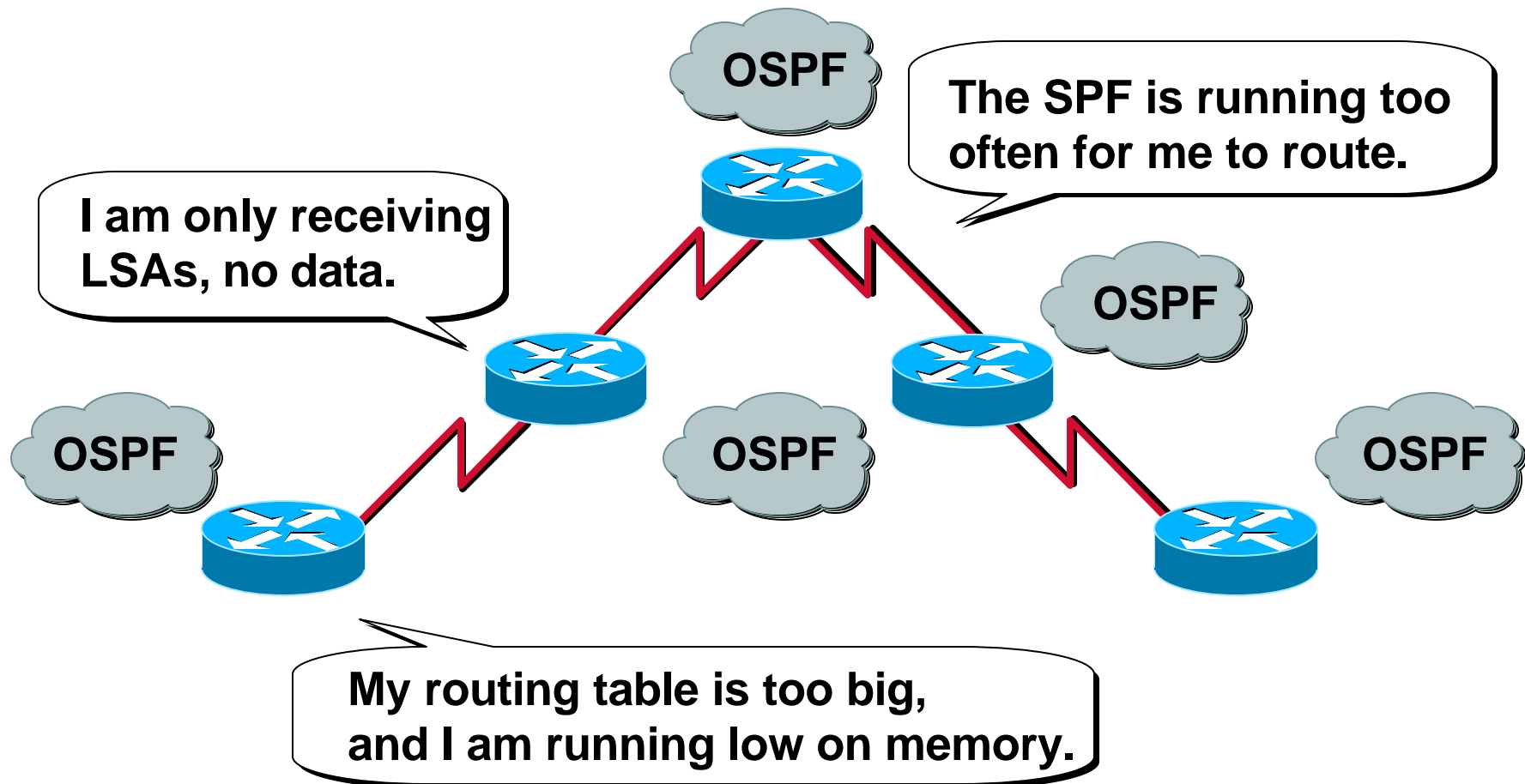


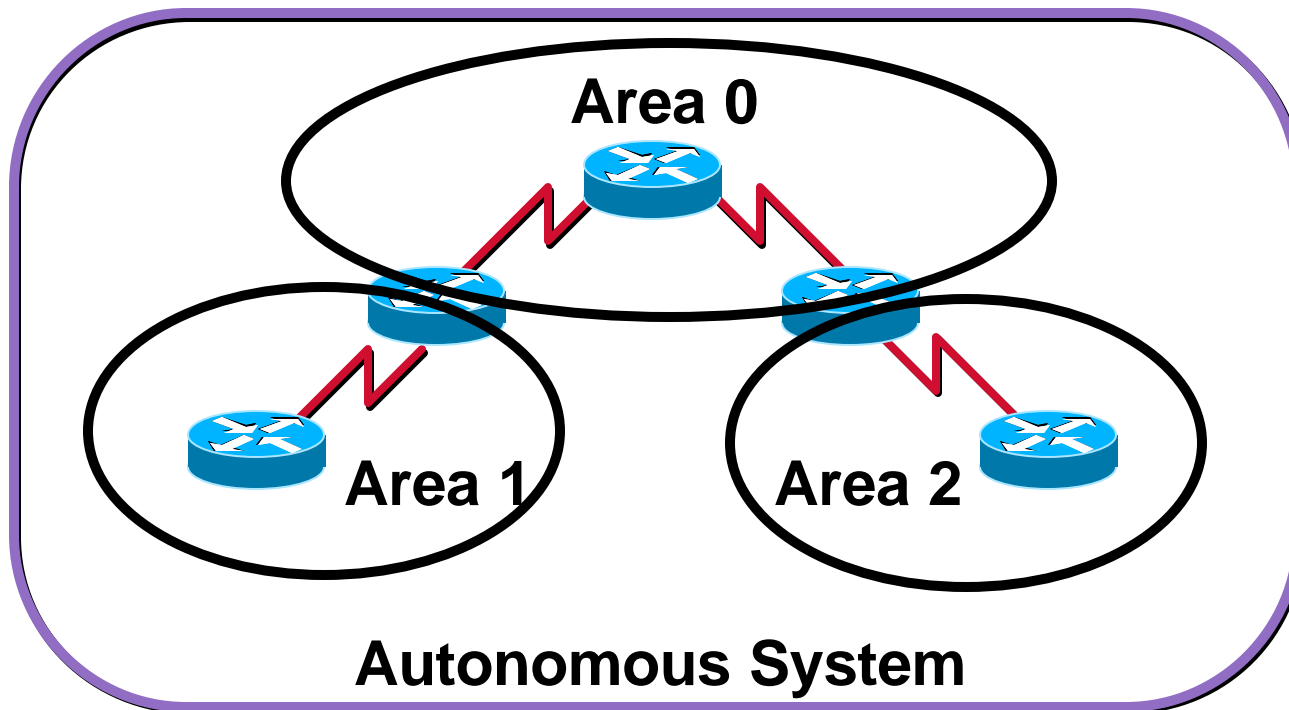


# Creating Multiple OSPF Areas

# Issues with Maintaining a Large OSPF Network

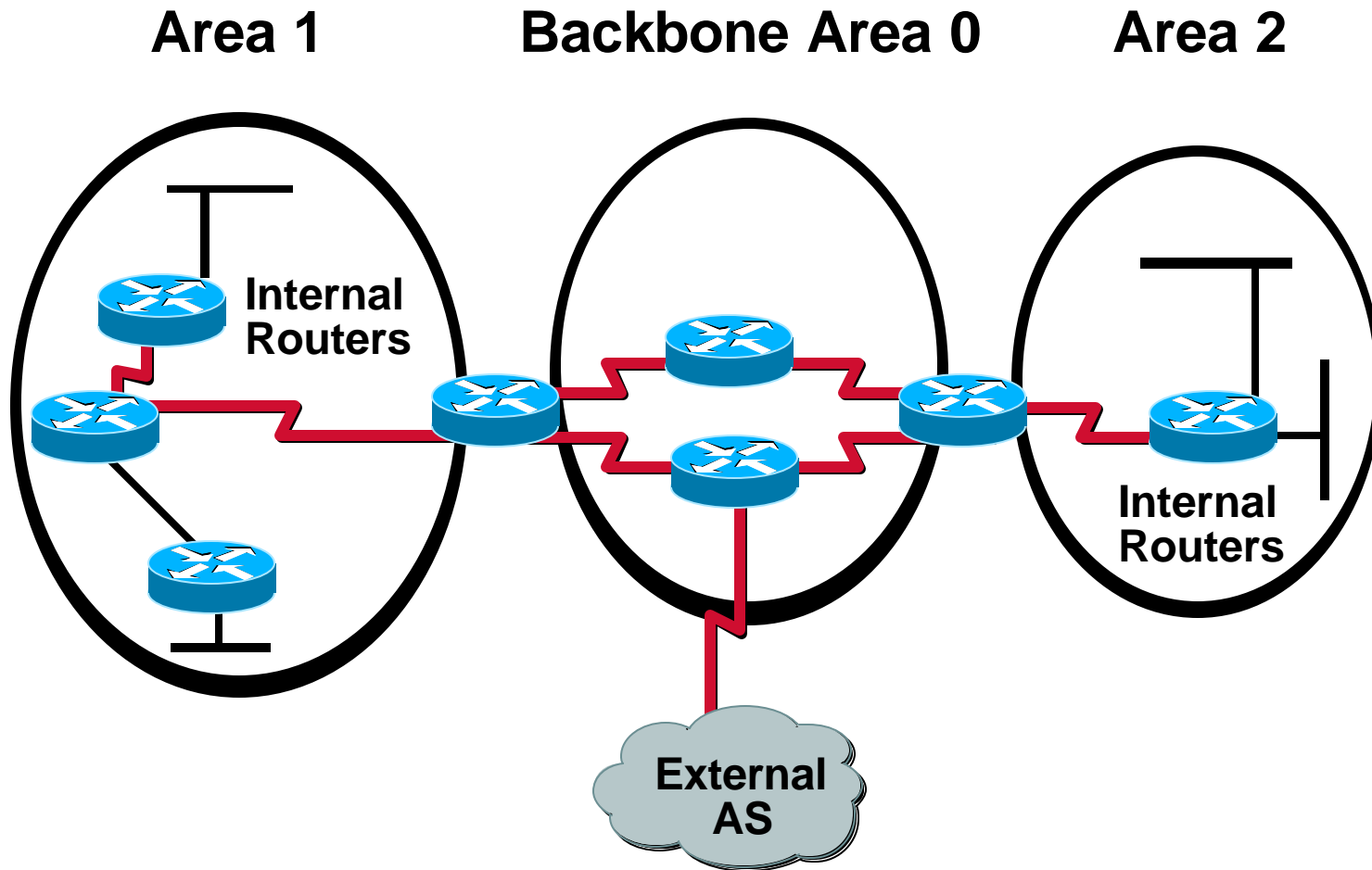


# The Solution: OSPF Hierarchical Routing



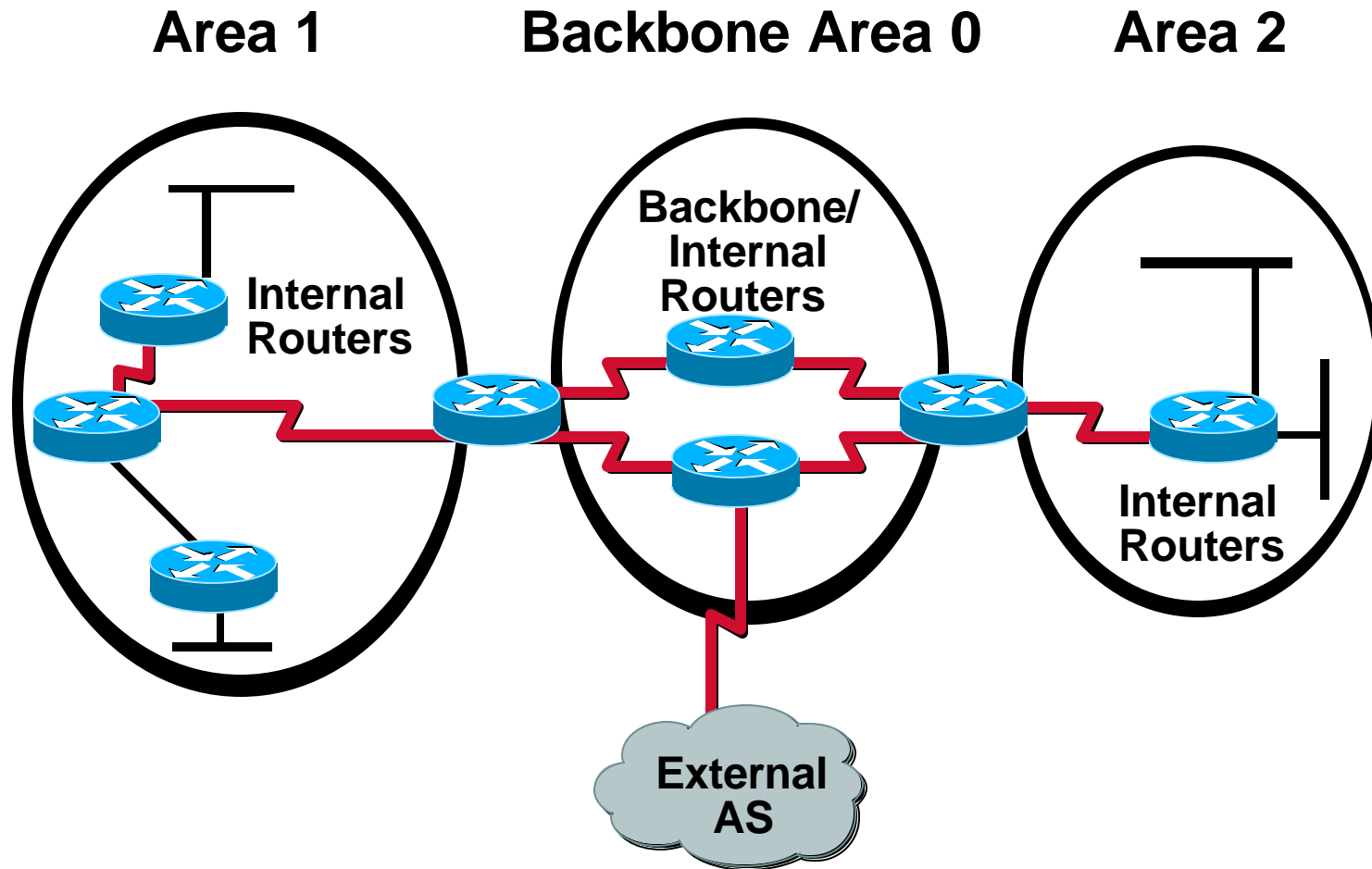
