



Implementing IS-IS

Integrated Intermediate System-to-Intermediate System (IS-IS), Internet Protocol Version 4 (IPv4), is a standards-based Interior Gateway Protocol (IGP). The Cisco software implements the IP routing capabilities described in International Organization for Standardization (ISO)/International Engineering Consortium (IEC) 10589 and RFC 1195, and adds the standard extensions for single topology and multitopology IS-IS for IP Version 6 (IPv6).

This module describes how to implement IS-IS (IPv4 and IPv6) on your Cisco IOS XR network.

- [Enable IS-IS and Configure Level 1 or Level 2 Routing, on page 1](#)
- [Customize Routes for IS-IS, on page 3](#)
- [Set Priority for Adding Prefixes to RIB, on page 7](#)
- [IS-IS Interfaces, on page 8](#)
- [Limit LSP Flooding, on page 11](#)
- [IS-IS Authentication, on page 15](#)
- [ISIS NSR, on page 19](#)
- [Configuring IS-IS Adjacency Stagger, on page 21](#)
- [IS-IS Overload Bit Avoidance, on page 22](#)
- [References for IS-IS, on page 23](#)

Enable IS-IS and Configure Level 1 or Level 2 Routing

This task explains how to enable IS-IS and configure the routing level for an area.



Note Configuring the routing level in Step 4 is optional, but is highly recommended to establish the proper level of adjacencies.



Note Users can configure the **no max-metric** command only with levels 1 or 2, that is, **no max-metric level {1|2}** in order to view the result in the output of the **show configuration** command. Else, the maximum metric configuration is not displayed in the output. This behavior is observed before committing the configuration to the router.

Before you begin

Although you can configure IS-IS before you configure an IP address, no IS-IS routing occurs until at least one IP address is configured.

SUMMARY STEPS

1. **configure**
2. **router isis** *instance-id*
3. **net** *network-entity-title*
4. **is-type** { **level-1** | **level-1-2** | **level-2-only** }
5. Use the **commit** or **end** command.
6. **show isis** [**instance** *instance-id*] **protocol**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **router isis** *instance-id*

Example:

```
RP/0/RP0/CPU0:router(config)# router isis isp
```

Enables IS-IS routing for the specified routing instance, and places the router in router configuration mode.

- By default, all IS-IS instances are automatically Level 1 and Level 2. You can change the level of routing to be performed by a particular routing instance by using the **is-type** router configuration command.

Step 3 **net** *network-entity-title*

Example:

```
RP/0/RP0/CPU0:router(config-isis)# net 47.0004.004d.0001.0001.0c11.1110.00
```

Configures network entity titles (NETs) for the routing instance.

- Specify a NET for each routing instance if you are configuring multi-instance IS-IS.
- This example configures a router with area ID 47.0004.004d.0001 and system ID 0001.0c11.1110.00.
- To specify more than one area address, specify additional NETs. Although the area address portion of the NET differs, the systemID portion of the NET must match exactly for all of the configured items.

Step 4 **is-type** { **level-1** | **level-1-2** | **level-2-only** }

Example:

```
RP/0/RP0/CPU0:router(config-isis)# is-type level-2-only
```

(Optional) Configures the system type (area or backbone router).

- By default, every IS-IS instance acts as a **level-1-2** router.
- The **level-1** keyword configures the software to perform Level 1 (intra-area) routing only. Only Level 1 adjacencies are established. The software learns about destinations inside its area only. Any packets containing destinations outside the area are sent to the nearest **level-1-2** router in the area.
- The **level-2-only** keyword configures the software to perform Level 2 (backbone) routing only, and the router establishes only Level 2 adjacencies, either with other Level 2-only routers or with **level-1-2** routers.
- The **level-1-2** keyword configures the software to perform both Level 1 and Level 2 routing. Both Level 1 and Level 2 adjacencies are established. The router acts as a border router between the Level 2 backbone and its Level 1 area.

Step 5 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 6 `show isis [instance instance-id] protocol`

Example:

```
RP/0/RP0/CPU0:router# show isis protocol
```

(Optional) Displays summary information about the IS-IS instance.

Customize Routes for IS-IS

This task explains how to perform route functions that include injecting default routes into your IS-IS routing domain and redistributing routes learned in another IS-IS instance. This task is optional.

SUMMARY STEPS

1. **configure**
2. **router isis** *instance-id*
3. **set-overload-bit** [**on-startup** { *delay* | **wait-for-bgp** }] [**level** { **1** | **2** }]
4. **address-family** { **ipv4** | **ipv6** } [**unicast**]
5. **default-information originate** [**route-policy** *route-policy-name*]
6. **distribute-list** { { **prefix-list** *prefix-list-name* | **route-policy** *route-policy-name* } } **in**
7. **redistribute isis** *instance* [**level-1** | **level-2** | **level-1-2**] [**metric** *metric*] [**metric-type** { **internal** | **external** }] [**policy** *policy-name*]
8. Do one of the following:

- **summary-prefix** *address / prefix-length* [**level** { **1** | **2** }]
- **summary-prefix** *ipv6-prefix / prefix-length* [**level** { **1** | **2** }]

9. **maximum-paths** *route-number*
10. **distance** *weight* [*address / prefix-length* [*route-list-name*]]
11. **set-attached-bit**
12. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **router isis** *instance-id*

Example:

```
RP/0/RP0/CPU0:router(config)# router isis isp
```

Enables IS-IS routing for the specified routing process, and places the router in router configuration mode.

