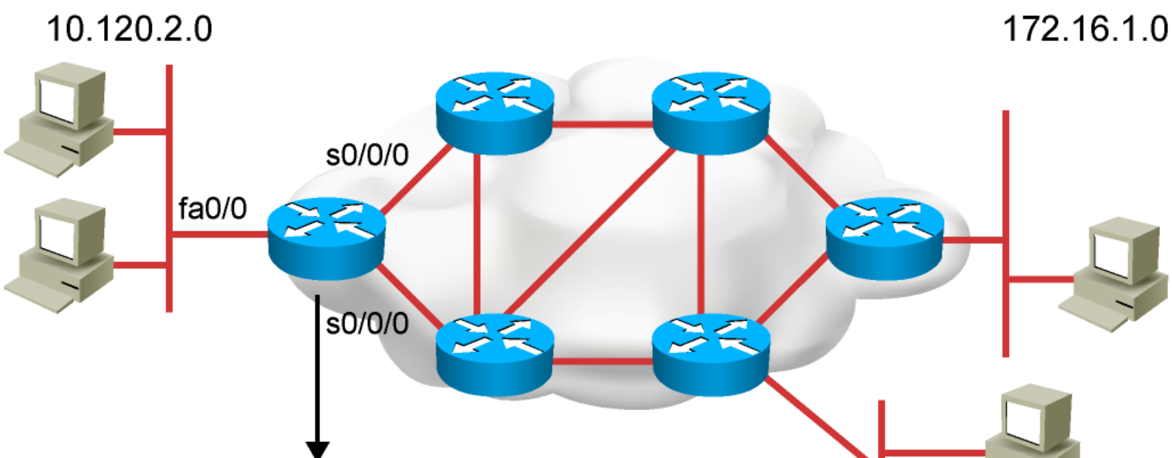
Dynamic Routing Protocol

What Is a Routing Protocol?

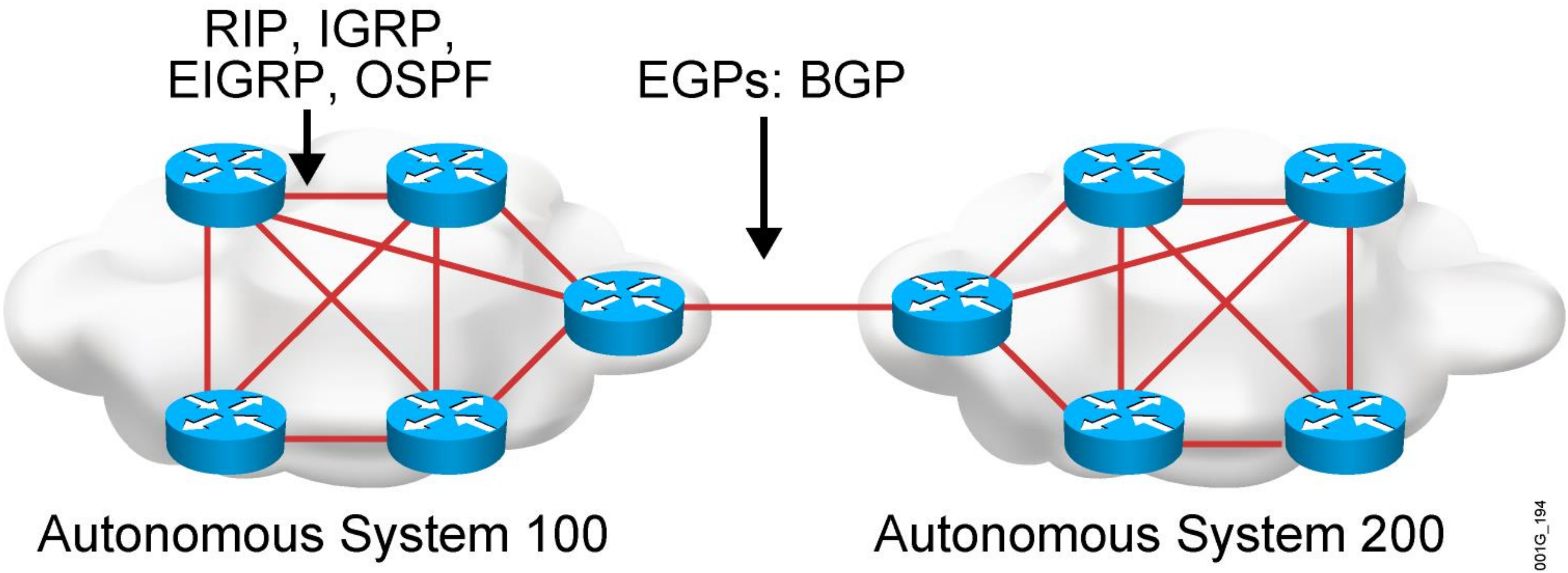
- **Routing protocols are used between routers to determine paths and maintain routing tables.**
- **After the path is determined, a router can route a routed protocol.**



Network Protocol	Destination Network	Exit Interface
Connected	10.120.2.0	fa0/0
RIP	172.16.1.0	s0/0/0
EIGRP	172.17.3.0	s0/0/0

Routed Protocol: IP
Routing Protocol: RIP, EIGRP

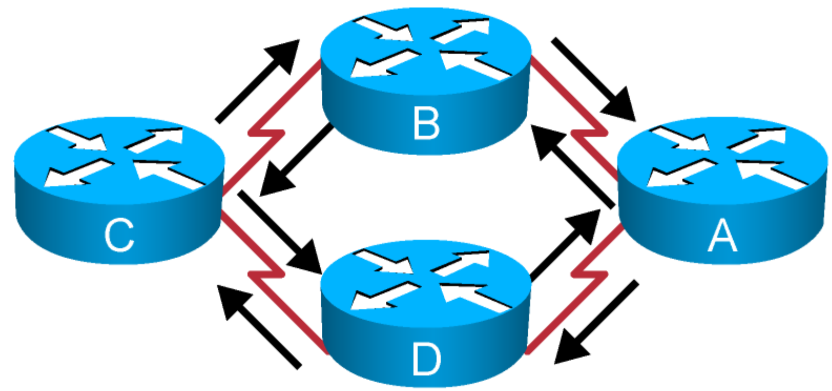
Autonomous Systems: Interior or Exterior Routing Protocols



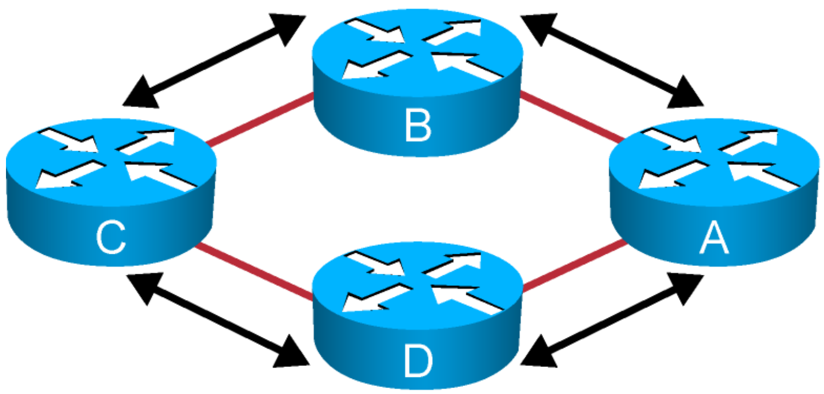
- An autonomous system is a collection of networks under a common administrative domain.
- IGPs operate within an autonomous system.
- EGPs connect different autonomous systems.