- **Consists of areas and autonomous systems**
- **Minimizes routing update traffic**

# Types of OSPF Routers (cont.)

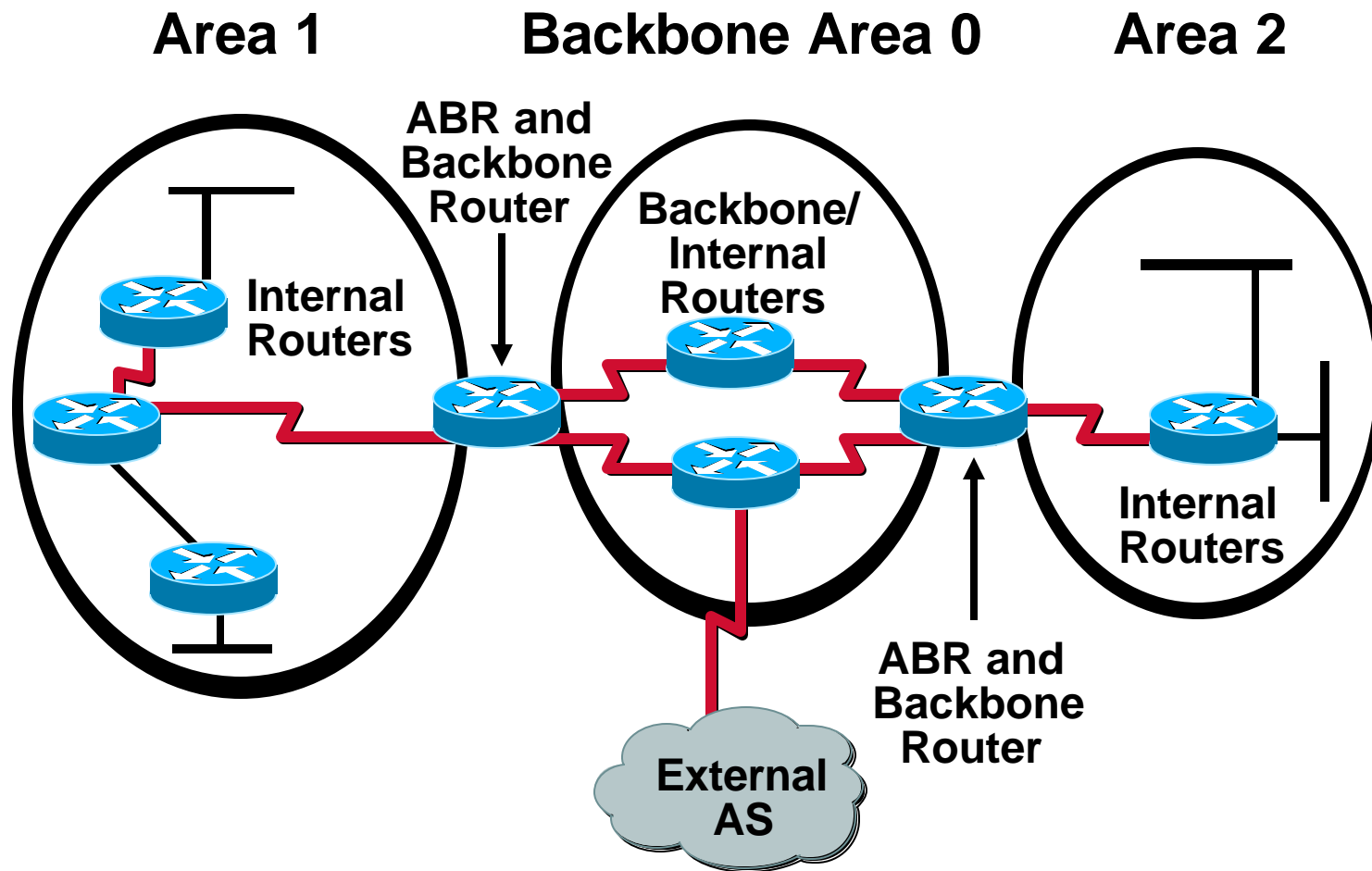




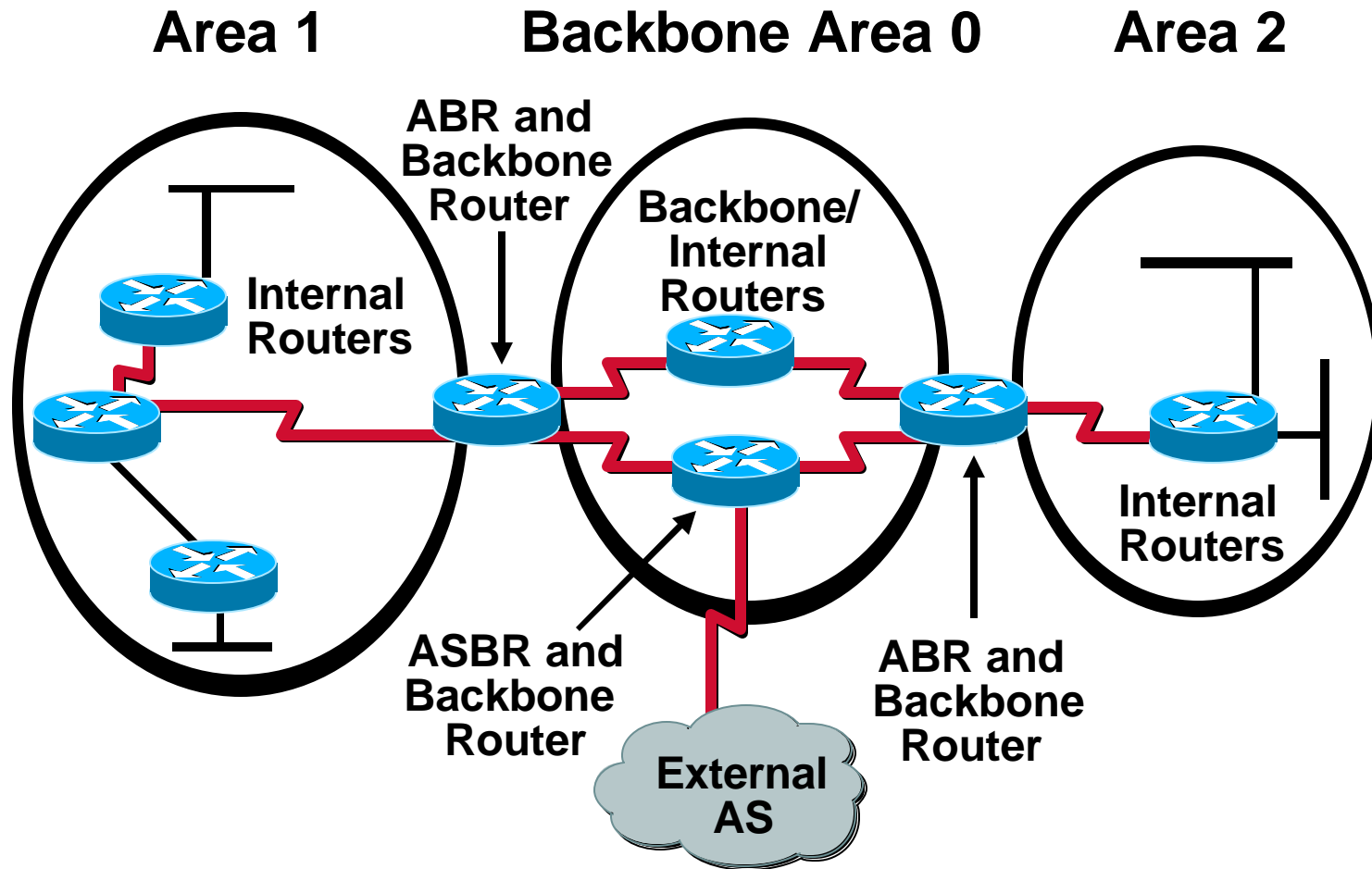
# Types of OSPF Routers (cont.)



