



## CHAPTER 4

# Integrated IS-IS

This chapter provides information and commands concerning the following Intermediate System-to-Intermediate System (IS-IS) topics:

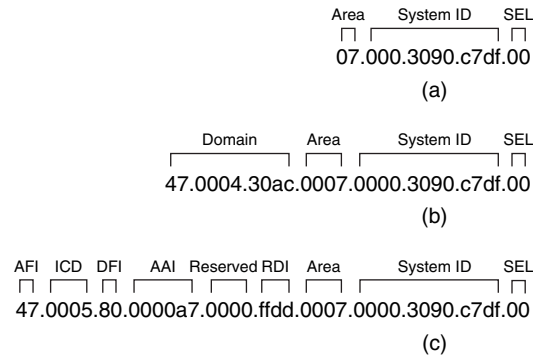
- ISO Network Entity Title (NET)
- Rules for creating a NET
- Examples of NETs: Cisco implementation
- Basic IS-IS configuration
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- Election of the designated IS (DIS)
- Rules for IS-IS adjacencies
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- Defining router types
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### **ISO Network Entity Title (NET)**

Figure 4-1 shows three of the different formats that an ISO NET can take:

- (a) An 8-octet area IS/system ID format
- (b) An OSI NSAP format
- (c) A GOSIP NSAP format

Figure 4-1 Formats for ISO NET



## Rules for Creating a NET

- The NET must begin with a single octet.
- Addresses starting with 49 (AF I= 49) are considered private IP address, analogous to RFC 1918.
  - Routed by IS-IS
  - Should not be advertised to other Connectionless Network Service (CLNS) networks (outside this IS-IS domain)
- Additional 2 bytes added for the area ID.
- All routers in the same area must have the same area address.
- The system ID must be the same number of octets throughout the domain.
- Cisco has implemented a fixed length of 6 octets for the system ID of a NET.
- It is customary to use the MAC address of the router, or an IP address of a loopback interface (192.168.111.3 = 192.168.111.003 = 1921.6811.1003).
- The practice of using a modified loopback IP address as the system ID may now be considered outdated because of the dynamic host name feature. This feature uses a new Type Length Value (TLV 137) to map the router's host name to the system ID.
- Each device must have a unique system ID within the area.
- The NET must end with a single octet—the network service access point (NSAP) selector byte (NSEL), usually set to 0x00.
  - When the NSEL is set to 0, it identifies the device itself.
  - The NSEL is like a TCP port number: It indicates the transport layer.

## Examples of NETs: Cisco Implementation

Example 1: NSAP **47.0001.aaaa.bbbb.cccc.00**

Area ID is **47.0001**  
 System ID is **aaaa.bbbb.cccc**  
 NSAP selector byte is **00**

Example 2: NSAP **39.0f01.0002.0000.0c00.1111.00**

Area ID is **39.0f01.0002**  
 System ID is **0000.0c00.1111**  
 NSAP selector byte is **00**

## Basic IS-IS Configuration

**NOTE:** IS-IS is the only IP routing protocol that must be enabled both as a process and on individual interfaces.

Router(config)# <b>router isis</b>	Enables the IS-IS routing process.
Router(config-router)# <b>network 49.0001.1111.1111.1111.00</b>	Configures the NET.
Router(config-router)# <b>exit</b>	Returns to global configuration mode.
Router(config)# <b>interface fastethernet 0/0</b>	Enters interface configuration mode.
Router(config-if)# <b>ip address 172.16.1.1 255.255.255.0</b>	Assigns the IP address and netmask.
Router(config-if)# <b>ip router isis</b>	Enables IS-IS routing on this interface. A “null” tag (area designator) is used for the routing process if no area tag is given.
	<b>TIP:</b> You cannot issue an <b>ip router isis</b> command on an interface until an IP address has been assigned to that interface.
	<b>NOTE:</b> The <b>ip router isis</b> command must be added to all interfaces whose networks are to be advertised by IS-IS. This includes transit interfaces (interfaces connected to IS-IS neighbors) and interfaces connected to stub networks (interfaces not connected to IS-IS networks).

