



Chapter 5: Adjust and Troubleshoot Single-Area OSPF



Scaling Networks

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Chapter 5

5.0 Introduction

5.1 Advanced Single-Area OSPF Implementations

5.2 Troubleshooting Single-Area OSPF Implementations

5.3 Summary



Chapter 5: Objectives

After completing this chapter, you will be able to:

- Modify the OSPF interface priority to influence the DR/BDR election.
- Configure a router to propagate a default route in an OSPF network.
- Modify OSPF interface settings to improve network performance.
- Configure OSPF authentication to ensure secure routing updates.
- Explain the process and tools used to troubleshoot a single-area OSPF network.
- Troubleshoot missing route entries in a single-area OSPFv2 route table.
- Troubleshoot missing route entries in a single-area OSPFv3 route table.



5.1 Advanced Single-Area OSPF Configurations



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Routing in the Distribution and Core Layers

Routing versus Switching

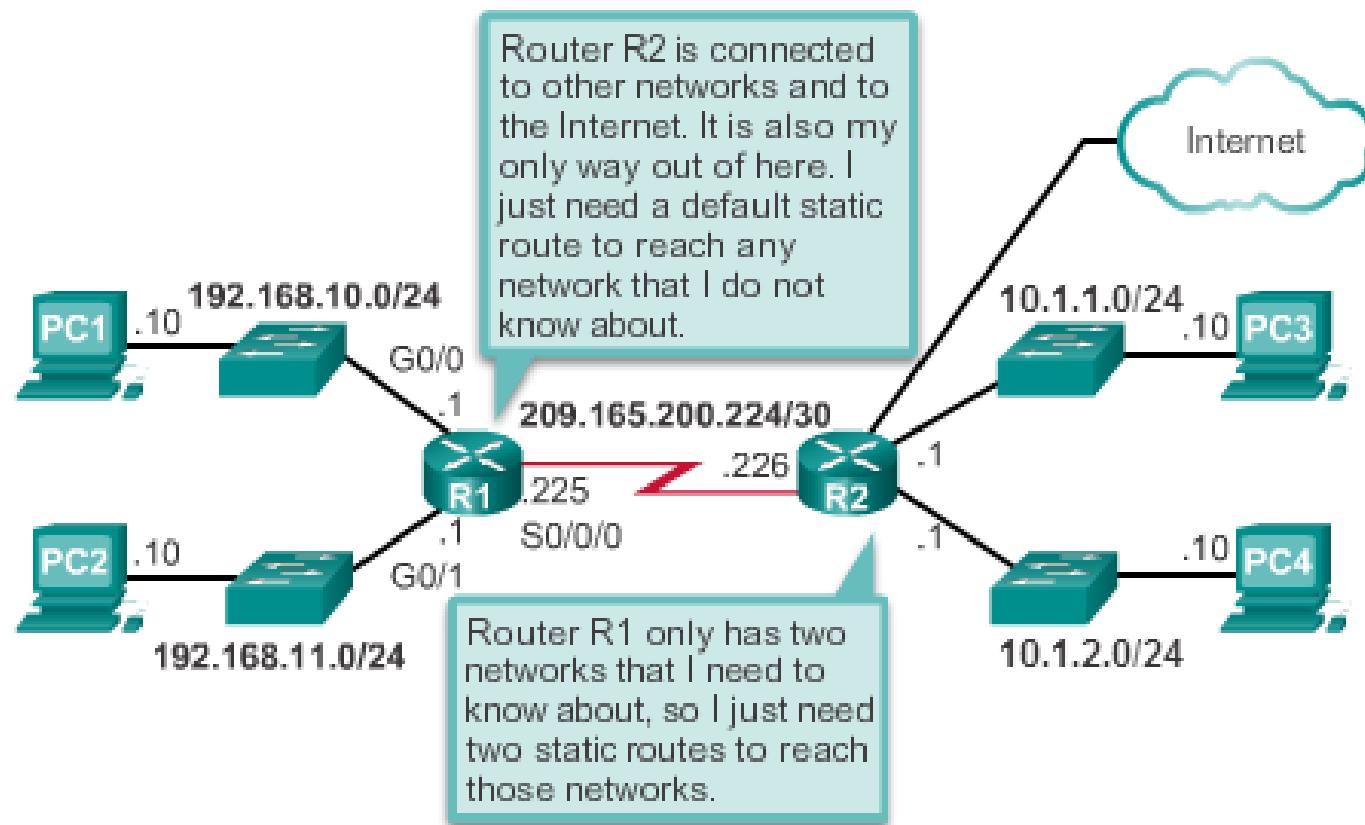
- Switches, link aggregation, LAN redundancy and wireless LANs are all technologies that provide or enhance user access to network resources.
- Scalable networks also require optimal reachability between sites. Remote network reachability is provided by routers and Layer 3 switches which operate in the distribution and core layers.



