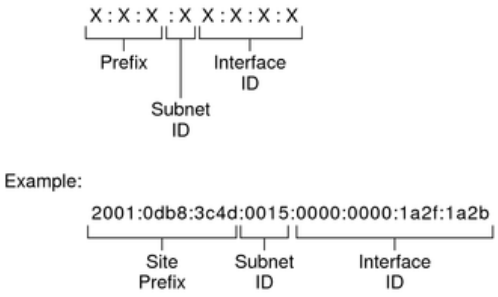
Part I: Understanding IPV6 protocol

1. Demonstrate the differences between IPv4 and IPv6

| | IPv4 | IPv6 |
|---|---|---|
| Bit Size | 32-bit address | 128 bit-address |
| Error detection | Checksum not available | Checksum is available |
| Header size | Minimum 20, bytes, upto 60 bytes | Fixed 40 bytes |
| Fragmentation | Fragmentation is done at sender or routers | It is only done at the sender side |
| Encryption and Authentication | Not available | Available |
| Representation | Represented in decimal | Represented in hexadecimal |
| DHCP configuration | It Supports Manual and DHCP address configuration | It supports Auto and renumbering address configuration |
| Transmission scheme | Broadcast | Multicast |
| Classes | It has five classes A-E | Has no classes |

2. Explain the IPv6 address format.




IPv6 Addressing Overview - System Administration Guide: IP Services

The leftmost 48 bits represent the site prefix which describe the public topology provided by the ISP. The next 16-bits represent the subnet ID which describes the private topology which is internal to the network. The next 64-bits represent the interface id which is either assigned from the MAC address or configured manually in EUI-64.

3. Explain the following Address types:

a. Global Unicast Address

This is a globally unique address that is used to identify specific nodes in the Internet. One Global Unicast Address identifies only one device and is used in one to one communications.

b. Unique Local Address

This type of addresses is used similar to global unicast addresses, however is limited to only private networks. This type can not be used in communication across the public internet. It has the prefix (fc00::/7). This type is also used to overcome the addressing conflicts when combining multiple private sites without renumbering. And is independent of internet connectivity.

c. Link Local Address:

Link Local Addressare intended for addressing on a single link for applications such as automated address setting or when routers are unavailable. It can also communicate with other nodes on the same network. The size of the address is 128 bits. The leftmost 10 bits is 1111111010 followed by 54 bits all zeros then 64 -bit which represents the interface id.

4. What is SLAAC?

SLAAC stands for Stateless Address Auto-configuration, which is an IPv6 feature that is used to auto assign addresses and auto configure devices on a network without keeping track of any meta-data of which devices are connected and which addresses are used. It is a bit similar to DHCP protocol, however DHCP is a Stateful Address Auto-configuration protocol. In SLAAC, there is no server responsible for managing conflicts in addresses, however each node is responsible for tackling the conflict itself. It works by the following five steps:

1. A new devices configure itself with a Link Local Address
2. This new device performs duplicate address detection (DAD)
3. Solicitation message is sent to the router
    a. Asks the routers on the network for the global unicast prefix
    b. Each router advertises its prefix
4. The device configures the local unique address
5. Then repeat DAD

Part II: Understanding IS-IS protocol

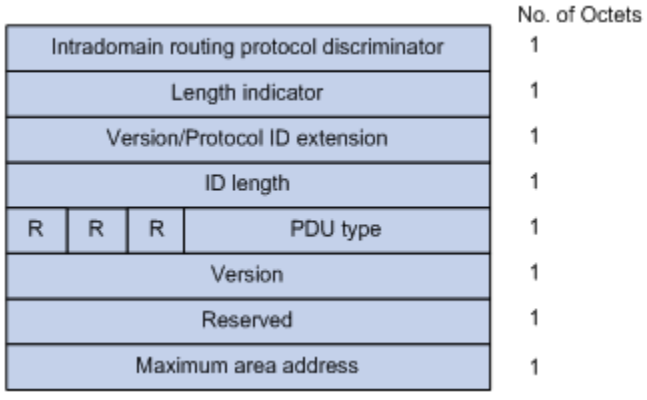
1. What is the IS-IS protocol and why is it used?

The IS-IS protocol is an interior gateway protocol (IGP) that makes routing decisions based on link-state information. It is developed by ANSI ISO. IGP that determines routes using the shortest-path-first algorithm (Dijkstra) like OSPF. IS-IS was created to allow datagrams to be routed using the CLNS OSI protocol stack provided by ISO, then the protocol was later extended to include IP routing.

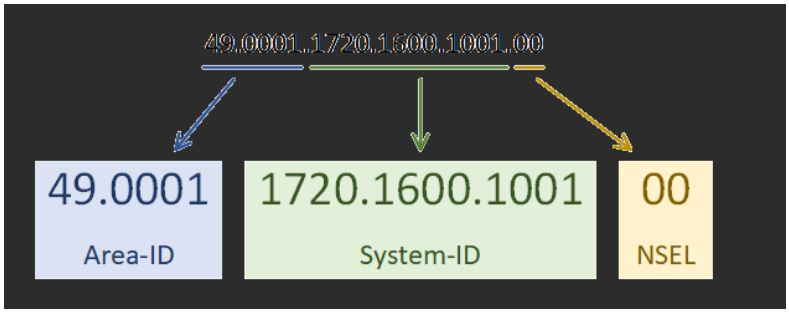
2. Discuss IS-IS packets

IS-IS packets are classified into three categories. Hello packets which are used to establish adjacency between neighbors. Link state packets are used to spread the routing knowledge between different nodes. Sequence number packets manage the flow of link packets by providing synchronization between the distributed routing tables. It is composed of header and variable length fields. The variable length field consists of 1 byte which describes the content of information. The size of this part depends on the content of the information. Typically, the value is composed of repeated blocks of similar information, the length of which is specified in a 1-byte length field. Type length and value combine together to form a tuple called TLV. There is a slight difference in the composition of the headers between 3 types of IS-IS packets, however the first eight bytes are repeated in all packets. Each packet then has its own different header field which varies in composition, length and order followed by TLVs.

