

A man in a white shirt and red tie is holding a large red pipe over a colorful landscape. The landscape is divided into sections of blue, green, and yellow, with a blue sky above. The man is standing on a green hill, and the pipe is arched over the landscape.

# Determining IP Routes

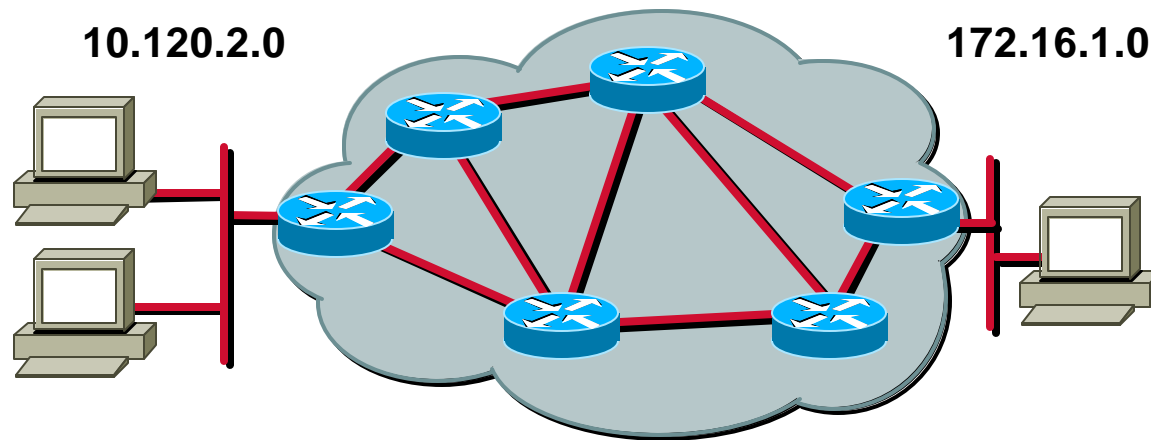


# Objectives

**Upon completion of this chapter, you will be able to complete the following tasks:**

- **Distinguish the use and operation of static and dynamic routes**
- **Configure and verify a static route**
- **Identify how distance vector IP routing protocols such as RIP and IGRP operate on Cisco routers**
- **Enable Routing Information Protocol (RIP)**
- **Enable Interior Gateway Routing Protocol (IGRP)**
- **Verify IP routing with show and debug commands**

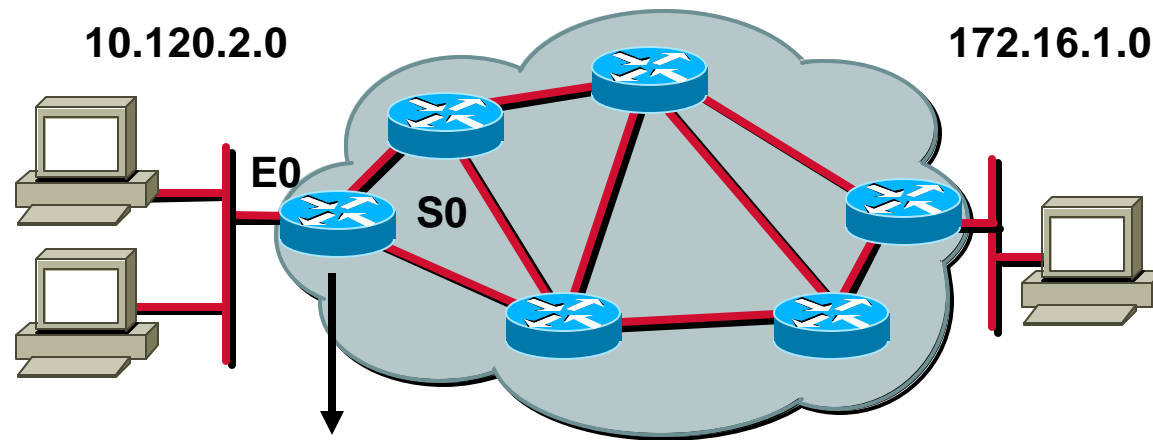
# What is Routing?



**To route, a router needs to know:**

- Destination addresses
- Sources it can learn from
- Possible routes
- Best route
- Maintain and verify routing information

# What is Routing? (cont.)



Network Protocol	Destination Network	Exit Interface
Connected	10.120.2.0	E0
Learned	172.16.1.0	S0

Routed Protocol: IP

**Routers must learn destinations that are not directly connected**

# Identifying Static and Dynamic Routes

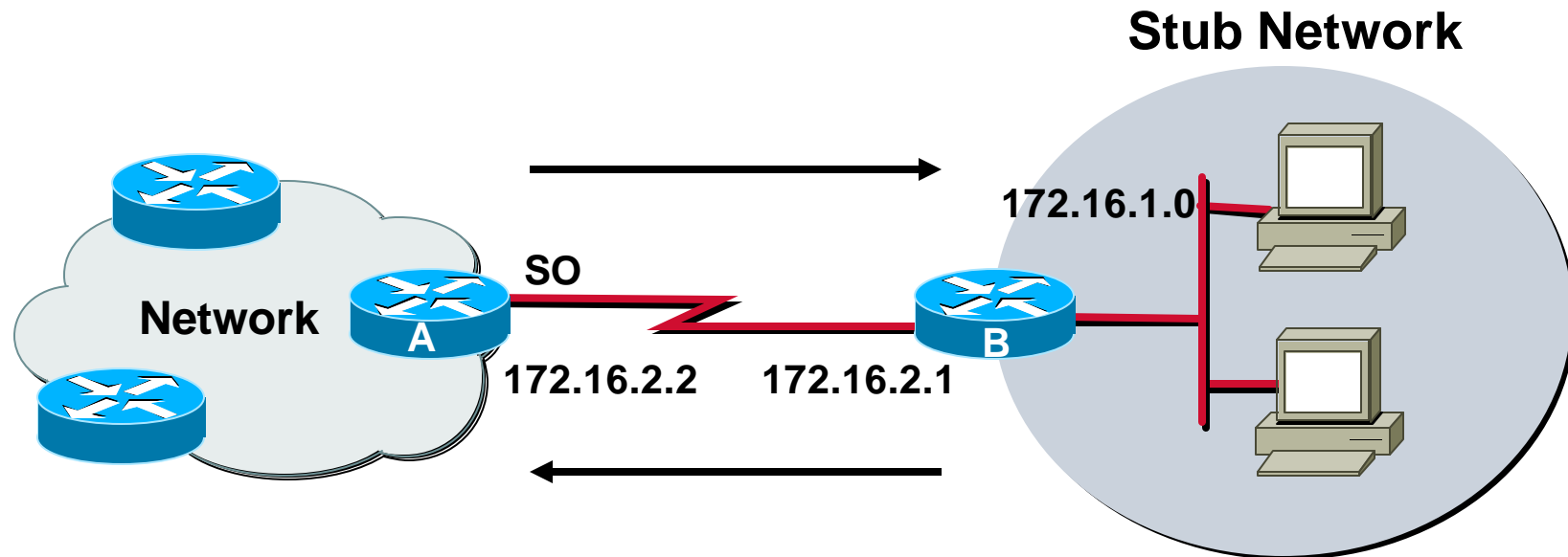
## **Static Route**

**Uses a route that a network administrator enters into the router manually**

## **Dynamic Route**

**Uses a route that a network routing protocol adjusts automatically for topology or traffic changes**

# Static Routes



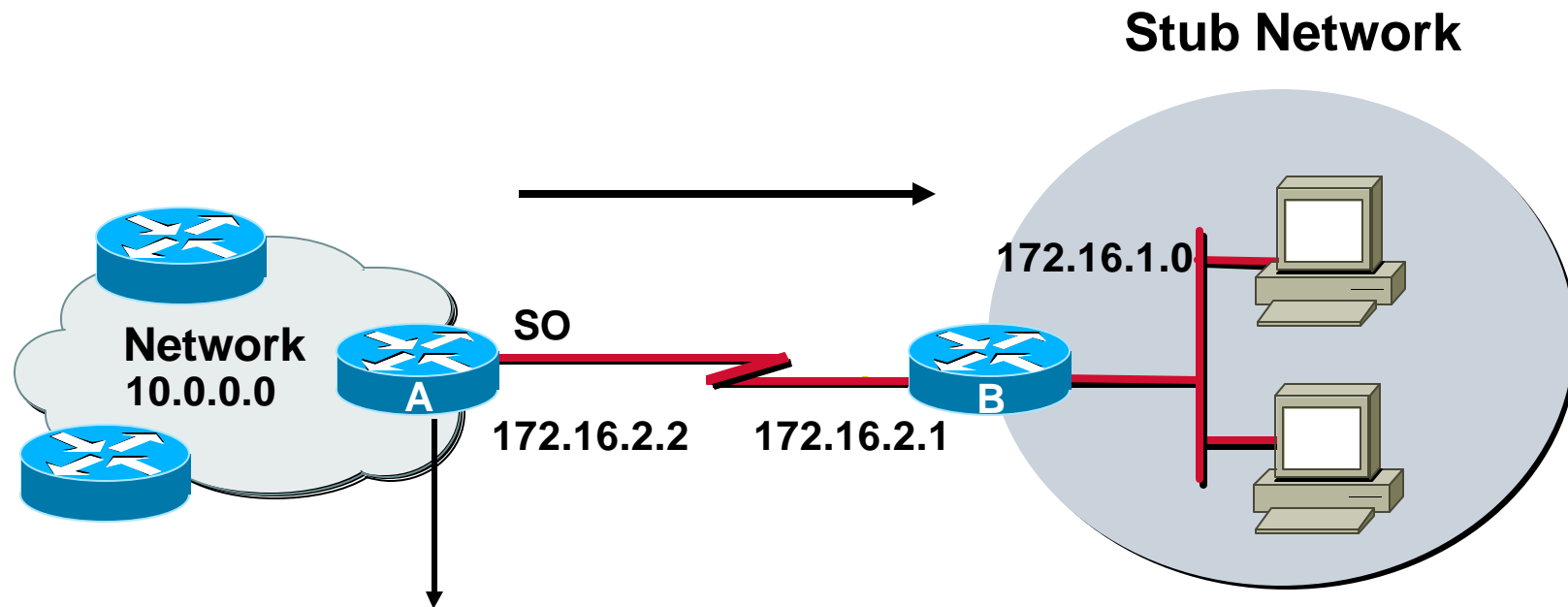
**Configure unidirectional static routes to and from a stub network to allow communications to occur.**

# Static Route Configuration

```
Router(config)#ip route network [mask]  
{address | interface}[distance] [permanent]
```

