CCNA 200-301

CISCO ™

Lesson 20

- Dynamic Routing Protocols
- Routing Protocol Functions
- Interior and Exterior Routing Protocols
- IGP Routing Protocol Algorithms
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- OSPF Overview
- OSPF Neighbor Forming
- Calculating the Best Routes with SPF

Dynamic Routing Protocols

Routers add IP routes to their routing tables using three methods: connected routes, staticroutes, and routes learned by using dynamic routing protocols. it is important to define a few related terms and clear up any misconceptions about the terms ***routing protocol***, ***routed protocol***, and ***routable protocol***.

- **Routing protocol:** A set of messages, rules, and algorithms used by routers for the overall purpose of learning routes. This process includes the exchange and analysis of routing information. Examples include RIP, EIGRP, OSPF, and BGP.
- **Routed protocol and routable protocol:** Both terms refer to a protocol that defines a packet structure and logical addressing, allowing routers to forward or route the packets. Routers forward packets defined by routed and routable protocols. Examples include IP Version 4 (IPv4) and IP Version 6 (IPv6).

The routing process forwards IP packets, but if a router does not have any routes in its IP routing table that match a packet's destination address, the router discards the packet.

Routing Protocol Functions

Cisco IOS software supports several IP routing protocols, performing the same general functions:

1. Learn routing information about IP subnets from neighboring routers.

2. Advertise routing information about IP subnets to neighboring routers.

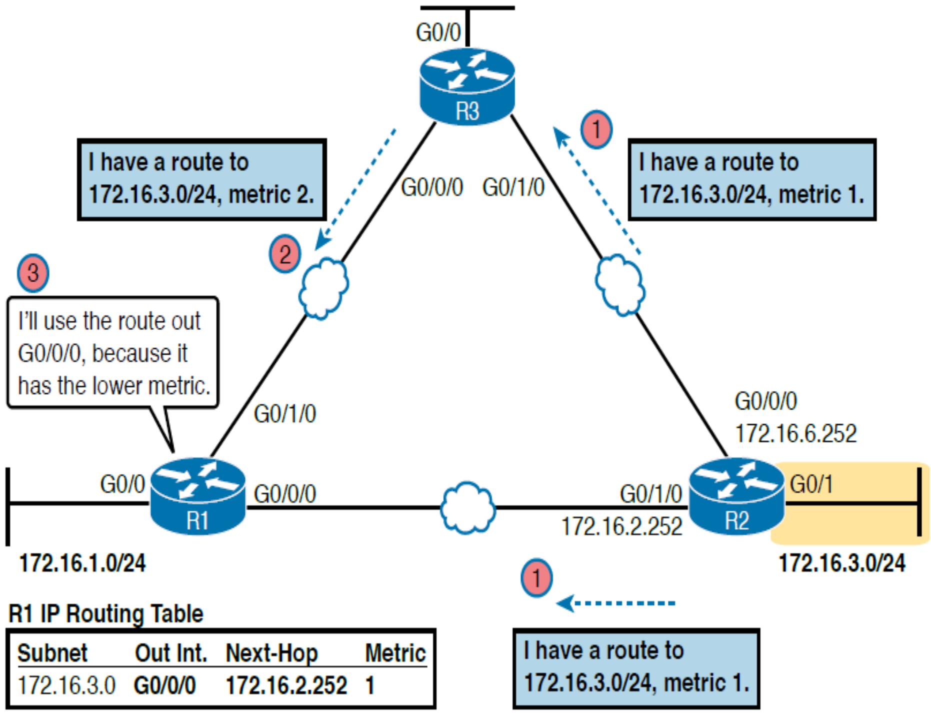
3. If more than one possible route exists to reach one subnet, pick the best route based on a metric.

4. If the network topology changes—for example, a link fails—react by advertising that some routes have failed and pick a new currently best route. (This process is called convergence.)

Step 1. R2 advertises a route to the lower right subnet—172.16.3.0/24—to both router R1 and R3.

Step 2. After R3 learns about the route to 172.16.3.0/24 from R2, R3 advertises that route to R1.