Routing in the Distribution and Core Layers

Static Routing

Static and Default Route Scenario

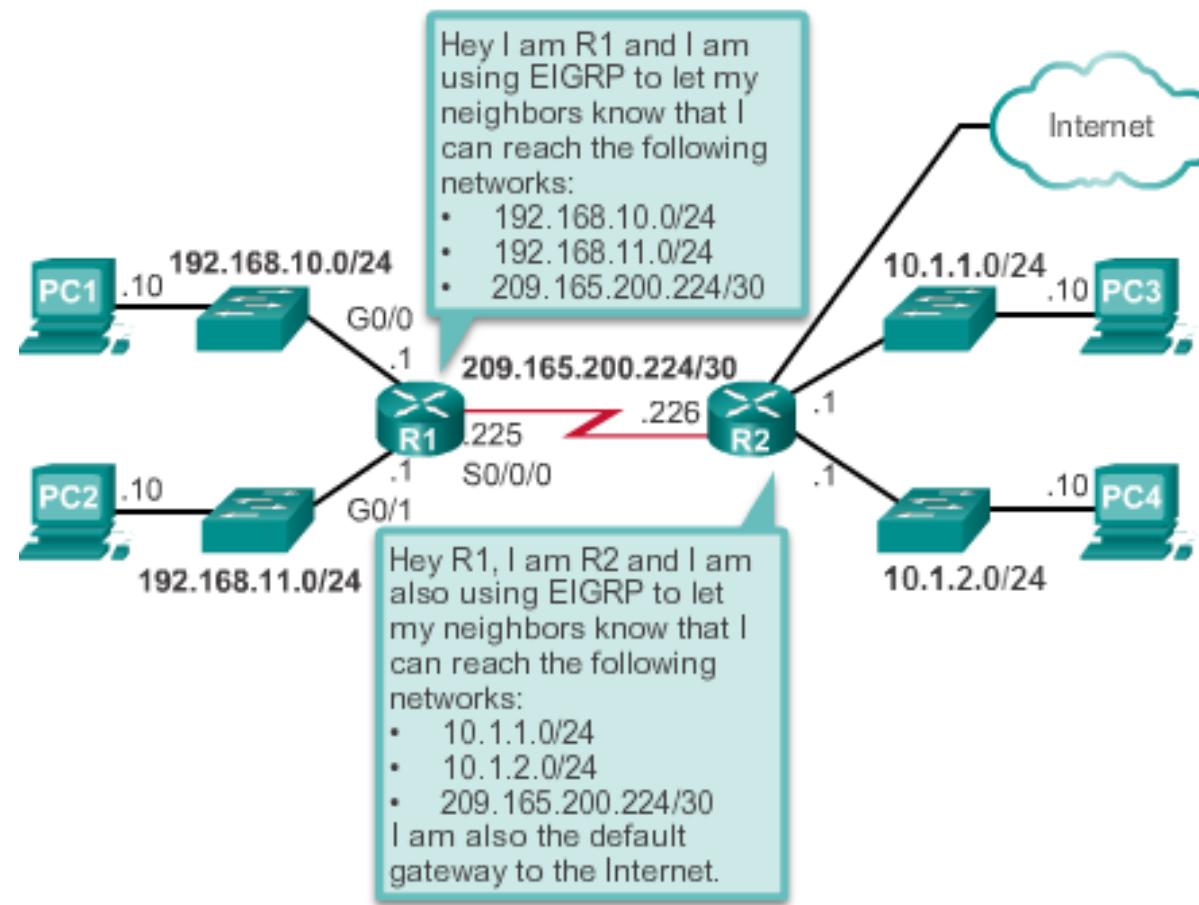




Routing in the Distribution and Core Layers

Dynamic Routing Protocols

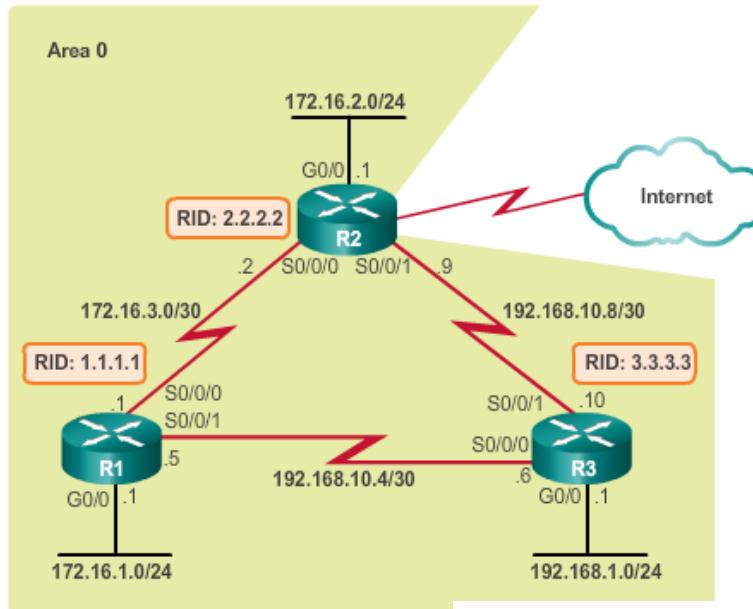
Dynamic Routing Protocol Scenario





Routing in the Distribution and Core Layers

Configuring Single-Area OSPF



```
R1(config)# interface GigabitEthernet0/0
R1(config-if)# bandwidth 1000000
R1(config-if)# exit
R1(config)# router ospf 10
R1(config-router)# router-id 1.1.1.1
R1(config-router)# auto-cost reference-bandwidth 1000
% OSPF: Reference bandwidth is changed.
    Please ensure reference bandwidth is consistent
across all routers.
R1(config-router)# network 172.16.1.0 0.0.0.255 area 0
R1(config-router)# network 172.16.3.0 0.0.0.3 area 0
R1(config-router)# network 192.168.10.4 0.0.0.3 area 0
R1(config-router)#
R1(config-router)# passive-interface g0/0
R1(config-router)#

```

```
R2(config)# interface GigabitEthernet0/0
R2(config-if)# bandwidth 1000000
R2(config-if)# exit
R2(config)# router ospf 10
R2(config-router)# router-id 2.2.2.2
R2(config-router)# auto-cost reference-bandwidth 1000
% OSPF: Reference bandwidth is changed.
    Please ensure reference bandwidth is consistent
across all routers.
R2(config-router)# network 172.16.2.1 0.0.0.0 area 0
R2(config-router)# network 172.16.3.2 0.0.0.0 area 0
R2(config-router)# network 192.168.10.9 0.0.0.0 area 0
R2(config-router)#
R2(config-router)# passive-interface g0/0
R2(config-router)#

```



Routing in the Distribution and Core Layers

Verifying Single-Area OSPF

```
R1# show ip ospf neighbor

Neighbor ID      Pri  State        Dead Time     Address          Interface
3.3.3.3           0    FULL/       - 00:00:32   192.168.10.6   Serial0/0/1
2.2.2.2           0    FULL/       - 00:00:38   172.16.3.2     Serial0/0/0
R1#
```

```
R1# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "ospf 10"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 1.1.1.1
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    172.16.1.0 0.0.0.255 area 0
    172.16.3.0 0.0.0.3 area 0
    192.168.10.4 0.0.0.3 area 0
  Passive Interface(s):
    GigabitEthernet0/0
  Routing Information Sources:
    Gateway          Distance      Last Update
    3.3.3.3           110          00:12:14
    2.2.2.2           110          00:12:46
  Distance: (default is 110)

R1#v
```



Routing in the Distribution and Core Layers

Verifying Single-Area OSPF (cont.)

```
R1# show ip ospf
Routing Process "ospf 10" with ID 1.1.1.1
start time: 00:06:18.952, Time elapsed: 00:39:56.400

<Output omitted>

Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 1000 mbps
Area BACKBONE(0)
    Number of interfaces in this area is 3
Area has no authentication
SPF algorithm last executed 00:15:21.436 ago
SPF algorithm executed 6 times
Area ranges are
Number of LSA 3. Checksum Sum 0x023523
Number of opaque link LSA 0. Checksum Sum 0x000000
Number of ncbitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0

R1#
```



