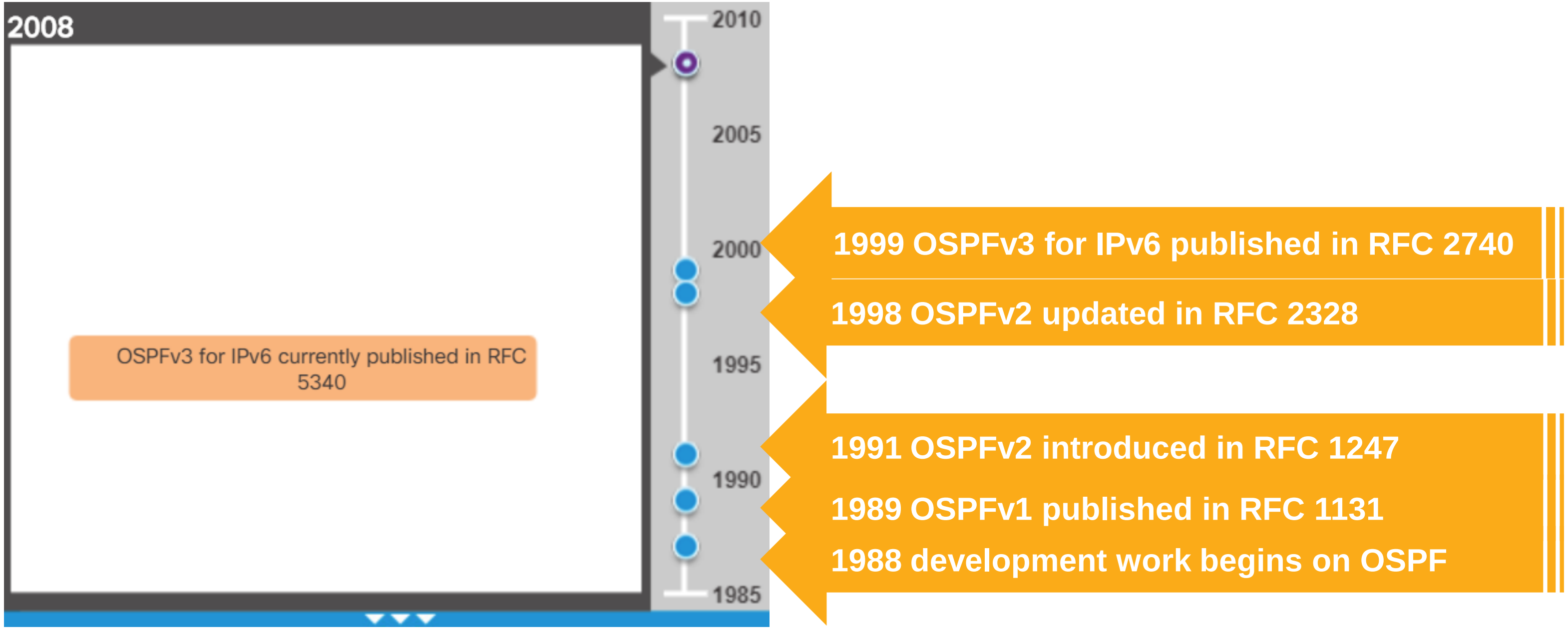
Chapter 8: Single-Area OSPF

Scaling Networks v6.0 Planning Guide

Evolution of OSPF

- OSPF is a link-state routing protocol

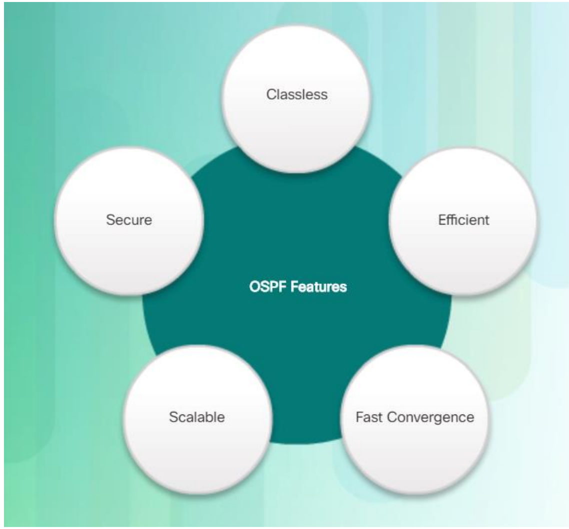
	Interior Gateway Protocols				Exterior Gateway Protocols
	Distance Vector		Link-State		Path Vector
IPv4	RIPv2	EIGRP	OSPFv2	IS-IS	BGP-4
IPv6	RIPng	EIGRP for IPv6	OSPFv3	IS-IS for IPv6	BGP-MP



Open Shortest Path First
Features of OSPF

v2 supports MD5 and SHA authentication
v3 uses IPsec for authentication

Supports a hierarchical design system through the use of areas



Routing changes trigger routing updates

- OSPF uses the Dijkstra shortest path first (SPF) algorithm to choose the best path.
- Administrative distance is used in determining what route gets installed in the routing table when the route is learned from multiple sources.
  - The lowest administrative distance is the one added to the routing table.

Route Source	Administrative Distance
Connected	0
Static	1
EIGRP summary route	5
External BGP	20
Internal EIGRP	90
IGRP	100
OSPF	110
IS-IS	115
RIP	120
External EIGRP	170
Internal BGP	200

Open Shortest Path First

Components of OSPF

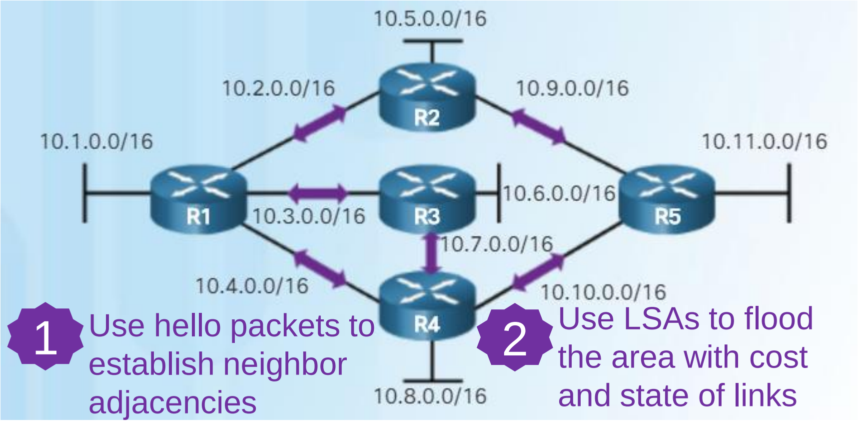
Database	Table	Description
Adjacency	Neighbor	• Lists all neighbor routers to which a router has established bidirectional communication • Unique for each router • View using the **show ip ospf neighbor** command
Link-state (LSDB)	Topology	• Lists information about all other routers • Represents the network topology • Contains the same LSDB as all other routers in the same area • View using the **show ip ospf database** command
Forwarding	Routing	• Lists routes generated when the SPF algorithm is run on the link-state database. • Unique to each router and contains information on how and where to send packets destined for remote networks • View using the **show ip route** command

