



Instructor Materials

Chapter 9: Multiarea OSPF



CCNA Routing and Switching

Scaling Networks

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Chapter 9: Best Practices

- In this chapter, the instructor should:
- Consider setting up an large OSPF single area network and edit the topology to a multiarea network.
- Discuss with students the differences between single-area OSPF and multiarea OSPF. Give them an assignment to draw a picture of OSPF single areas and multiple areas.
- Make sure the students pay particular attention to the LSA types discussed on pages 9.1.2.2 – 9.1.2.6. These types should be memorized. Compare and contrast the LSA types.
- Give the students plenty of practice with hands-on labs based on multiarea OSPF configuration.
- Enlarge and print some of the graphics in this chapter or give the students an assignment of making posters with the concepts in this chapter.
- Walk the students through all the commands in the chapter, but focus on the areas of possible confusion.



Chapter 9: Multiarea OSPF



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Chapter 9 - Sections & Objectives

- 9.1 Multiarea OSPF Operation
 - Explain how multiarea OSPF operates in a small to medium-sized business network.
- 9.2 Implement Multiarea
 - Implement multiarea OSPFv2 and OSPFv3.



9.1 Multiarea OSPF Operation



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Multiarea OSPF Operation

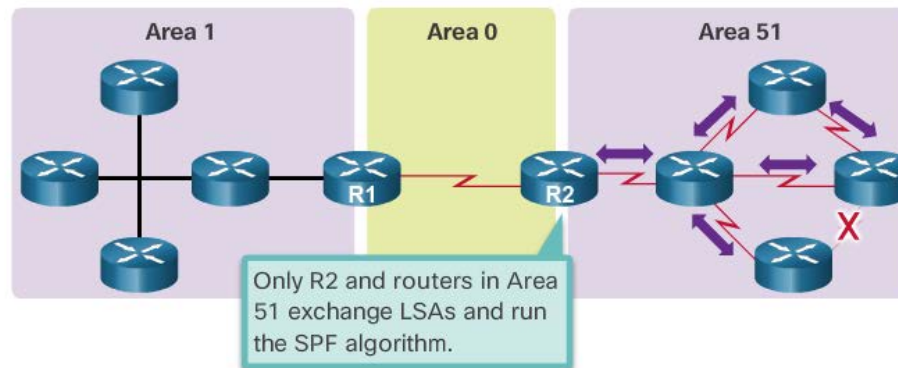
Why Multiarea OSPF?

■ Single-Area OSPF

- If the routes are not summarized, the routing table can become very large.
- Each router must maintain detailed information about every network in the routing domain.

■ Multiarea OSPF

- Smaller routing tables
- Reduced link-state update overhead
- Reduced frequency of SPF calculations

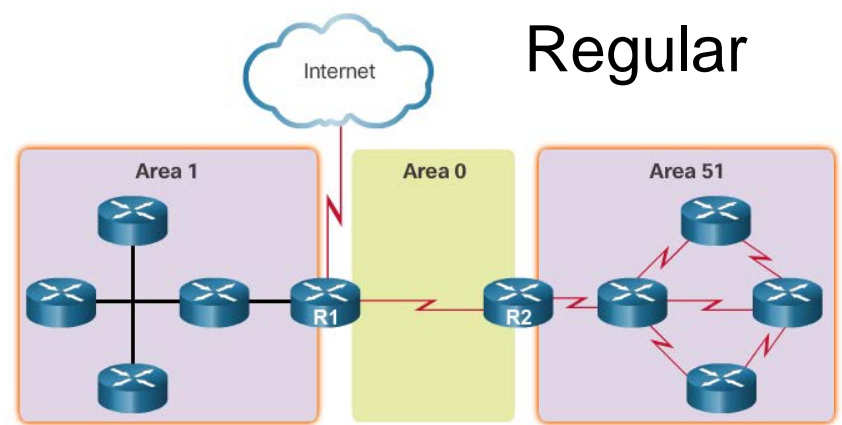
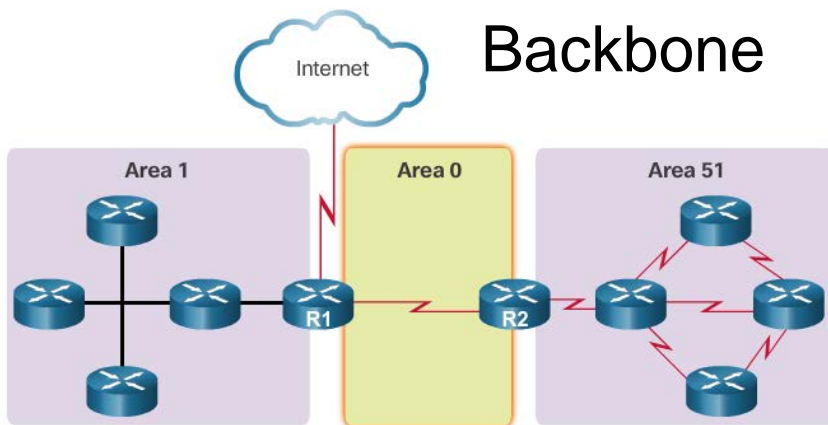




Multiarea OSPF Operation

Why Multiarea OSPF?