- By default, all IS-IS instances are automatically Level 1 and Level 2. You can change the level of routing to be performed by a particular routing instance by using the **is-type** command.

Step 3 **set-overload-bit** [**on-startup** { *delay* | **wait-for-bgp** }] [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# set-overload-bit
```

(Optional) Sets the overload bit.

Note The configured overload bit behavior does not apply to NSF restarts because the NSF restart does not set the overload bit during restart.

Step 4 **address-family** { **ipv4** | **ipv6** } [**unicast**]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# address-family ipv4 unicast
```

Specifies the IPv4 or IPv6 address family, and enters router address family configuration mode.

Step 5 **default-information originate** [**route-policy** *route-policy-name*]

Example:

```
RP/0/RP0/CPU0:router(config-isis-af)# default-information originate
```

(Optional) Injects a default IPv4 or IPv6 route into an IS-IS routing domain.

- The **route-policy** keyword and *route-policy-name* argument specify the conditions under which the IPv4 or IPv6 default route is advertised.
- If the **route-policy** keyword is omitted, then the IPv4 or IPv6 default route is unconditionally advertised at Level 2.

Step 6 **distribute-list** { {**prefix-list** *prefix-list-name* | **route-policy** *route-policy-name* } } **in**

Example:

```
RP/0/RP0/CPU0:router(config-isis)# distribute-list { {prefix-list | prefix-list-name} |
{route-policy | route-policy-name} } in
```

(Optional) Filters the routes that Intermediate System-to-Intermediate System (IS-IS) installs in the Routing Information Base (RIB).

Warning When **distribute-list in** command is configured, some routes that IS-IS computes are not installed in the forwarding plane of the local router, but other IS-IS routers will not be aware of this. This introduces a difference between the forwarding state computed by other IS-IS routers and the actual forwarding state on this router. In some cases, this could lead to traffic being dropped or looped. Hence, be careful about when to use this command.

Step 7 **redistribute isis** *instance* [**level-1** | **level-2** | **level-1-2**] [**metric** *metric*] [**metric-type** { **internal** | **external** }] [**policy** *policy-name*]

Example:

```
RP/0/RP0/CPU0:router(config-isis-af)# redistribute isis 2 level-1
```

(Optional) Redistributes routes from one IS-IS instance into another instance.

- In this example, an IS-IS instance redistributes Level 1 routes from another IS-IS instance.

Step 8 Do one of the following:

- **summary-prefix** *address / prefix-length* [**level** { **1** | **2** }]
- **summary-prefix** *ipv6-prefix / prefix-length* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis-af)# summary-prefix 10.1.0.0/16 level 1
```

or

```
RP/0/RP0/CPU0:router(config-isis-af)# summary-prefix 3003:xxxx::/24 level 1
```

(Optional) Allows a Level 1-2 router to summarize Level 1 IPv4 and IPv6 prefixes at Level 2, instead of advertising the Level 1 prefixes directly when the router advertises the summary.

- This example specifies an IPv4 address and mask.

or

- This example specifies an IPv6 prefix, and the command must be in the form documented in RFC 2373 in which the address is specified in hexadecimal using 16-bit values between colons.
- Note that IPv6 prefixes must be configured only in the IPv6 router address family configuration submode, and IPv4 prefixes in the IPv4 router address family configuration submode.

Step 9 **maximum-paths** *route-number***Example:**

```
RP/0/RP0/CPU0:router(config-isis-af)# maximum-paths 16
```

(Optional) Configures the maximum number of parallel paths allowed in a routing table.

Step 10 **distance** *weight* [*address / prefix-length* [*route-list-name*]]**Example:**

```
RP/0/RP0/CPU0:router(config-isis-af)# distance 90
```

(Optional) Defines the administrative distance assigned to routes discovered by the IS-IS protocol.

- A different administrative distance may be applied for IPv4 and IPv6.

Step 11 **set-attached-bit****Example:**

```
RP/0/RP0/CPU0:router(config-isis-af)# set-attached-bit
```

(Optional) Configures an IS-IS instance with an attached bit in the Level 1 LSP.

Step 12 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Redistributing IS-IS Routes Between Multiple Instances: Example

The following example shows usage of the **set- attached-bit** and **redistribute** commands. Two instances, instance “1” restricted to Level 1 and instance “2” restricted to Level 2, are configured.

The Level 1 instance is propagating routes to the Level 2 instance using redistribution. Note that the administrative distance is explicitly configured higher on the Level 2 instance to ensure that Level 1 routes are preferred.

Attached bit is being set for the Level 1 instance since it is redistributing routes into the Level 2 instance. Therefore, instance “1” is a suitable candidate to get from the area to the backbone.

```
router isis 1
  is-type level-2-only
  net 49.0001.0001.0001.0001.00
  address-family ipv4 unicast
  distance 116
  redistribute isis 2 level 2
!
```

```

interface HundredGigE 0/3/0/0
 address-family ipv4 unicast
 !
 !
router isis 2
 is-type level-1
 net 49.0002.0001.0001.0002.00
 address-family ipv4 unicast
 set
-attached-bit

!
interface HundredGigE 0/1/0/0
 address-family ipv4 unicast

```

Set Priority for Adding Prefixes to RIB

This optional task describes how to set the priority (order) for which specified prefixes are added to the RIB. The prefixes can be chosen using an access list (ACL), prefix list, or by matching a tag value.

SUMMARY STEPS

1. **configure**
2. **router isis** *instance-id*
3. **address-family** { **ipv4** | **ipv6** } [**unicast**]
4. **metric-style wide** [**transition**] [**level** { **1** | **2** }]
5. **spf prefix-priority** [**level** { **1** | **2** }] { **critical** | **high** | **medium** } { *access-list-name* | **tag** *tag* }
6. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **router isis** *instance-id*

Example:

```
RP/0/RP0/CPU0:router(config)# router isis isp
```

Enables IS-IS routing for the specified routing process, and places the router in router configuration mode. In this example, the IS-IS instance is called *isp*.

Step 3 **address-family** { **ipv4** | **ipv6** } [**unicast**]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# address-family ipv4 unicast
```

Specifies the IPv4 or IPv6 address family, and enters router address family configuration mode.