- OSPF packet types: hello, database description, link-state request, link-state update, link-state acknowledgment

Open Shortest Path First

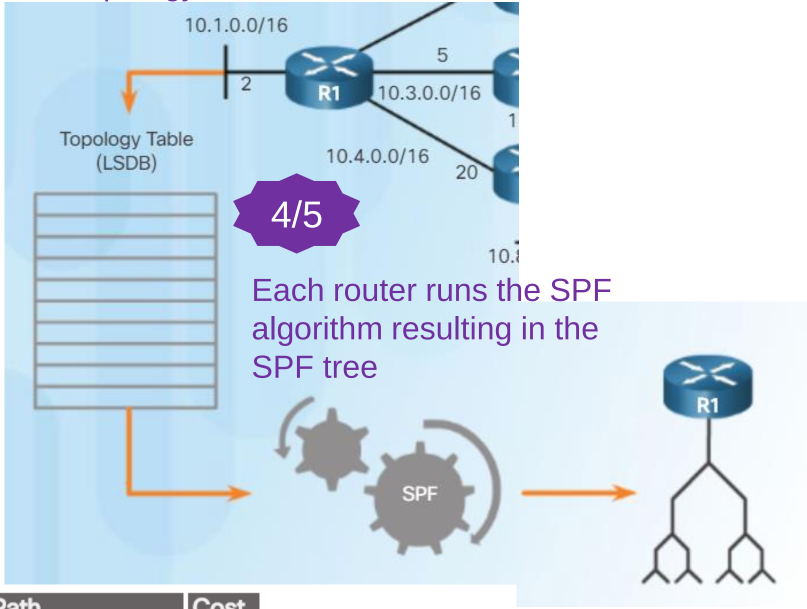
Link-State Operation

3 Each router builds a topology table



1 Use hello packets to establish neighbor adjacencies

2 Use LSAs to flood the area with cost and state of links



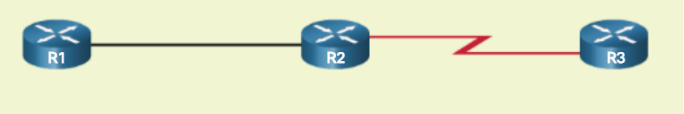
4/5 Each router runs the SPF algorithm resulting in the SPF tree

6 Each router builds a routing table that includes the path to get to the distant network and the cost to get there.

Destination	Shortest Path	Cost
10.5.0.0/16	R1→R2	22
10.6.0.0/16	R1→R3	7
10.7.0.0/16	R1→R3	15
10.8.0.0/16	R1→R3→R4	17
10.9.0.0/16	R1→R2	30
10.10.0.0/16	R1→R3→R4	25
10.11.0.0/16	R1→R3→R4→R5	27
10.5.0.0/16	R1→R2	22

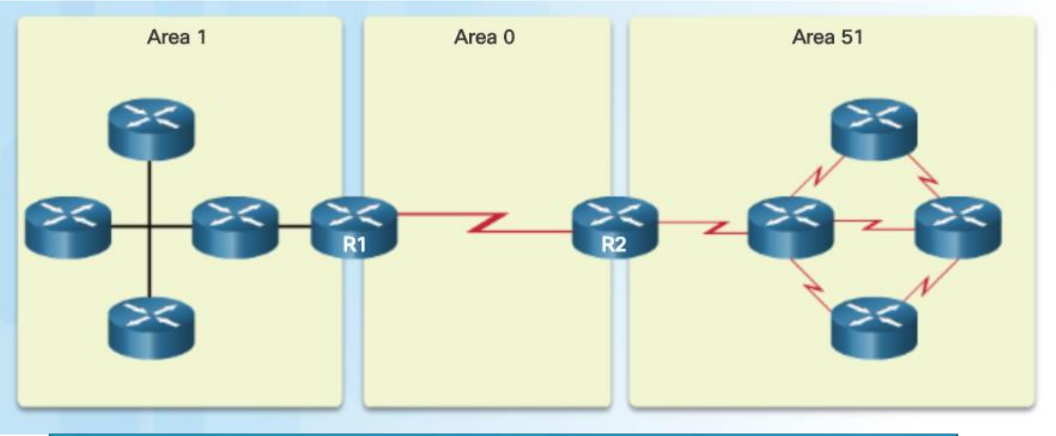
Single-Area and Multiarea OSPF

Single-Area OSPF



- All routers contained in one area
- Called the backbone area
- Known as Area 0
- Used in smaller networks with few routers

Multiarea OSPF



- Designed using a hierarchical scheme
- All areas connect to area 0
- More commonly seen with numerous areas around area 0 (like a daisy or aster)
- Routers that connect area 0 to another area is known as an Area Border Router (ABR)
- Used in large networks
- Multiple areas reduces processing and memory overhead
- A failure in one area does not affect other areas

Encapsulating OSPF Messages

- OSPF adds its own Layer 3 header after the IP Layer 3 header.
  - The IP header contains the OSPF multicast address of either 224.0.0.5 or 224.0.0.6 and the protocol field of 89 which indicates it is an OSPF packet.
- OSPF Packet Header identifies the type of OSPF packet, the router ID, and the area ID
- OSPF Packet Type contains the specific OSPF packet type information

Data Link Frame Header	IP Packet Header	OSPF Packet Header	OSPF Packet Type-Specific Database

Data Link Frame (Ethernet Fields shown here)
MAC Destination Address = Multicast: 01-00-5E-00-00-05 or 01-00-5E-00-00-06
MAC Source Address = Address of sending interface

IP Packet
IP Source Address = Address of sending interface
IP Destination Address = Multicast: 224.0.0.5 or 224.0.0.6
Protocol Field = 89 for OSPF

