Distance vector Routing protocols

CISCO SYSTEMS

IP Routing Configuration Tasks

Router configuration

- **Select routing protocols**

- **Specify networks or interfaces**

Network 172.16.0.0

RIP

IGRP, RIP

IGRP

Network 160.89.0.0
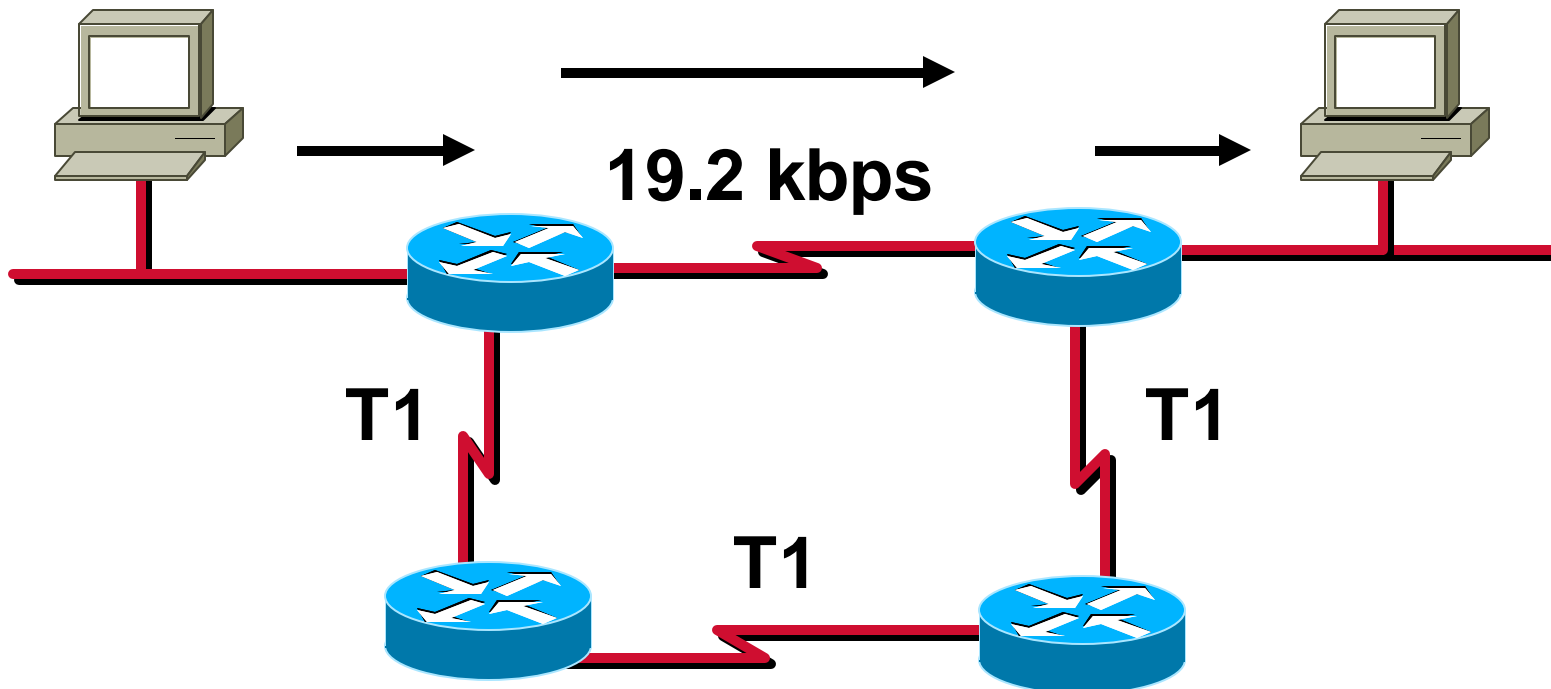
RIP

Network 172.30.0.0
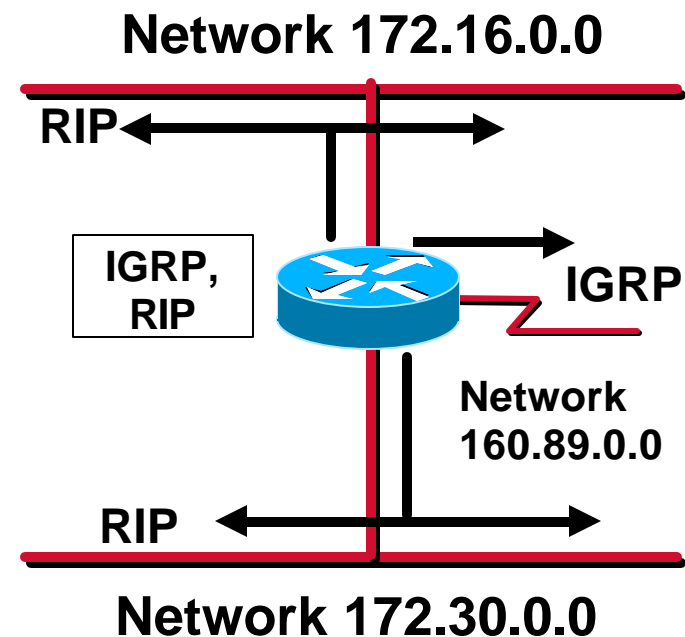
Dynamic Routing Configuration

Router(config)#router *protocol* [*keyword*]

- Defines an IP routing protocol

Router(config-router)#network *network-number*

- Mandatory configuration command for each IP routing process

- Identifies the physically connected network that routing updates are forwarded to

