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Advanced Cisco CCNP Networking

Basic OSPF Configuration

Lab 1

Purpose
The first purpose of this lab was to review the implementation and concept of OSPF. The second function of this lab was to gain experience using the equipment in the CCNP lab.

Background Information on Lab Concepts
OSPF (Open Shortest Path First) is a routing protocol (for IPV4 and IPV6) used to distribute traffic in a network. Notably, OSPF is a link-state protocol. This means OSPF has full awareness of the topology of its network by sending position requests (or LSA's) to each router on the network. It essentially has a picture of all the devices in the area, allowing it to find the shortest path to route traffic. The method OSPF uses to find the shortest path between links is called Dijkstra's Algorithm. Dijkstra's Algorithm is generally used to find the shortest path between two points, and it is frequently utilized in GPS apps such as Google Maps. To understand how OSPF uses Dijkstra's Algorithm, imagine you are in a large maze and must deliver envelopes to mailboxes scattered throughout the maze. While walking through the maze, you discover a mailbox, and deliver your first envelope. Eventually, after an extended period of time, you find all of the mailboxes and deliver all of your envelopes. When you are given a new set of envelopes to deliver, you enter the maze again, but this time you remember the position of the mailboxes from your last time entering the maze. Since you remember the mailbox positions, you can deliver the envelopes faster. Eventually, after multiple series of delivering the envelopes, you have learned the layout of the mailboxes and maze. Therefore, you can efficiently deliver the envelopes. OSPF works the same way. Instead of delivering envelopes to mailboxes, OSPF delivers packets to routers. Overtime, it learns the topology (or maze) of the network and finds the shortest path between routers using Dijkstra's Algorithm. By having a full picture of the network and knowing the shortest path between routers, OSPF can quickly route traffic. However, where OSPF can come short is the processing power it requires. Running Dijkstra's Algorithm as well as storing the topology of the network (especially in large networks) can require increased CPU usage.

Lab Summary
Before setting up the lab, my team familiarized ourselves on the configuration of OSPF. We noted new commands that would be required to setup OSPF. Afterwards, we started by setting up our topology in packet tracer (a networking simulation application). Our next step was to subnet the required networks and assign IPV4 addresses to each interface. We then created a document including all the commands and IP addresses needed for setting up OSPF. We tested and debugged this configuration in packet tracer. Once the simulated configuration functioned correctly, we applied it to the equipment in the CCNP lab. We encountered some issues, which are covered later in the problem section of this document. After these problems were resolved, we tested the network by pinging each interface and reviewing the IP routes, and we found everything was configured properly.

Lab Commands
`Router> **enable**`
Turns on privileged exec mode which allows changes to be made to the router.

`Router# **config t**`
Enters the router config file and allows you to make changes to the router configuration file.

`Router# **copy run start**`
Saves the running-configuration (current config on the router, includes the edits you have made during the session, clears when the router powers off) to the startup-configuration (file that router pulls running-config from on bootup, default config).

`Router# show **ip route**`
Displays information about the various routes that are available to the router, including the protocol by which the route was acquired (OSPF, RIP, EGRIP, static, etc.)

`Router# show` **`ip ospf`**
Displays general information about all OSPF instances and roles on the router.

`Router# show` **`ip ospf interface`**
Displays the OSPF status of all OSPF-enabled interfaces on the router.

`Router# show` **`ip route`**
Displays information about the various routes that are available to the router, including the protocol by which the route was acquired (OSPF, RIP, EGRIP, static, etc.)