Format of header field shared by all IS-IS packets



3.Discuss the ISO Network Addresses used by the protocol.




The network address is used to identify the router.As shown from the diagram, the address is divided into parts. The first part is the area id which is variable length; it must be at least one byte. The routers in the same area share the same area-id. The second part is the system id where each router has a unique system id in the area. NSEL stands for N-Selector. In the OSI stack, this has a special meaning, however for IS-IS, it will always be zero.

4.Discuss the different levels of the protocol.

In the IS-IS protocol the topology is divided into areas like the OSPF area divisions. Each few routers are set to be neighbors if they share the same area. The communication between the routers classify them into the following levels:

- Level one routers (L1) are able to communicate and route to routers in the same area
- Level two routers (L2) are able to communicate and route to routers in different area
- Routers can have both levels (L1-L2)

5.How is the matrix calculated in IS-IS protocol?

Each node has a default cost value of 10, and uses dijkestra's algorithm to update the weights and find the shortest path for each node. The total cost from a source node to a destination is calculated by summing the propagated costs between all intermediate nodes in the path from source to destination. There is an upper bound of the calculated cost which is 1023, this is insufficient for large networks. Thus. ISIS cannot be used for large networks routing. Unlike other protocols that calculate the costs based on bandwidth, congestion, number of hops, TTL, etc. IS-IS has a set values corresponding to each bandwidth, here is Huwawei's cost table:

| Cost | Bandwidth Range |
|---|---|
| 60 | Interface bandwidth ≤ 10 Mbit/s |
| 50 | 10 Mbit/s < Interface bandwidth ≤ 100 Mbit/s |
| 40 | 100 Mbit/s < Interface bandwidth ≤ 155 Mbit/s |
| 30 | 155 Mbit/s < Interface bandwidth ≤ 622 Mbit/s |
| 20 | 622 Mbit/s < Interface bandwidth ≤ 2.5 Gbit/s |
| 10 | 2.5 Gbit/s < Interface bandwidth |

Configuring the Cost of an IS-IS Interface - S7700 and S9700 V200R011C10 Configuration Guide - IP Unicast Routing - Huawei

6.Explain how routers exchange the topology information with each other.

The ISIS protocol ia a link state routing protocol, that works as follows:

- Each node is responsible for flooding it's and it's neighborship information to the whole network periodically
- Each node has a complete vision of the network topology. And builds graph to run Dijkestra's shortest path algorithm.

7.Discuss and compare between the end systems and intermediate systems.

End systems are either users or processes executing in the computer which is used either to reach information or provide service. In other words, they are the source and destinations of the network. Each end device is distinguished by the address which is used to reach the desired destination. Servers have web server software to provide the data and clients request it and receive it.

Intermediate systems are responsible for delivering data between different end systems. They also connect the end devices to the network

8.What is the main advantage of this protocol against the other interior gateway protocols?

IS-IS is mainly better because it supports both IPv4 and IPv6 protocols, it also supports larger scales of neworks than OSPF due to its layered implementation.

Part III: Practical experiment

# Note: R11 is R7

1- Verify the ipv4 configuration in each router

a. Provide screenshot for each router

```
R1#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES NVRAM  administratively down down
Serial2/0                  unassigned      YES NVRAM  administratively down down
Serial2/1                  10.0.12.1       YES NVRAM  up                    up
Serial2/2                  10.0.15.1       YES NVRAM  up                    up
Serial2/3                  unassigned      YES NVRAM  administratively down down
GigabitEthernet3/0         10.0.11.1       YES NVRAM  up                    up
R1#
```

```
R2#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES NVRAM  administratively down down
Serial2/0                  10.0.12.2       YES NVRAM  up                    up
Serial2/1                  10.0.25.1       YES NVRAM  up                    up
Serial2/2                  unassigned      YES NVRAM  administratively down down
Serial2/3                  unassigned      YES NVRAM  administratively down down
GigabitEthernet3/0         unassigned      YES NVRAM  administratively down down
R2#
```

```
R3#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES NVRAM  administratively down down
Serial2/0                  10.0.13.1       YES NVRAM  up                    up
Serial2/1                  unassigned      YES NVRAM  administratively down down
Serial2/2                  unassigned      YES NVRAM  administratively down down
Serial2/3                  unassigned      YES NVRAM  administratively down down
GigabitEthernet3/0         unassigned      YES NVRAM  administratively down down
GigabitEthernet4/0         unassigned      YES NVRAM  administratively down down
GigabitEthernet5/0         unassigned      YES NVRAM  administratively down down
GigabitEthernet6/0         10.0.14.1       YES NVRAM  up                    up
R3#
```

```
R4#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES NVRAM  administratively down down
Serial2/0                  unassigned      YES NVRAM  administratively down down
Serial2/1                  unassigned      YES NVRAM  administratively down down
Serial2/2                  unassigned      YES NVRAM  administratively down down
Serial2/3                  unassigned      YES NVRAM  administratively down down
GigabitEthernet3/0         10.0.11.2       YES NVRAM  up                    up
GigabitEthernet4/0         unassigned      YES NVRAM  administratively down down
GigabitEthernet5/0         unassigned      YES NVRAM  administratively down down
GigabitEthernet6/0         10.0.14.2       YES NVRAM  up                    up
R4#
```

```
R5#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES NVRAM  administratively down down
Serial2/0                  10.0.15.2       YES NVRAM  up                    up
Serial2/1                  10.0.25.2       YES NVRAM  up                    up
Serial2/2                  unassigned      YES NVRAM  administratively down down
Serial2/3                  unassigned      YES NVRAM  administratively down down
GigabitEthernet3/0         10.0.16.1       YES NVRAM  up                    up
R5#
```

```
R6#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES NVRAM  administratively down down
Serial2/0                  unassigned      YES NVRAM  administratively down down
Serial2/1                  unassigned      YES NVRAM  administratively down down
Serial2/2                  unassigned      YES NVRAM  administratively down down
Serial2/3                  unassigned      YES NVRAM  administratively down down
GigabitEthernet3/0         10.0.16.2       YES NVRAM  up                    up
R6#
```

```
R11#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES unset  administratively down down
Serial2/0                  10.0.13.2       YES manual up                    up
Serial2/1                  unassigned      YES unset  administratively down down
Serial2/2                  unassigned      YES unset  administratively down down
Serial2/3                  unassigned      YES unset  administratively down down
GigabitEthernet3/0         10.0.17.1       YES manual up                    up
R11#
```

```
R8#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            unassigned      YES NVRAM  administratively down down
Serial2/0                  unassigned      YES NVRAM  administratively down down
Serial2/1                  unassigned      YES NVRAM  administratively down down
Serial2/2                  unassigned      YES NVRAM  administratively down down
Serial2/3                  unassigned      YES NVRAM  administratively down down
GigabitEthernet3/0         10.0.17.2       YES NVRAM  up                    up
R8#
```