Router(config-if)# <b>no shutdown</b>	Activates the interface.
Router(config-if)# <b>exit</b>	Returns to global configuration mode.

### Neighbors and Timers

Router(config)# <b>interface fastethernet 0/0</b>	Enters interface configuration mode.
Router(config-if)# <b>isis hello-interval 20</b>	Changes the interval to 20 seconds between exchanges of Hello protocol data units (PDU). The default is 10 seconds.
	<b>NOTE:</b> A faster hello interval facilitates faster convergence but increases bandwidth and CPU use. It might also add to instability in the network. A slower hello interval saves bandwidth and CPU use.
Router(config-if)# <b>isis hello-multiplier 4</b>	Changes the length of the hold-time multiplier. By default, an IS-IS router waits 3 times the hello interval until it considers a neighbor dead.
	<b>TIP:</b> The <b>isis hello-interval</b> and the <b>isis hello-multiplier</b> commands are changed on a per-interface basis. Timers can vary on different interfaces.
	<b>NOTE:</b> It makes more sense to tune the hello interval and hello multiplier on point-to-point interfaces than on LAN interfaces.
	<b>NOTE:</b> Hello intervals and hold times do <i>not</i> have to match between IS-IS neighbors for an adjacency to form.

### Election of the Designated IS (DIS)

Router(config)# <b>interface fastethernet 0/0</b>	Enters interface configuration mode.
Router(config-if)# <b>isis priority 100</b>	Changes the priority to 100 for the DIS election process.
	<b>NOTE:</b> DIS priority is a number that ranges from 0 to 127. The Cisco default is 64. The highest priority wins the DIS election. If all priorities are the same, the numerically highest MAC address wins the election. There is no way to make a router ineligible from being the DIS—there is no IS-IS equivalent to the <b>OSPF priority 0</b> option.
	<b>NOTE:</b> There is <i>no</i> backup DIS.

### Rules for IS-IS Adjacencies

- L1 routers form L1 adjacencies with L1 and L1-L2 routers in their area.
- L2 routers form L2 adjacencies with L2 and L1-L2 routers in their area or another area.
- L1/L2 routers form L1 and L2 adjacencies with each other in their area or another area.
- An L1 router does *not* form an adjacency with an L2 router, regardless of area.
- The system ID must be unique to each router.
- Hello intervals and hold times do *not* have to match.

### Routing Metrics

Router(config)# <b>interface serial 0/0</b>	Enters interface configuration mode.
Router(config-if)# <b>isis metric 50</b>	Changes the metric to 50. The range is from 0 to 63.
	<b>NOTE:</b> The default metric for IS-IS is 10, regardless of interface type. This makes hop count the IS-IS routing metric, if all interfaces are left at the default metric.

	<b>NOTE:</b> The total cost of any route is a sum of the individual metrics of the outgoing interfaces.
	<b>NOTE:</b> The maximum metric value is 1023.

### Wide Metrics

Router(config)# <b>router isis</b>	Enables the IS-IS routing process.
Router(config-router)# <b>metric-style wide</b>	Enables the wide metric.
	<b>NOTE:</b> To support better metric granularity, Cisco IOS Software allows for a wider metric field. This field could be 24 bits wide for the Extended IP Reachability TLV or 32 bits wide for the Extended IP Reachability TLV. These fields are used primarily when working with traffic engineering.

### Manual Summarization

Router(config)# <b>router isis</b>	Enables the IS-IS routing process.
Router(config-router)# <b>summary-address 192.168.0.0 255.255.255.240</b>	Enables manual summarization for the given address and netmask.

### Injecting Default Routes

Router(config)# <b>ip route 0.0.0.0 0.0.0.0 172.16.0.1</b>	Creates a default route.
Router(config)# <b>router isis</b>	Enables the IS-IS routing process.
Router(config-router)# <b>default-information originate</b>	Injects the default route into the IS-IS routing domain.