Classes of Routing Protocols

Distance Vector



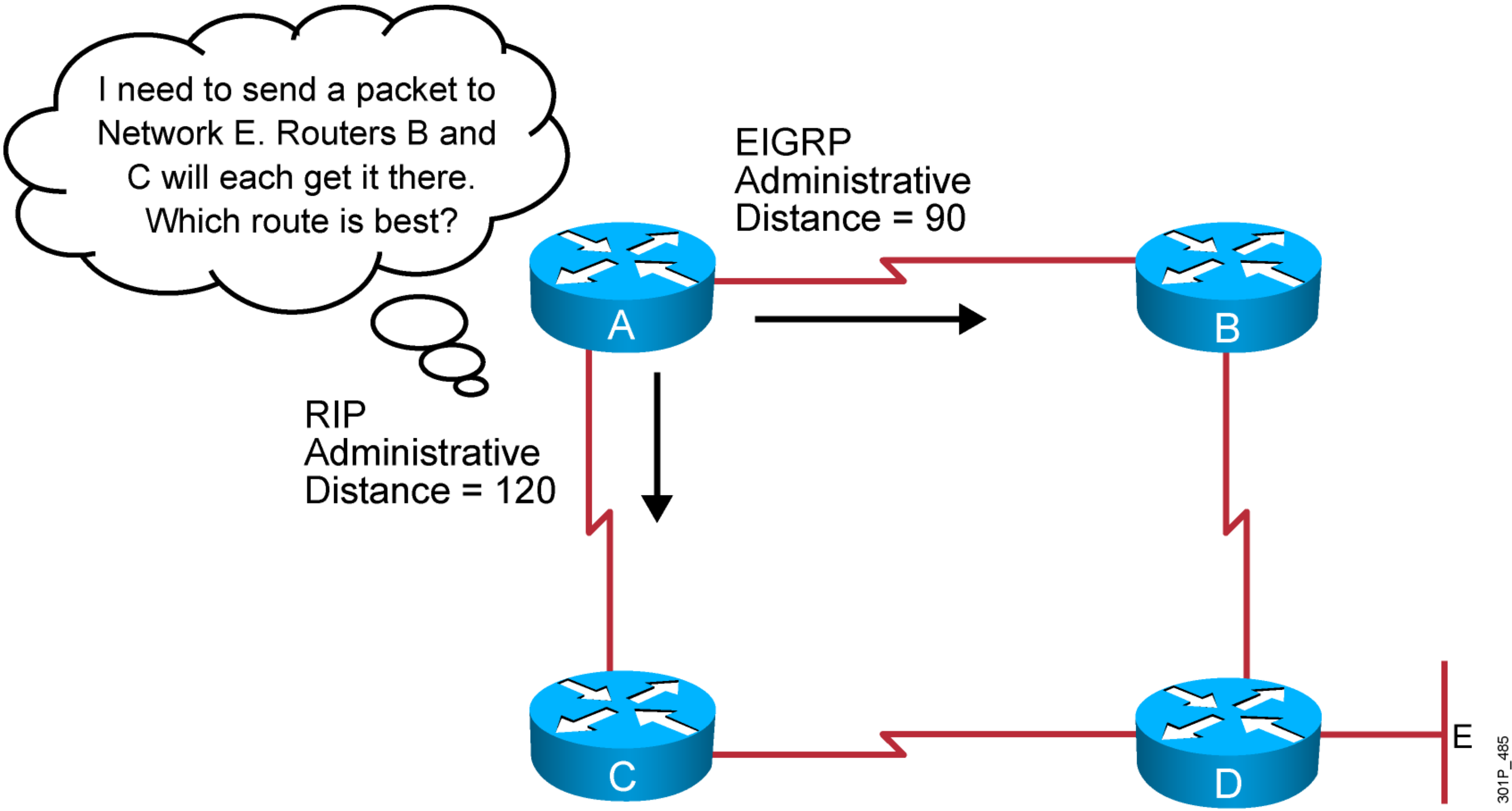
Hybrid Routing



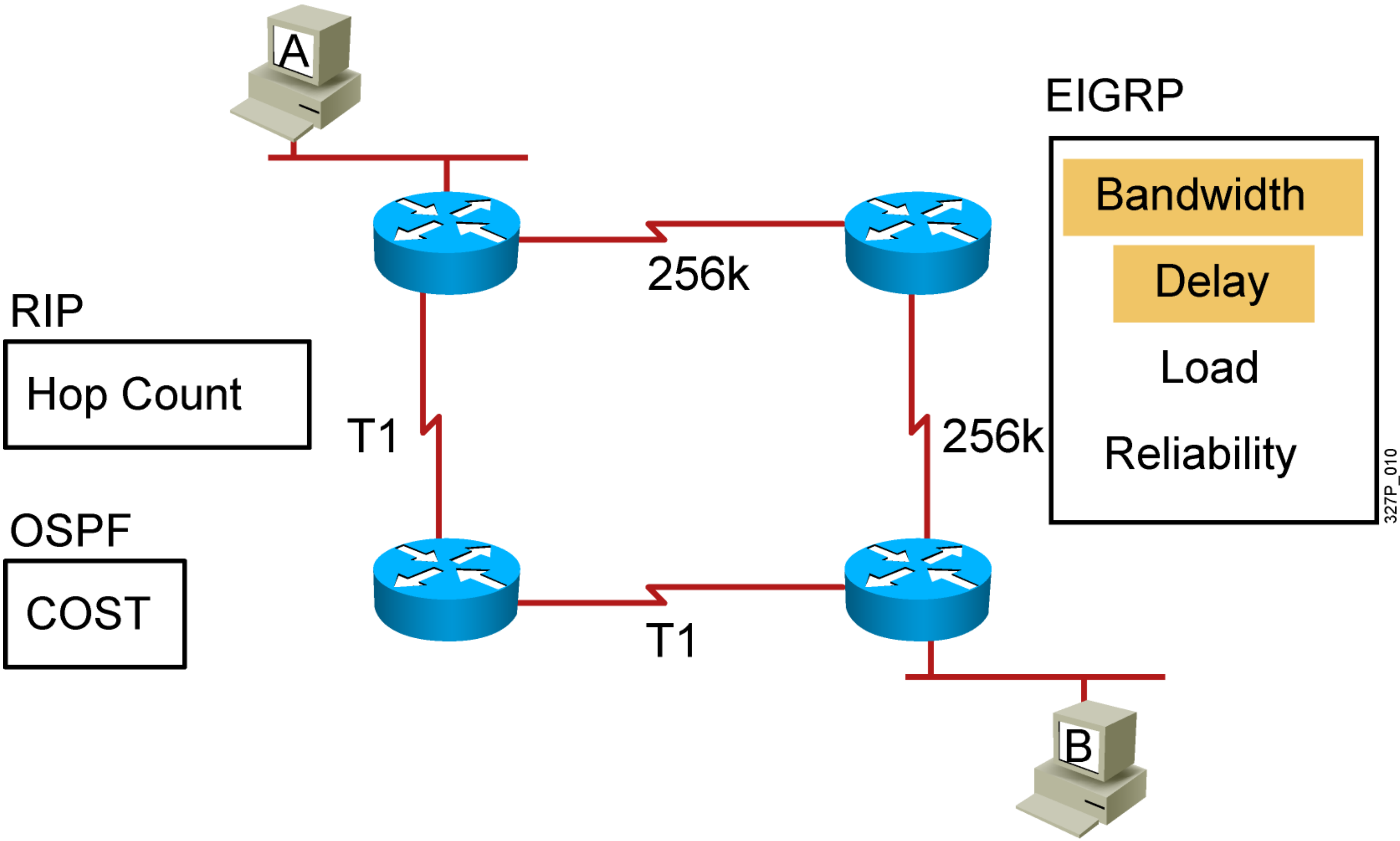
Link-State

301P_196

Administrative Distance: Ranking Routes



Selecting the Best Route Using Metrics



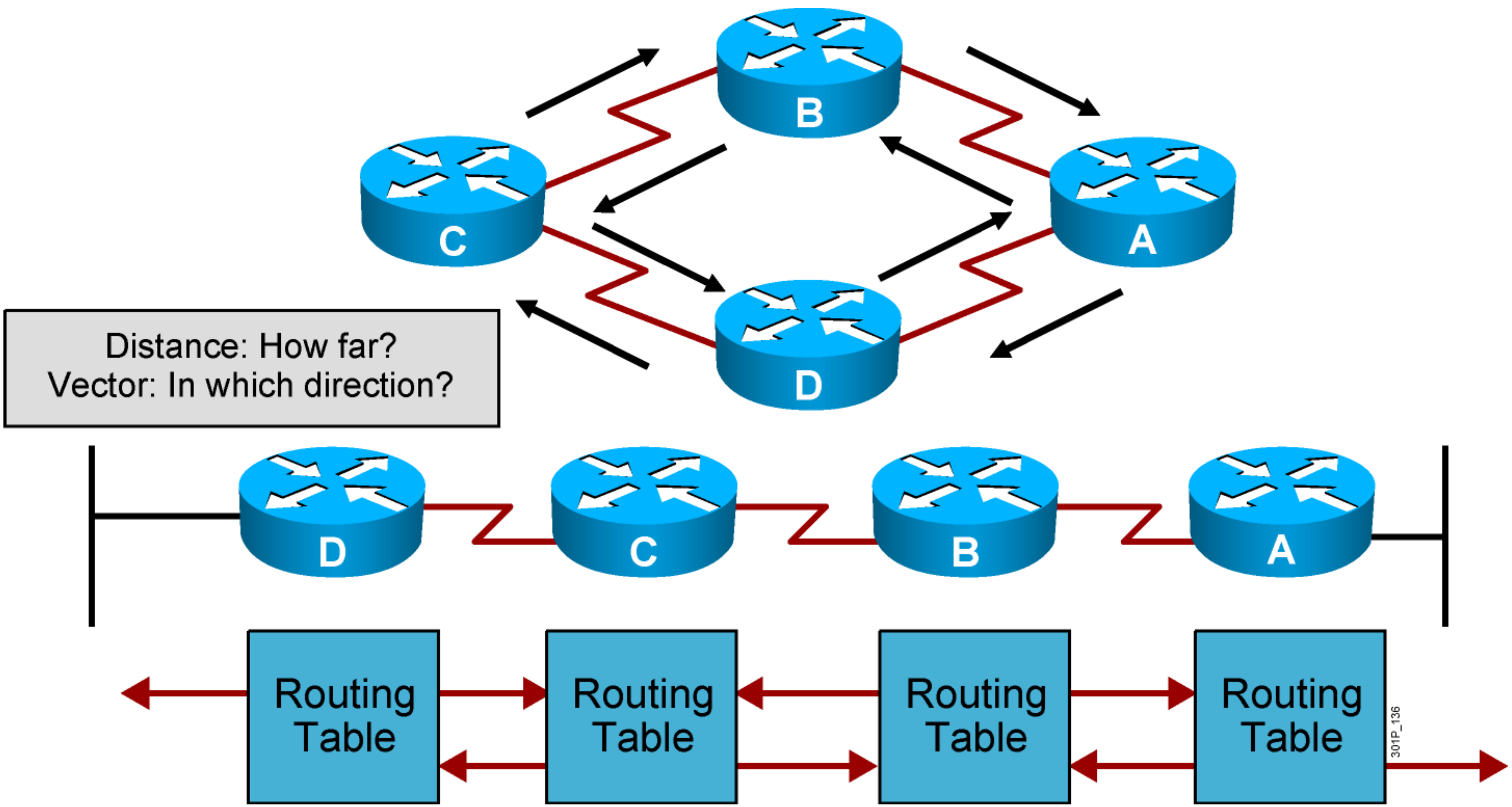
Classful Routing Protocol

- Classful routing protocols do not include the subnet mask with the route advertisement.
- Within the same network, consistency of the subnet masks is assumed.
- Summary routes are exchanged between foreign networks.
- These are examples of classful routing protocols:
  - RIPv1
  - IGRP

