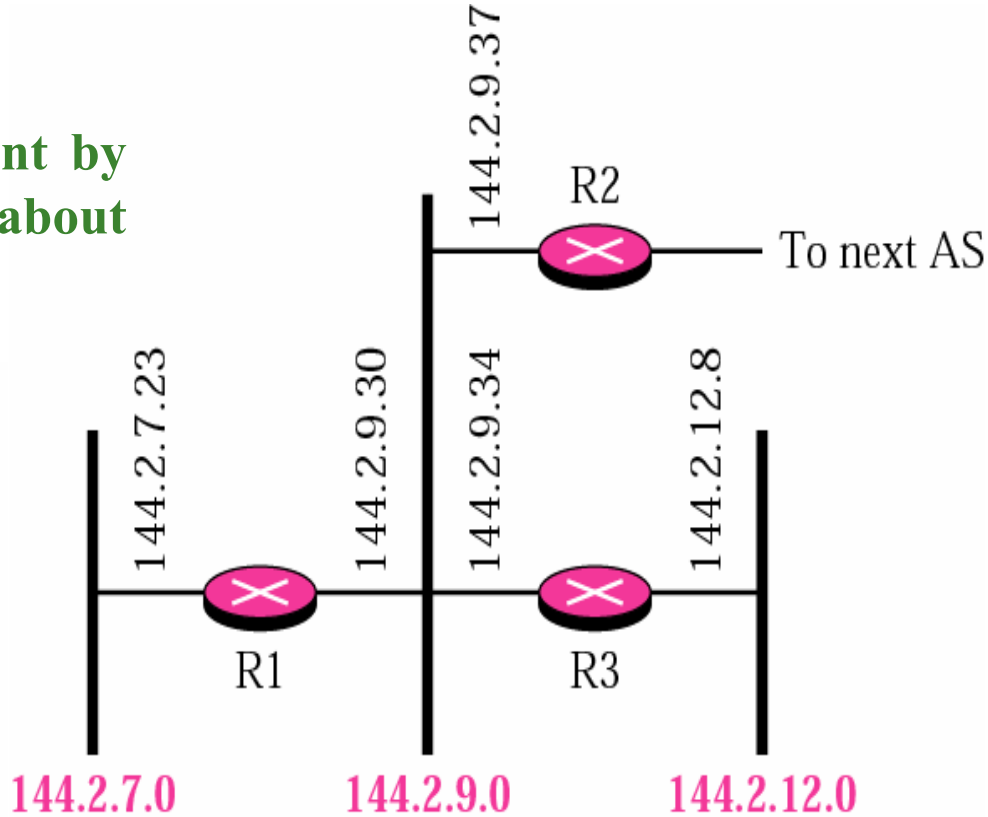
- Solicited responding to a previous request
- Unsolicited (sent periodically to all neighbors)

Example 1

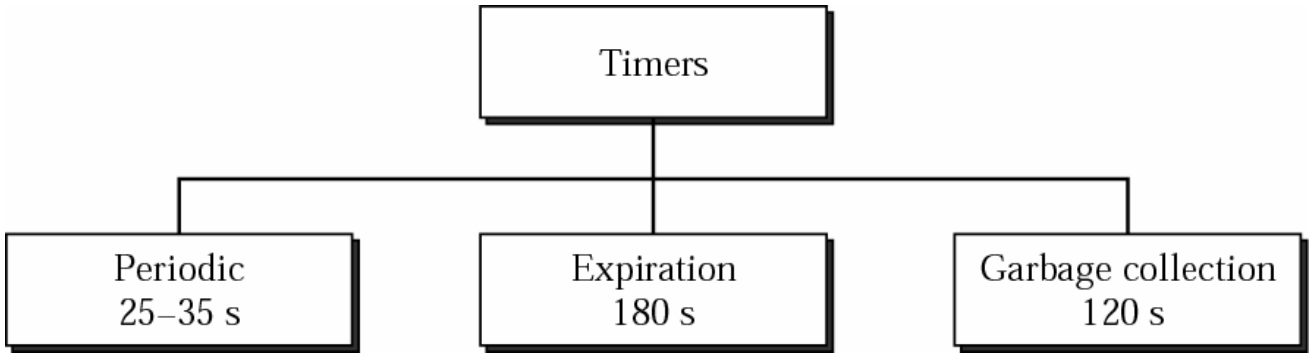
What is the periodic response sent by router R1? Assume R1 knows about the whole autonomous system.