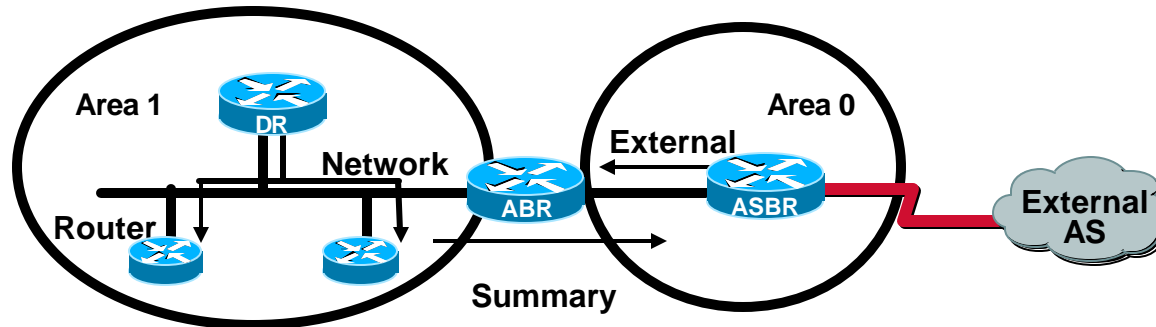
# Types of OSPF Routers (cont.)



# Types of OSPF Routers (cont.)



# LSAs in OSPF Database



```
p1r3#show ip ospf database
```

```
OSPF Router with ID (10.64.0.1) (Process ID 1)
```

## Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
10.1.2.1	10.1.2.1	651	0x80000005	0xD482	4

## Net Link States (Area 1)

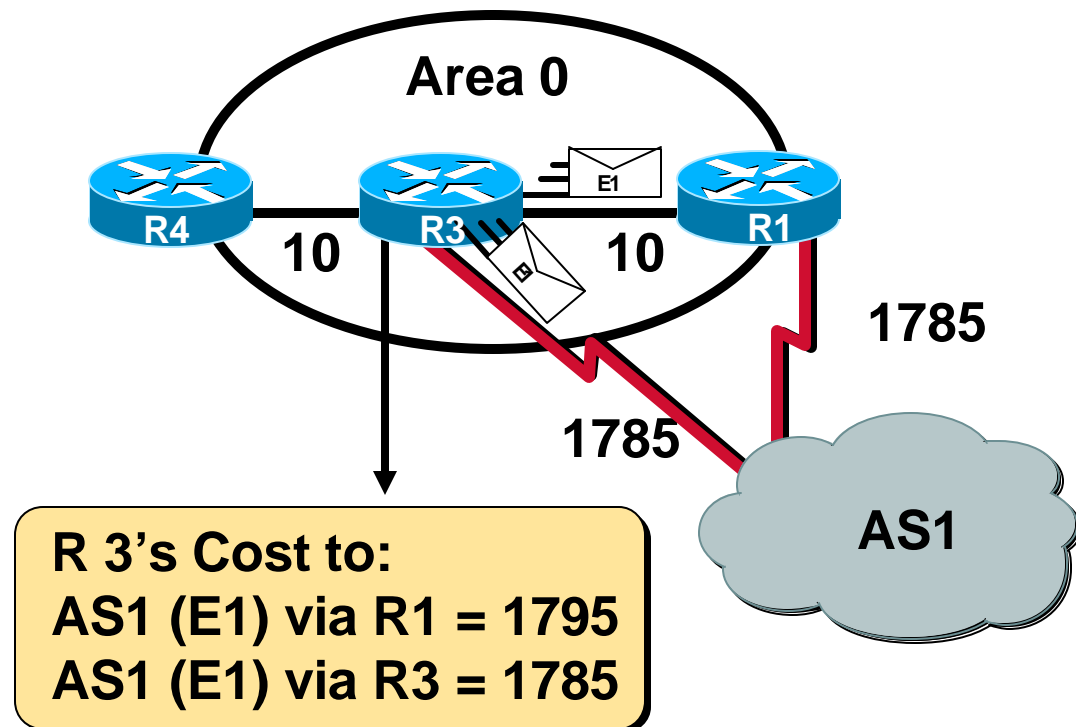
Link ID	ADV Router	Age	Seq#	Checksum
10.64.0.1	10.64.0.1	538	0x80000002	0xAD9A

## Summary Net Link States (Area 1)

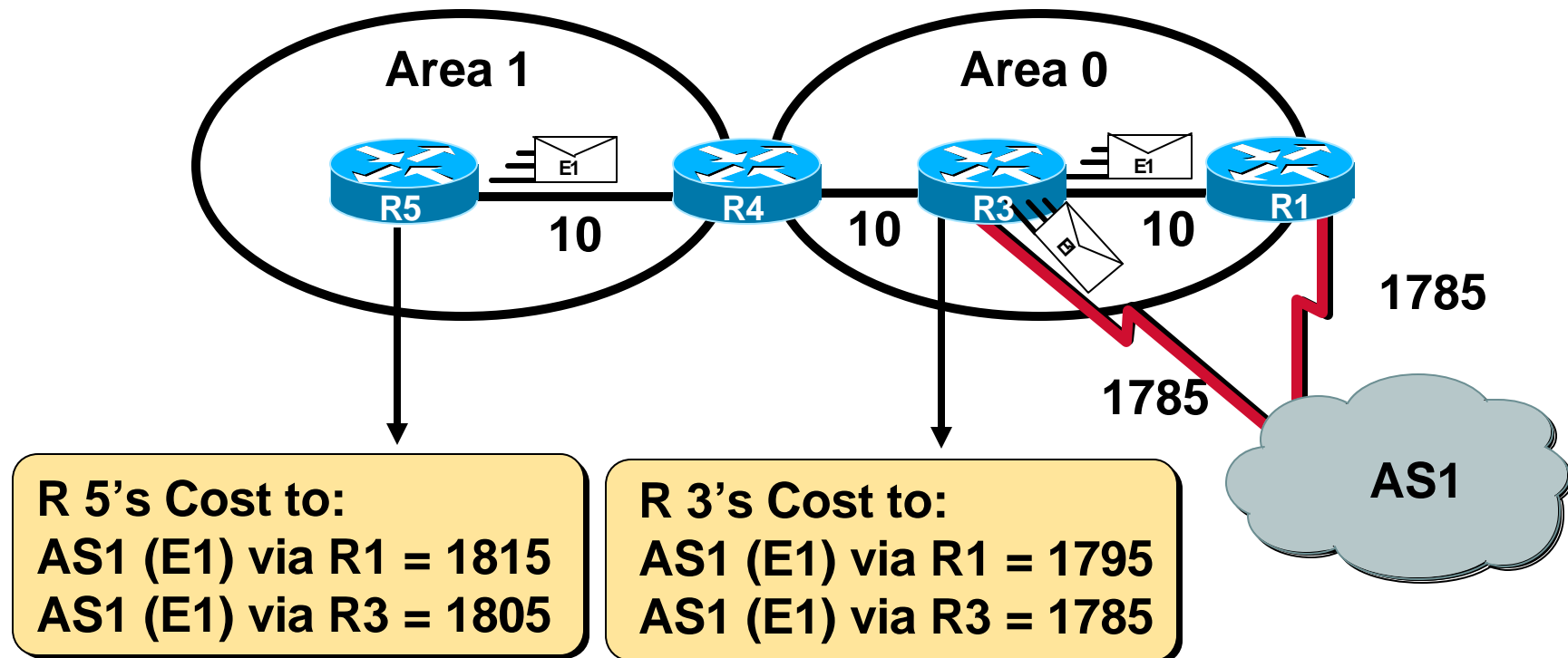
Link ID	ADV Router	Age	Seq#	Checksum
10.2.1.0	10.2.1.2	439	0x80000002	0xE6F8



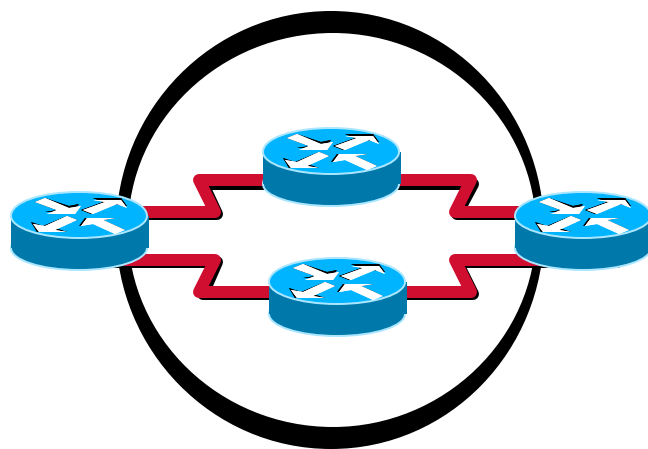
# Calculating Costs for Summary and AS External Routes