Classless Routing Protocol

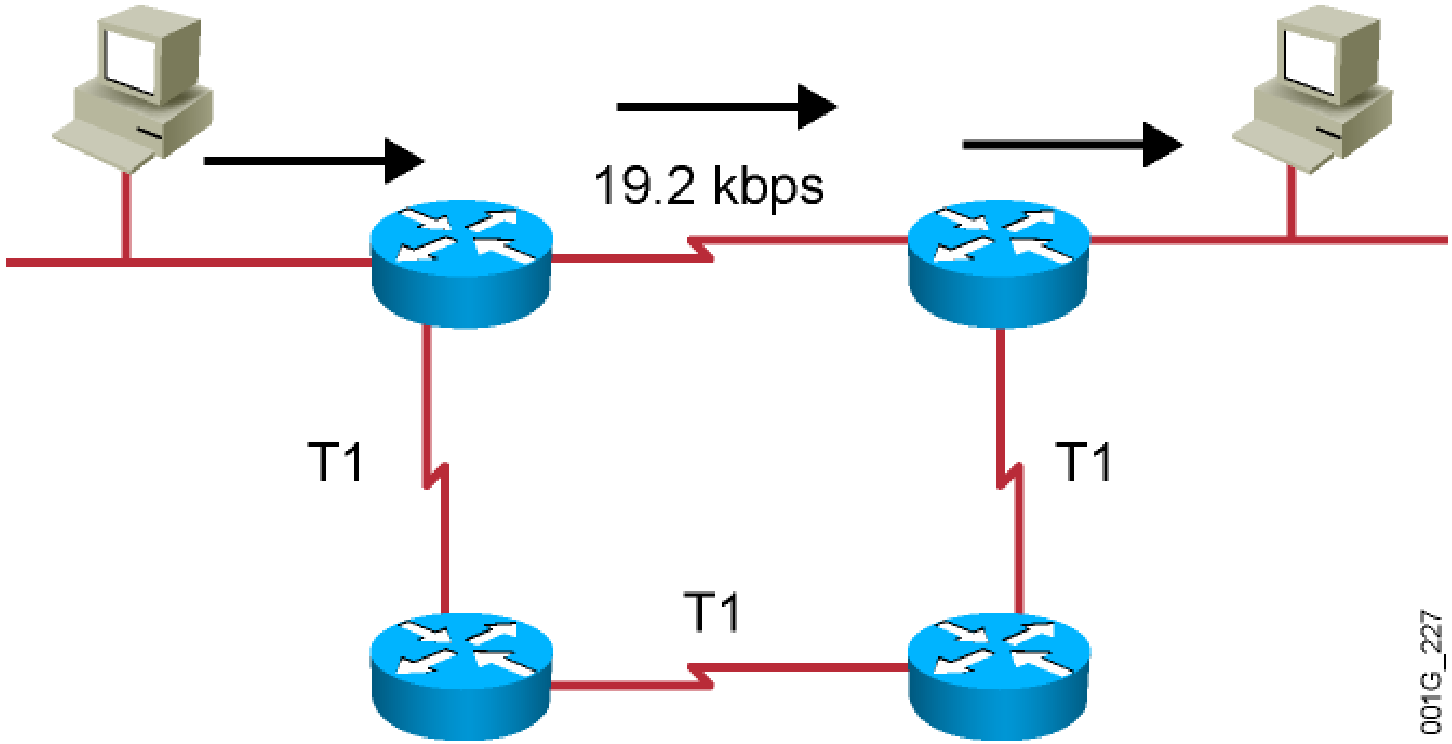
- Classless routing protocols include the subnet mask with the route advertisement.
- Classless routing protocols support a variable-length subnet mask (VLSM).
- Summary routes can be manually controlled within the network.
- These are examples of classless routing protocols:
  - RIPv2
  - EIGRP
  - OSPF
  - IS-IS

Distance Vector Routing Protocols



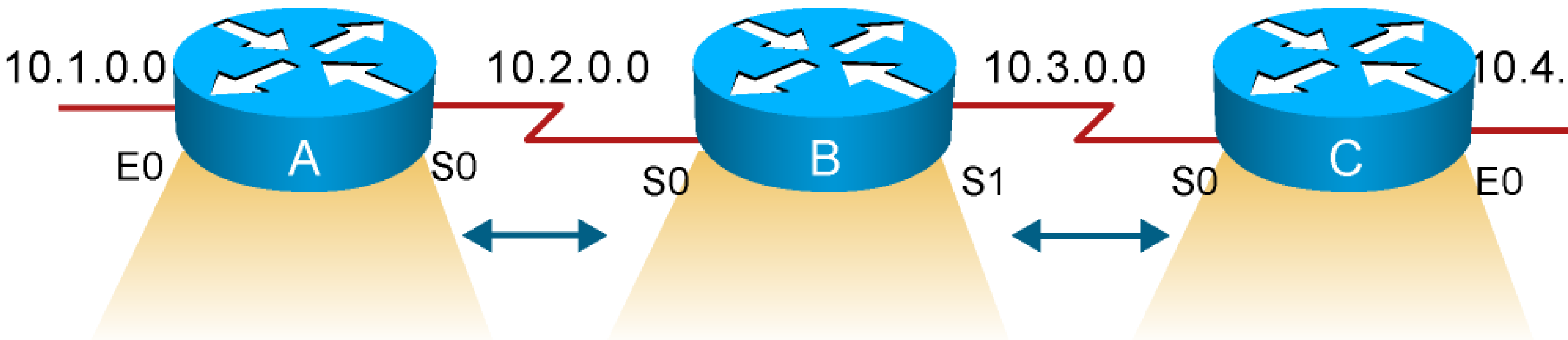
- **Routers pass periodic copies of their routing table to neighboring routers and accumulate distance vectors**

RIP Overview



- Maximum is 16 equal-cost paths (default = 4)
- Hop-count metric selects the path
- Routes update every 30 seconds

Sources of Information and Discovering Routes



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	2

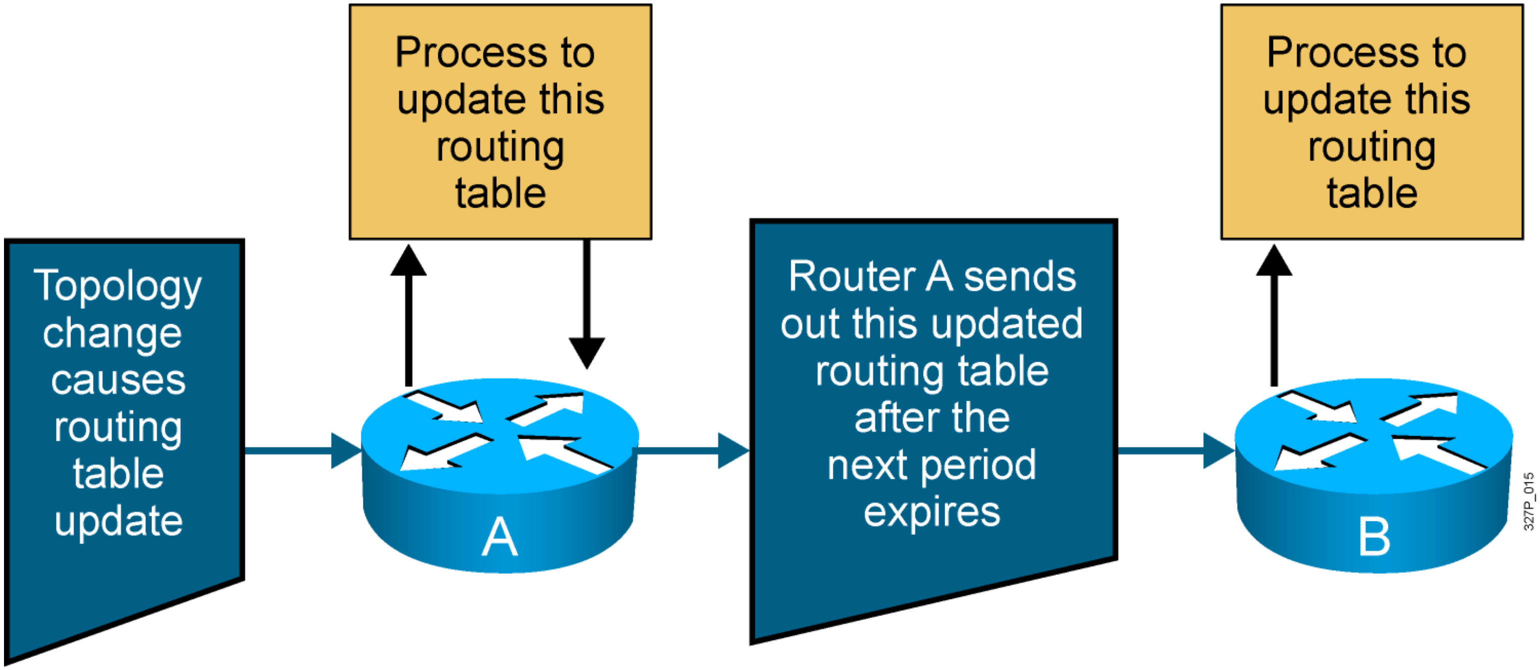
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	1
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	E0	0
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_014

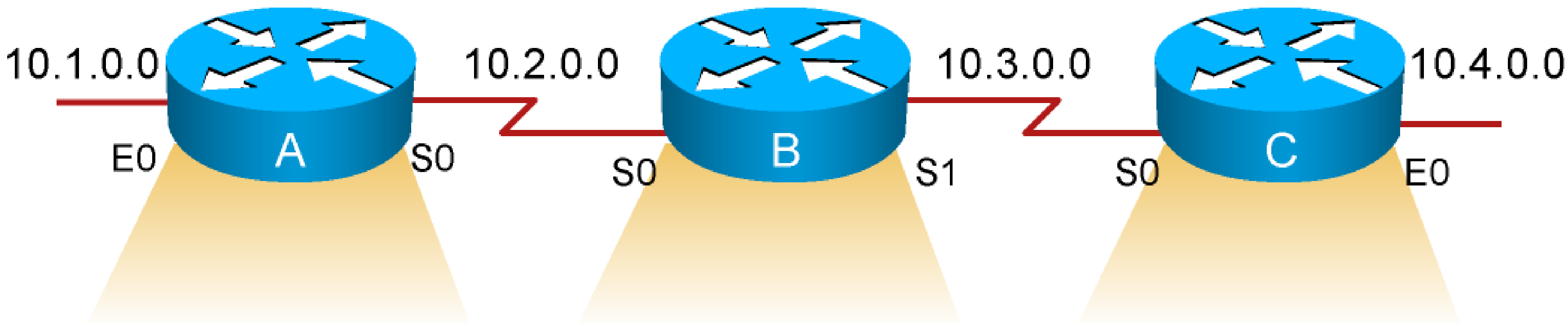
Routers discover the best path to destinations from each neighbor.

