BSCI

Section 5

Intermediate System-to-Intermediate System (IS-IS)

Intermediate System-to-Intermediate System (IS-IS) is a routing protocol developed by the ISO. It is a link-state protocol and behaves much like Open Shortest Path First (OSPF). The two protocols have some significant differences, however.

IS-IS was developed as part of the Open System Interconnection (OSI) stack of protocols. It uses OSI protocols to deliver its packets and establish its adjacencies. IS-IS routers need to be assigned OSI addresses, which they use as a Router ID to create network structure.

IS-IS has been adapted to carry IP network information, and this form is called Integrated IS-IS. Integrated IS-IS has the most important characteristic necessary in a modern routing protocol: It supports VLSM and converges rapidly. It is also scalable to support very large networks.

Question 1

What type of company typically uses IS-IS?

Question 2

Describe IS-IS Level 1 routing.

Question 1 Answer

Large ISPs typically use IS-IS because it is scalable to very large networks.

Question 2 Answer

Level 1 routing is routing within an IS-IS area. Level 1 routing is done based on System ID. Any traffic bound for other areas is sent to a router that performs Level 2 functions.

Question 3

Describe IS-IS Level 2 routing.

Question 4

What is the role of a L1/L2 IS-IS router?

Question 3 Answer

Level 2 routing is routing between areas. Level 2-capable routers comprise the IS-IS backbone and can be in separate areas. Any traffic bound for other areas must go through a Level 2-capable router. Level 2 routing is based on area ID.

Question 4 Answer

A L1/L2 router performs both Level 1 and Level 2 routing functions. This type of router is equivalent to an Area Border Router (ABR) in OSPF. It communicates with Level 1 routers and also with Level 2-capable routers.

Question 5

Describe the differences in backbone requirements between OSPF and IS-IS.

Question 6

What are the three parts of the OSI address used by a Cisco router running IS-IS?

Question 5 Answer

OSPF requires that an area be defined as a backbone area and that each other area border that backbone area. Special configuration (a virtual link) is required for any area that does not border the backbone area. IS-IS backbone routers can reside in any area. There merely must be an unbroken chain of Level 2 or Level 1/2 routers in order for the backbone to function.

Question 6 Answer

The three parts are area address, system ID, and NSEL. The area address can be from 1 to 13 bytes in length. All routers in an area use the same area address. The system ID is 6 bytes in length and should be unique to each router. The NSEL is 1 byte long and always has a value of 00 for routers.

Question 7

A router has a Network Entity Title (NET) of 49.001a.1122.3344.5566.00. To what area does this router belong, and what is its system ID?

Question 8

How many NSAP addresses does a router with 8 serial and 2 Ethernet interfaces need if all the interfaces are running IS-IS?

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Question 7 Answer

The area is 49.001a. The router's system ID is 1122.3344.5566. The easiest way to figure this out is to start from the right and work towards the left. The last two numbers of the NET are the NSEL; they are always 00 on a router. The next 12 numbers (separated into 3 groups of 4 numbers) are the system ID. On Cisco routers, the system ID is always this length—6 bytes. Anything to the left of the system ID is the area ID.

Question 8 Answer

IS-IS devices need only one NSAP address, regardless of how many interfaces they have (although they are allowed to have up to three to deal with migrations). The address is assigned to the device itself. Contrast this with IP, where each interface is assigned a unique IP address.

Question 9

Which of the following is a valid router NET address, and why?

- 2.49.0000.00c0.1234.00
- 40.0000.00c0.1234.56
- 1234.5678.90ab.cdef.0001.00

Question 10

Compare IS-IS routing between areas with IS-IS routing within an area.

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Question 9 Answer

- 2.49.0000.00c0.1234.00 is *not* a valid NET address because the first number in the area address has to be at least one byte (two numbers) long.
- 40.0000.00c0.1234.56 is *not* a valid NET address because the last two numbers, the NSEL, must always be 00.
- 1234.5678.90ab.cdef.0001.00 is a valid NET address. The area ID is 1234.5678, and the system ID is 90ab.cdef.0001. The NSEL is 00.