Step 4 **metric-style wide** [**transition**] [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis-af)# metric-style wide level 1
```

Configures a router to generate and accept only wide-link metrics in the Level 1 area.

Step 5 **spf prefix-priority** [**level** { **1** | **2** }] { **critical** | **high** | **medium** } { *access-list-name* | **tag** *tag* }

Example:

```
RP/0/RP0/CPU0:router(config-isis-af)# spf prefix-priority high tag 3
```

Installs all routes tagged with the value 3 first.

Step 6 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

IS-IS Interfaces

IS-IS interfaces can be configured as one of the following types:

- **Active**—advertises connected prefixes and forms adjacencies. This is the default for interfaces.
- **Passive**—advertises connected prefixes but does not form adjacencies. The **passive** command is used to configure interfaces as passive. Passive interfaces should be used sparingly for important prefixes such as loopback addresses that need to be injected into the IS-IS domain. If many connected prefixes need to be advertised then the redistribution of connected routes with the appropriate policy should be used instead.
- **Suppressed**—does not advertise connected prefixes but forms adjacencies. The **suppress** command is used to configure interfaces as suppressed.
- **Shutdown**—does not advertise connected prefixes and does not form adjacencies. The **shutdown** command is used to disable interfaces without removing the IS-IS configuration.

Tag IS-IS Interface Routes

This optional task describes how to associate a tag with a connected route of an IS-IS interface.

SUMMARY STEPS

1. **configure**
2. **router isis** *instance-id*
3. **address-family** { **ipv4** | **ipv6** } [**unicast**]
4. **metric-style wide** [**transition**] [**level** { **1** | **2** }]
5. **exit**
6. **interface** *type number*
7. **address-family** { **ipv4** | **ipv6** } [**unicast**]
8. **tag** *tag*
9. Use the **commit** or **end** command.
10. **show isis** [**ipv4** | **ipv6** | **afi-all**] [**unicast** | **safi-all**] **route** [**detail**]

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **router isis** *instance-id*

Example:

```
RP/0/RP0/CPU0:router(config)# router isis isp
```

Enables IS-IS routing for the specified routing process, and places the router in router configuration mode. In this example, the IS-IS instance is called isp.

Step 3 **address-family** { **ipv4** | **ipv6** } [**unicast**]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# address-family ipv4 unicast
```

Specifies the IPv4 or IPv6 address family, and enters router address family configuration mode.

Step 4 **metric-style wide** [**transition**] [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis-af)# metric-style wide level 1
```

Configures a router to generate and accept only wide link metrics in the Level 1 area.

Step 5 **exit**

Example:

```
RP/0/RP0/CPU0:router(config-isis-af)# exit
```

Exits router address family configuration mode, and returns the router to router configuration mode.

Step 6 `interface type number`

Example:

```
RP/0/RP0/CPU0:router(config-isis)# interface HundredGigE 0/1/0/3
Enters interface configuration mode.
```

Step 7 `address-family { ipv4 | ipv6 } [unicast]`

Example:

```
RP/0/RP0/CPU0:router(config-isis-if)# address-family ipv4 unicast
Specifies the IPv4 or IPv6 address family, and enters address family configuration mode.
```

Step 8 `tag tag`

Example:

```
RP/0/RP0/CPU0:router(config-isis-if-af)# tag 3
Sets the value of the tag to associate with the advertised connected route.
```

Step 9 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 10 `show isis [ipv4 | ipv6 | afi-all] [unicast | safi-all] route [detail]`

Example:

```
RP/0/RP0/CPU0:router# show isis ipv4 route detail
Displays tag information. Verify that all tags are present in the RIB.
```

Tagging Routes: Example

The following example shows how to tag routes.

```
route-policy isis-tag-55
end-policy
!
route-policy isis-tag-555
  if destination in (5.5.5.0/24 eq 24) then
    set tag 555
  pass
  else
    drop
  endif
```

```
end-policy
!
router static
  address-family ipv4 unicast
    0.0.0.0/0 2.6.0.1
    5.5.5.0/24 Null0
  !
!
router isis uut
  net 00.0000.0000.12a5.00
  address-family ipv4 unicast
  metric-style wide
  redistribute static level-1 route-policy isis-tag-555
  spf prefix-priority critical tag 13
  spf prefix-priority high tag 444
  spf prefix-priority medium tag 777
```

Limit LSP Flooding

Limiting link-state packets (LSP) may be desirable in certain “meshy” network topologies. An example of such a network might be a highly redundant one such as a fully meshed set of point-to-point links over a nonbroadcast multiaccess (NBMA) transport. In such networks, full LSP flooding can limit network scalability. One way to restrict the size of the flooding domain is to introduce hierarchy by using multiple Level 1 areas and a Level 2 area. However, two other techniques can be used instead of or with hierarchy: Block flooding on specific interfaces and configure mesh groups.

Both techniques operate by restricting the flooding of LSPs in some fashion. A direct consequence is that although scalability of the network is improved, the reliability of the network (in the face of failures) is reduced because a series of failures may prevent LSPs from being flooded throughout the network, even though links exist that would allow flooding if blocking or mesh groups had not restricted their use. In such a case, the link-state databases of different routers in the network may no longer be synchronized. Consequences such as persistent forwarding loops can ensue. For this reason, we recommend that blocking or mesh groups be used only if specifically required, and then only after careful network design.

Control LSP Flooding for IS-IS

Flooding of LSPs can limit network scalability. You can control LSP flooding by tuning your LSP database parameters on the router globally or on the interface. This task is optional.

Many of the commands to control LSP flooding contain an option to specify the level to which they apply. Without the option, the command applies to both levels. If an option is configured for one level, the other level continues to use the default value. To configure options for both levels, use the command twice. For example:

```
RP/0/RP0/CPU0:router(config-isis)# lsp-refresh-interval 1200 level 2
RP/0/RP0/CPU0:router(config-isis)# lsp-refresh-interval 1100 level 1
```

SUMMARY STEPS

1. **configure**
2. **router isis** *instance-id*

3. **lsp-refresh-interval** *seconds* [**level** { **1** | **2** }]
4. **lsp-check-interval** *seconds* [**level** { **1** | **2** }]
5. **lsp-gen-interval** { [**initial-wait** *initial* | **secondary-wait** *secondary* | **maximum-wait** *maximum*] ... } [**level** { **1** | **2** }]
6. **lsp-mtu** *bytes* [**level** { **1** | **2** }]
7. **max-lsp-lifetime** *seconds* [**level** { **1** | **2** }]
8. **ignore-lsp-errors** **disable**
9. **interface** *type interface-path-id*
10. **lsp-interval** *milliseconds* [**level** { **1** | **2** }]
11. **csnp-interval** *seconds* [**level** { **1** | **2** }]
12. **retransmit-interval** *seconds* [**level** { **1** | **2** }]
13. **retransmit-throttle-interval** *milliseconds* [**level** { **1** | **2** }]
14. **mesh-group** { *number* | **blocked** }
15. Use the **commit** or **end** command.
16. **show isis interface** [*type interface-path-id* | **level** { **1** | **2** }] [**brief**]
17. **show isis** [**instance** *instance-id*] **database** [**level** { **1** | **2** }] [**detail** | **summary** | **verbose**] [* | *lsp-id*]
18. **show isis** [**instance** *instance-id*] **lsp-log** [**level** { **1** | **2** }]
19. **show isis database-log** [**level** { **1** | **2** }]

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **router isis** *instance-id*

Example:

```
RP/0/RP0/CPU0:router(config)# router isis isp
```

Enables IS-IS routing for the specified routing instance, and places the router in router configuration mode.

- You can change the level of routing to be performed by a particular routing instance by using the **is-type** router configuration command.

Step 3 **lsp-refresh-interval** *seconds* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# lsp-refresh-interval 10800
```

(Optional) Sets the time between regeneration of LSPs that contain different sequence numbers

- The refresh interval should always be set lower than the **max-lsp-lifetime** command.

Step 4 **lsp-check-interval** *seconds* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# lsp-check-interval 240
```

(Optional) Configures the time between periodic checks of the entire database to validate the checksums of the LSPs in the database.

- This operation is costly in terms of CPU and so should be configured to occur infrequently.

Step 5 **lsp-gen-interval** { [**initial-wait** *initial* | **secondary-wait** *secondary* | **maximum-wait** *maximum*] ... }
[**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# lsp-gen-interval maximum-wait 15 initial-wait 5 secondary-wait 5
```

(Optional) Reduces the rate of LSP generation during periods of instability in the network. Helps reduce the CPU load on the router and number of LSP transmissions to its IS-IS neighbors.

- During prolonged periods of network instability, repeated recalculation of LSPs can cause an increased CPU load on the local router. Further, the flooding of these recalculated LSPs to the other Intermediate Systems in the network causes increased traffic and can result in other routers having to spend more time running route calculations.

Step 6 **lsp-mtu** *bytes* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# lsp-mtu 1300
```

(Optional) Sets the maximum transmission unit (MTU) size of LSPs.

Step 7 **max-lsp-lifetime** *seconds* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# max-lsp-lifetime 11000
```

(Optional) Sets the initial lifetime given to an LSP originated by the router.

- This is the amount of time that the LSP persists in the database of a neighbor unless the LSP is regenerated or refreshed.

Step 8 **ignore-lsp-errors** **disable**

Example:

```
RP/0/RP0/CPU0:router(config-isis)# ignore-lsp-errors disable
```

(Optional) Sets the router to purge LSPs received with checksum errors.

Step 9 **interface** *type interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config-isis)# interface HundredGigE 0/1/0/3
```

Enters interface configuration mode.

Step 10 **lsp-interval** *milliseconds* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis-if)# lsp-interval 100
```

(Optional) Configures the amount of time between each LSP sent on an interface.

Step 11 **csnp-interval** *seconds* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis-if)# csnp-interval 30 level 1
```

(Optional) Configures the interval at which periodic CSNP packets are sent on broadcast interfaces.

- Sending more frequent CSNPs means that adjacent routers must work harder to receive them.
- Sending less frequent CSNP means that differences in the adjacent routers may persist longer.

Step 12 **retransmit-interval** *seconds* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis-if)# retransmit-interval 60
```

(Optional) Configures the amount of time that the sending router waits for an acknowledgment before it considers that the LSP was not received and subsequently resends.

```
RP/0/RP0/CPU0:router(config-isis-if)# retransmit-interval 60
```

Step 13 **retransmit-throttle-interval** *milliseconds* [**level** { **1** | **2** }]

Example:

```
RP/0/RP0/CPU0:router(config-isis-if)# retransmit-throttle-interval 1000
```

(Optional) Configures the amount of time between retransmissions on each LSP on a point-to-point interface.