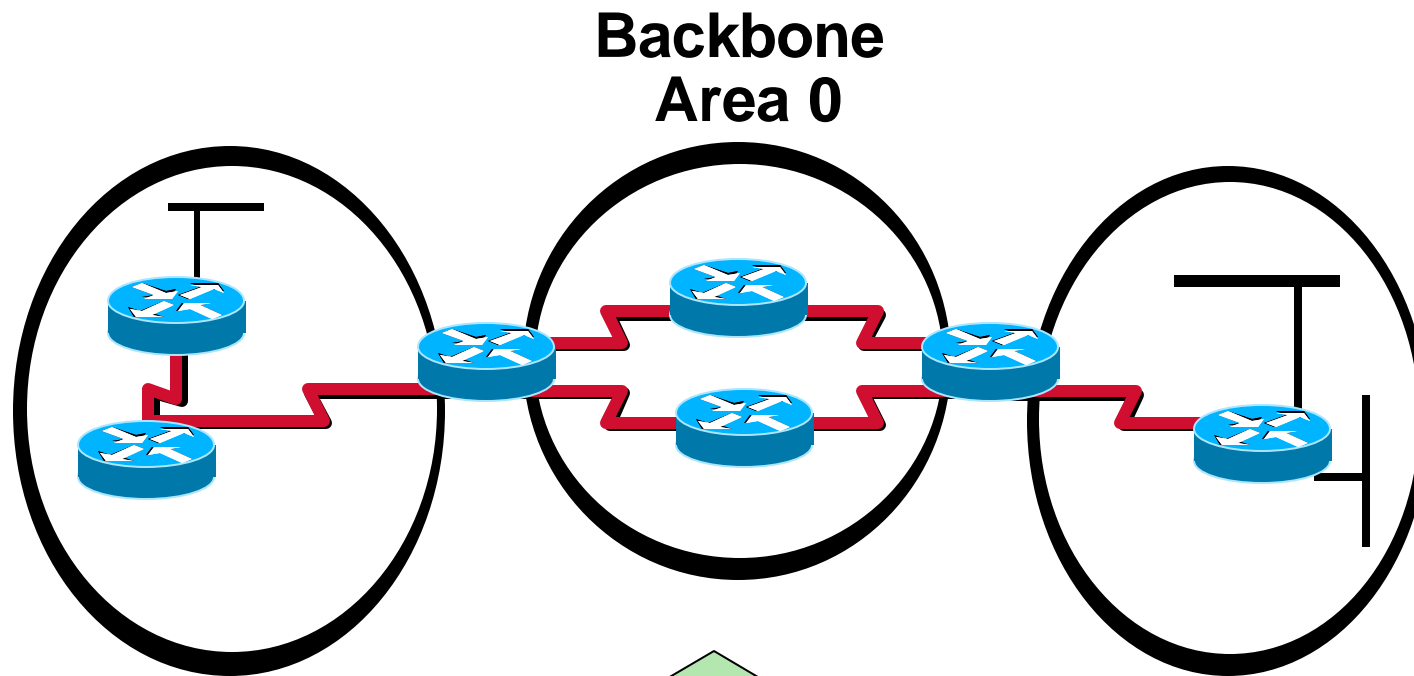
# Calculating Costs for Summary and AS External Routes (cont.)



# Types of Areas



# Types of Areas (cont.)



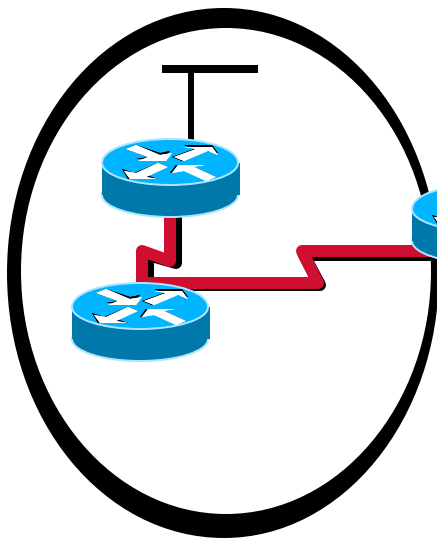
**Interconnects  
areas;  
accepts all  
LSAs.**

Cisco.com



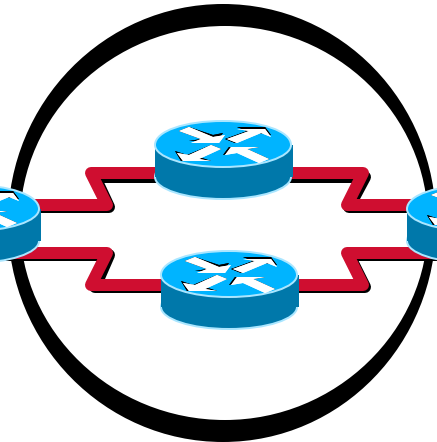
# Types of Areas (cont.)

**Stub Area**

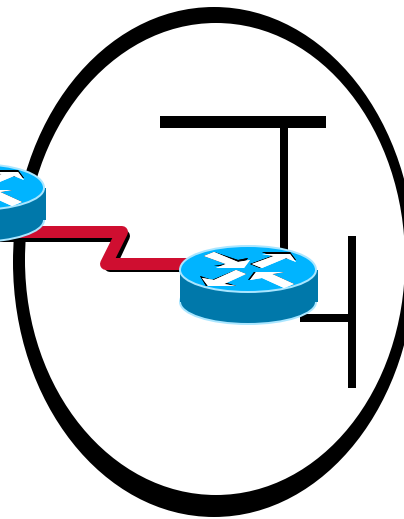


**Does not accept external LSAs.**

**Backbone Area 0**

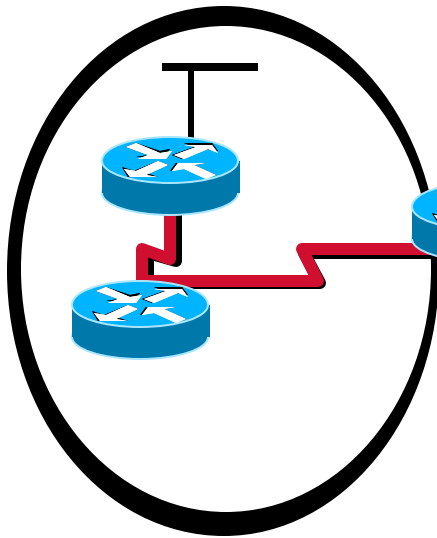


**Interconnects areas; accepts all LSAs.**



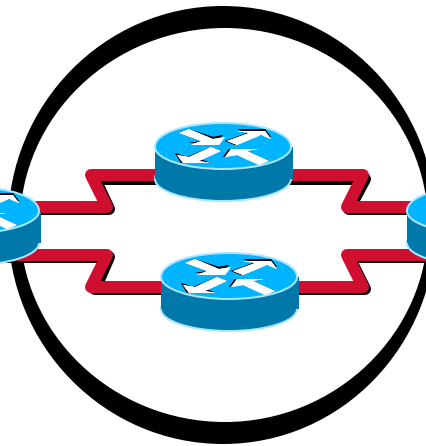
# Types of Areas (cont.)