Step 3. R1 must make a decision about the two routes it learned about for reaching subnet 172.16.3.0/24—one with metric 1 from R2 and one with metric 2 from R3. R1 chooses the lower metric route through R2 (function 3).



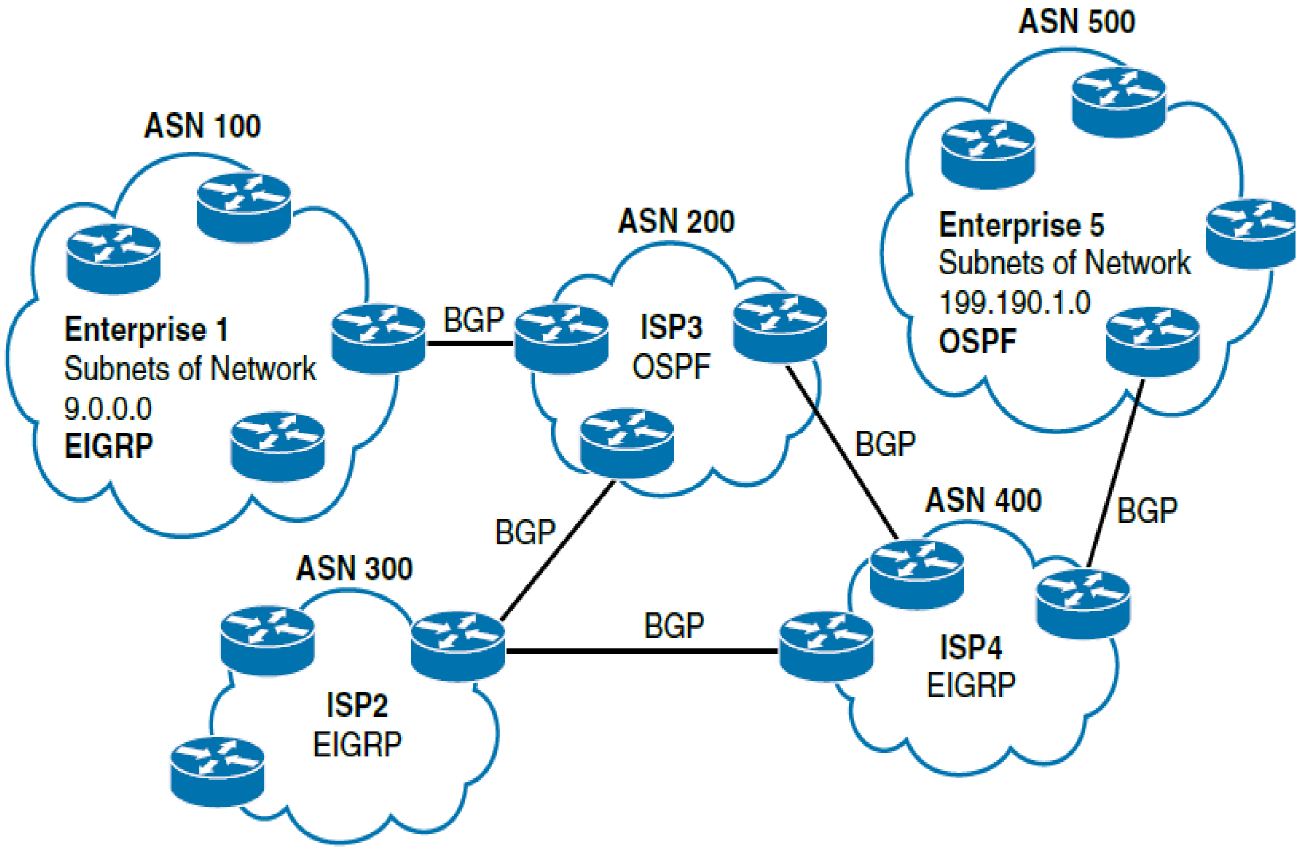
Interior and Exterior Routing Protocols

IP routing protocols fall into one of two major categories: ***interior gateway protocols*** (**IGP**) or ***exterior gateway protocols*** (**EGP**). The definitions of each are as follows:

■ **IGP:** A routing protocol that was designed and intended for use inside a single autonomous system (AS). (OSPF,EIGRP,RIP, IS-IS)

■ **EGP:** A routing protocol that was designed and intended for use between different autonomous systems. (BGP)

Autonomous system **(AS).** An AS is a network under the administrative control of a single organization.



