



# Configuring OSPF in a Single Area





# OSPF Overview

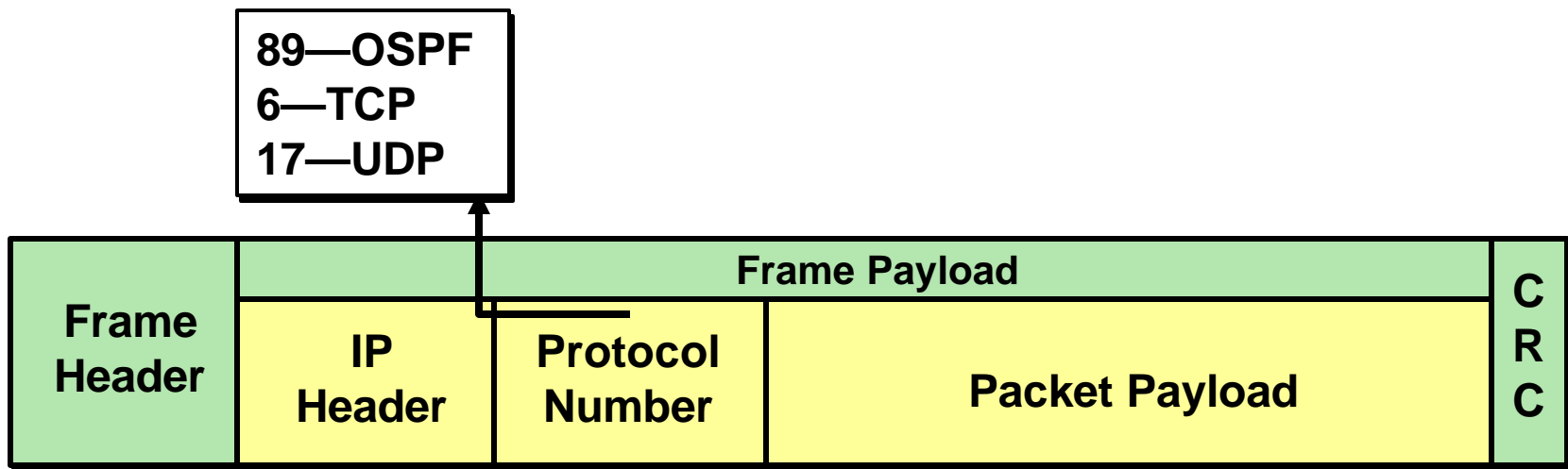
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# What Is OSPF?

- **Has fast convergence**
- **Supports VLSM**
- **Processes updates efficiently**
- **Selects paths based on bandwidth**
- **Supports equal-cost multipath**

# OSPF in IP Packets



## OSPF is a link-state routing protocol

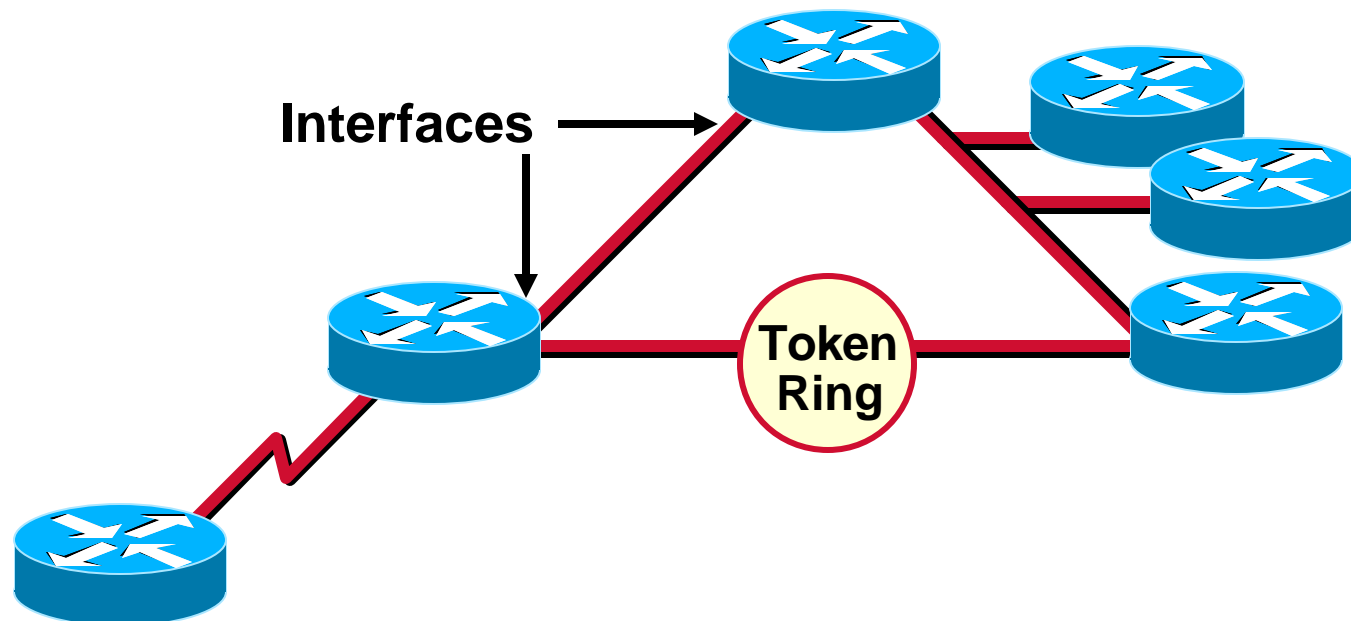
- Relies on IP packets for delivery of routing information
- Uses protocol number 89



# OSPF Terminology

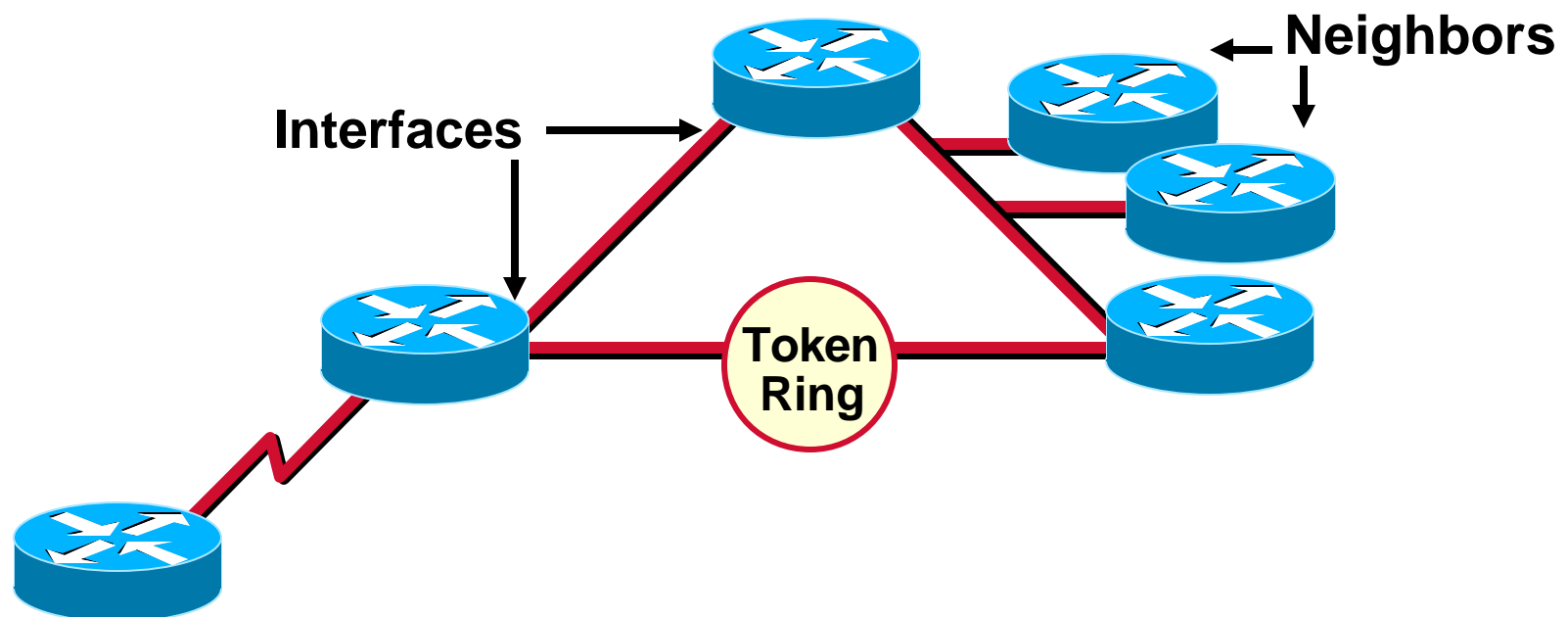
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# OSPF Terminology