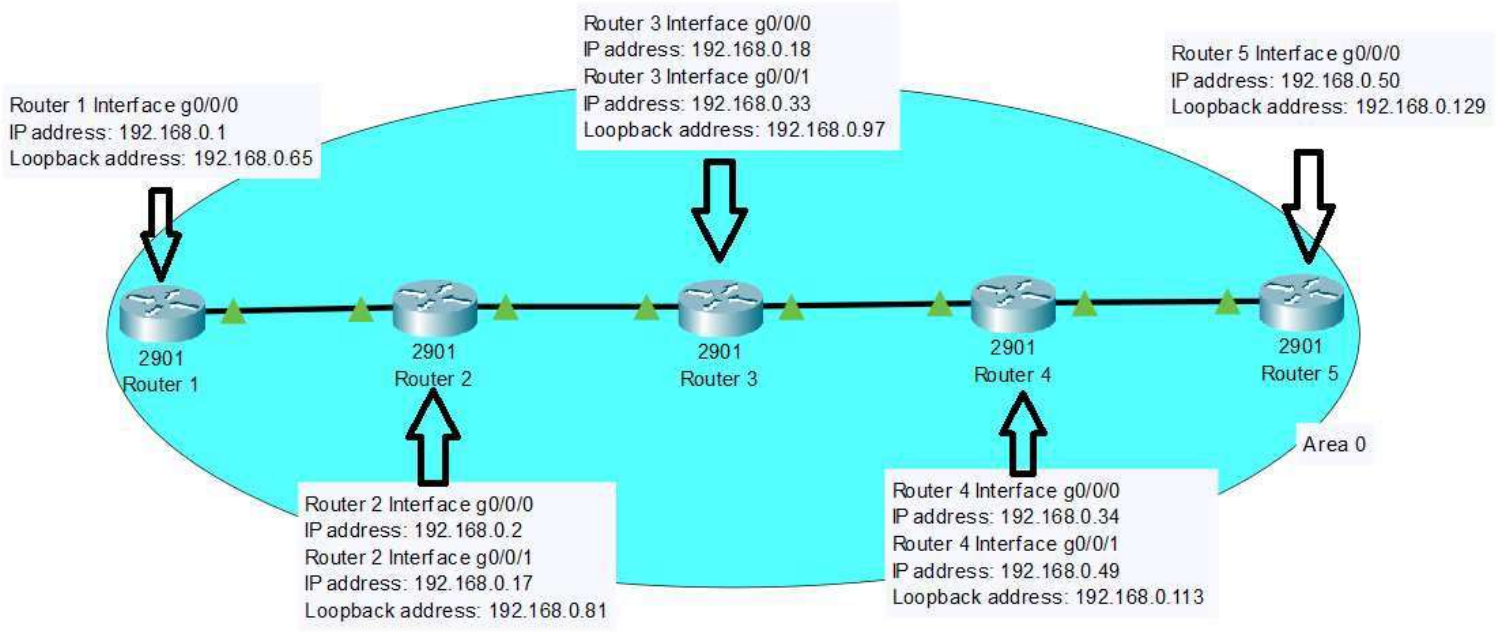
`Router# show` **`ip ospf neighbor`**
Displays the OSPF status of routers that are directly connected and OSPF-enabled.

`Router(config)#` **`interface [`*`interface`*`] [`*`id`*`]`**
Enables configuration on a specific interface.

`Router(config)#` **`router ospf [`*`process id`*`]`**
Enables the OSPF routing protocol and enters router configuration mode.
It is good practice for the process ID to be the same, however isn't necessary for OSPF to form adjacencies; process ID is only locally significant. Each OSPF process retains a different routing table, so depending on the configuration, process ID could determine what routes are redistributed. A router can have multiple OSPF processes but will contain a separate OSPF database per process.

`Router(config-router)#` **`network [`*`network address`*`] [`*`wildcard mask`*`] area [`*`area number`*`]`**
Activates OSPFv2 for a specific subnet.
This command is typed after you enter router OSPF configuration mode. Routers in a particular area share a complete topological database and have route summaries of external areas.

Network Diagram with IP's



Configurations

Router 1:

```
R1#show run:
Building configuration...
Current configuration : 1850 bytes
Last configuration change at 17:51:00 UTC
Thu Sep 9 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-
core
hostname R1
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO21482DXE
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface Loopback0
ip address 192.168.0.65 255.255.255.240
interface GigabitEthernet0/0/0
ip address 192.168.0.1 255.255.255.240
negotiation auto
interface GigabitEthernet0/0/1
no ip address
shutdown
negotiation auto
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0/2/0
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
```

```
shutdown
router ospf 1
network 192.168.0.0 0.0.0.15 area 0
network 192.168.0.16 0.0.0.15 area 0
network 192.168.0.32 0.0.0.15 area 0
network 192.168.0.48 0.0.0.15 area 0
network 192.168.0.64 0.0.0.15 area 0
network 192.168.0.80 0.0.0.15 area 0
network 192.168.0.96 0.0.0.15 area 0
network 192.168.0.112 0.0.0.15 area 0
network 192.168.0.128 0.0.0.15 area 0
ip forward-protocol nd
```

```
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

