OSPF

Routing Protocols and Concepts – Chapter 11

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Objectives

- 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

	Interior Gateway Protocols: Distance Vector Routing Protocols		Interior Gateway Protocols: Link State Routing Protocols		Exterior Gateway Protocols: Path Vector
Classful	RIP	IGRP			EGP
Classless	RIPv2	EIGRP	OSPFv2	IS-IS	BGPv4
IPv6	RIPng	EIGRP for IPv6	OSPFv3	IS-IS for IPv6	BGPv4 for IPv6

In this chapter, you will learn to:

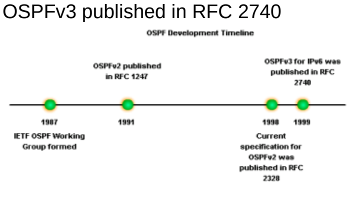
- Describe the background and basic features of OSPF.
- Identify and apply the basic OSPF configuration commands.
- Describe, modify and calculate the metric used by OSPF.
- Describe the Designated Router/Backup Designated Router (DR/BDR) election proess in multiaccess networks.
- Employ the `default-information originate` command to configure and propagate a default route in OSPF.

Introduction to OSPF

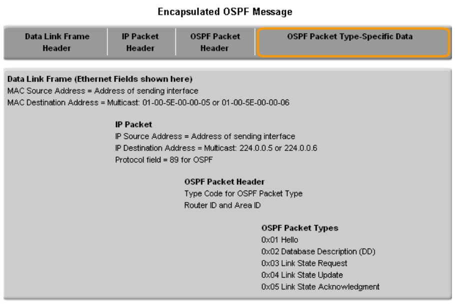
Background of OSPF

- Began in 1987
- 1989 OSPFv1 released in RFC 1131

  This version was experimental & never deployed
- 1991 OSPFv2 released in RFC 1247
- 1998 OSPFv2 *updated* in RFC 2328
- 1999 OSPFv3 published in RFC 2740



OSPF Message



Introduction to OSPF

OSPF Message Encapsulation

- OSPF packet type

  There exist 5 types

- OSPF packet header

  Contains - Router ID and area ID and Type code for OSPF packet type

- IP packet header

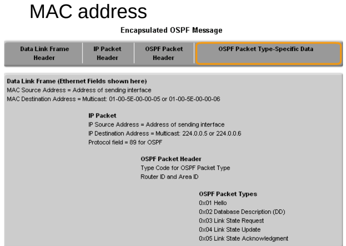
  Contains - Source IP address, Destination IP address, & Protocol field set to 89

Introduction to OSPF

OSPF Message Encapsulation

- Data link frame header

  Contains - Source MAC address and Destination MAC address



Introduction to OSPF

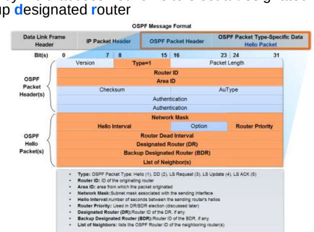
OSPF Packet Types

Type	Packet Name	Description
1	Hello	Discovers neighbors and builds adjacencies between them
2	Database Description (DBD)	Checks for database synchronization between routers
3	Link-State Request (LSR)	Requests specific link-state records from router to router
4	Link-State Update (LSU)	Sends specifically requested link-state records
5	Link-State Acknowledgement (LSAck)	Acknowledges the other packet types

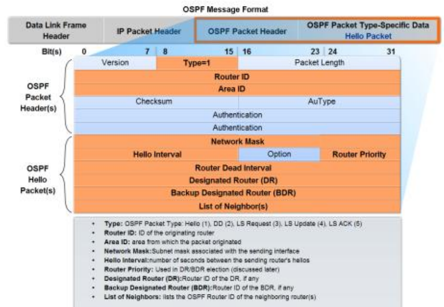
Introduction to OSPF

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

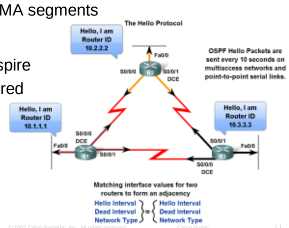


Packet Header



Introduction to OSPF

- 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



Hello Intervals

- Before two routers can form an OSPF neighbor adjacency, they must agree on three values: Hello interval, Dead interval, and network type.
- The OSPF Hello interval indicates how often an OSPF router transmits its Hello packets.
- By default, OSPF Hello packets are sent every 10 seconds on multiaccess and point-to-point segments and every 30 seconds on non-broadcast multiaccess (NBMA) segments (Frame Relay, X.25, ATM).
- In most cases, OSPF Hello packets are sent as multicast to an address reserved for ALLSPFRouters at 224.0.0.5.
- Using a multicast address allows a device to ignore the packet if its interface is not enabled to accept OSPF packets. This saves CPU processing time on non-OSPF devices.