- OSPF Two-Layer Area Hierarchy
 - Backbone (Transit) area and Regular (Non-backbone) area
- Types of OSPF Routers
 - Internal router
 - Backbone router
 - Area Border Router (ABR)
 - Autonomous System Boundary Router (ASBR)





Multiarea OSPF Operation

Multiarea OSPF LSA Operation

■ OSPF LSA Types

- Individually, they act as database records and provide specific OSPF network details. In combination, they describe the entire topology of an OSPF network or area.

LSA Type	Description
1	Router LSA
2	Network LSA
3 and 4	Summary LSAs
5	AS External LSA
6	Multicast OSPF LSA
7	Defined for NSSAs
8	External Attributes LSA for Border Gateway Protocol (BGP)
9, 10, or 11	Opaque LSAs



Multiarea OSPF Operation

Multiarea OSPF LSA Operation

■ OSPF LSA Types

- **Type 1** - Contains a list of the directly connected interfaces, link types, neighbors, and link states.
- **Type 2** - Contains the router ID and IP address of the DR, along with the router ID of all other routers on the multiaccess segment.
- **Type 3** - Used by ABRs to advertise networks from other areas.
- **Type 4** - Identifies the ASBR and provides a route to it.
- **Type 5** - Describe routes to networks outside the OSPF routing domain.

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Multiarea OSPF Operation

OSPF Routing Table and Types of Routes

■ OSPF Routing Table Entries

- O – Indicates the route is intra-area.
- O IA – Indicates a summary LSA.
- O E1 or O E2 – Indicates an external LSA.

■ OSPF Route Calculation

- Each router uses the SPF algorithm against the LSDB to build the SPF tree. The SPF tree is used to determine the best path(s).

```
R1# show ip route | begin Gateway
Gateway of last resort is 192.168.10.2 to network 0.0.0.0
O*E2 0.0.0.0/0 [110/1] via 192.168.10.2, 00:00:19, Serial0/0/0
    10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C    10.1.1.0/24 is directly connected, GigabitEthernet0/0
L    10.1.1.1/32 is directly connected, GigabitEthernet0/0
C    10.1.2.0/24 is directly connected, GigabitEthernet0/1
L    10.1.2.1/32 is directly connected, GigabitEthernet0/1
O    10.2.1.0/24 [110/648] via 192.168.10.2, 00:04:34, Serial0/0/0
O IA 192.168.1.0/24 [110/1295] via 192.168.10.2, 00:01:48, Serial0/0/0
O IA 192.168.2.0/24 [110/1295] via 192.168.10.2, 00:01:48, Serial0/0/0
    192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C    192.168.10.0/30 is directly connected, Serial0/0/0
L    192.168.10.1/32 is directly connected, Serial0/0/0
O    192.168.10.4/30 [110/1294] via 192.168.10.2, 00:01:55, Serial0/0/0
R1#
```



9.2 Configuring Multiarea OSPF



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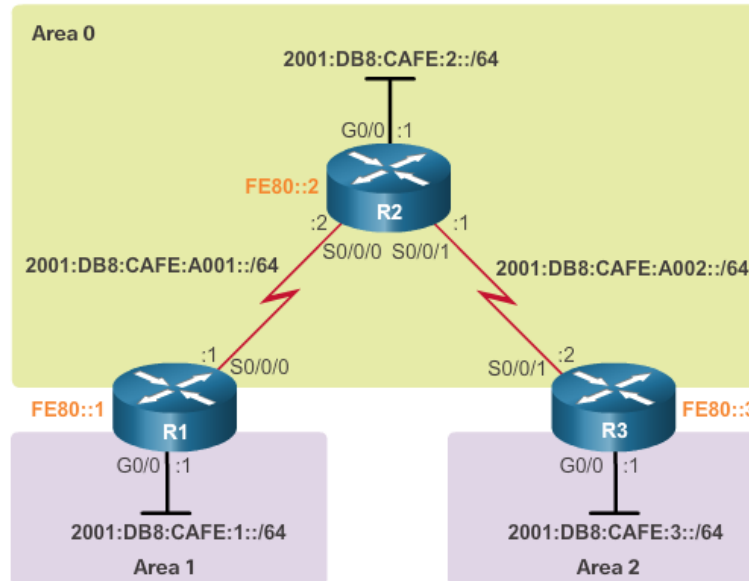
Configuring Multiarea OSPF

Configuring Multiarea OSPF

■ Implementing Multiarea OSPF

- The type of OSPF implementation chosen depends on the specific network design requirements and existing topology.
- A router simply becomes an ABR when it has two network statements in different areas.