IGP Routing Protocol Algorithms

A routing protocol's underlying algorithm determines how the routing protocol does its job. The **term *routing protocol algorithm*** simply refers to the logic and processes used by different routing protocols to solve the problem of learning all routes, choosing the best route to each subnet, and converging in reaction to changes in the internetwork. Three main branches of routing protocol algorithms exist for IGP routing protocols:

- Distance vector (sometimes called Bellman-Ford after its creators)
- Advanced distance vector (sometimes called "balanced hybrid")
- Link-state

Historically speaking, distance vector protocols were invented first, mainly in the early 1980s. Routing Information Protocol (RIP) was the first popularly used IP distance vector protocol, with the Cisco-proprietary Interior Gateway Routing Protocol (IGRP) being introduced a little later.

By the early 1990s, distance vector protocols' somewhat slow convergence and potential for routing loops drove the development of new alternative routing protocols that used new algorithms. Link-state protocols—in particular, Open Shortest Path First (OSPF) and Integrated Intermediate System to Intermediate System (IS-IS)—solved the main issues. They also came with a price: they required extra CPU and memory on routers, with more planning required from the network engineers.

Routing Protocols Metric

Routing protocols choose the best route to reach a subnet by choosing the route with the lowest metric. For example, RIP uses a counter of the number of routers (hops) between a router and the destination subnet. OSPF totals the cost associated with each interface in the end-to-end route, with the cost based on link bandwidth. Table lists the most common IP routing protocols and some details about the metric in each case.

IGP	Metric	Description
RIPv2	Hop count	The number of routers (hops) between a router and the destination subnet
OSPF	Cost	The sum of all interface cost settings for all links in a route, with the cost defaulting to be based on interface bandwidth
EIGRP	Calculation based on bandwidth and delay	Calculated based on the route's slowest link and the cumulative delay associated with each interface in the route

Administrative Distance

Depending on the network topology, the two routing protocols might learn routes to the same subnets. When a single routing protocol learns multiple routes to the same subnet, the metric tells it which route is best. However, when two different routing protocols learn routes to the same subnet, because each routing protocol's metric is based on different information, IOS cannot compare the metrics. For example, OSPF might learn a route to subnet 10.1.1.0 with metric 101, and EIGRP might learn a route to 10.1.1.0 with metric 2,195,416, but the EIGRP-learned route might be the better route—or it might not. There is simply no basis for comparison between the two metrics.

When IOS must choose between routes learned using different routing protocols, IOS uses a concept called ***administrative distance***. Administrative distance is a number that denotes how believable an entire routing protocol is on a single router. The lower the number, the better, or more believable, the routing protocol.

Route Type	Administrative Distance
Connected	0
Static	1
BGP (external routes [eBGP])	20
EIGRP (internal routes)	90
IGRP	100
OSPF	110
IS-IS	115
RIP	120
EIGRP (external routes)	170
BGP (internal routes [iBGP])	200
DHCP default route	254
Unusable	255

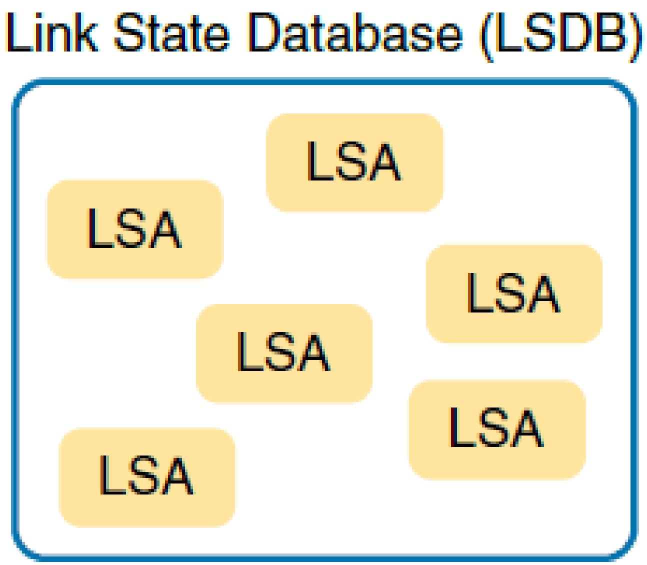
OSPF Overview

Link-state protocols build IP routes with a couple of major steps. First, the routers together build a lot of information about the network: routers, links, IP addresses, status information, and so on. Then the routers flood the information, so all routers know the same information. At that point, each router can calculate routes to all subnets, but from each router's own perspective.

