OSPF

Tags	
Klaar	JA
Week	Week 3

Features of OSPF

OSPF has an administrative distance of 110

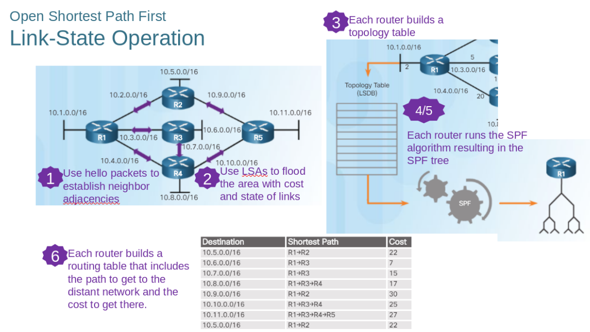
OSPFv2 supports MD5 and SHA authentication

OSPFv3 uses IPsec for authentication

Components of OSPF:

Database	Table	Description
Adjacency	Neighbor	• Lists all neighbor routers to which a router has established bidirectional communication • Unique for each router • View using the **show ip ospf neighbor** command
Link-state (LSDB)	Topology	• Lists information about all other routers • Represents the network topology • Contains the same LSDB as all other routers in the same area • View using the **show ip ospf database** command
Forwarding	Routing	• Lists routes generated when the SPF algorithm is run on the link-state database. • Unique to each router and contains information on how and where to send packets destined for remote networks • View using the **show ip route** command

LS Operation



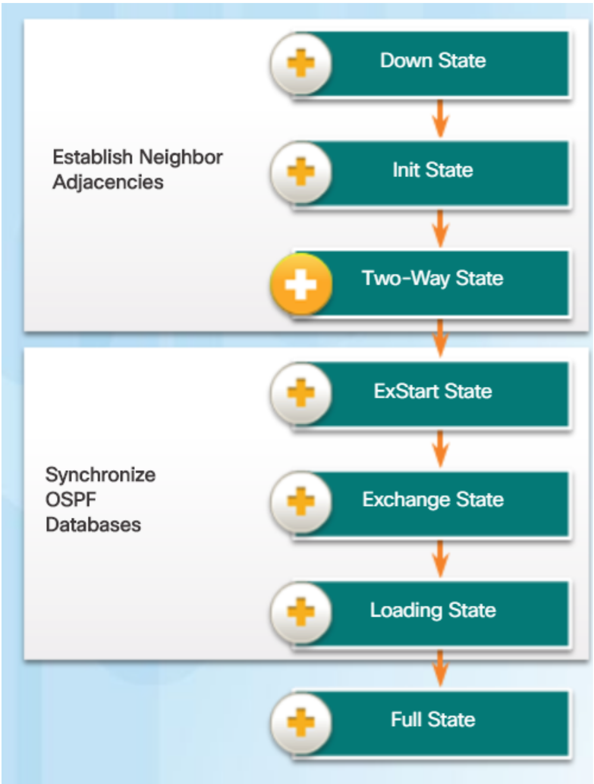
Transmitted to multicast address 224.0.0.5 or 224.0.0.6 in IPv4

Transmitted to multicast address FF02::5 in IPv6

OSPF Packet 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 Acknowledgment (LSAck)	Acknowledges the other packet types

Hello timers are sent every 10 seconds, dead intervals are by default 4x the hello interval (4x10 seconds =40 seconds)

OSPF Operational States



OSPF progresses through several states while attempting to reach convergence:

- Down – No Hello packets received; router sends Hello packets
- Init – Hello packets are received that contain the sending router's Router ID
- Two-Way – Used to elect a DR and BDR on an Ethernet link
- ExStart – Negotiate master/slave relationship and DBD packet sequence number; the master initiates the DBD packet exchange
- Exchange – Routers exchange DBD packets; if additional router information is required, then transition to the Loading State, otherwise, transition to the Full State
- Loading – LSRs and LSUs are used to gain additional route information; routes are processed using the shortest path first (SPF) algorithm; transition to the Full State
- Full – Routers have converged databases

OSPF Metric (Cost)

OSPF Cost = reference bandwidth (100.000.000 bps) / interface bandwidth)

Interface Type	Reference Bandwidth in bps		Default Bandwidth in bps	Cost
10 Gbps Ethernet	100,000,000	÷	10,000,000,000	1
1 Gbps Ethernet	100,000,000	÷	1,000,000,000	1
100 Mbps Ethernet	100,000,000	÷	100,000,000	1
10 Mbps Ethernet	100,000,000	÷	10,000,000	10
1.544 Mbps Serial	100,000,000	÷	1,544,000	64
128 kbps Serial	100,000,000	÷	128,000	781
64 kbps Serial	100,000,000	÷	64,000	1562