RIP Overview

19.2 kbps

T1

T1

T1

- **Maximum six paths (default = 4)**
- **Hop count metric selects the path**
- **Routes update every 30 seconds**
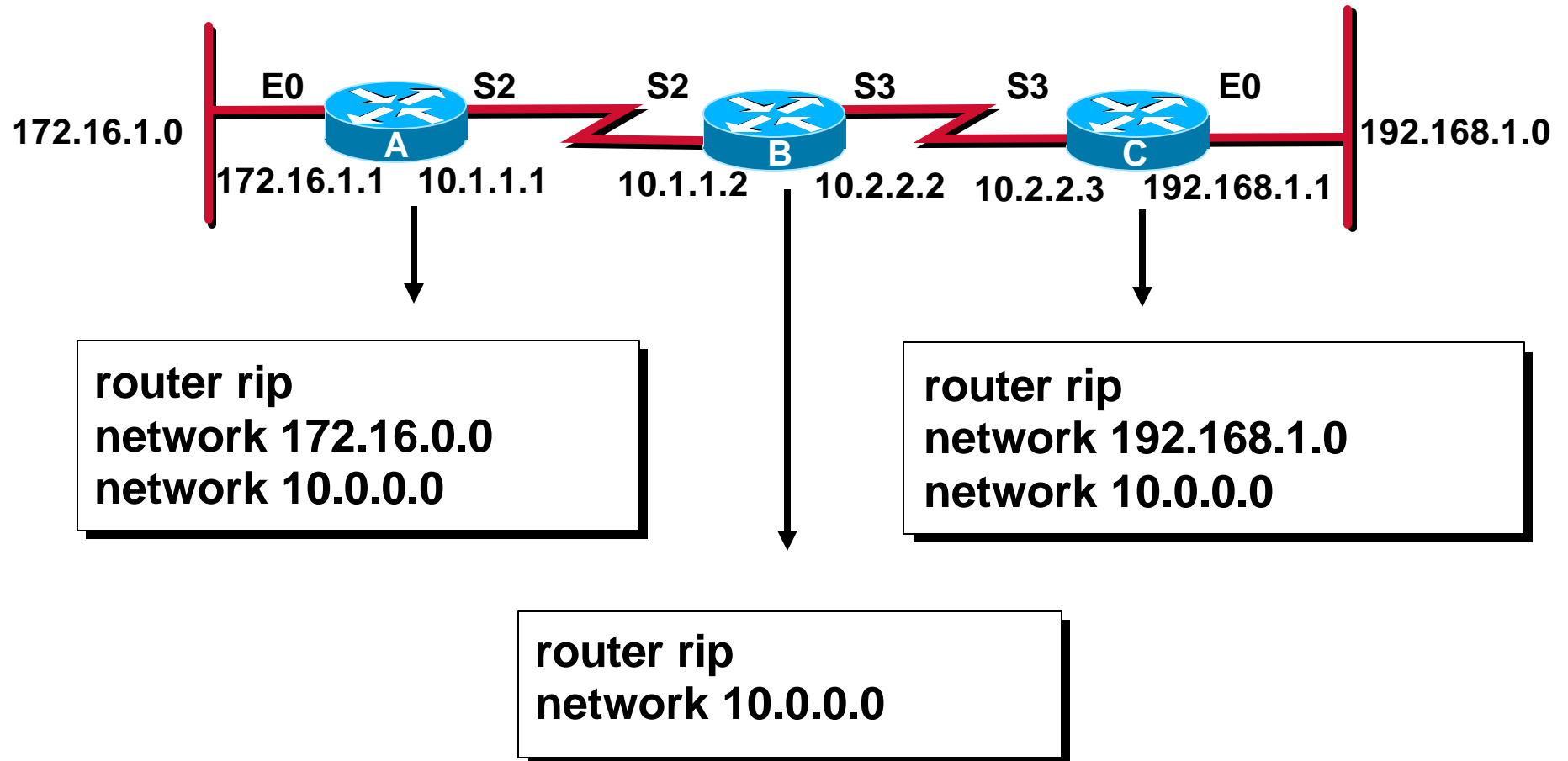
RIP Configuration

```
Router(config)#router rip
```
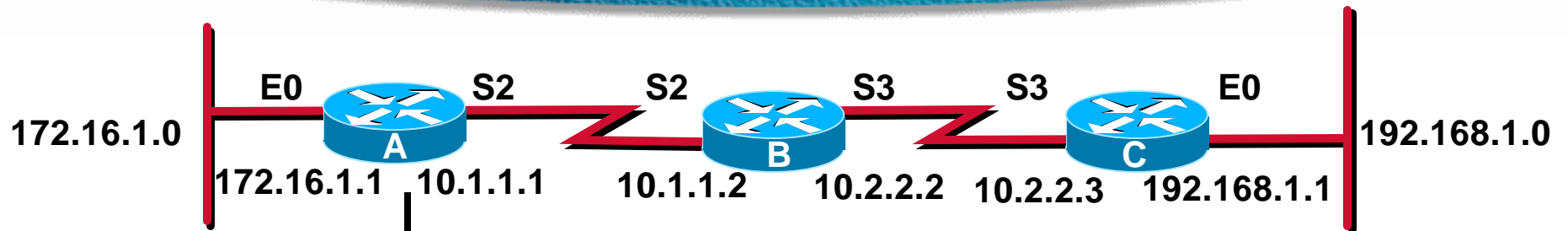
- Starts the RIP routing process

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

- Selects participating attached networks
- The network number must be a major classful network number

RIP Configuration Example

172.16.1.0   E0   **A**   S2   S2   **B**   S3   S3   **C**   E0   192.168.1.0

172.16.1.1   10.1.1.1   10.1.1.2   10.2.2.2   10.2.2.3   192.168.1.1

```
router rip
network 172.16.0.0
network 10.0.0.0
```

```
router rip
network 192.168.1.0
network 10.0.0.0
```

```
router rip
network 10.0.0.0
```

Verifying the Routing Protocol—RIP

172.16.1.0

E0   S2   S2   S3   S3   E0

A   B   C

192.168.1.0

172.16.1.1   10.1.1.1   10.1.1.2   10.2.2.2   10.2.2.3   192.168.1.1
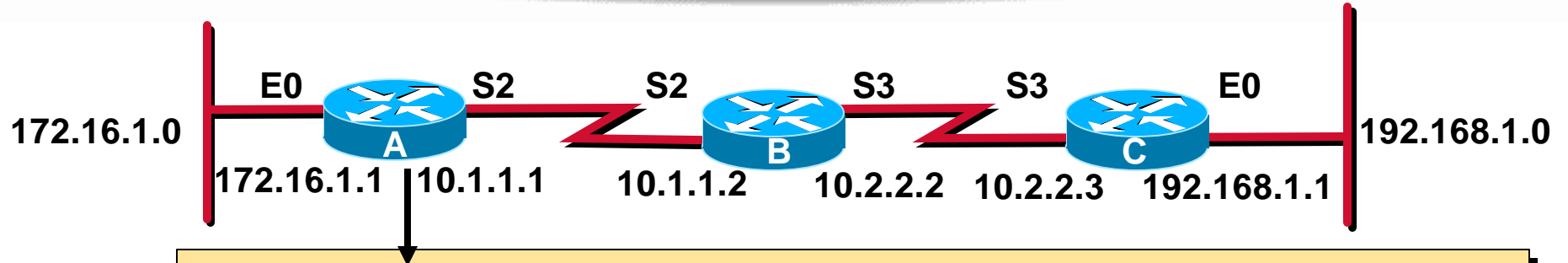
```
RouterA#sh ip protocols
Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 0 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Redistributing: rip
  Default version control: send version 1, receive any version
   Interface      Send  Recv  Key-chain
   Ethernet0       1    1 2
   Serial2         1    1 2
  Routing for Networks:
   10.0.0.0
   172.16.0.0
  Routing Information Sources:
   Gateway        Distance    Last Update
   10.1.1.2        120      00:00:10
  Distance: (default is 120)
```