2- Verify the ipv6 configuration in each router

a. Provide screenshot for each router

```
R1#show ipv6 interface brief
FastEthernet0/0        [administratively down/down]
    unassigned
Serial2/0              [administratively down/down]
    unassigned
Serial2/1              [up/up]
    FE80::C801:1BFF:FE94:0
    2001:D88:11:A001::1
Serial2/2              [up/up]
    FE80::C801:1BFF:FE94:0
    2001:D88:11:A002::1
Serial2/3              [administratively down/down]
    unassigned
GigabitEthernet3/0     [up/up]
    FE80::C801:1BFF:FE94:54
    2001:D88:11:A003::1
R1#
```

```
R2#show ipv6 interface brief
FastEthernet0/0        [administratively down/down]
    unassigned
Serial2/0              [up/up]
    FE80::C802:21FF:FE28:0
    2001:D88:11:A001::2
Serial2/1              [up/up]
    FE80::C802:21FF:FE28:0
    2001:D88:11:A004::1
Serial2/2              [administratively down/down]
    unassigned
Serial2/3              [administratively down/down]
    unassigned
GigabitEthernet3/0     [administratively down/down]
    unassigned
R2#
```

```
R3#show ipv6 interface brief
FastEthernet0/0        [administratively down/down]
    unassigned
Serial2/0              [up/up]
    FE80::C803:11FF:FE7C:0
    2001:D88:11:A006::1
Serial2/1              [administratively down/down]
    unassigned
Serial2/2              [administratively down/down]
    unassigned
Serial2/3              [administratively down/down]
    unassigned
GigabitEthernet3/0     [administratively down/down]
    unassigned
GigabitEthernet4/0     [administratively down/down]
    unassigned
GigabitEthernet5/0     [administratively down/down]
    unassigned
GigabitEthernet6/0     [up/up]
    FE80::C803:11FF:FE7C:A8
    2001:D88:11:A005::1
R3#
```

```
R4#show ipv6 interface brief
FastEthernet0/0        [administratively down/down]
    unassigned
Serial2/0              [administratively down/down]
    unassigned
Serial2/1              [administratively down/down]
    unassigned
Serial2/2              [administratively down/down]
    unassigned
Serial2/3              [administratively down/down]
    unassigned
GigabitEthernet3/0     [up/up]
    FE80::C804:42FF:FE14:54
    2001:D88:11:A003::2
GigabitEthernet4/0     [administratively down/down]
    unassigned
GigabitEthernet5/0     [administratively down/down]
    unassigned
GigabitEthernet6/0     [up/up]
    FE80::C804:42FF:FE14:A8
    2001:D88:11:A005::2
R4#
```

```
R5#show ipv6 interface brief
FastEthernet0/0        [administratively down/down]
    unassigned
Serial2/0              [up/up]
    FE80::C805:2DFF:FE98:0
    2001:D88:11:A002::2
Serial2/1              [up/up]
    FE80::C805:2DFF:FE98:0
    2001:D88:11:A004::2
Serial2/2              [administratively down/down]
    unassigned
Serial2/3              [administratively down/down]
    unassigned
GigabitEthernet3/0     [up/up]
    FE80::C805:2DFF:FE98:54
    2001:D88:11:A007::1
R5#
```

```
R6#show ipv6 interface brief
FastEthernet0/0        [administratively down/down]
    unassigned
Serial2/0              [administratively down/down]
    unassigned
Serial2/1              [administratively down/down]
    unassigned
Serial2/2              [administratively down/down]
    unassigned
Serial2/3              [administratively down/down]
    unassigned
GigabitEthernet3/0     [up/up]
    FE80::C806:35FF:FEFC:54
    2001:D88:11:A007::2
R6#
```

```
R11#show ipv6 interface brief
FastEthernet0/0        [administratively down/down]
    unassigned
Serial2/0              [up/up]
    FE80::C80B:CFF:FE2C:0
    2001:D88:11:A006::2
Serial2/1              [administratively down/down]
    unassigned
Serial2/2              [administratively down/down]
    unassigned
Serial2/3              [administratively down/down]
    unassigned
GigabitEthernet3/0     [up/up]
    FE80::C80B:CFF:FE2C:54
    2001:D88:11:A008::1
R11#
```

```
R8#show ipv6 interface brief
FastEthernet0/0        [administratively down/down]
    unassigned
Serial2/0              [administratively down/down]
    unassigned
Serial2/1              [administratively down/down]
    unassigned
Serial2/2              [administratively down/down]
    unassigned
Serial2/3              [administratively down/down]
    unassigned
GigabitEthernet3/0     [up/up]
    FE80::C808:45FF:FE3C:54
    2001:D88:11:A008::2
R8#
```