**Stub Area**



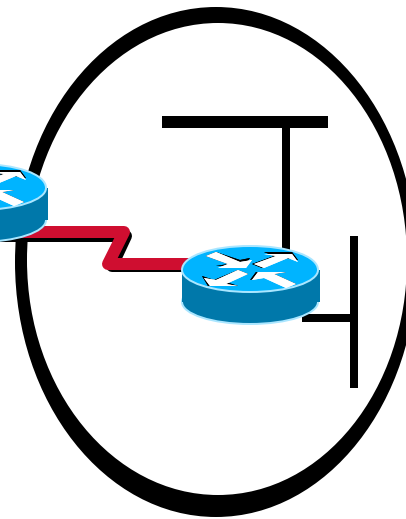
**Does not accept external LSAs.**

**Backbone Area 0**



**Interconnects areas; accepts all LSAs.**

**Totally Stubby Area**

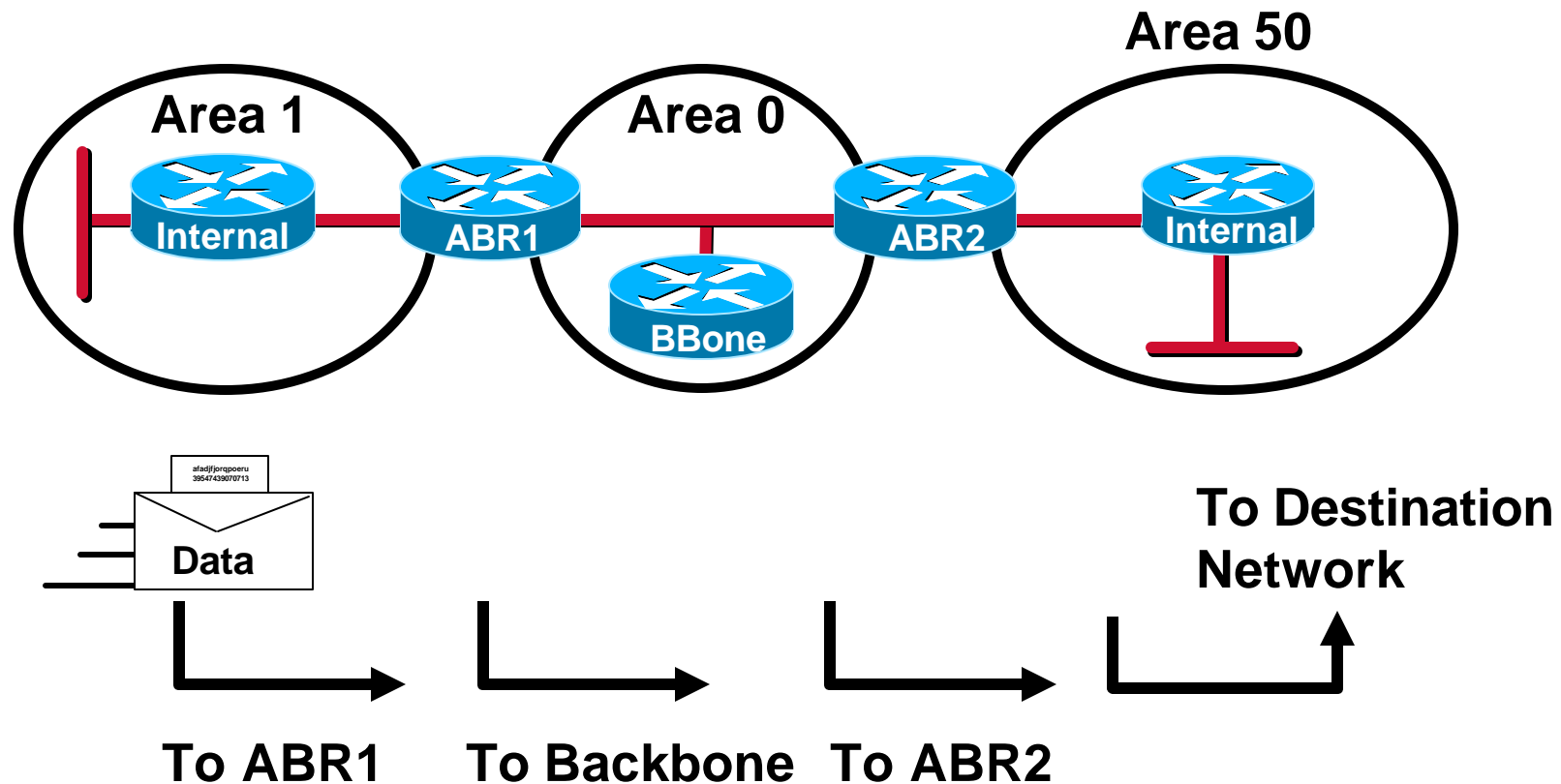


**Does not accept external or summary LSAs.**



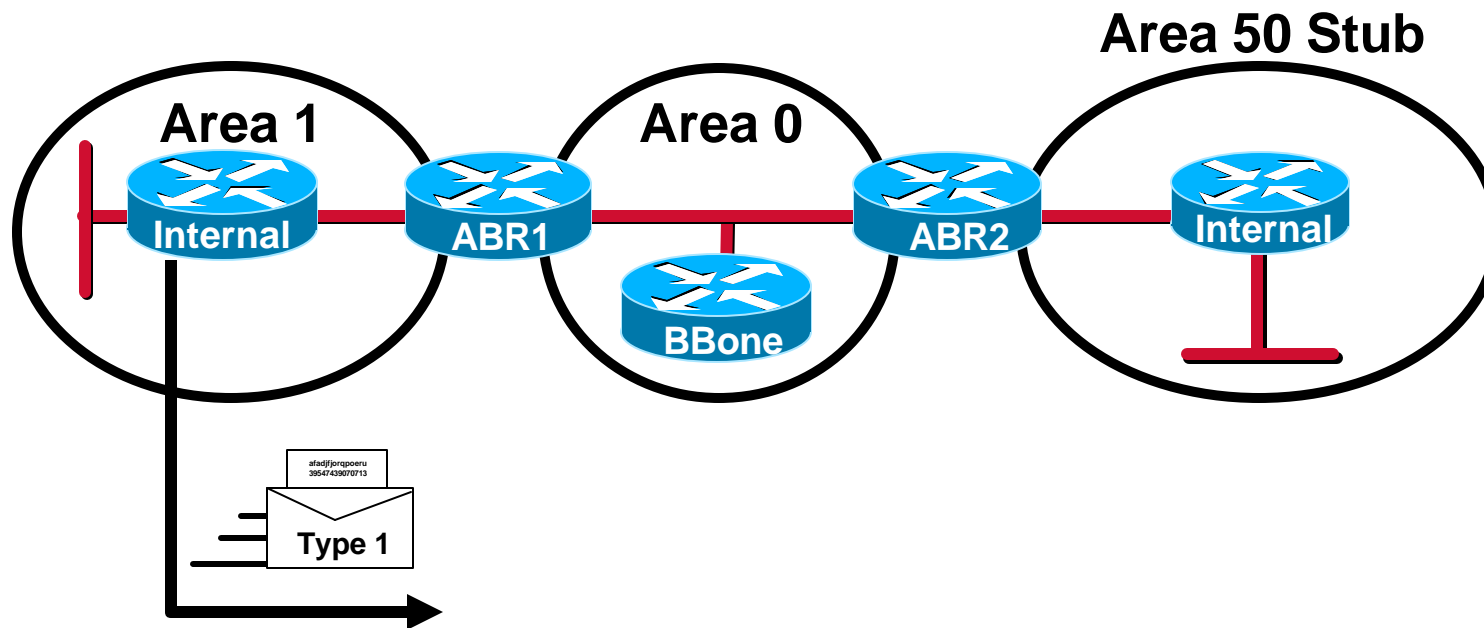
# OSPF Operation Across Multiple Areas

# Forwarding Packets in a Multiarea Network

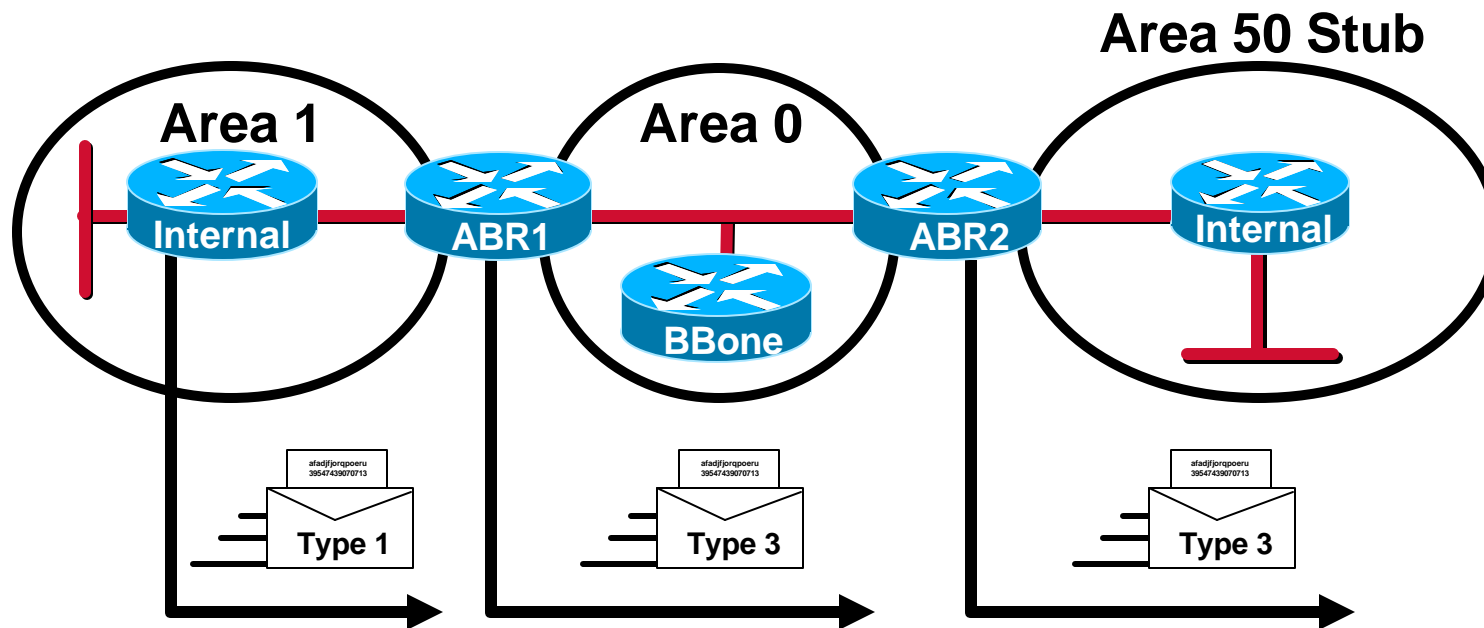




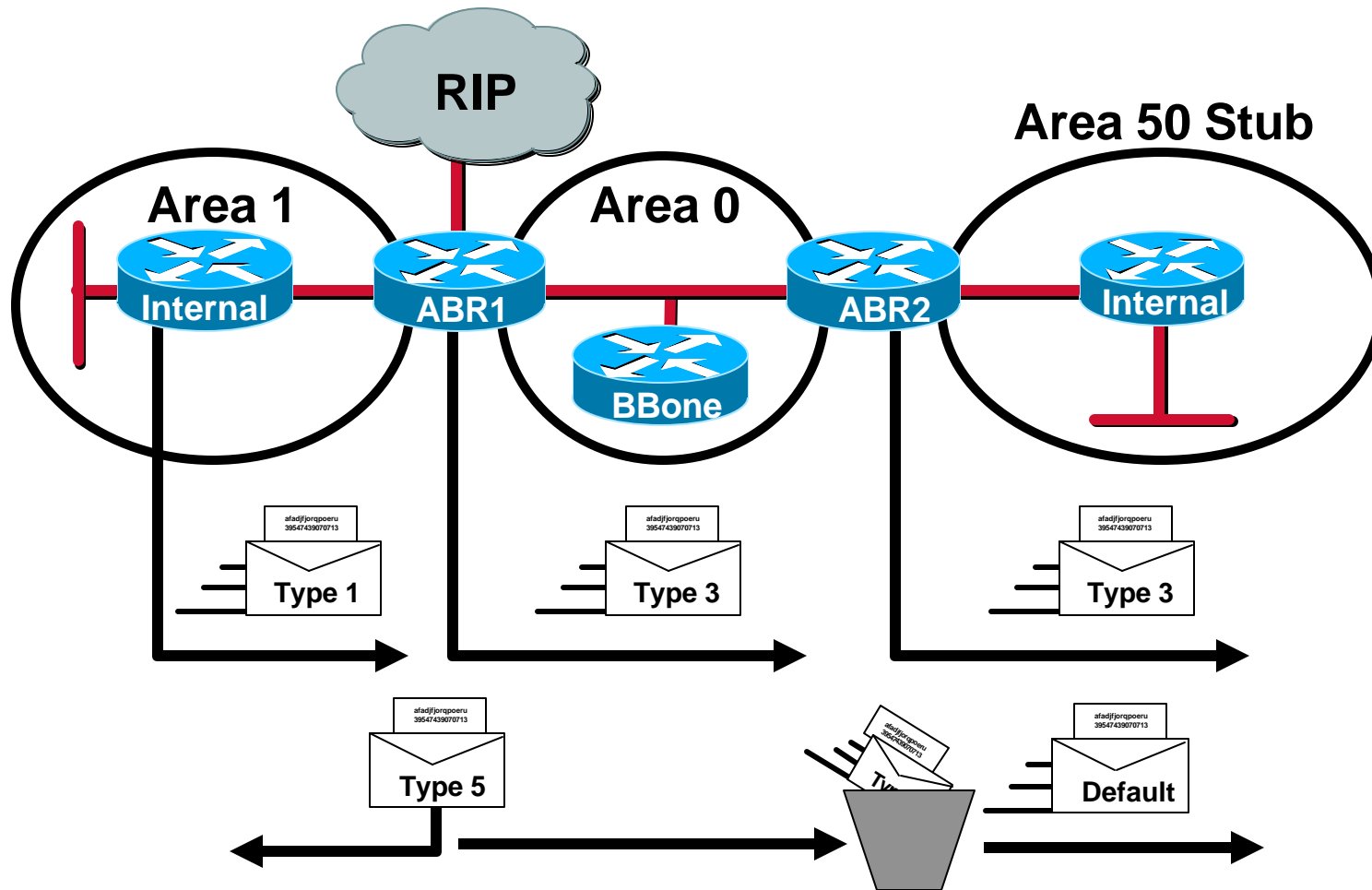
# Flooding LSUs to Multiple Areas (cont.)