Because there is no difference in cost between 100mbps/1gbps/10gbps you can change reference-bandwith to 10.000.000.000. In cisco you can use the command `reference-bandwidth 10000`

Interface Type	Reference Bandwidth in bps		Default Bandwidth in bps	Cost
10 Gbps Ethernet	10,000,000,000	÷	10,000,000,000	1
1 Gbps Ethernet	10,000,000,000	÷	1,000,000,000	10
100 Mbps Ethernet	10,000,000,000	÷	100,000,000	100
10 Mbps Ethernet	10,000,000,000	÷	10,000,000	1000
1.544 Mbps Serial	10,000,000,000	÷	1,544,000	6477
128 kbps Serial	10,000,000,000	÷	128,000	78126
64 kbps Serial	10,000,000,000	÷	64,000	156250

Manually setting the OSPF Cost

Example of serial with default bandwidth 64:

```
R1(config)# int s0/0/1
R1(config-if)# no bandwidth 64
R1(config-if)# ip ospf cost 15625
```

Multiarea OSPF

Advantages of Multiarea OSPF:

- Smaller routing tables - Fewer routing table entries as network addresses can be summarized between areas.
- Reduced link-state update overhead.
- Reduced frequency of SPF calculations.

Multiarea OSPF is implemented in a two-layer area hierarchy.

- Backbone (Transit) area - An OSPF area whose primary function is the fast and efficient movement of IP packets:
  - Interconnects with other OSPF area types.
  - Also called OSPF area 0.
- Regular (nonbackbone) area - Connects users and resources:
  - Usually set up along functional or geographical groupings
  - All traffic from other areas must cross a transit area.

Types of OSPF routers

There are four different types of OSPF routers:

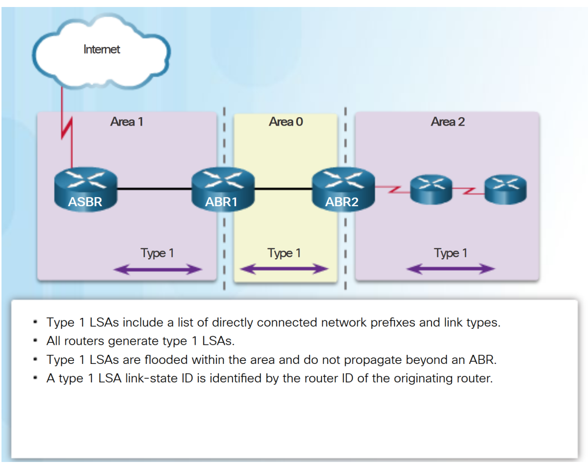
1. Internal router –A router that has all of its interfaces in the same area.

2. Backbone router - A router in the backbone area. The backbone area is set to area 0
3. Area Border Router (ABR) – A router that has interfaces attached to multiple areas.
4. Autonomous System Boundary Router (ASBR) – A router that has at least one interface attached to an external internetwork.

A router can be classified as more than one router type

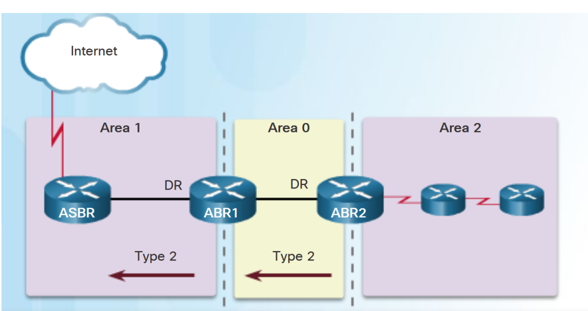
OSPF LSA Types

LSA Type 1



Routers advertise their directly connected OSPF-enabled links in a type 1 LSA .
Type 1 LSAs are also referred to as router link entries.
Type 1 LSAs are flooded only within the area in which they originated.
ABRs advertise the networks learned from the type 1 LSAs to other areas as type 3 LSAs.
The type 1 LSA link ID is identified by the router ID of the originating router.