3- Verify the neighborship for each router

a. Provide screenshot for each router

```
R1#show isis neighbors

Tag null:
System Id      Type Interface   IP Address      State Holdtime Circuit Id
R4             L2   Gi3/0       10.0.11.2       UP    7        R4.01
R5             L2   Se2/2       10.0.15.2       UP    28       00
R2             L2   Se2/1       10.0.12.2       UP    26       00
```

```
R2#show isis neighbors

Tag null:
System Id      Type Interface   IP Address      State Holdtime Circuit Id
R1             L2   Se2/0       10.0.12.1       UP    28       00
R5             L2   Se2/1       10.0.25.2       UP    21       01
```

```
R3#show isis neighbors

System Id      Type Interface   IP Address      State Holdtime Circuit Id
R4             L2   Gi6/0       10.0.14.2       UP    7        R4.02
R11            L2   Se2/0       10.0.13.2       UP    23       00
R3#
```

```
R4#show isis neighbors

System Id      Type Interface   IP Address      State Holdtime Circuit Id
R1             L2   Gi3/0       10.0.11.1       UP    22       R4.01
R3             L2   Gi6/0       10.0.14.1       UP    24       R4.02
R4#
```

```
R5#show isis neighbors

System Id      Type Interface   IP Address      State Holdtime Circuit Id
R1             L2   Se2/0       10.0.15.1       UP    25       01
R2             L2   Se2/1       10.0.25.1       UP    25       01
R6             L1   Gi3/0       10.0.16.2       UP    9        R6.01
R5#
```

```
R6#show isis neighbors

System Id      Type Interface   IP Address      State Holdtime Circuit Id
R5             L1   Gi3/0       10.0.16.1       UP    24       R6.01
R6#
```

```
System Id      Type Interface   IP Address      State Holdtime Circuit Id
R3             L2   Se2/0       10.0.13.1       UP    26       00
R8             L1   Gi3/0       10.0.17.2       UP    9        R8.01
```

```
R8#show isis neighbors

System Id      Type Interface   IP Address      State Holdtime Circuit Id
R11            L1   Gi3/0       10.0.17.1       UP    9        R11.01
R8#
```

4- Verify IS-IS database for each router

a. Provide screenshot for each router

```
R1#show isis database

Tag null:
IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R1.00-00            * 0x00000005   0x28B7        709               1/0/0
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00              0x0000000A   0xCDE2        1176              0/0/0
R1.00-00            * 0x00000007   0x2BB4        661               0/0/0
R2.00-00              0x00000006   0xECB1        718               0/0/0
R4.00-00              0x00000005   0x982D        701               0/0/0
R4.01-00              0x00000004   0xE68E        789               0/0/0
R4.02-00              0x00000004   0x64CB        789               0/0/0
R5.00-00              0x00000005   0xE708        799               0/0/0
R11.00-00             0x00000005   0x2781        472               0/0/0

Tag 1:
IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R1.00-00            * 0x00000004   0xE062        696               0/0/0
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R1.00-00            * 0x00000004   0xE062        815               0/0/0
R1#
```

```
R2#show isis database

Tag null:
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00              0x0000000A   0xCDE2        1169              0/0/0
R1.00-00              0x00000007   0x2BB4        653               0/0/0
R2.00-00            * 0x00000006   0xECB1        714               0/0/0
R4.00-00              0x00000005   0x982D        693               0/0/0
R4.01-00              0x00000004   0xE68E        782               0/0/0
R4.02-00              0x00000004   0x64CB        781               0/0/0
R5.00-00              0x00000005   0xE708        793               0/0/0
R11.00-00             0x00000005   0x2781        465               0/0/0

Tag 1:
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R2.00-00            * 0x00000004   0xEC2C        630               0/0/0
R2#
```

```
R3#show isis neighbors

System Id      Type Interface   IP Address      State Holdtime Circuit Id
R4             L2   Gi6/0       10.0.14.2       UP    7        R4.02
R11            L2   Se2/0       10.0.13.2       UP    23       00
R3#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00            * 0x00000009   0x0936        781               1/0/0
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00            * 0x0000000A   0xCDE2        1168              0/0/0
R1.00-00              0x00000007   0x2BB4        645               0/0/0
R2.00-00              0x00000006   0xECB1        702               0/0/0
R4.00-00              0x00000005   0x982D        689               0/0/0
R4.01-00              0x00000004   0xE68E        778               0/0/0
R4.02-00              0x00000004   0x64CB        777               0/0/0
R5.00-00              0x00000005   0xE708        783               0/0/0
R11.00-00             0x00000005   0x2781        464               0/0/0
R3#
```

```
R4#show isis neighbors

System Id      Type Interface   IP Address      State Holdtime Circuit Id
R1             L2   Gi3/0       10.0.11.1       UP    22       R4.01
R3             L2   Gi6/0       10.0.14.1       UP    24       R4.02
R4#show isis database

IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00              0x0000000A   0xCDE2        1162              0/0/0
R1.00-00              0x00000007   0x2BB4        642               0/0/0
R2.00-00              0x00000006   0xECB1        700               0/0/0
R4.00-00            * 0x00000005   0x982D        686               0/0/0
R4.01-00            * 0x00000004   0xE68E        775               0/0/0
R4.02-00            * 0x00000004   0x64CB        774               0/0/0
R5.00-00              0x00000005   0xE708        780               0/0/0
R11.00-00             0x00000005   0x2781        458               0/0/0
R4#
```

```
R5#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R6.00-00              0x00000005   0xABA8        756               0/0/0
R6.01-00              0x00000004   0xFBE1        775               0/0/0
R5.00-00            * 0x00000006   0xF2A8        606               1/0/0
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00              0x0000000A   0xCDE2        1155              0/0/0
R1.00-00              0x00000007   0x2BB4        639               0/0/0
R2.00-00              0x00000006   0xECB1        698               0/0/0
R4.00-00              0x00000005   0x982D        679               0/0/0
R4.01-00              0x00000004   0xE68E        768               0/0/0
R4.02-00              0x00000004   0x64CB        767               0/0/0
R5.00-00            * 0x00000005   0xE708        781               0/0/0
R11.00-00             0x00000005   0x2781        451               0/0/0
R5#
```

```
R6#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R6.00-00            * 0x00000005   0xABA8        754               0/0/0
R6.01-00            * 0x00000004   0xFBE1        773               0/0/0
R5.00-00              0x00000006   0xF2A8        601               1/0/0
R6#
```

```
R11#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00              0x00000005   0x4141        983               0/0/0
R11.00-00           * 0x00000008   0x83C3        1054              1/0/0
R11.01-00           * 0x00000004   0x0F33        1023              0/0/0
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00              0x0000000A   0xCDE2        1149              0/0/0
R1.00-00              0x00000007   0x2BB4        625               0/0/0
R2.00-00              0x00000006   0xECB1        683               0/0/0
R4.00-00              0x00000005   0x982D        669               0/0/0
R4.01-00              0x00000004   0xE68E        758               0/0/0
R4.02-00              0x00000004   0x64CB        757               0/0/0
R5.00-00              0x00000005   0xE708        763               0/0/0
R11.00-00           * 0x00000005   0x2781        448               0/0/0
R11#
```

```
R8#show isis neighbors

System Id      Type Interface   IP Address      State Holdtime Circuit Id
R11            L1   Gi3/0       10.0.17.1       UP    9        R11.01
R8#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R8.00-00            * 0x00000005   0x4141        972               0/0/0
R11.00-00             0x00000008   0x83C3        1040              1/0/0
R11.01-00             0x00000004   0x0F33        1008              0/0/0
R8#
```