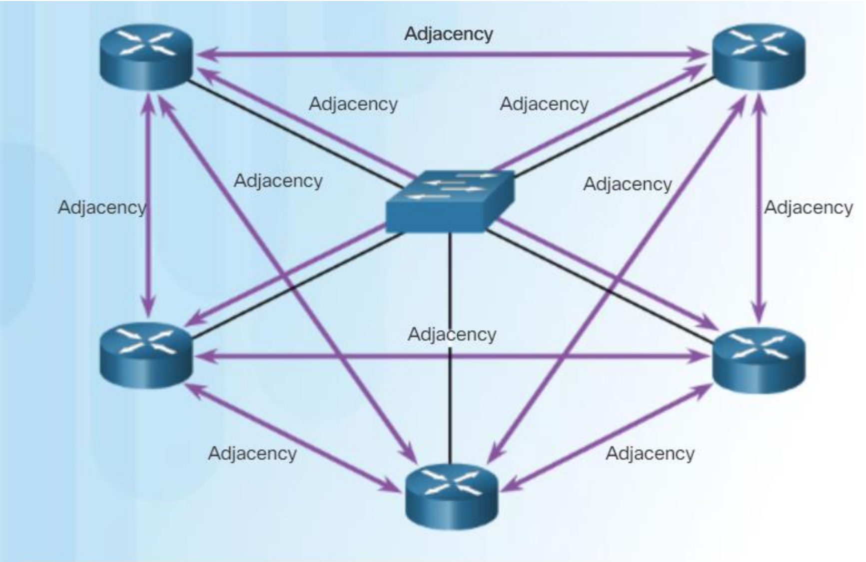
OSPF Packet Header
Type code for OSPF packet type
Router ID and Area ID

OSPF Packet Types
0x01 Hello
0x02 Database Description (DD)
0X03 Link State Request
0X04 Link State Update
0X05 Link State Acknowledgment

OSPF DR and BDR

- Why have a DR/BDR election?
- Reduce the number of LSAs sent – The DR is the only router used to send LSAs for the shared network
- Reduce the number of adjacencies over a multi-access network like Ethernet

Routers	Adjacencies
n	n (n - 1) / 2
5	10
10	45
20	190
100	4,950

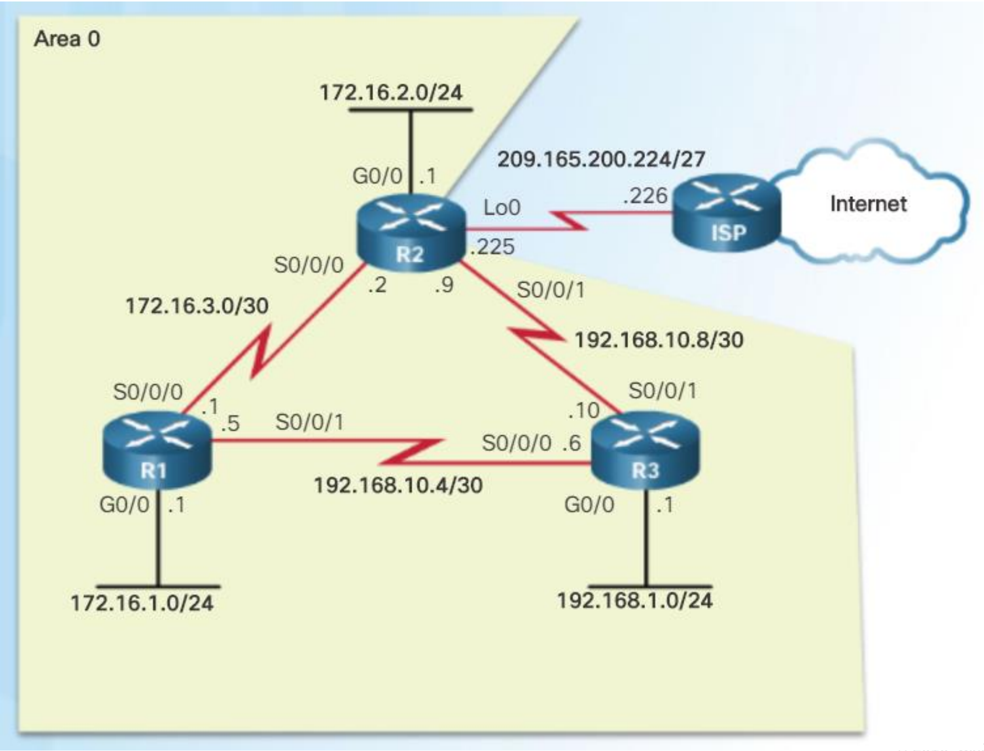


Number of Adjacencies = n (n - 1) / 2
n = number of routers
Example: 5 (5 - 1) / 2 = 10 adjacencies

8.2 Single-Area OSPFv2

OSPF Network Topology

- Topology used to describe OSPF configuration



Router OSPF Configuration Mode

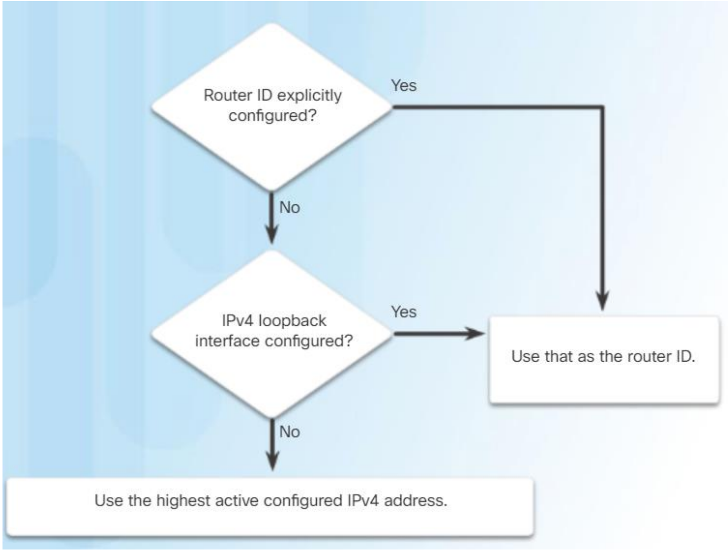
- OSPFv2 configuration uses the router ospf configuration mode
  - From global configuration mode, type **router ospf** *process-id* to enter commands

```
R1(config)# router ospf 10
R1(config-router)# ?
Router configuration commands:
 auto-cost            Calculate OSPF interface cost according to
                      bandwidth
 network              Enable routing on an IP network
 no                   Negate a command or set its defaults
 passive-interface    Suppress routing updates on an interface
 priority             OSPF topology priority
 router-id            router-id for this OSPF process
```

Note there are other commands used in this mode.