Displaying the IP Routing Table

172.16.1.0
E0 — A — S2
172.16.1.1 10.1.1.1

S2 — B — S3
10.1.1.2 10.2.2.2

S3 — C — E0
10.2.2.3 192.168.1.1

192.168.1.0

```
RouterA#sh 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, Ethernet0
    10.0.0.0/24 is subnetted, 2 subnets
R      10.2.2.0 [120/1] via 10.1.1.2, 00:00:07, Serial2
C      10.1.1.0 is directly connected, Serial2
R   192.168.1.0/24 [120/2] via 10.1.1.2, 00:00:07, Serial2
```
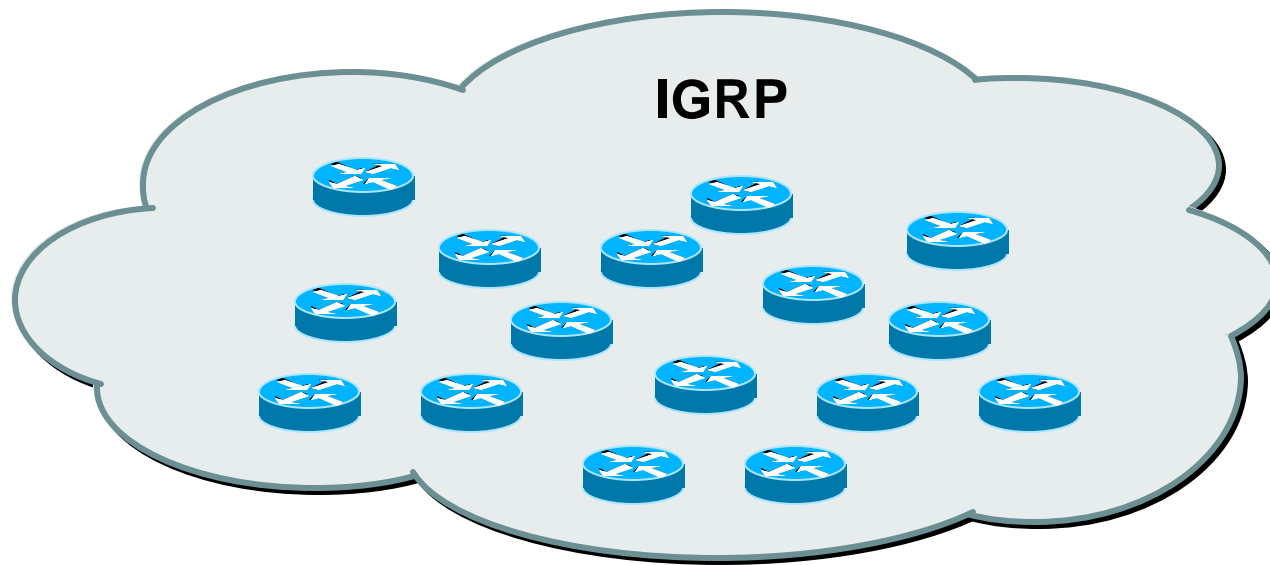
debug ip rip Command
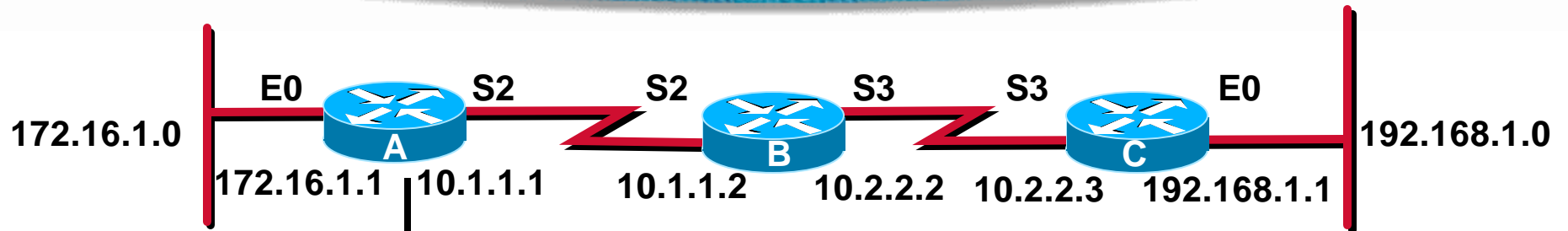
```
RouterA#debug ip rip
RIP protocol debugging is on
RouterA#
00:06:24: RIP: received v1 update from 10.1.1.2 on Serial2
00:06:24:      10.2.2.0 in 1 hops
00:06:24:      192.168.1.0 in 2 hops
00:06:33: RIP: sending v1 update to 255.255.255.255 via Ethernet0 (172.16.1.1)
00:06:34:      network 10.0.0.0, 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 Serial2 (10.1.1.1)
00:06:34:      network 172.16.0.0, metric 1
```

Network diagram:

- E0 / S2 Router A — 172.16.1.0, 172.16.1.1, 10.1.1.1
- S2 / S3 Router B — 10.1.1.2, 10.2.2.2
- S3 / E0 Router C — 10.2.2.3, 192.168.1.1, 192.168.1.0

Introduction to IGRP

IGRP

- **More scalable than RIP**
- **Sophisticated metric**
- **Multiple-path support**

