OSPF Notes

- No auto summarization, must be switched on manually
- Route propagation: multicast on change
- Path metric: bandwidth
- Updates are event triggered (RIP = periodic updates)
- Route computation algorithm: Dijkstra (RIP = Bellman-Ford)
- Area Border Router (ABR), is the router between two OSPF areas
- ASBR (Autonomous System Border Router), is the router between two autonomous systems

Router ID (RID) – the "name" of the router, an IP address used to identify it. The highest IP address of all configured loopback interfaces is chosen for RID. If no loopback IPs are configured, then the highest IP of all physical interfaces is chosen.

Neighbors – two or more routers that have an interface in a common network. Parameters that must be configured exactly the same way for two OSPF routers to become neighbors are:

- Area ID
- Stub area flag (if set at all)
- Authentication password (if using one)
- Hello and Dead intervals

Adjacency – a relationship between two OSPF routers that permits direct exchange of route updates. OSPF will share routes only with neighbors that have also established adjacencies.

Designated Router (DR) – elected whenever OSPF routers are connected to the same broadcast network, to minimize the number of adjacencies formed, and to publicize received routing information to and from the remaining routers on the broadcast network or link. Router with highest priority wins, but if tied, router ID will be used to decide. All routers on a shared network will establish adjacencies with the DR and BDR (Backup DR).

Backup DR (BDR) – receives all routing updates from OSPF adjacent routers but does not disperse LSA updates.

Hello protocol – provides dynamic neighbor discovery and maintains neighbor relationships. Hello packets and Link State Advertisements (LSAs) build and maintain the topology database. Hello packets are addressed to multicast address 224.0.0.5.

Neighborship database – a list of all OSPF routers for which Hello packets have been seen.

Topology database – contains information from all of the LSA packets received for a specific area. The router uses information from the topology database as input into the Dijkstra algorithm, which then computes the shortest path to every network.

LSA (Link State Advertisement) – an OSPF data packet containing link-state and routing information that's shared among OSPF routers. An OSPF router will exchange LSAs only with routers to which it has established an adjacency.

OSPF area – a grouping of contiguous networks and routers. A router can be a member of more than one area at a time, the area ID being associated with specific interfaces on the router. All of the routers within the same area have the same topology table. Area 0 is the backbone area, and it must be used in any OSPF topology!

Broadcast (multi-access) networks such as Ethernet, allow multiple devices to connect or to access the same network, enabling a broadcast ability. In OSPF, a DR or BDR must be elected for each broadcast multi-access network. Default Hello time = 10 secs, Dead = 40 secs.

Non-broadcast multi-access (NBMA) networks are networks such as Frame Relay, X.25 and ATM (Asynchronous Transfer Mode). These types of networks allow for multi-access without ability to broadcast, unlike Ethernet. NBMA networks require special OSPF configuration to function properly. Hello = 30 secs, Dead = 120 secs.

Point-to-Point networks, physical or logical, eliminate the need for DRs or BDRs. Default Hello and Dead timers same as for Broadcast, Hello = 10 secs, Dead = 40.

OSPF Operation is basically divided into these three categories:

1) Neighbor and adjacency initialization
2) LSA flooding
3) SPF tree calculation

LSA flooding – is used so that all OSPF routers can have the same topology map, which they will use to make SPF calculations. LSA updates indicate topology changes. Point-to-point networks (all SPF routers) use multicast address 224.0.0.5 for LSA; Broadcast networks (all DR routers) use 224.0.0.6; Point-to-multipoint networks use adjacent router's unicast IP address. Recipients of LSA updates must acknowledge that they've received the flooded update, and then they must validate it.

SPF Tree Calculation – within an area, each router calculates the best/shortest path to every network in that same area.

OSPF Metrics (COST) – cost is associated with every outgoing interface, and if two routers are sharing a link, they must have the same cost for that link. The cost of the entire path from source to destination is the sum of the costs of all outgoing interfaces along that path.

Cisco equation: $cost = \frac{10^8}{bandwidth}$

Example for Fast Ethernet: $cost = \frac{10^8}{100Mbps} = \frac{100000000}{100000000bps} = 1$

Example for Gigabit Ethernet: $cost = \frac{10^8}{100Mbps} = \frac{1000000000}{100000000bps} = 10$

OSPF Process – multiple OSPF processes can be used on an ASBR, to connect two different OSPF networks. Each process maintains a separate topology. Each OSPF router can have a different Proccess ID (PID) – it's not a condition for neighborship/adjacency.

Loopback interfaces & OSPF – Cisco suggests using loopback interfaces whenever you configure OSPF, for stability purposes. By using a virtual interface, it is ensured that an interface is always active and available for OSPF processes.

- The highest active IP address on a router will become that router's RID during bootup, BUT if a loopback address is configured, that address will become RID – regardless of other IPs. If several loopbacks are configured, the highest loopback IP out of all configured loopback IPs will become RID.
- Loopback addresses on different routers must belong to different networks! That's why /32 should be used for loopbacks – for example, if R1 has 192.168.1.1/32, R2 can take the very next one – 192.168.1.2; but if R1 had 192.168.1.1/24, R2 would have to take 192.168.2.1.
- If loopback is configured after creation of OSPF, the router needs to be rebooted for loopback to become RID. Another way to do it is to assign loopback addresses prior to creating the OSPF process. That way, loopback IP will automatically become RID. Third way is to manually set RID:
    - **`R(config)#router ospf 1`**
    - **`R(config-router)#router-id 200.1.1.1`**
    - **`R(config-router)#do clear ip ospf process`**

Example, assuming A and B are OSPF neighbors:

`A(config)#do show ip ospf neighbor`

```
Neighbor ID      Pri      State      Dead Time        Address        Interface
```

Neighbor ID: RID of the neighbor

Pri: Indicates the priority of the neighbor router. The router with the highest priority becomes DR. If priorities tie, then the router with the highest ID (RID) becomes DR. By default, priorities are set to 1. Router with Pri=0 never becomes DR or a BDR, it is always a DROTHER.

State: Indicates the functional state of the NEIGHBOR router. If it's "FULL/DR" on A -> B is DR. "FULL" means A is fully adjacent with its neighbor B.

Dead Time: Indicates the time A will wait to receive an OSPF Hello packet from B before declaring it's down (in seconds).

Address: Indicates the IP address of the interface (on B) which is connected to A.

Interface: Indicates the interface on this router (A) which formed the adjacency with B.