OSPF Capstone Project (Instructor Version)

Instructor Note: Red font color or Gray highlights indicate text that appears in the instructor copy only.

Objectives

- Configure basic OSPFv2 to enable internetwork communications in a small- to medium-sized IPv4 business network.
- Implement advanced OSPF features to enhance operation in a small- to medium-sized business network.
- Implement multiarea OSPF for IPv4 to enable internetwork communications in a small- to medium-sized business network.
- Configure basic OSPFv3 to enable internetwork communications in a small- to medium-sized IPv6 business network.

Instructor Notes:

- Students should be able to design, configure, and secure OSPF in a network.
- Documentation is a large factor of this project and students must be able to explain their network design and verification through the use of **`show`** commands.
- This activity is:
  - Best completed in groups of 2-3 students
  - Suggested to be a graded assignment after completing all of the OSPF Chapters

Scenario

Your company has made the decision to implement the OSPF routing protocol on its network. You have decided that you need to review the concepts related to OSPF in order to make a smooth transition to this protocol.

Create a network using Packet Tracer. Configure the network with these OSPF routing protocol options:

- Multiarea OSPFv2
- Single-area OSPFv3
- Bandwidth
- Cost
- Authentication
- Default routes
- DR and BDR elections for segments

Required Resources

- Packet Tracer
- Student/group-created rubric for assessment of the assignment

Step 1: Design and build a network from scratch.

a. Your design must include three routers connected to a multi-access network in area 0 for use with IPv4.

1) Enable authentication.

2) Establish the DR and BDR using the **`router id`** command.

Step 2: Add one additional router with two connections to area 0, representing another OSPF area.

Step 3: Configure the bandwidth or cost to favor one route.

Step 4: Add a network containing end devices and a passive OSPF interface.

Step 5: Add a route to a default network such as the Internet.

Step 6: Add an IPv6 addressing scheme on the routers and configure OSPFv3.

a. Enable IPv6 unicast routing.

b. Establish the DR and BDR using the **`router id`** command.

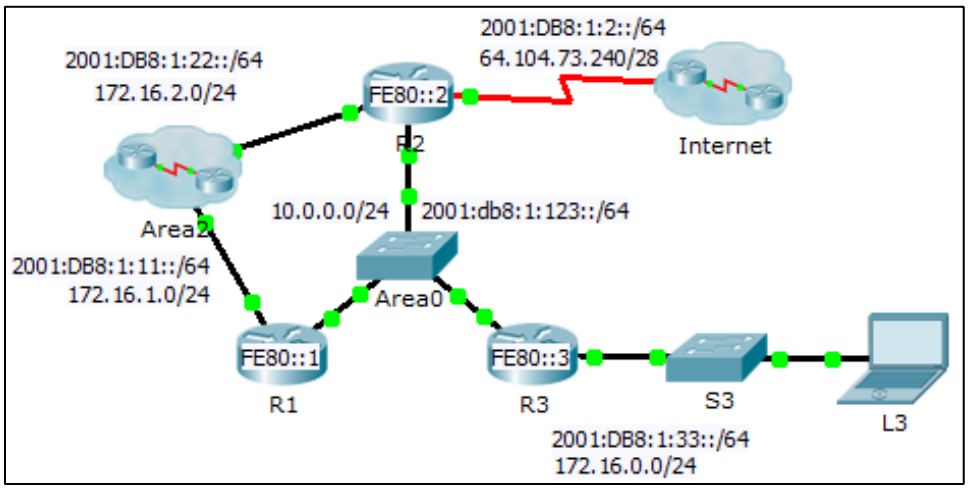
c. Do not configure timers, bandwidth, cost, default routes, or authentication.

Instructor-Sample Rubric

The example rubric includes a total of 100 points for the points earned category, if minimum standards are met. Instructors may wish to consider adding bonus points for additional/advanced work in any requirement category.

Requirement	Points Earned
Physical Topology • A minimum three routers are present in area 0. • One router exists in another area. • One Internet connection with one PC exists in the topology.	(10 suggested)
Logical Addressing and Connectivity • IPv4 and IPv6 networks should have full connectivity. Connectivity is verified with pings to every IP, including the Internet.	(20 suggested)
OSPF Requirement 1 • Two OSPFv2 areas exist. • Two OSPFv3 areas exist.	(20 suggested)
OSPF Requirement 2 • OSPF authentication and passive interfaces are used to secure the protocol.	(20 suggested)
OSPF Requirement 3 • Router IDs are used for the election of the DR and BDR.	(10 suggested)
OSPF Requirement 4 • The OSPF cost is changed to manipulate preferred routes.	(10 suggested)
OSPF Requirement 5 • Static routes and default information originate are used to reach the Internet.	(10 suggested)