- This time is usually greater than or equal to the **lsp-interval** command time because the reason for lost LSPs may be that a neighboring router is busy. A longer interval gives the neighbor more time to receive transmissions.

Step 14 **mesh-group** { *number* | **blocked** }

Example:

```
RP/0/RP0/CPU0:router(config-isis-if)# mesh-group blocked
```

(Optional) Optimizes LSP flooding in NBMA networks with highly meshed, point-to-point topologies.

- This command is appropriate only for an NBMA network with highly meshed, point-to-point topologies.

Step 15 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** — Exits the configuration session without committing the configuration changes.
- **Cancel** — Remains in the configuration session, without committing the configuration changes.

Step 16 `show isis interface [type interface-path-id | level { 1 | 2 }] [brief]`

Example:

```
RP/0/RP0/CPU0:router# show isis interface HundredGigE 0/1/0/1 brief
```

(Optional) Displays information about the IS-IS interface.

Step 17 `show isis [instance instance-id] database [level { 1 | 2 }] [detail | summary | verbose] [* | lsp-id]`

Example:

```
RP/0/RP0/CPU0:router# show isis database level 1
```

(Optional) Displays the IS-IS LSP database.

Step 18 `show isis [instance instance-id] lsp-log [level { 1 | 2 }]`

Example:

```
RP/0/RP0/CPU0:router# show isis lsp-log
```

(Optional) Displays LSP log information.

Step 19 `show isis database-log [level { 1 | 2 }]`

Example:

```
RP/0/RP0/CPU0:router# show isis database-log level 1
```

(Optional) Display IS-IS database log information.

IS-IS Authentication

Authentication is available to limit the establishment of adjacencies by using the **hello-password** command, and to limit the exchange of LSPs by using the **lsp-password** command.

IS-IS supports plain-text authentication, which does not provide security against unauthorized users. Plain-text authentication allows you to configure a password to prevent unauthorized networking devices from forming adjacencies with the router. The password is exchanged as plain text and is potentially visible to an agent able to view the IS-IS packets.

When an HMAC-MD5 password is configured, the password is never sent over the network and is instead used to calculate a cryptographic checksum to ensure the integrity of the exchanged data.

IS-IS stores a configured password using simple encryption. However, the plain-text form of the password is used in LSPs, sequence number protocols (SNPs), and hello packets, which would be visible to a process that can view IS-IS packets. The passwords can be entered in plain text (clear) or encrypted form.

To set the domain password, configure the **lsp-password** command for Level 2; to set the area password, configure the **lsp-password** command for Level 1.

The keychain feature allows IS-IS to reference configured keychains. IS-IS key chains enable hello and LSP keychain authentication. Keychains can be configured at the router level (in the case of the **lsp-password** command) and at the interface level (in the case of the **hello-password** command) within IS-IS. These commands reference the global keychain configuration and instruct the IS-IS protocol to obtain security parameters from the global set of configured keychains.

IS-IS is able to use the keychain to implement hitless key rollover for authentication. Key rollover specification is time based, and in the event of clock skew between the peers, the rollover process is impacted. The configurable tolerance specification allows for the accept window to be extended (before and after) by that margin. This accept window facilitates a hitless key rollover for applications (for example, routing and management protocols).

Configure Authentication for IS-IS

This task explains how to configure authentication for IS-IS. This task is optional.

SUMMARY STEPS

1. **configure**
2. **router isis** *instance-id*
3. **lsp-password** { **hmac-md5** | **text** } { **clear** | **encrypted** } *password* [**level** { **1** | **2** }] [**send-only**] [**snmp send-only**]
4. **interface** *type interface-path-id*
5. **hello-password** { **hmac-md5** | **text** } { **clear** | **encrypted** } *password* [**level** { **1** | **2** }] [**send-only**]
6. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **router isis** *instance-id*

Example:

```
RP/0/RP0/CPU0:router(config)# router isis isp
```

Enables IS-IS routing for the specified routing instance, and places the router in router configuration mode.

- You can change the level of routing to be performed by a particular routing instance by using the **is-type** command.

Step 3 **lsp-password** { **hmac-md5** | **text** } { **clear** | **encrypted** } *password* [**level** { **1** | **2** }] [**send-only**] [**snmp send-only**]

Example:

```
RP/0/RP0/CPU0:router(config-isis)# lsp-password hmac-md5 clear password1 level 1
```

Configures the LSP authentication password.

- The **hmac-md5** keyword specifies that the password is used in HMAC-MD5 authentication.
- The **text** keyword specifies that the password uses cleartext password authentication.
- The **clear** keyword specifies that the password is unencrypted when entered.
- The **encrypted** keyword specifies that the password is encrypted using a two-way algorithm when entered.
- The **level 1** keyword sets a password for authentication in the area (in Level 1 LSPs and Level SNPs).
- The **level 2** keywords set a password for authentication in the backbone (the Level 2 area).
- The **send-only** keyword adds authentication to LSP and sequence number protocol data units (SNPs) when they are sent. It does not authenticate received LSPs or SNPs.
- The **snp send-only** keyword adds authentication to SNPs when they are sent. It does not authenticate received SNPs.