**Defines a path to an IP destination network or subnet**

# Static Route Example

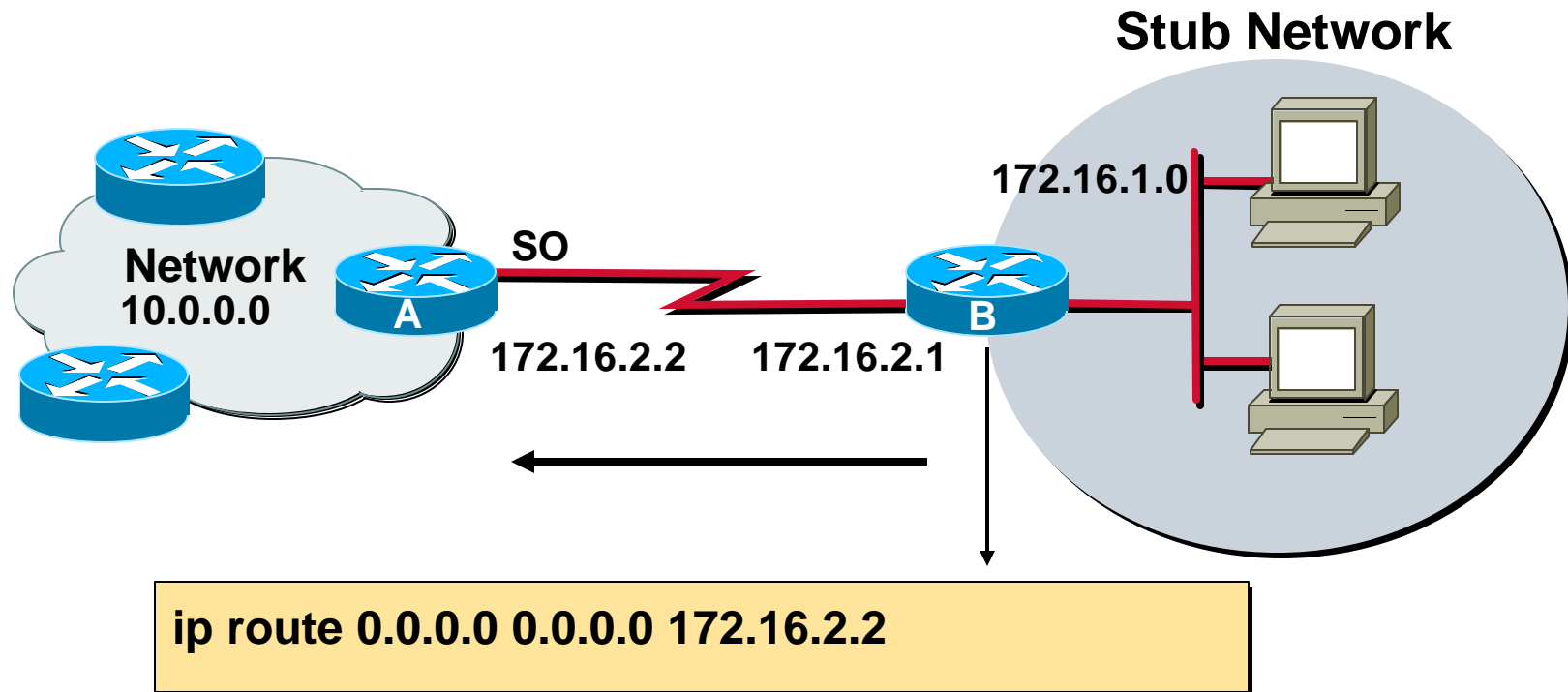


```
ip route 172.16.1.0 255.255.255.0 172.16.2.1
```

- This is a unidirectional route. You must have a route configured in the opposite direction.



# Default Routes

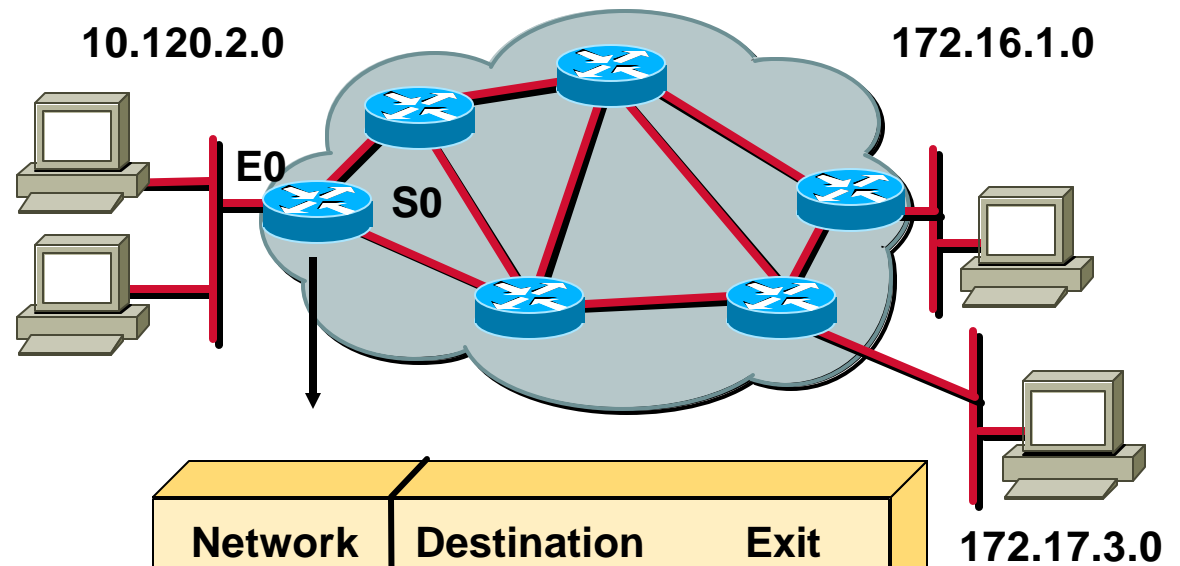


- This route allows the stub network to reach all known networks beyond router A.

# What is a Routing Protocol?

**Routing** protocols are used between routers to determine paths and maintain routing tables.

Once the path is determined a router can route a **routed** protocol.



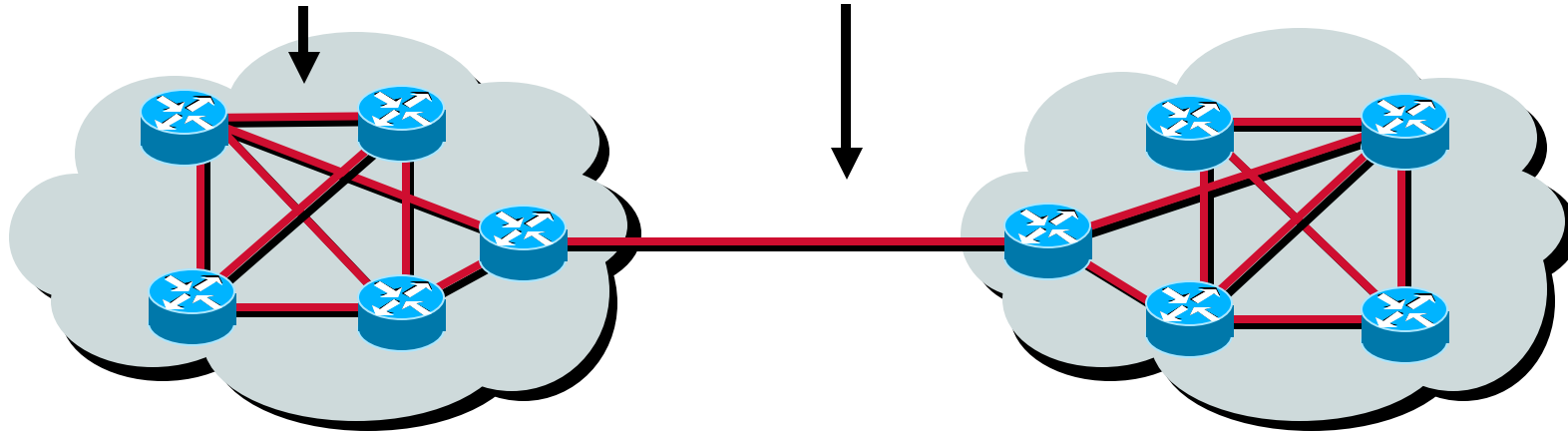
Network Protocol	Destination Network	Exit Interface
Connected	10.120.2.0	E0
RIP	172.16.2.0	S0
IGRP	172.17.3.0	S1

**Routed Protocol: IP**  
**Routing protocol: RIP, IGRP**

# Autonomous Systems: Interior or Exterior Routing Protocols

**IGPs: RIP, IGRP**

**EGPs: BGP**

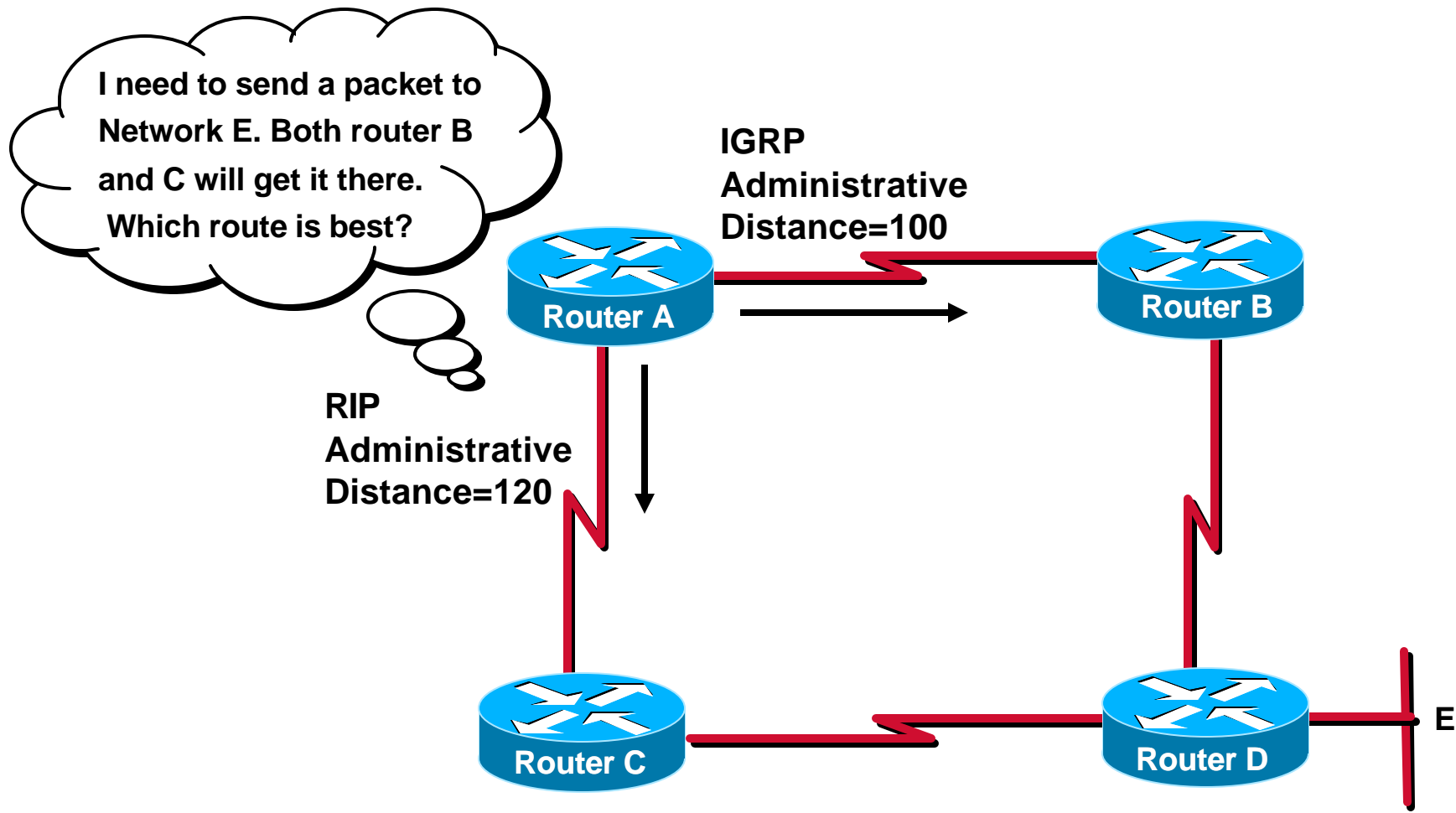


**Autonomous System 100**

**Autonomous System 200**

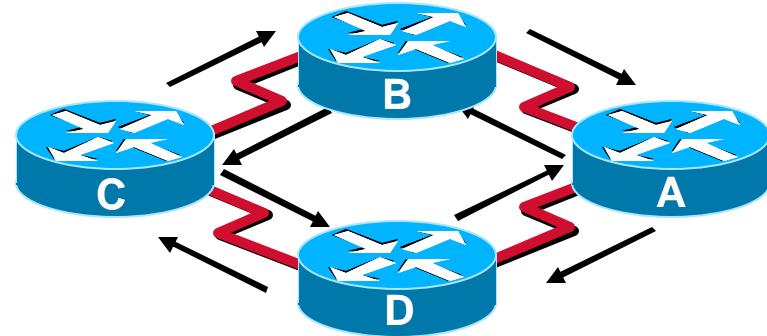
- An autonomous system is a collection of networks under a common administrative domain
- IGPs operate within an autonomous system
- EGPs connect different autonomous systems