Routing in the Distribution and Core Layers

Verifying Single-Area OSPF (cont.)

```
R1# show ip ospf interface
GigabitEthernet0/0 is up, line protocol is up
  Internet Address 172.16.1.1/24, Area 0, Attached via Network Statement
    Process ID 10, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
    Topology-MTID      Cost      Disabled      Shutdown      Topology Name
              0          1        no            no           Base
    Transmit Delay is 1 sec, State DR, Priority 1
    Designated Router (ID) 1.1.1.1, Interface address 172.16.1.1
    No backup designated router on this network
    Timer intervals configured, Hello 10, Dead 40, Wait 40,
    Retransmit 5
      oob-resync timeout 40
      NO Hellos (Passive interface)
      Supports Link-local Signaling (LLS)
      Cisco NSF helper support enabled
      IETF NSF helper support enabled
      Index 1/1, flood queue length 0
      Next 0x0(0)/0x0(0)
      Last flood scan length is 0, maximum is 0
      Last flood scan time is 0 msec, maximum is 0 msec
      Neighbor Count is 0, Adjacent neighbor count is 0
      Suppress hello for 0 neighbor(s)
Serial0/0/1 is up, line protocol is up
  Internet Address 192.168.10.5/30, Area 0, Attached via Network Statement
    Process ID 10, Router ID 1.1.1.1, Network Type POINT_TO_POINT,
    Cost: 647

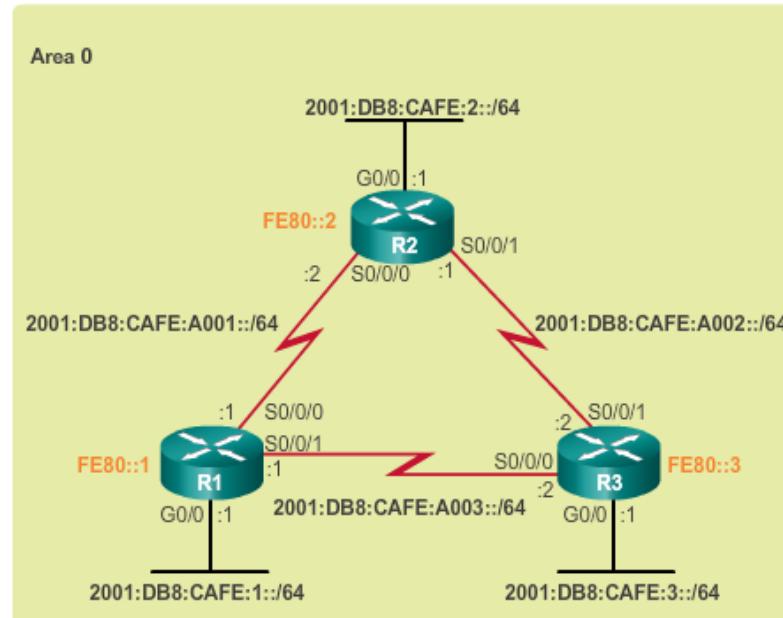
<Output omitted>
```

```
R1# show ip ospf interface brief
Interface      PID      Area      IP Address/Mask      Cost      State Nbrs F/C
Gi0/0          10       0          172.16.1.1/24          1        DR      0/0
Se0/0/1         10       0          192.168.10.5/30        647      P2P     1/1
Se0/0/0         10       0          172.16.3.1/30          647      P2P     1/1
R1#
```



Routing in the Distribution and Core Layers

Configuring Single-Area OSPFv3



```
R1(config)# ipv6 router ospf 10
R1(config-rtr)# router-id 1.1.1.1
R1(config-rtr)# auto-cost reference-bandwidth 1000
% OSPFv3-10-IPv6: Reference bandwidth is changed.
    Please ensure reference bandwidth is consistent across all
routers.
R1(config-rtr)#
R1(config-rtr)# interface GigabitEthernet 0/0
R1(config-if)# bandwidth 1000000
R1(config-if)# ipv6 ospf 10 area 0
R1(config-if)#
R1(config-if)# interface Serial0/0/0
R1(config-if)# ipv6 ospf 10 area 0
R1(config-if)#
R1(config-if)# interface Serial0/0/1
R1(config-if)# ipv6 ospf 10 area 0
R1(config-if)#
R1(config-if)#
R1#
```

```
R2(config)# ipv6 router ospf 10
R2(config-rtr)# router-id 2.2.2.2
R2(config-rtr)# auto-cost reference-bandwidth 1000
% OSPFv3-10-IPv6: Reference bandwidth is changed.
    Please ensure reference bandwidth is consistent across all
routers.
R2(config-rtr)#
R2(config-rtr)# interface GigabitEthernet 0/0
R2(config-if)# bandwidth 1000000
R2(config-if)# ipv6 ospf 10 area 0
R2(config-if)#
R2(config-if)# interface Serial0/0/0
R2(config-if)# ipv6 ospf 10 area 0
R2(config-if)#
R2(config-if)# interface Serial0/0/1
R2(config-if)# ipv6 ospf 10 area 0
R2(config-if)#
R2(config-if)#
R2#
```



Routing in the Distribution and Core Layers

Verifying Single-Area OSPFv3

```
R1# show ipv6 ospf neighbor

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

Neighbor ID Pri State      Dead Time Interface ID Interface
3.3.3.3      0  FULL/ -    00:00:31  6             Serial0/0/1
2.2.2.2      0  FULL/ -    00:00:37  6             Serial0/0/0
2.2.2.2      1  FULL/BDR   00:00:38  3             GigabitEthernet0/0
3.3.3.3      1  FULL/DROTHER 00:00:32  3             GigabitEthernet0/0
R1#
```

```
R1# show ipv6 protocols

IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "ospf 10"

  Router ID 1.1.1.1
  Number of areas: 1 normal, 0 stub, 0 nssa
  Interfaces (Area 0):
    Serial0/0/1
    Serial0/0/0
    GigabitEthernet0/0
  Redistribution:
    None
R1#
```



Routing in the Distribution and Core Layers

Verifying Single-Area OSPFv3 (cont.)

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 10 entries
Codes: C - Connected, L - Local, S - Static,
       U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary,
       D - EIGRP
       EX - EIGRP external, ND - ND Default, NDP - ND Prefix,
       DCE - Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter,
       OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1,
       ON2 - OSPF NSSA ext 2
o  2001:DB8:CAFE:2::/64 [110/1]
    via GigabitEthernet0/0, directly connected
o  2001:DB8:CAFE:3::/64 [110/1]
    via GigabitEthernet0/0, directly connected
o  2001:DB8:CAFE:A002::/64 [110/648]
    via FE80::2, GigabitEthernet0/0
    via FE80::3, GigabitEthernet0/0
R1#
```