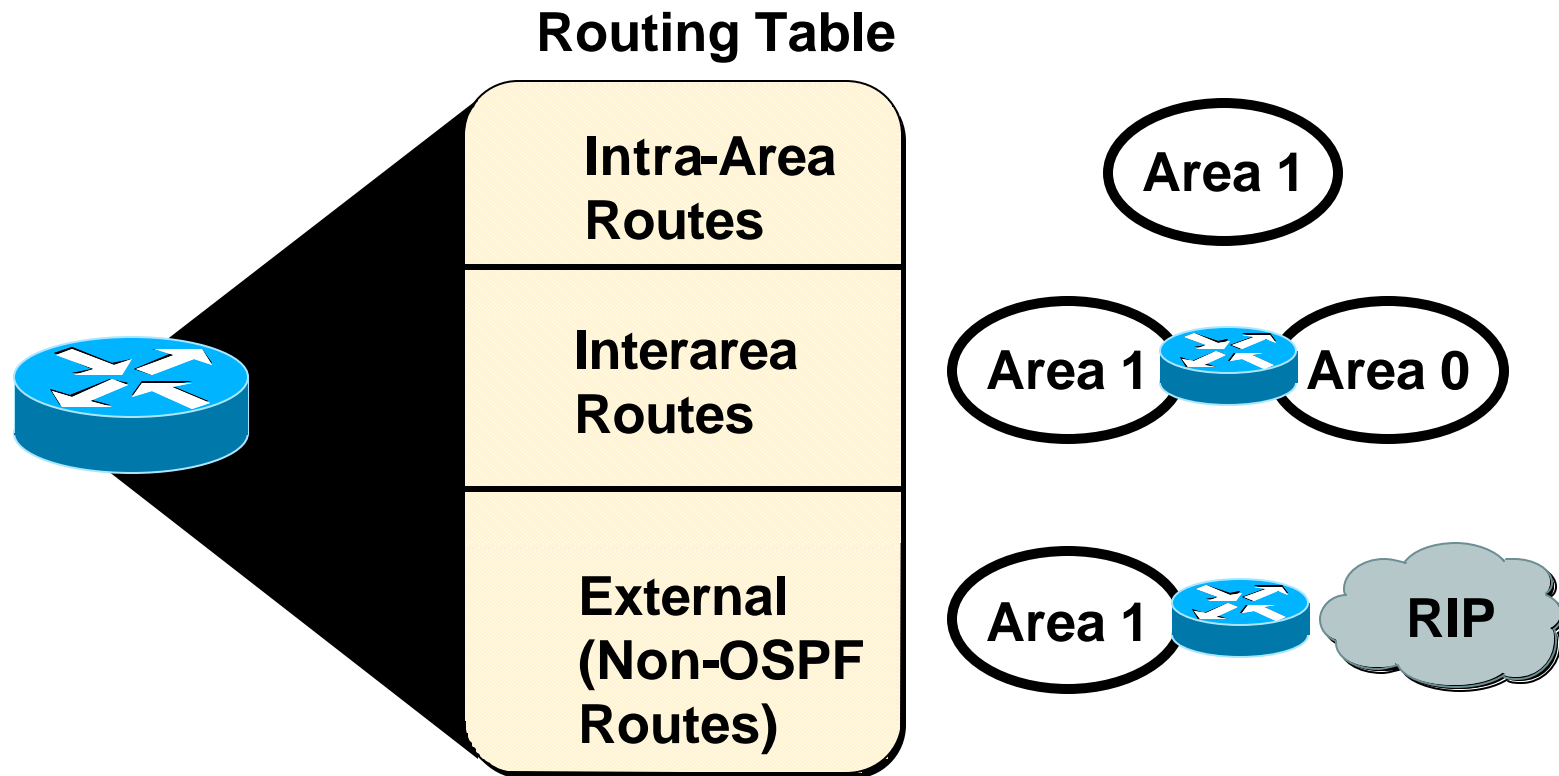
# Flooding LSUs to Multiple Areas (cont.)



# Flooding LSUs to Multiple Areas (cont.)



# Flooding LSUs to Multiple Areas (cont.)

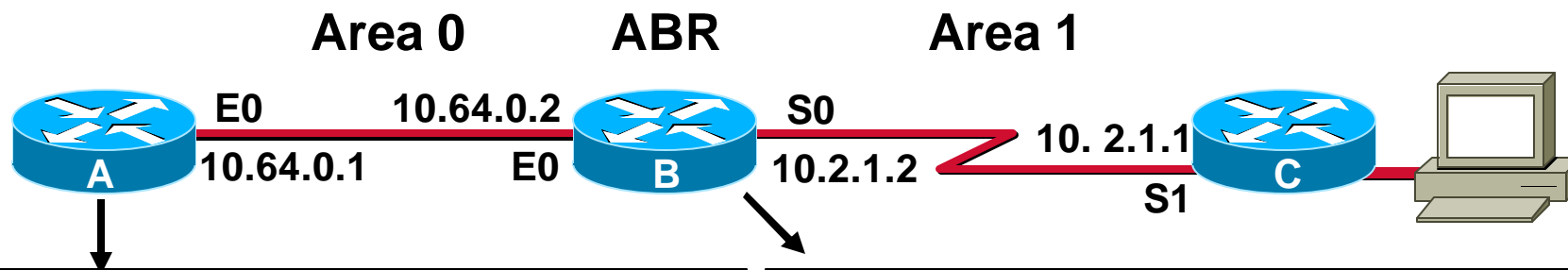






# Using and Configuring OSPF Multiarea Components

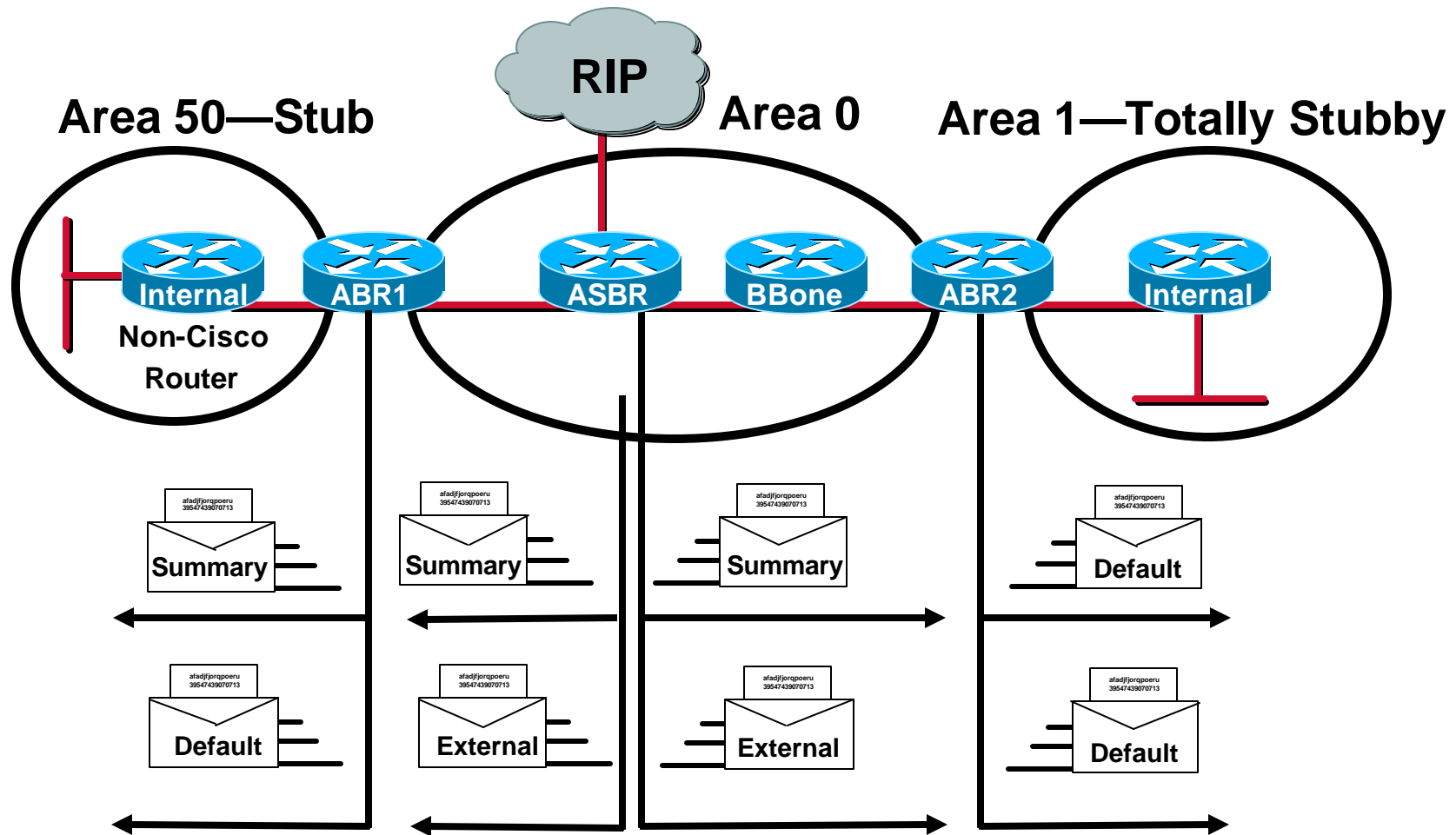
# Configuring OSPF ABRs



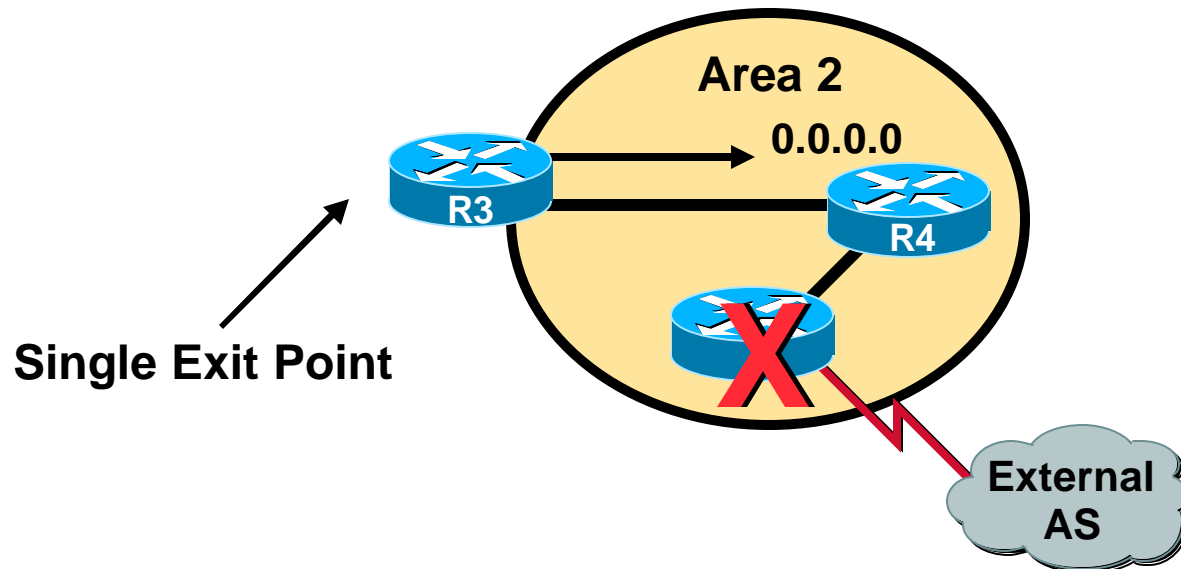
```
<Output Omitted>
interface Ethernet0
 ip address 10.64.0.1 255.255.255.0
!
<Output Omitted>
router ospf 77
network 10.0.0.0 0.255.255.255 area 0
```

```
<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 1
network 10.64.0.2 0.0.0.0 area 0
```