# Administrative Distance: Ranking Routes

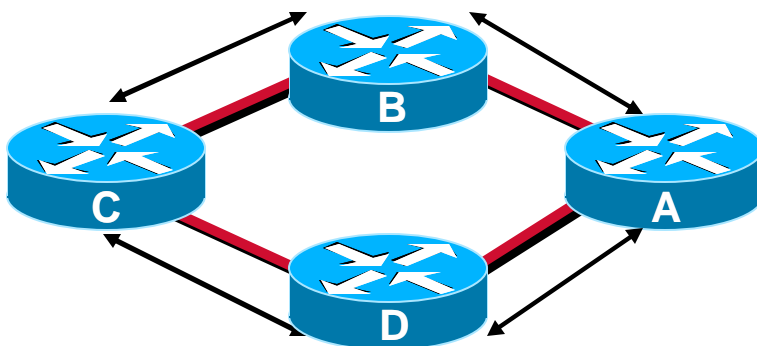


# Classes of Routing Protocols

Distance Vector

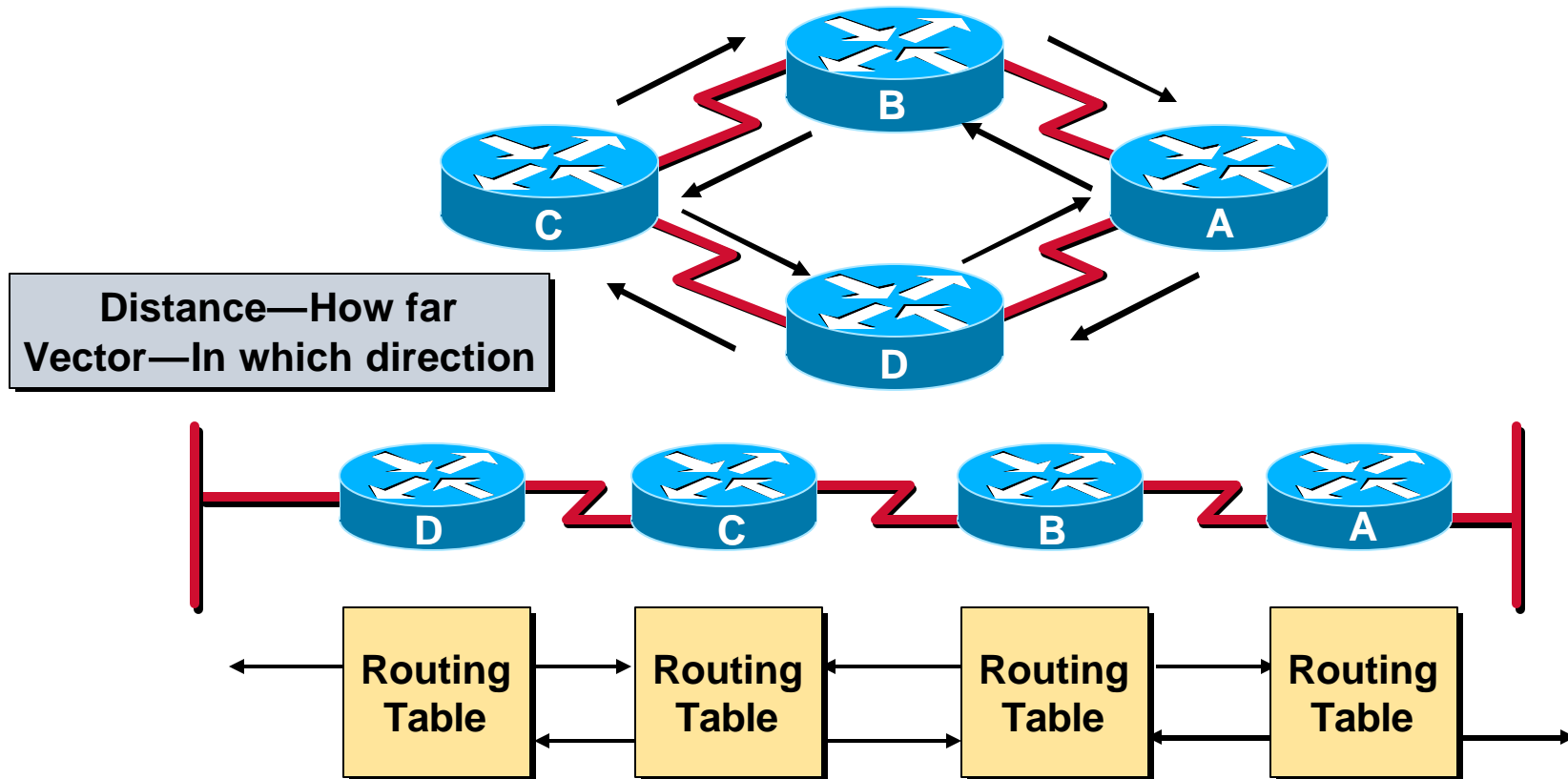


Hybrid Routing



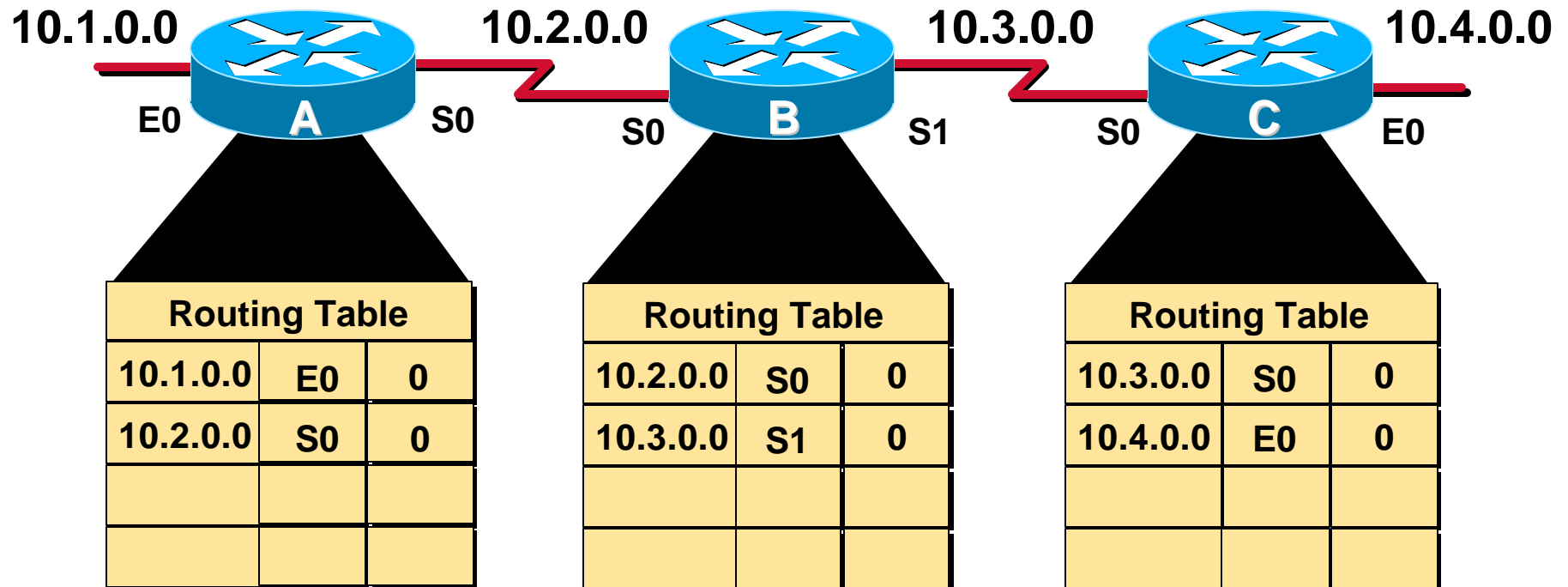
Link State

# Distance Vector Routing Protocols



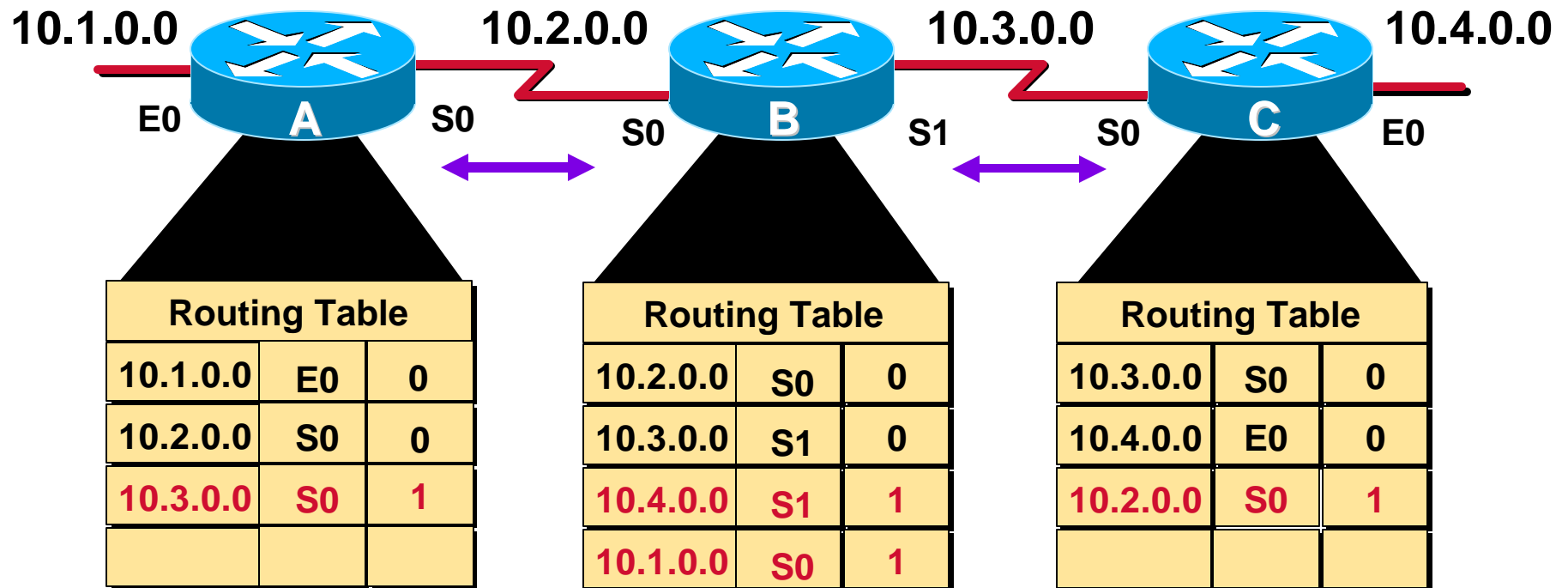
**Pass periodic copies of routing table to neighbor routers and accumulate distance vectors**