Maintaining Routing Information



Updates proceed step by step from router to router.

Inconsistent Routing Entries: Counting to Infinity and Routing Loops



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	2

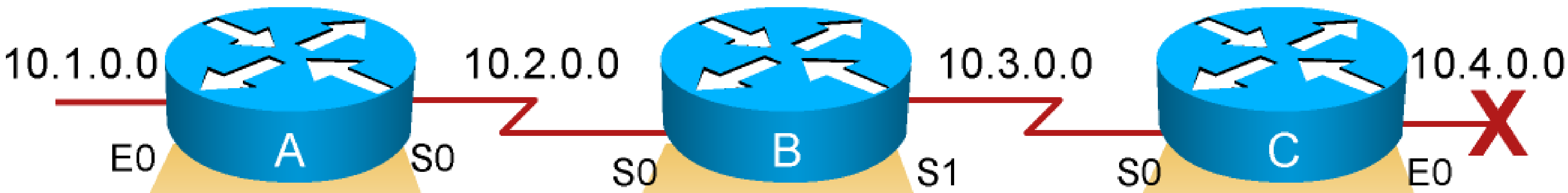
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	1
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	E0	0
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_017

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

Counting to Infinity



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	2

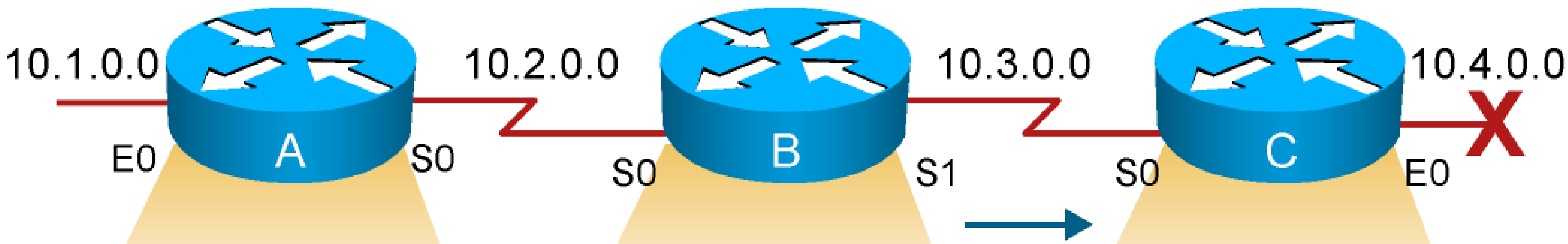
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	1
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	E0	Down
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_016

Slow convergence produces inconsistent routing.

Counting to Infinity (Cont.)



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	2

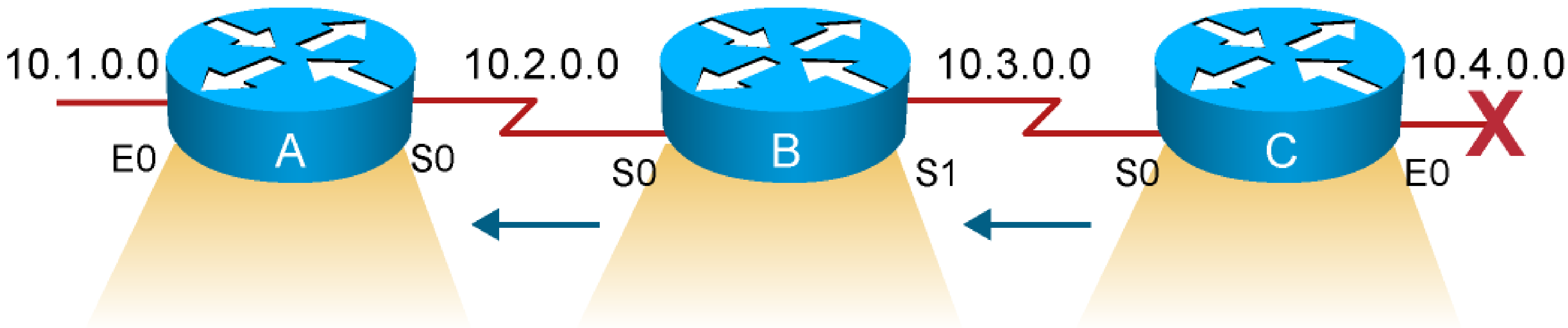
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	1
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	S0	2
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_018

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

Counting to Infinity (Cont.)



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	4

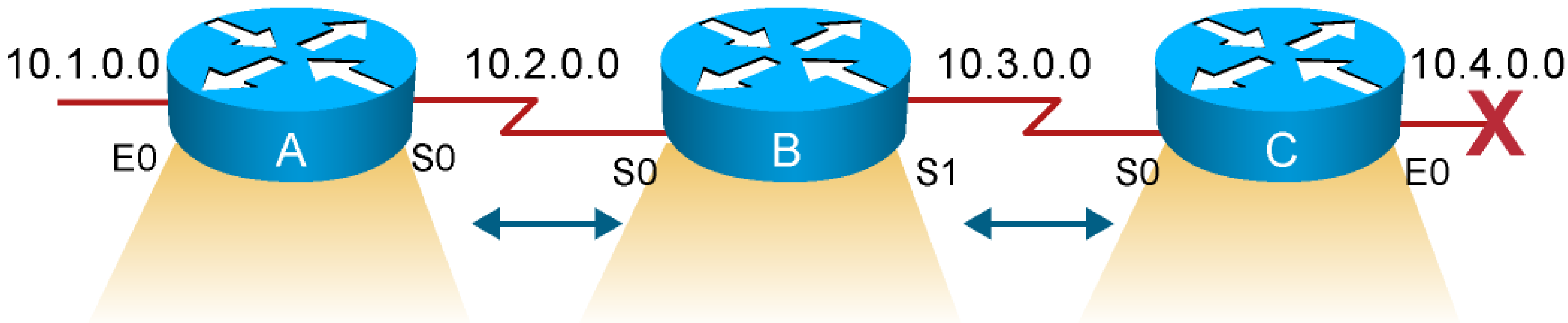
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	3
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	S0	2
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_019

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

Counting to Infinity (Cont.)



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	6

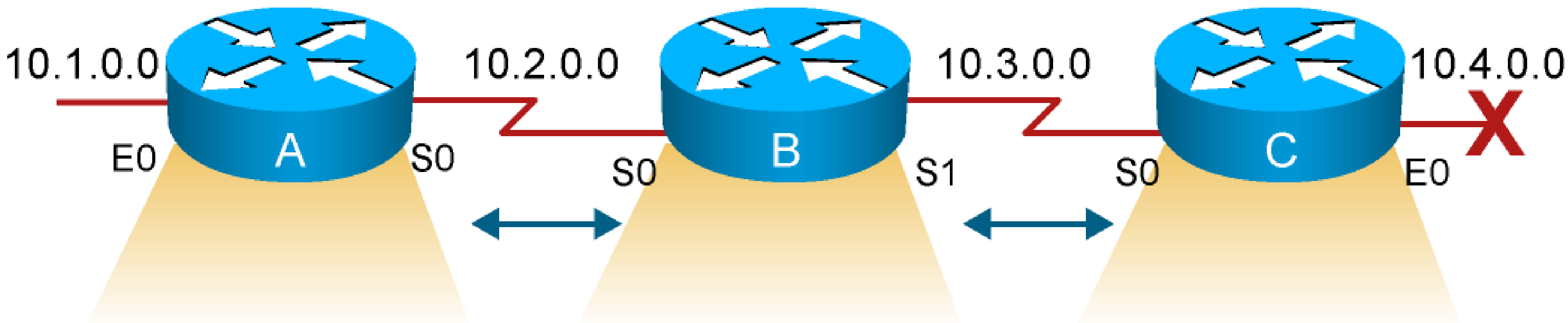
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	5
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	S0	4
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_020

The hop count for network 10.4.0.0 counts to infinity.