LSA Type 2

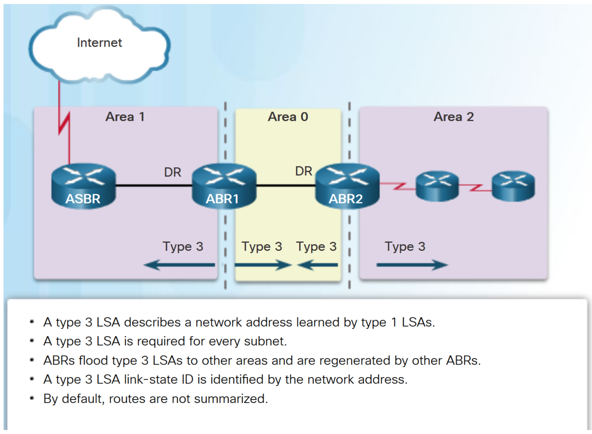


- Type 2 LSAs identify the routers and the network addresses of the multiaccess links.
- Only a DR generates a type 2 LSA.
- Type 2 LSAs are flooded within the multiaccess network and do not go beyond an ABR.
- A type 2 LSA link-state ID is identified by the DR router ID.

Only found on multiaccess and nonbroadcast multiaccess (NBMA) networks
Contain the router ID and IP address of the DR, along with the router ID of all other routers on the multiaccess segment
Give other routers information about multiaccess networks within the same area

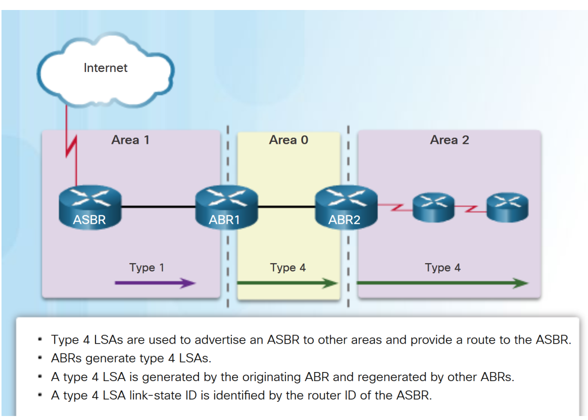
Not forwarded outside of an area
Also referred to as network link entries
Link-state ID is DR router ID

LSA Type 3



They are used by ABRs to advertise networks from other areas.
The ABR creates a type 3 LSA for each of its learned OSPF networks.
ABRs flood type 3 LSAs from one area to other areas.
To reduce impact of flooding in a large OSPF deployment, configuration of manual route summarization on the ABR is recommended.
The link-state ID is set to the network address.

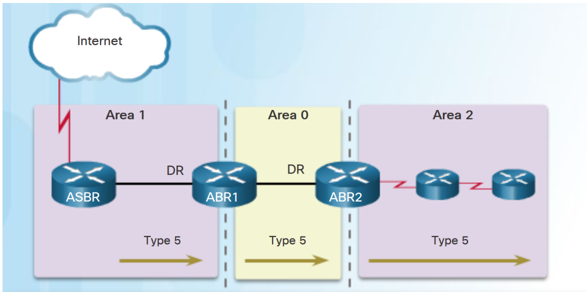
LSA Type 4



They identify an ASBR and provide a route to it.
They are generated by an ABR only when an ASBR exists within an area.
They are flooded to other areas by ABRs.
The link-state ID is set to the ASBR router ID.

LSA Type 5

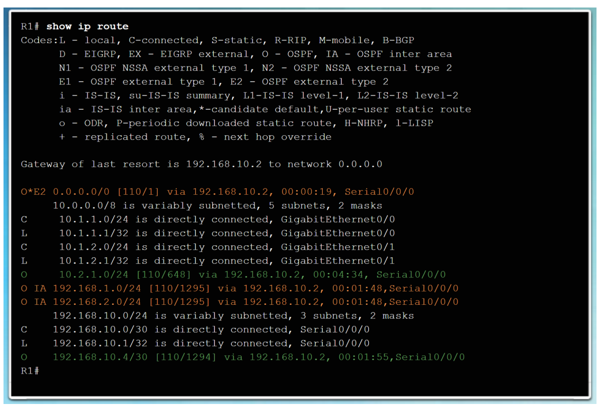
They advertise external routes, also referred to as external LSA entries.
They are originated by the ASBR and



- Type 5 LSAs are used to advertise external (i.e., non-OSPF) network addresses.
- An ASBR generates a type 5 LSA.
- Type 5 LSAs are flooded throughout the area and regenerated by other ABRs.
- A type 5 LSA link-state ID is the external network address.
- By default, routes are not summarized.

flooded to the entire routing domain. The link-state ID is the external network number.