Instructor Topology Example Solution



Suggested Addressing Table

Device	Interface	IPv4 Address	Subnet Mask	Default Gateway
		IPv6 Address/Prefix		Router ID
R1	G0/0	172.16.1.1	255.255.255.0	10.1.1.1
	G0/2	10.0.0.1	255.255.255.0	
	G0/0	2001:DB8:1:11::1/64		
	G0/2	2001:DB8:1:123::1/64		
	Link-local	FE80::1		
R2	G0/0	172.16.2.1	255.255.255.0	10.2.2.2
	G0/2	10.0.0.2	255.255.255.0	
	S0/0/0	64.104.73.242	255.255.255.240	
	G0/0	2001:DB8:1:22::1/64		
	G0/2	2001:DB8:1:123::2/64		
	S0/0/0	2001:DB8:1:2::1/64		
	Link-local	FE80::2		
R3	G0/0	172.16.0.1	255.255.255.0	10.3.3.3
	G0/2	10.0.0.2	255.255.255.0	
	G0/0	2001:DB8:1:33::1/64		
	G0/2	2001:DB8:1:123::3/64		
	Link-local	FE80::3		
A2	G0/0	172.16.2.2	255.255.255.0	2.2.2.2
	G0/2	172.16.1.2	255.255.255.0	
	G0/0	2001:DB8:1:22::2/64		
	G0/2	2001:DB8:1:11::2/64		
	Link-local	FE80::A		
L3	NIC	172.16.0.1	255.255.255.0	172.16.0.1
	NIC	2001:DB8:1:33::1/64		FE80::3

Device Configurations After Completion of the Activity

```
R1# show run
Building configuration...

Current configuration : 1291 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname R1
!
ipv6 unicast-routing
!
license udi pid CISCO2911/K9 sn FTX1524UZ5Y
!
spanning-tree mode pvst
!
interface GigabitEthernet0/0
 ip address 172.16.1.1 255.255.255.0
 ip ospf message-digest-key 1 md5 Area2
 duplex auto
 speed auto
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:1:11::1/64
 ipv6 ospf 1 area 2
!
interface GigabitEthernet0/1
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface GigabitEthernet0/2
 ip address 10.0.0.1 255.255.255.0
 ip ospf message-digest-key 1 md5 Area0
 duplex auto
 speed auto
 ipv6 address FE80::1 link-local
 ipv6 address 2001:DB8:1:123::1/64
 ipv6 ospf 1 area 0
!
interface Serial0/0/0
 no ip address
 shutdown
!
interface Serial0/0/1
 no ip address
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 1
 router-id 10.1.1.1
 log-adjacency-changes
 area 0 authentication message-digest
 area 2 authentication message-digest
 network 10.0.0.0 0.0.0.255 area 0
 network 172.16.1.0 0.0.0.255 area 2
```

```
!
ipv6 router ospf 1
 router-id 10.1.1.1
 log-adjacency-changes
!
ip classless
!
line con 0
!
line aux 0
!
line vty 0 4
 login
!
end

R2# show run
Building configuration...

Current configuration : 1494 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname R2
!
ipv6 unicast-routing
!
license udi pid CISCO2911/K9 sn FTX1524GRRS
!
spanning-tree mode pvst
!
interface GigabitEthernet0/0
 ip address 172.16.2.1 255.255.255.0
 ip ospf message-digest-key 1 md5 Area2
 duplex auto
 speed auto
 ipv6 address FE80::2 link-local
 ipv6 address 2001:DB8:1:22::1/64
 ipv6 ospf 1 area 2
!
interface GigabitEthernet0/1
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface GigabitEthernet0/2
 ip address 10.0.0.2 255.255.255.0
 ip ospf message-digest-key 1 md5 Area0
 duplex auto
 speed auto
 ipv6 address FE80::2 link-local
 ipv6 address 2001:DB8:1:123::2/64
 ipv6 ospf 1 area 0
!
interface Serial0/0/0
 ip address 64.104.73.242 255.255.255.240
 ipv6 address FE80::2 link-local
 ipv6 address 2001:DB8:1:2::1/64
 ipv6 ospf 1 area 0
```

```
!
interface Serial0/0/1
 no ip address
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 1
 router-id 10.2.2.2
 log-adjacency-changes
 area 0 authentication message-digest
 area 2 authentication message-digest
 passive-interface Serial0/0/0
 network 10.0.0.0 0.0.0.255 area 0
 network 172.16.2.0 0.0.0.255 area 2
 default-information originate
!
ipv6 router ospf 1
 router-id 10.2.2.2
 log-adjacency-changes
!
ip classless
ip route 0.0.0.0 0.0.0.0 Serial0/0/0
!
line con 0
!
line aux 0
!
line vty 0 4
 login
!
end

R3# show run
Building configuration...

Current configuration : 1291 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname R3
!
ipv6 unicast-routing
!
license udi pid CISCO2911/K9 sn FTX15247W10
!
spanning-tree mode pvst
!
interface GigabitEthernet0/0
 ip address 172.16.0.1 255.255.255.0
 ip ospf message-digest-key 1 md5 Area0
 duplex auto
 speed auto
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:1:33::1/64
 ipv6 ospf 1 area 0
!
interface GigabitEthernet0/1
```

```
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface GigabitEthernet0/2
 ip address 10.0.0.3 255.255.255.0
 ip ospf message-digest-key 1 md5 Area0
 duplex auto
 speed auto
 ipv6 address FE80::3 link-local
 ipv6 address 2001:DB8:1:123::3/64
 ipv6 ospf 1 area 0
!
interface Serial0/0/0
 no ip address
 shutdown
!
interface Serial0/0/1
 no ip address
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 1
 router-id 10.3.3.3
 log-adjacency-changes
 area 0 authentication message-digest
 passive-interface GigabitEthernet0/0
 network 10.0.0.0 0.0.0.255 area 0
 network 172.16.0.0 0.0.0.255 area 0
!
ipv6 router ospf 1
 router-id 10.3.3.3
 log-adjacency-changes
!
ip classless
!
line con 0
!
line aux 0
!
line vty 0 4
 login
!
end

A2# show run
Building configuration...

Current configuration : 1157 bytes
!
version 15.1
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname A2
!
ipv6 unicast-routing
!
```

```
license udi pid CISCO2911/K9 sn FTX1524DVBW
!
spanning-tree mode pvst
!
interface GigabitEthernet0/0
 ip address 172.16.2.2 255.255.255.0
 ip ospf message-digest-key 1 md5 Area2
 ip ospf cost 2000
 duplex auto
 speed auto
 ipv6 address FE80::A link-local
 ipv6 address 2001:DB8:1:22::2/64
 ipv6 ospf 1 area 2
!
interface GigabitEthernet0/1
 ip address 172.16.1.2 255.255.255.0
 ip ospf message-digest-key 1 md5 Area2
 ip ospf cost 1000
 duplex auto
 speed auto
 ipv6 address FE80::A link-local
 ipv6 address 2001:DB8:1:11::2/64
 ipv6 ospf 1 area 2
!
interface GigabitEthernet0/2
 no ip address
 duplex auto
 speed auto
 shutdown
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 1
 router-id 2.2.2.2
 log-adjacency-changes
 area 2 authentication message-digest
 network 172.16.2.0 0.0.0.255 area 2
!
ipv6 router ospf 1
 router-id 2.2.2.2
 log-adjacency-changes
!
ip classless
!
line con 0
!
line aux 0
!
line vty 0 4
 login
!
End
```