5- Show the IS-IS paths to Intermediate Systems interfaces for each router show the next hop and comment on the matrix calculation.

Note that the cost varies from 10 to 60, and is incremented by 10 from one node to the next. The shortest path is calculated by dijkstra and the total cost is the sum over the costs along the calculated shortest path.

```
R1#show ip route isis
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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 11 subnets, 2 masks
i L2     10.0.13.0/24 [115/30] via 10.0.11.2, 00:05:55, GigabitEthernet3/0
i L2     10.0.14.0/24 [115/20] via 10.0.11.2, 00:06:04, GigabitEthernet3/0
i L2     10.0.16.0/24 [115/20] via 10.0.15.2, 00:05:19, Serial2/2
i L2     10.0.17.0/24 [115/40] via 10.0.11.2, 00:04:22, GigabitEthernet3/0
i L2     10.0.25.0/24 [115/20] via 10.0.15.2, 00:05:19, Serial2/2
                      [115/20] via 10.0.12.2, 00:05:19, Serial2/1
R1#
```

```
R2#show ip route isis
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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
i L2     10.0.11.0/24 [115/20] via 10.0.12.1, 00:07:08, Serial2/0
i L2     10.0.13.0/24 [115/40] via 10.0.12.1, 00:05:59, Serial2/0
i L2     10.0.14.0/24 [115/30] via 10.0.12.1, 00:06:08, Serial2/0
i L2     10.0.15.0/24 [115/20] via 10.0.25.2, 00:05:44, Serial2/1
                      [115/20] via 10.0.12.1, 00:05:44, Serial2/0
i L2     10.0.16.0/24 [115/20] via 10.0.25.2, 00:05:44, Serial2/1
i L2     10.0.17.0/24 [115/50] via 10.0.12.1, 00:04:26, Serial2/0
R2#
```

```
R3#show ip route isis
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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
i L2     10.0.11.0/24 [115/20] via 10.0.14.2, 00:06:03, GigabitEthernet6/0
i L2     10.0.12.0/24 [115/30] via 10.0.14.2, 00:06:03, GigabitEthernet6/0
i L2     10.0.15.0/24 [115/30] via 10.0.14.2, 00:06:03, GigabitEthernet6/0
i L2     10.0.16.0/24 [115/40] via 10.0.14.2, 00:05:26, GigabitEthernet6/0
i L2     10.0.17.0/24 [115/20] via 10.0.13.2, 00:04:30, Serial2/0
i L2     10.0.25.0/24 [115/40] via 10.0.14.2, 00:05:26, GigabitEthernet6/0
R3#
```

```
R4#show ip route isis
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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
i L2     10.0.12.0/24 [115/20] via 10.0.11.1, 00:06:19, GigabitEthernet3/0
i L2     10.0.13.0/24 [115/20] via 10.0.14.1, 00:06:06, GigabitEthernet6/0
i L2     10.0.15.0/24 [115/20] via 10.0.11.1, 00:06:19, GigabitEthernet3/0
i L2     10.0.16.0/24 [115/30] via 10.0.11.1, 00:05:30, GigabitEthernet3/0
i L2     10.0.17.0/24 [115/30] via 10.0.14.1, 00:04:33, GigabitEthernet6/0
i L2     10.0.25.0/24 [115/30] via 10.0.11.1, 00:05:30, GigabitEthernet3/0
R4#
```

```
R5#show ip route isis
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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 11 subnets, 2 masks
i L2     10.0.11.0/24 [115/20] via 10.0.15.1, 00:05:34, Serial2/0
i L2     10.0.12.0/24 [115/20] via 10.0.25.1, 00:05:34, Serial2/1
                      [115/20] via 10.0.15.1, 00:05:34, Serial2/0
i L2     10.0.13.0/24 [115/40] via 10.0.15.1, 00:05:34, Serial2/0
i L2     10.0.14.0/24 [115/30] via 10.0.15.1, 00:05:34, Serial2/0
i L2     10.0.17.0/24 [115/50] via 10.0.15.1, 00:04:37, Serial2/0
R5#
```

```
R6#show ip route isis
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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 10.0.16.1 to network 0.0.0.0

i*L1  0.0.0.0/0 [115/10] via 10.0.16.1, 00:05:17, GigabitEthernet3/0
      10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
i L1     10.0.15.0/24 [115/20] via 10.0.16.1, 00:05:17, GigabitEthernet3/0
i L1     10.0.25.0/24 [115/20] via 10.0.16.1, 00:05:17, GigabitEthernet3/0
R6#
```

```
R11#show ip route isis
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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
i L2     10.0.11.0/24 [115/30] via 10.0.13.1, 00:04:44, Serial2/0
i L2     10.0.12.0/24 [115/40] via 10.0.13.1, 00:04:44, Serial2/0
i L2     10.0.14.0/24 [115/20] via 10.0.13.1, 00:04:44, Serial2/0
i L2     10.0.15.0/24 [115/40] via 10.0.13.1, 00:04:44, Serial2/0
i L2     10.0.16.0/24 [115/50] via 10.0.13.1, 00:04:44, Serial2/0
i L2     10.0.25.0/24 [115/50] via 10.0.13.1, 00:04:44, Serial2/0
R11#
```

```
R8#show ip route isis
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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 10.0.17.1 to network 0.0.0.0

i*L1  0.0.0.0/0 [115/10] via 10.0.17.1, 00:04:42, GigabitEthernet3/0