Note To disable SNP password checking, the **snp send-only** keywords must be specified in the **lsp-password** command.

Step 4 **interface** *type interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config-isis)# interface GigabitEthernet 0/1/0/3
```

Enters interface configuration mode.

Step 5 **hello-password** { **hmac-md5** | **text** } { **clear** | **encrypted** } *password* [**level** { **1** | **2** }] [**send-only**]

Example:

```
RP/0/RP0/CPU0:router(config-isis-if)#hello-password text clear mypassword
```

Configures the authentication password for an IS-IS interface.

Step 6 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configure Keychains for IS-IS

This task explains how to configure keychains for IS-IS. This task is optional.

Keychains can be configured at the router level (**lsp-password** command) and at the interface level (**hello-password** command) within IS-IS. These commands reference the global keychain configuration and instruct the IS-IS protocol to obtain security parameters from the global set of configured keychains. The router-level configuration (**lsp-password** command) sets the keychain to be used for all IS-IS LSPs generated by this router, as well as for all Sequence Number Protocol Data Units (SN PDUs). The keychain used for HELLO PDUs is set at the interface level, and may be set differently for each interface configured for IS-IS.

SUMMARY STEPS

1. **configure**
2. **router isis** *instance-id*
3. **lsp-password keychain** *keychain-name* [**level** { **1** | **2** }] [**send-only**] [**snp send-only**]
4. **interface** *type interface-path-id*
5. **hello-password keychain** *keychain-name* [**level** { **1** | **2** }] [**send-only**]
6. Use the **commit** or **end** command.

DETAILED STEPS

Step 1 **configure****Example:**

```
RP/0/RP0/CPU0:router# configure
Enters mode.
```

Step 2 **router isis** *instance-id***Example:**

```
RP/0/RP0/CPU0:router(config)# router isis isp
Enables IS-IS routing for the specified routing instance, and places the router in router configuration mode.
```

- You can change the level of routing to be performed by a particular routing instance by using the **is-type** command.

Step 3 **lsp-password keychain** *keychain-name* [**level** { **1** | **2** }] [**send-only**] [**snp send-only**]**Example:**

```
RP/0/RP0/CPU0:router(config-isis)# lsp-password keychain isis_a level 1
Configures the keychain.
```

Step 4 **interface** *type interface-path-id***Example:**

```
RP/0/RP0/CPU0:router(config-isis)# interface HundredGigE 0/1/0/3
Enters interface configuration mode.
```

Step 5 `hello-password keychain keychain-name [level { 1 | 2 }] [send-only]`

Example:

```
RP/0/RP0/CPU0:router(config-isis-if)#hello-password keychain isis_b
```

Configures the authentication password for an IS-IS interface.

Step 6 Use the `commit` or `end` command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

ISIS NSR

Non Stop Routing (NSR) suppresses IS-IS routing changes for devices with redundant route processors during processor switchover events (RP failover or ISSU), reducing network instability and downtime. When Non Stop Routing is used, switching from the active to standby RP have no impact on the other IS-IS routers in the network. All information needed to continue the routing protocol peering state is transferred to the standby processor prior to the switchover, so it can continue immediately upon a switchover.

To preserve routing across process restarts, NSF must be configured in addition to NSR.

Configuring ISIS-NSR

Step 1 `configure`

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 `router isis instance-id`

Example:

```
RP/0/RP0/CPU0:router(config)# router isis 1
```

Enables IS-IS routing for the specified routing instance, and places the router in router configuration mode.

Step 3 `nsr`

Example:

```
RP/0/RP0/CPU0:router(config-isis)# nsr
```

Configures the NSR feature.

Step 4 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Step 5 **show isis nsr adjacency**

Example:

```
RP/0/RP0/CPU0:router
# show isis nsr adjacency
System Id Interface SNPA State Hold Changed NSF IPv4 BFD IPv6 BFD
R1-v1S Nii0 *PtoP* Up 83 00:00:33 Yes None None
```

Displays adjacency information.

Step 6 **show isis nsr status**

Example:

```
RP/0/RP0/CPU0:router
router#show isis nsr status
IS-IS test NSR(v1a) STATUS (HA Ready):
                V1 Standby V2 Active V2 Standby
SYNC STATUS:           TRUE      FALSE(0) FALSE(0)
PEER CHG COUNT:        1          0        0
UP TIME:                00:03:12   not up   not up
```

Displays the NSR status information.

Step 7 **show isis nsr statistics**

Example:

```
RP/0/RP0/CPU0:router
router#show isis nsr statistics
IS-IS test NSR(v1a) MANDATORY STATS :
                V1 Active                V1 Standby                V2 Active                V2
Standby
L1 ADJ:                0                0                0
0
L2 ADJ:                2                2                0
0
LIVE INTERFACE:        4                4                0
0
PTP INTERFACE:         1                1                0
0
LAN INTERFACE:         2                2                0
0
LOOPBACK INTERFACE:    1                1                0
0
```