Solution to Counting to Infinity: Defining a Maximum



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	16

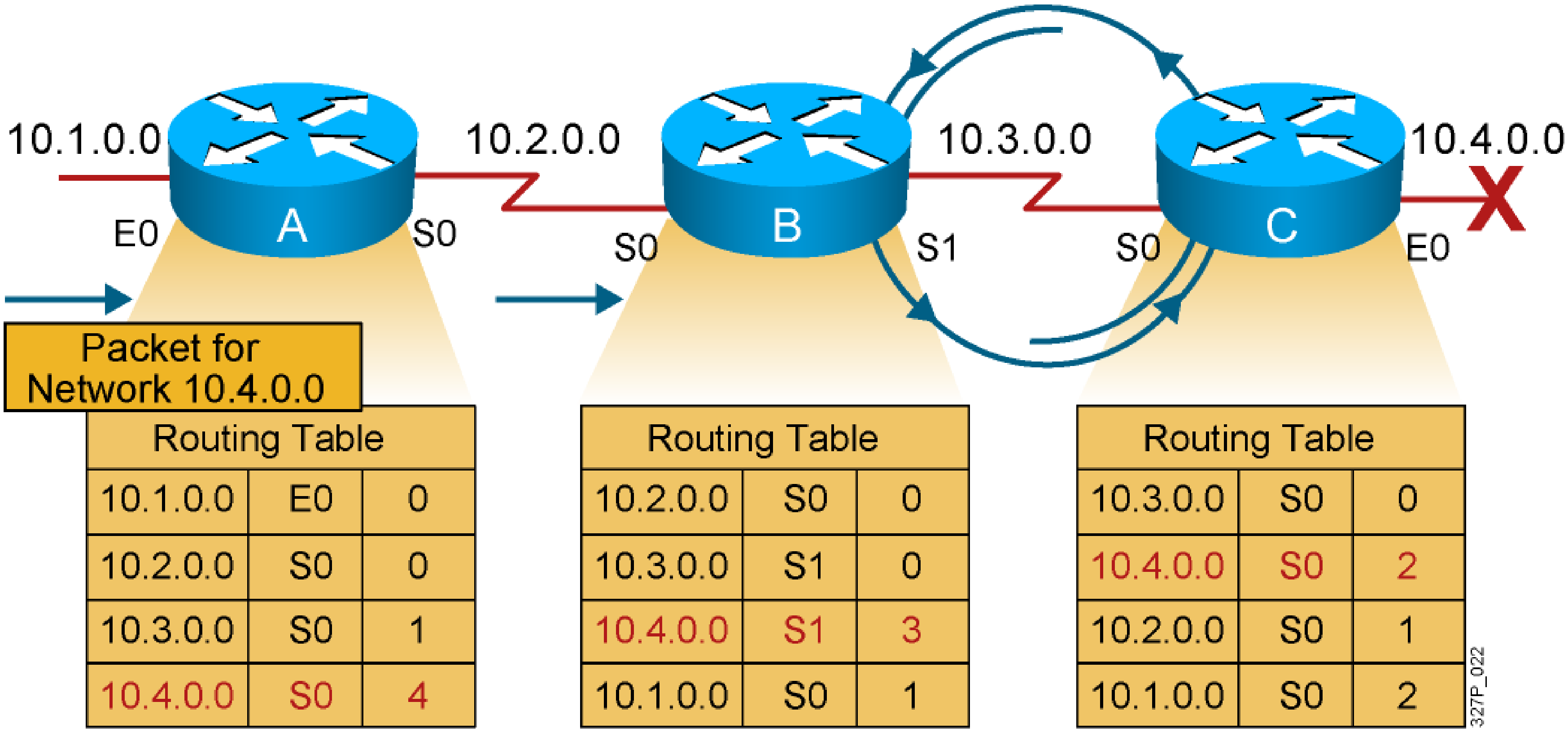
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	16
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	S0	16
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_021

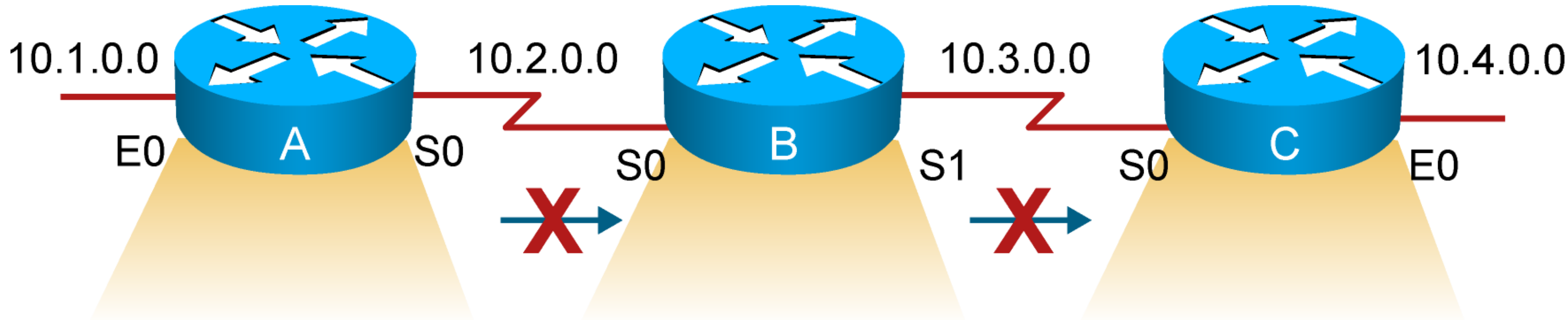
A limit is set on the number of hops to prevent infinite loops.

Routing Loops



Packets for network 10.4.0.0 bounce (loop) between routers B and C.

Solution to Routing Loops: Split Horizon



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	2

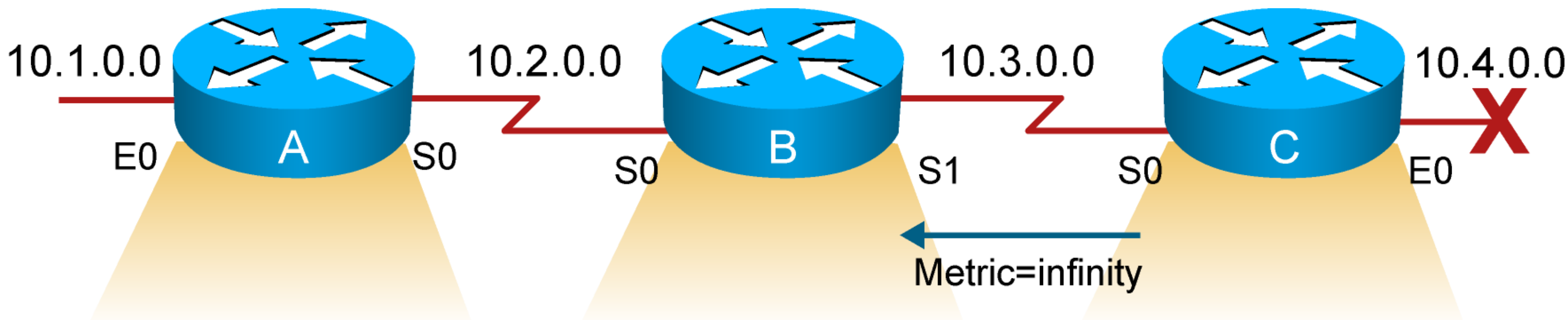
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	1
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	E0	0
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_023

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

Solution to Routing Loops: Route Poisoning and Poison Reverse



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	2

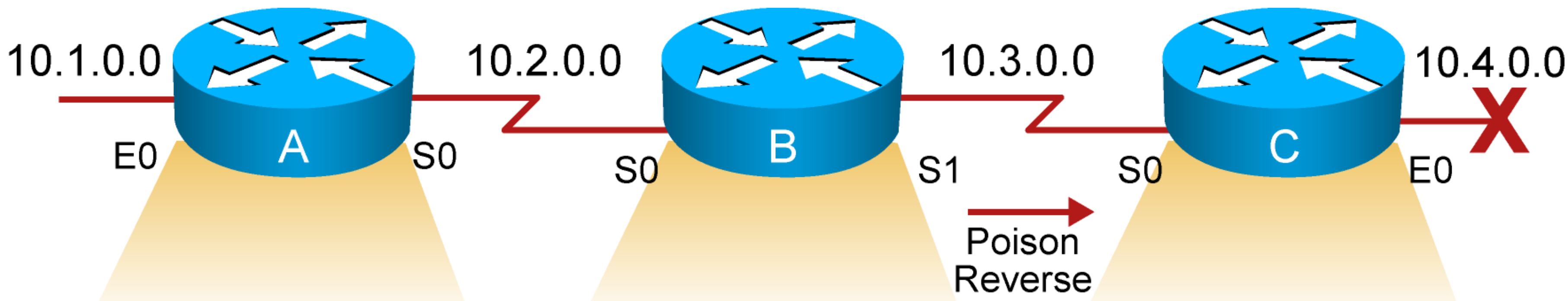
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	1
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	E0	Down
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_024

Routers advertise the distance of routes that have gone down to infinity.

Solution to Routing Loops: Route Poisoning and Poison Reverse (Cont.)



Routing Table		
10.1.0.0	E0	0
10.2.0.0	S0	0
10.3.0.0	S0	1
10.4.0.0	S0	2

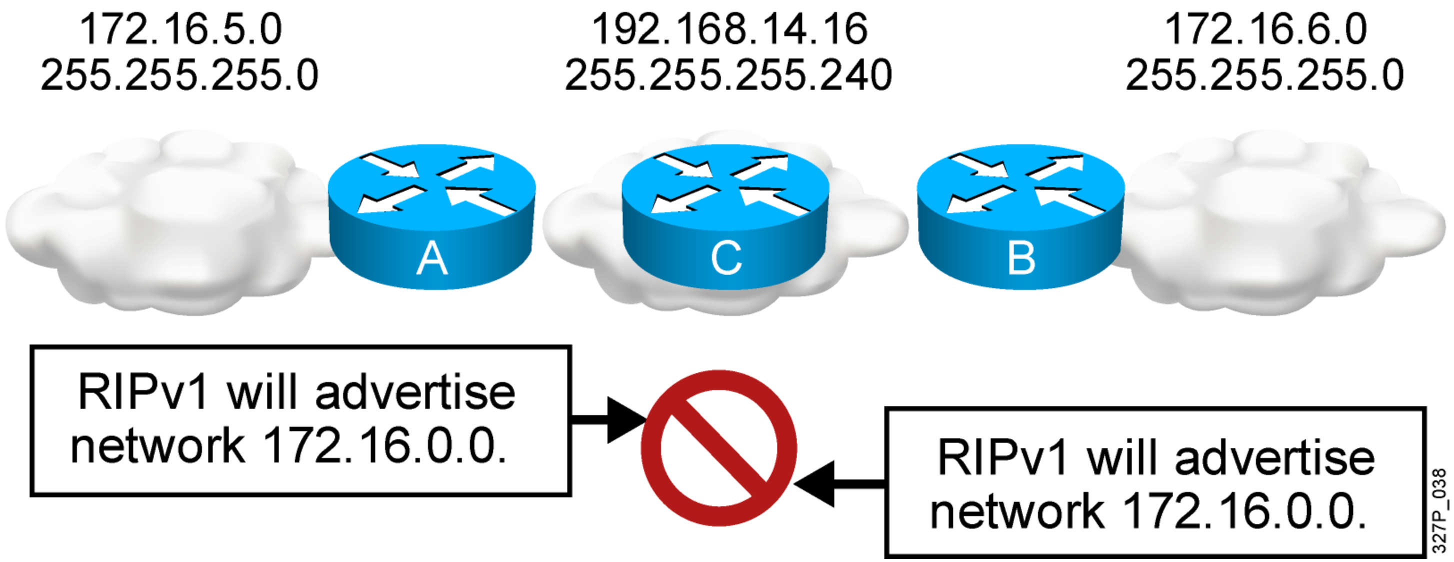
Routing Table		
10.2.0.0	S0	0
10.3.0.0	S1	0
10.4.0.0	S1	Possibly Down
10.1.0.0	S0	1