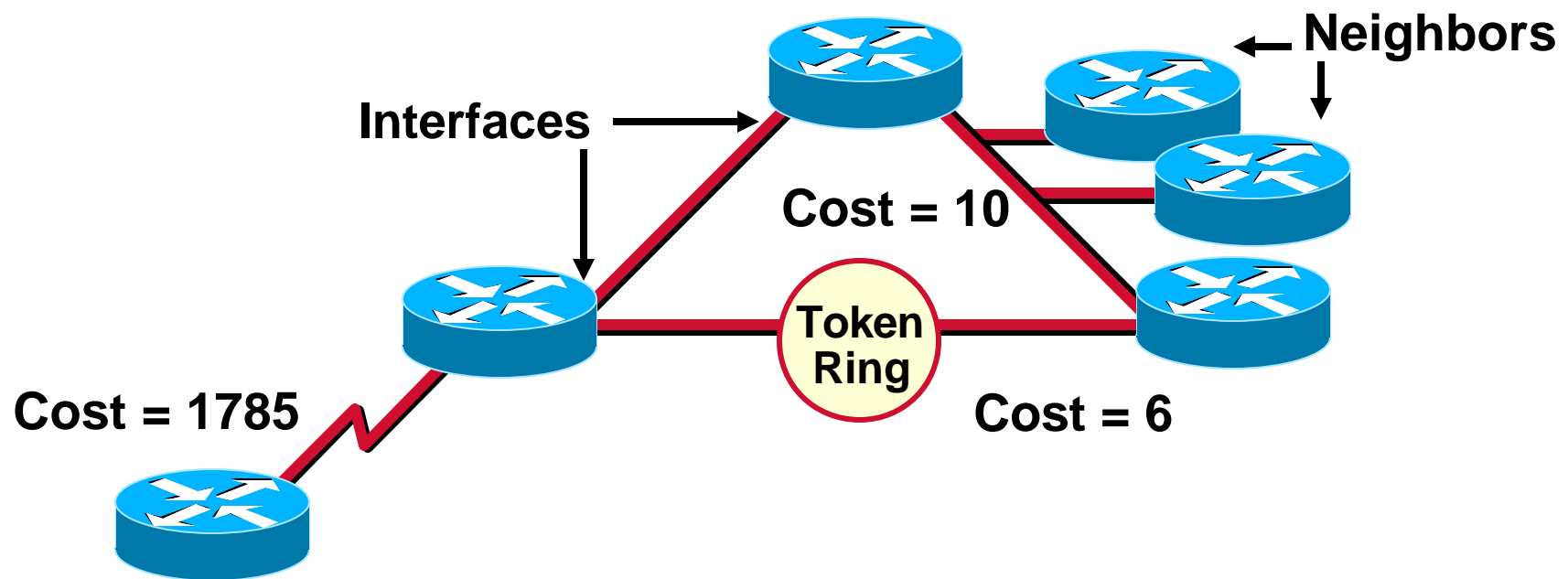




## OSPF Terminology (cont.)

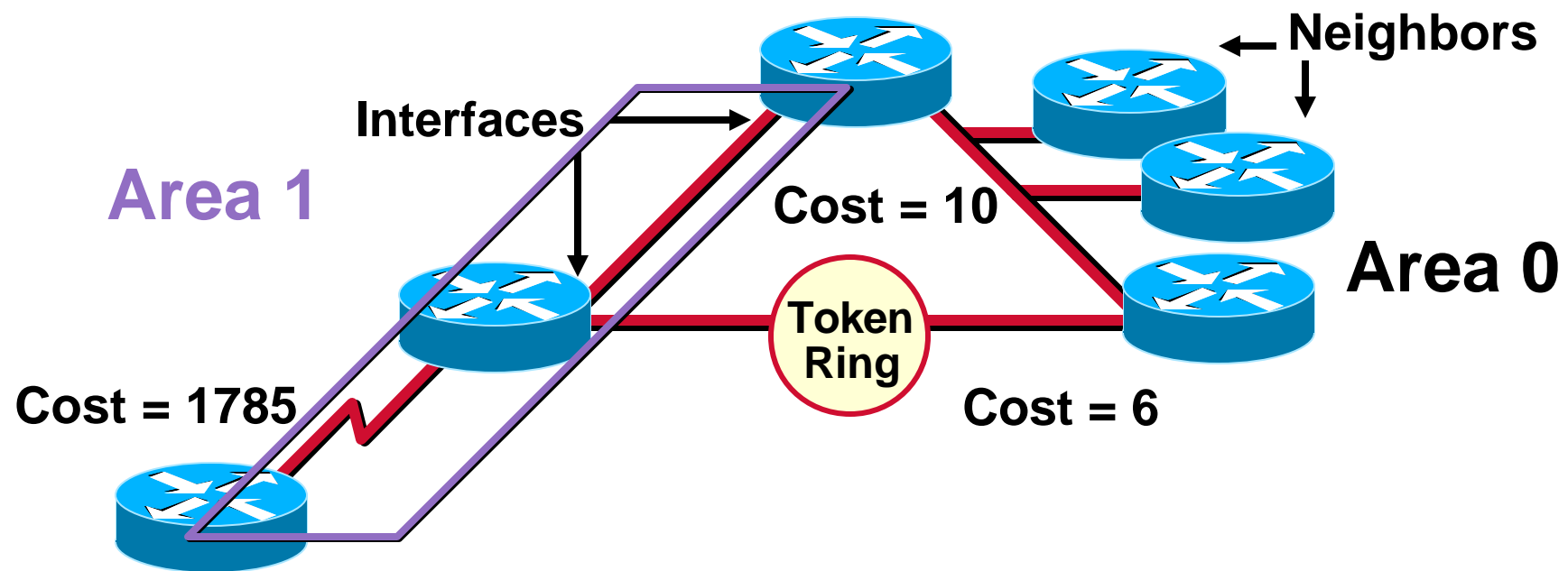


# OSPF Terminology (cont.)



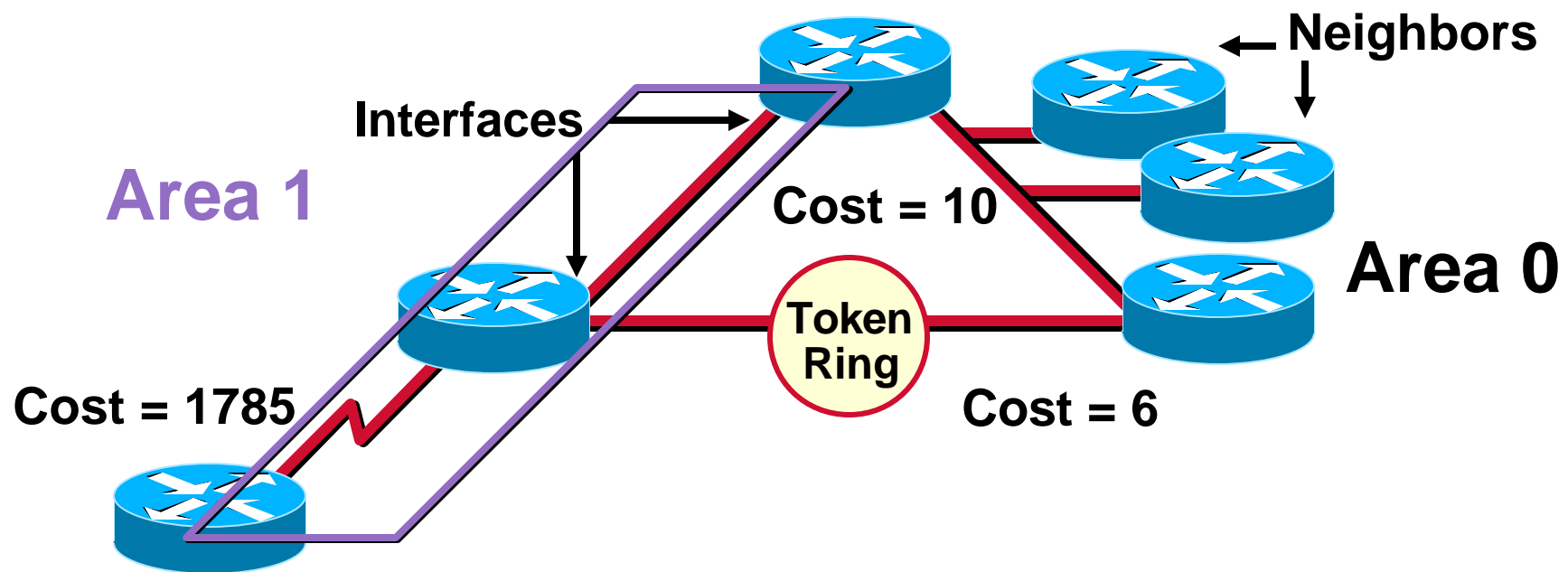


# OSPF Terminology (cont.)



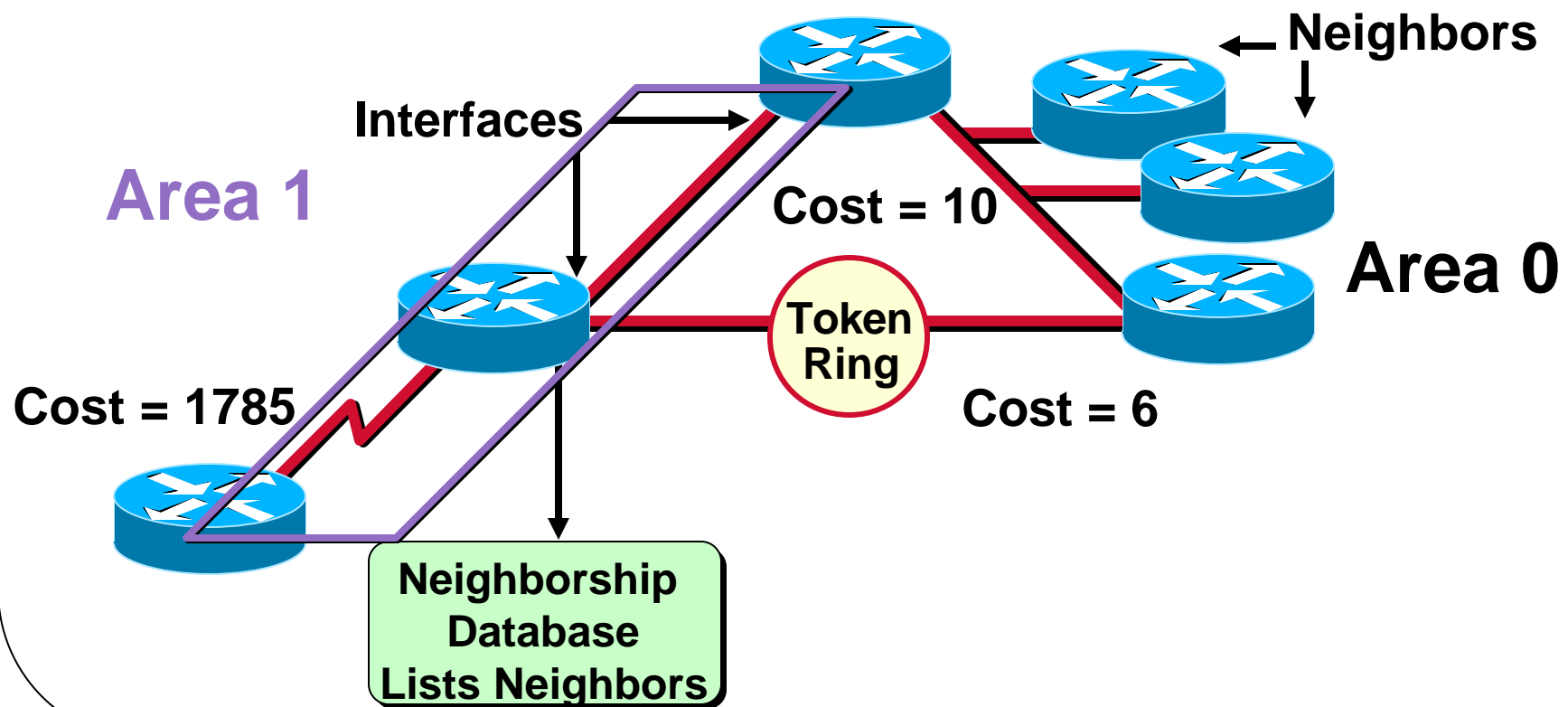
# OSPF Terminology (cont.)