# Using Stub and Totally Stubby Areas



# Stub and Totally Stubby Area Restrictions



- Typically a single exit point into area; if multiple exit points, suboptimal paths may be selected
- An ASBR cannot be internal to stub
- Area is not the backbone Area 0
- Virtual links are not allowed



# Configuring Stub and Totally Stubby Areas

Router(config-router)#

```
area area-id stub [no-summary]
```

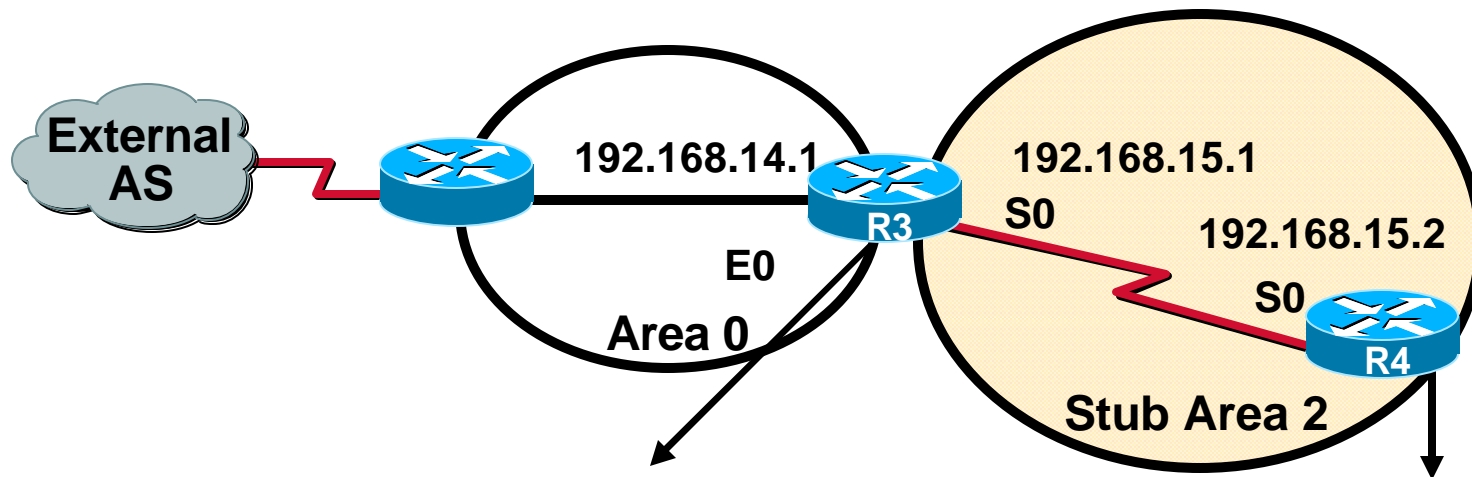
- **Creates a stub area**

Router(config-router)#

```
area area-id default-cost cost
```

- **Specifies cost for default route sent into stub area**

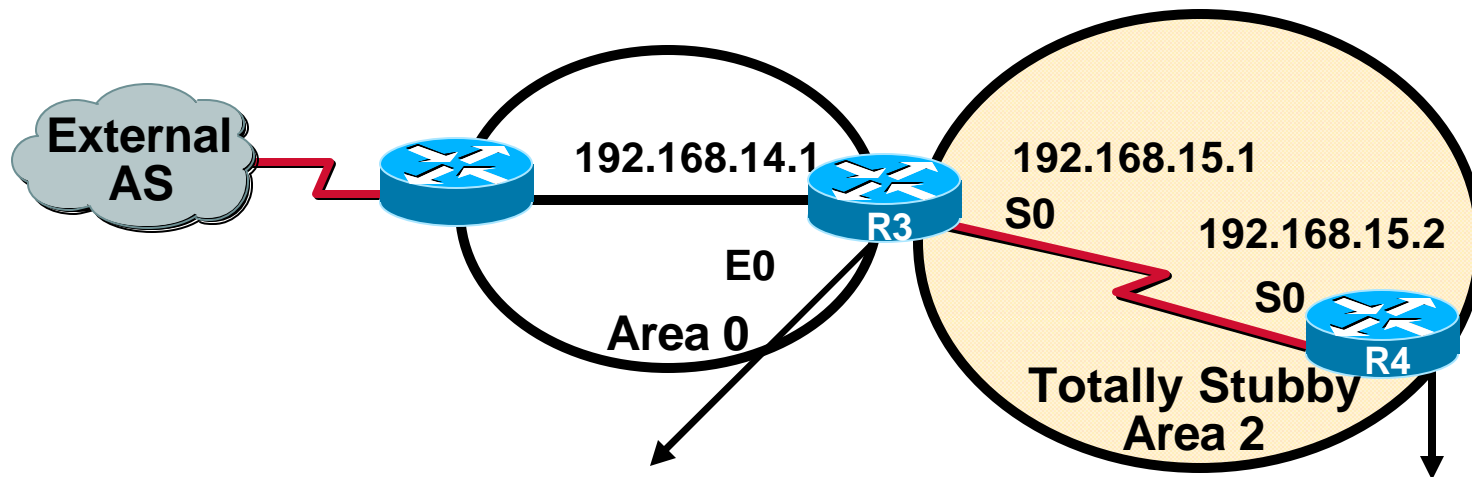
# OSPF Stub Area Configuration Example



```
R3#  
  
interface Ethernet 0  
ip address 192.168.14.1 255.255.255.0  
interface Serial 0  
ip address 192.168.15.1 255.255.255.252  
  
router ospf 100  
network 192.168.14.0 0.0.0.255 area 0  
network 192.168.15.0 0.0.0.255 area 2  
area 2 stub
```

```
R4#  
  
interface Serial 0  
ip address 192.168.15.2 255.255.255.252  
  
router ospf 15  
network 192.168.15.0 0.0.0.255 area 2  
area 2 stub
```

# OSPF Totally Stubby Configuration Example



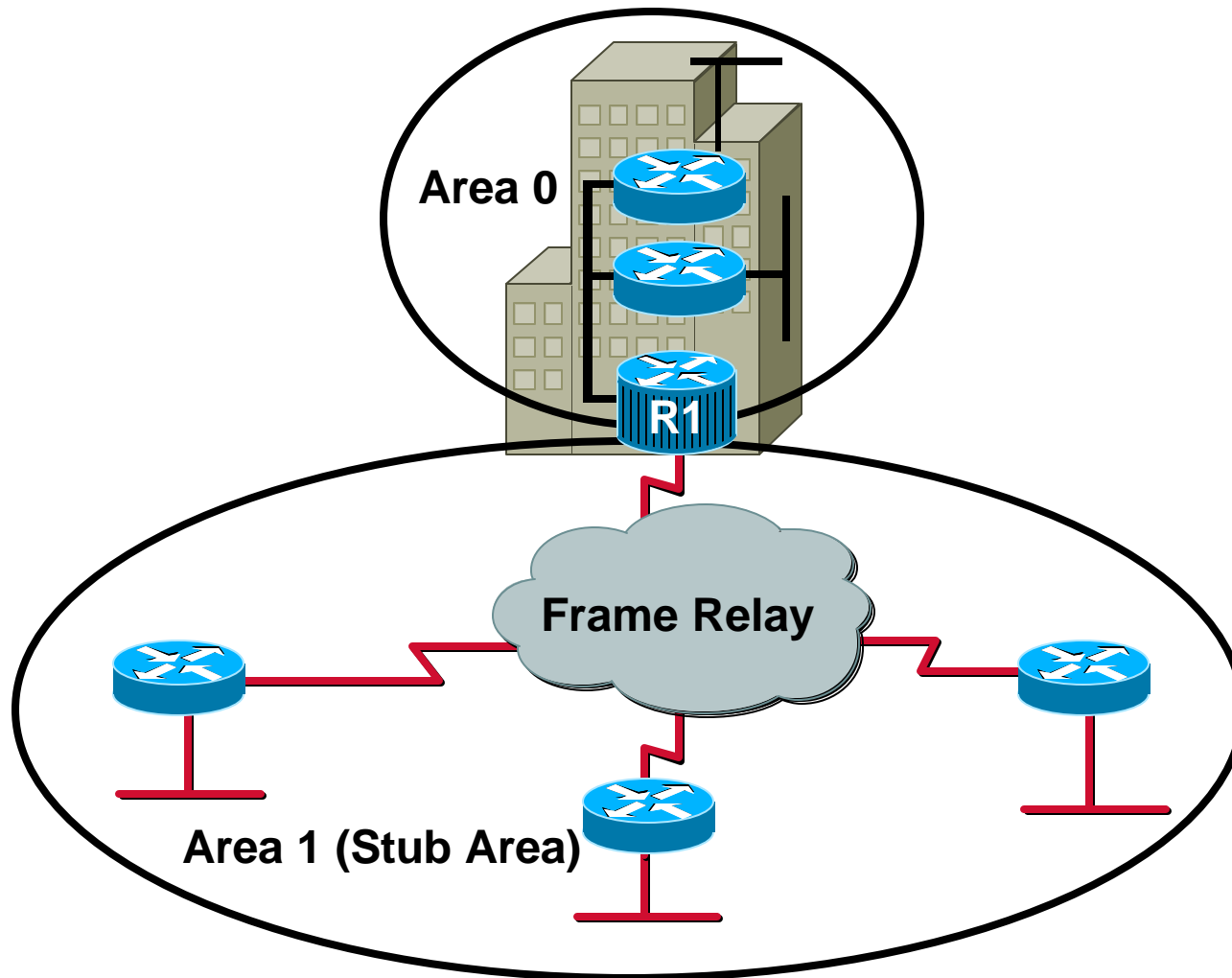
R3#

```
router ospf 100
network 192.168.14.0 0.0.0.255 area 0
network 192.168.15.0 0.0.0.255 area 2
area 2 stub no-summary
```