Dead Intervals

- The Dead interval is the period, expressed in seconds, that the router will wait to receive a Hello packet before declaring the neighbor "down."
- Cisco uses a default of four times the Hello interval. For multiaccess and point-to-point segments, this period is 40 seconds. For NBMA networks, the Dead interval is 120 seconds.
- If the Dead interval expires before the routers receive a Hello packet, OSPF will remove that neighbor from its link-state database.
- The router floods the link-state information about the "down" neighbor out all OSPF enabled interfaces.

Introduction to OSPF

- 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

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

LSUs Contain Link-State Advertisements (LSAs)

Type	Packet Name	Description
1	Hello	Discovers neighbors and builds adjacencies between them
2	DBD	Checks for database synchronization between router
3	LSR	Requests specific link-state records from router to router
4	LSU	Sends specifically requested link-state records
5	LSAck	Acknowledges the other packet types

LSA Type	Description
1	Router LSAs
2	Network LSAs
3 or 4	Summary LSAs
5	Autonomous System Extrenal LSAs
6	Multicast OSPF LSAs
7	Defined for Not-So-Stubby Areas
8	External Attributes LSA for Border Gatway Protocol(BGP)
9,10,11	Opaque LSAs

The acronyms LSA and LSU are often used interchangeably.

An LSU contains one or more LSAs.

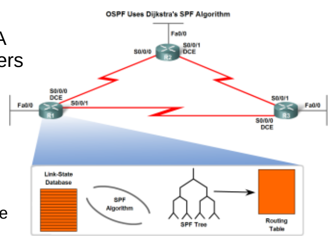
LSAs contain route information for destination networks.

LSA specifics are discussed in CCNP.

Introduction to OSPF

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

Administrative Distance

- Default Administrative Distance for OSPF is 110

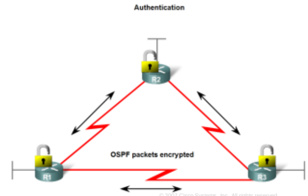
Default Administrative Distances

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

Introduction to OSPF

- OSPF Authentication
  - –Purpose is to encrypt & authenticate routing information
  - –This is an interface specific configuration
  - –Routers will only accept routing information from other routers that have been configured with the same password or authentication information

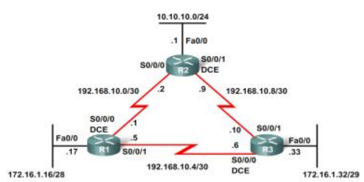
Authentication



Basic OSPF Configuration

Lab Topology

- Topology used for this chapter
  - Discontiguous IP addressing scheme
  - Since OSPF is a classless routing protocol the subnet mask is configured



Basic OSPF Configuration

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

- 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-ask **area** area-id

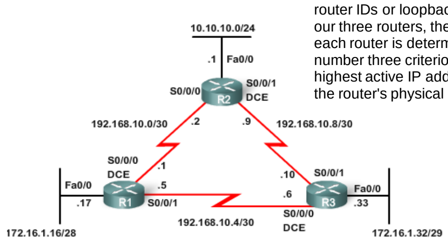
```
R1(config)#router ospf 1
R1(config-router)#network 172.16.1.16 0.0.0.15 area 0
R1(config-router)#network 192.168.10.0 0.0.0.3 area 0
R1(config-router)#network 192.168.10.4 0.0.0.3 area 0
```

```
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

- Router ID
  - –This is an IP address used to identify a router in an OSPF domain
  - –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
    - ▪The process-id is locally significant, which means that it does not have to match other OSPF routers in order to establish adjacencies with those neighbors. This differs from EIGRP. The EIGRP process ID or autonomous system number does need to match for two EIGRP neighbors to become adjacent.

Sample Topology



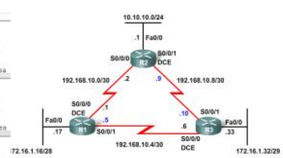
- Because we have not configured router IDs or loopback interfaces on our three routers, the router ID for each router is determined by the number three criterion in the list: the highest active IP address on any of the router's physical interfaces.

Basic OSPF Configuration

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