Routing Table		
10.3.0.0	S0	0
10.4.0.0	S0	Infinity
10.2.0.0	S0	1
10.1.0.0	S0	2

327P_025

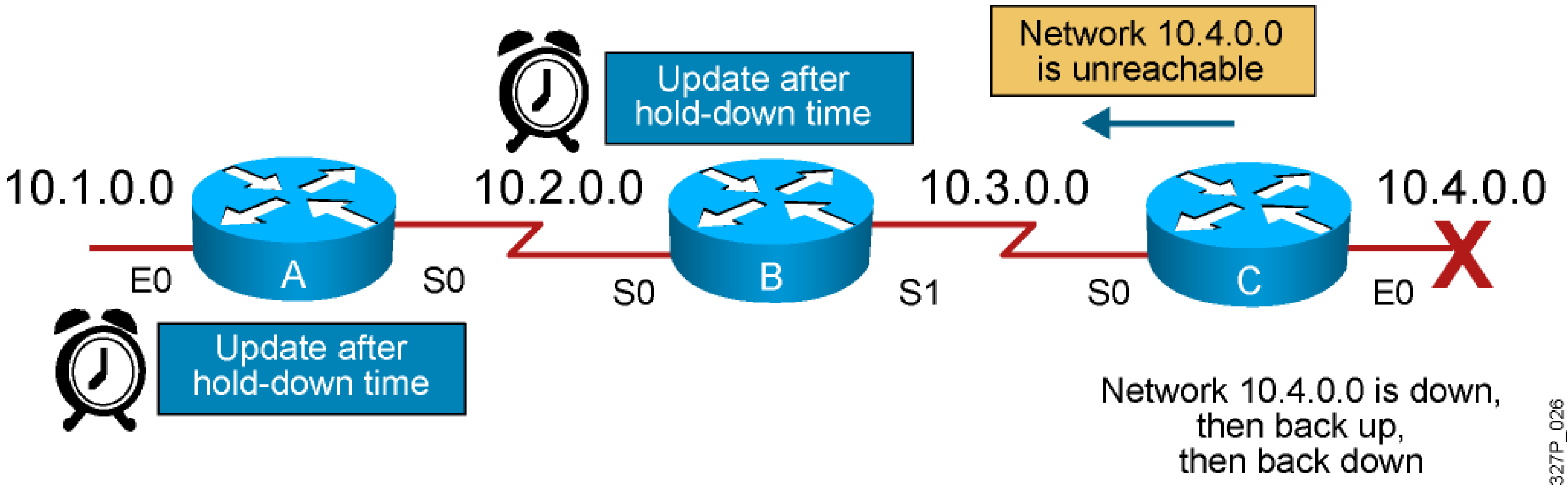
Poison reverse overrides split horizon.

Summarizing Routes in a Discontiguous Network



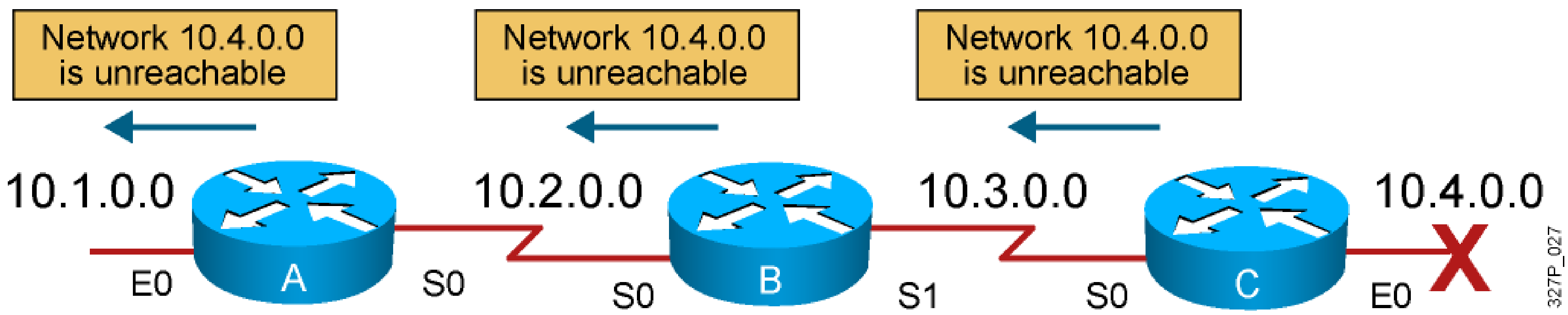
- Classful RIPv1 and IGRP do not advertise subnets, and therefore cannot support discontiguous subnets.
- Classless OSPF, EIGRP, and RIPv2 can advertise subnets, and therefore can support discontiguous subnets.

Solution to Routing Loops: Hold-Down Timers



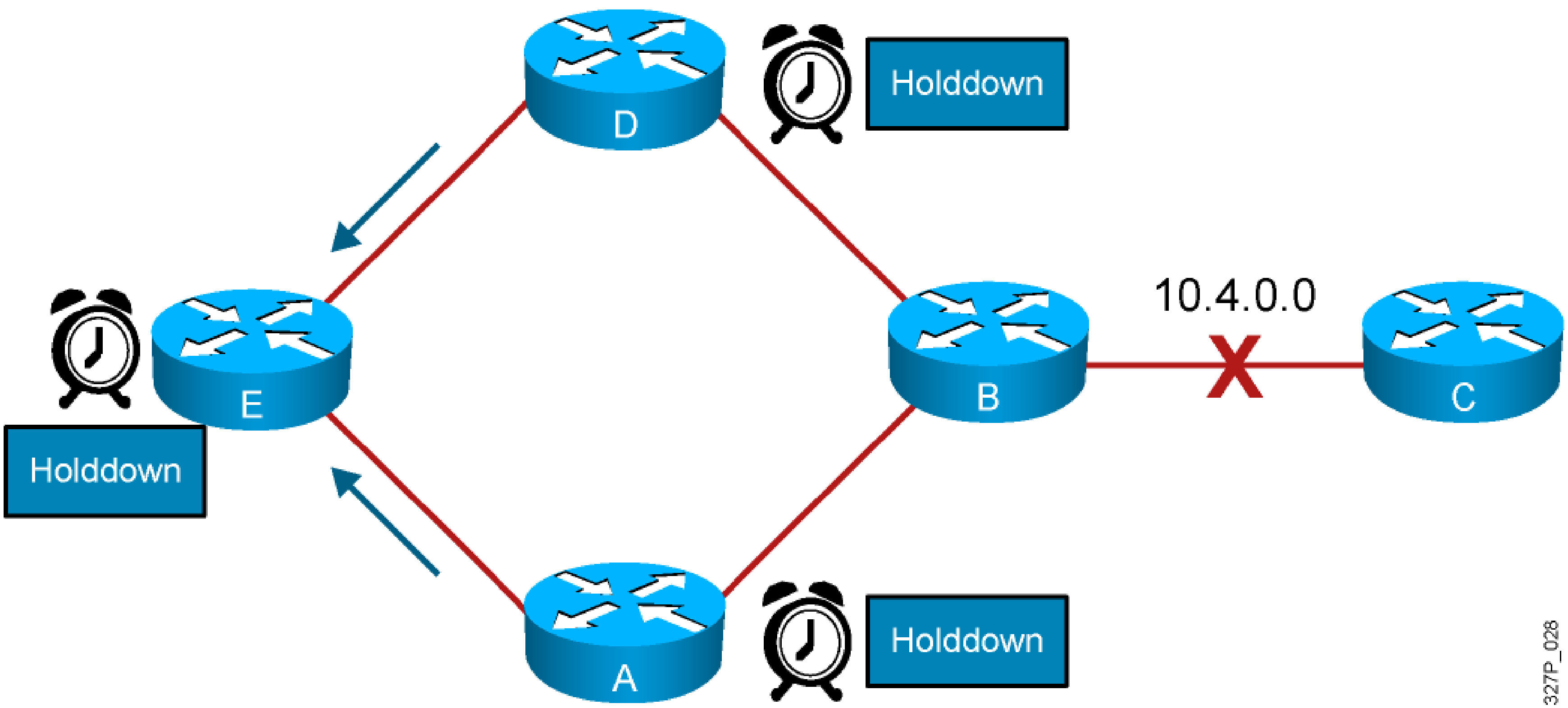
The router keeps an entry for the "possibly down" state in the network, allowing time for other routers to recompute for this topology change.