```
R1# show ipv6 ospf interface brief
Interface      PID   Area           Intf ID     Cost  State Mbrs F/C
Se0/0/1        10    0               7          647   P2P   1/1
Se0/0/0        10    0               6          647   P2P   1/1
Gi0/0          10    0               3          1     DR    2/2
R1#
```



OSPF in Multiaccess Networks

OSPF Network Types

- **Point-to-point** – Two routers interconnected over a common link. Often the configuration in WAN links.
- **Broadcast Multiaccess** – Multiple routers interconnected over an Ethernet network.
- **Non-broadcast Multiaccess (NBMA)** – Multiple routers interconnected in a network that does not allow broadcasts, such as Frame Relay.
- **Point-to-multipoint** – Multiple routers interconnected in a hub-and-spoke topology over an NBMA network.
- **Virtual links** – Special OSPF network used to interconnect distant OSPF areas to the backbone area.



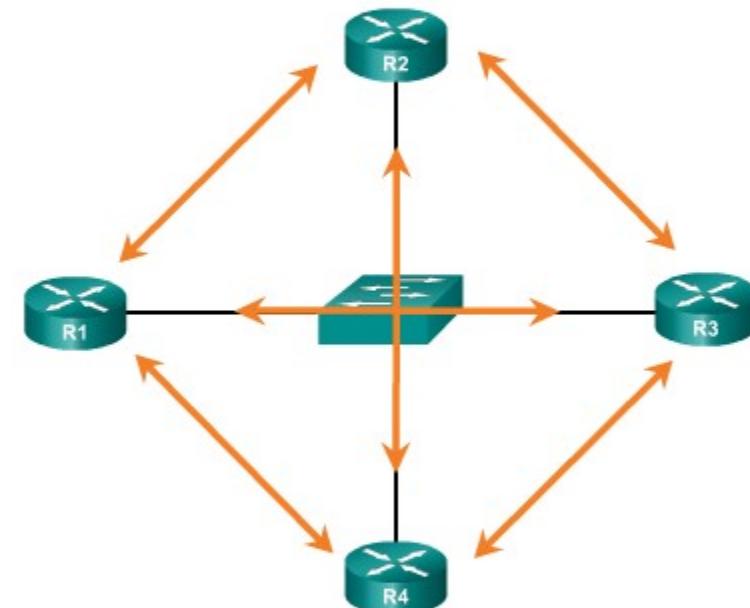
OSPF in Multiaccess Networks

Challenges in Multiaccess Networks

Multiaccess networks can create two challenges for OSPF:

- **Creation of multiple adjacencies** – creating adjacencies with multiple routers would lead to an excessive number of LSAs being exchanged.
- **Extensive flooding of LSAs** – Link-state routers flood the network when OSPF is initialized or when there is a change.

- Formula used to calculate the number of required adjacencies $n(n-1)/2$
- A topology of 4 routers would result in $4(4-1)/2 = 6$





OSPF in Multiaccess Networks

OSPF Designated Router

- The designated router (DR) is the solution to managing adjacencies and flooding of LSAs on a multiaccess network.
- The backup designated router (BDR) is elected in case the DR fails.
- All other non-DR and non-BDR routers become DROTHERs. DROTHERs only form adjacencies with the DR and BDR.
- DROTHERs only send their LSAs to the DR and BDR using the multicast address 224.0.0.6.
- DR uses the multicast address 224.0.0.5 to send LSAs to all other routers. DR only router flooding LSAs.
- DR/BDR Elections only necessary on multiaccess networks.

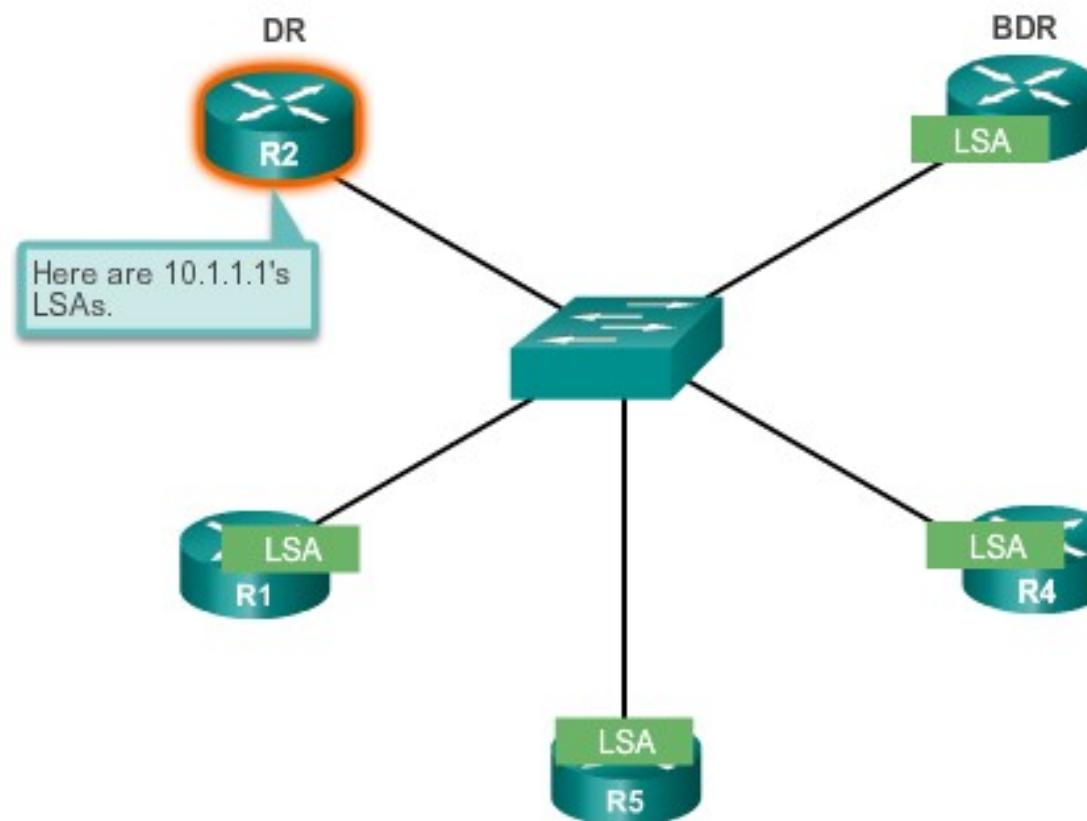


OSPF in Multiaccess Networks

OSPF Designated Router (cont.)

Role of the DR

DR sends out any LSAs to all other routers.





OSPF in Multiaccess Networks

Verifying DR/BDR Roles

Verifying the Role of R1