## Autonomous System



# OSPF Terminology (cont.)

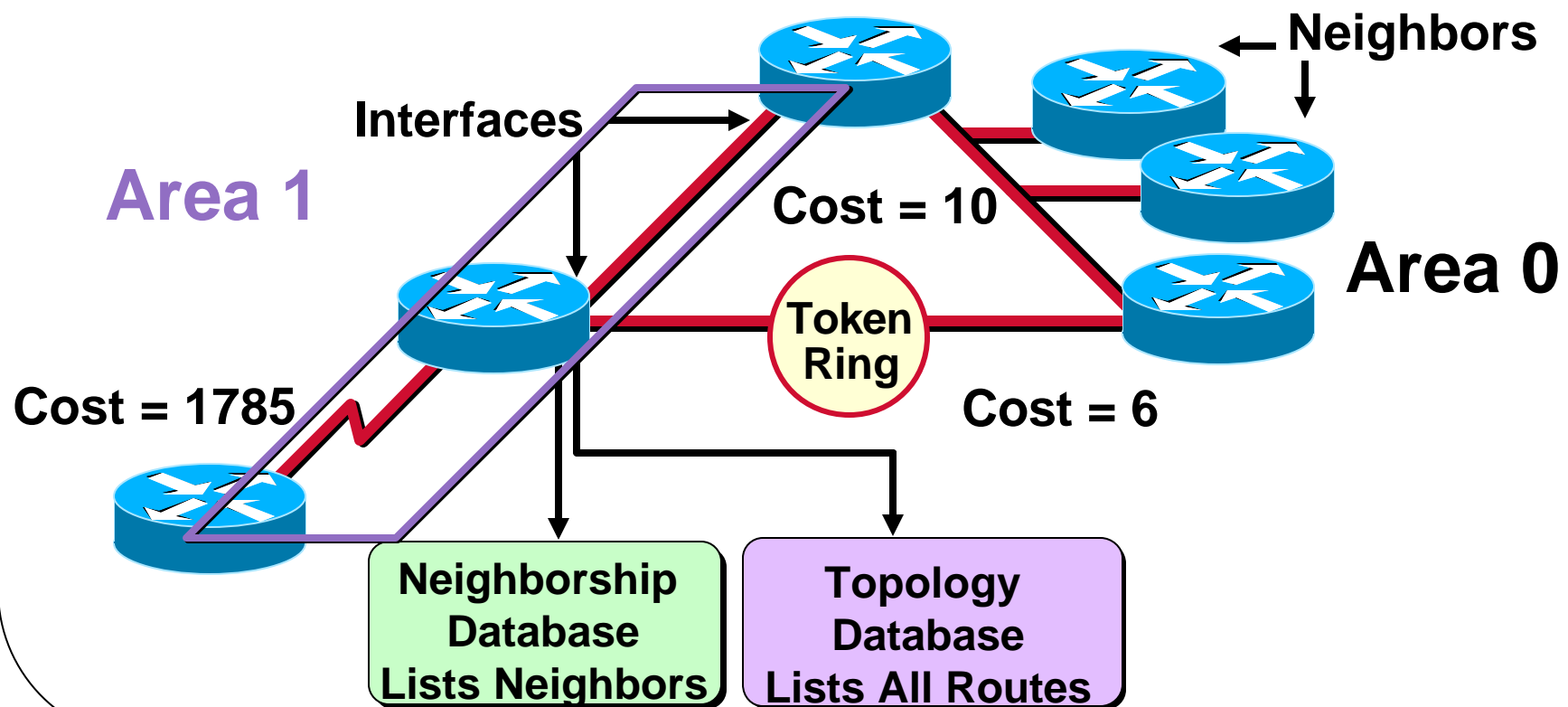
## Autonomous System





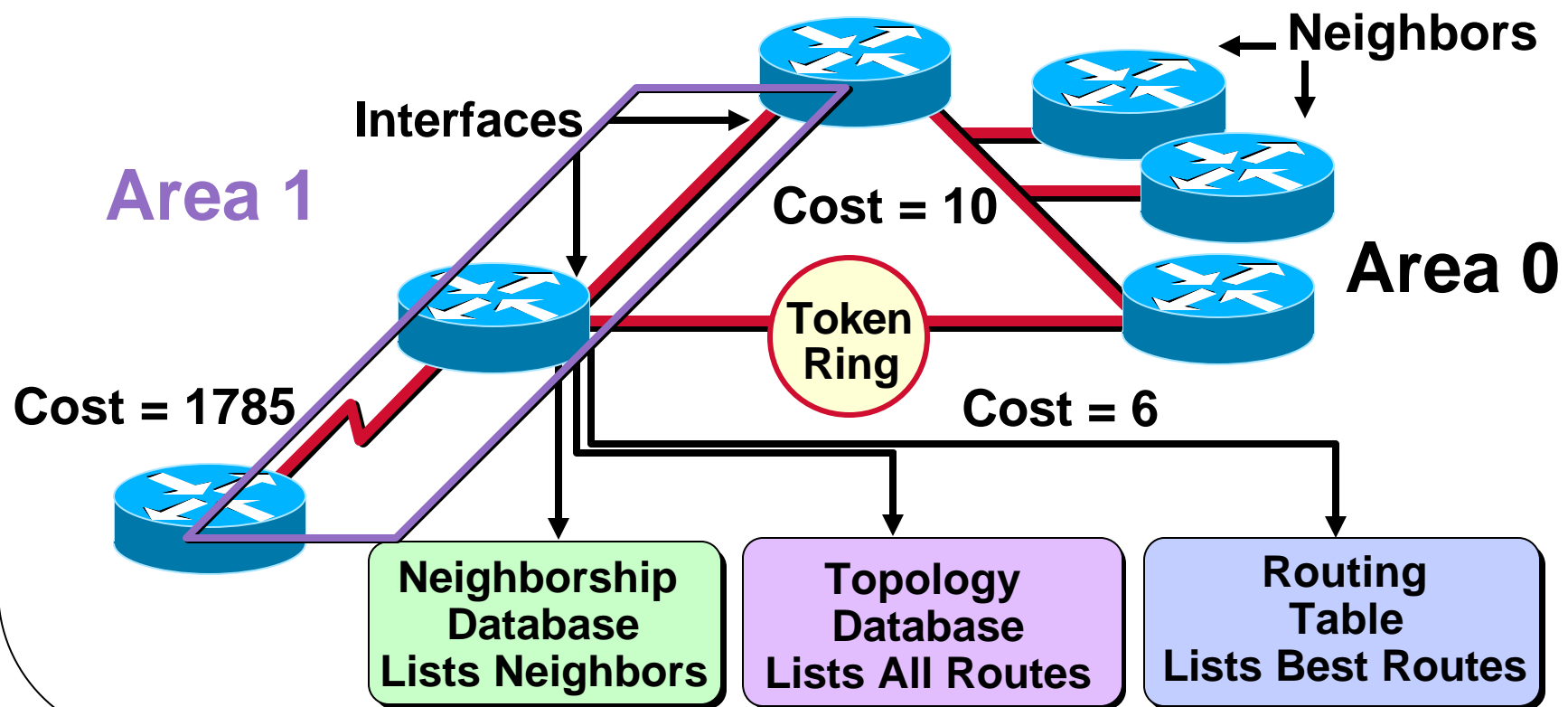
# OSPF Terminology (cont.)

## Autonomous System



# OSPF Terminology (cont.)

## Autonomous System





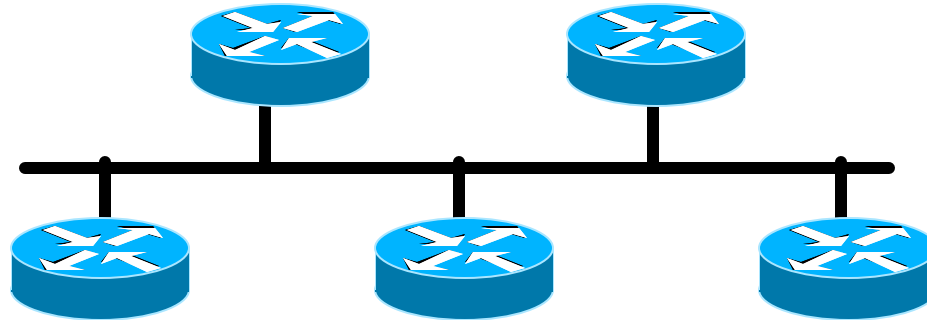
# OSPF Operation

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# OSPF Topologies

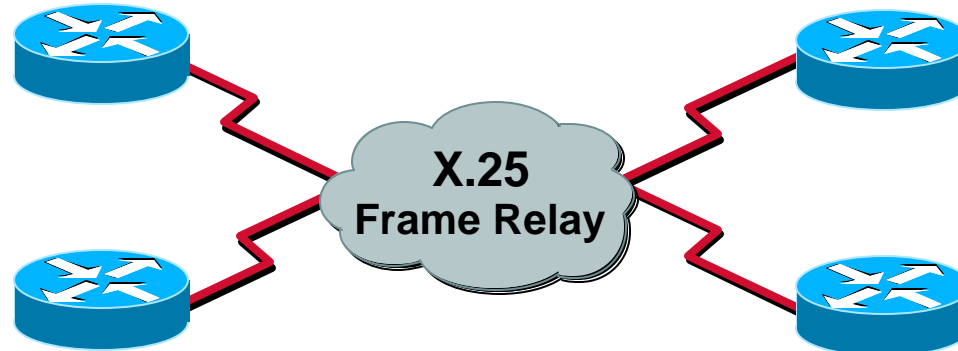
**Broadcast  
Multiaccess**



**Point-to-Point**



**NBMA**

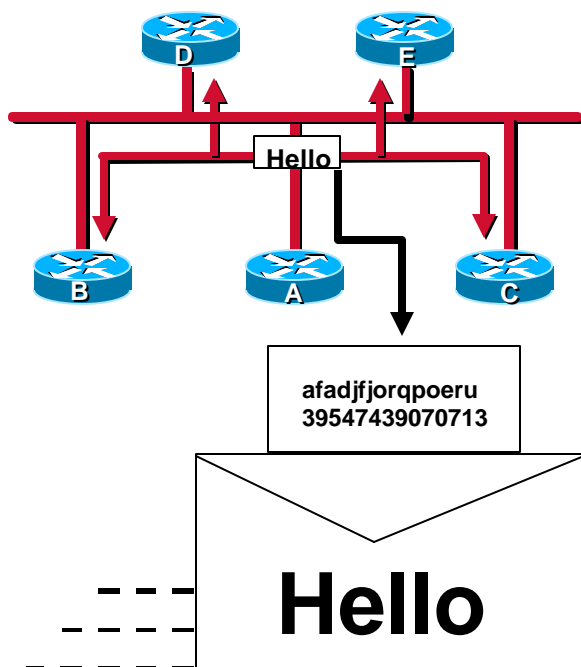




# OSPF Operation in a Broadcast Multiaccess Topology

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# Neighborhood

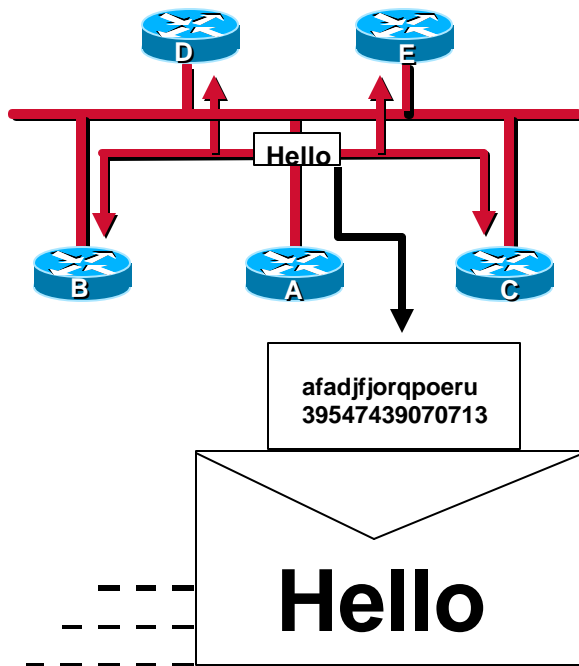


**Router ID**  
**Hello/dead intervals \***  
**Neighbors**  
**Area-ID \***  
**Router priority**  
**DR IP address**  
**BDR IP address**  
**Authentication password\***  
**Stub area flag \***

**\* Entry must match on neighboring routers**



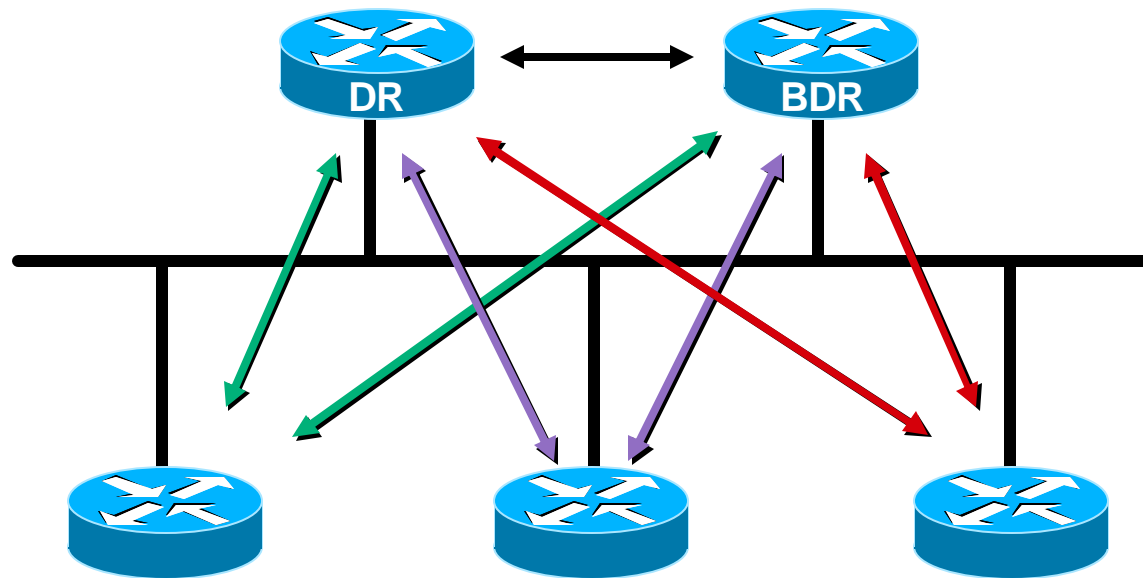
# Neighborhood (cont.)



Router ID  
Hello/dead intervals \*  
Neighbors  
Area-ID \*  
Router priority  
DR IP address  
BDR IP address  
Authentication password\*  
Stub area flag \*

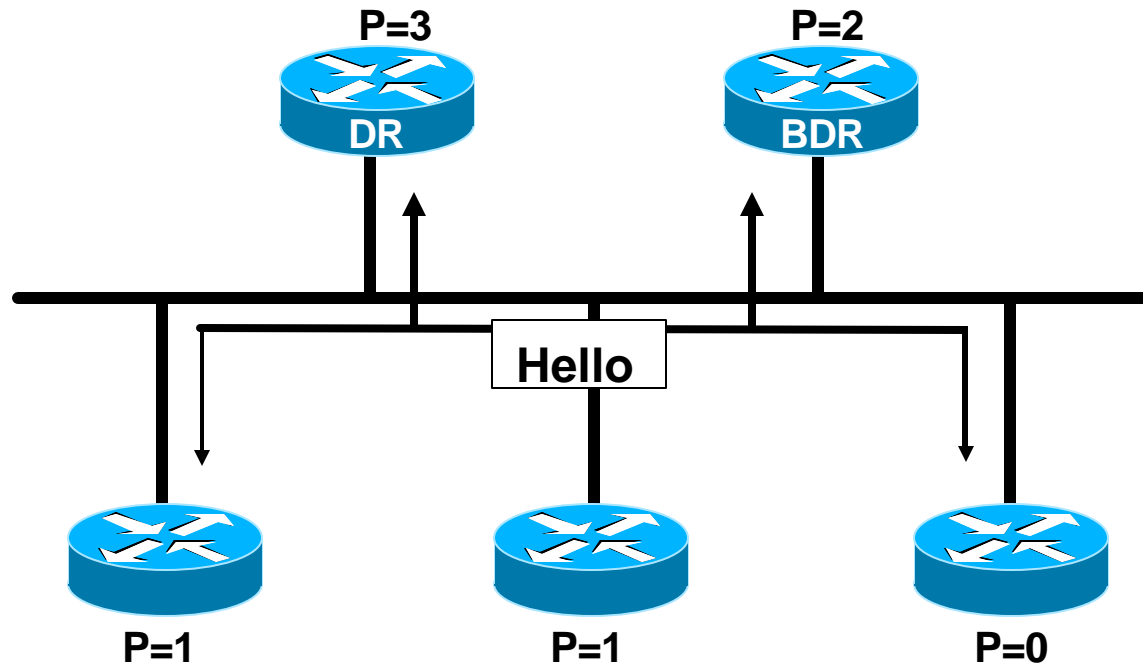
\* Entry must match on neighboring routers

# DR and BDR



- Hellos elect DR and BDR to represent segment
- Each router then forms adjacency with DR and BDR