Triggered Updates

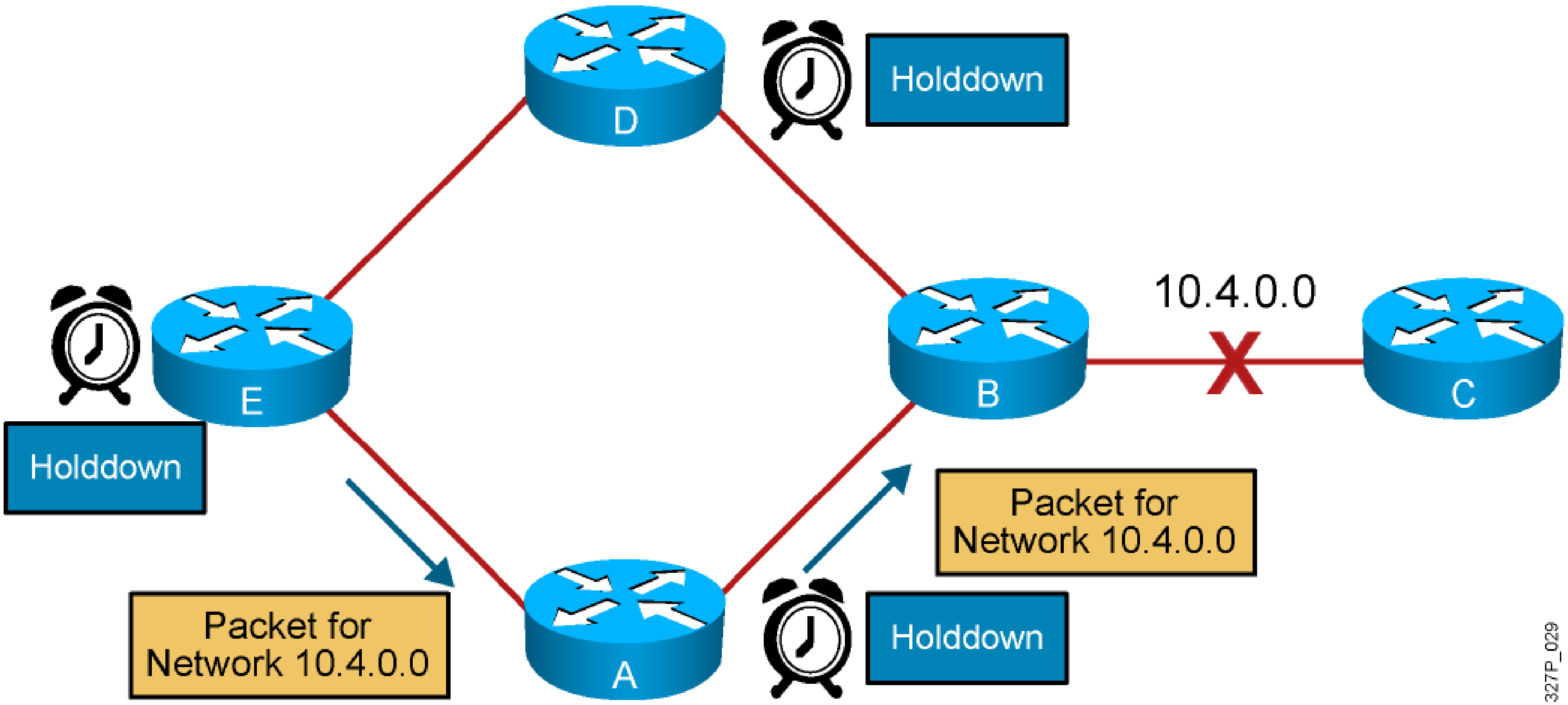


The router sends updates when a change in its routing table occurs.

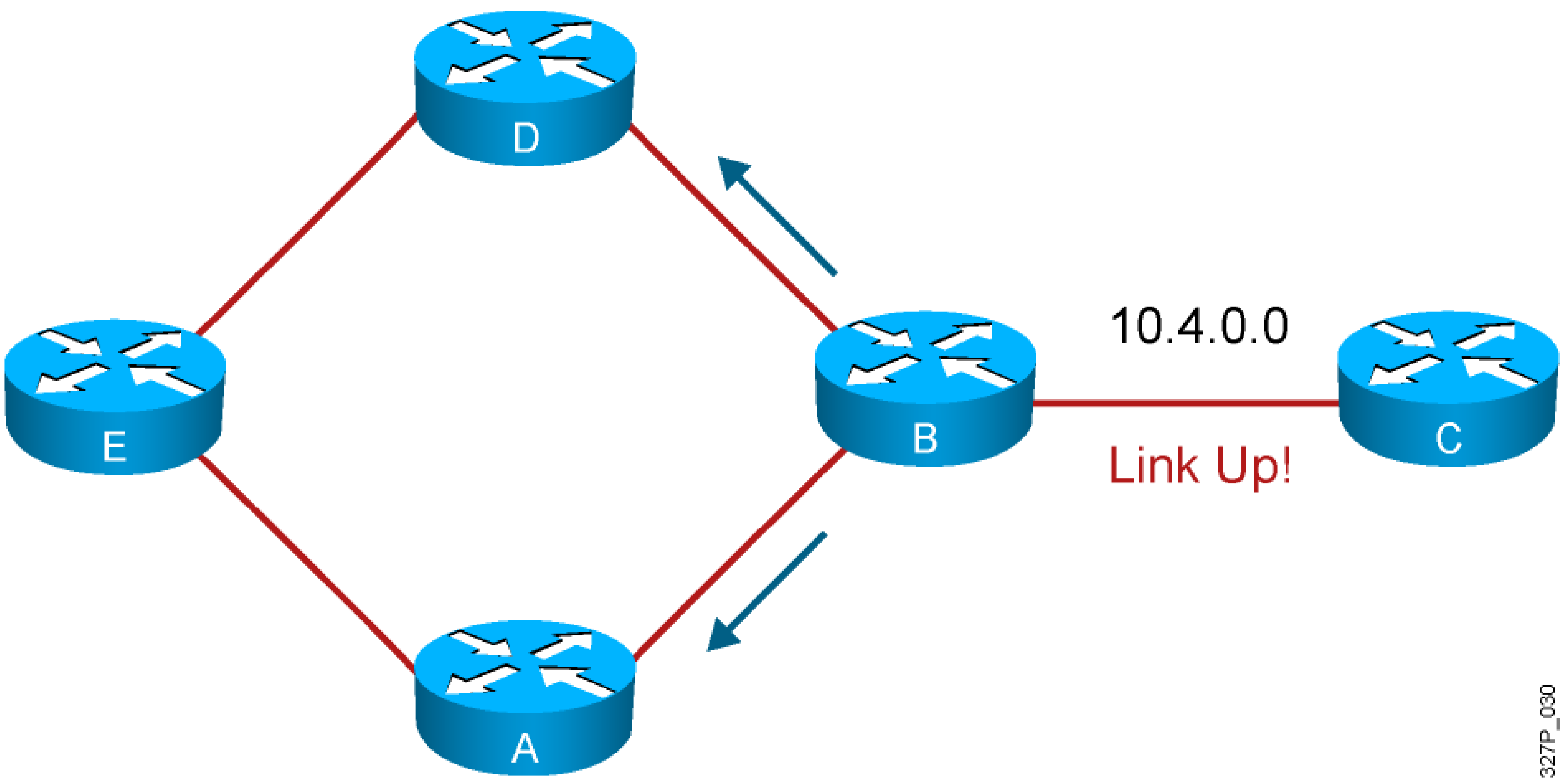
Eliminating Routing Loops



Eliminating Routing Loops (Cont.)



Eliminating Routing Loops (Cont.)

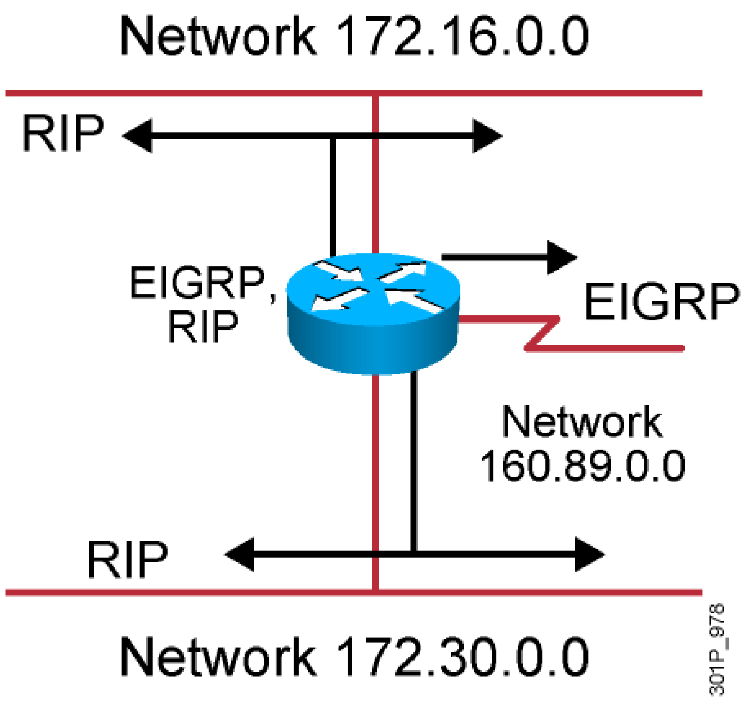


RIPv1 and RIPv2 Comparison

	RIPv1	RIPv2
Routing protocol	Classful	Classless
Supports variable-length subnet mask?	No	Yes
Sends the subnet mask along with the routing update?	No	Yes
Addressing type	Broadcast	Multicast
Defined in …	RFC 1058	RFCs 1721, 1722, and 2453
Supports manual route summarization?	No	Yes
Authentication support?	No	Yes

IP Routing Configuration Tasks

- **Router configuration**
  - **Select routing protocols**
  - **Specify networks or interfaces**