# Distance Vector—Sources of Information and Discovering Routes



**Routers discover the best path to destinations from each neighbor**

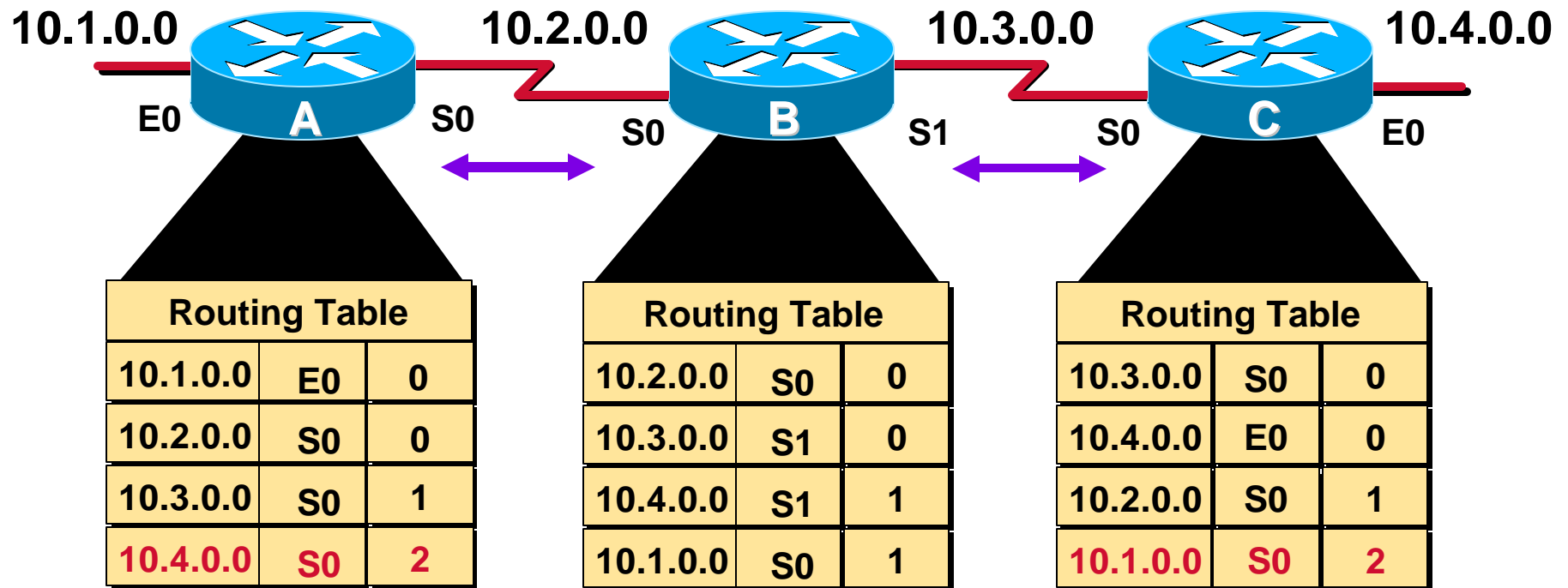
# Distance Vector—Sources of Information and Discovering Routes



**Routers discover the best path to destinations from each neighbor**

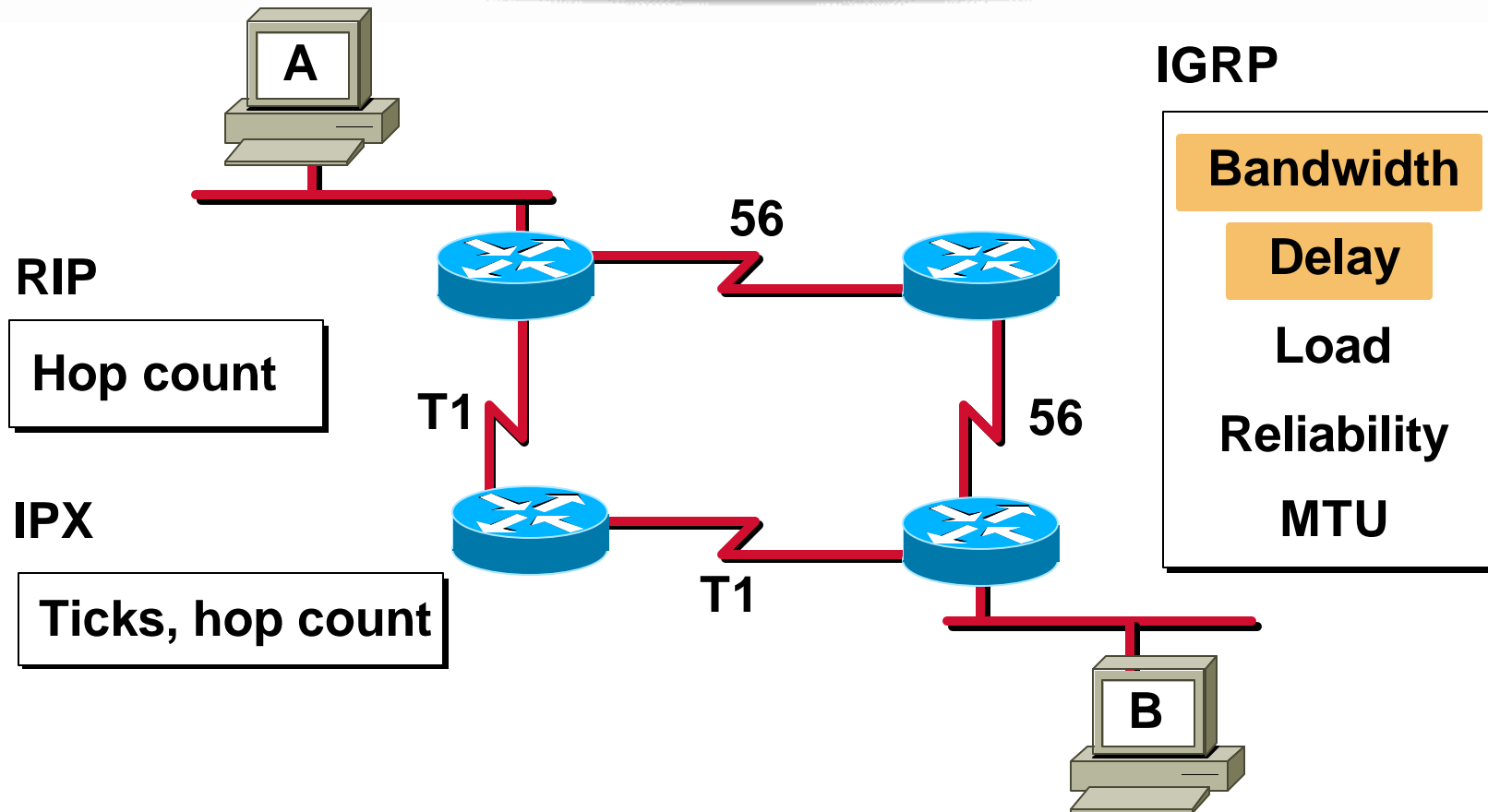


# Distance Vector—Sources of Information and Discovering Routes



Routers discover the best path to destinations from each neighbor

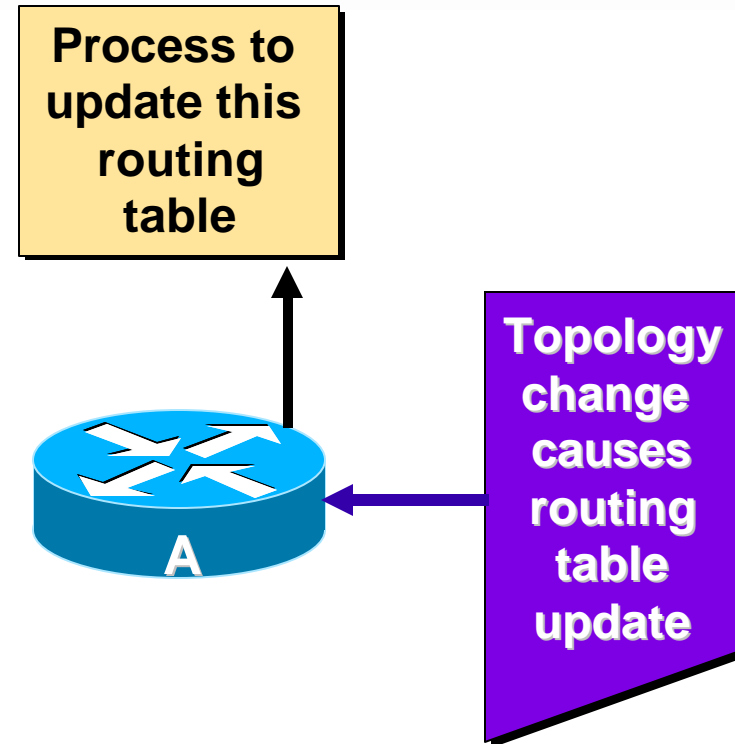
# Distance Vector—Selecting Best Route with Metrics