```
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 ospf *process-id*
    - Router(config-router)#router-id *ip-address*
- Modifying the Router ID
  - –Use the command Router#clear ip ospf process

Modifying the Router ID

- The router ID is selected when OSPF is configured with its first OSPF network command.
- If the OSPF router-id command or the loopback address is configured after the OSPF network command, the router ID will be derived from the interface with the highest active IP address.
- The router ID can be modified with the IP address from a subsequent OSPF router-id command by reloading the router or by using the following command:
  - **Router#clear ip ospf process**

Basic OSPF Configuration

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
```


OSPF Parameters

1. **Neighbor ID** - The router ID of the neighboring router.
2. **Pri** - The OSPF priority of the interface. This is discussed in a later section.
3. **State** - The OSPF state of the interface. FULL state means that the router and its neighbor have identical OSPF link-state databases. OSPF states are discussed in CCNP.
4. **Dead Time** - The amount of time remaining that the router will wait to receive an OSPF Hello packet from the neighbor before declaring the neighbor down. This value is reset when the interface receives a Hello packet.
5. **Address** - The IP address of the neighbor's interface to which this router is directly connected.
6. **Interface** - The interface on which this router has formed adjacency with the neighbor.

Basic OSPF Configuration

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

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

- 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 Costs

- The Cisco IOS uses the cumulative bandwidths of the outgoing interfaces from the router to the destination network as the cost value.
- At each router, the cost for an interface is calculated as 10 to the 8th power divided by bandwidth in bps.
- This is known as the **reference bandwidth**. Dividing 10 to the 8th power by the interface bandwidth is done so that interfaces with the higher bandwidth values will have a lower calculated cost.
- Remember, in routing metrics, the lowest cost route is the preferred route (for example, with RIP, 3 hops is better than 10 hops).
- The figure shows the default OSPF costs for several types of interfaces.

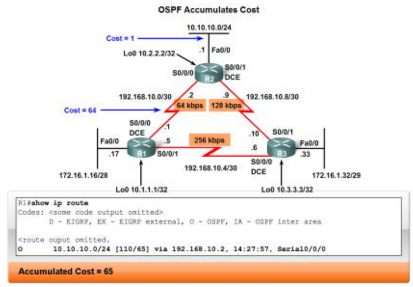
Bandwidth and Costs

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

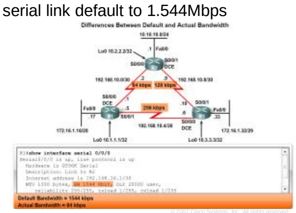
- COST of an OSPF route

  Is the accumulated value from one router to the next



OSPF Metric

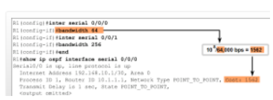
- Usually the actual speed of a link **is different** than the default bandwidth
  - –This makes it imperative that the bandwidth value reflects link's actual speed
    - Reason: so routing table has best path information
- The **show interface** command will display interface's bandwidth
  - -Most serial link default to 1.544Mbps

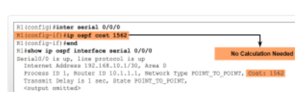


Basic OSPF Configuration

Modifying the Cost of a link