RIP Configuration

```
RouterX(config)# router rip
```

- Starts the RIP routing process

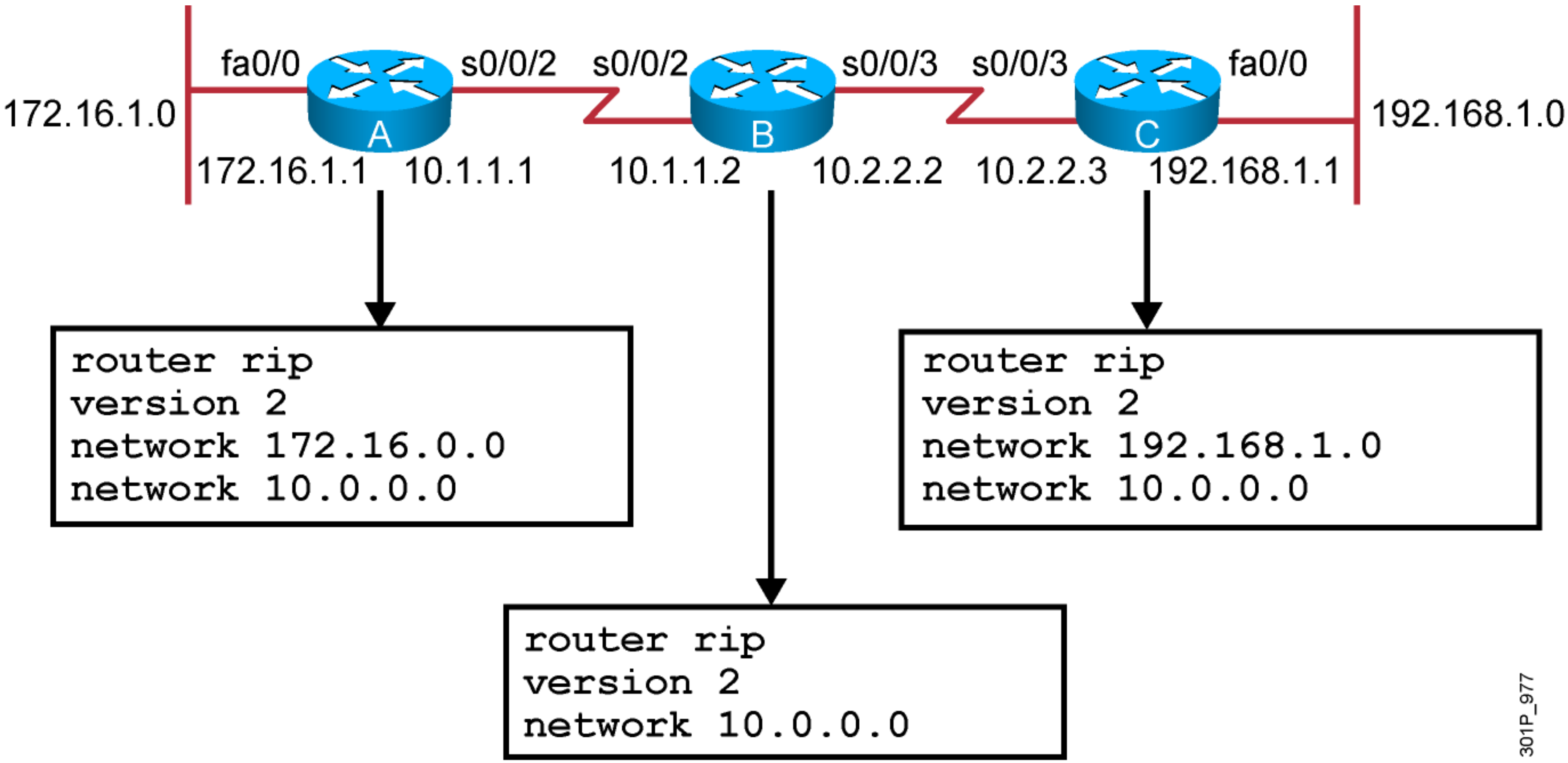
```
RouterX(config-router)# version 2
```

- Enables RIP version 2

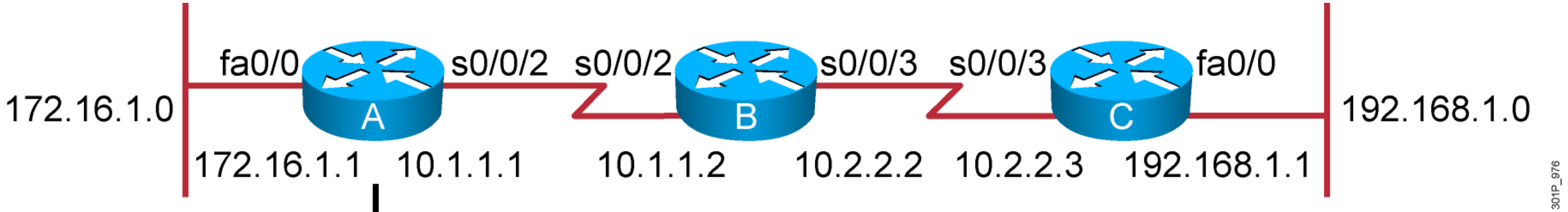
```
RouterX(config-router)# network network-number
```

- Selects participating attached networks
- Requires a major classful network number

RIP Configuration Example



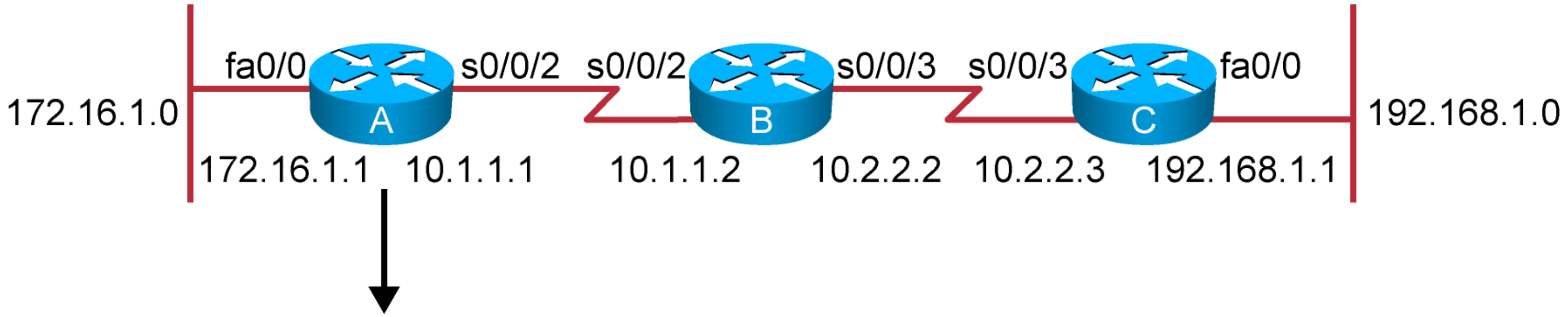
Verifying the RIP Configuration




```
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 6 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Redistributing: rip
  Default version control: send version 2, receive version 2
    Interface             Send  Recv  Triggered RIP  Key-chain
    FastEthernet0/0        2     2
    Serial0/0/2            2     2
  Automatic network summarization is in effect
  Maximum path: 4
  Routing for Networks:
    10.0.0.0
    172.16.0.0
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.1.2             120      00:00:25
  Distance: (default is 120)

RouterA#
```

Displaying the IP Routing Table

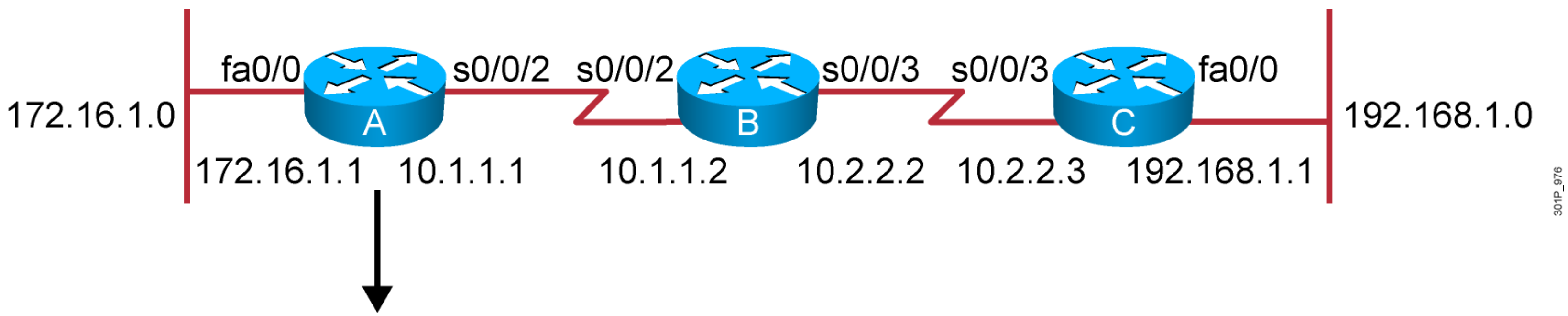



```
RouterA# show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR
       T - traffic engineered route

Gateway of last resort is not set


     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.1.0 is directly connected, fastethernet0/0
     10.0.0.0/24 is subnetted, 2 subnets
R       10.2.2.0 [120/1] via 10.1.1.2, 00:00:07, Serial0/0/2
C       10.1.1.0 is directly connected, Serial0/0/2
R    192.168.1.0/24 [120/2] via 10.1.1.2, 00:00:07, Serial0/0/2
```

debug ip rip Command




```
RouterA# debug ip rip
RIP protocol debugging is on
RouterA#
00:06:24: RIP: received v1 update from 10.1.1.2 on Serial0/0/2
00:06:24:      10.2.2.0 in 1 hops
00:06:24:      192.168.1.0 in 2 hops
00:06:33: RIP: sending v1 update to 255.255.255.255 via FastEthernet0/0 (172.16.1.1)
00:06:34:      network 10.0.0.0, metric 1
00:06:34:      network 192.168.1.0, metric 3
00:06:34: RIP: sending v1 update to 255.255.255.255 via Serial0/0/2 (10.1.1.1)
00:06:34:      network 172.16.0.0, metric 1
```

CISCO