Router IDs

- Router IDs are used to uniquely identify an OSPF router
- Router IDs are 32 bits long in both OSPFv2 (IPv4) and OSPFv3 (IPv6)
- Used in the election of the DR if a priority number is not configured
- Ways a router gets a router ID
  1. Configured using the **router-id *rid*** OSPF router configuration mode command
  2. If a router ID is not configured, the highest configured loopback interface is used
  3. If there are no configured loopback interfaces, then the highest active IPv4 address is used (not recommended because if the interface with the highest IPv4 address goes down, the router ID selection process starts over)



If a loopback address is used, do not route this network using a network statement!

Configuring an OSPF Router ID

- Use the **router-id** *x.x.x.x* command to configure a router ID.
- Use the **show ip protocols** command to verify the router ID.

```
R1(config)# router ospf 10
R1(config-router)# router-id 1.1.1.1
R1(config-router)# end
R1#
*Mar 25 19:50:36.595: %SYS-5-CONFIG_I: Configured from console by console
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 0. 0 normal 0 stub 0 nssa
   Maximum path: 4
   Routing for Networks:
   Routing Information Sources:
   Gateway          Distance      Last Update
   Distance: (default is 110)
```

Modifying a Router ID

- Use the **clear ip ospf process** command after changing the router ID to make the change effective.

```
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 192.168.10.5
```

Original RID

```
R1(config)# router ospf 10
R1(config-router)# router-id 1.1.1.1
% OSPF: Reload or use "clear ip ospf process" command, for this to take effect
```

Change RID

Don't forget this command to make the router ID change effective.

```
R1# clear ip ospf process
Reset ALL OSPF processes? [no]: y
R1#
*Mar 25 19:46:22.423: %OSPF-5-ADJCHG: Process 10, Nbr
3.3.3.3 on Serial0/0/1 from FULL to DOWN, Neighbor Down:
 Interface down or detached
*Mar 25 19:46:22.423: %OSPF-5-ADJCHG: Process 10, Nbr
2.2.2.2 on Serial0/0/0 from FULL to DOWN, Neighbor Down:
 Interface down or detached
*Mar 25 19:46:22.475: %OSPF-5-ADJCHG: Process 10, Nbr
3.3.3.3 on Serial0/0/1 from LOADING to FULL, Loading Done
*Mar 25 19:46:22.475: %OSPF-5-ADJCHG: Process 10, Nbr
2.2.2.2 on Serial0/0/0 from LOADING to FULL, Loading Done
R1#
R1# show ip protocols | section Router ID
  Router ID 1.1.1.1
```

Applied RID Change

Using a Loopback Interface as the Router ID

- Older IOS version did not have the **router-id** OSPF configuration command.
- Loopback interfaces were used to provide a stable router ID.

Do NOT advertise this network! It is a common mistake made in OSPF configurations.

```
R1(config)# interface loopback 0
R1(config-if)# ip address 1.1.1.1 255.255.255.255
R1(config-if)# end
R1#
```

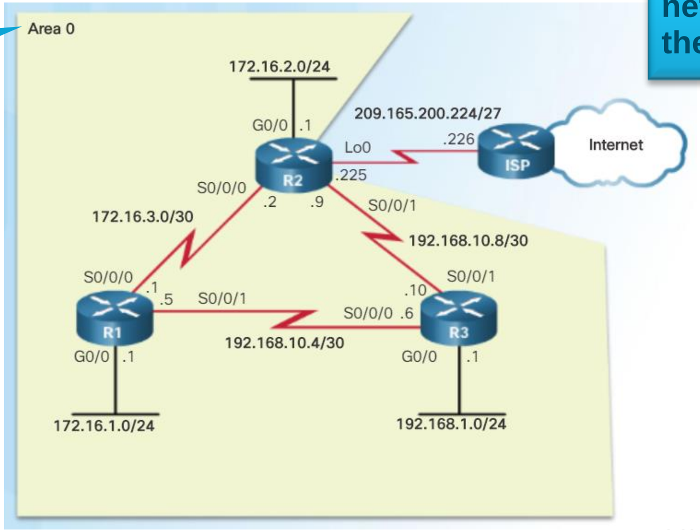

Enabling OSPF on Interfaces

- Use the **network** command to specify which interface(s) participate in the OSPFv2 area.
  - (config)# **router ospf** *x*
  - (config-router)# **network** *x.x.x.x wildcard_mask* **area** *area-id*

Common misconception!

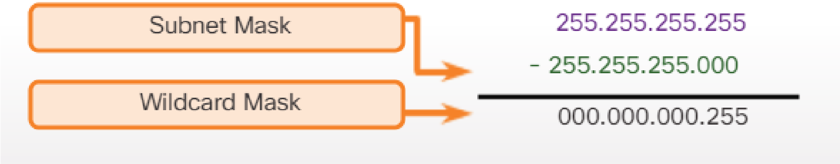
R2 has 3 interfaces in Area 0 so three network statements are used (not 6 network statements for all 6 networks in the entire area)

If a single-area topology is used, it is best to use Area 0

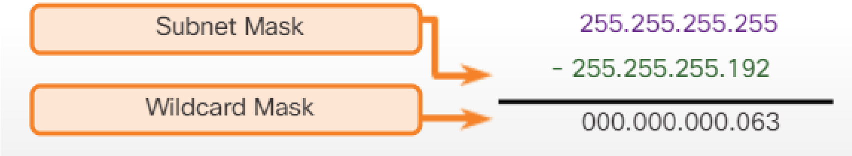


Wildcard Mask

- To determine the wildcard mask, subtract the normal mask from 255.255.255.255
- A wildcard mask bit of 0 – match the bit
- A wildcard mask bit of 1 – ignore the bit
- A wildcard mask is a series of 0s with the rest 1s (the 0s and 1s are not alternating like an IP address)