```
R1#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.0.81      1   FULL/DR         00:00:35    192.168.0.2     GigabitEthernet0/0/0
```

```
R1#show ip ospf
Routing Process "ospf 1" with ID 192.168.0.65
Start time: 00:10:16.387, Time elapsed: 00:26:13.307
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
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
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
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 100 mbps
    Area BACKBONE(0)
        Number of interfaces in this area is 2 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:05:36.244 ago
        SPF algorithm executed 1 times
        Area ranges are
        Number of LSA 9. Checksum Sum 0x03B402
        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

R1#show ip  ospf  interface
Loopback0 is up, line protocol is up
  Internet Address 192.168.0.65/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.65, Network Type LOOPBACK, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 192.168.0.1/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.65, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.0.81, Interface address 192.168.0.2
  Backup Designated router (ID) 192.168.0.65, Interface address 192.168.0.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, 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 1/1/1, flood queue length 0
  Next 0x0(0)/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 192.168.0.81  (Designated Router)
  Suppress hello for 0 neighbor(s)

R1#show ip ospf border-routers
            OSPF Router with ID (192.168.0.65) (Process ID 1)
                Base Topology (MTID 0)
Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

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
       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
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

      192.168.0.0/24 is variably subnetted, 11 subnets, 2 masks
C        192.168.0.0/28 is directly connected, GigabitEthernet0/0/0
L        192.168.0.1/32 is directly connected, GigabitEthernet0/0/0
O  192.168.0.16/28
           [110/2] via 192.168.0.2, 00:09:14, GigabitEthernet0/0/0
O        192.168.0.32/28
           [110/3] via 192.168.0.2, 00:09:14, GigabitEthernet0/0/0
O        192.168.0.48/28
           [110/4] via 192.168.0.2, 00:09:14, GigabitEthernet0/0/0
```

```
C        192.168.0.64/28 is directly connected, Loopback0
L        192.168.0.65/32 is directly connected, Loopback0
O  192.168.0.81/32
             [110/2] via 192.168.0.2, 00:09:14, GigabitEthernet0/0/0
O        192.168.0.97/32
             [110/3] via 192.168.0.2, 00:09:14, GigabitEthernet0/0/0
O        192.168.0.113/32
             [110/4] via 192.168.0.2, 00:09:14, GigabitEthernet0/0/0
O        192.168.0.129/32
             [110/5] via 192.168.0.2, 00:09:14, GigabitEthernet0/0/0
```

Router 2:

```
R2#show run
Building configuration...
Current configuration : 1866 bytes
Last configuration change at 17:38:14 UTC
Thu Sep 9 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-
core
hostname R2
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO21500G1N
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface Loopback0
ip address 192.168.0.81 255.255.255.240
interface GigabitEthernet0/0/0
ip address 192.168.0.2 255.255.255.240
negotiation auto
interface GigabitEthernet0/0/1
ip address 192.168.0.17 255.255.255.240
negotiation auto
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0/2/0
no ip address
shutdown
negotiation auto
interface GigabitEthernet0/2/1
no ip address
shutdown
negotiation auto
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
shutdown
router ospf 1
network 192.168.0.0 0.0.0.15 area 0
network 192.168.0.16 0.0.0.15 area 0
network 192.168.0.32 0.0.0.15 area 0
network 192.168.0.48 0.0.0.15 area 0
network 192.168.0.64 0.0.0.15 area 0
network 192.168.0.80 0.0.0.15 area 0
network 192.168.0.96 0.0.0.15 area 0
network 192.168.0.112 0.0.0.15 area 0
network 192.168.0.128 0.0.0.15 area 0
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

```
R2#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.0.97      1   FULL/DR         00:00:37    192.168.0.18    GigabitEthernet0/0/1
192.168.0.65      1   FULL/BDR        00:00:38    192.168.0.1     GigabitEthernet0/0/0
```

```
R2#show ip ospf
```

```
Routing Process "ospf 1" with ID 192.168.0.81
Start time: 00:18:55.769, Time elapsed: 00:31:43.284
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
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
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
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 100 mbps
    Area BACKBONE(0)
        Number of interfaces in this area is 3 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:21:15.328 ago
        SPF algorithm executed 16 times
        Area ranges are
        Number of LSA 9. Checksum Sum 0x03B402
        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

R2#show ip  ospf  interface
Loopback0 is up, line protocol is up
  Internet Address 192.168.0.81/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.81, Network Type LOOPBACK, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
  Internet Address 192.168.0.17/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.81, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.0.97, Interface address 192.168.0.18
  Backup Designated router (ID) 192.168.0.81, Interface address 192.168.0.17
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```