IGRP Composite Metric

19.2 kbps

19.2 kbps

Source
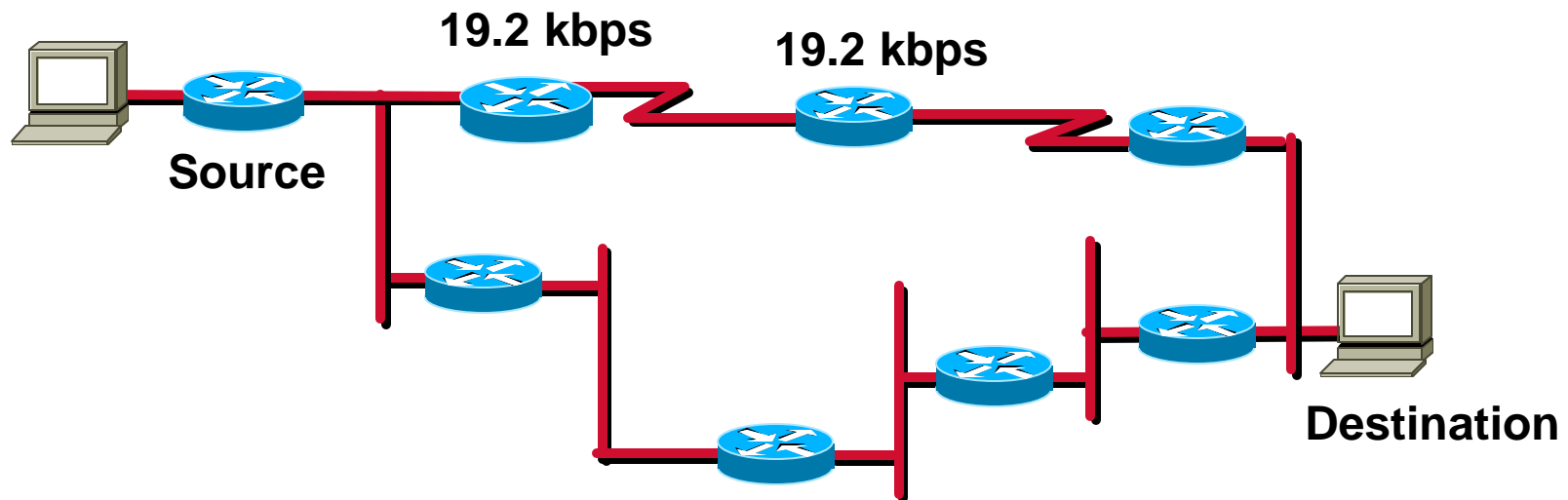
Destination

- **Bandwidth**
- **Delay**
- **Reliability**
- **Loading**
- **MTU**

Blank Slide for Instructor Notes

IGRP Unequal Multiple Paths
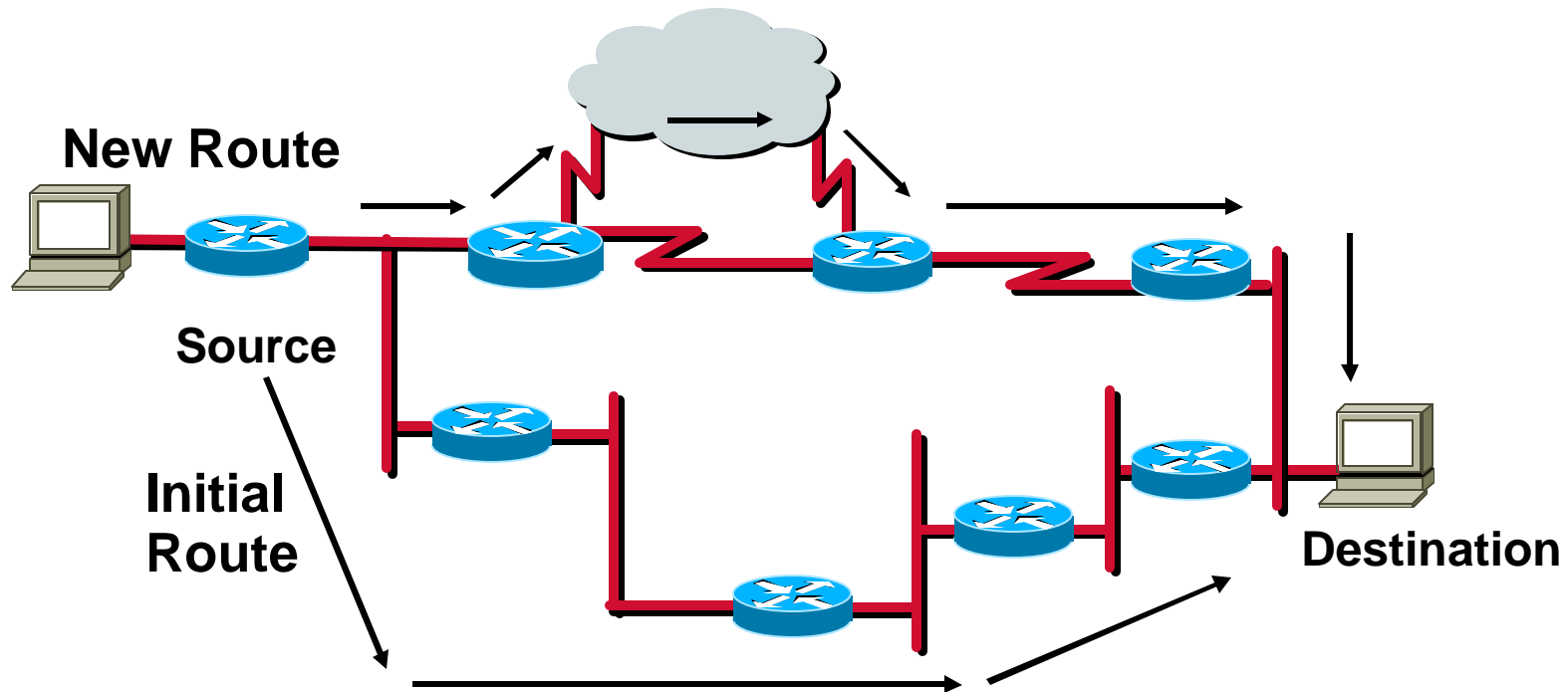
- **Maximum six paths (default = 4)**
- **Within metric variance**
- **Next-hop router closer to destination**