	<b>NOTE:</b> Using the <b>default-information originate</b> command will inform a router that it is an interdomain router.
	<b>NOTE:</b> The <b>default-information originate</b> command will only be used on an L2 or an L1/L2 router.

### Defining Router Types

Router(config)# <b>router isis</b>	Enables the IS-IS routing process.
Router(config-router)# <b>is-type level-1</b>	The router will perform only Level 1 routing (intra-area or within a single area).
Router(config-router)# <b>is-type level-1-2</b>	The router will perform both Level 1 routing (intra-area) and Level 2 routing (inter-area).
Router(config-router)# <b>is-type level-2-only</b>	The router will perform only Level 2 routing. This router will not communicate with Level 1 routers in its own area.
	<b>NOTE:</b> The default for an IS-IS router is to perform both Level 1 <i>and</i> Level 2 routing.

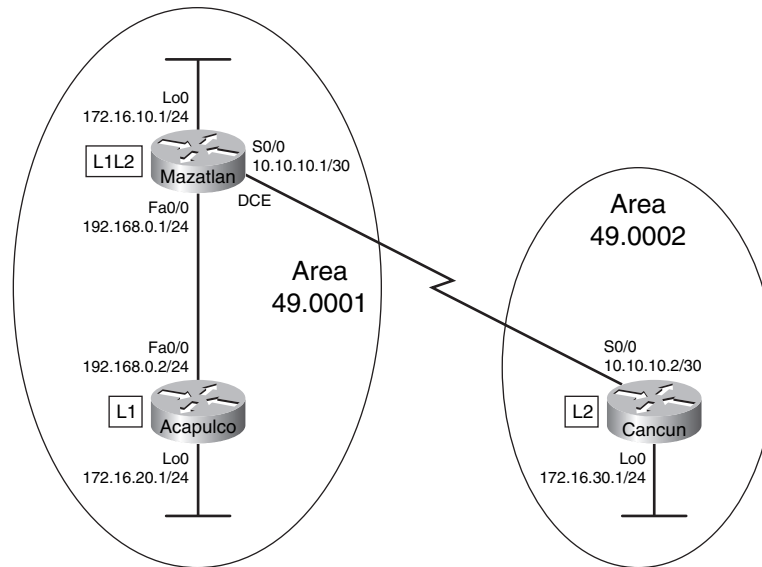
### Verifying Integrated IS-IS Routing

Router# <b>show clns neighbor</b>	Displays both ES and IS neighbor information.
Router# <b>show isis database</b>	Displays the IS-IS link-state database in summary form.
Router# <b>show isis database detail</b>	Displays the IS-IS link-state database. The contents of each link-state packet are also displayed.
Router# <b>show ip route</b>	Displays the current state of the routing table.
Router# <b>show isis topology</b>	Displays a list of all connected routers in all areas.

## Configuration Example: Multi-Area IS-IS

Figure 4-2 shows the network topology for the configuration that follows, which demonstrates how to configure Integrated IS-IS using the commands covered in this chapter.

Figure 4-2 Multi-Area IS-IS



### Mazatlan Router

Router> <b>enable</b>	Moves to privileged mode.
Router# <b>configure terminal</b>	Moves to global configuration mode.
Router(config)# <b>hostname Mazatlan</b>	Assigns the host name to the router.
Mazatlan(config)# <b>interface fastethernet 0/0</b>	Enters interface configuration mode.
Mazatlan(config-if)# <b>ip address 192.168.0.1 255.255.255.0</b>	Assigns an IP address and netmask.
Mazatlan(config-if)# <b>ip router isis</b>	Enables IS-IS routing on this interface.