```
    oob-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 1/2/2, flood queue length 0
  Next 0x0(0)/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 192.168.0.97  (Designated Router)
  Suppress hello for 0 neighbor(s)
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 192.168.0.2/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.81, 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) 192.168.0.81, Interface address 192.168.0.2
  Backup Designated router (ID) 192.168.0.65, Interface address 192.168.0.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.0.65  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)

R2#show ip ospf border-routers
            OSPF Router with ID (192.168.0.81) (Process ID 1)


                Base Topology (MTID 0)

Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

R2#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
       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
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

      192.168.0.0/24 is variably subnetted, 12 subnets, 2 masks
C        192.168.0.0/28 is directly connected, GigabitEthernet0/0/0
L        192.168.0.2/32 is directly connected, GigabitEthernet0/0/0
```

```
C        192.168.0.16/28 is directly connected, GigabitEthernet0/0/1
L        192.168.0.17/32 is directly connected, GigabitEthernet0/0/1
O  192.168.0.32/28
           [110/2] via 192.168.0.18, 00:30:07, GigabitEthernet0/0/1
O        192.168.0.48/28
           [110/3] via 192.168.0.18, 00:29:25, GigabitEthernet0/0/1
O        192.168.0.65/32
           [110/2] via 192.168.0.1, 00:23:30, GigabitEthernet0/0/0
C        192.168.0.80/28 is directly connected, Loopback0
L        192.168.0.81/32 is directly connected, Loopback0
O        192.168.0.97/32
           [110/2] via 192.168.0.18, 00:24:24, GigabitEthernet0/0/1
O        192.168.0.113/32
           [110/3] via 192.168.0.18, 00:24:11, GigabitEthernet0/0/1
O        192.168.0.129/32
           [110/4] via 192.168.0.18, 00:23:58, GigabitEthernet0/0/1
```

Router 3:

```
R3#show run
Building configuration...
Current configuration : 1715 bytes
Last configuration change at 17:46:53 UTC
Thu Sep 9 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-
core
hostname R3
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO21441WDF
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface Loopback0
ip address 192.168.0.97 255.255.255.240
interface GigabitEthernet0/0/0
ip address 192.168.0.18 255.255.255.240
negotiation auto
interface GigabitEthernet0/0/1
ip address 192.168.0.33 255.255.255.240
negotiation auto
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
shutdown
router ospf 1
network 192.168.0.0 0.0.0.15 area 0
network 192.168.0.16 0.0.0.15 area 0
network 192.168.0.32 0.0.0.15 area 0
network 192.168.0.48 0.0.0.15 area 0
network 192.168.0.64 0.0.0.15 area 0
network 192.168.0.80 0.0.0.15 area 0
network 192.168.0.96 0.0.0.15 area 0
network 192.168.0.112 0.0.0.15 area 0
network 192.168.0.128 0.0.0.15 area 0
!
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

```
R3#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.0.113     1   FULL/DR         00:00:30    192.168.0.34    GigabitEthernet0/0/1
```

```
192.168.0.81      1   FULL/BDR        00:00:39    192.168.0.17    GigabitEthernet0/0/0

R3#show ip ospf
Routing Process "ospf 1" with ID 192.168.0.97
Start time: 00:18:58.990, Time elapsed: 00:37:38.181
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
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
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
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 100 mbps
    Area BACKBONE(0)
        Number of interfaces in this area is 3 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:28:40.980 ago
        SPF algorithm executed 14 times
        Area ranges are
        Number of LSA 9. Checksum Sum 0x03AC06
        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


R3#show ip  ospf  interface
Loopback0 is up, line protocol is up
  Internet Address 192.168.0.97/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.97, Network Type LOOPBACK, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
  Internet Address 192.168.0.33/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.97, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
```

```
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.0.113, Interface address 192.168.0.34
  Backup Designated router (ID) 192.168.0.97, Interface address 192.168.0.33
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/2/2, flood queue length 0
  Next 0x0(0)/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 192.168.0.113  (Designated Router)
  Suppress hello for 0 neighbor(s)
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 192.168.0.18/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.97, 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) 192.168.0.97, Interface address 192.168.0.18
  Backup Designated router (ID) 192.168.0.81, Interface address 192.168.0.17
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 3
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.0.81  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)

R3#show ip ospf border-routers
 OSPF Router with ID (192.168.0.97) (Process ID 1)
                Base Topology (MTID 0)
Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

R3#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
       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
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
Gateway of last resort is not set
      192.168.0.0/24 is variably subnetted, 12 subnets, 2 masks
O        192.168.0.0/28
           [110/2] via 192.168.0.17, 00:38:31, GigabitEthernet0/0/0
C        192.168.0.16/28 is directly connected, GigabitEthernet0/0/0
```

```
L        192.168.0.18/32 is directly connected, GigabitEthernet0/0/0
C        192.168.0.32/28 is directly connected, GigabitEthernet0/0/1
L        192.168.0.33/32 is directly connected, GigabitEthernet0/0/1
O        192.168.0.48/28
           [110/2] via 192.168.0.34, 00:36:50, GigabitEthernet0/0/1
O        192.168.0.65/32
           [110/3] via 192.168.0.17, 00:30:55, GigabitEthernet0/0/0
O        192.168.0.81/32
           [110/2] via 192.168.0.17, 00:31:08, GigabitEthernet0/0/0
C        192.168.0.96/28 is directly connected, Loopback0
L        192.168.0.97/32 is directly connected, Loopback0
O        192.168.0.113/32
           [110/2] via 192.168.0.34, 00:31:36, GigabitEthernet0/0/1
O        192.168.0.129/32
           [110/3] via 192.168.0.34, 00:31:23, GigabitEthernet0/0/1
```

Router 4:

```
R4#show run
Building configuration...
Current configuration : 1716 bytes
Last configuration change at 17:40:03 UTC
Thu Sep 9 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-
core
hostname R4
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO215009QY
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface Loopback0
ip address 192.168.0.113 255.255.255.240
interface GigabitEthernet0/0/0
ip address 192.168.0.34 255.255.255.240
negotiation auto
interface GigabitEthernet0/0/1
ip address 192.168.0.49 255.255.255.240
negotiation auto
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
shutdown
router ospf 1
network 192.168.0.0 0.0.0.15 area 0
network 192.168.0.16 0.0.0.15 area 0
network 192.168.0.32 0.0.0.15 area 0
network 192.168.0.48 0.0.0.15 area 0
network 192.168.0.64 0.0.0.15 area 0
network 192.168.0.80 0.0.0.15 area 0
network 192.168.0.96 0.0.0.15 area 0
network 192.168.0.112 0.0.0.15 area 0
network 192.168.0.128 0.0.0.15 area 0
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

```
R4#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.0.129     1   FULL/DR         00:00:32    192.168.0.50    GigabitEthernet0/0/1
192.168.0.97      1   FULL/BDR        00:00:34    192.168.0.33    GigabitEthernet0/0/0
```

```
R4#show ip ospf
```

```
Routing Process "ospf 1" with ID 192.168.0.113
Start time: 00:18:55.086, Time elapsed: 00:43:19.564
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
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
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
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 100 mbps
    Area BACKBONE(0)
        Number of interfaces in this area is 3 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:35:21.707 ago
        SPF algorithm executed 11 times
        Area ranges are
        Number of LSA 9. Checksum Sum 0x03A20B
        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

R4#show ip  ospf  interface
Loopback0 is up, line protocol is up
  Internet Address 192.168.0.113/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.113, Network Type LOOPBACK, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/1 is up, line protocol is up
  Internet Address 192.168.0.49/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.113, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State BDR, Priority 1
  Designated Router (ID) 192.168.0.129, Interface address 192.168.0.50
  Backup Designated router (ID) 192.168.0.113, Interface address 192.168.0.49
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
```