Configuring IGRP

Router(config)#router igrp *autonomous-system*

- **Defines IGRP as the IP routing protocol**

Router(config-router)#network *network-number*

- **Selects participating attached networks**
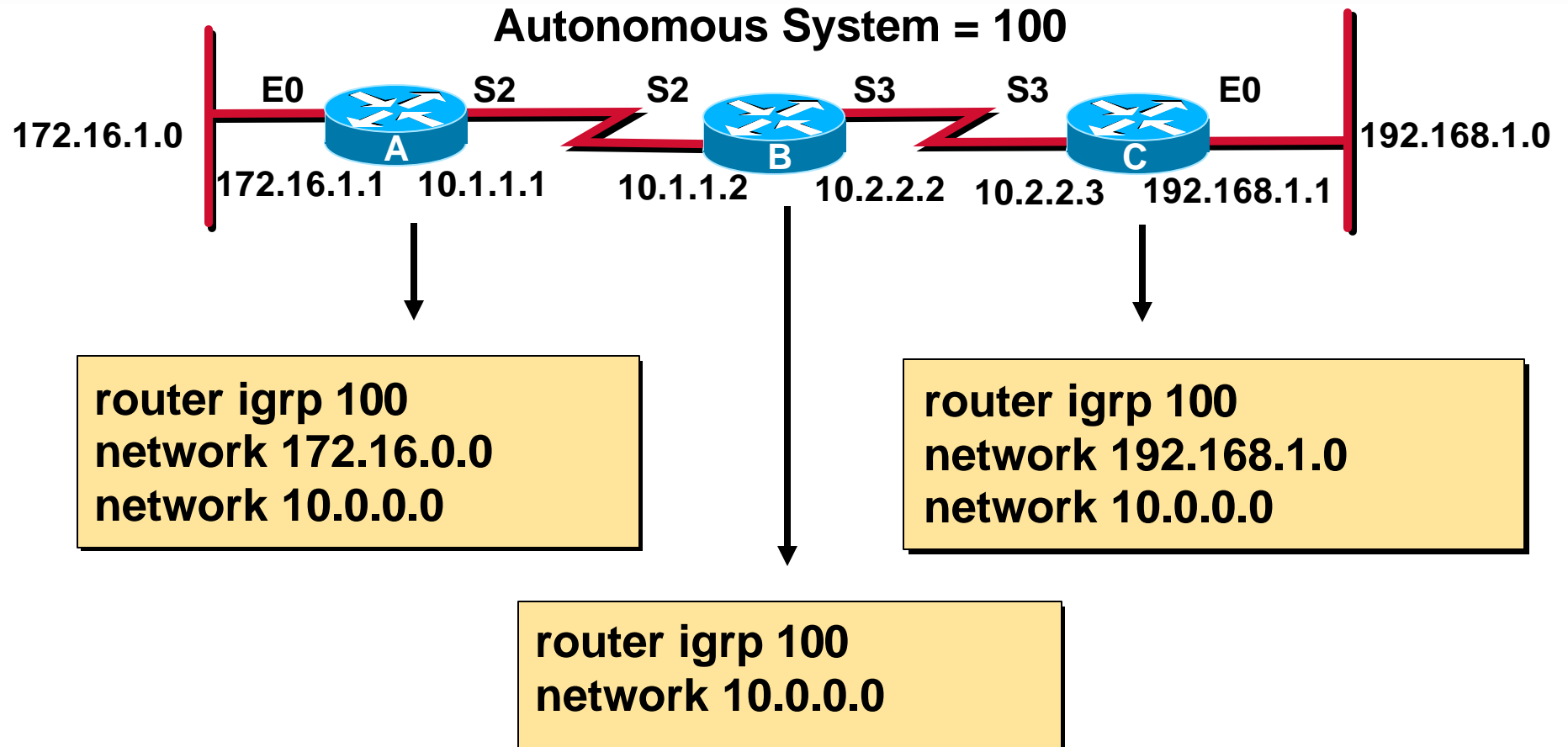
Configuring IGRP (cont.)

```
Router(config-router)#variance multiplier
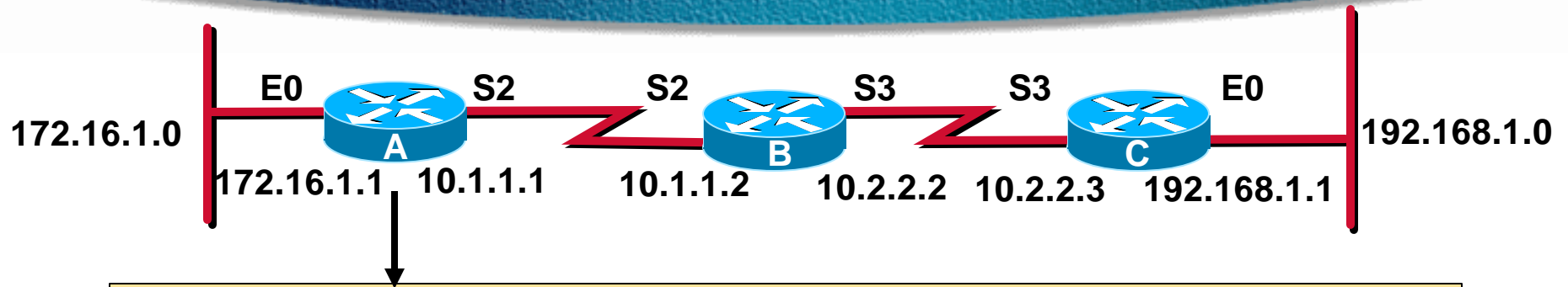```

- **Control IGRP load balancing**