Topology Information and LSAs.

Routers using link-state routing protocols need to collectively advertise practically every detail about the internetwork to all the other routers. At the end of the process of ***flooding*** the information to all routers, every router in the internetwork has the exact same information about the internetwork. Flooding a lot of detailed information to every router sounds like a lot of work, and relative to distance vector routing protocols, it is.

Open Shortest Path First (OSPF), the most popular link-state IP routing protocol, organizes topology information using LSAs and the link-state database (LSDB). Figure represents the ideas. Each LSA is a data structure with some specific information about the network topology; the LSDB is simply the collection of all the LSAs known to a router.

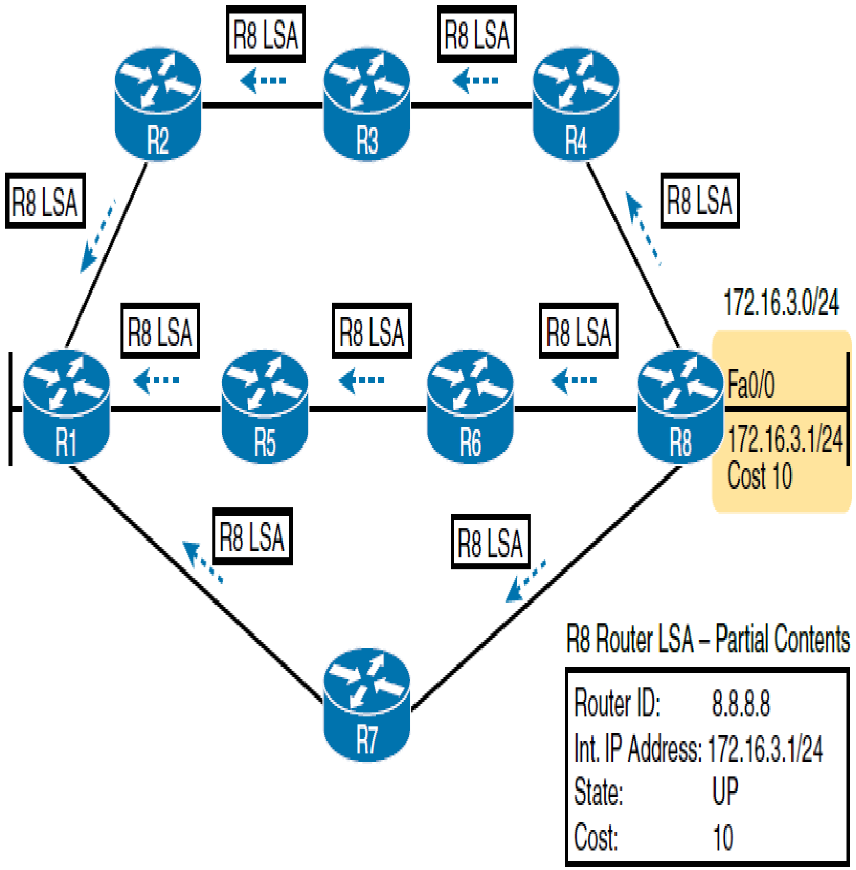


OSPF Overview

Figure shows the general idea of the flooding process, with R8 creating and flooding its ***router LSA***. The router LSA for Router R8 describes the router itself, including the existence of subnet 172.16.3.0/24, as seen on the right side of the figure

Figure shows the rather basic flooding process, with R8 sending the original LSA for itself, and the other routers flooding the LSA by forwarding it until every router has a copy. The flooding process causes every router to learn the contents of the LSA while preventing the LSA from being flooded around in circles. Basically, before sending an LSA to yet another neighbor, routers communicate, asking "Do you already have this LSA?," and then sending the LSA to the next neighbor only if the neighbor has not yet learned about the LSA.