```
R1# show ip ospf interface GigabitEthernet 0/0
GigabitEthernet0/0 is up, line protocol is up
  Internet Address 192.168.1.1/28,Area 0,Attached via Network Statement
  Process ID 10, Router ID 1.1.1.1, Network Type BROADCAST, Cost: 1
  Topology-MTID      Cost      Disabled      Shutdown      Topology Name
          0            1            no            no            Base
  1 Transmit Delay is 1 sec, State BROTHER, Priority 1
  Designated Router (ID) 3.3.3.3, Interface address 192.168.1.3
  2 Backup Designated router (ID) 2.2.2.2, Interface address 192.168.1.2
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    nob-resync timeout 40
    Hello due in 00:00:06
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
  3   Adjacent with neighbor 2.2.2.2 (Backup Designated Router)
      Adjacent with neighbor 3.3.3.3 (Designated Router)
  Suppress hello for 0 neighbor(s)
R1#
```

1 Transmit Delay is 1 sec, State BROTHER, Priority 1
Designated Router (ID) 3.3.3.3, Interface address 192.168.1.3
2 Backup Designated router (ID) 2.2.2.2, Interface address 192.168.1.2
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
nob-resync timeout 40
Hello due in 00:00:06
Supports Link-local Signaling (LLS)
Cisco NSF helper support enabled
IETF NSF helper support enabled
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 2
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 2, Adjacent neighbor count is 2
3 Adjacent with neighbor 2.2.2.2 (Backup Designated Router)
Adjacent with neighbor 3.3.3.3 (Designated Router)
Suppress hello for 0 neighbor(s)



OSPF in Multiaccess Networks

Verifying DR/BDR Adjacencies

State of neighbors in multiaccess networks can be:

- **FULL/DROTHER** – This is a DR or BDR router that is fully adjacent with a non-DR or BDR router.
- **FULL/DR** – The router is fully adjacent with the indicated DR neighbor.
- **FULL/BDR** – The router is fully adjacent with the indicated BDR neighbor.
- **2-WAY/DROTHER** – The non-DR or BDR router has a neighbor adjacency with another non-DR or BDR router.

```
R1# show ip ospf neighbor

Neighbor ID Pri State          Dead Time   Address      Interface
  1 2.2.2.2      1 FULL/BDR      00:00:36  192.168.1.2 GigabitEthernet0/0
  2 3.3.3.3      1 FULL/DR       0:00:35    192.168.1.3 GigabitEthernet0/0

R1#
```



OSPF in Multiaccess Networks

Default DR/BDR Election Process

- The router with the highest interface priority is elected as the DR.
- The router with the second highest interface priority is elected as the BDR.
- Priority can be configured between 0-255. (Priority of 0 - router cannot become the DR. 0)
- If interface priorities are equal, then the router with highest router ID is elected DR and second highest the BDR
- Three ways to determine router ID:
 - Router ID can be manually configured.
 - If not configured, the ID determined by the highest loopback IP address.
 - If no loopbacks, the ID is determined by the highest active IPv4 address.
- In an IPv6 network, the router ID must be configured manually.



OSPF in Multiaccess Networks

DR/BDR Election Process

DR remains the DR until one of the following occurs:

- The DR fails.
- The OSPF process on the DR fails or is stopped.
- The multiaccess interface on the DR fails or is shutdown.

If the DR fails, the BDR is automatically promoted to DR.

- There is then a new BDR election and the DROTHER with the higher priority or router ID is elected as the new BDR.



OSPF in Multiaccess Networks

The OSPF Priority

- Instead of setting the router ID on all routers, it is better to control the election by setting interface priorities.
 - To change the priority, use one of the following commands:
 - ip ospf priority value** (OSPFv2 interface command)
 - ipv6 ospf priority value** (OSPFv3 interface command)
- To begin another OSPF election, use one of the following methods:
 - Shutdown the router interfaces and then re-enable them starting with the DR, then the BDR, and then all other routers.
 - Re-

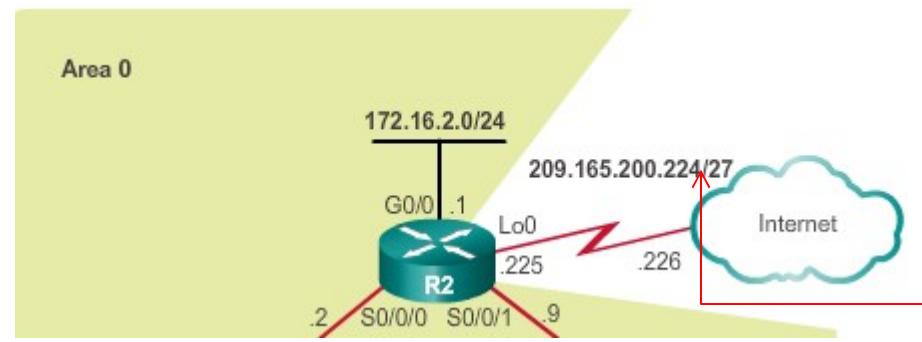
```
R1(config)# interface GigabitEthernet 0/0
R1(config-if)# ip ospf priority 255
R1(config-if)# end
R1#
```



Default Route Propagation

Propagating a Default Static Route in OSPFv2

The router connected to the Internet that is used to propagate a default route is often called the edge, entrance or gateway router. In an OSPF network, it may also be called the autonomous system boundary router (ASBR).



```
R2(config)# ip route 0.0.0.0 0.0.0.0 209.165.200.226
R2(config)#
R2(config)# router ospf 10
R2(config-router)# default-information originate
R2(config-router)# end
R2#
```



Default Route Propagation

Verifying the Propagated Default Route

```
R2# show ip route | begin Gateway

Gateway of last resort is 209.165.200.226 to network
0.0.0.0

S* 0.0.0.0/0 [1/0] via 209.165.200.226, Loopback0
    172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
O  172.16.1.0/24 [110/65] via 172.16.3.1, 00:01:44,
    Serial0/0/0
C  172.16.2.0/24 is directly connected, GigabitEthernet0/0
L  172.16.2.1/32 is directly connected, GigabitEthernet0/0
C  172.16.3.0/30 is directly connected, Serial0/0/0
L  172.16.3.2/32 is directly connected, Serial0/0/0
O  192.168.1.0/24 [110/65] via 192.168.10.10, 00:01:12,
    Serial0/0/1
    192.168.10.0/24 is variably subnetted, 3 subnets, 2
        masks
O  192.168.10.4/30 [110/128] via 192.168.10.10, 00:01:12,
    Serial0/0/1
        [110/128] via 172.16.3.1, 00:01:12, Serial0/0/0
C  192.168.10.8/30 is directly connected, Serial0/0/1
L  192.168.10.9/32 is directly connected, Serial0/0/1
209.165.200.0/24 is variably subnetted, 2 subnets, 2
    masks
```



Default Route Propagation

Propagating a Default Static Route in OSPFv3

Enabling OSPFv3 on the R1 Interfaces

```
R2(config)# ipv6 route ::/0 2001:DB8:FEED:1::2
R2(config)#
R2(config)# ipv6 router ospf 10
R2(config-rtr)# default-information originate
R2(config-rtr)# end
R2#
*Apr 10 11:36:21.995: %SYS-5-CONFIG_I: Configured from console by
console
R2#
```

Verifying the propagated IPv6 default Route