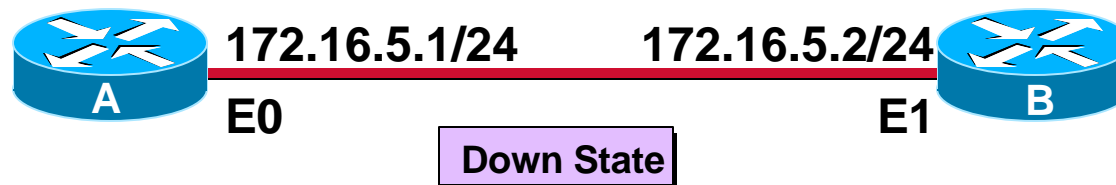
# Electing the DR and BDR



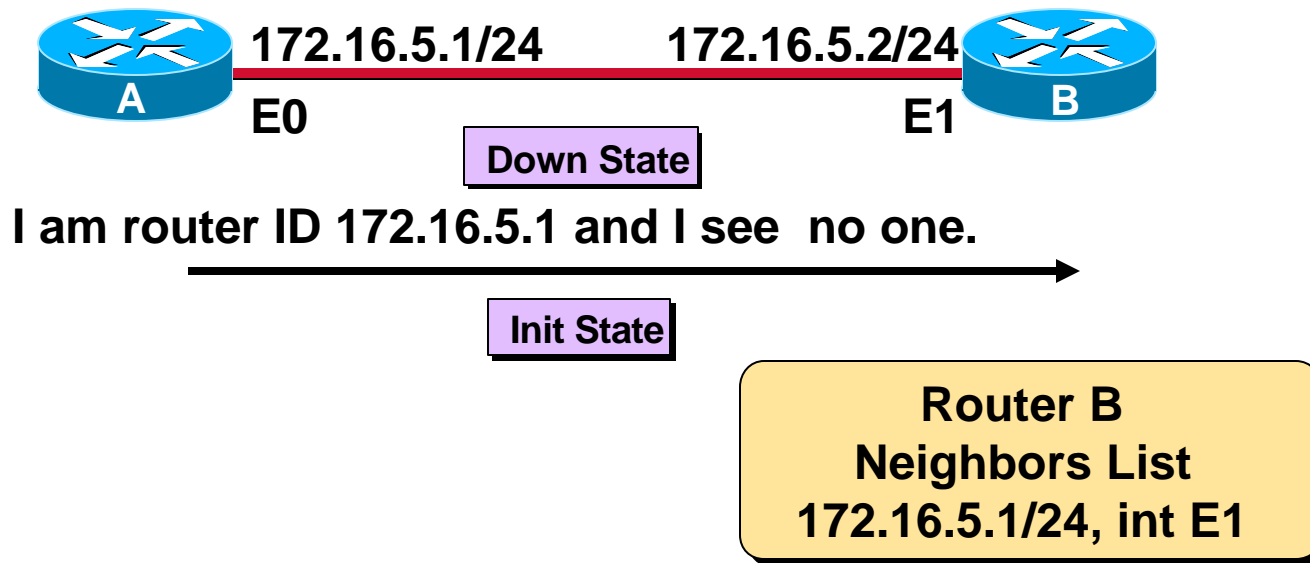
- Hello packets exchanged via IP multicast
- Router with highest OSPF priority elected



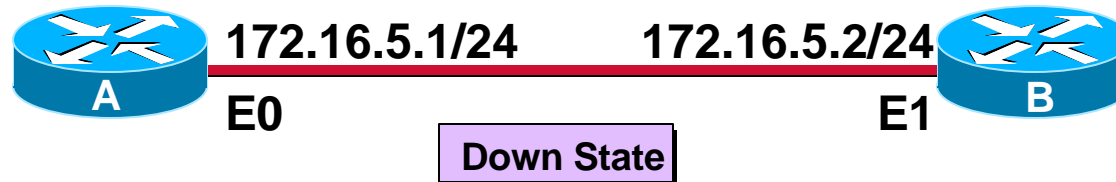
# Exchange Process



# Exchange Process



# Exchange Process



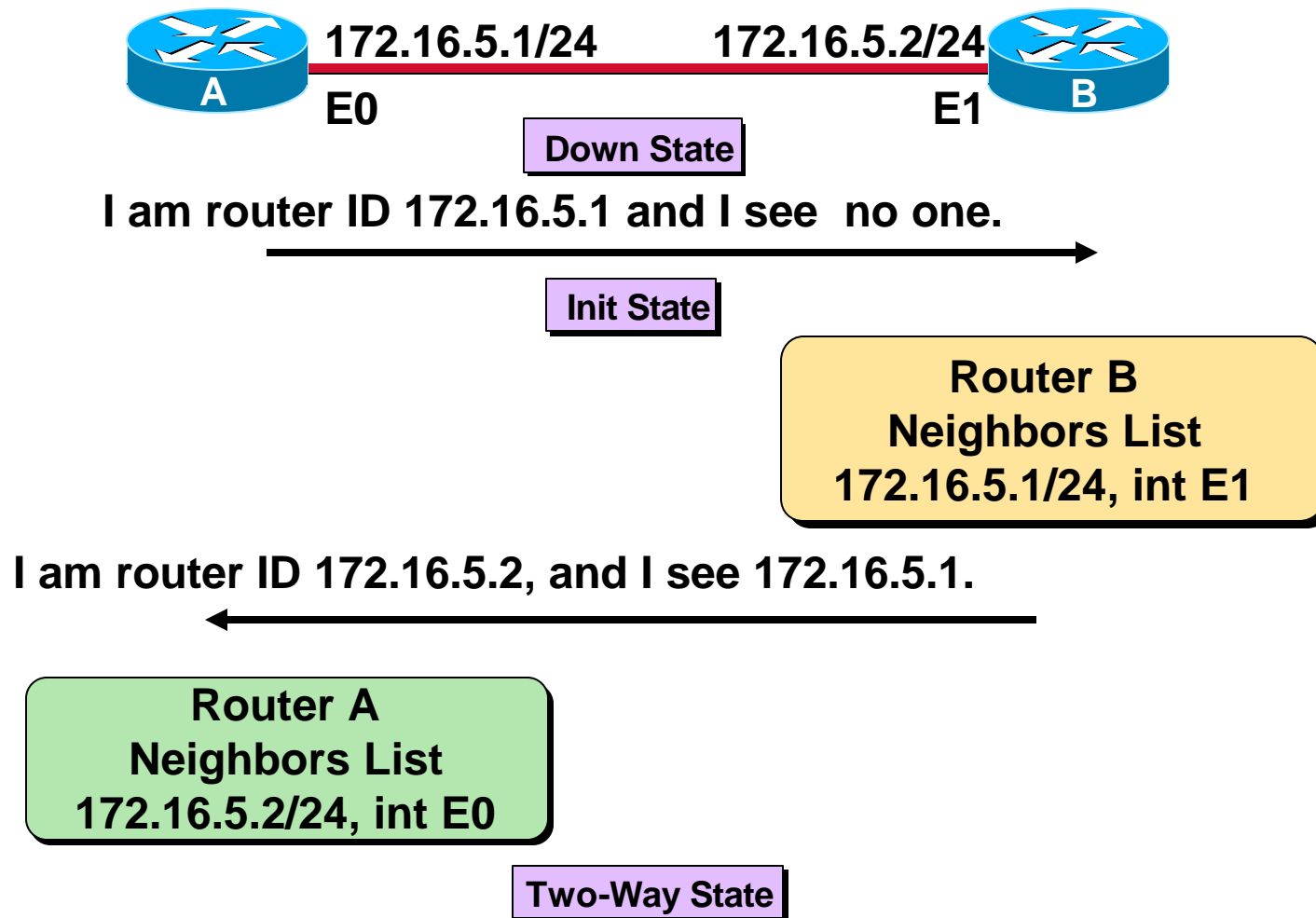
I am router ID 172.16.5.1 and I see no one.

Init State

Router B  
Neighbors List  
172.16.5.1/24, int E1

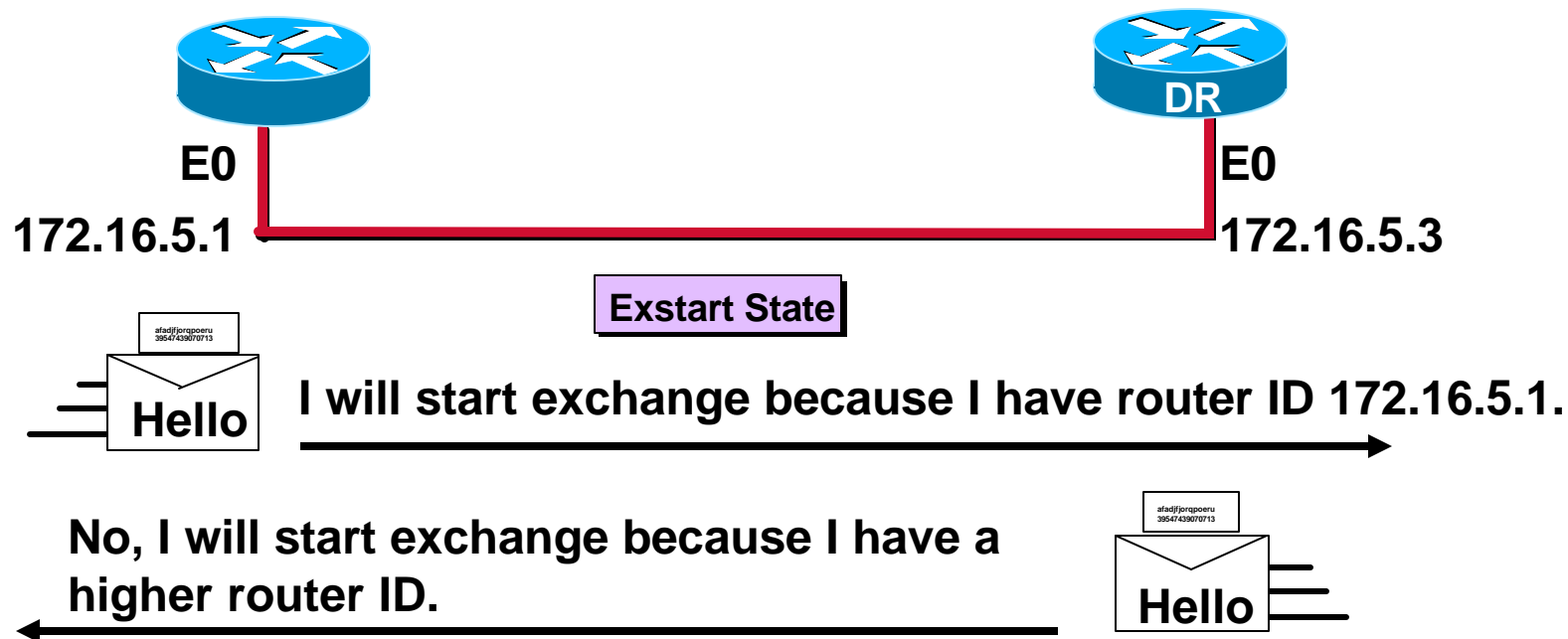
I am router ID 172.16.5.2, and I see 172.16.5.1.