```
Router(config-router)#traffic-share
{ balanced | min }
```

- **Control how load-balanced traffic is distributed**

IGRP Configuration Example

Autonomous System = 100

172.16.1.0   E0   A   S2   S2   B   S3   S3   C   E0   192.168.1.0

172.16.1.1   10.1.1.1   10.1.1.2   10.2.2.2   10.2.2.3   192.168.1.1

router igrp 100
network 172.16.0.0
network 10.0.0.0

router igrp 100
network 192.168.1.0
network 10.0.0.0

router igrp 100
network 10.0.0.0

Verifying the Routing Protocol—IGRP

E0 **S2** **S2** **S3** **S3** **E0**

172.16.1.0   A   B   C   192.168.1.0
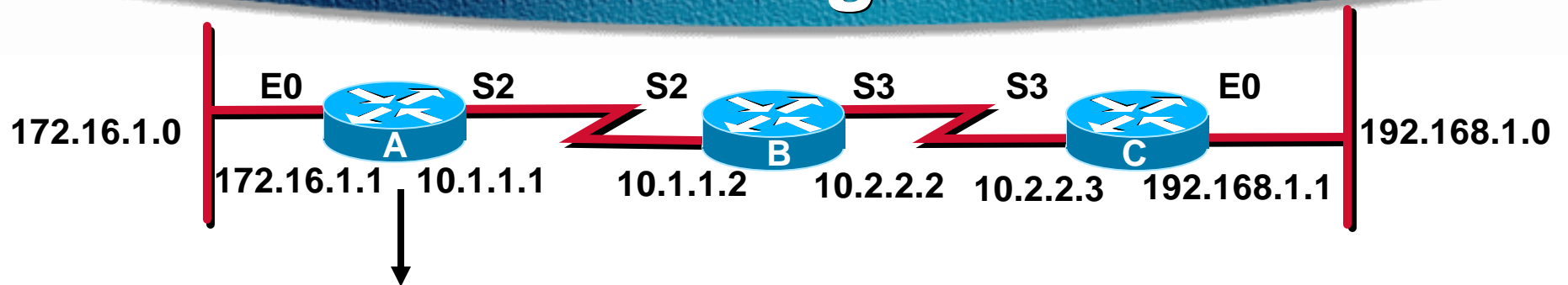
172.16.1.1   10.1.1.1   10.1.1.2   10.2.2.2   10.2.2.3   192.168.1.1

```
RouterA#sh ip protocols
Routing Protocol is "igrp 100"
  Sending updates every 90 seconds, next due in 21 seconds
  Invalid after 270 seconds, hold down 280, flushed after 630
  Outgoing update filter list for all interfaces is
  Incoming update filter list for all interfaces is
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  IGRP metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  IGRP maximum hopcount 100
  IGRP maximum metric variance 1
  Redistributing: igrp 100
  Routing for Networks:
    10.0.0.0
    172.16.0.0
  Routing Information Sources:
    Gateway        Distance    Last Update
    10.1.1.2          100      00:01:01
  Distance: (default is 100)
```

Displaying the IP Routing Table

172.16.1.0

| E0 | | S2 | S2 | | S3 | S3 | | E0 |

172.16.1.1   10.1.1.1   10.1.1.2   10.2.2.2   10.2.2.3   192.168.1.1   192.168.1.0

```
RouterA#sh 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, Ethernet0
    10.0.0.0/24 is subnetted, 2 subnets
I     10.2.2.0 [100/90956] via 10.1.1.2, 00:00:23, Serial2
C     10.1.1.0 is directly connected, Serial2
I   192.168.1.0/24 [100/91056] via 10.1.1.2, 00:00:23, Serial2
```
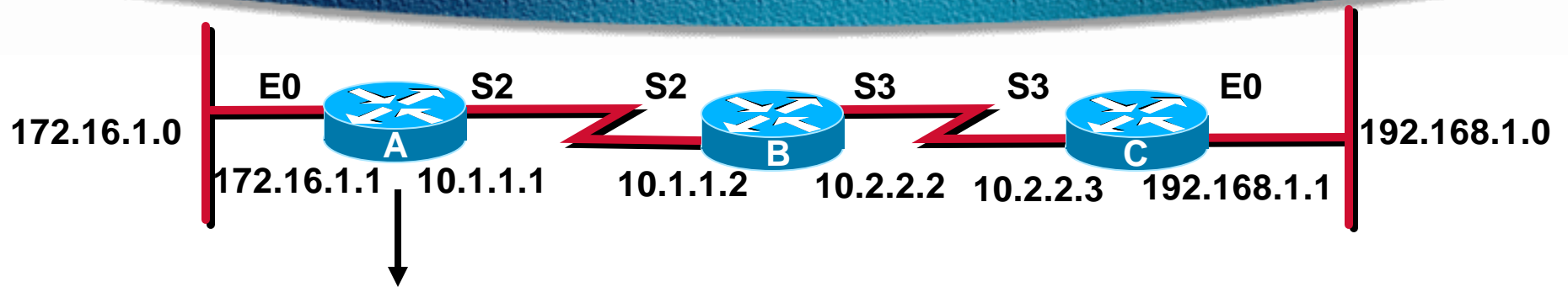
debug ip igrp transaction Command

E0   S2   S2   S3   S3   E0

172.16.1.0   A   B   C   192.168.1.0

172.16.1.1   10.1.1.1   10.1.1.2   10.2.2.2   10.2.2.3   192.168.1.1

```
RouterA#debug ip igrp transactions
IGRP protocol debugging is on
RouterA#
00:21:06: IGRP: sending update to 255.255.255.255 via Ethernet0 (172.16.1.1)
00:21:06:      network 10.0.0.0, metric=88956
00:21:06:      network 192.168.1.0, metric=91056
00:21:07: IGRP: sending update to 255.255.255.255 via Serial2 (10.1.1.1)
00:21:07:      network 172.16.0.0, metric=1100
00:21:16: IGRP: received update from 10.1.1.2 on Serial2
00:21:16:      subnet 10.2.2.0, metric 90956 (neighbor 88956)
00:21:16:      network 192.168.1.0, metric 91056 (neighbor 89056)
```
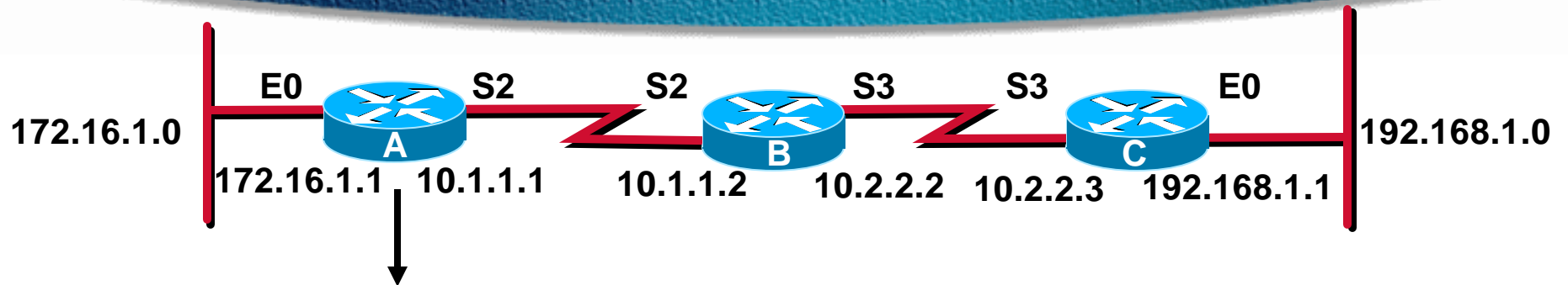
debug ip igrp events Command

172.16.1.0

E0 — A — S2

172.16.1.1   10.1.1.1

S2 — B — S3

10.1.1.2   10.2.2.2

S3 — C — E0

10.2.2.3   192.168.1.1

192.168.1.0