```
R2# show ipv6 route static
IPv6 Routing Table - default - 12 entries
Codes:C -Connected, L - Local, S - Static, U - Per-user Static route
      B -BGP, R - RIP, H - NHRP, I1 - ISIS L1
      I2 -ISIS L2, IA - ISIS interarea, IS-ISIS summary,D-EIGRP
      EX -EIGRP external, ND-ND Default,NDp-ND Prefix,DCE-Destination
      NDr -Redirect, O - OSPF Intra,OI-OSPF Inter,OE1-OSPF ext 1
      OE2 -OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
S  ::/0 [1/0]
    via 2001:DB8:FEED:1::2, Loopback0
R2#
```



Fine-tuning OSPF Interfaces

OSPF Hello and Dead Intervals

OSPF Hello and Dead intervals must match, or a neighbor adjacency will not occur.

Verifying the OSPF Intervals on R1

```
R1# show ip ospf interface serial 0/0/0 | include Timer
    Timer intervals configured, Hello 10, Dead 40, Wait 40,
    Retransmit 5
    Timer intervals configured, Hello 10, Dead 40, Wait 40,
    Retransmit 5
    Timer intervals configured, Hello 10, Dead 40, Wait 40,
    Retransmit 5
R1#
```

Verifying OSPF Timer Activity

```
R1# show ip ospf neighbor
      Neighbor ID   Pri   State     Dead Time   Address          Interface
      3.3.3.3        0     FULL/-  00:00:35  192.168.10.6  Serial0/0/1
      2.2.2.2        0     FULL/-  00:00:33  172.16.3.2    Serial0/0/0
R1#
```



Fine-tuning OSPF Interfaces

Modifying OSPF Intervals

- Modifying OSPFv2 Intervals

```
R1(config)# interface serial 0/0/0
R1(config-if)# ip ospf hello-interval 5
R1(config-if)# ip ospf dead-interval 20
R1(config-if)# end
R1#
```

- Modifying OSPFv3 Intervals

```
R1(config)# interface serial 0/0/0
R1(config-if)# ipv6 ospf hello-interval 5
R1(config-if)# ipv6 ospf dead-interval 20
R1(config-if)# end
R1#
```

- Verifying the OSPFv3 interface intervals

```
R2# show ipv6 ospf interface s0/0/0 | include Timer
    Timer intervals configured, Hello 5, Dead 20, Wait 20,
    Retransmit 5
R2#
R2# show ipv6 ospf neighbor

        OSPFv3 Router with ID (2.2.2.2) (Process ID 10)

    Neighbor ID      Pri      State      Dead Time      Interface ID      Interface
3.3.3.3            0      FULL/-      00:00:38      7              Serial0/0/1
1.1.1.1            0      FULL/-      00:00:19      6              Serial0/0/0
R2#
```



Secure OSPF

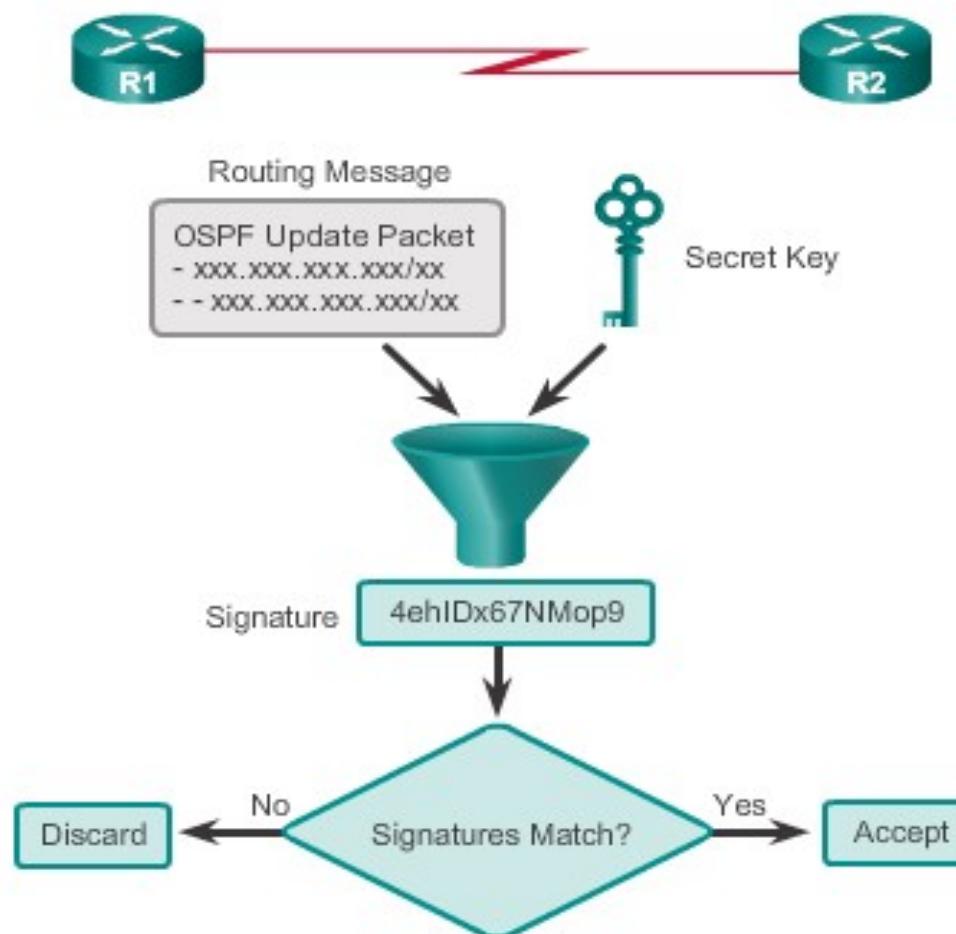
Secure Routing Updates

- When neighbor authentication has been configured on a router, the router authenticates the source of each routing update packet that it receives.
- An authenticating key that is known to both the sending and the receiving route is exchanged.
- OSPF supports three types of authentication:
 - **Null** – no authentication.
 - **Simple password authentication** – the password in the update is sent in plaintext over the network (outdated method).
 - **MD5 authentication** – Most secure and recommended method of authentication. Password is calculated using the MD5 algorithm.



Secure OSPF MD5 Authentication

Operation of the MD5 Algorithm





Secure OSPF

Configuring OSPF MD5 Authentication

- MD5 authentication can be enabled globally for all interfaces or on a per-interface basis.
- To enable OSPF MD5 authentication globally, configure:
 - **ip ospf message-digest-key key md5 password** (interface configuration command)
 - **area area-id authentication message-digest** (router configuration command)
- To enable MD5 authentication on a per-interface basis, configure:
 - **ip ospf message-digest-key key md5 password** (interface configuration command)
 - **ip ospf authentication message-digest** (interface configuration command)



Secure OSPF OSPF MD5 Authentication Example

```
R1(config)# router ospf 10
R1(config-router)# area 0 authentication message-digest
R1(config-router)# exit
R1(config)#
*Apr  8 09:58:09.899: %OSPF-5-ADJCHG: Process 10, Nbr 2.2.2.2
on Serial0/0/0 from FULL to DOWN, Neighbor Down: Dead timer
expired
R1(config)#
*Apr  8 09:58:28.627: %OSPF-5-ADJCHG: Process 10, Nbr 3.3.3.3
on Serial0/0/1 from FULL to DOWN, Neighbor Down: Dead timer
expired
R1(config)#
R1(config)# interface GigabitEthernet 0/0
R1(config-if)# ip ospf message-digest-key 1 md5 CISCO-123
R1(config-if)# exit
R1(config)#
R1(config)# interface Serial 0/0/0
R1(config-if)# ip ospf message-digest-key 1 md5 CISCO-123
R1(config-if)# exit
R1(config)#
R1(config)# interface Serial 0/0/1
R1(config-if)# ip ospf message-digest-key 1 md5 CISCO-123
R1(config-if)#

```

continued



Secure OSPF

OSPF MD5 Authentication Example (cont.)