Question 10 Answer

Inter-area, or Level 2, routing is done based on area ID. The SPF algorithm is run to determine the shortest path to other areas. Once the packet reaches the destination area, then intra-area, or Level 1, routing is done based on system ID. The SPF algorithm is run to determine the shortest path to each system in the area. Note that in IS-IS, the SPF algorithm does not calculate paths to IP networks, just areas and end systems. Thus, when the IP information changes, the SPF algorithm does not need to be recalculated.

Question 11

Describe the link-state databases maintained by a L1 router, a L2 router, and a L1/L2 router.

Question 12

In IS-IS routing, where are area boundaries? Where are they in OSPF routing?

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Question 11 Answer

A L1 router maintains a database of all routers within the area and tags L1/L2 routers for use as default routes. A L2 router maintains a database of all the areas in the autonomous system and the closest next-hop L2 or L1/L2 router for each area. A L1/L2 router maintains two separate databases—a L1 database for intra-area routing and a L2 database for inter-area routing. It also advertises a default route into its area.

Question 12 Answer

In IS-IS, the area boundaries are on the links between routers. Area membership is assigned to a router as a whole. In OSPF, the area boundaries are within the router. Area membership is assigned on an interface-by-interface basis.

Question 13

What are the four types of IS-IS protocol data units (PDUs), and their use?

Question 14

What is the recommended network topology when using IS-IS in a Frame Relay network, and why?

Question 13 Answer

- **Hellos**—Establish and maintain adjacencies
- **LSP (Link State PDU)**—Advertises link-state information
- **CSNP (Complete Sequence Number PDU)**—An update containing the complete list of LSPs known to the router
- **PSNP (Partial Sequence Number PDU)**—Used to acknowledge a routing update (LSP) on point-to-point links and to request missing information about a route after receiving a CSNP

Question 14 Answer

Point-to-point, using subinterfaces. It is possible to run IS-IS in broadcast mode over Frame Relay; however, the network must be fully meshed, and CLNS must be mapped to each DLCI. If one PVC goes down and the network is no longer fully meshed, IS-IS does not work properly. For this reason, it is recommended to use point-to-point subinterfaces instead.

Question 15

If two Cisco routers are directly connected via an Ethernet link, belong to the same area, and both are L1/L2 routers, what types of adjacencies do they establish?

Question 16

Describe the role of the DIS in an IS-IS broadcast network.

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Question 15 Answer

They establish both a L1 and a L2 adjacency, maintain a separate database for each level, and send each other both L1 and L2 types of hellos.

Question 16 Answer

The Designated IS (DIS) creates a logical router called a *pseudonode*. Each router on the LAN forms an adjacency to the pseudonode, as well as to each other. The DIS generates one advertisement for the entire LAN network, on behalf of the pseudonode, rather than each router's advertising the same LAN network. Other routers in the area use the pseudonode's LSP in their SPF calculations for that network. The DIS also ensures that all the routers on the LAN maintain synchronized databases by sending periodic CSNPs out onto the LAN (every 10 seconds by default).

Question 17

What criteria are used in electing the DIS?

Question 18

How often are hellos sent on an IS-IS point-to-point link?

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Question 17 Answer

An IS-IS DIS is elected based on highest priority value, and then on highest SNPA address (typically the MAC address). The priority is assigned to each interface and has a default value of 64. Priority can be configured; the range is 1–127. In case of a tie, the router with the highest SPNA address for that interface is elected the DIS. No backup DIS exists.

Question 18 Answer

Hellos are exchanged every 10 seconds on a point-to-point link, by default.

Question 19

How often are hellos sent on an IS-IS broadcast link?

Question 20

When using Integrated IS-IS, you are routing IP network information. Why then does the router still need a NET address?