- Both sides of a serial link should be configured with the same bandwidth
  - –Commands used to modify bandwidth value
    - **Bandwidth** command
      - –Example: Router(config-if)#**bandwidth**_bandwidth-kbps_
    - **ip ospf cost** command – allows you to directly specify interface cost
      - -Example:R1(config)#interface serial 0/0/0
        R1(config-if)#ip ospf cost 1562





Basic OSPF Configuration

Modifying the Cost of the link

- Difference between bandwidth command & the ip ospf cost command
  - –**Ip ospf cost** command
    - Sets cost to a specific value
  - –**Bandwidth** command
    - Link cost is calculated

Equivalent Commands

bandwidth Commands		ip ospf cost Commands
Router R1 R1(config)#interface serial 0/0/0 R1(config-if)#bandwidth 64	=	Router R1 R1(config)#interface serial 0/0/0 R1(config-if)#ip ospf cost 1562
R1(config)#interface serial 0/0/1 R1(config-if)#bandwidth 256	=	R1(config)#interface serial 0/0/1 R1(config-if)#ip ospf cost 390
Router R2 R2(config)#interface serial 0/0/0 R2(config-if)#bandwidth 64	=	Router R2 R2(config)#interface serial 0/0/0 R2(config-if)#ip ospf cost 1562
R2(config)#interface serial 0/0/1 R2(config-if)#bandwidth 128	=	R2(config)#interface serial 0/0/1 R2(config-if)#ip ospf cost 781
Router R3 R3(config)#interface serial 0/0/0 R3(config-if)#bandwidth 256	=	Router R3 R3(config)#interface serial 0/0/0 R3(config-if)#ip ospf cost 390
R3(config)#interface serial 0/0/1 R3(config-if)#bandwidth 128	=	R3(config)#interface serial 0/0/0 R3(config-if)#ip ospf cost 781

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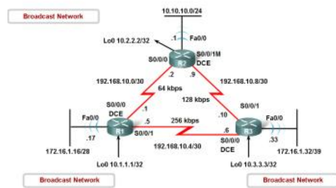
OSPF and Multiaccess Networks

Challenges in Multiaccess Networks

- OSPF defines five network types:
  - –Point-to-point
  - –Broadcast Multiaccess
  - –Nonbroadcast Multiaccess (NBMA)
  - –Point-to-multipoint
  - –Virtual links

OSPF Network Types Used in the Topology



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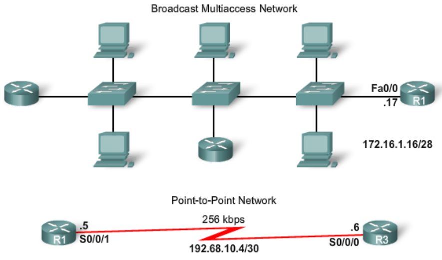
Network Types

Broadcast Multiaccess Network



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Multi-access vs. P-to-P

- A **multi-access** network is a network with more than two devices on the same shared media.
- In the top portion of the figure, the Ethernet LAN attached to R1 is extended to show possible devices that might be attached to the 172.16.1.16/28 network. Ethernet LANs are an example of a broadcast multi-access network.
- They are **broadcast networks** because all devices on the network see all broadcast frames.
- They are multi-access networks because there may be numerous hosts, printers, routers, and other devices that are all members of the same network.
- In contrast, on a point-to-point network there are only two devices on the network, one at each end.
- The WAN link between **R1** and **R3** is an example of a point-to-point link. The bottom portion of the figure shows the point-to-point link between R1 and R3.

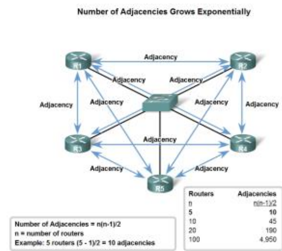
Presentation_ID.scr

Note

- NBMA and point-to-multi-point networks include Frame Relay, ATM, and X.25 networks.
- NBMA networks are discussed in another CCNA course. Point-to-multipoint networks are discussed in CCNP.