```
R1(config)# interface GigabitEthernet 0/0
R1(config-if)# ip ospf message-digest-key 1 md5 CISCO-123
R1(config-if)# ip ospf authentication message-digest
R1(config-if)# exit
R1(config)#
R1(config)# interface Serial 0/0/0
R1(config-if)# ip ospf message-digest-key 1 md5 CISCO-123
R1(config-if)# ip ospf authentication message-digest
R1(config-if)# exit
R1(config)#
R1(config)# interface Serial 0/0/1
R1(config-if)# ip ospf message-digest-key 1 md5 CISCO-123
R1(config-if)# ip ospf authentication message-digest
R1(config-if)# exit
R1(config)#
*Apr  8 10:20:10.647: %OSPF-5-ADJCHG: Process 10, Nbr 2.2.2.2
on Serial0/0/0 from FULL to DOWN, Neighbor Down: Dead timer
expired
R1(config)#
*Apr  8 10:20:50.007: %OSPF-5-ADJCHG: Process 10, Nbr 3.3.3.3
on Serial0/0/1 from FULL to DOWN, Neighbor Down: Dead timer
expired
R1(config)#
```



Secure OSPF

Verifying OSPF MD5 Authentication

```
R1# show ip ospf interface serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Internet Address 172.16.3.1/30, Area 0, Attached via
Network Statement
  Process ID 10, Router ID 1.1.1.1, Network Type
  POINT_TO_POINT, Cost: 64
  Topology-MTID  Cost  Disabled  Shutdown   Topology Name
    0        64      no       no          Base
  Transmit Delay is 1 sec, State POINT_TO_POINT
  Timer intervals configured, Hello 5, Dead 20, Wait 20,
Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:02
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2
  Suppress hello for 0 neighbor(s)
  Message digest authentication enabled
    Youngest key id is 1
R1#
R1# show ip ospf interface | include Message
  Message digest authentication enabled
  Message digest authentication enabled
  Message digest authentication enabled
R1#
```



Secure OSPF

Verifying OSPF MD5 Authentication (cont.)

Verify the Routing Table on R1

```
R1# show ip route ospf
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1,
       L2 - IS-IS level-2, ia - IS-IS inter area,
       * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route
       H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is 172.16.3.2 to network 0.0.0.0

O*E2 0.0.0.0/0 [110/1] via 172.16.3.2, 00:33:17, Serial0/0/0
      172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
O        172.16.2.0/24 [110/65] via 172.16.3.2, 00:33:17, Serial0/0/0
O        192.168.1.0/24 [110/65] via 192.168.10.6, 00:30:43, Serial0/0/1
      192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
O          192.168.10.8/30 [110/128] via 192.168.10.6, 00:30:43, Serial0/0/1
                           [110/128] via 172.16.3.2, 00:33:17, Serial0/0/0
R1#
```



5.2 Troubleshooting Single-Area OSPF Implementations



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Components of Troubleshooting Single-Area OSPF

Forming OSPF Adjacencies

OSPF Adjacencies



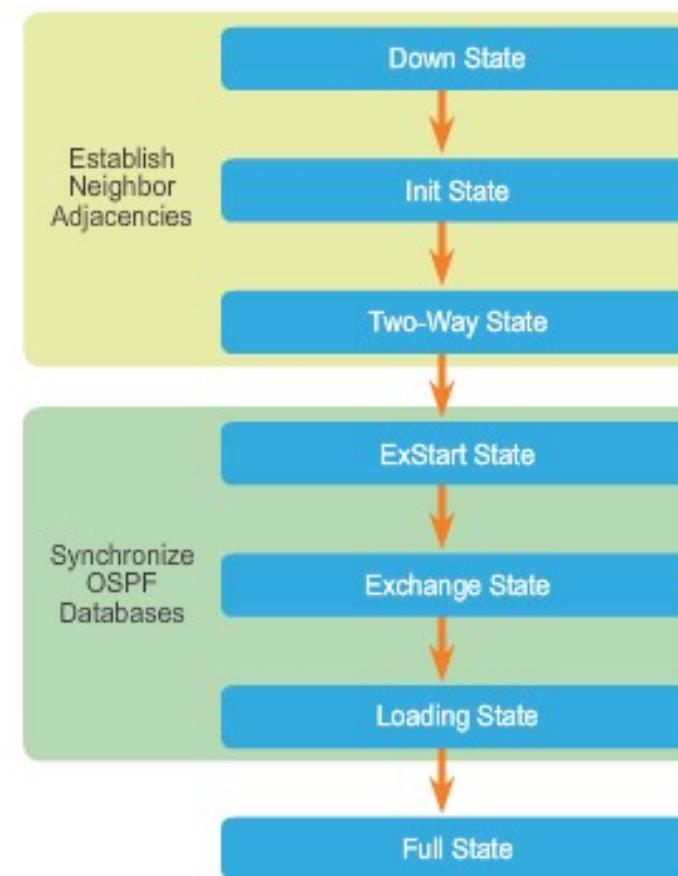
OSPF Adjacencies will not form if:

- The interfaces are not on the same network.
- OSPF network types do not match.
- OSPF Hello or Dead Timers do not match.
- Interface to neighbor is incorrectly configured as passive.
- There is a missing or incorrect OSPF network command.
- Authentication is misconfigured.



Components of Troubleshooting Single-Area OSPF Transitioning via OSPF States

The router should not remain in any states other than FULL or 2Way for extended periods of time.





Components of Troubleshooting Single-Area OSPF

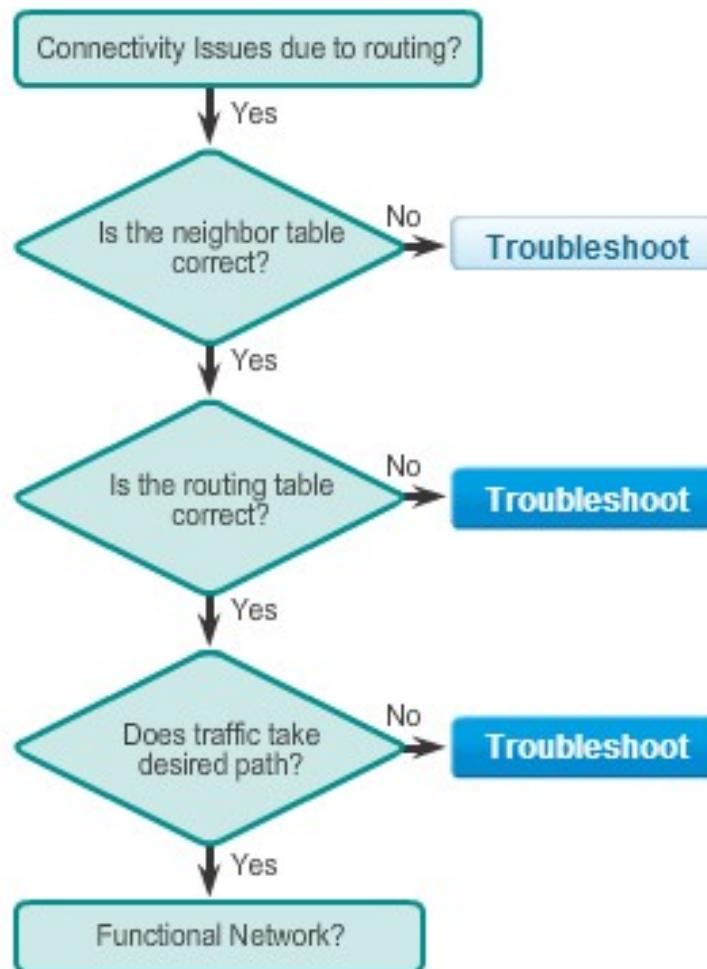
OSPF Troubleshooting Commands

- **show ip protocols** – Verifies vital OSPF configuration information.
- **show ip ospf neighbor** – Verifies that the router has formed an adjacency with its neighboring routers.
- **show ip ospf interface** – Displays the OSPF parameters configured on an interface, such as the OSPF process ID.
- **show ip ospf** – Examines the OSPF process ID and router ID.
- **show ip route ospf** – Displays only the OSPF learned routes in the routing table.
- **clear ip ospf [process-id] process** – Resets the OSPFv2 neighbor adjacencies.



Components of Troubleshooting Single-Area OSPF

Components of Troubleshooting OSPF



Troubleshoot

- Are the interfaces operational?
- Are the interfaces enabled for OSPF?
- Does the OSPF area match?
- Is there an interface that is configured as passive?

Show commands