RIP message

2	1	Reserved	
2		All 0s	
144.2.7.0			Network 144.2.7.0
All 0s			
All 0s			
--			
2		All 0s	
144.2.9.0			Network 144.2.9.0
All 0s			
All 0s			
--			
2		All 0s	
144.2.12.0			Network 144.2.12.0
All 0s			
All 0s			
1			



RIP Timers



- Periodic Timer (25 < random < 35): controls advertising of update messages. There ONE such timer
- Expiration Timers: governs route validity. Reset upon receipt of an update. If it ever expires, destination is considered unreachable.
  - Yet, entry is not removed from table, it continues to be advertised with hop count = 16 (i.e. infinity)
- Garbage Collection Timers: Reset to 120sec when a route is invalidated. If it expires, the route entry is completely removed from routing table

Example 2

A routing table has 20 entries. It does not receive information about five routes for 200 seconds. How many timers are running at this time?

Solution

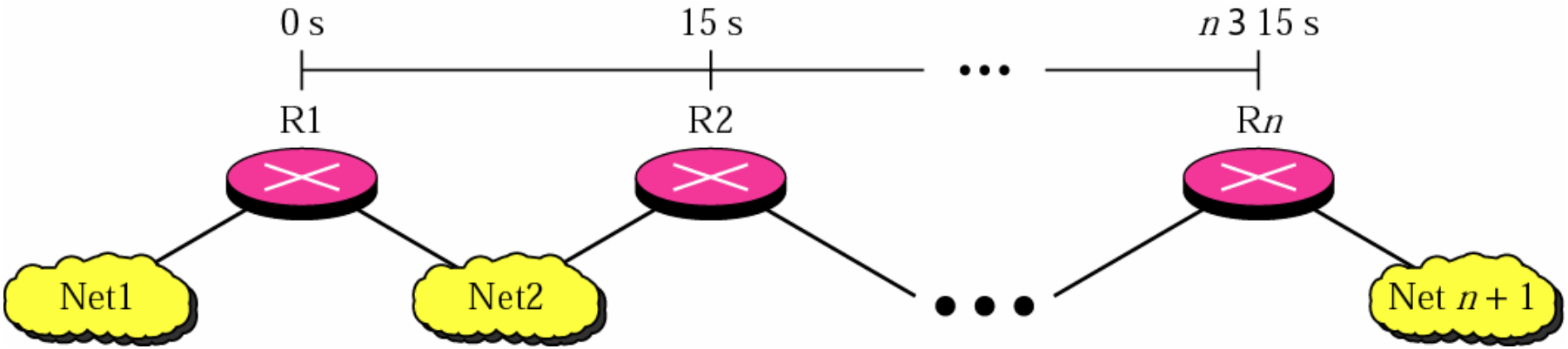
The timers are listed below:

Periodic timer: 1

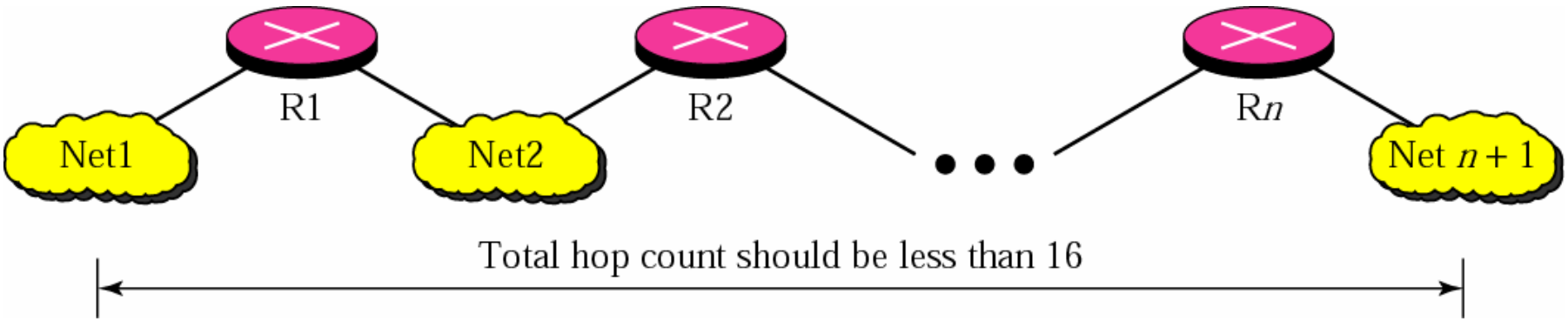
Expiration timer: 20 - 5 = 15

Garbage collection timer: 5

RIP Problems: 1) Slow convergence

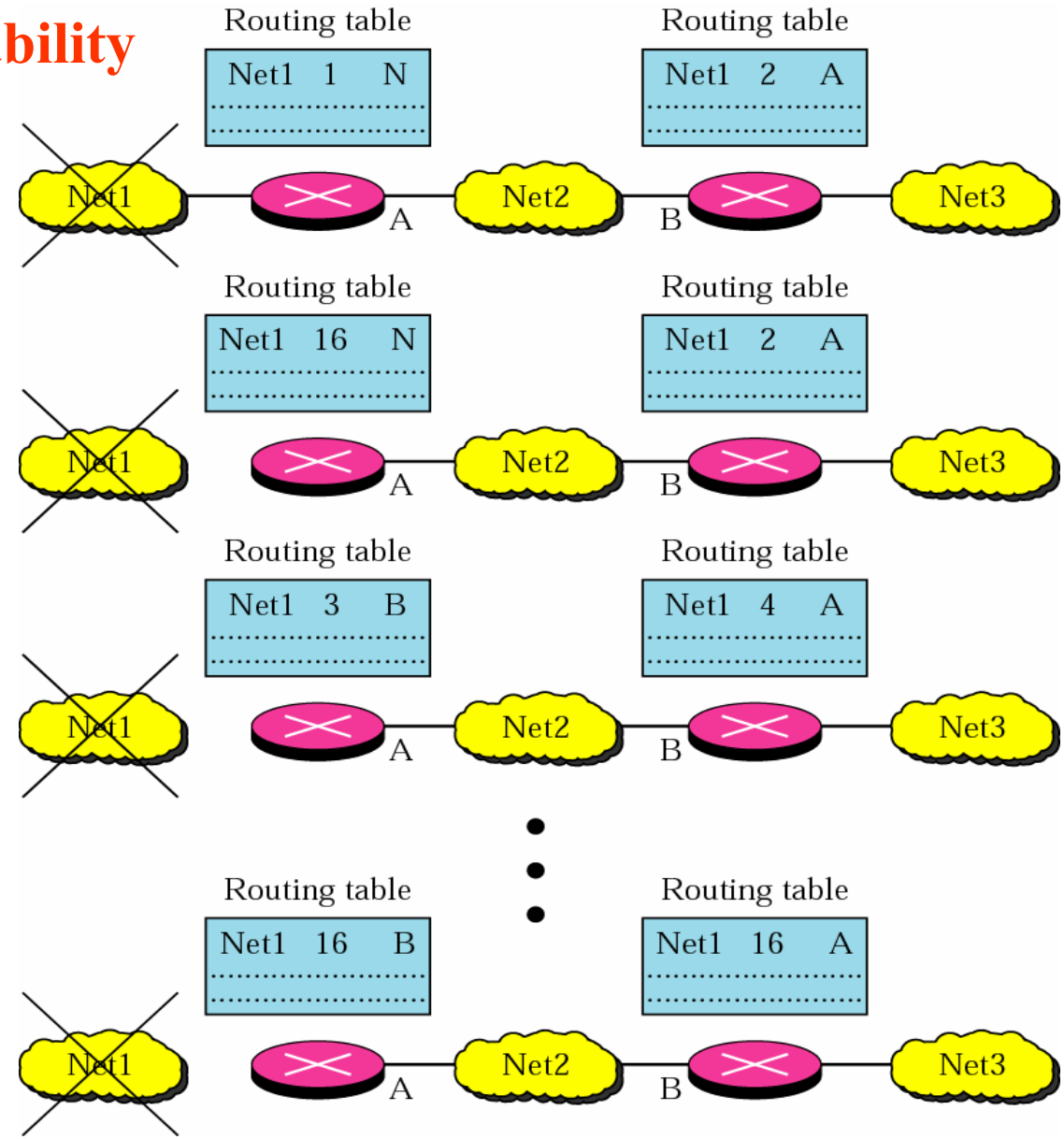


- Network topology changes propagate slowly (avg. 15 sec per hop)
- Solution: Limit the diameter of an autonomous system to 15 hops.