- Virtual links are a special type of link that can be used in multi-area OSPF. OSPF virtual links are discussed in CCNP.

OSPF in Multiaccess Networks

- 2 challenges presented by multiaccess networks
  - –Multiple adjacencies
  - –Extensive LSA flooding



Multiple Adjacencies

- The creation of an adjacency between every pair of routers in a network would create an unnecessary number of adjacencies.
- This would lead to an **excessive number of LSAs** passing between routers on the same network.
- To understand the problem with multiple adjacencies, we need to study a formula.
- For any number of routers (designated as n) on a multiaccess network, there will be **n (n - 1) / 2** adjacencies.
- The figure shows a simple topology of five routers, all of which are attached to the same multiaccess Ethernet network.
- Without some type of mechanism to reduce the number of adjacencies, collectively these routers would form 10 adjacencies: **5 (5 - 1) / 2 = 10.** This may not seem like much, but as routers are added to the network, the number of adjacencies increases dramatically.

Flooding of LSAs

- Link-state routers flood their link-state packets when OSPF is initialized or when there is a change in the topology.
- In a multiaccess network this flooding can become excessive.
- If R2 sends out an LSA. This event triggers every other router to also send out an LSA.
- Not shown are the required acknowledgements sent for every LSA received.
- If every router in a multiaccess network had to flood and acknowledge all received LSAs to all other routers on that same multiaccess network, the network traffic would become quite chaotic.

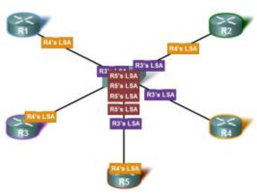
OSPF in Multiaccess Networks

- Extensive flooding of LSAs

  For every LSA sent out there must be an acknowledgement of receipt sent back to transmitting router.

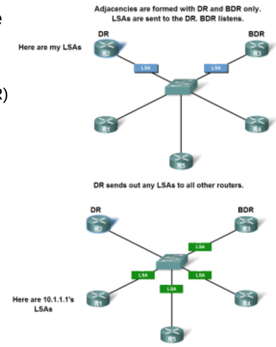
  consequence: lots of bandwidth consumed and chaotic traffic

LSA Flooding Scenario



OSPF in Multiaccess Networks

- Solution to LSA flooding issue is the use of
  - –Designated router (DR)
  - –Backup designated router (BDR)
- DR & BDR selection
  - –Routers are elected to send & receive LSA
- Sending & Receiving LSA
  - –DRothers send LSAs via multicast 224.0.0.6 to DR & BDR
  - –DR forward LSA via multicast address 224.0.0.5 to all other routers

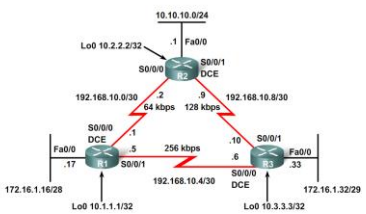


OSPF in Multiaccess Networks

DR/BDR Election Process

- DR/BDR elections **DO NOT** occur in point to point networks

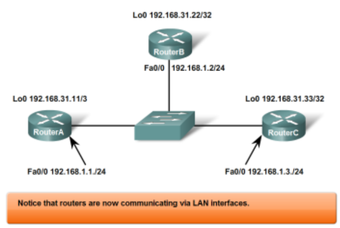
Point-to-Point Three Router Topology



OSPF in Multiaccess Networks

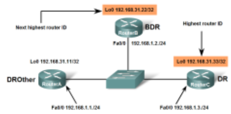
- DR/BDR elections **will take place on multiaccess networks** as shown below

Multiaccess Three Router Topology



OSPF in Multiaccess Networks

- Criteria for getting elected DR/BDR
  1. **DR:** Router with the highest OSPF interface priority.
  2. **BDR**: Router with the second highest OSPF interface priority.
  3. If OSPF interface priorities are equal, the highest router ID is used to break the tie.

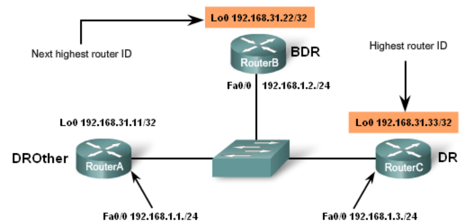


