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# OSPF

Routing Protocols and Concepts – Chapter 11

## Objectives

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- Describe the background and basic features of OSPF
- Identify and apply the basic OSPF configuration commands
- Describe, modify and calculate the metric used by OSPF
- Describe the Designated Router/Backup Designated Router (DR/BDR) election process in multiaccess networks
- Describe the uses of additional configuration commands in OSPF

# Introduction to OSPF

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Hello Protocol

- OSPF Hello Packet
  - Purpose of Hello Packet
    - Discover OSPF neighbors & establish adjacencies
    - Advertise guidelines on which routers must agree to become neighbors
    - Used by multi-access networks to elect a **d**esignated **r**outer and a **b**ackup **d**esignated **r**outer

# Introduction to OSPF

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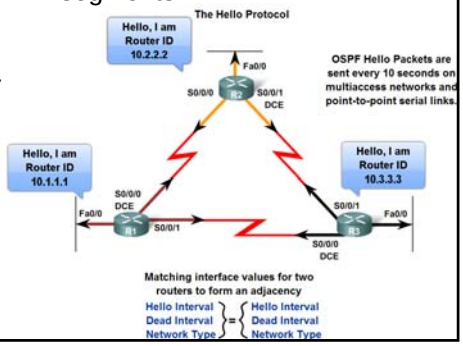
- Hello Packets continued
  - Contents of a Hello Packet
    - router ID of transmitting router
- OSPF Hello Intervals
    - Usually multicast (224.0.0.5)
    - Sent every 30 seconds for NBMA segments
- OSPF Dead Intervals
    - This is the time that must transpire before the neighbor is considered down
    - Default time is 4 times the hello interval



# Introduction to OSPF

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- Hello protocol packets contain information that is used in electing
  - Designated Router (DR)
    - DR is responsible for updating all other OSPF routers
  - Backup Designated Router (BDR)
    - This router takes over DR's responsibilities if DR fails

# Introduction to OSPF

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OSPF Link-state Updates

- Purpose of a Link State Update (LSU)
  - Used to deliver link state advertisements
- Purpose of a Link State Advertisement (LSA)
  - Contains information about neighbors & path costs

# Introduction to OSPF

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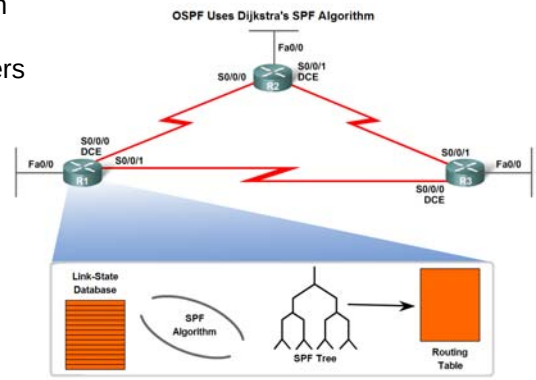
OSPF Algorithm

- OSPF routers build & maintain link-state database containing LSA received from other routers
  - Information found in database is utilized upon execution of Dijkstra SPF algorithm
  - SPF algorithm used to create SPF tree
  - SPF tree used to populate routing table




# Introduction to OSPF

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Administrative Distance

- Default Administrative Distance for OSPF is 110

**Default Administrative Distances**

| 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 |

# Basic OSPF Configuration

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The router ospf command

- To enable OSPF on a router use the following command
  - R1(config)#**router ospf *process-id***
  - Process id
    - A locally significant number between **1** and **65535** this means it does not have to match other OSPF routers

```
R1(config)#router ospf 1
R1(config-router)#
```

```
R2(config)#router ospf 1
R2(config-router)#
```

```
R3(config)#router ospf 1
R3(config-router)#
```

# Basic OSPF Configuration

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- OSPF network command
  - Requires entering: **network address wildcard mask** - the inverse of the subnet mask
  - **area-id -** area-id refers to the OSPF area.
    OSPF area is a group of routers that share link state information
  - Example: Router(config-router)#**network** network-address wildcard-mask **area** area-id

```
R1(config)#router ospf 1
R1(config-router)#network 172.16.1.16 0.0.0.15 area 0
R1(config-router)#network 192.168.10.0 0.0.0.3 area 0
R1(config-router)#network 192.168.10.4 0.0.0.3 area 0
```

```
R2(config)#router ospf 1
R2(config-router)#network 10.10.10.0 0.0.0.255 area 0
R2(config-router)#network 192.168.10.0 0.0.0.3 area 0
R2(config-router)#network 192.168.10.8 0.0.0.3 area 0
```

# Basic OSPF Configuration

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- Router ID
  - This is an IP address used to identify a router
  - 3 criteria for deriving the router ID
    - Use IP address configured with OSPF *router-id* command
    - Takes precedence over loopback and physical interface addresses
    - If router-id command not used then router chooses highest IP address of any loopback interfaces
    - If no loopback interfaces are configured then the highest IP address on any active interface is used

# Basic OSPF Configuration

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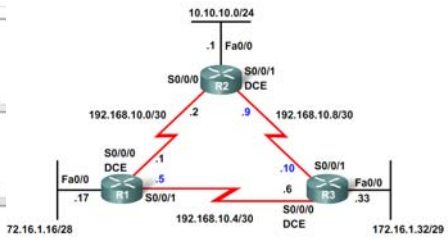
OSPF Router ID