Once flooded, routers do occasionally reflood each LSA. Routers reflood an LSA when some information changes (for example, when a link goes up or comes down). They also reflood each LSA based on each LSA's separate aging timer (default 30 minutes).



Dijkstra SPF Math to Find the Best Routes

The link-state flooding process results in every router having an identical copy of the LSDB in memory, but the flooding process alone does not cause a router to learn what routes to add to the IP routing table. Although incredibly detailed and useful, the information in the LSDB does not explicitly state each router's best route to reach a destination. To build routes, link-state routers have to do some math. Thankfully, you and I do not have to know the math! However, all link-state protocols use a type of math algorithm, called the Dijkstra Shortest Path First (SPF) algorithm, to process the LSDB. That algorithm analyzes (with math) the LSDB and builds the routes that the local router should add to the IP routing table—routes that list a subnet number and mask, an outgoing interface, and a next-hop router IP address.

Now that you have the big ideas down, the next several topics walk through the three main phases of how OSPF routers accomplish the work of exchanging LSAs and calculating routes. Those three phases are

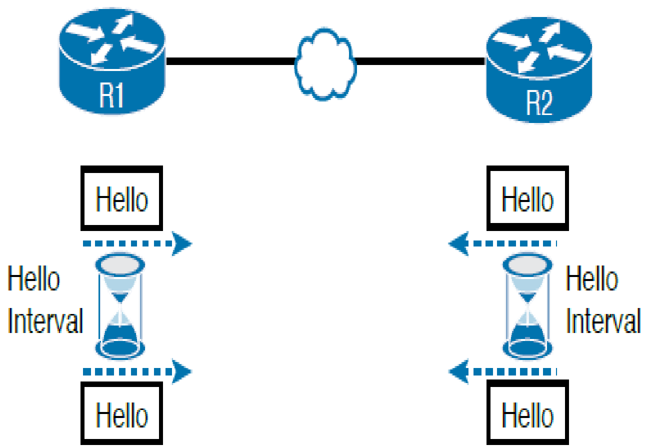
- **Becoming neighbors:** A relationship between two routers that connect to the same data link, created so that the neighboring routers have a means to exchange their LSDBs.
- **Exchanging databases:** The process of sending LSAs to neighbors so that all routers learn the same LSAs.
- **Adding the best routes:** The process of each router independently running SPF, on their local copy of the LSDB, calculating the best routes, and adding those to the IPv4 routing table.

OSPF Neighbor Forming

OSPF neighbors are routers that both use OSPF and both sit on the same data link. Two routers can become OSPF neighbors if connected to the same VLAN, or same serial link, or same Ethernet WAN link.

Two routers need to do more than simply exist on the same link to become OSPF neighbors; they must send OSPF messages and agree to become OSPF neighbors. To do so, the routers send OSPF Hello messages, introducing themselves to the potential neighbor. Assuming the two potential neighbors have compatible OSPF parameters, the two form an OSPF neighbor relationship, and would be displayed in the output of the **show ip ospf neighbor** command.

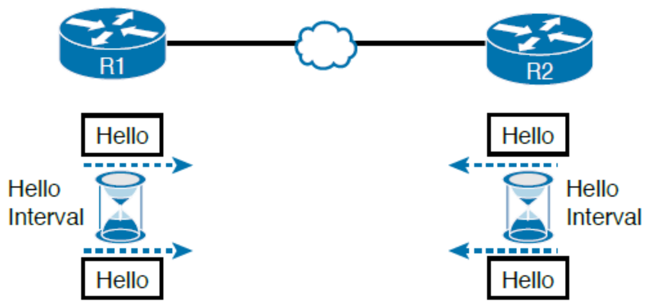
The process starts with messages called OSPF ***Hello* messages**. The Hellos in turn list each router's *router ID* (RID), which serves as each router's unique name or identifier for OSPF. Finally, OSPF does several checks of the information in the Hello messages to ensure that the two routers should become neighbors. OSPF RIDs are 32-bit numbers. As a result, most command output lists these as dotted-decimal numbers (DDN). By default, IOS chooses one of the router's interface IPv4 addresses to use as its OSPF RID.