# Exchange Process

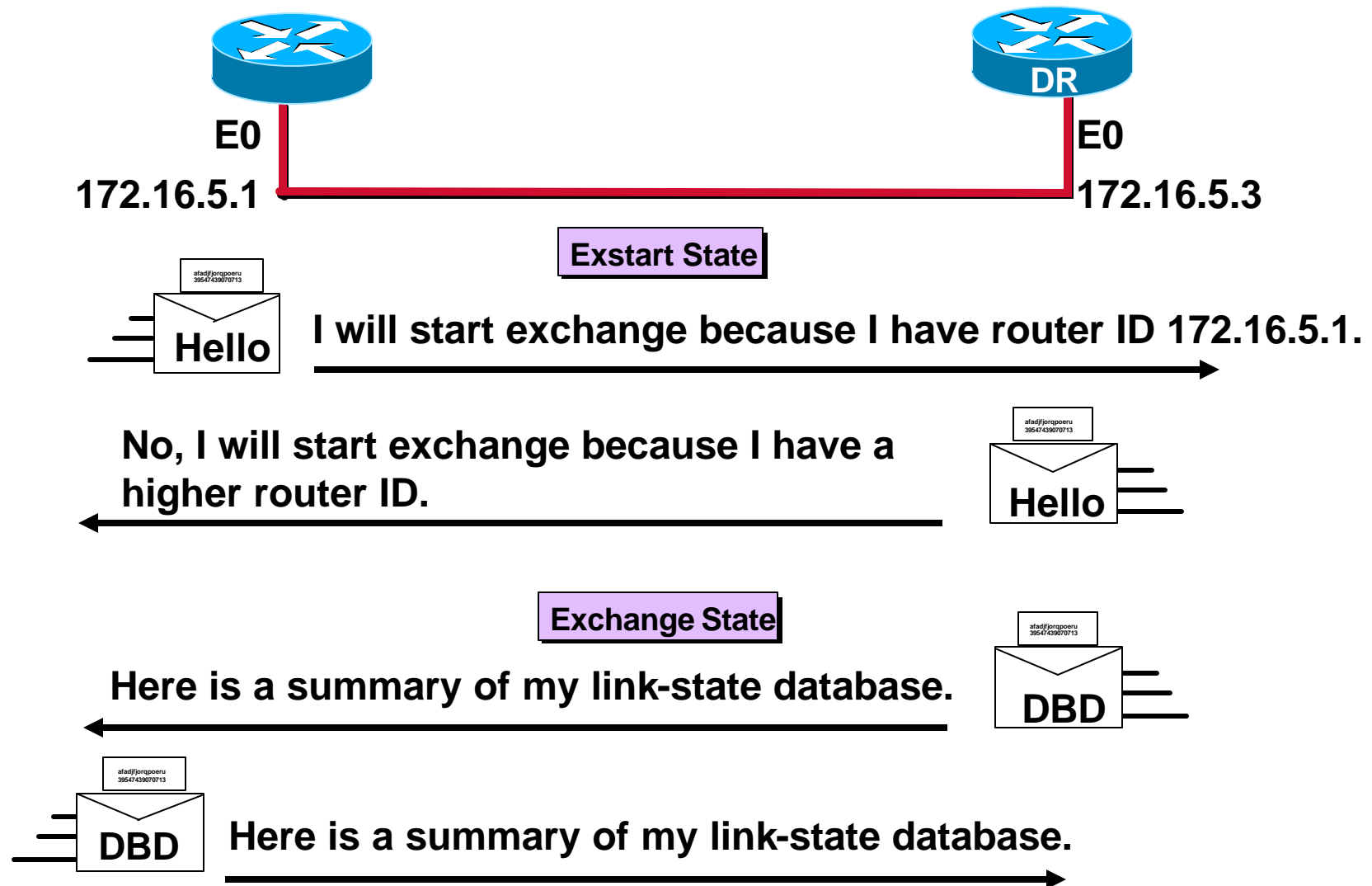




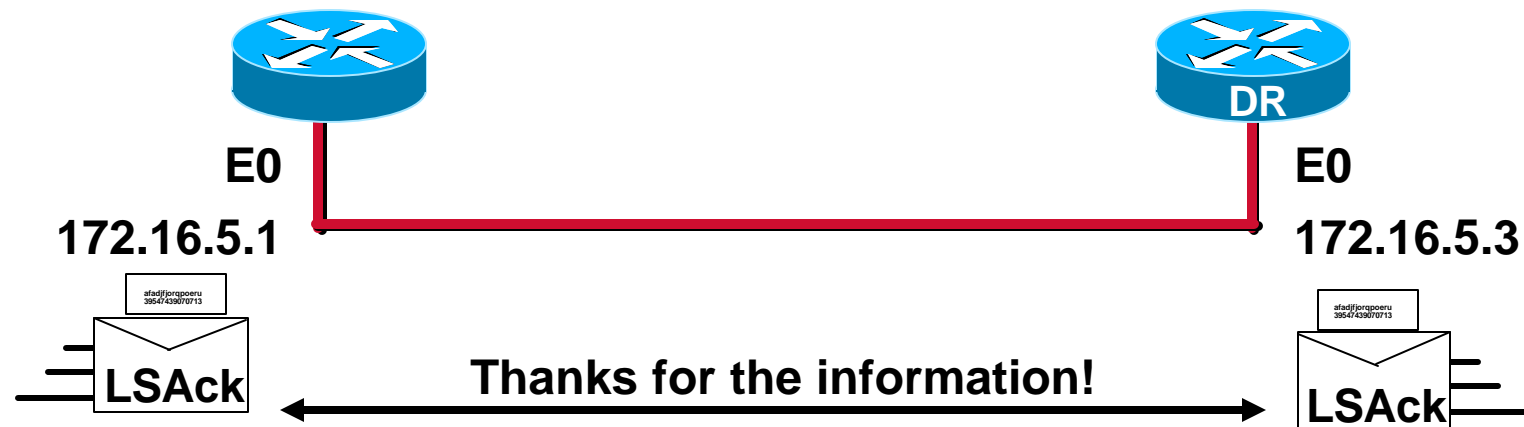
# Discovering Routes



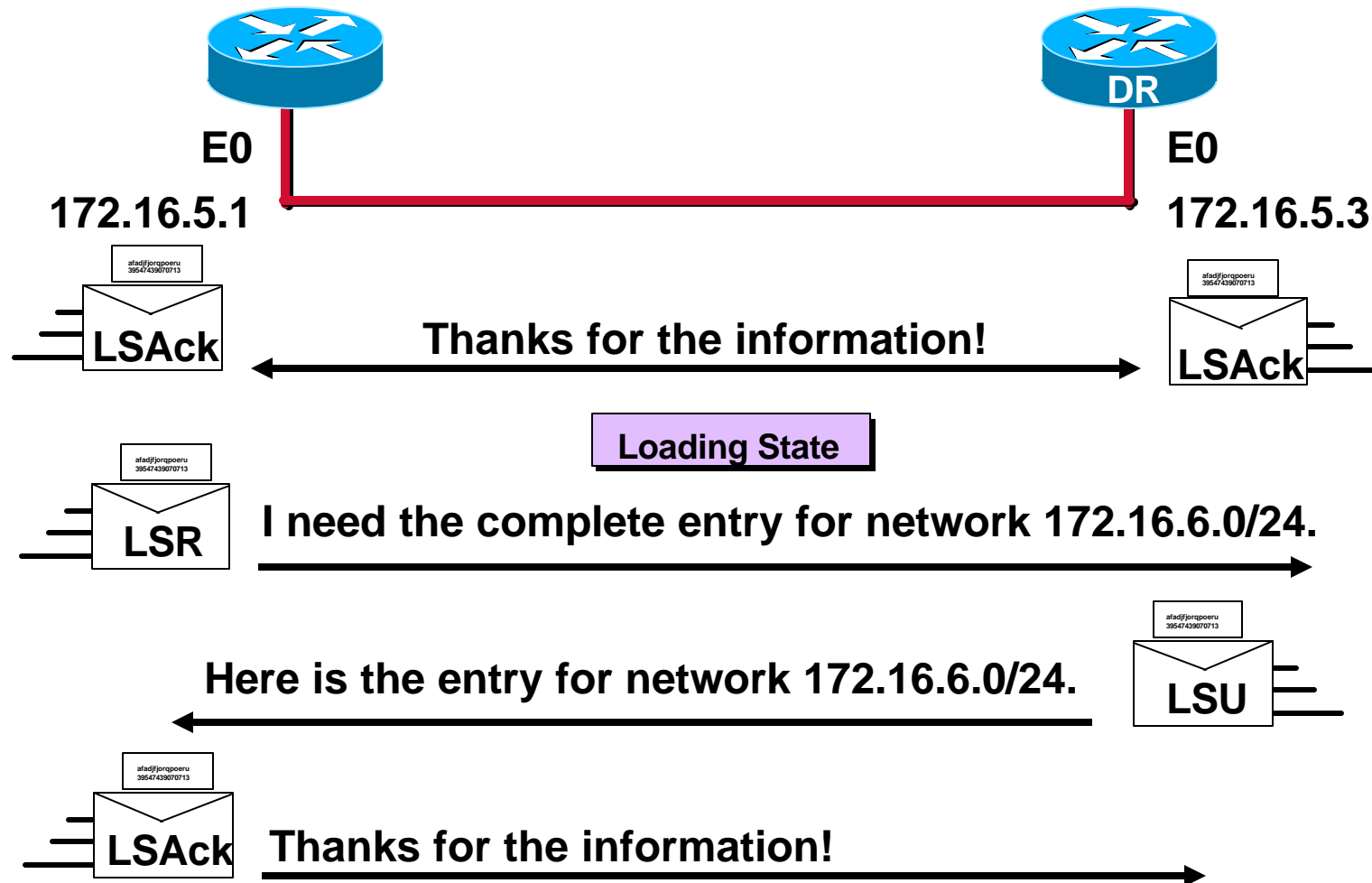
# Discovering Routes



# Discovering Routes (cont.)

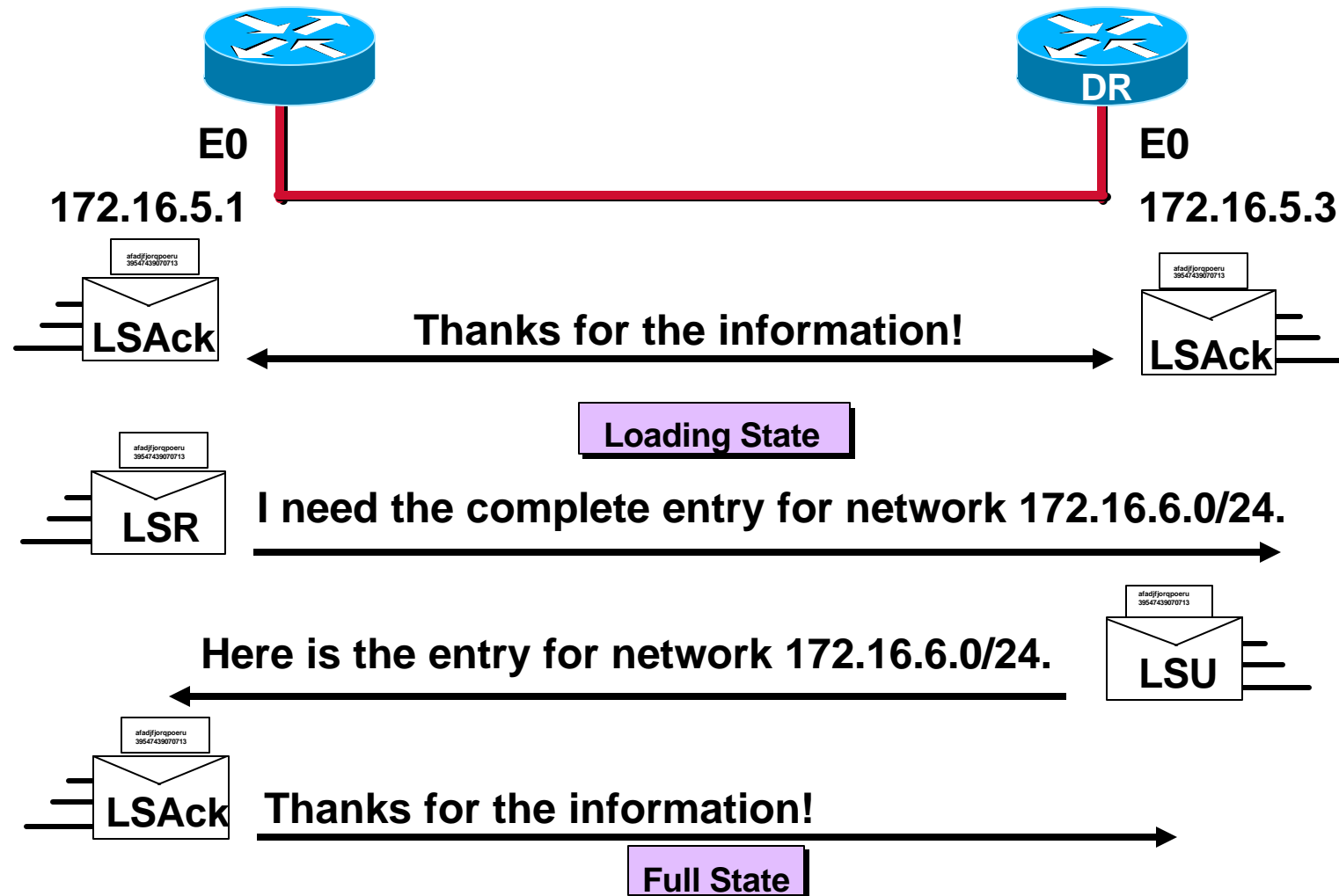


# Discovering Routes (cont.)

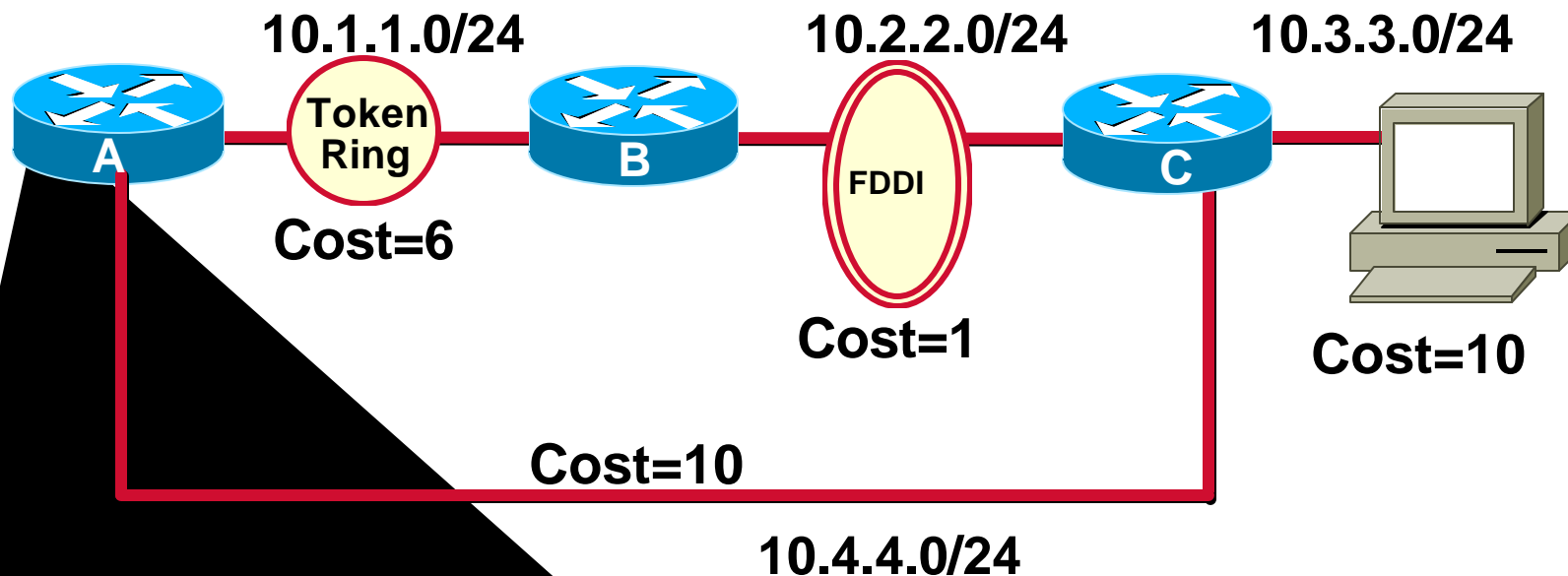




# Discovering Routes (cont.)



# Choosing Routes

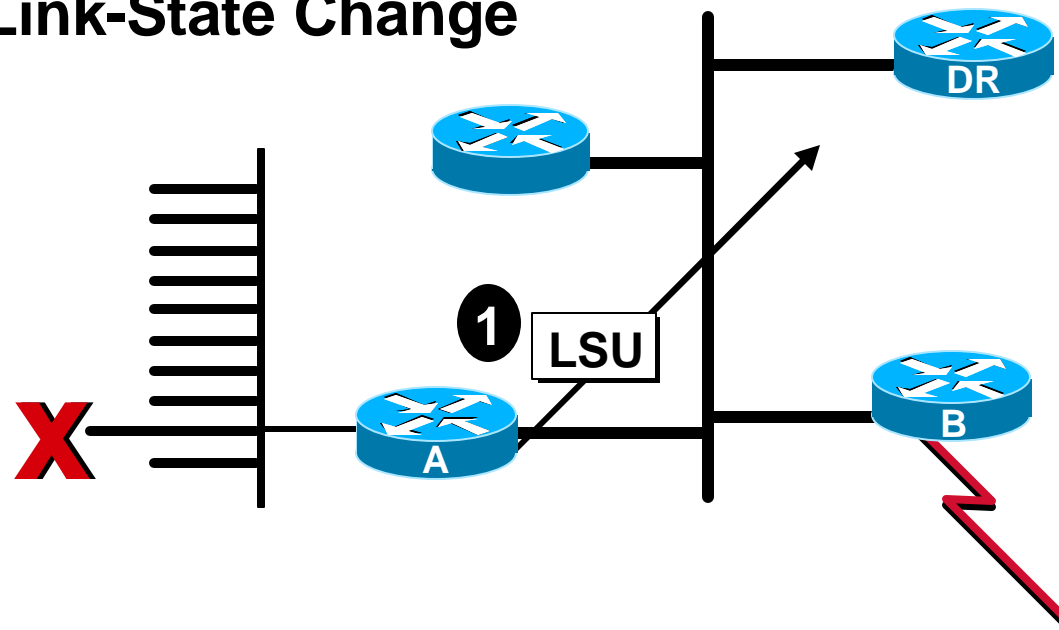