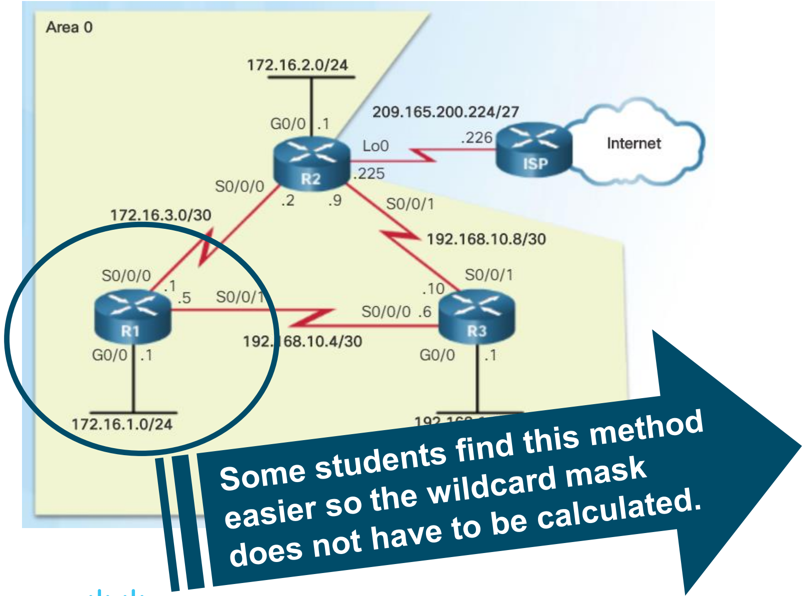
/24 mask



/26 mask

The **network** Command

- Two ways to use the **network** command
  - Advertise the particular network, calculating the wildcard mask
  - Advertise the IP address on the router interface with a 0.0.0.0 wildcard mask



Method 1 Traditional Method Network Number and Wildcard Mask

```
R1(config)# router ospf 10
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
```

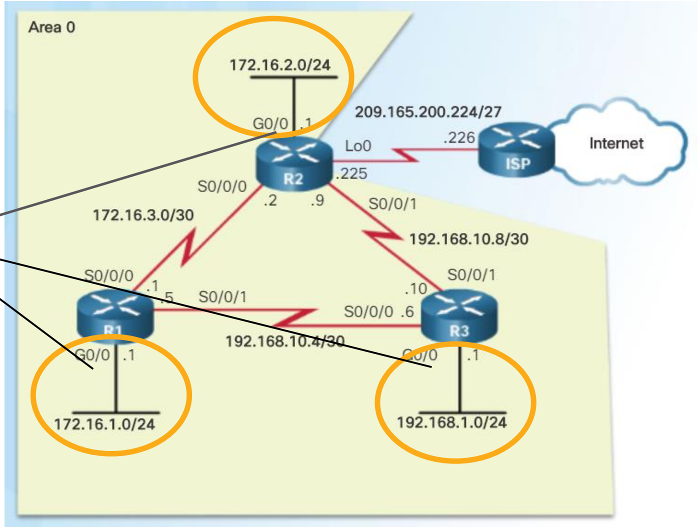
Method 2 Interface IP Address and 0.0.0.0

```
R1(config)# router ospf 10
R1(config-router)# network 172.16.1.1 0.0.0.0 area 0
R1(config-router)# network 172.16.3.1 0.0.0.0 area 0
R1(config-router)# network 192.168.10.5 0.0.0.0 area 0
```

Passive Interface

- An interface configured as a passive interface does not **SEND** OSPF messages.
- Best practice for interfaces that have users attached (security)
- Doesn't waste bandwidth sending messages out OSPF-enabled interfaces that don't have another router attached.

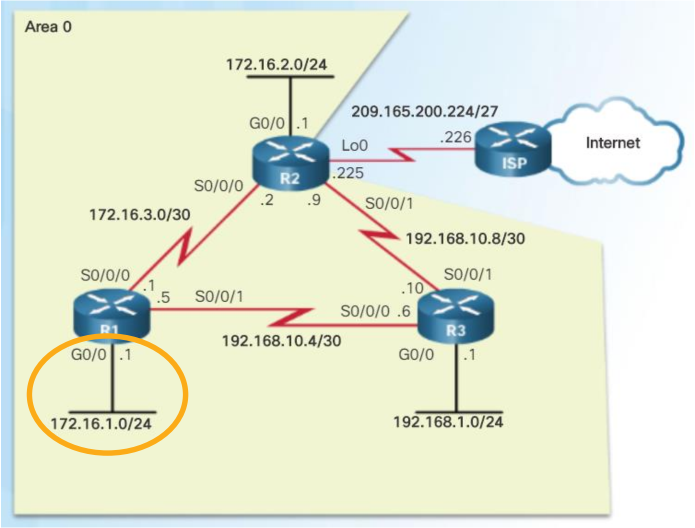
Interfaces to configure as a passive interface



Configuring Passive Interfaces

- Use the **passive-interface** command to configure
- Use the **show ip protocols** to verify

```
R1(config)# router ospf 10
R1(config-router)# passive-interface GigabitEthernet 0/0
```




```
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:
    172.16.1.1 0.0.0.0 area 0
    172.16.3.1 0.0.0.0 area 0
    192.168.10.5 0.0.0.0 area 0
  Passive Interface(s):
    GigabitEthernet0/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    3.3.3.3              110      00:08:35
    2.2.2.2              110      00:08:35
  Distance: (default is 110)
```


Packet Tracer – Configuring OSPFv2 in a Single-Area

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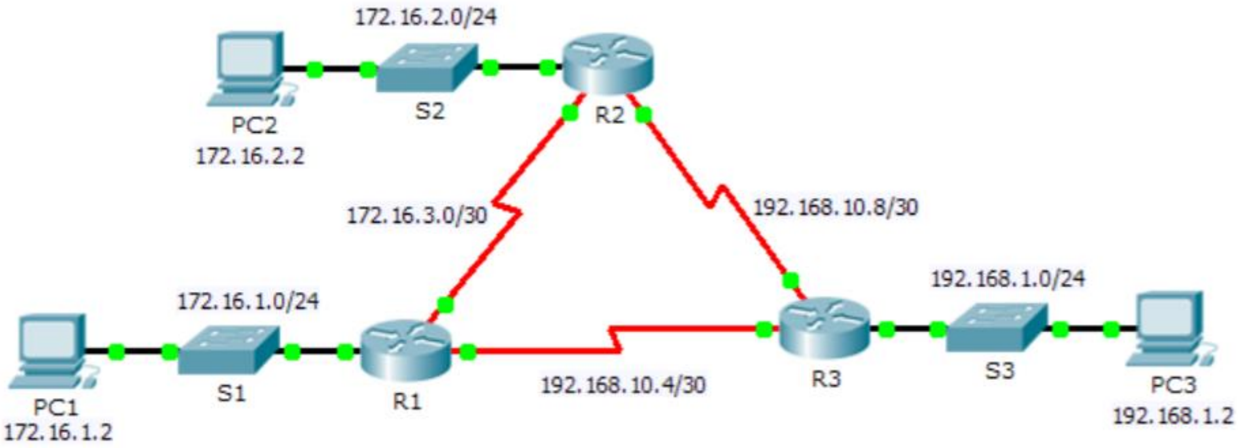
Packet Tracer – Configuring OSPFv2 in a Single Area