Information used to select the best path for routing

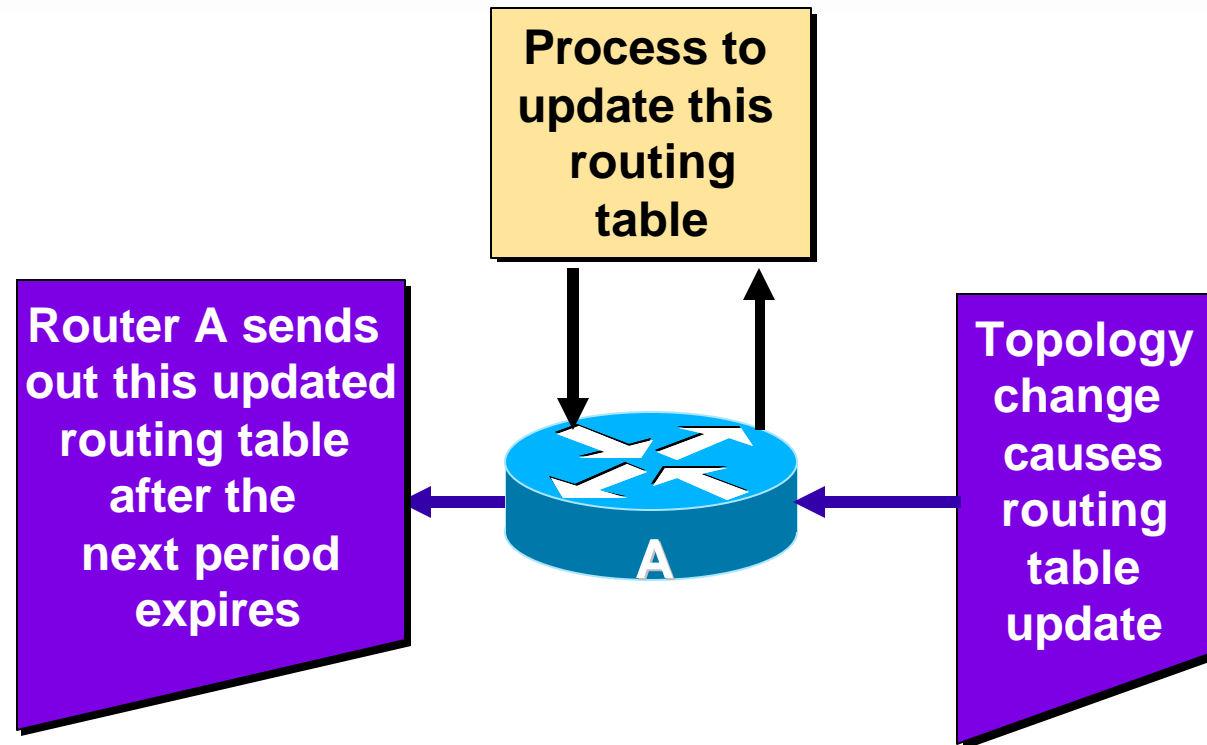
**Do not delete**

# Distance Vector—Maintaining Routing Information



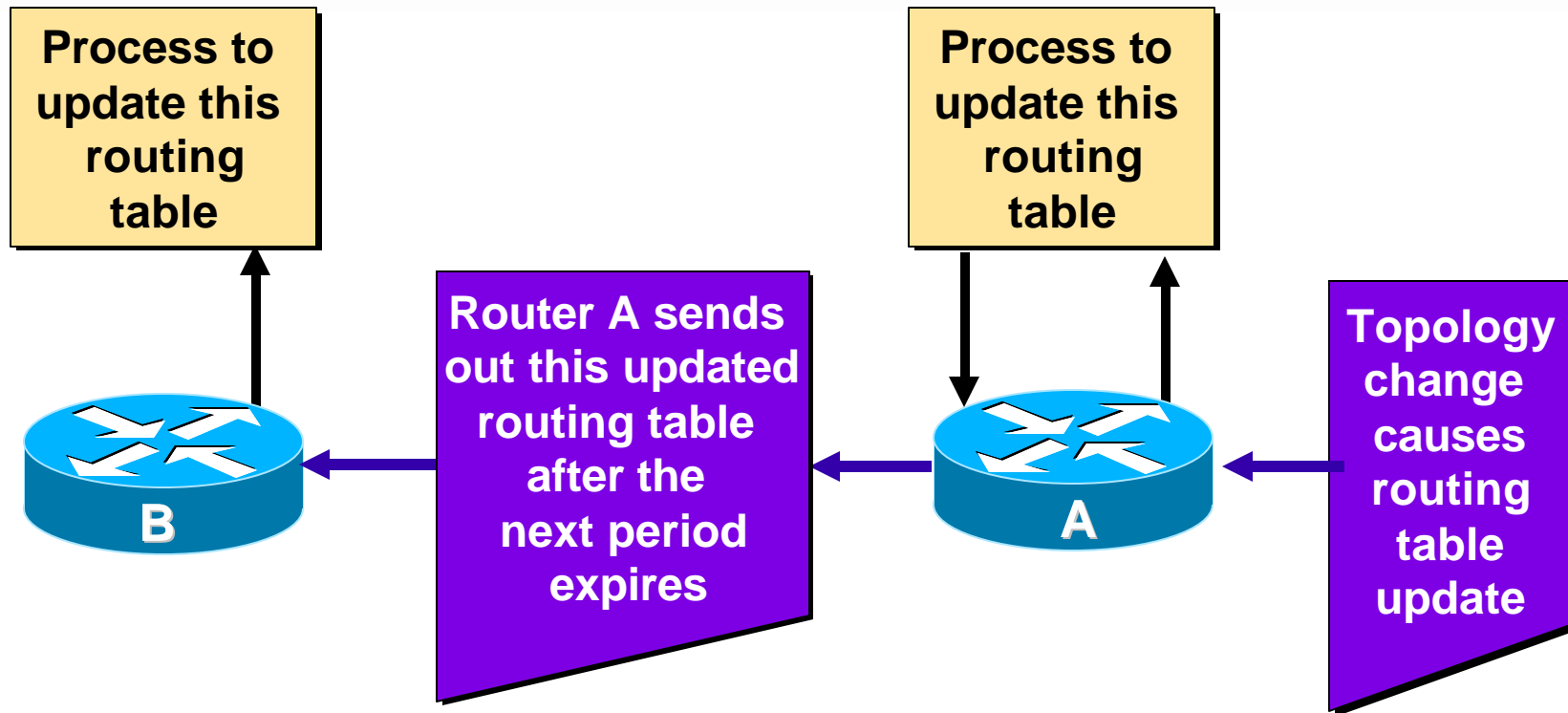
**Updates proceed step-by-step  
from router to router**

# Distance Vector—Maintaining Routing Information



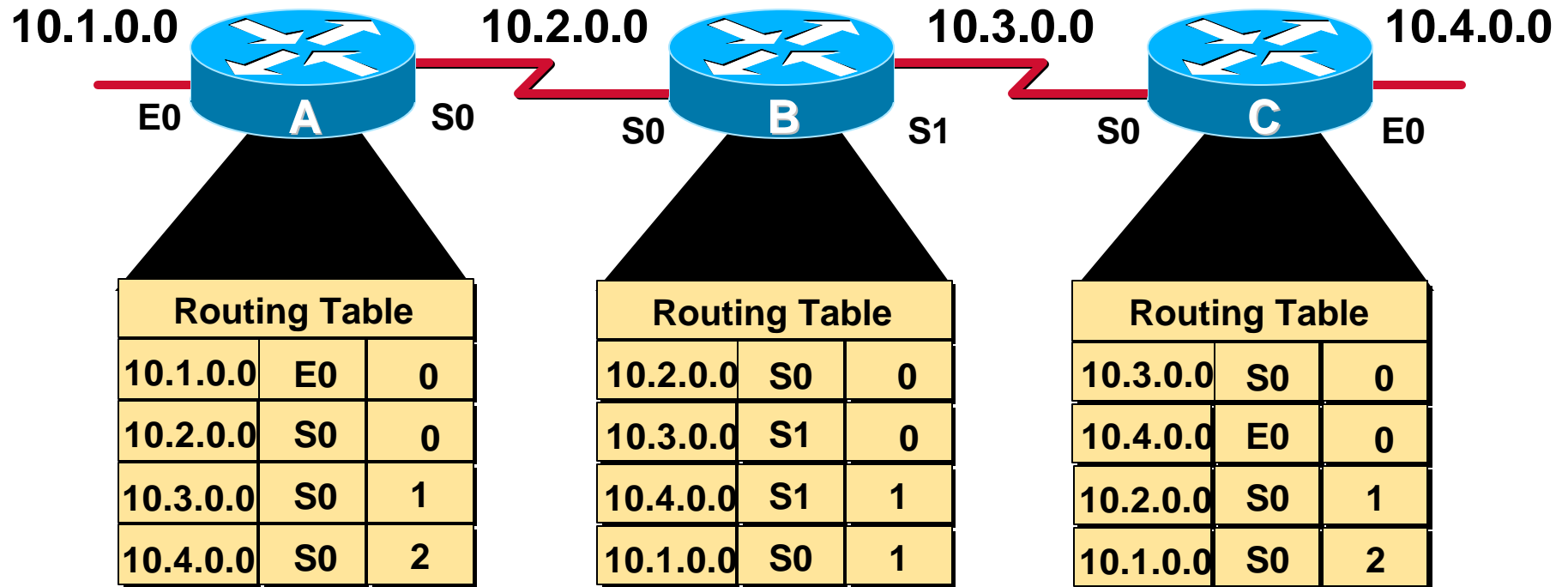
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# Distance Vector—Maintaining Routing Information



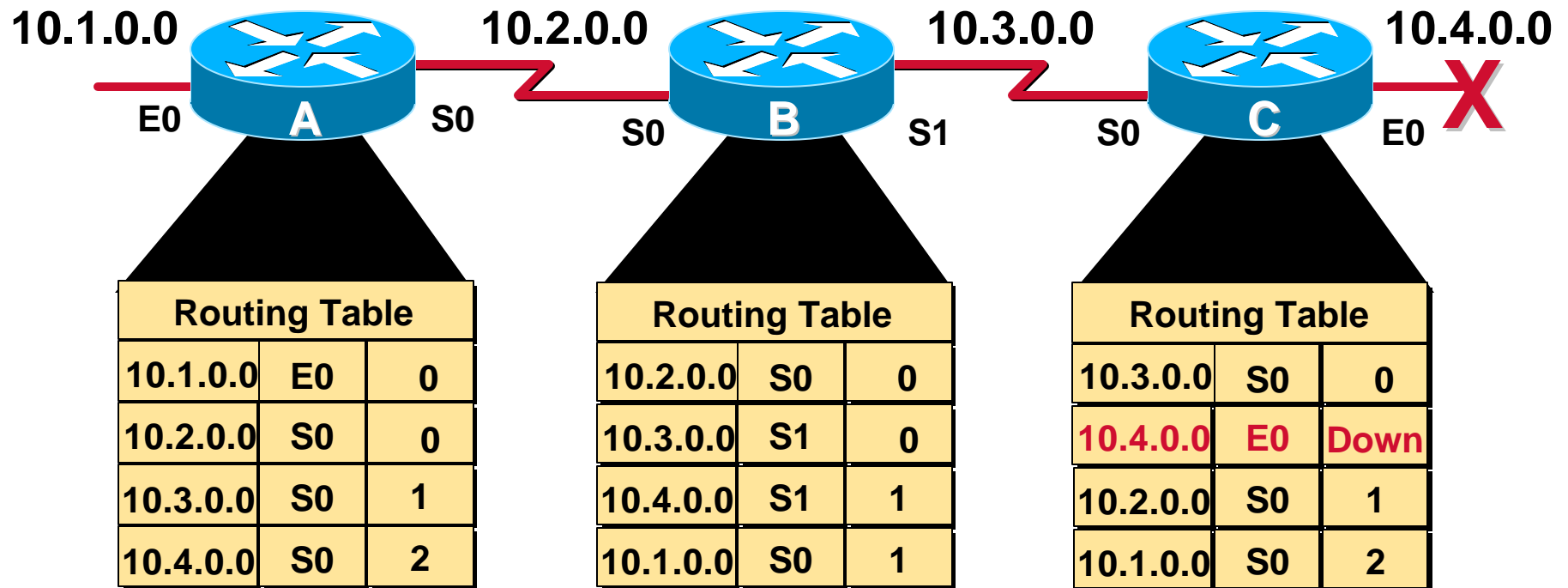
**Updates proceed step-by-step  
from router to router**

# Maintaining Routing Information Problem—Routing Loops



Each node maintains the distance from itself to each possible destination network