- Commands used to verify current router ID
  - Show ip protocols
  - Show ip ospf
  - Show ip ospf interface

```
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 192.168.10.5
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
R2#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 192.168.10.9
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
R3#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 192.168.10.10
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
```



# Basic OSPF Configuration

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```
R1(config)#interface loopback 0
R1(config-if)#ip add 10.1.1.1 255.255.255.255
```

OSPF Router ID

- Router ID & Loopback addresses
  - Highest loopback address will be used as router ID if router-id command isn't used
  - Advantage of using loopback address
  - the loopback interface cannot fail → OSPF stability
- The OSPF router-id command
  - Introduced in IOS 12.0
  - Command syntax
    - Router(config)#router *ospfprocess-id*
    - Router(config-router)#router-id *ip-address*
- Modifying the Router ID
  - Use the command Router#clear ip ospf process

# Basic OSPF Configuration

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Verifying OSPF

- Use the **show ip ospf** command to verify & trouble shoot OSPF networks
  - Command will display the following:
    - Neighbor adjacency
  - No adjacency indicated by -
    - Neighboring router's Router ID is not displayed
    - A state of **full** is not displayed
  - Consequence of no adjacency-
    - No link state information exchanged
    - Inaccurate SPF trees & routing tables

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
10.3.3.3          1   FULL/  -        00:00:30    192.168.10.6    Serial0/0/1
10.2.2.2          1   FULL/  -        00:00:33    192.168.10.2    Serial0/0/0
```

# Basic OSPF Configuration

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Verifying OSPF - Additional Commands

| Command | Description |
|---|---|
| Show ip protocols | Displays OSPF process ID, router ID, networks router is advertising & administrative distance |
| Show ip ospf | Displays OSPF process ID, router ID, OSPF area information & the last time SPF algorithm calculated |
| Show ip ospf interface | Displays hello interval and dead interval |

# Basic OSPF Configuration

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Examining the routing table

- Use the show ip route command to display the routing table
  - -An “O’ at the beginning of a route indicates that the router source is OSPF
  - -Note OSPF does not automatically summarize at major network boundaries

```
R1#show ip route

Codes: <some code output omitted>
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area

Gateway of last resort is not set

     192.168.10.0/30 is subnetted, 3 subnets
C       192.168.10.0 is directly connected, Serial0/0/0
C       192.168.10.4 is directly connected, Serial0/0/1
O       192.168.10.8 [110/128] via 192.168.10.2, 14:27:57, Serial0/0/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
O       172.16.1.32/29 [110/65] via 192.168.10.6, 14:27:57, Serial0/0/1
C       172.16.1.16/28 is directly connected, FastEthernet0/0
     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O       10.10.10.0/24 [110/65] via 192.168.10.2, 14:27:57, Serial0/0/0
C       10.1.1.1/32 is directly connected, Loopback0
```

# OSPF Metric

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- OSPF uses **cost** as the metric for determining the best route
  - The best route will have the lowest cost
  - Cost is based on bandwidth of an interface
    - Cost is calculated using the formula
  - $10^8$ / bandwidth
  - Reference bandwidth
    - defaults to 100Mbps
    - can be modified using
    - **auto-cost reference-bandwidth** command

| Interface Type | $10^8$/bps = Cost |
|---|---|
| Fast Ethernet and faster | $10^8$/100,000,000 bps = 1 |
| Ethernet | $10^8$/10,000,000 bps = 10 |
| E1 | $10^8$/2,048,000 bps = 48 |
| T1 | $10^8$/1,544,000 bps = 64 |
| 128 kbps | $10^8$/128,000 bps = 781 |
| 64 kbps | $10^8$/64,000 bps = 1562 |
| 56 kbps | $10^8$/56,000 bps = 1785 |

# OSPF Metric

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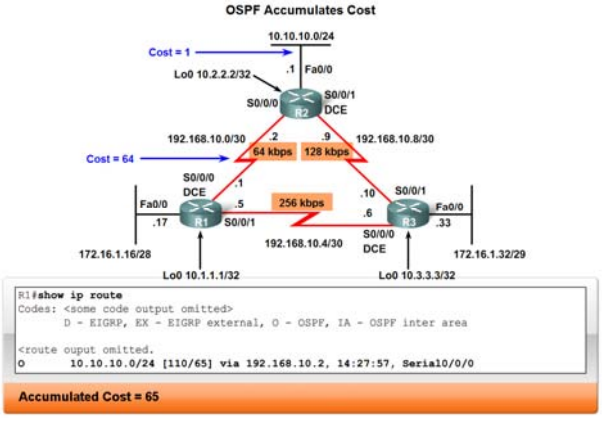
- COST of an OSPF route
  - Is the accumulated value from one router to the next



# Summary

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- OSPF Characteristics
  - Metric = cost
    - Lowest cost = best path
- Configuration
  - Enable OSPF on a router using the following command
    - R1(config)#**router ospf *process-id***
  - use the network command to define which interfaces will participate in a given OSPF process
    - Router(config-router)#**network** network-address wildcard-mask **area** area-id

# Summary

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- Verifying OSPF configuration
  - Use the following commands
    - show ip protocol
    - show ip route
    - show ip ospf interface
    - show ip ospf neighbor