Topology



OSPF Metric = Cost

- OSPF uses the metric of cost to determine the best path used to reach a destination network (Cost = reference bandwidth / interface bandwidth)
- Lowest cost is a better path
- The interface bandwidth influences the cost assigned
  - A lower bandwidth interface has a higher cost

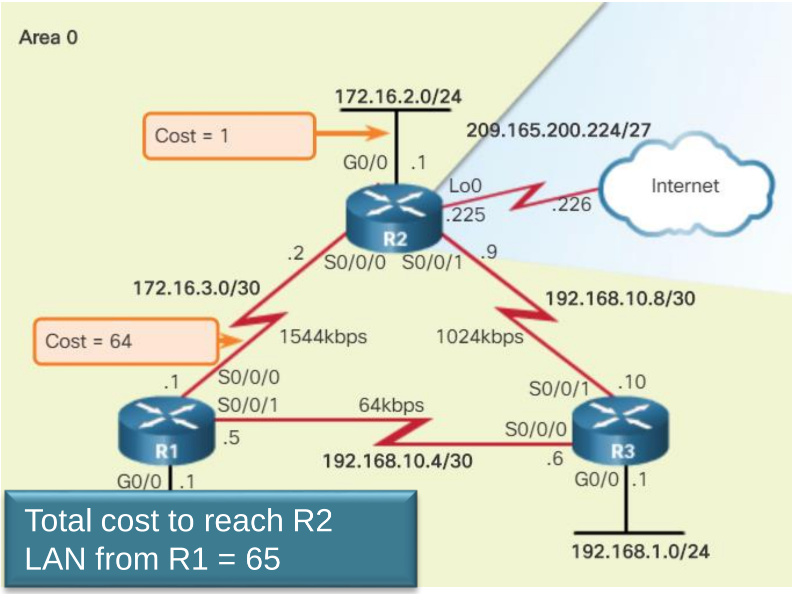
Important Concept!

Interface Type	Reference Bandwidth in bps		Default Bandwidth in bps	Cost
10 Gbps Ethernet	100,000,000	÷	10,000,000,000	1
1 Gbps Ethernet	100,000,000	÷	1,000,000,000	1
100 Mbps Ethernet	100,000,000	÷	100,000,000	1
10 Mbps Ethernet	100,000,000	÷	10,000,000	10
1.544 Mbps Serial	100,000,000	÷	1,544,000	64
128 kbps Serial	100,000,000	÷	128,000	781
64 kbps Serial	100,000,000	÷	64,000	1562

This is an issue because it is the same cost due to the default reference bandwidth. Needs to be adjusted!

OSPF Accumulates Costs

- The “cost” for a destination network is an accumulation of all cost values from source to destination.
- The cost metric can be seen in the routing table as the second number within the brackets.



Cost metric to destination network 172.16.2.0 from R1

```
R1# show ip route | include 172.16.2.0
O        172.16.2.0/24 [110/65] via 172.16.        39:07,
         Serial0/0/0
R1#
R1# show ip route 172.16.2.0
Routing entry for 172.16.2.0/24
  Known via "ospf 10", distance 110, metric 65, type intra
  area
  Last update from 172.16.3.2 on Serial0/0/0, 03:39:15 ago
  Routing Descriptor Blocks:
  * 172.16.3.2, from 2.2.2.2, 03:39:15 ago, via Serial0/0/0
      Route metric is 65, traffic share count is 1
R1#
```

Adjusting the Reference Bandwidth

- Changing the OSPF reference bandwidth affects only the OSPF calculation used to determine the metric, not the bandwidth of the interface.
- Use the **auto-cost reference-bandwidth** command to change the OSPF reference bandwidth.
- Default reference bandwidth is 100 Mbps.

Interface Type	Reference Bandwidth in bps		Default Bandwidth in bps	Cost
10 Gbps Ethernet	100,000,000	÷	10,000,000,000	1
1 Gbps Ethernet	100,000,000	÷	1,000,000,000	1
100 Mbps Ethernet	100,000,000	÷	100,000,000	1
10 Mbps Ethernet	100,000,000	÷	10,000,000	10
1.544 Mbps Serial	100,000,000	÷	1,544,000	64
128 kbps Serial	100,000,000	÷	128,000	781
64 kbps Serial	100,000,000	÷	64,000	1562

With the default reference bandwidth applied makes 100Mbps Ethernet, 1 Gbps Ethernet, and 10 Gbps Ethernet appear to be the same bandwidth within the best path calculations.

Adjusting the Reference Bandwidth (Cont.)

- To adjust to distinguish between 100 Mbps Ethernet and Gigabit Ethernet, use the **auto-cost reference-bandwidth 1000** command.
- To adjust to distinguish between 100 Mbps Ethernet and Gigabit Ethernet, use the **auto-cost reference-bandwidth 10000** command.

Interface Type	Reference Bandwidth in bps		Default Bandwidth in bps	Cost
10 Gbps Ethernet	1,000,000,000	÷	10,000,000,000	1
1 Gbps Ethernet	1,000,000,000	÷	1,000,000,000	1
100 Mbps Ethernet	1,000,000,000	÷	100,000,000	10
10 Mbps Ethernet	1,000,000,000	÷	10,000,000	100
1.544 Mbps Serial	1,000,000,000	÷	1,544,000	647
128 kbps Serial	1,000,000,000	÷	128,000	7812
64 kbps Serial	1,000,000,000	÷	64,000	15625