```
RouterA#show ip ospf neighbor

Neighbor ID     Pri   State        Dead Time   Address       Interface
192.168.31.33     1   FULL/DR      00:00:39    192.168.1.3   FastEthernet0/0
192.168.31.22     1   FULL/BDR     00:00:36    192.168.1.2   FastEthernet0/0

RouterB#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address       Interface
192.168.31.33     1   FULL/DR         00:00:34    192.168.1.3   FastEthernet0/0
192.168.31.11     1   FULL/DROTHER    00:00:38    192.168.1.1   FastEthernet0/0

RouterC#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address       Interface
192.168.31.22     1   FULL/BDR        00:00:35    192.168.1.2   FastEthernet0
192.168.31.11     1   FULL/DROTHER    00:00:32    192.168.1.1   FastEthernet0
```

Priority is equal at the default value of 1.

```
RouterA#show ip ospf interface fastethernet 0/0
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.1.1/24, Area 0
  Process ID 1, Router ID 192.168.31.11, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DROTHER, Priority 1
  Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
  Backup Designated router (ID) 192.168.31.22, Interface address 192.168.1.2
  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)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
    Adjacent with neighbor 192.168.31.22  (Backup Designated Router)
    Adjacent with neighbor 192.168.31.33  (Designated Router)
  Suppress hello for 0 neighbor(s)
```


DR and BDR Selection



Selection Process

- In this example, the default OSPF interface priority is 1.
- As a result, based on the selection criteria listed above, the OSPF router ID is used to elect the DR and BDR. As you can see, RouterC becomes the DR and RouterB, with the second highest router ID, becomes the BDR. Because RouterA is not elected as either the DR or BDR, it becomes the DROther.
- DROthers only form FULL adjacencies with the DR and BDR, but will still form a neighbor adjacency with any DROthers that join the network.
- This means that all DROther routers in the multiaccess network still receive Hello packets from all other DROther routers.
- In this way, they are aware of all routers in the network. When two DROther routers form a neighbor adjacency, the neighbor state is displayed as 2WAY. The different neighbor states are discussed in CCNP.

OSPF in Multiaccess Networks

- Timing of DR/BDR Election
  - Occurs as soon as 1st router has its interface enabled on multiaccess network
    - When a DR is elected it remains as the DR until one of the following occurs
      - -The DR fails.
      - -The OSPF process on the DR fails.
      - -The multiaccess interface on the DR fails.

Presentation_ID.scr

OSPF in Multiaccess Networks

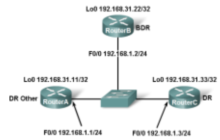
- Manipulating the election process
  - -If you want to influence the election of DR & BDR then do one of the following
    - Boot up the DR first, followed by the BDR, and then boot all other routers,

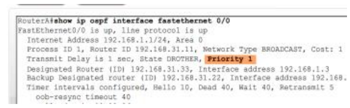
      OR
    - Shut down the interface on all routers, followed by a **no shutdown** on the DR, then the BDR, and then all other routers.

OSPF in Multiaccess Networks

OSPF Interface Priority

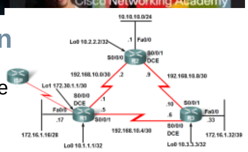
- Manipulating the DR/BDR election process continued
  - –Use the ip ospf priority interface command.
  - –Example:Router(config-if)#**ip ospf priority** {**0 - 255**}
    - Priority number range 0 to 255
      - –0 means the router cannot become the DR or BDR
      - –1 is the default priority value





```
RouterA#show ip ospf interface fastethernet 0/0
FastEthernet0/0 is up, line protocol is up
  Internet Address 192.168.1.1/24, Area 0
  Process ID 1, Router ID 192.168.31.11, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DROTHER, Priority 1
  Designated Router (ID) 192.168.31.33, Interface address 192.168.1.3
  Backup Designated router (ID) 192.168.31.22, Interface address 192.168.
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
```


More OSPF Configuration



Redistributing an OSPF Default Route

- Topology includes a link to ISP
  - –Router connected to ISP
    - Called an autonomous system border router
    - Used to propagate a default route
      - –Example of static default route

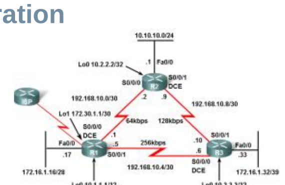
        R1(config)#**ip route 0.0.0.0 0.0.0.0 loopback 1**
      - –Requires the use of the **default-information originate** command
      - –Example of default-information originate command

        R1(config-router)#**default-information originate**

More OSPF Configuration

Fine-Tuning OSPF

- Since link speeds are getting faster it may be necessary to change reference bandwidth values
  - –Do this using the **auto-cost reference-bandwidth** command
  - –Example:
  - **R1(config-router)#auto-cost reference-bandwidth 10000**



```
R1(config-if)#router ospf 1
R1(config-router)#auto-cost reference-bandwidth ?
  <1-4294967>  The reference bandwidth in terms of Mbits per second

R1(config-router)#auto-cost reference-bandwidth  10000
```

```
R2(config-if)#router ospf 1
R2(config-router)#auto-cost reference-bandwidth  10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all routers.
```

```
R3(config-if)#router ospf 1
R3(config-router)#auto-cost reference-bandwidth  10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all routers.
```

More OSPF Configuration

Fine-Tuning OSPF

- Modifying OSPF timers
  - –Reason to modify timers
    - ▪Faster detection of network failures
  - –Manually modifying Hello & Dead intervals
    - ▪Router(config-if)#**ip ospf hello-interval seconds**
    - ▪Router(config-if)#**ip ospf dead-interval seconds**
  - –Point to be made
    - ▪Hello & Dead intervals must be the same between neighbors

```
R1(config)#interface serial 0/0/0
R1(config-if)#ip ospf hello-interval 5
R1(config-if)#ip ospf dead-interval 20
R1(config-if)#end

<Wait 20 seconds for IOS message>
```


Summary

- RFC 2328 describes OSPF link state concepts and operations
- OSPF Characteristics
  - –A commonly deployed link state routing protocol
  - –Employs **DR**s & **BDR**s on multi-access networks
    - ▪DRs & BDRs are elected
    - ▪DR & BDRs are used to transmit and receive LSAs
  - –Uses 5 packet types:
    - **1: HELLO**
    - **2: DATABASE DESCRIPTION**
    - **3: LINK STATE REQUEST**
    - **4: LINK STATE UPDATE**
    - **5: LINK STATE ACKNOWLEDGEMENT**

Summary

- 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

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