Topology Table		
Net	Cost	Out Interface
10.2.2.0	7	To0
10.3.3.0	17	To0
10.3.3.0	20	E0

This is the best route to 10.3.3.0.

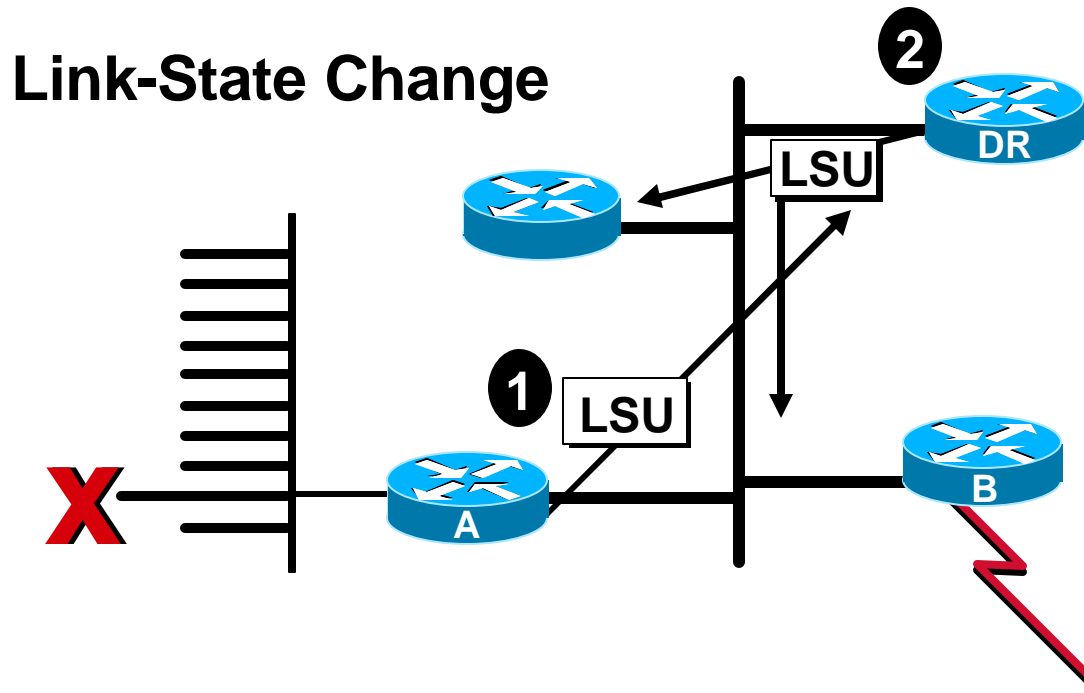
# Maintaining Routing Information

## Link-State Change



**Router A notifies all OSPF DRs on 224.0.0.6**

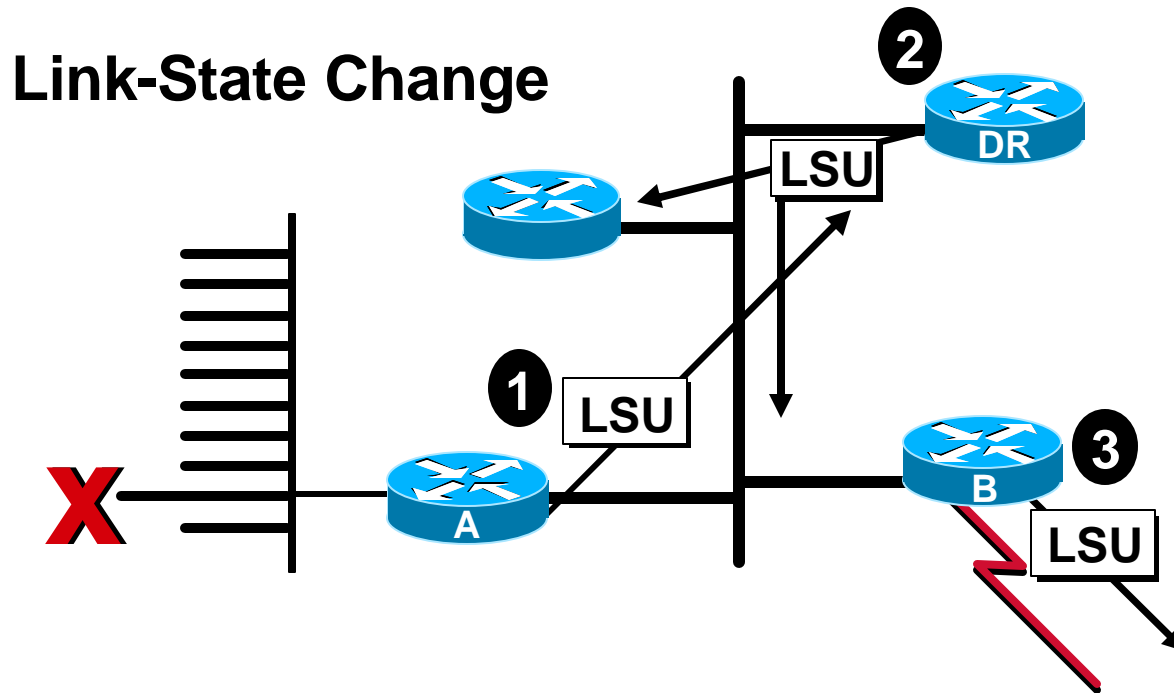
# Maintaining Routing Information (cont.)