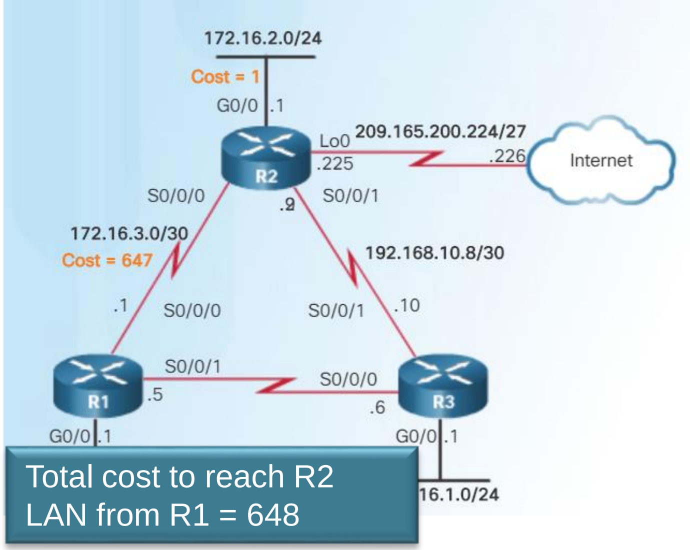
auto-cost reference-bandwidth 1000 command applied

Interface Type	Reference Bandwidth in bps		Default Bandwidth in bps	Cost
10 Gbps Ethernet	10,000,000,000	÷	10,000,000,000	1
1 Gbps Ethernet	10,000,000,000	÷	1,000,000,000	10
100 Mbps Ethernet	10,000,000,000	÷	100,000,000	100
10 Mbps Ethernet	10,000,000,000	÷	10,000,000	1000
1.544 Mbps Serial	110,000,000,000	÷	1,544,000	6477
128 kbps Serial	10,000,000,000	÷	128,000	78126
64 kbps Serial	10,000,000,000	÷	64,000	156250

auto-cost reference-bandwidth 10000 command applied

Adjusting the Reference Bandwidth (Cont.)

- If the routers in the topology are adjusted to accommodate Gigabit links, the cost of the serial link is now 647 instead of 64. The total cost from R1 to the R2 LAN is now 648 instead of 65.
- If there were FastEthernet links in the topology, OSPF would make better choices.



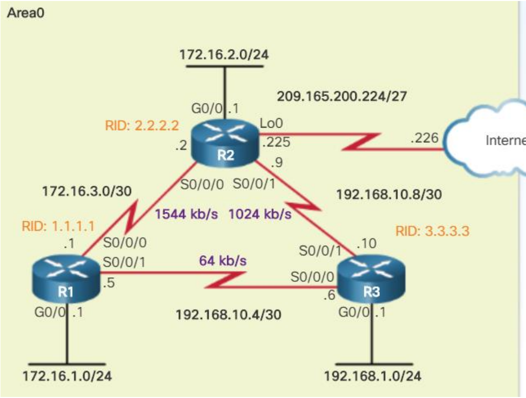
Total cost to reach R2 LAN from R1 = 648

```
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:647
 Topology-MTID    Cost    Disabled    Shutdown      Topology Name
       0           647       no          no            Base
```

```
R1# show ip route | include 172.16.2.0
O       172.16.2.0/24 [110/648] via 172.16.3.2, 00:06:03, Serial0/0/0
R1#
R1# show ip route 172.16.2.0
Routing entry for 172.16.2.0/24
  Known via "ospf 10", distance 110, metric 648, type intra area
  Last update from 172.16.3.2 on Serial0/0/0, 00:06:17 ago
  Routing Descriptor Blocks:
  * 172.16.3.2, from 2.2.2.2, 00:06:17 ago, via Serial0/0/0
      Route metric is 648, traffic share count is 1
```

Default Interface Bandwidth

- Bandwidth values defined on an interface do not change the capacity of the interface.
- Bandwidth values defined on an interface are used by the EIGRP and OSPF routing protocols to compute the metric.
- Serial links default to 1.544 Mbps and that might not be an accurate bandwidth for the transmission rate.
- Use the **show interfaces** command to see the interface bandwidth..



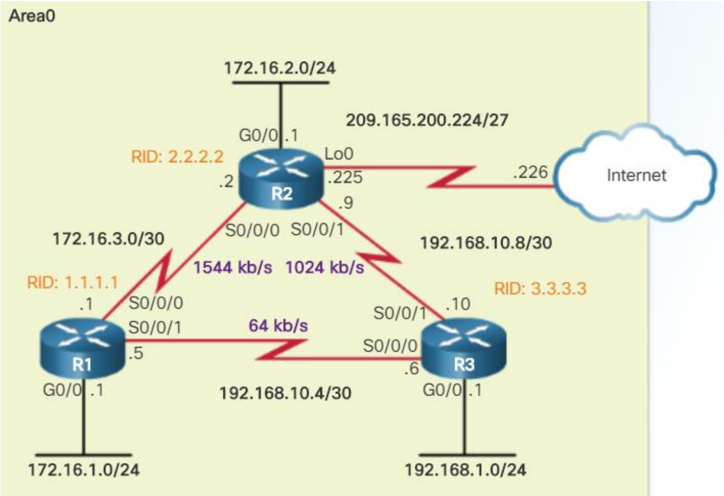

```
R1# show interfaces serial 0/0/0
Serial0/0/0 is up, line protocol is up
    Hardware is WIC MBRD Serial
    Description: Link to R2
    Internet address is 172.16.3.1/30
    MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
       reliability 255/255, txload 1/255, rxload 1/255
```

```
R1# show ip ospf interface serial 0/0/1
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
    Topology-MTID    Cost    Disabled    Shutdown    Topology Name
          0           647       no          no           Base
```

```
R1# show interfaces serial 0/0/1 | include BW
    MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
```

```
R1# show ip ospf interface serial 0/0/1 | include Cost:
     Process ID 10, Router ID 1.1.1.1, Network Type
POINT_TO_POINT, Cost: 647
```


Adjusting the Interface Bandwidth




```
R1(config)# int s0/0/1
R1(config-if)# bandwidth 64
R1(config-if)# end
R1#
*Mar 27 10:10:07.735: %SYS-5-CONFIG_I: Configured from console by c
R1#
R1#  show interfaces serial 0/0/1 | include BW
  MTU 1500 bytes, BW 64 Kbit/sec, DLY 20000 usec,
R1#
R1#  show ip ospf interface serial 0/0/1 | include Cost:
  Process ID 10, Router ID 1.1.1.1, Network Type
  POINT_TO_POINT, Cost: 15625
R1#
```

- The bandwidth must be adjusted at each end of the serial links, therefore:
  - R2 requires its S0/0/1 interface to be adjusted to 1,024 kb/s.
  - R3 requires its serial 0/0/0 to be adjusted to 64 kb/s and its serial 0/0/1 to be adjusted to 1,024 kb/s.
- Note: Command only modifies OSPF bandwidth metric. Does not modify the actual link bandwidth.