```
RouterA#debug ip igrp events
IGRP event debugging is on
RouterA#
00:23:44: IGRP: sending update to 255.255.255.255 via Ethernet0 (172.16.1.1)
00:23:44: IGRP: Update contains 0 interior, 2 system, and 0 exterior routes.
00:23:44: IGRP: Total routes in update: 2
00:23:44: IGRP: sending update to 255.255.255.255 via Serial2 (10.1.1.1)
00:23:45: IGRP: Update contains 0 interior, 1 system, and 0 exterior routes.
00:23:45: IGRP: Total routes in update: 1
00:23:48: IGRP: received update from 10.1.1.2 on Serial2
00:23:48: IGRP: Update contains 1 interior, 1 system, and 0 exterior routes.
00:23:48: IGRP: Total routes in update: 2
```
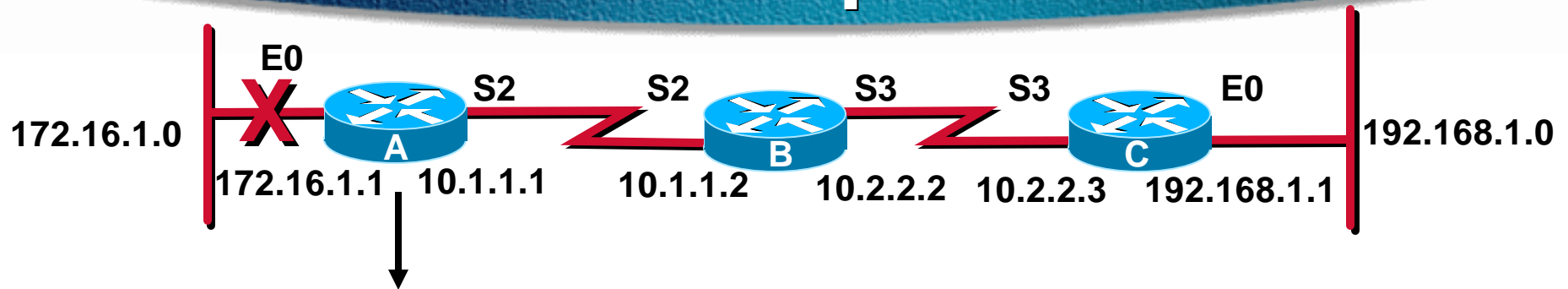
Updating Routing Information Example


```
RouterA# debug ip igrp trans
00:31:15: %LINEPROTO-5-UPDOWN: Line protocol on Interface Ethernet0, changed state to down
00:31:15: IGRP: edition is now 3
00:31:15: IGRP: sending update to 255.255.255.255 via Serial2 (10.1.1.1)
00:31:15:      network 172.16.0.0, metric=4294967295
00:31:16: IGRP: Update contains 0 interior, 1 system, and 0 exterior routes.
00:31:16: IGRP: Total routes in update: 1
00:31:16: IGRP: broadcasting request on Serial2
00:31:16: IGRP: received update from 10.1.1.2 on Serial2
00:31:16:      subnet 10.2.2.0, metric 90956 (neighbor 88956)
00:31:16:      network 172.16.0.0, metric 4294967295 (inaccessible)
00:31:16:      network 192.168.1.0, metric 91056 (neighbor 89056)
00:31:16: IGRP: Update contains 1 interior, 2 system, and 0 exterior routes.
00:31:16: IGRP: Total routes in update: 3
```
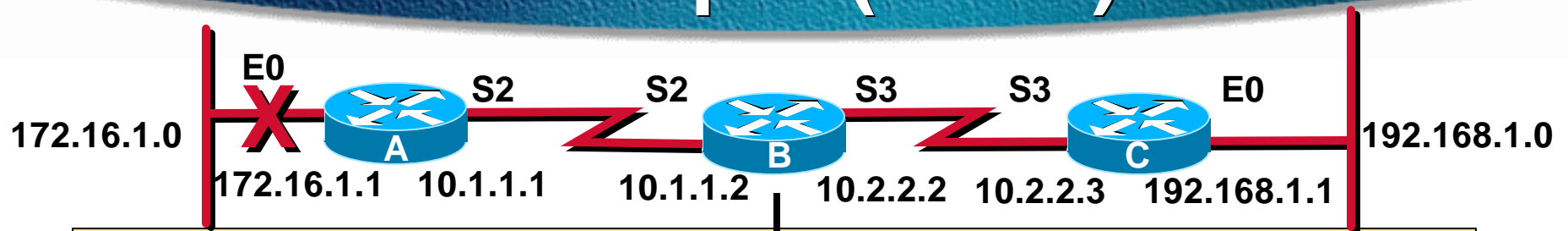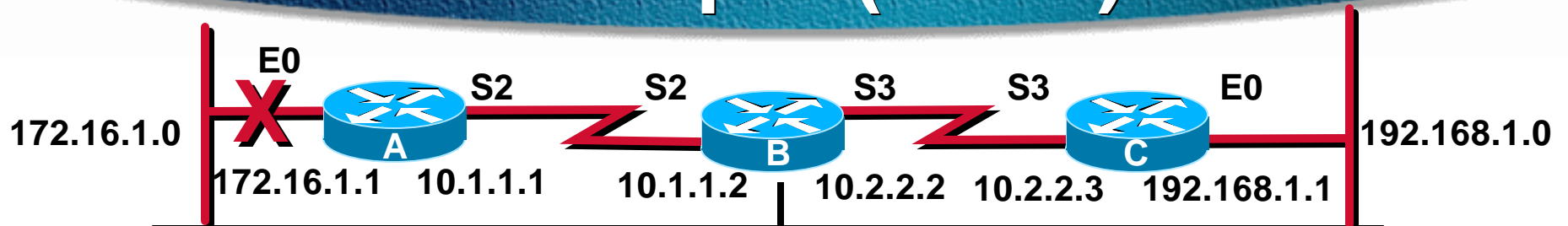
Updating Routing Information Example (cont.)