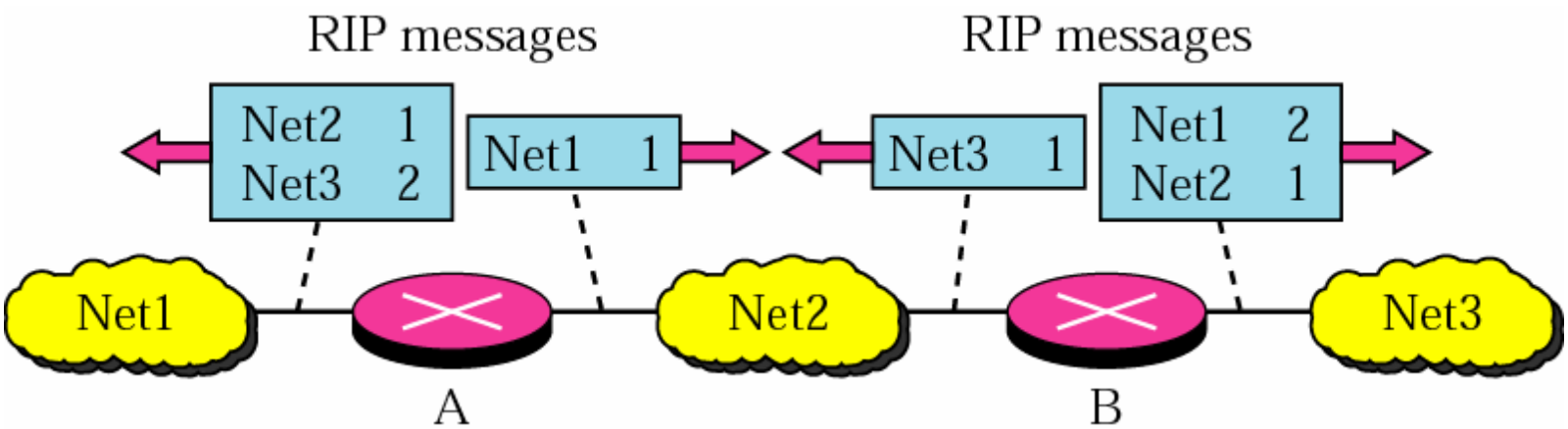
RIP Problems: 2) Instability

- Net1 is disconnected from Router A
- Router A updates its hop count to 16
- Router A waits for 30 seconds before sending it advertisement
- Router B advertises Net1 (with hop-count =2) to A before A has a chance to advertise that Net1 is disconnected
- A is fooled and sets its Hop-count to 2+1=3