Manually Setting the OSPF Cost

- Instead of manually setting the interface bandwidth, the OSPF cost can be manually configured using the **ip ospf cost** *value* interface configuration mode command.

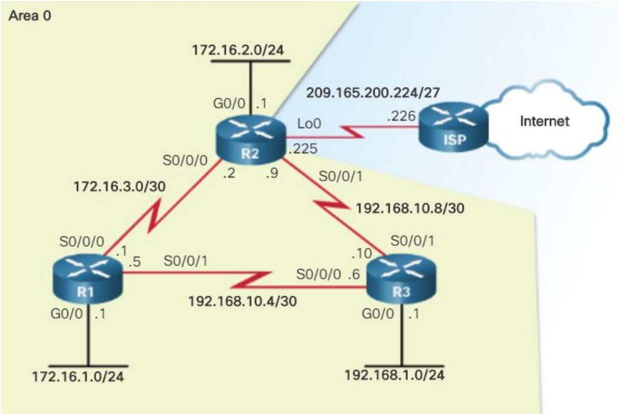
The **no bandwidth 64** is used to remove the command that was previously applied and reset the bandwidth back to the default.

```
R1(config)# int s0/0/1
R1(config-if)# no bandwidth 64
R1(config-if)# ip ospf cost 15625
R1(config-if)# end
R1#
R1# show interface serial 0/0/1 | include BW
    MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
R1#
R1# show ip ospf interface serial 0/0/1 | include Cost:
    Process ID 10, Router ID 1.1.1.1, Network Type POINT_TO_POINT,
    Cost: 15625
```

Adjusting the Interface Bandwidth		Manually Setting the OSPF Cost
R1(config)# **interface S0/0/1** R1(config-if)# **bandwidth 64**	=	R1(config)# **interface S0/0/1** R1(config-if)# **ip ospf cost 15625**
R2(config)# **interface S0/0/1** R2(config-if)# **bandwidth 1024**	=	R2(config)# **interface S0/0/1** R2(config-if)# **ip ospf cost 976**
R3(config)# **interface S0/0/0** R3(config-if)# **bandwidth 64**	=	R3(config)# **interface S0/0/0** R3(config-if)# **ip ospf cost 15625**
R3(config)# **interface S0/0/1** R3(config-if)# **bandwidth 1024**	=	R3(config)# **interface S0/0/1** R3(config-if)# **ip ospf cost 976**

Verify OSPF Neighbors

- Use the **show ip ospf neighbor** to verify the router has formed an adjacency with a directly-connected router.



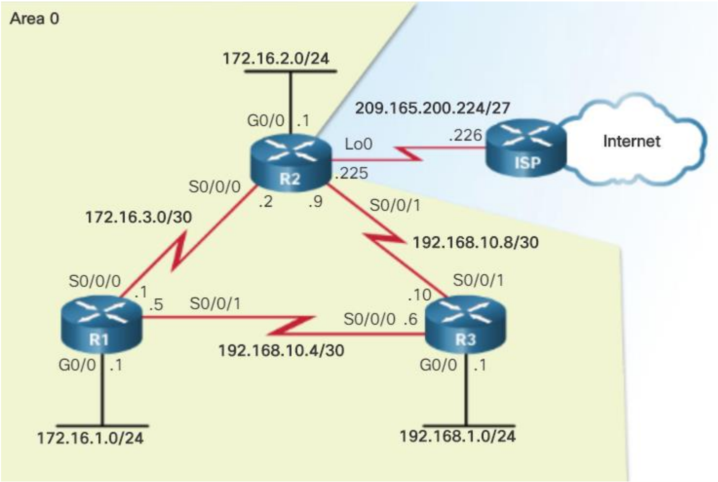

```
R1# show ip ospf neighbor

Neighbor ID  Pri State   Dead Time  Address       Interface
3.3.3.3       0  FULL/-  00:00:37   192.168.10.6  Serial0/0/1
2.2.2.2       0  FULL/-  00:00:30   172.16.3.2    Serial0/0/0
```

Output	Description
Neighbor ID	The router ID of the neighbor router
Pri	The OSPFv2 priority of the interface used in the DR/BDR election process
State	The OSPFv2 state – Full means that the link-state database has had the algorithm executed and the neighbor router and R1 have identical LSDBs. Ethernet multi-access interfaces may show as 2WAY. The dash indicates that no DR/BDR is required.
Dead time	Amount of time remaining before expecting to receive a hello packet from the neighbor before declaring the neighbor down. This value is reset when a hello packet is received.
Address	The address of the neighbor's directly-connected interface
Interface	The interface on R1 used to form an adjacency with the neighbor router

Verify OSPF Protocol Settings

- The **show ip protocols** command is used to verify the OSPFv2 process ID, router ID, networks being advertised by the router, neighbors that are sending OSPF updates, and the administrative distance (110 by default).




```
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
  Routing Information Sources:
    Gateway         Distance      Last Update
    2.2.2.2              110      00:17:18
    3.3.3.3              110      00:14:49
  Distance: (default is 110)
```

Verify OSPF Process Information

- The **show ip ospf** command is another way to see the OSPFv2 process ID and router ID.

```
R1# show ip ospf
Routing Process "ospf 10" with ID 1.1.1.1
Start time: 01:37:15.156, Time elapsed: 01:32:57.776
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Event-log enabled, Maximum number of events: 1000, Mode:
cyclic
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msecs
Minimum hold time between two consecutive SPFs 10000 msecs
Maximum wait time between two consecutive SPFs 10000 msecs
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
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 01:30:45.364 ago
       SPF algorithm executed 3 times
       Area ranges are
       Number of LSA 3. Checksum Sum 0x02033A
       Number of opaque link LSA 0. Checksum Sum 0x000000
       Number of DCbitless LSA 0
       Number of indication LSA 0
       Number of DoNotAge LSA 0
       Flood list length 0
```

Verify OSPF Interface Settings

- Use the **show ip ospf interface** command to see details for every OSPFv2-enabled interface especially to see if the network statements were correctly composed.
- Use the **show ip ospf interface brief** command to see key information about OSPFv2-enabled interfaces on a particular router.

```
R1# show ip ospf interface brief
Interface  PID  Area  IP Address/Mask  Cost  State  Nbrs F/C
Se0/0/1    10   0     192.168.10.5/30  15625 P2P    1/1
Se0/0/0    10   0     172.16.3.1/30    647   P2P    1/1
Gi0/0      10   0     172.16.1.1/24    1     DR     0/0
```

Lab - Configuring Basic Single-Area OSPFv2

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Topology