OSPF Routing Table Entries



```
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
      + - replicated route, % - next hop override

Gateway of last resort is 192.168.10.2 to network 0.0.0.0

O*E2 0.0.0.0/0 [110/1] via 192.168.10.2, 00:00:19, Serial0/0/0
     10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C     10.1.1.0/24 is directly connected, GigabitEthernet0/0
L     10.1.1.1/32 is directly connected, GigabitEthernet0/0
C     10.1.2.0/24 is directly connected, GigabitEthernet0/1
L     10.1.2.1/32 is directly connected, GigabitEthernet0/1
O     10.2.1.0/24 [110/648] via 192.168.10.2, 00:04:34, Serial0/0/0
O IA 192.168.1.0/24 [110/1295] via 192.168.10.2, 00:01:48,Serial0/0/0
O IA 192.168.2.0/24 [110/1295] via 192.168.10.2, 00:01:48,Serial0/0/0
     192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C    192.168.10.0/30 is directly connected, Serial0/0/0
L    192.168.10.1/32 is directly connected, Serial0/0/0
O    192.168.10.4/30 [110/1294] via 192.168.10.2, 00:01:55,Serial0/0/0
R1#
```

O - The routing table reflects the link-state information with a designation of O, meaning that the route is intra-area

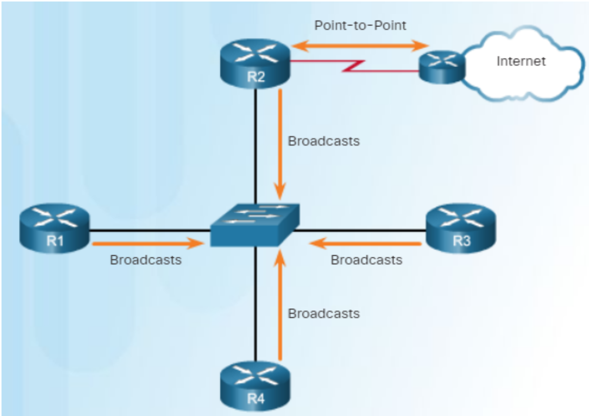
O IA - Summary LSAs appear in the routing table as IA (interarea routes).

O E1 or O E2 - External LSAs appear in the routing table marked as external type 1 (E1) or external type 2 (E2) routes.

Broadcast Multiaccess adjacencies

Use the n *(n-1) / 2 formula to calculate the number of adjacencies required for any number of routers (i.e., n) on a multiaccess network.

Routers (n)	Adjacencies (n (n-1)/2)
4	6
5	10



10	45
20	190
50	1225

OSPF Designated Router

On multiaccess networks, OSPF elects a DR to be the collection and distribution point for LSAs sent and received.
A BDR is also elected in case the DR fails. If the DR stops producing Hello packets, the BDR promotes itself and assumes the role of DR.
All other non-DR or BDR routers become DROTHER (a router that is neither the DR nor the BDR) and DROTHERs only form full adjacencies with the DR and BDR in the network.
Instead of flooding LSAs to all routers in the network, DROTHERs only send their LSAs to the DR and BDR using the multicast address 224.0.0.6 (all DR routers).

DR/BDR Election Process

1. The routers in the network elect the router with the highest interface priority as the DR.
    a. The router with the second highest interface priority is elected as the BDR.
    b. The priority can be configured to be any number between 0 – 255 but the default priority is 1.
2. If the interface priorities are equal, then the router with the highest router ID is elected the DR.
    a. The router with the second highest router ID is the BDR.

Configuration example

Router-id

The router-id can be set using the `router-id xx.xx.xx.xx` command

1. If the router-id is not statically set, then the router-id will be the highest IP-address of the loopback interfaces
2. If there are no loopback interfaces configured, then the router-id will be the highest IP-address of the physical interfaces

Use `clear ip ospf process` to make the router-id change effective

OSPF Priority

To control the DR and BDR election, the priority of an interface can be configured using:

`ip ospf priority <0-255>`

Networks

networks must include a wildcard-mask and an area

en example of a network 192.168.1.0 255.255.255.0 in area 0 is:

`network 192.168.1.0 0.0.0.255 area 0`

Passive interface

An interface configured as a passive interface does not SEND OSPF messages.
Best practice for interfaces that have users attached (security)
Doesn't waste bandwidth sending messages out OSPF-enabled interfaces that don't have another router attached.

example to set GIG0/0 to passive:

```
R1(config)# router ospf 10
R1(config-router)# passive-interface GigabitEthernet 0/0
```

Modifying Hello and Dead timers

`ip ospf hello-interval <seconds>`
`ip ospf dead-interval <seconds>`

Use the no ip ospf hello-interval and no ip ospf dead-interval to reset the timers to their default

Default Static Route in OSPF

first create a default static route
`ip route 0.0.0.0 0.0.0.0 xx.xx.xx.xx`

Then type `default-information originate`

Verifying Configuration

You can verify the OSPF configuration by using the following commands:

`show ip protocols`

`show ip ospf`

`show ip ospf interface brief`