- Router A notifies all OSPF DRs on 224.0.0.6
- DR notifies others on 224.0.0.5

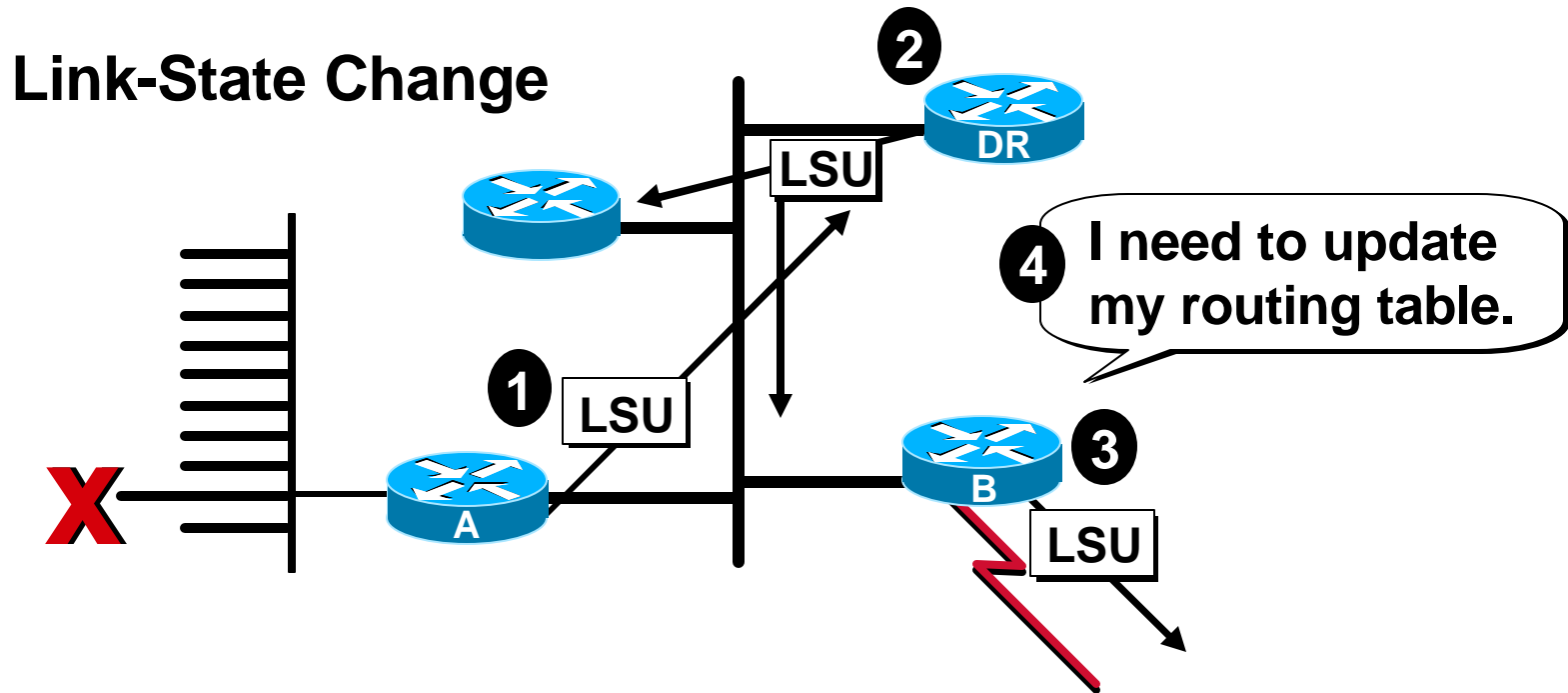


# Maintaining Routing Information (cont.)



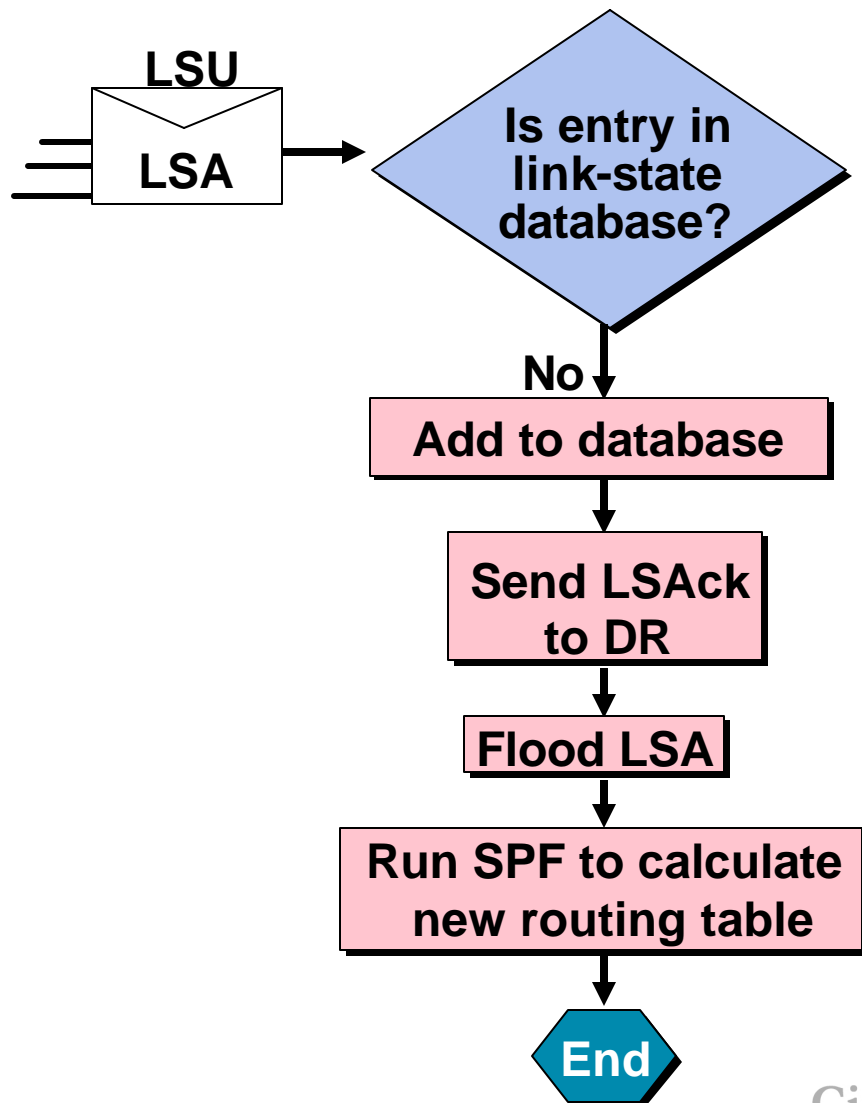
- Router A notifies all OSPF DRs on 224.0.0.6
- DR notifies others on 224.0.0.5