OSPF Neighbor Forming cont.

Routers R1 and R2 both send Hello messages onto the link. They continue to send Hellos ata regular interval based on their Hello timer settings. The Hello messages themselves have the following features:

- The Hello message follows the IP packet header, with IP protocol type 89.
- Hello packets are sent to multicast IP address 224.0.0.5, a multicast IP address intended for all OSPF-speaking routers.
- OSPF routers listen for packets sent to IP multicast address 224.0.0.5, in part hoping to receive Hello packets and learn about new neighbors.

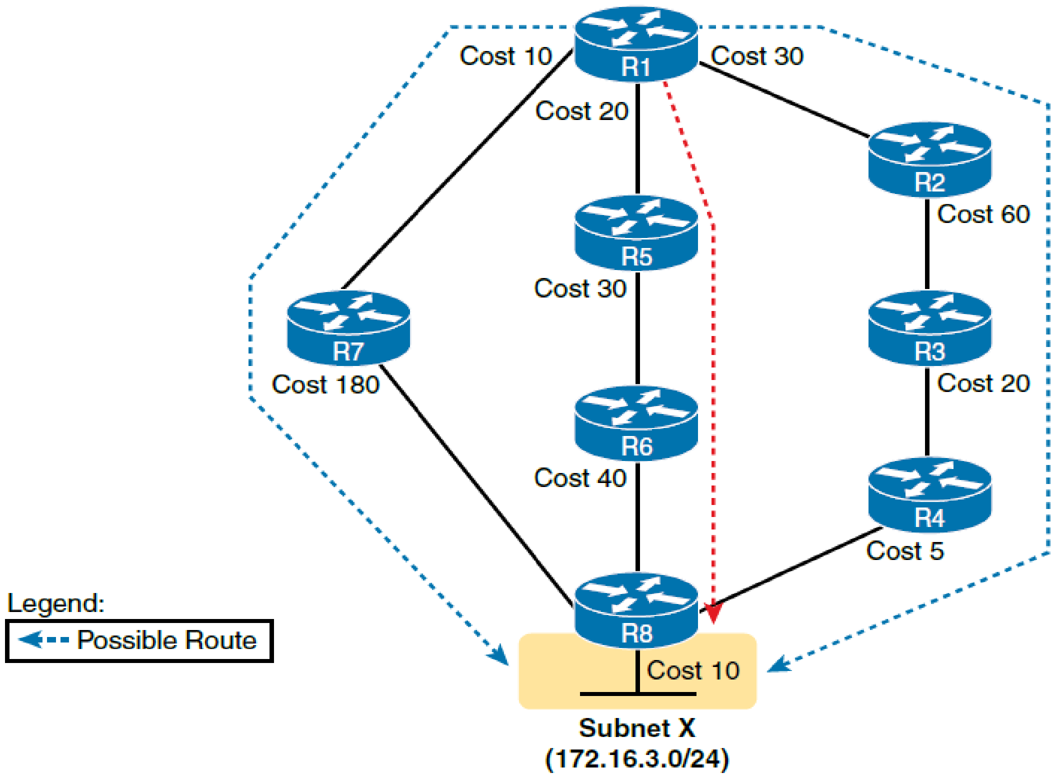


Calculating the Best Routes with SPF

Once SPF has identified a route, OSPF calculates the metric for a route as follows:

The sum of the OSPF interface costs for all outgoing interfaces in the route.

Figure shows an example with three possible routes from R1 to Subnet X (172.16.3.0/24) at the bottom of the figure.



R1–R7–R8	Left	10 + 180 + 10 = 200
R1–R5–R6–R8	Middle	20 + 30 + 40 + 10 = 100
R1–R2–R3–R4–R8	Right	30 + 60 + 20 + 5 + 10 = 125

That is all for Lesson 20

The key is :

Learn

Repeat

Practice

You will be able to reach your goals.

GOOD LUCK !!!!!...