```
    oob-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 1/2/2, flood queue length 0
  Next 0x0(0)/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 192.168.0.129  (Designated Router)
  Suppress hello for 0 neighbor(s)
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 192.168.0.34/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.113, 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) 192.168.0.113, Interface address 192.168.0.34
  Backup Designated router (ID) 192.168.0.97, Interface address 192.168.0.33
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-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 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 2
  Last flood scan time is 0 msec, maximum is 1 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.0.97  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)

R4#show ip ospf border-routers
OSPF Router with ID (192.168.0.113) (Process ID 1)
             Base Topology (MTID 0)
Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

R4#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
       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
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
Gateway of last resort is not set
      192.168.0.0/24 is variably subnetted, 12 subnets, 2 masks
O        192.168.0.0/28
           [110/3] via 192.168.0.33, 00:44:10, GigabitEthernet0/0/0
O        192.168.0.16/28
           [110/2] via 192.168.0.33, 00:44:10, GigabitEthernet0/0/0
C        192.168.0.32/28 is directly connected, GigabitEthernet0/0/0
L        192.168.0.34/32 is directly connected, GigabitEthernet0/0/0
C        192.168.0.48/28 is directly connected, GigabitEthernet0/0/1
```

```
L        192.168.0.49/32 is directly connected, GigabitEthernet0/0/1
O        192.168.0.65/32
           [110/4] via 192.168.0.33, 00:37:31, GigabitEthernet0/0/0
O        192.168.0.81/32
           [110/3] via 192.168.0.33, 00:37:44, GigabitEthernet0/0/0
O        192.168.0.97/32
           [110/2] via 192.168.0.33, 00:38:25, GigabitEthernet0/0/0
C        192.168.0.112/28 is directly connected, Loopback0
L        192.168.0.113/32 is directly connected, Loopback0
O        192.168.0.129/32
           [110/2] via 192.168.0.50, 00:37:59, GigabitEthernet0/0/1
```

Router 5:

```
R5#show run
Building configuration...
Current configuration : 1700 bytes
Last configuration change at 17:46:56 UTC
Thu Sep 9 2021
version 15.5
service timestamps debug datetime msec
service timestamps log datetime msec
no platform punt-keepalive disable-kernel-
core
hostname R5
boot-start-marker
boot-end-marker
vrf definition Mgmt-intf
address-family ipv4
exit-address-family
address-family ipv6
exit-address-family
no aaa new-model
subscriber templating
multilink bundle-name authenticated
license udi pid ISR4321/K9 sn FDO214420HM
spanning-tree extend system-id
redundancy
mode none
vlan internal allocation policy ascending
interface Loopback0
ip address 192.168.0.129 255.255.255.240
interface GigabitEthernet0/0/0
ip address 192.168.0.50 255.255.255.240
negotiation auto
interface GigabitEthernet0/0/1
no ip address
shutdown
negotiation auto
interface Serial0/1/0
no ip address
shutdown
interface Serial0/1/1
no ip address
shutdown
interface GigabitEthernet0
vrf forwarding Mgmt-intf
no ip address
shutdown
negotiation auto
interface Vlan1
no ip address
shutdown
router ospf 1
network 192.168.0.0 0.0.0.15 area 0
network 192.168.0.16 0.0.0.15 area 0
network 192.168.0.32 0.0.0.15 area 0
network 192.168.0.48 0.0.0.15 area 0
network 192.168.0.64 0.0.0.15 area 0
network 192.168.0.80 0.0.0.15 area 0
network 192.168.0.96 0.0.0.15 area 0
network 192.168.0.112 0.0.0.15 area 0
network 192.168.0.128 0.0.0.15 area 0
ip forward-protocol nd
no ip http server
no ip http secure-server
ip tftp source-interface GigabitEthernet0
control-plane
line con 0
stopbits 1
line aux 0
stopbits 1
line vty 0 4
login
end
```

```
R5#show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.0.113     1   FULL/BDR        00:00:36    192.168.0.49    GigabitEthernet0/0/0
R5#show ip ospf
Routing Process "ospf 1" with ID 192.168.0.129
Start time: 00:18:39.892, Time elapsed: 00:48:23.760
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
```

