OSPF Capstone Project (Instructor Version)

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

1. 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:
	1. Best completed in groups of 2-3 students
	2. Suggested to be a graded assignment after completing all of the OSPF Chapters
1. 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
1. Required Resources
* Packet Tracer
* Student/group-created rubric for assessment of the assignment
	1. Design and build a network from scratch.
		1. 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.
	2. Add one additional router with two connections to area 0, representing another OSPF area.
	3. Configure the bandwidth or cost to favor one route.
	4. Add a network containing end devices and a passive OSPF interface.
	5. Add a route to a default network such as the Internet.
	6. Add an IPv6 addressing scheme on the routers and configure OSPFv3.
		1. Enable IPv6 unicast routing.
		2. Establish the DR and BDR using the **router id** command.
		3. Do not configure timers, bandwidth, cost, default routes, or authentication.

Instructor-Sample Rubric

|  |  |
| --- | --- |
| 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) |

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.

1. Instructor Topology Example Solution



1. 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 |

1. 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

1. 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

1. 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)

1. 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

1. 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