Question 19 Answer

Hellos are exchanged every 10 seconds on a broadcast link by all routers except the DIS. The DIS sends a hello every 3.3 seconds.

Question 20 Answer

Because Integrated IS-IS uses a CLNS address to identify the router. SPF calculations are based on system ID and area ID, not IP subnet. Only a partial route calculation is done if IP routing information changes. Routers form CLNS adjacencies based on area ID and IS type; the IP subnet does not even have to match on both sides of a connection for the routers to form an adjacency. If the IP subnet doesn't match, IP does not work properly, however.

Question 21

What command displays the IS-IS adjacencies formed by the router?

Question 22

What command displays the result of the SPF calculations performed by IS-IS (the shortest path to each system and area)?

Question 21 Answer

```
show clns neighbors
```

Recall that IS-IS routers form adjacencies via CLNS.

Question 22 Answer

```
show isis topology
```

On a L1 router, only routers within the local area are listed. On a L1/L2 router, both local and remote routers are listed.

Question 23

What command gives a summary of the IS-IS process on the router?

Question 24

What configuration must be done on a router to begin IS-IS routing, and what are the commands to do so?

Question 23 Answer

```
show clns protocol
```

This command displays the router's system ID, its IS type, area ID, interfaces participating in IS-IS routing, routes being redistributed, the administrative distance for CLNS, and the type of metrics in use.

Question 24 Answer

- **Enable IS-IS routing—router isis** in global config mode
- **Assign the router a NET—net [number]** in router config mode
- **Enable IS-IS on the interfaces—ip router isis** in interface config mode

Question 25

You have an IS-IS router that is performing both L1 and L2 routing and has both L1 and L2 neighbors. How would you optimize the router's operation to conserve bandwidth and router resources?

Question 26

What is a device's OSI address called, and what is the particular type of OSI address used by a router called?

Question 25 Answer

Configure each interface as either L1 or L2 circuit type, depending on the type of adjacency needed out that interface. The command to do this is, at the interface configuration mode, **isis circuit-type [level-1 | level-1-2 | level-2-only]**. This prevents unnecessary hellos from being sent out interfaces, which uses bandwidth and router resources.

Question 26 Answer

An OSI address is called a Network Service Access Point, or NSAP. It is composed of an area address, a system ID, and the NSAP selector byte, or NSEL. When the NSEL is set to 00, the address is called a Network Entity Title, or NET. A router's NSEL is always 00, so the router's address is a NET.

Question 27

What is a SNPA, and how it is derived?

Question 28

A Level 1 (L1) router has traffic bound for a router in a different area. What does the L1 router do with the traffic?

Question 27 Answer

SNPA stands for Subnetwork Point of Attachment. It identifies a point at which a device connects to a network. It is roughly equivalent to a Layer 2 address in the non-CLNS world. The SNPA for a local-area network (LAN) connection is the MAC address of the interface. The SNPA for a wide-area network (WAN) interface is the virtual circuit identifier. For example, the data-link connection identifier (DLCI) on a Frame Relay connection. If the WAN interface is using High-Level Data Link Control (HDLC) encapsulation, the SNPA is simply *HDLC*. For example:

```
R2# show clns neighbor
System Id Interface SNPA            State  Holdtime  Type  Protocol
R1        Et0       0000.0c09.9fea  Up     24        L1L2  IS-IS
R3        Se0       *HDLC*          Up     28        L1L2  IS-IS
```

Question 28 Answer

A Level 1 router has routes only to systems within its own area, and a default route for everything else. The default route points to a router doing Level 2 (L2) routing. Any traffic bound for a destination out of the local area is sent to the closest L1/L2 router. The SPF algorithm is used to determine the shortest paths to local area routers and L1/L2 routers.

Question 29

What two types of network topology are supported by IS-IS?

Question 29 Answer

Broadcast and point-to-point. Broadcast topology typically describes a LAN, but it might also be used with an NBMA network such as Frame Relay.