# Maintaining Routing Information (cont.)

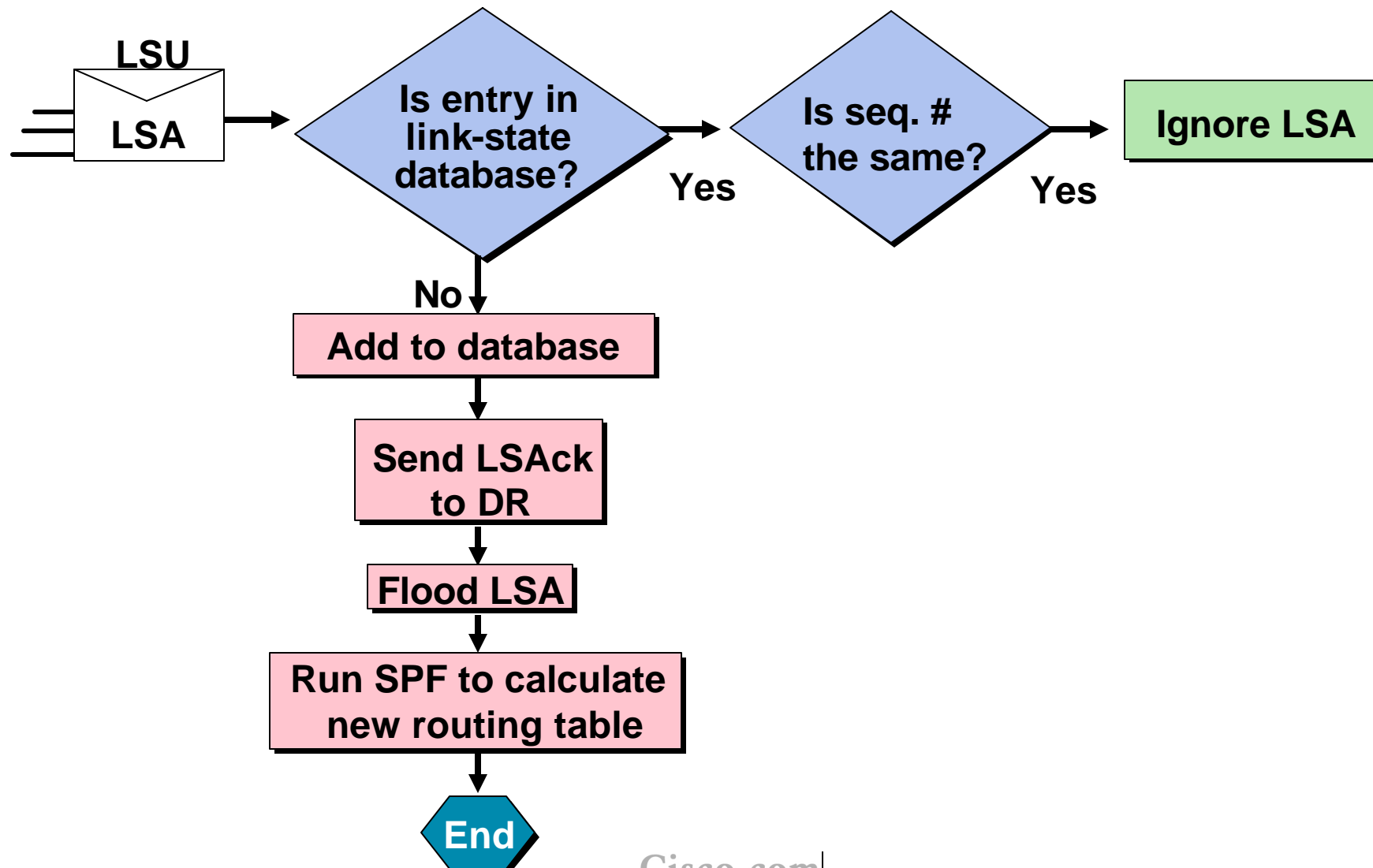


- Router A notifies all OSPF DRs on 224.0.0.6
- DR notifies others on 224.0.0.5

# Maintaining Routing Information (cont.)

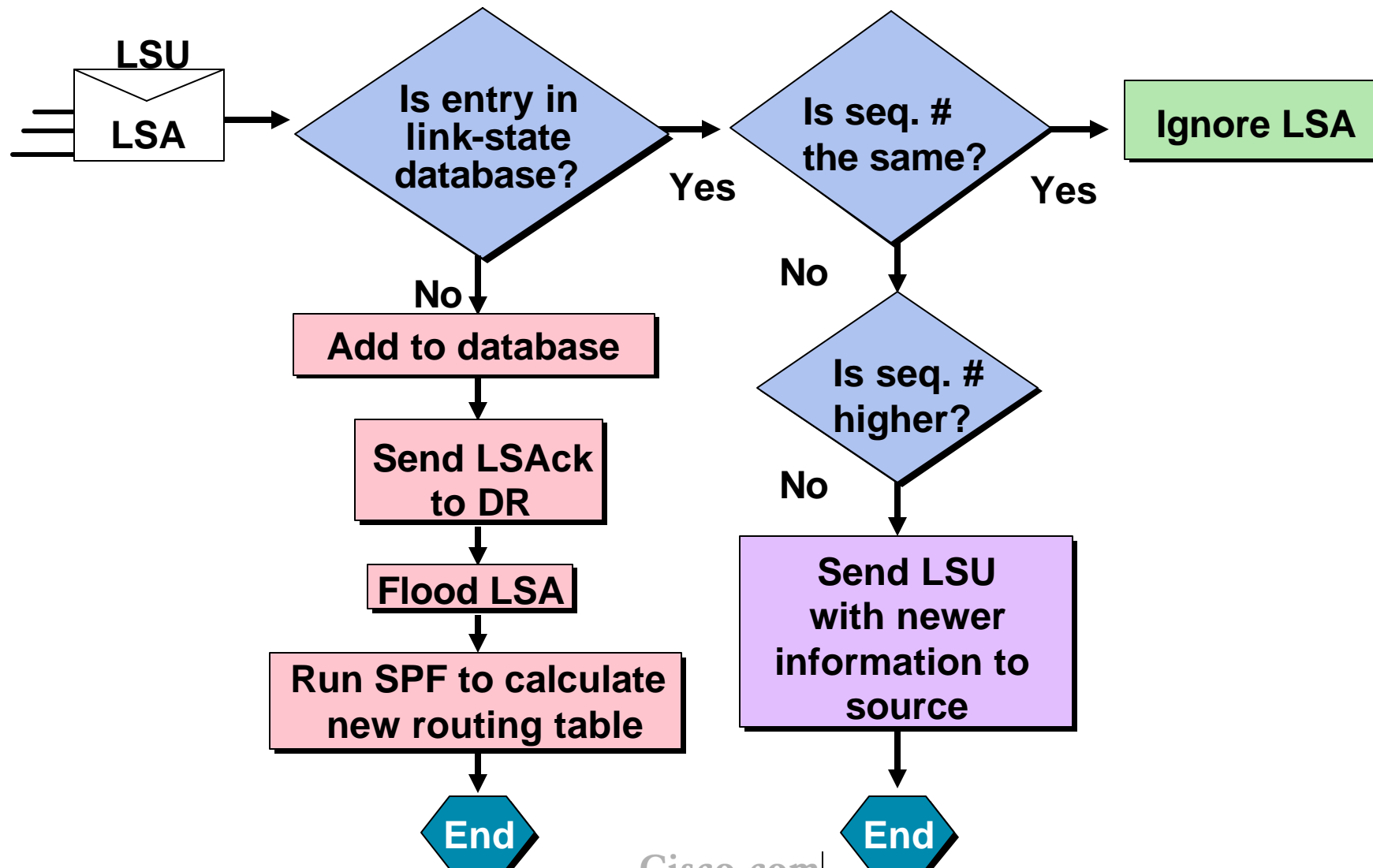


# Maintaining Routing Information (cont.)

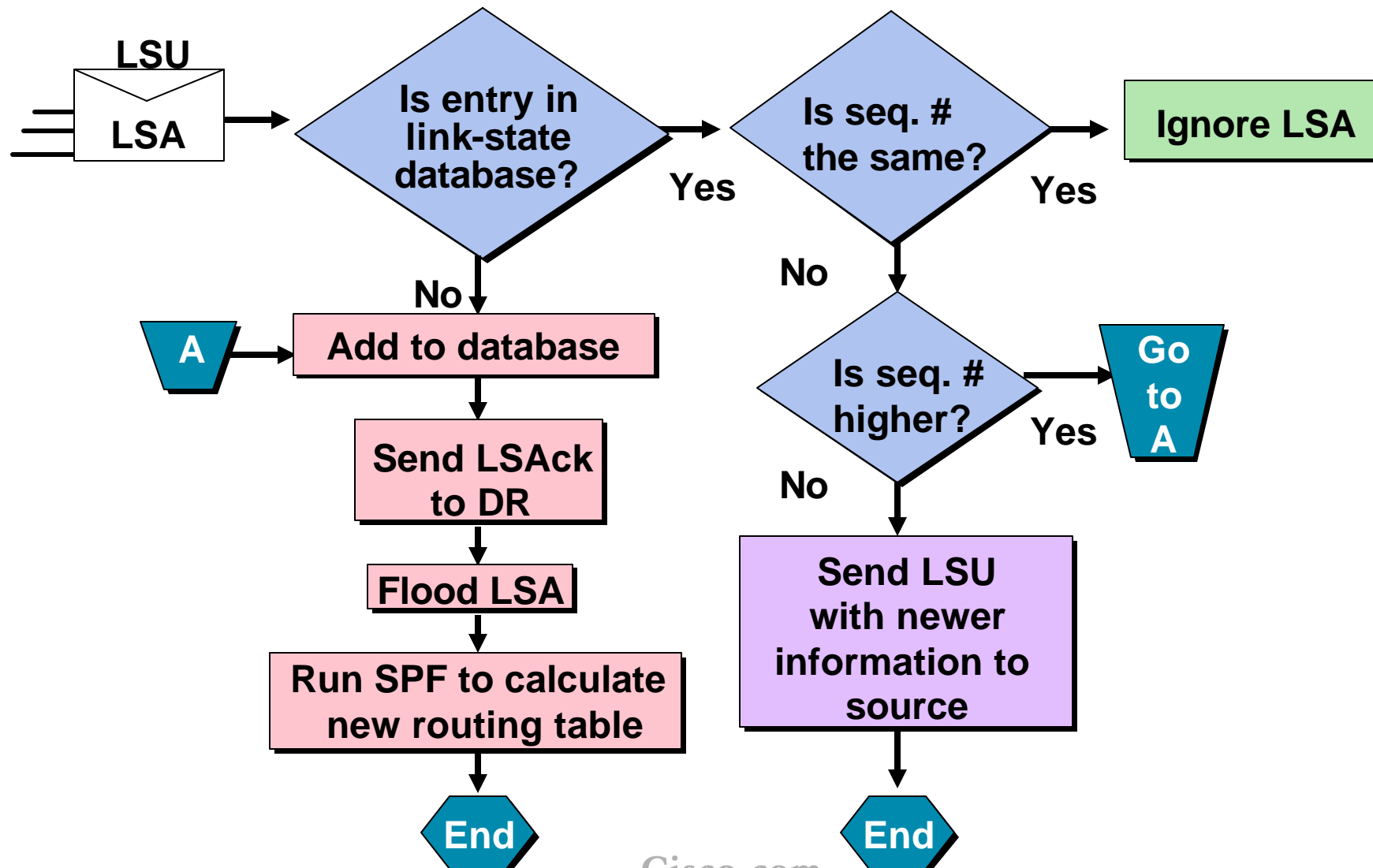




# Maintaining Routing Information (cont.)



# Maintaining Routing Information (cont.)





# OSPF Operation in a Point-to-Point Topology

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# Point-to-Point Neighborhood



- Router dynamically detects its neighboring router using the Hello protocol
- No election: Adjacency is automatic as soon as the two routers can communicate
- OSPF packets are always sent as multicast 224.0.0.5

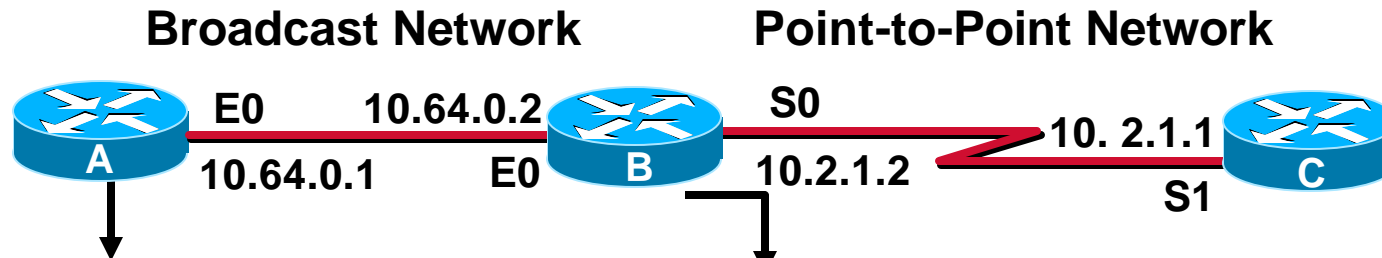




# Configuring OSPF in a Single Area

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# Configuring OSPF on Internal Routers



```
<Output Omitted>
interface Ethernet0
 ip address 10.64.0.1 255.255.255.0
!
<Output Omitted>
router ospf 1
network 10.0.0.0 0.255.255.255 area 0
```

```
<Output Omitted>
interface Ethernet0
 ip address 10.64.0.2 255.255.255.0
!
interface Serial0
 ip address 10.2.1.2 255.255.255.0
<Output Omitted>
router ospf 50
network 10.2.1.2 0.0.0.0 area 0
network 10.64.0.2 0.0.0.0 area 0
```

Can assign network or  
interface address.

# Configuring Optional Commands

## Unadvertised Loopback Address

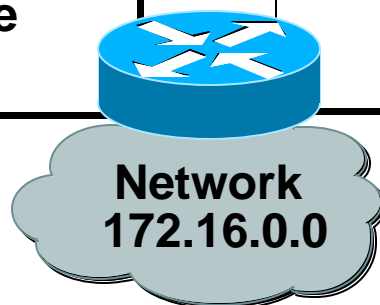
Ex: 192.168.255.254

- Not in OSPF table
- Saves address space
- Cannot use ping

## Advertised Loopback Address

Ex: 172.16.17.5

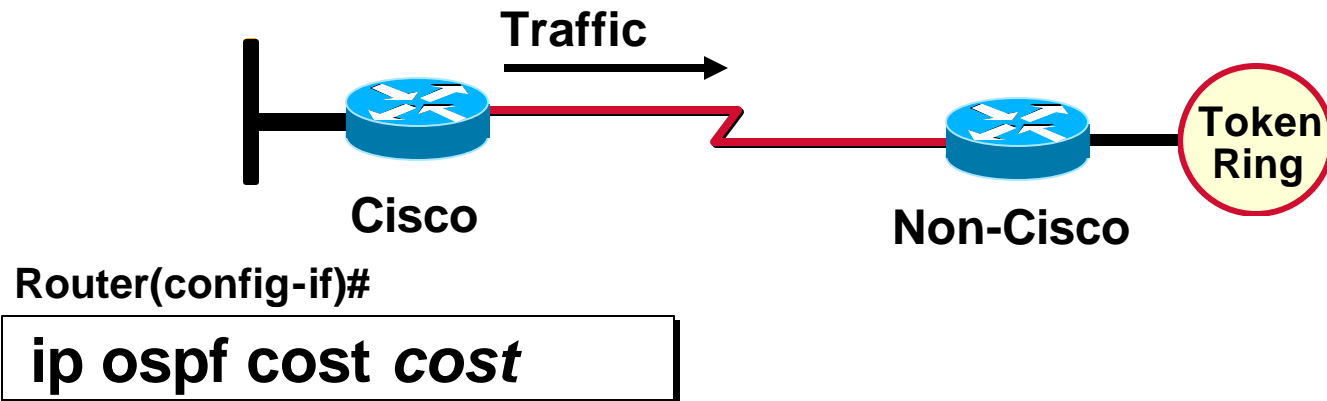
- In OSPF table
- Uses address space
- Can use ping



## Router ID:

- Number by which the router is known to OSPF
- Default: The highest IP address on an active interface at the moment of OSPF process startup
- Can be overridden by a loopback interface: Highest IP address of any active loopback interface

# Configuring Optional Commands (cont.)



- Assigns a cost to an outgoing interface
- May be required for interoperability
- Uses default cost between Cisco devices



# Configuring OSPF in Point-to-Point Mode

```
R1(config)#interface Serial0
R1(config-if)#no ip address
R1(config-if)#encapsulation frame-relay
R1(config)#interface Serial0.1 point-to-point
R1(config-subif)#ip address 10.1.1.1 255.255.255.0
R1(config-subif)#frame-relay interface-dlci 51
R1(config)#interface Serial0.2 point-to-point
R1(config-subif)#ip address 10.1.2.1 255.255.255.0
R1(config-subif)#frame-relay interface-dlci 52
R1(config)#router ospf 1
R1(config-router)#network 10.1.0.0 0.0.255.255 area 0
```

- **OSPF considers each subinterface as a physical point-to-point network**
- **Adjacency is automatic**



# Verifying OSPF Operation

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# Verifying OSPF Operation

Router#

```
show ip protocols
```

- **Verifies that OSPF is configured**

Router#

```
show ip route
```

- **Displays all the routes learned by the router**

Router#

```
show ip ospf interface
```

- **Displays area-ID and adjacency information**

# Verifying OSPF Operation (cont.)

Router#

```
show ip ospf
```

- **Displays OSPF timers and statistics**

Router#

```
show ip ospf neighbor detail
```

- **Displays information about DR, BDR, and neighbors**

Router#

```
show ip ospf database
```

- **Displays the link-state database**



# Verifying OSPF Operation (cont.)

Router#

```
clear ip route *
```

- Allows you to clear the IP routing table

Router#

```
debug ip ospf option
```

- Displays router interaction during the hello, exchange, and flooding processes

# show ip ospf interface

**R2#sh ip ospf int e0**

**Ethernet0 is up, line protocol is up**

**Internet Address 192.168.0.12/24, Area 0**

**Process ID 1, Router ID 192.168.0.12, Network Type BROADCAST, Cost: 10**

**Transmit Delay is 1 sec, State DROTHER, Priority 1**

**Designated Router (ID) 192.168.0.11, Interface address 192.168.0.11**

**Backup Designated router (ID) 192.168.0.13, Interface address 192.168.0.13**

**Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5**

**Hello due in 00:00:04**

**Neighbor Count is 3, Adjacent neighbor count is 2**

**Adjacent with neighbor 192.168.0.13 (Backup Designated Router)**

**Adjacent with neighbor 192.168.0.11 (Designated Router)**

**Suppress hello for 0 neighbor(s)**

# show ip ospf neighbor— Multiaccess and Point-to-Point

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.0.13	1	2WAY/DROTHER	00:00:31	192.168.0.13	Ethernet0
192.168.0.14	1	FULL/BDR	00:00:38	192.168.0.14	Ethernet0
192.168.0.11	1	2WAY/DROTHER	00:00:36	192.168.0.11	Ethernet0
192.168.0.12	1	FULL/DR	00:00:38	192.168.0.12	Ethernet0

## OSPF over Ethernet—Multiaccess Network

Neighbor ID	Pri	State	Dead Time	Address	Interface
192.168.0.11	1	FULL/ -	00:00:39	10.1.1.2	Serial1

## OSPF over HDLC—Point-to-Point Network

# show ip ospf database

R2#show ip ospf database

OSPF Router with ID (192.168.0.12) (Process ID 1)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
192.168.0.10	192.168.0.10	817	0x80000003	0xFF56	1
192.168.0.11	192.168.0.11	817	0x80000003	0xFD55	1
192.168.0.12	192.168.0.12	816	0x80000003	0xFB54	1
192.168.0.13	192.168.0.13	816	0x80000003	0xF953	1
192.168.0.14	192.168.0.14	817	0x80000003	0xD990	1

Net Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
192.168.0.14	192.168.0.14	812	0x80000002	0x4AC8



# debug ip ospf adj

```
192.168.0.14 on Ethernet0, state 2WAY
OSPF: end of Wait on interface Ethernet0
OSPF: DR/BDR election on Ethernet0
OSPF: Elect BDR 192.168.0.14
OSPF: Elect DR 192.168.0.14
    DR: 192.168.0.14 (Id)  BDR: 192.168.0.14 (Id)
OSPF: Send DBD to 192.168.0.14 on Ethernet0 seq 0x11DB opt 0x2 flag 0x7 len 32
OSPF: Build router LSA for area 0, router ID 192.168.0.11
OSPF: Neighbor change Event on interface Ethernet0
OSPF: Rcv DBD from 192.168.0.14 on Ethernet0 seq 0x1598 opt 0x2 flag 0x7 len 32
    state EXSTART
OSPF: NBR Negotiation Done. We are the SLAVE
OSPF: Send DBD to 192.168.0.14 on Ethernet0 seq 0x1598 opt 0x2 flag 0x2 len 52
OSPF: Rcv DBD from 192.168.0.14 on Ethernet0 seq 0x1599 opt 0x2 flag 0x3 len 92
    state EXCHANGE
OSPF: Exchange Done with 192.168.0.14 on Ethernet0
OSPF: Send DBD to 192.168.0.14 on Ethernet0 seq 0x159A opt 0x2 flag 0x0 len 32
OSPF: Synchronized with 192.168.0.14 on Ethernet0, state FULL
OSPF: Build router LSA for area 0, router ID 192.168.0.11
OSPF: Neighbor change Event on interface Ethernet0
OSPF: DR/BDR election on Ethernet0
OSPF: Elect BDR 192.168.0.13
OSPF: Elect DR 192.168.0.14
    DR: 192.168.0.14 (Id)  BDR: 192.168.0.13 (Id)
```