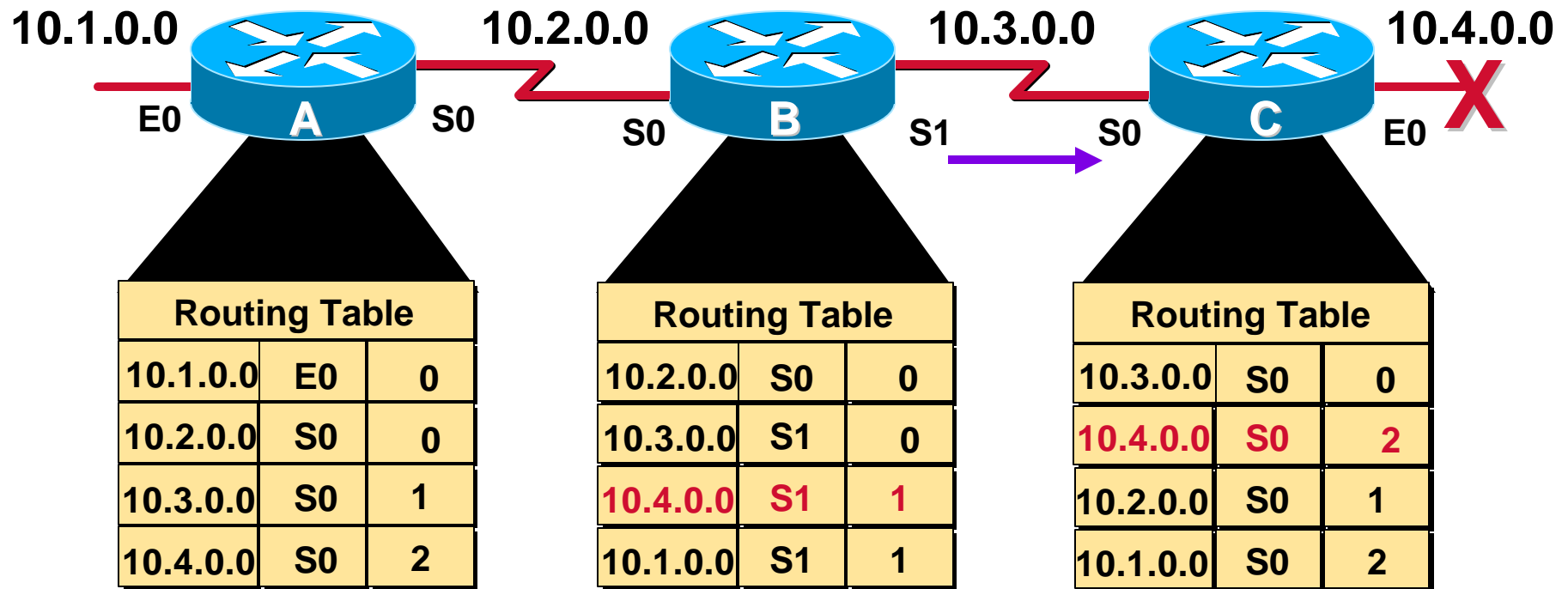
# Maintaining Routing Information Problem—Routing Loops



**Slow convergence produces inconsistent routing**

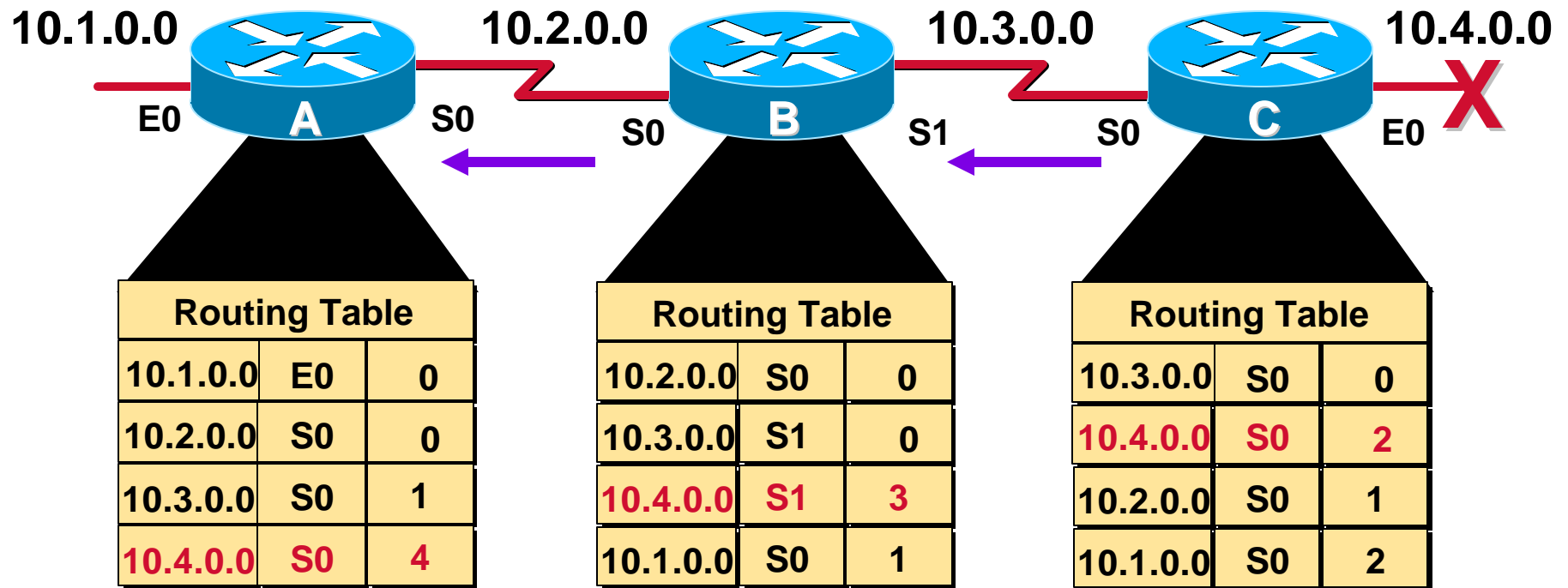


# Maintaining Routing Information Problem—Routing Loops



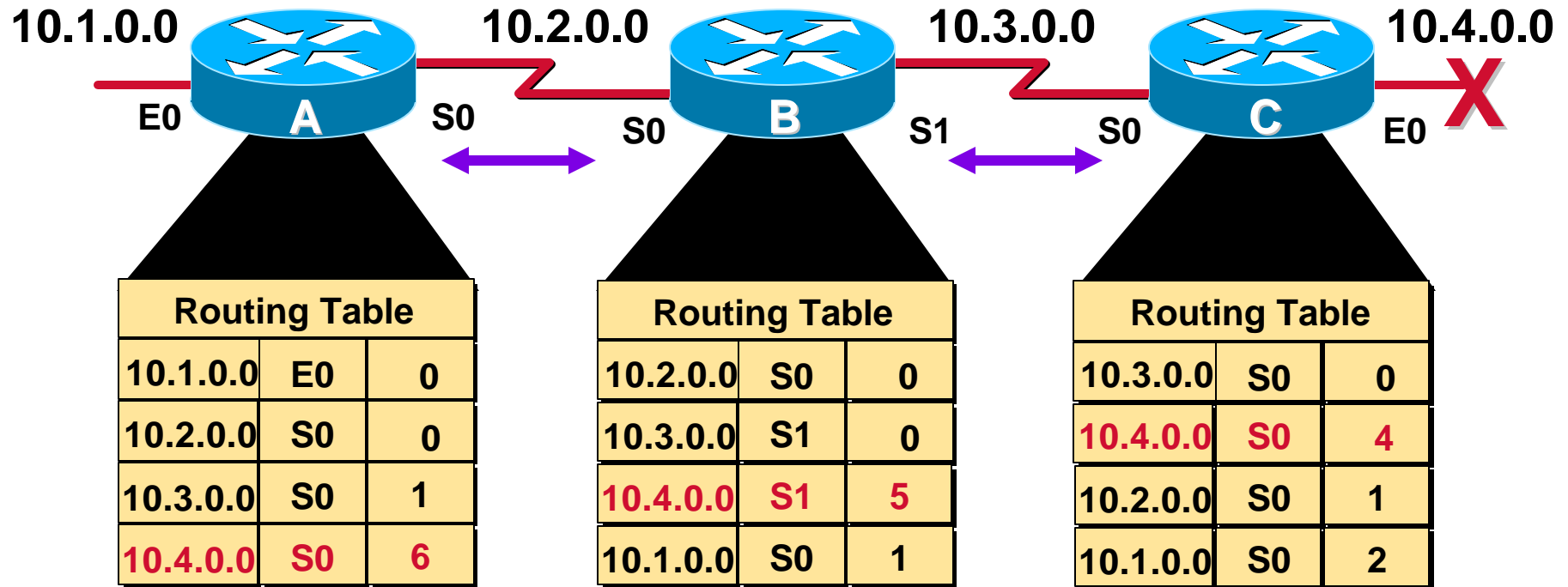
**Router C concludes that the best path to network 10.4.0.0 is through Router B**

# Maintaining Routing Information Problem—Routing Loops



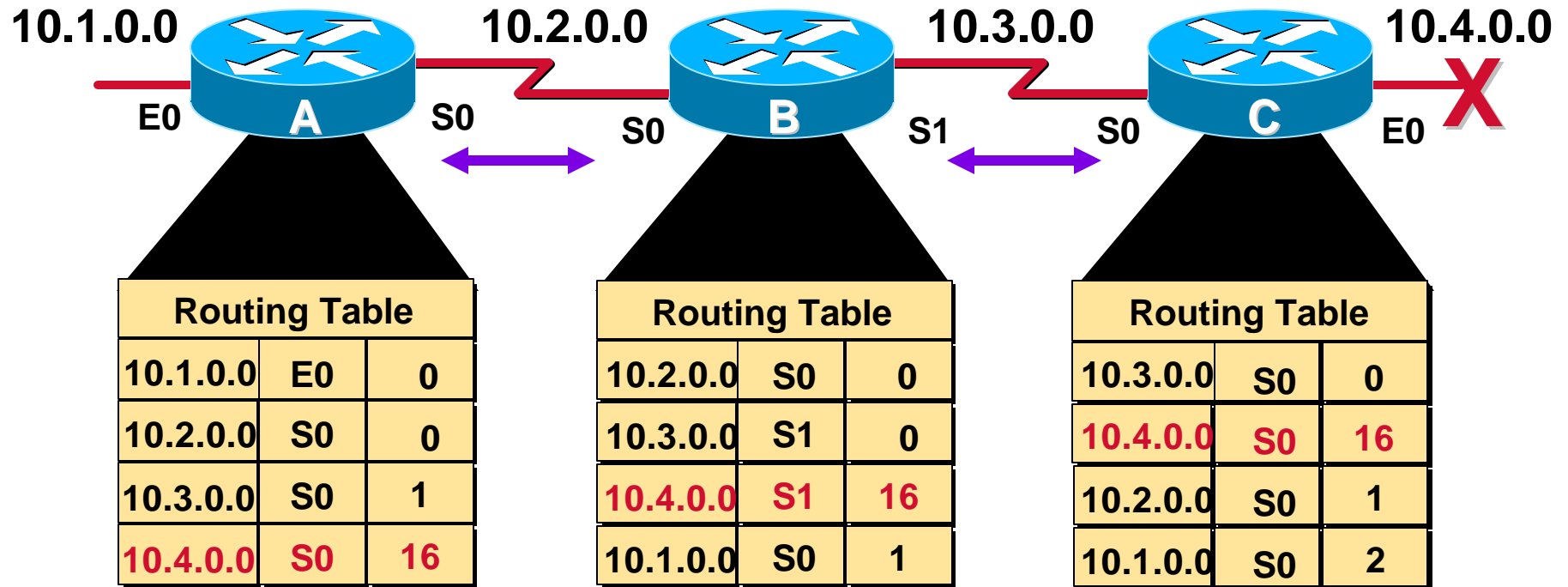
Router A updates its table to reflect the new but erroneous hop count