      10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
i L1     10.0.13.0/24 [115/20] via 10.0.17.1, 01:04:44, GigabitEthernet3/0
R8#
```

```
R1#show isis topology

IS-IS TID 0 paths to level-1 routers
System Id            Metric     Next-Hop             Interface   SNPA
R1                   --

IS-IS TID 0 paths to level-2 routers
System Id            Metric     Next-Hop             Interface   SNPA
R1                   --
R2                   10         R2                   Se2/1       *HDLC*
R3                   20         R4                   Gi3/0       ca04.26a8.0054
R4                   10         R4                   Gi3/0       ca04.26a8.0054
R5                   10         R5                   Se2/2       *HDLC*
R7                   30         R4                   Gi3/0       ca04.26a8.0054
R1#
```

```
R2#show isis topology


IS-IS TID 0 paths to level-2 routers
System Id            Metric     Next-Hop             Interface   SNPA
R1                   10         R1                   Se2/0       *HDLC*
R2                   --
R3                   30         R1                   Se2/0       *HDLC*
R4                   20         R1                   Se2/0       *HDLC*
R5                   10         R5                   Se2/1       *HDLC*
R7                   40         R1                   Se2/0       *HDLC*
R2#
```

```
R3#show isis topology

IS-IS TID 0 paths to level-1 routers
System Id           Metric     Next-Hop           Interface   SNPA
R3                  --

IS-IS TID 0 paths to level-2 routers
System Id           Metric     Next-Hop           Interface   SNPA
R1                  20         R4                 Gi6/0       ca04.26a8.00a8
R2                  30         R4                 Gi6/0       ca04.26a8.00a8
R3                  --
R4                  10         R4                 Gi6/0       ca04.26a8.00a8
R5                  30         R4                 Gi6/0       ca04.26a8.00a8
R7                  10         R7                 Se2/0       *HDLC*
R3#
```

```
R4#
*May 14 21:30:08.283: %SYS-5-CONFIG_I: Configured from console by console
R4#show isis topology


IS-IS TID 0 paths to level-2 routers
System Id           Metric     Next-Hop           Interface   SNPA
R1                  10         R1                 Gi3/0       ca01.2164.0054
R2                  20         R1                 Gi3/0       ca01.2164.0054
R3                  10         R3                 Gi6/0       ca03.3918.00a8
R4                  --
R5                  20         R1                 Gi3/0       ca01.2164.0054
R7                  20         R3                 Gi6/0       ca03.3918.00a8
R4#
```

```
R5#show isis topology

IS-IS TID 0 paths to level-1 routers
System Id           Metric     Next-Hop           Interface   SNPA
R5                  --
R6                  10         R6                 Gi3/0       ca06.2294.0054

IS-IS TID 0 paths to level-2 routers
System Id           Metric     Next-Hop           Interface   SNPA
R1                  10         R1                 Se2/0       *HDLC*
R2                  10         R2                 Se2/1       *HDLC*
R3                  30         R1                 Se2/0       *HDLC*
R4                  20         R1                 Se2/0       *HDLC*
R5                  --
R7                  40         R1                 Se2/0       *HDLC*
R5#
```

```
R6#show isis topology

IS-IS TID 0 paths to level-1 routers
System Id           Metric     Next-Hop           Interface   SNPA
R5                  10         R5                 Gi3/0       ca05.0878.0054
R6                  --
R6#
```

```
R7#show isis topology

IS-IS TID 0 paths to level-1 routers
System Id           Metric     Next-Hop           Interface   SNPA
R7                  --
R9                  10         R9                 Gi3/0       ca09.2a58.0054

IS-IS TID 0 paths to level-2 routers
System Id           Metric     Next-Hop           Interface   SNPA
R1                  30         R3                 Se2/0       *HDLC*
R2                  40         R3                 Se2/0       *HDLC*
R3                  10         R3                 Se2/0       *HDLC*
R4                  20         R3                 Se2/0       *HDLC*
R5                  40         R3                 Se2/0       *HDLC*
R7                  --
R7#
```

```
R9#show isis topology

IS-IS TID 0 paths to level-1 routers
System Id           Metric     Next-Hop            Interface   SNPA
R7                  10         R7                  Gi3/0       ca07.3f98.0054
R9                  --
R9#
```