OSPFv3 Multiarea Topology





Configuring Multiarea OSPF

Verifying Multiarea OSPF

- Verifying Multiarea OSPF v2
 - The same verification commands used to verify single-area OSPFv2 also can be used to verify the multiarea OSPF topology.
 - For the equivalent OSPFv3 command, simply substitute ip with ipv6.
- Verify General Multiarea OSPFv2 Settings
 - Use the show ip protocols command to verify the OSPFv2 status.
 - The Routing for Networks section identifies the networks and their respective areas.
- Verify the OSPFv2 Routes
 - The most common command used to verify a multiarea OSPFv2 configuration is the show ip route command. Add the ospf parameter to display only OSPFv2-related information.



Configuring Multiarea OSPF

Verifying Multiarea OSPF (Cont.)

■ Verify the Multiarea OSPFv2 LSDB

- Use the `show ip ospf database` command to verify the contents of the OSPFv2 LSDB.
- There are many command options available with the **`show ip ospf database`** command.

■ Verify Multiarea OSPFv3

- Like OSPFv2, OSPFv3 provides similar OSPFv3 verification commands.

```
R1# show ipv6 ospf database

      OSPFv3 Router with ID (1.1.1.1) (Process ID 10)

          Router Link States (Area 0)

ADV Router  Age      Seq#          Fragment ID  Link count  Bits
1.1.1.1     1617    0x80000002    0             1           B
2.2.2.2     1484    0x80000002    0             2           None
3.3.3.3     14      0x80000001    0             1           B

          Inter Area Prefix Link States (Area 0)

ADV Router  Age      Seq#          Prefix
1.1.1.1     1833    0x80000001    2001:DB8:CAFE:1::/64
3.3.3.3     1476    0x80000001    2001:DB8:CAFE:3::/64

          Link (Type-8) Link States (Area 0)

ADV Router  Age      Seq#          Link ID      Interface
1.1.1.1     1843    0x80000001    6            Se0/0/0
2.2.2.2     1619    0x80000001    6            Se0/0/0

          Intra Area Prefix Link States (Area 0)
```



9.3 Chapter Summary



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Chapter Summary

Summary

- Single-area OSPF is useful in smaller networks but in larger networks multiarea OSPF is a better choice. Multiarea OSPF solves the issues of large routing table, large link-state database, and frequent SPF algorithm calculations.
- The main area is called the backbone area (area 0) and all other areas must connect to the backbone area. Routing still occurs between the areas while many of the routing operations, such as recalculating the database, are kept within an area.
- There are four different types of OSPF routers: Internal router, Backbone router, Area Border Router (ABR), and Autonomous System Boundary Router (ASBR). A router can be classified as more than one router type.
- Link State Advertisements (LSAs) are the building blocks of OSPF. This chapter concentrated on LSA type 1 to LSA type 5. Type 1 LSAs are referred to as the router link entries. Type 2 LSAs are referred to as the network link entries and are flooded by a DR. Type 3 LSAs are referred to as the summary link entries and are created and propagated by ABRs. A type 4 summary LSA is generated by an ABR only when an ASBR exists within an area. Type 5 external LSAs describe routes to networks outside the OSPF autonomous system. Type 5 LSAs are originated by the ASBR and are flooded to the entire autonomous system.
- OSPFv2 routes in an IPv4 routing table are identified using the following descriptors: O, O IA, O E1 or O E2. Each router uses the SPF algorithm against the LSDB to build the SPF tree. The SPF tree is used to determine the best paths.



Chapter Summary

Summary (Cont.)

- There are no special commands required to implement a multiarea OSPF network. A router simply becomes an ABR when it has two **network** statements in different areas.
- An example of multiarea OSPF configuration:


```
R1(config)# router ospf 10
R1(config-router)# router-id 1.1.1.1
R1(config-router)# network 10.1.1.1 0.0.0.0 area 1
R1(config-router)# network 10.1.2.1 0.0.0.0 area 1
R1(config-router)# network 192.168.10.1 0.0.0.0 area 0
```
- Commands that are used to verify OSPFv2 configuration consist of the following:
 - show ip ospf neighbor**
 - show ip ospf**
 - show ip ospf interface**
 - show ip protocols**
 - show ip ospf interface brief**
 - show ip route ospf**
 - show ip ospf database**
- To use the equivalent OSPFv3 command, simply substitute **ip** with **ipv6**.

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