```
Supports area transit capability
Supports NSSA (compatible with RFC 3101)
Supports Database Exchange Summary List Optimization (RFC 5243)
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
EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
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 100 mbps
    Area BACKBONE(0)
        Number of interfaces in this area is 2 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:41:07.593 ago
        SPF algorithm executed 9 times
        Area ranges are
        Number of LSA 9. Checksum Sum 0x03A20B
        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

R5#show ip  ospf  interface
Loopback0 is up, line protocol is up
  Internet Address 192.168.0.129/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.129, Network Type LOOPBACK, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Loopback interface is treated as a stub Host
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 192.168.0.50/28, Area 0, Attached via Network Statement
  Process ID 1, Router ID 192.168.0.129, 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) 192.168.0.129, Interface address 192.168.0.50
  Backup Designated router (ID) 192.168.0.113, Interface address 192.168.0.49
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-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 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 3
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 192.168.0.113  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)

R5#show ip ospf border-routers
            OSPF Router with ID (192.168.0.129) (Process ID 1)
                Base Topology (MTID 0)
Internal Router Routing Table
Codes: i - Intra-area route, I - Inter-area route

R5#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
       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
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR
Gateway of last resort is not set
      192.168.0.0/24 is variably subnetted, 11 subnets, 2 masks
O        192.168.0.0/28
           [110/4] via 192.168.0.49, 00:48:56, GigabitEthernet0/0/0
O        192.168.0.16/28
           [110/3] via 192.168.0.49, 00:48:56, GigabitEthernet0/0/0
O        192.168.0.32/28
           [110/2] via 192.168.0.49, 00:48:56, GigabitEthernet0/0/0
C        192.168.0.48/28 is directly connected, GigabitEthernet0/0/0
L        192.168.0.50/32 is directly connected, GigabitEthernet0/0/0
O        192.168.0.65/32
           [110/5] via 192.168.0.49, 00:43:01, GigabitEthernet0/0/0
O        192.168.0.81/32
           [110/4] via 192.168.0.49, 00:43:14, GigabitEthernet0/0/0
O        192.168.0.97/32
           [110/3] via 192.168.0.49, 00:43:55, GigabitEthernet0/0/0
O        192.168.0.113/32
           [110/2] via 192.168.0.49, 00:43:42, GigabitEthernet0/0/0
C        192.168.0.128/28 is directly connected, Loopback0
L        192.168.0.129/32 is directly connected, Loopback0
```

Pings:

Router 1:

```
R1#ping 192.168.0.65
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.65, timeout is 2 seconds:
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 192.168.0.97
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms

R1#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R1#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Router 2:

```
R2#ping 192.168.0.65
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.65, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R2#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R2#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R2#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R2#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Router 3:

```
R3#ping 192.168.0.65
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.65, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

```
R3#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R3#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Router 4:

```
R4#ping 192.168.0.65
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.65, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R4#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R4#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R4#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R4#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Router 5:

```
R5#ping 192.168.0.65
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.65, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R5#ping 192.168.0.81
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.81, timeout is 2 seconds:
```

```
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R5#ping 192.168.0.97
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.97, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

R5#ping 192.168.0.113
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.113, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms

R5#ping 192.168.0.129
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.129, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Problems

Problems we encountered in this lab were mostly a result of unfamiliarity with the equipment. For example, we were unable to connect our console cables to the correct router. Another member of the lab, Colby, explained to us that the console cables were color coded. With this information, and with Colby's help, we were able to correctly connect our PC to the router's console. A second issue we experienced was incorrectly configuring the wildcard mask, which we discovered when testing the connection between different interfaces, and when our configuration file was proofread by another student, Gabriel Rosas. To fix this issue, we correctly configured our wildcard masks. An overall issue we experienced was the increased freedom we were given. We were expected to solve most of our problems without instructor help. We were able to manage by working together and learning each of our individual strengths.

Conclusions

The purpose of this lab was for us to familiarize ourselves with the CCNP equipment and how to setup OSPF. To setup OSPF, we first researched how it worked and what new commands we should know. We then created a simulated network in packet tracer and applied that configuration to the equipment in the CCNP lab. Most of our configuration was setup correctly, but, as explained above, we did have to remedy a few issues. Through this lab, I learned how to use the equipment in the CCNP lab, as well as how to work with other members in my team to setup the necessary configurations.

Instructor Signoff