```
RouterB#debug ip igrp trans
IGRP protocol debugging is on
RouterB#
1d19h: IGRP: sending update to 255.255.255.255 via Serial2 (10.1.1.2)
1d19h:      subnet 10.2.2.0, metric=88956
1d19h:      network 192.168.1.0, metric=89056
1d19h: IGRP: sending update to 255.255.255.255 via Serial3 (10.2.2.2)
1d19h:      subnet 10.1.1.0, metric=88956
1d19h:      network 172.16.0.0, metric=89056
1d19h: IGRP: received update from 10.1.1.1 on Serial2
1d19h:      network 172.16.0.0, metric 4294967295 (inaccessible)
1d19h: IGRP: edition is now 10
1d19h: IGRP: sending update to 255.255.255.255 via Serial2 (10.1.1.2)
1d19h:      subnet 10.2.2.0, metric=88956
1d19h:      network 172.16.0.0, metric=4294967295
1d19h:      network 192.168.1.0, metric=89056
1d19h: IGRP: sending update to 255.255.255.255 via Serial3 (10.2.2.2)
1d19h:      subnet 10.1.1.0, metric=88956
1d19h:      network 172.16.0.0, metric=4294967295
```

Updating Routing Information Example (cont.)

E0

172.16.1.0

S2   **S2**   **S3**   **S3**   **E0**

A   **B**   **C**

192.168.1.0

172.16.1.1   10.1.1.1   10.1.1.2   10.2.2.2   10.2.2.3   192.168.1.1

```
RouterB#sh 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

I    172.16.0.0/16 is possibly down, routing via 10.1.1.1, Serial2
     10.0.0.0/24 is subnetted, 2 subnets
C       10.1.1.0 is directly connected, Serial2
C       10.2.2.0 is directly connected, Serial3
I    192.168.1.0/24 [100/89056] via 10.2.2.3, 00:00:14, Serial3
RouterB#ping 172.16.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
RouterB#
```
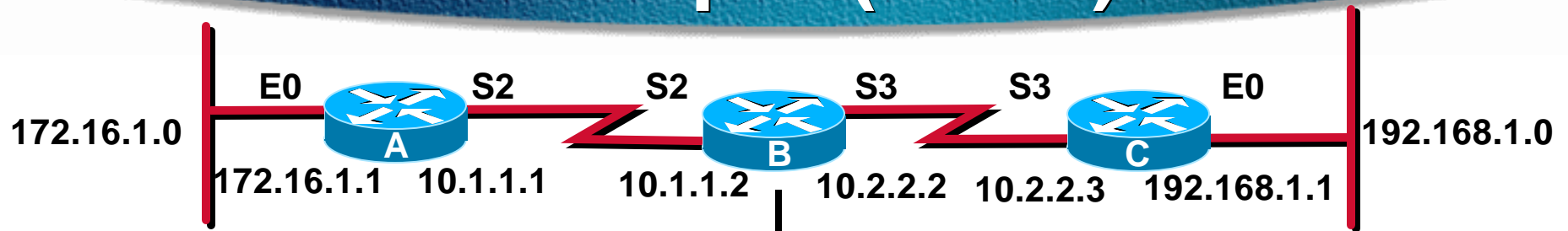
Updating Routing Information Example (cont.)

172.16.1.0

E0   S2   S2   S3   S3   E0

A   **B**   **C**

172.16.1.1   10.1.1.1   10.1.1.2   10.2.2.2   10.2.2.3   192.168.1.1

192.168.1.0

```
RouterB#debug ip igrp transactions
RouterB#
1d20h: IGRP: received update from 10.1.1.1 on Serial2
1d20h:     network 172.16.0.0, metric 89056 (neighbor 1100)
RouterB#
RouterB#sh 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

I    172.16.0.0/16 is possibly down, routing via 10.1.1.1, Serial2
     10.0.0.0/24 is  subnetted, 2 subnets
C       10.1.1.0 is directly connected, Serial2
C       10.2.2.0 is directly connected, Serial3
I    192.168.1.0/24 [100/89056] via 10.2.2.3, 00:00:18, Serial3
RouterB#ping 172.16.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/38/48 ms
```
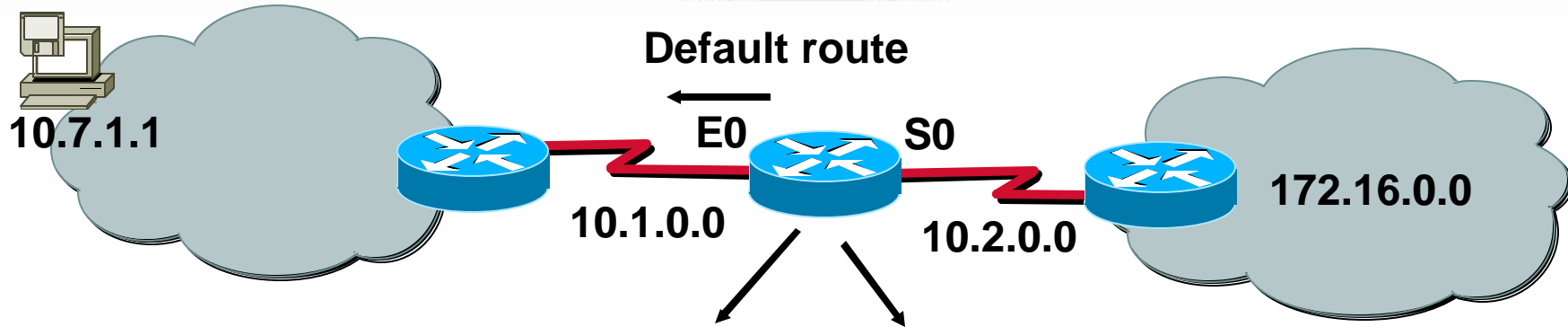
ip classless Command

Default route

10.7.1.1

E0   S0

10.1.0.0   172.16.0.0

10.2.0.0

Router(config)#ip classless

Network Protocol	Destination Network	Exit Interface
C	10.1.0.0	E0
C	10.2.0.0	S0
RIP	172.16.0.0 via	S0
	0.0.0.0	E0

To get to 10.7.1.1:

- With *ip classless* → Default
- With *no ip classless* → Drop