```
show ip ospf neighbors  
show ip interface brief  
show ip ospf interface
```



Troubleshoot Single-Area OSPFv2 Routing Issues

Troubleshooting Neighbor Issues

- Verify active OSPF interfaces using the **show ip ospf interface** command.
- Verify the OSPF settings using the **show ip protocols** command.
- Disable the interface as passive using the **no passive-interface** command.
- Verify routes using the **show ip route** command.

```
Gateway of last resort is 172.16.3.2 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 172.16.3.2, 00:00:18,
serial0/0/0
      172.16.0.0/16 is variably subnetted, 5 subnets, 3
masks
O      172.16.2.0/24 [110/65] via 172.16.3.2, 00:00:18,
serial0/0/0
O      192.168.1.0/24 [110/129] via 172.16.3.2, 00:00:18,
Serial0/0/0
      192.168.10.0/30 is subnetted, 1 subnets
O          192.168.10.8 [110/128] via 172.16.3.2, 00:00:18,
Serial0/0/0
```



Troubleshoot Single-Area OSPFv2 Routing Issues

Troubleshooting OSPF Routing Table Issues

- The **show ip protocols** command verifies networks that are advertised in OSPF.

```
R3# show ip protocols
*** IP Routing is NSF aware ***
Routing Protocol is "ospf 10"
    Outgoing update filter list for all interfaces is not set
    Incoming update filter list for all interfaces is not set
    Router ID 3.3.3.3
    Number of areas in this router is 1. 1 normal 0 stub 0
    nssa
    Maximum path: 4
    Routing for Networks:
        192.168.10.8 0.0.0.3 area 0
```

- For an interface to be enabled for OSPF, a matching **network** command must be configured under the OSPF routing process.

```
R3# conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)# router ospf 10
R3(config-router)# network 192.168.1.0 0.0.0.255 area 0
R3(config-router)# end
```

- Use the **show ip route** command to verify routes in a routing table.
- Use the **show ip protocols** command to verify that a route is being advertised.



Troubleshoot Single-Area OSPFv3 Routing Issues

OSPFv3 Troubleshooting Commands

- **show ipv6 protocols** – Verifies vital OSPFv3 configuration information.
- **show ipv6 ospf neighbor** – Verifies that the router has formed an adjacency with its neighboring routers.
- **show ipv6 ospf interface** – Displays the OSPFv3 parameters configured on an interface.
- **show ipv6 ospf** – Examines the OSPFv3 process ID and router ID.
- **show ipv6 route ospf** – Displays only the OSPFv3 learned routes in the routing table.
- **clear ipv6 ospf [process-id] process** – Resets the OSPFv3 neighbor adjacencies.



Chapter 5: Summary

- OSPF defines five network types: point-to-point, broadcast multiaccess, NBMA, point-to-multipoint, and virtual links.
- The DR and BDR are elected to overcome challenges of flooding in an OSPF network.
- The routers in the network elect the router with the highest interface priority as DR. The router with the second highest interface priority is elected as the BDR.
- If all priorities are equal, the router with the highest ID is elected DR and the second highest ID becomes the BDR.
- To propagate a default route in OSPF, the ASBR must be configured with a default static route and the **default-information originate** command.
- Verify routes with the **show ip route** or **show ipv6 route** command.



Chapter 5: Summary (cont.)

- For OSPF to make a correct path determination, it may be necessary to adjust the default interface bandwidth.
- To adjust the reference bandwidth, use the auto-cost reference-bandwidth Mbps router configuration mode command.
- To adjust the interface bandwidth, use the bandwidth kilobits interface configuration mode command.
- The OSPF Hello and Dead intervals must match or a neighbor adjacency does not occur.
- OSPF supports three types of authentication: null, simple password authentication, and MD5 authentication.
- When troubleshooting OSPF neighbors, be aware that the FULL or 2WAY states are normal.



Chapter 5: Summary (cont.)

- Troubleshooting commands: `show ip protocols`, `show ip ospf neighbor`, `show ip ospf interface`, `show ip ospf`
- Troubleshooting OSPFv3 commands: `show ipv6 protocols`, `show ipv6 ospf neighbor`, `show ipv6 ospf interface`, `show ipv6 ospf`, `show ipv6 route ospf`, and `clear ipv6 ospf [process-id] process`

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