Show IP Route

```
R1>en
R1# show ip route
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, E - EGP
```

```
        i - IS-IS, 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

Gateway of last resort is 10.0.0.2 to network 0.0.0.0

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.0.0.0/24 is directly connected, GigabitEthernet0/2
L       10.0.0.1/32 is directly connected, GigabitEthernet0/2
     172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
O       172.16.0.0/24 [110/2] via 10.0.0.3, 00:02:18, GigabitEthernet0/2
C       172.16.1.0/24 is directly connected, GigabitEthernet0/0
L       172.16.1.1/32 is directly connected, GigabitEthernet0/0
O IA    172.16.2.0/24 [110/2] via 10.0.0.2, 00:02:18, GigabitEthernet0/2
O*E2 0.0.0.0/0 [110/1] via 10.0.0.2, 00:02:18, GigabitEthernet0/2
```

Show IP Protocols

```
R1# show ip protocols

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 10.1.1.1
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.0.0.0 0.0.0.255 area 0
    172.16.1.0 0.0.0.255 area 2
  Routing Information Sources:
    Gateway         Distance      Last Update
    10.1.1.1             110      00:08:18
    10.2.2.2             110      00:07:29
    10.3.3.3             110      00:07:38
  Distance: (default is 110)
```

Show IP OSPF Neighbor

```
R1# show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.3.3.3          1   FULL/DR         00:00:33    10.0.0.3        GigabitEthernet0/2
10.2.2.2          1   FULL/BDR        00:00:33    10.0.0.2        GigabitEthernet0/2
```

Show IP Interface Brief

```
R1# show ip int brief
Interface              IP-Address      OK? Method Status                Protocol

GigabitEthernet0/0     172.16.1.1      YES manual up                    up

GigabitEthernet0/1     unassigned      YES unset  administratively down down

GigabitEthernet0/2     10.0.0.1        YES manual up                    up

Serial0/0/0            unassigned      YES unset  administratively down down

Serial0/0/1            unassigned      YES unset  administratively down down

Vlan1                  unassigned      YES unset  administratively down down
```