# Symptom: Counting to Infinity



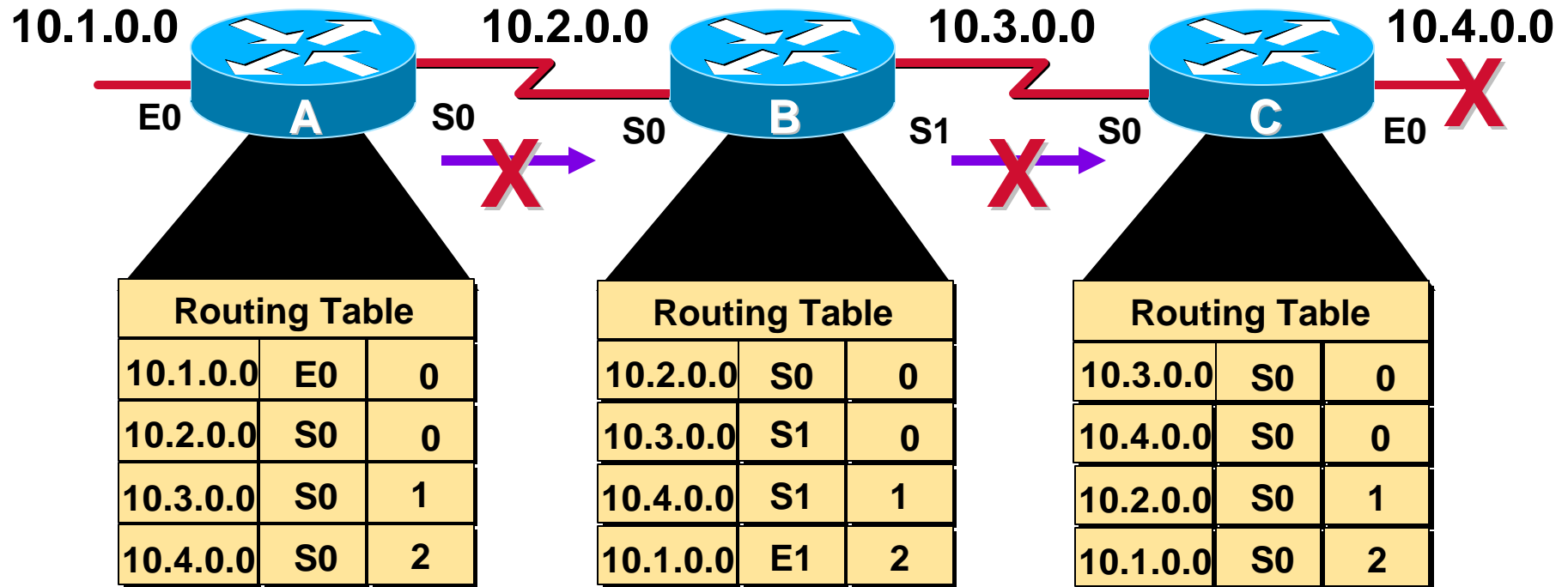
- Packets for network 10.4.0.0 bounce between routers A, B, and C
- Hop count for network 10.4.0.0 counts to infinity

# Solution: Defining a Maximum



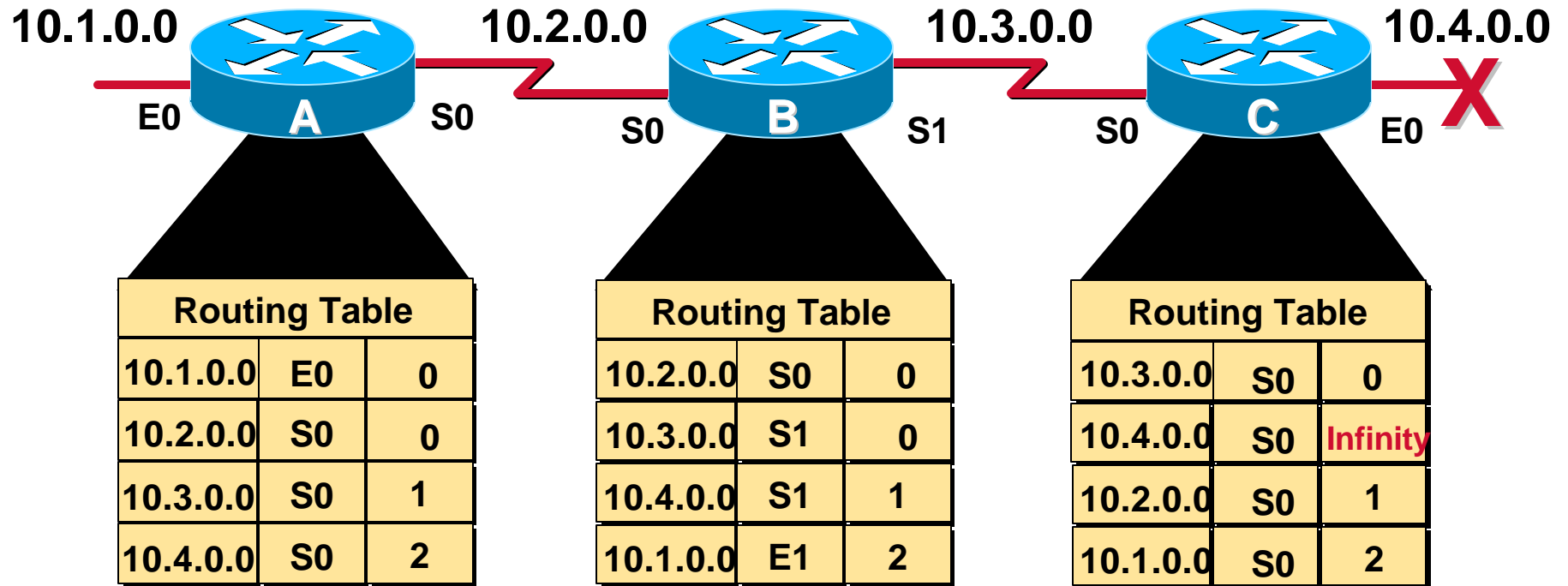
**Define a limit on the number of hops to prevent infinite loops**

# Solution: Split Horizon



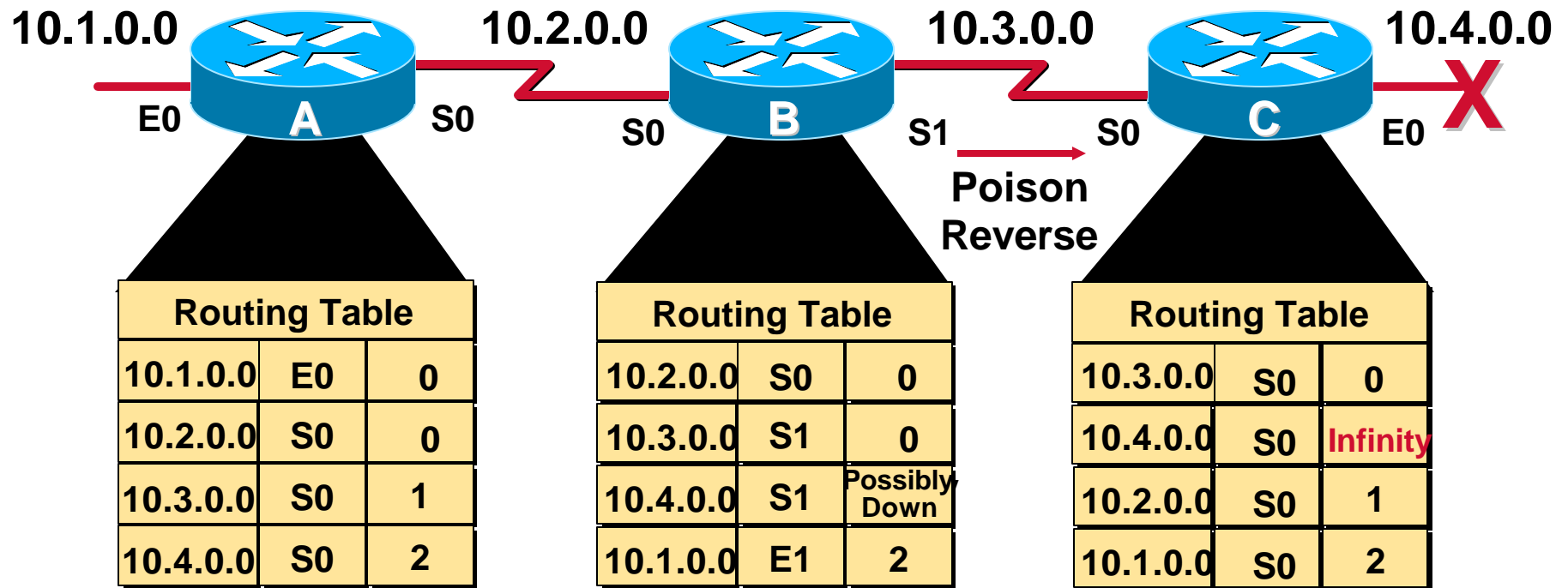
**It is never useful to send information about a route back in the direction from which the original packet came**

# Solution: Route Poisoning



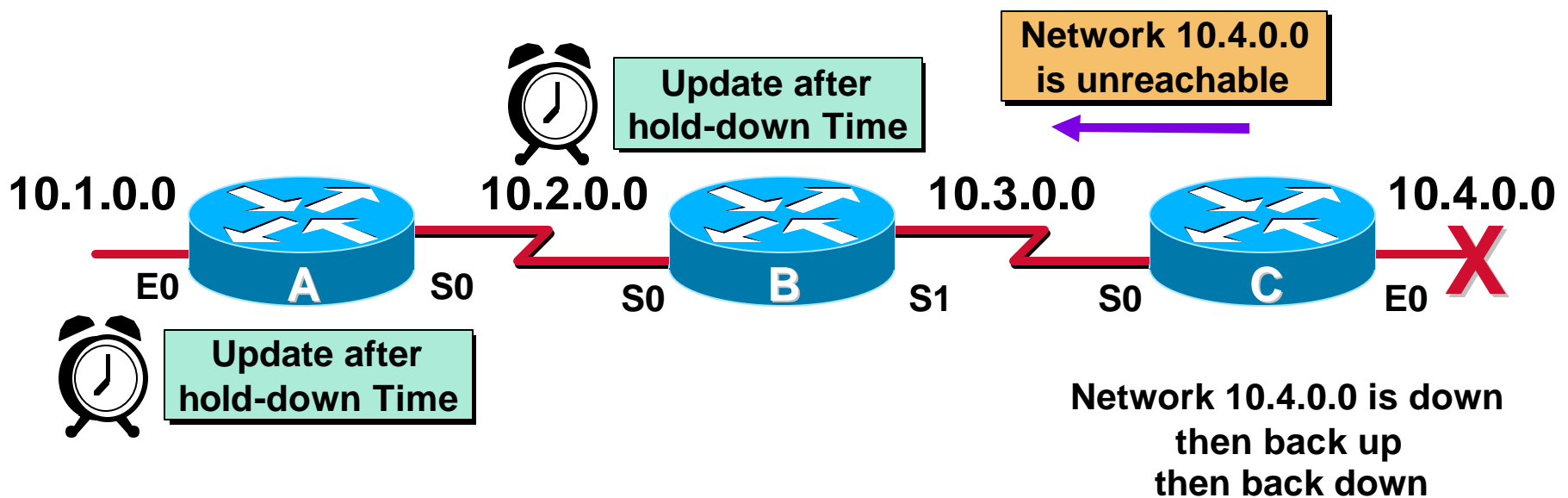
Routers set the distance of routes that have gone down to infinity