6- Verify the routes for both IPv4 and IPv6 for each router.

ipv4

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

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 11 subnets, 2 masks
C        10.0.11.0/24 is directly connected, GigabitEthernet3/0
L        10.0.11.1/32 is directly connected, GigabitEthernet3/0
C        10.0.12.0/24 is directly connected, Serial2/1
L        10.0.12.1/32 is directly connected, Serial2/1
i L2     10.0.13.0/24 [115/30] via 10.0.11.2, 00:49:22, GigabitEthernet3/0
i L2     10.0.14.0/24 [115/20] via 10.0.11.2, 00:51:44, GigabitEthernet3/0
C        10.0.15.0/24 is directly connected, Serial2/2
L        10.0.15.1/32 is directly connected, Serial2/2
i L2     10.0.16.0/24 [115/20] via 10.0.15.2, 00:52:03, Serial2/2
 --More--
```

```
R2#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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
i L2     10.0.11.0/24 [115/20] via 10.0.12.1, 00:52:44, Serial2/0
C        10.0.12.0/24 is directly connected, Serial2/0
L        10.0.12.2/32 is directly connected, Serial2/0
i L2     10.0.13.0/24 [115/40] via 10.0.12.1, 00:49:43, Serial2/0
i L2     10.0.14.0/24 [115/30] via 10.0.12.1, 00:52:05, Serial2/0
i L2     10.0.15.0/24 [115/20] via 10.0.25.2, 00:52:24, Serial2/1
                      [115/20] via 10.0.12.1, 00:52:24, Serial2/0
i L2     10.0.16.0/24 [115/20] via 10.0.25.2, 00:52:24, Serial2/1
i L2     10.0.17.0/24 [115/50] via 10.0.12.1, 00:45:48, Serial2/0
 --More--
```

```
R3#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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
i L2     10.0.11.0/24 [115/20] via 10.0.14.2, 00:52:10, GigabitEthernet6/0
i L2     10.0.12.0/24 [115/30] via 10.0.14.2, 00:52:10, GigabitEthernet6/0
C        10.0.13.0/24 is directly connected, Serial2/0
L        10.0.13.1/32 is directly connected, Serial2/0
C        10.0.14.0/24 is directly connected, GigabitEthernet6/0
L        10.0.14.1/32 is directly connected, GigabitEthernet6/0
i L2     10.0.15.0/24 [115/30] via 10.0.14.2, 00:52:10, GigabitEthernet6/0
i L2     10.0.16.0/24 [115/40] via 10.0.14.2, 00:52:10, GigabitEthernet6/0
i L2     10.0.17.0/24 [115/20] via 10.0.13.2, 00:45:54, Serial2/0
 --More--
```

```
R4#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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
C        10.0.11.0/24 is directly connected, GigabitEthernet3/0
L        10.0.11.2/32 is directly connected, GigabitEthernet3/0
i L2     10.0.12.0/24 [115/20] via 10.0.11.1, 00:52:15, GigabitEthernet3/0
i L2     10.0.13.0/24 [115/20] via 10.0.14.1, 00:49:51, GigabitEthernet6/0
C        10.0.14.0/24 is directly connected, GigabitEthernet6/0
L        10.0.14.2/32 is directly connected, GigabitEthernet6/0
i L2     10.0.15.0/24 [115/20] via 10.0.11.1, 00:52:15, GigabitEthernet3/0
i L2     10.0.16.0/24 [115/30] via 10.0.11.1, 00:52:15, GigabitEthernet3/0
i L2     10.0.17.0/24 [115/30] via 10.0.14.1, 00:45:57, GigabitEthernet6/0
 --More--
```

```
R5#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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 11 subnets, 2 masks
i L2     10.0.11.0/24 [115/20] via 10.0.15.1, 00:52:36, Serial2/0
i L2     10.0.12.0/24 [115/20] via 10.0.25.1, 00:52:36, Serial2/1
                      [115/20] via 10.0.15.1, 00:52:36, Serial2/0
i L2     10.0.13.0/24 [115/40] via 10.0.15.1, 00:49:54, Serial2/0
i L2     10.0.14.0/24 [115/30] via 10.0.15.1, 00:52:16, Serial2/0
C        10.0.15.0/24 is directly connected, Serial2/0
L        10.0.15.2/32 is directly connected, Serial2/0
C        10.0.16.0/24 is directly connected, GigabitEthernet3/0
L        10.0.16.1/32 is directly connected, GigabitEthernet3/0
 --More--
```

```
R6#show isis database

IS-IS Level-1 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R6.00-00            * 0x00000005   0xABA8        754               0/0/0
R6.01-00            * 0x00000004   0xFBE1        773               0/0/0
R5.00-00              0x00000006   0xF2A8        601               1/0/0
R6#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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 10.0.16.1 to network 0.0.0.0

i*L1  0.0.0.0/0 [115/10] via 10.0.16.1, 00:52:38, GigabitEthernet3/0
      10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
i L1     10.0.15.0/24 [115/20] via 10.0.16.1, 00:52:38, GigabitEthernet3/0
C        10.0.16.0/24 is directly connected, GigabitEthernet3/0
L        10.0.16.2/32 is directly connected, GigabitEthernet3/0
i L1     10.0.25.0/24 [115/20] via 10.0.16.1, 00:52:38, GigabitEthernet3/0
R6#
```

```
R11#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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 10 subnets, 2 masks
i L2     10.0.11.0/24 [115/30] via 10.0.13.1, 00:46:18, Serial2/0
i L2     10.0.12.0/24 [115/40] via 10.0.13.1, 00:46:18, Serial2/0
C        10.0.13.0/24 is directly connected, Serial2/0
L        10.0.13.2/32 is directly connected, Serial2/0
i L2     10.0.14.0/24 [115/20] via 10.0.13.1, 00:46:18, Serial2/0
i L2     10.0.15.0/24 [115/40] via 10.0.13.1, 00:46:18, Serial2/0
i L2     10.0.16.0/24 [115/50] via 10.0.13.1, 00:46:18, Serial2/0
C        10.0.17.0/24 is directly connected, GigabitEthernet3/0
L        10.0.17.1/32 is directly connected, GigabitEthernet3/0
 --More--
```