```

TE Tunnel:                1                1                0
0
TE LINK:                  2                2                0
0
NSR OPTIONAL STATS :
L1 LSP:                   0                0                0
0
L2 LSP:                   4                4                0
0
IPV4 ROUTES:              3                3                0
0
IPV6 ROUTES:              4                4                0
0

```

Shows number of ISIS adjacencies, lsps, routes, tunnels, Te links on active and standby routers.

Configuring IS-IS Adjacency Stagger

Certain events like process restart or reload can involve a significant processing overhead. Updating routing tables with all adjacencies, maintaining them, and synchronizing the database with each adjacent router requires a lot of bandwidth. These processes may require large number of packets being sent and/or received, depending on the state of the database on the routers. If packets are dropped in any direction, it can lead to an unstable state.

We cannot prevent events like process restart or reload, but we can handle such events better by limiting the number of adjacencies that area being established simultaneously. To limit the number of adjacencies from getting established simultaneously, you can configure adjacency stagger. By configuring IS-IS adjacency stagger, you can specify the initial number neighbourhood routers from which adjacencies can fully form after a process restart or reload. If you configure IS-IS adjacency stagger, you can also specify the subsequent number of simultaneous neighbors that are allowed to form adjacency.

Restrictions

- IS-IS adjacency stagger is only supported on point-to-point interfaces and not on LAN interfaces.
- IS-IS adjacency stagger is not supported with NSF (non-stop forwarding) mechanisms.

Configuration Example

To configure IS-IS adjacency stagger on a point-to-point interface, you must use the following configuration steps:

1. Configure IS-IS.
2. Configure adjacency stagger.

Configuration

```

/* Enter the global configuration mode and configure IS-IS */
Router# config
Router(config)# router isis 1

/* Configure IS-IS adjacency stagger */

```

```
Router(config-isis)# adjacency stagger 2 3
Router(config-isis)# commit
```

IS-IS Overload Bit Avoidance

The IS-IS overload bit avoidance feature allows network administrators to prevent label switched paths (LSPs) from being disabled when a router in that path has its Intermediate System-to-Intermediate System (IS-IS) overload bit set.

When the IS-IS overload bit avoidance feature is activated, all nodes with the overload bit set, including head nodes, mid nodes, and tail nodes, are ignored, which means that they are still available for use with label switched paths (LSPs).



Note The IS-IS overload bit avoidance feature does *not* change the default behavior on nodes that have their overload bit set if those nodes are not included in the path calculation (PCALC).

The IS-IS overload bit avoidance feature is activated using the following command:

```
mpls traffic-eng path-selection ignore overload
```

The IS-IS overload bit avoidance feature is deactivated using the **no** form of this command:

```
no mpls traffic-eng path-selection ignore overload
```

When the IS-IS overload bit avoidance feature is deactivated, nodes with the overload bit set cannot be used as nodes of last resort.

Configure IS-IS Overload Bit Avoidance

This task describes how to activate IS-IS overload bit avoidance.

Before you begin

The IS-IS overload bit avoidance feature is valid only on networks that support the following features:

- MPLS
- IS-IS

SUMMARY STEPS

1. **configure**
2. **mpls traffic-eng path-selection ignore overload**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters mode.

Step 2 **mpls traffic-eng path-selection ignore overload**

Example:

```
RP/0/RP0/CPU0:router(config)# mpls traffic-eng path-selection ignore overload
```

Activates IS-IS overload bit avoidance.

Configuring IS-IS Overload Bit Avoidance: Example

The following example shows how to activate IS-IS overload bit avoidance:

```
config
 mpls traffic-eng path-selection ignore overload
```

The following example shows how to deactivate IS-IS overload bit avoidance:

```
config
 no mpls traffic-eng path-selection ignore overload
```

References for IS-IS

This section provides additional conceptual information on IS-IS. It includes the following topics:

IS-IS Functional Overview

Small IS-IS networks are typically built as a single area that includes all routers in the network. As the network grows larger, it may be reorganized into a backbone area made up of the connected set of all Level 2 routers from all areas, which is in turn connected to local areas. Within a local area, routers know how to reach all system IDs. Between areas, routers know how to reach the backbone, and the backbone routers know how to reach other areas.

The IS-IS routing protocol supports the configuration of backbone Level 2 and Level 1 areas and the necessary support for moving routing information between the areas. Routers establish Level 1 adjacencies to perform routing within a local area (intra-area routing). Routers establish Level 2 adjacencies to perform routing between Level 1 areas (interarea routing).

Each IS-IS instance can support either a single Level 1 or Level 2 area, or one of each. By default, all IS-IS instances automatically support Level 1 and Level 2 routing. You can change the level of routing to be performed by a particular routing instance using the **is-type** command.

Multiple IS-IS instances can exist on the same physical interface. However, you must configure different instance-id for every instance that shares the same physical interface.

Alternatively, you can also create dot1q sub-interfaces and configure each dot1q sub-interface to different IS-IS instances.

Default Routes

You can force a default route into an IS-IS routing domain. Whenever you specifically configure redistribution of routes into an IS-IS routing domain, the software does not, by default, redistribute the default route into the IS-IS routing domain. The **default-information originate** command generates a *default route* into IS-IS, which can be controlled by a route policy. You can use the route policy to identify the level into which the default route is to be announced, and you can specify other filtering options configurable under a route policy. You can use a route policy to conditionally advertise the default route, depending on the existence of another route in the routing table of the router.

Overload Bit on Router

The overload bit is a special bit of state information that is included in an LSP of the router. If the bit is set on the router, it notifies routers in the area that the router is not available for transit traffic. This capability is useful in four situations:

1. During a serious but nonfatal error, such as limited memory.
2. During the startup and restart of the process. The overload bit can be set until the routing protocol has converged. However, it is not employed during a normal NSF restart or failover because doing so causes a routing flap.
3. During a trial deployment of a new router. The overload bit can be set until deployment is verified, then cleared.
4. During the shutdown of a router. The overload bit can be set to remove the router from the topology before the router is removed from service.

Overload Bit Configuration During Multitopology Operation

Because the overload bit applies to forwarding for a single topology, it may be configured and cleared independently for IPv4 and IPv6 during multitopology operation. For this reason, the overload is set from the router address family configuration mode. If the IPv4 overload bit is set, all routers in the area do not use the router for IPv4 transit traffic. However, they can still use the router for IPv6 transit traffic.

Attached Bit on an IS-IS Instance

The attached bit is set in a router that is configured with the **is-type** command and **level-1-2** keyword. The attached bit indicates that the router is connected to other areas (typically through the backbone). This functionality means that the router can be used by Level 1 routers in the area as the default route to the backbone. The attached bit is usually set automatically as the router discovers other areas while computing its Level 2 SPF route. The bit is automatically cleared when the router becomes detached from the backbone.



Note If the connectivity for the Level 2 instance is lost, the attached bit in the Level 1 instance LSP would continue sending traffic to the Level 2 instance and cause the traffic to be dropped.

To simulate this behavior when using multiple processes to represent the **level-1-2** keyword functionality, you would manually configure the attached bit on the Level 1 process.

IS-IS Support for Route Tags

The IS-IS Support for route tags feature provides the capability to associate and advertise a tag with an IS-IS route prefix. Additionally, the feature allows you to prioritize the order of installation of route prefixes in the RIB based on a tag of a route. Route tags may also be used in route policy to match route prefixes (for example, to select certain route prefixes for redistribution).

Flood Blocking on Specific Interfaces

With this technique, certain interfaces are blocked from being used for flooding LSPs, but the remaining interfaces operate normally for flooding. This technique is simple to understand and configure, but may be more difficult to maintain and more error prone than mesh groups in the long run. The flooding topology that IS-IS uses is fine-tuned rather than restricted. Restricting the topology too much (blocking too many interfaces) makes the network unreliable in the face of failures. Restricting the topology too little (blocking too few interfaces) may fail to achieve the desired scalability.

To improve the robustness of the network in the event that all nonblocked interfaces drop, use the **csnp-interval** command in interface configuration mode to force periodic complete sequence number PDUs (CSNPs) packets to be used on blocked point-to-point links. The use of periodic CSNPs enables the network to become synchronized.

Maximum LSP Lifetime and Refresh Interval

By default, the router sends a periodic LSP refresh every 15 minutes. LSPs remain in a database for 20 minutes by default. If they are not refreshed by that time, they are deleted. You can change the LSP refresh interval or maximum LSP lifetime. The LSP interval should be less than the LSP lifetime or else LSPs time out before they are refreshed. In the absence of a configured refresh interval, the software adjusts the LSP refresh interval, if necessary, to prevent the LSPs from timing out.

Minimum Remaining Lifetime

The Minimum Remaining Lifetime feature prevents premature purging and unnecessary flooding of LSPs. If the Remaining Lifetime field gets corrupted during flooding, this corruption is undetectable. The consequences of such corruption depend on how the Remaining Lifetime value is altered. This feature resolves this problem by enabling IS-IS to reset the Remaining Lifetime value of the received LSP, to the maximum LSP lifetime. By default, the maximum LSP lifetime is configured as 1200 seconds and you can configure it to a different value using the **max-lsp-lifetime** *seconds* command. This action ensures that whatever be the value of Remaining Lifetime that is received, a system other than the originator of an LSP will never purge the LSP, until the LSP has existed in the database at least for maximum LSP lifetime.

If the remaining lifetime for the LSP reaches 0, the LSP is kept in the link state database for an additional 60 seconds. This additional lifetime is known as Zero Age Lifetime. If the corresponding router does not update the LSP even after the Zero Age Lifetime, the LSP is deleted from the link state database.

The Remaining Lifetime field is also useful in identifying a problem in the network. If the received LSP lifetime value is less than the Zero Age Lifetime, which is 60 seconds, IS-IS generates an error message indicating that it's a corrupted lifetime event. The sample error message is as follows:

```
Dec 14 15:36:45.663 : isis[1011]: RECV L2 LSP 1111.1111.1112.03-00 from 1111.1111.1112.03:
possible corrupted lifetime 59 secs for L2 lsp 1111.1111.1112.03-00 from SNPA 02e9.4522.5326
detected.
```

IS-IS saves the received remaining lifetime value in LSP database. The value is shown in the **show isis database** command output under the **Rcvd** field.

For more information about the **show isis database** command, see *IS-IS Commands* Chapter of the *Routing Command Reference for Cisco NCS 5000 Series Routers*.

Mesh Group Configuration

Configuring mesh groups (a set of interfaces on a router) can help to limit flooding. All routers reachable over the interfaces in a particular mesh group are assumed to be densely connected with each router having at least one link to every other router. Many links can fail without isolating one or more routers from the network.

In normal flooding, a new LSP is received on an interface and is flooded out over all other interfaces on the router. With mesh groups, when a new LSP is received over an interface that is part of a mesh group, the new LSP is not flooded over the other interfaces that are part of that mesh group.

Multi-Instance IS-IS

You can configure up to 16 IS-IS instances. MPLS can run on multiple IS-IS processes as long as the processes run on different sets of interfaces. Each interface may be associated with only a single IS-IS instance. Cisco IOS XR software prevents the double-booking of an interface by two instances at configuration time; two instances of MPLS configuration cause an error.

Because the Routing Information Base (RIB) treats each of the IS-IS instances as equal routing clients, you must be careful when redistributing routes between IS-IS instances. The RIB does not know to prefer Level 1 routes over Level 2 routes. For this reason, if you are running Level 1 and Level 2 instances, you must enforce the preference by configuring different administrative distances for the two instances.