# Solution: Poison Reverse



**Poison Reverse overrides split horizon**

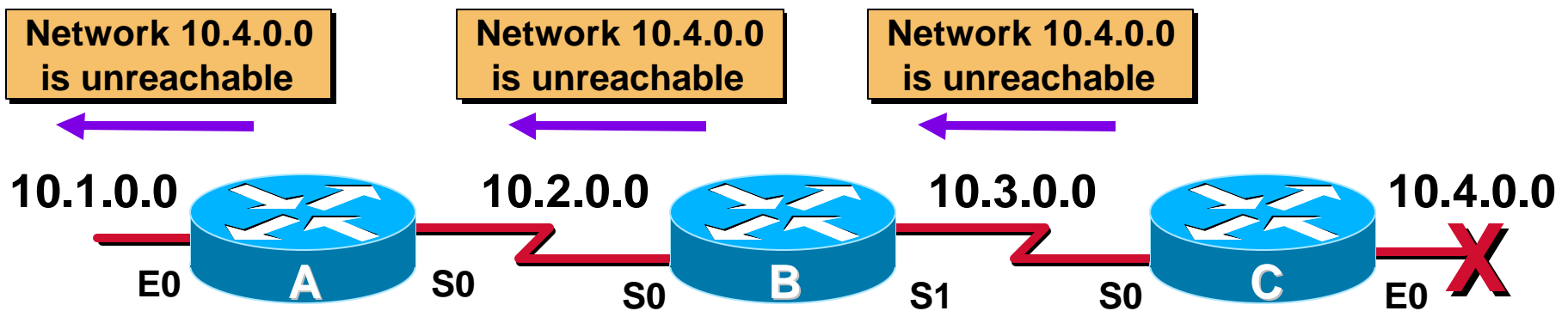
# Solution: Hold-Down Timers



Router keeps an entry for the network possibly down state, allowing time for other routers to recompute for this topology change

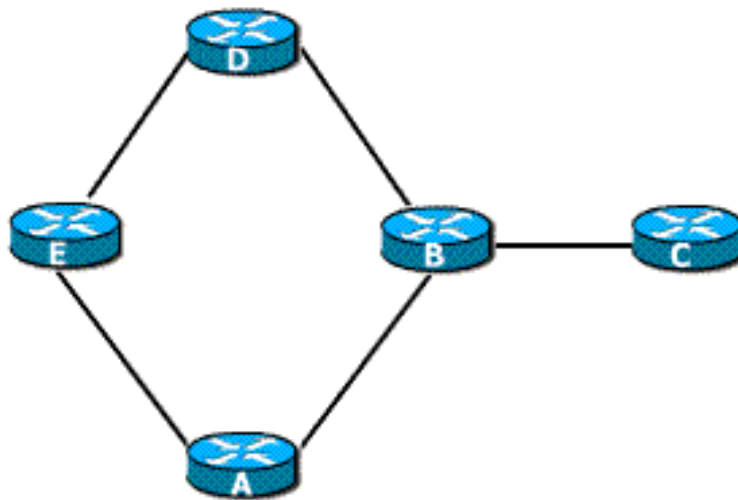


# Solution: Triggered Updates

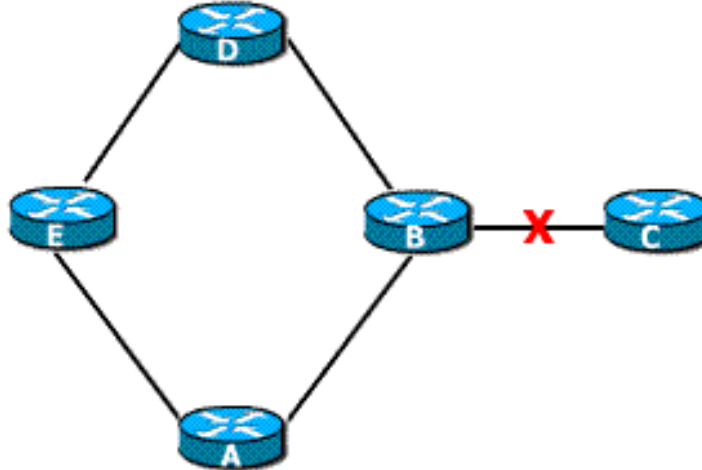


Router sends updates when a change in its routing table occurs

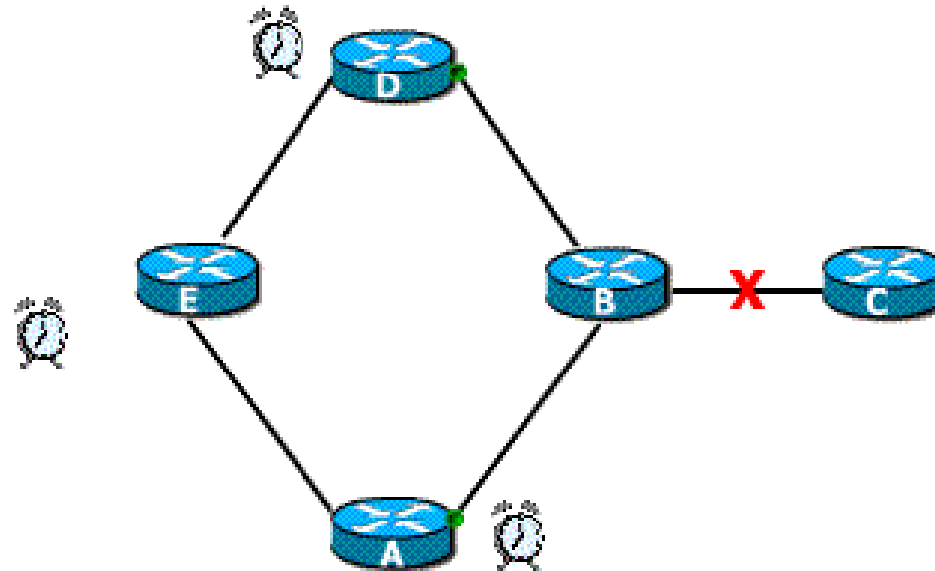
# Implementing Solutions in Multiple Routes



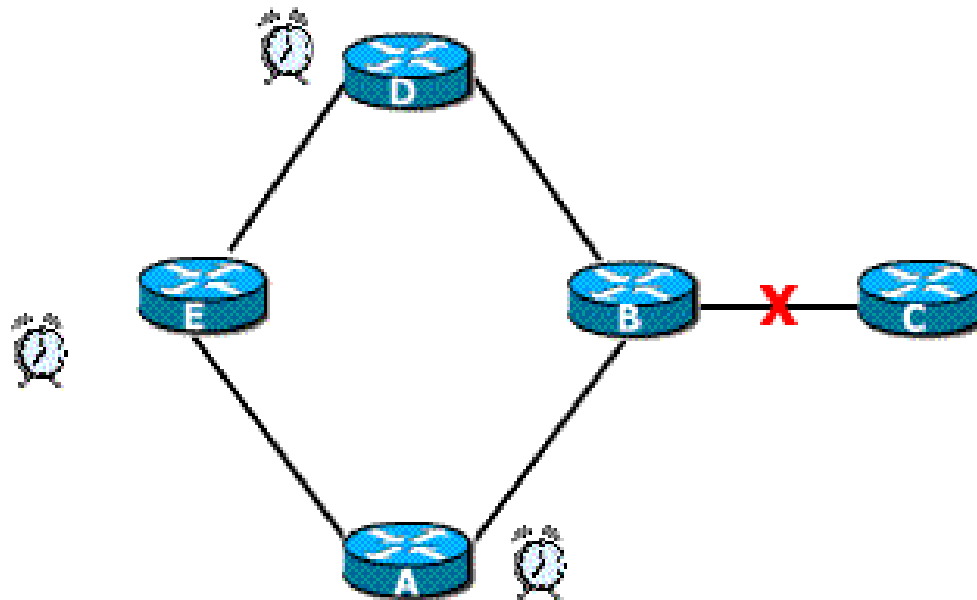
# Implementing Solutions in Multiple Routes (cont.)



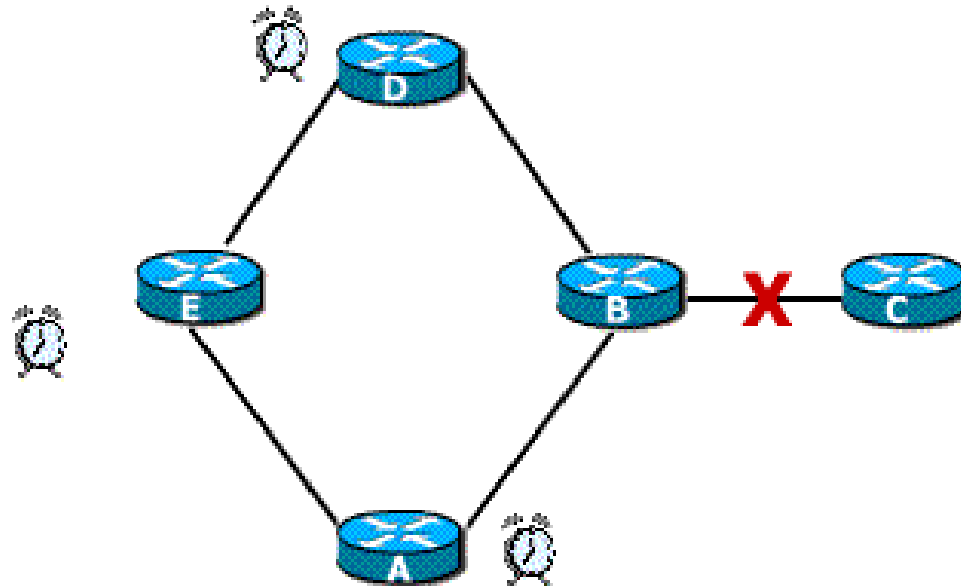
# Implementing Solutions in Multiple Routes (cont.)



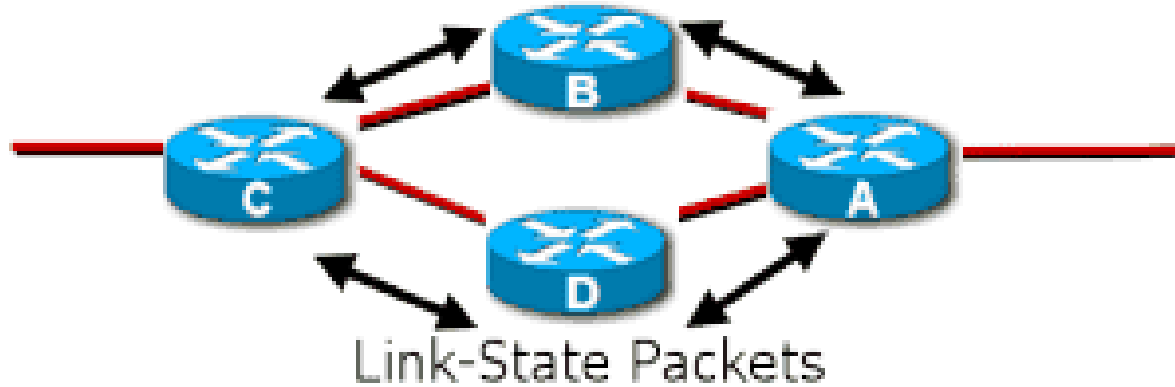
# Implementing Solutions in Multiple Routes (cont.)



# Implementing Solutions in Multiple Routes (cont.)



# Link-State Routing Protocols

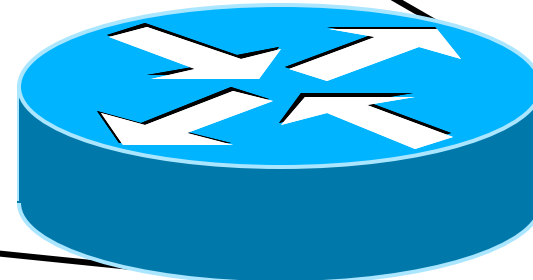


# Hybrid Routing

**Choose a  
routing path based  
on distance vectors**

**Balanced Hybrid Routing**

**Converge rapidly using  
change-based  
updates**



**Share attributes of both distance-vector  
and link-state routing**