OSPF

Open Shortest Path First using Dijkstra's algorithm, has 3 versions → 1 is old, 2 for IPV4 and 3 for IPV4 and IPV6.
Routers store information about network in LSAs (Link State Advertisements) which are organized in LSDB (Link State Database), routers flood LSAs until all routers in the OSPF area develop the same LSDB (network map).
LSAs are flooded until all routers receive a copy, LSDB contains LSAs for all different links in network, each LSA has an aging timer (30 minutes by default) then it will be re flooded.
OSPF uses areas to divide up the network, to decrease time and not use exponential processing power on routers to calculate routes and reduce LSDB, also any small network change causes every router to flood LSAs and re run SPF
Area: a set of routers and links sharing the same LSDB, routers of all interfaces in the same area called internal routers.
Backbone area (0): an area all other areas must connect to.
routers with interface in multiple areas are called are border routers (ABRs), maintain a separate LSDB for each area they are connected to, it's recommended to connect an ABR to a max of 2 areas.
Routers connected to the backbone area are backbone routers.
Intra-area route: is a route to a destination in the same OSPF area.
Interarea route: a route to a destination in a different OSPF area.
OSPF areas are contiguous and not divided up, OSPF interfaces in the same subnet must be in the same area.
Command: router ospf <process-id>, a router can run multiple ospf processes at the same time each identified with an id and each id is locally significant where routers with different OSPF IDs can become OSPF neighbors.
OSPF uses wild card masks and in the network command you have to identify the area too.
Command: passive interface <interface> stops the router from sending OSPF hello messages out of the interface, yet it will continue sending LSAs informing it's neighbors about the subnet configured on interface.
To configure a router id use command: router-id <id> then reload the router or use the command: clear ip ospf process.
Autonomous system boundary router (ASBR) is an OSPF router connecting the OSPF network to an external network as Internet for example, doesn't support unequal cost load-balancing like EIGRP and max ECMP of 4 by default.
Last resort = default route.
To show LSDB use command show ip ospf database. To show neighbors → show ip ospf neighbors.
Command: show ip ospf interface <int optional>

OSPF metric/cost is auto calculated based on the bandwidth/speed of the interface, the interface cost is calculated by dividing a reference bandwidth (default 100 mbps) by the interface bandwidth, any value less than 1 is 1.
To change refernce bandwidth use the command: auto-cost reference-bandwidth < mbps> must be greater than the network fastest links to allow for future updates, should be consistent across all routers, loopback interfaces cost is 1.
To configure an interface cost manually, go to interface and run command ip ospf cost <cost>, you can change the interface bandwidth without affecting its speed yet not recommended. To change it run bandwidth <kbps> on interface.
Command: show ip ospf interface brief.

OSPF Neighbors: to share information, calculate routes,.. etc, OSPF hello messages out of active OSPF interfaces at regular intervals (default 10 secs for ethernet connection), multicast to introduce the router to potential OSPF neighbors.
Mukticast address is 224.0.0.5 and OSPF are encapsulated in IP header of value 89 in protocol field.
Hello message include: my router ID and neighbor RID, if neighbor no known 0.0.0.0 NRID is sent.

Neighbor States: 1- down → initial state when the router doesn't know about any neighbors yet.
When a router receives hello message it adds an entry for the sender in OSPF neighbor table and state becomes init.
2- Init state: hello packet is received without my own router id.
3-way state: a router has received a hello packet with his own router id in it, reaching this state means that they can become OSPF neighbors so they are now ready to share LSAs to build a common LSDB, in some network types a designated and backup designated routers are elected at this point.
4- Exstart state: the router with higher ID will become the master and initiate LSAs exchange and the other becomes the slave, they exchange DBD (Database Description Packets → summary of LSDB of router to ensure consistency).
5- Exchange state: the routers exchange DBDs which contain a list of LSAs in their LSDB basic and not detailed info, the routers compare the info in the DBD the receive to their own LSDB info to determine which LSAs they must receive from their neighbor.

6- Loading state: routers send LSR (Link State Request) to request neighbors send them missing LSAs, then the other router reply with LSU (Link State Update) and finally the original router swnd LSAck (Link state acknowledge).
7- Full state: the routers have a full OSPF adjacency and identical LSDBs.
They continue to send and listen for hello packets every 10 secs by default to maintain the neighbor adjacency.
Every timer a hello packet is received a dead timer (40 secs by default) is reset, if it reaches 0 neighbor is removed.
To activate ospf directly on an interface use command ip ospf <process-id> area <area> on a specific interface.
Command: passive-interface default → to make all interfaces passive by default then remove specific ones with “no”.
Enabling OSPF on an interface even if passive makes the other routers know about it.
E2 → OSPF external type 2 (the internal metric to reach R1 is ignored).
OSPF areas are 4 octets.

Loopback interface: a virtual interface that is always up/up unless manuallu shutdown, not dependent on a physical interface and can provide a consistent ip address to reach/identify the router.
OSPF network types: 1-Broadcast enabled on Ethernet and FDDI ints. 2- Point to Point enabled on PPP and HDLC ints.
3- non broadcast enabled on frame relay and X.25 interfaces.
Broadcast: dynamically discover neighbors, a DR and BDR are elected on each subnet and the remaining routers are DROther, DR is 1st place, BDR is 2nd place based on router with highest OSPF interface priority (default 1) then highest OSPF ID, to change OSPF interface priority run command ip ospf priority on interface if 0 can’t be DR or BDR, non-preemptive, when DR comes down the BDR becomes the new DR no matter its priority than an election is held for the next BDR, the neighbor state between 2 DROthers is 2-way, only full adjacency with DR and BDR (exchange LSAs with them yet all routers have the same LSDB using multicast address 224.0.0.6).
Default encapsulation on serial interfaces is Cisco HDLC (no mac address), to use PPP run: encapsulation PPP on both ends, command: show controllers < int-id > to know which side is DCE and which one is DTE.
In point to point network type no DR or BDR is elected, neighbors are dynamically discovered and use the same default timers, to manually configure OSPF network type on an interface run ip ospf netwotk <type>.

OSPF neighbor requirements: 1- Area number must match. 2-Interfaces must be in the same subnet.
3- OSPF process must not be shutdown with shutdown command. 4- OSPF router IDs must be unique, If a router has no OSPF neighbors it’s free to change its router id without clearing OSPF process.
5- Hello and Dead timers must match, can be changed by running ip ospf hello/dead-interval <number> on interfaces use no ip ospf hello/dead-interval to return them to their default values.
6- Authentication settings must match (a password can be confisured on an interface by running:
ip ospf authentication -key <password>) on interface and enabled by running: ip ospf authentication on interface.
7- IP MTU settings must match or routers can become OSPF neighbors yet don’t function properly, to configure MTU run the command ip mtu <mtu> on an interface.
8- OSPF network type must match in order to function properly

LSAs types → 1- Router LSA: identifies the router using its router id and lists networks attached to the router OSPF-activated interfaces.
2- Network LSA: generated by DR of each multi access network (EX: broadcast) to list the routers attached to the multi access networks.
3- Type 5 AS-External LSA: generated by ASBRs to describe routes to destinations outside AS (OSPF domain).