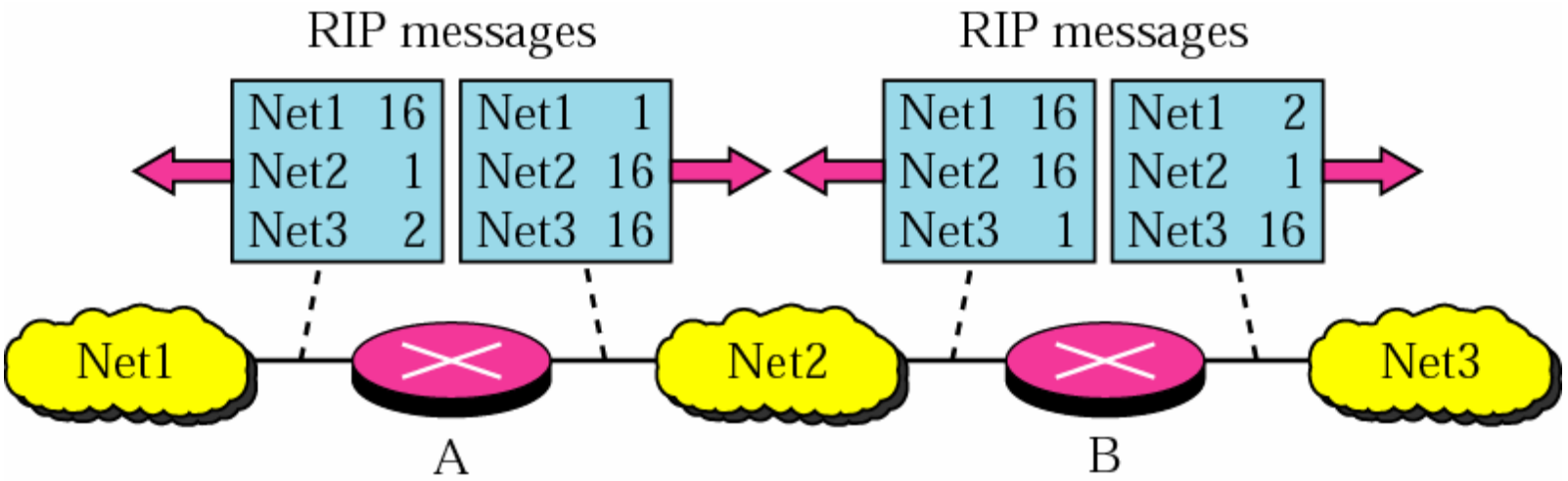
Remedies for RIP Instability

- Triggered Update:
  - Send an immediate update (with hop count =16) whenever a network becomes unreachable, otherwise send periodic updates.
- Split Horizons:
  - Never sent same information back to the interface it came from

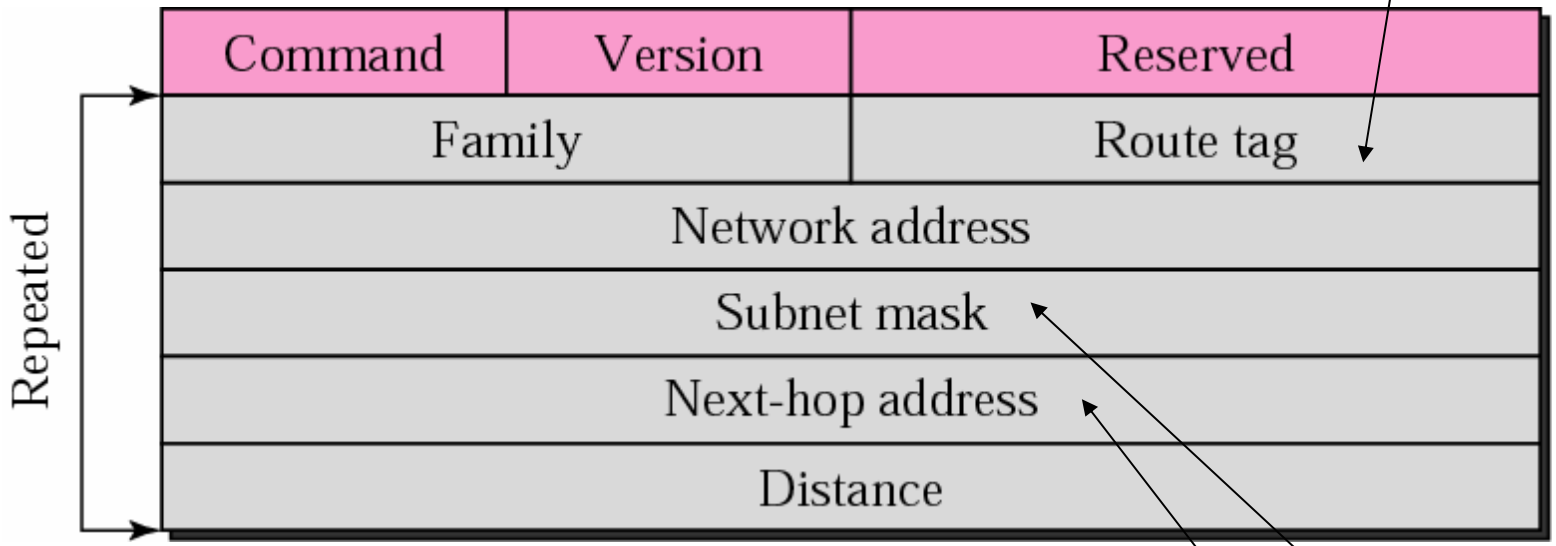


Remedies for RIP Instability: Poison reverse

- A variation of Split Horizon.



RIP-v2 Format: Same length as in RIP-v1



- RIP version 2 supports CIDR.
- RIP messages are encapsulated in a UDP datagram
- RIP uses the services of UDP on well-known port 520.

Authentication

- Protect against unauthorized advertisement
- First entry (with family type = FFFF) is used for authontication