Mazatlan(config-if)#no shutdown	Enables the interface.
Mazatlan(config-if)#int loopback 0	Moves to interface configuration mode.
Mazatlan(config-if)#ip address 172.16.10.1 255.255.255.0	Assigns an IP address and netmask.
Mazatlan(config-if)#ip router isis	Enables IS-IS routing on this interface.
Mazatlan(config-if)#interface serial 0/0	Moves to interface configuration mode.
Mazatlan(config-if)#ip address 10.10.10.1 255.255.255.252	Assigns an IP address and netmask.
Mazatlan(config-if)#ip router isis	Enables IS-IS routing on this interface.
Mazatlan(config-if)#clock rate 56000	Sets the clock rate.
Mazatlan(config-if)#no shutdown	Enables the interface.
Mazatlan(config-if)#exit	Returns to global configuration mode.
Mazatlan(config)#router isis	Enables the IS-IS routing process.
Mazatlan(config-router)#net 49.0001.1111.1111.1111.00	Configures the NET.
Mazatlan(config-router)#is-type level-1-2	The router will perform both Level 1 and 2 routing.
Mazatlan(config-router)#exit	Returns to global configuration mode.
Mazatlan(config)#exit	Returns to privileged mode.
Mazatlan#copy running-config startup-config	Saves the configuration to NVRAM.

### Acapulco Router

Router>enable	Moves to privileged mode.
Router#configure terminal	Moves to global configuration mode.
Router(config)#hostname Acapulco	Assigns the host name to the router.

Acapulco(config)# <b>interface fastethernet 0/0</b>	Enters interface configuration mode.
Acapulco(config-if)# <b>ip address 192.168.0.2 255.255.255.0</b>	Assigns an IP address and netmask.
Acapulco(config-if)# <b>ip router isis</b>	Enables IS-IS routing on this interface.
Acapulco(config-if)# <b>no shut</b>	Enables the interface.
Acapulco(config-if)# <b>interface loopback 0</b>	Moves to interface configuration mode.
Acapulco(config-if)# <b>ip address 172.16.20.1 255.255.255.0</b>	Assigns an IP address and netmask.
Acapulco(config-if)# <b>ip router isis</b>	Enables IS-IS routing on this interface.
Acapulco(config-if)# <b>exit</b>	Returns to global configuration mode.
Acapulco(config)# <b>router isis</b>	Enables the IS-IS routing process.
Acapulco(config-router)# <b>net 49.0001.2222.2222.2222.00</b>	Configures the NET.
Acapulco(config-router)# <b>is-type level-1</b>	The router will perform Level 1 routing only.
Acapulco(config-router)# <b>exit</b>	Returns to global configuration mode.
Acapulco(config)# <b>exit</b>	Returns to privileged mode.
Acapulco# <b>copy running-config startup-config</b>	Saves the configuration to NVRAM.

### Cancun Router

Router> <b>enable</b>	Moves to privileged mode.
Router# <b>configure terminal</b>	Moves to global configuration mode.
Router(config)# <b>hostname Cancun</b>	Assigns a host name to the router.
Cancun(config)# <b>interface serial 0/0</b>	Enters interface configuration mode.
Cancun(config-if)# <b>ip address 10.10.10.2 255.255.255.252</b>	Assigns an IP address and netmask.

Cancun(config-if)# <b>ip router isis</b>	Enables IS-IS routing on this interface.
Cancun(config-if)# <b>no shutdown</b>	Starts the interface.
Cancun(config-if)# <b>interface loopback 0</b>	Moves to interface configuration mode.
Cancun(config-if)# <b>ip address 172.16.30.1 255.255.255.0</b>	Assigns an IP address and netmask.
Cancun(config-if)# <b>ip router isis</b>	Enables IS-IS routing on this interface.
Cancun(config-if)# <b>exit</b>	Returns to global configuration mode.
Cancun(config)# <b>router isis</b>	Enables the IS-IS routing process.
Cancun(config-router)# <b>net 49.0002.3333.3333.00</b>	Configures the NET.
Cancun(config-router)# <b>is-type level-2-only</b>	Router will perform Level 2 routing only.
Cancun(config-router)# <b>exit</b>	Returns to global configuration mode.
Cancun(config)# <b>exit</b>	Returns to privileged mode.
Cancun# <b>copy running-config startup-config</b>	Saves the configuration to NVRAM.