```
R8#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
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is 10.0.17.1 to network 0.0.0.0

i*L1  0.0.0.0/0 [115/10] via 10.0.17.1, 00:46:09, GigabitEthernet3/0
      10.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
i L1     10.0.13.0/24 [115/20] via 10.0.17.1, 00:46:09, GigabitEthernet3/0
C        10.0.17.0/24 is directly connected, GigabitEthernet3/0
L        10.0.17.2/32 is directly connected, GigabitEthernet3/0
R8#
```

ipv6

```
R1#show ipv6 route
IPv6 Routing Table - default - 7 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
       lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
C   2001:D88:11:A001::/64 [0/0]
     via Serial2/1, directly connected
L   2001:D88:11:A001::1/128 [0/0]
     via Serial2/1, receive
C   2001:D88:11:A002::/64 [0/0]
     via Serial2/2, directly connected
L   2001:D88:11:A002::1/128 [0/0]
     via Serial2/2, receive
C   2001:D88:11:A003::/64 [0/0]
     via GigabitEthernet3/0, directly connected
L   2001:D88:11:A003::1/128 [0/0]
     via GigabitEthernet3/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

```
R2#show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
       lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
C   2001:D88:11:A001::/64 [0/0]
     via Serial2/0, directly connected
L   2001:D88:11:A001::2/128 [0/0]
     via Serial2/0, receive
C   2001:D88:11:A004::/64 [0/0]
     via Serial2/1, directly connected
L   2001:D88:11:A004::1/128 [0/0]
     via Serial2/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

```
R3#show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
       lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
C   2001:D88:11:A005::/64 [0/0]
     via GigabitEthernet6/0, directly connected
L   2001:D88:11:A005::1/128 [0/0]
     via GigabitEthernet6/0, receive
C   2001:D88:11:A006::/64 [0/0]
     via Serial2/0, directly connected
L   2001:D88:11:A006::1/128 [0/0]
     via Serial2/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

```
R4#show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
       lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
C   2001:D88:11:A003::/64 [0/0]
     via GigabitEthernet3/0, directly connected
L   2001:D88:11:A003::2/128 [0/0]
     via GigabitEthernet3/0, receive
C   2001:D88:11:A005::/64 [0/0]
     via GigabitEthernet6/0, directly connected
L   2001:D88:11:A005::2/128 [0/0]
     via GigabitEthernet6/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

```
R5#show ipv6 route
IPv6 Routing Table - default - 7 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
       lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
C   2001:D88:11:A002::/64 [0/0]
     via Serial2/0, directly connected
L   2001:D88:11:A002::2/128 [0/0]
     via Serial2/0, receive
C   2001:D88:11:A004::/64 [0/0]
     via Serial2/1, directly connected
L   2001:D88:11:A004::2/128 [0/0]
     via Serial2/1, receive
C   2001:D88:11:A007::/64 [0/0]
     via GigabitEthernet3/0, directly connected
L   2001:D88:11:A007::1/128 [0/0]
     via GigabitEthernet3/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

```
R6#show ipv6 route
IPv6 Routing Table - default - 3 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
       lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
C   2001:D88:11:A007::/64 [0/0]
     via GigabitEthernet3/0, directly connected
L   2001:D88:11:A007::2/128 [0/0]
     via GigabitEthernet3/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
R6#
```

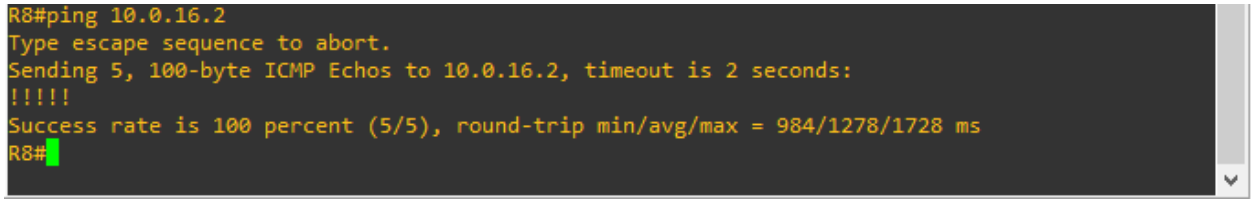
```
R11#show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
       lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
C   2001:D88:11:A006::/64 [0/0]
     via Serial2/0, directly connected
L   2001:D88:11:A006::2/128 [0/0]
     via Serial2/0, receive
C   2001:D88:11:A008::/64 [0/0]
     via GigabitEthernet3/0, directly connected
L   2001:D88:11:A008::1/128 [0/0]
     via GigabitEthernet3/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
R11#
```

```
R8#show ipv6 route
IPv6 Routing Table - default - 3 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, la - LISP alt
       lr - LISP site-registrations, ld - LISP dyn-eid, a - Application
C   2001:D88:11:A008::/64 [0/0]
     via GigabitEthernet3/0, directly connected
L   2001:D88:11:A008::2/128 [0/0]
     via GigabitEthernet3/0, receive
L   FF00::/8 [0/0]
     via Null0, receive
R8#
```

7- By using wireshark show the different packets and comment on each packet ( the packets between R1 &R2) HINT: you should be able to see 4 different packets.

ISIS hello : establishes neighbor ships, and maintains it
ISIS PSNP: caries link information
ISIS LSNP: request link-state PDU information
ISIS LSP: contains a complete list of link-state PDUs

8- From R8 ping R6 one with IPV4 and one with IPV6. (Provide one screenshot for each ping).

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