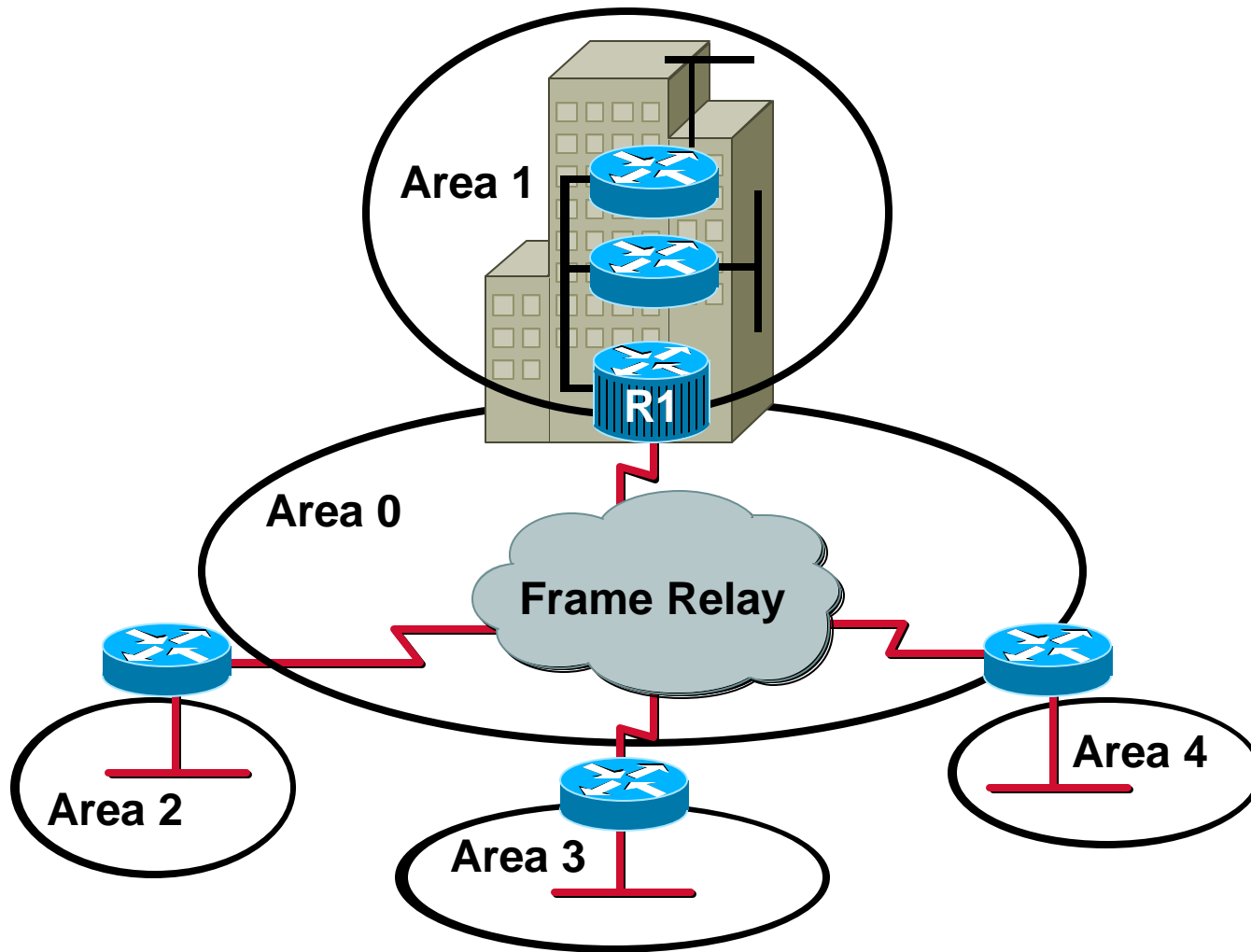
R4#

```
router ospf 15
network 192.168.15.0 0.0.0.255 area 2
area 2 stub
```

# Multiple-Area NBMA Environment

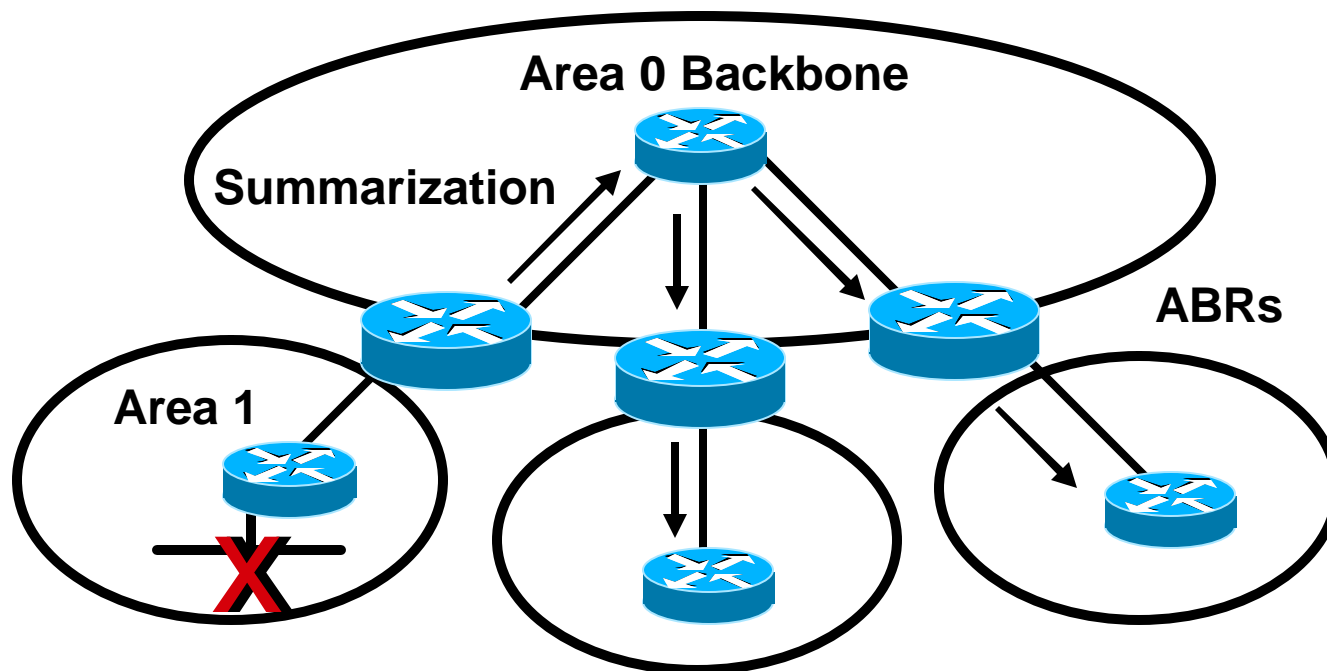


# Multiple-Area NBMA Environment (cont.)





# Supporting Route Summarization

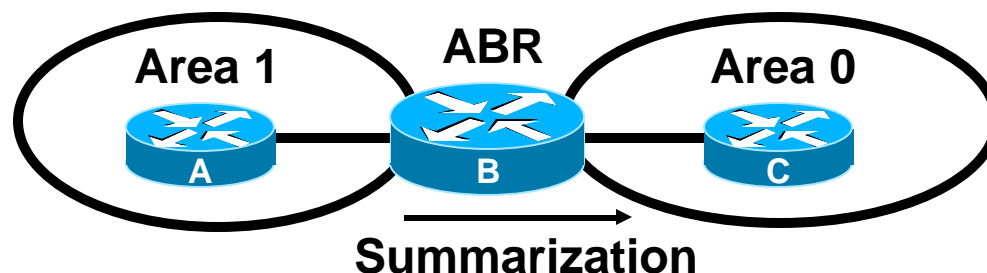


- **Minimizes number of routing table entries**
- **Localizes impact of a topology change**
- **Reduces LSAs and saves CPU**

# Supporting VLSM

- **OSPF carries subnet mask information**
- **Use hierarchical addressing scheme**

# Using Route Summarization



Routing Table for B

O 172.16.8.0	255.255.252.0
O 172.16.12.0	255.255.252.0
O 172.16.16.0	255.255.252.0
O 172.16.20.0	255.255.252.0
O 172.16.24.0	255.255.252.0
O 172.16.28.0	255.255.252.0

LSAs Sent to Router C

IA 172.16.8.0 255.255.248.0
IA 172.16.16.0 255.255.240.0

- Interarea (IA) summary link carries mask
- One entry can represent several subnets

# Configuring Route Summarization

Router(config-router)#

```
area area-id range address mask
```

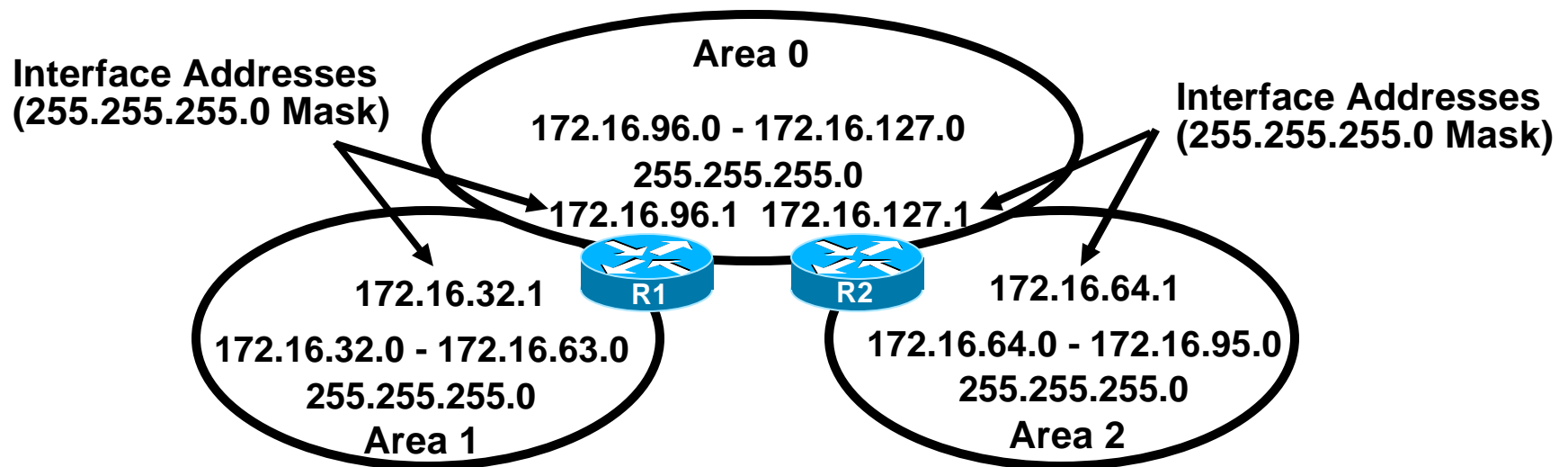
- **Consolidates interarea (IA) routes on an ABR**

Router(config-router)#

```
summary-address address mask [not-advertise] [tag tag]
```

- **Consolidates external routes, usually on an ASBR**

# Route Summarization Configuration Example



```
R1#  
router ospf 100  
network 172.16.32.1 0.0.0.0 area 1  
network 172.16.96.1 0.0.0.0 area 0  
area 0 range 172.16.96.0 255.255.224.0  
area 1 range 172.16.32.0 255.255.224.0
```

```
R2#  
router ospf 100  
network 172.16.64.1 0.0.0.0 area 2  
network 172.16.127.1 0.0.0.0 area 0  
area 0 range 172.16.96.0 255.255.224.0  
area 2 range 172.16.64.0 255.255.224.0
```





# Verifying OSPF Operation

# show ip ospf Command

Router#

```
show ip ospf border-routers
```

- Lists the ABRs and ASBRs in the autonomous system

Router#

```
show ip ospf virtual-links
```

- Displays the status of the virtual link

Router#

```
show ip ospf process-id
```

- Displays statistics about each area to which the router is connected

Router#

```
show ip ospf database
```

- Displays the contents of the OSPF link-state database