IPv6 Routing: IS-IS Multitopology Support for IPv6

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IS-IS Enhancements for IPv6

IS-IS in IPv6 functions the same and offers many of the same benefits as IS-IS in IPv4. IPv6 enhancements to IS-IS allow IS-IS to advertise IPv6 prefixes in addition to IPv4 and OSI routes. Extensions to the IS-IS command-line interface (CLI) allow configuration of IPv6-specific parameters. IPv6 IS-IS extends the address families supported by IS-IS to include IPv6, in addition to OSI and IPv4.

IS-IS in IPv6 supports either single-topology mode or multiple topology mode.

IS-IS Multitopology Support for IPv6

IS-IS multitopology support for IPv6 allows IS-IS to maintain a set of independent topologies within a single area or domain. This mode removes the restriction that all interfaces on which IS-IS is configured must support the identical set of network address families. It also removes the restriction that all routers in the IS-IS area (for Level 1 routing) or domain (for Level 2 routing) must support the identical set of network layer address families. Because multiple SPFs are performed, one for each configured topology, it is sufficient that connectivity exists among a subset of the routers in the area or domain for a given network address family to be routable.

You can use the **isis ipv6 metric** command to configure different metrics on an interface for IPv6 and IPv4.

When multitopology support for IPv6 is used, use the **metric-style wide**command to configure IS-IS to use new-style TLVs because TLVs used to advertise IPv6 information in link-state packets (LSPs) are defined to use only extended metrics.

Transition from Single-Topology to Multitopology Support for IPv6

All routers in the area or domain must use the same type of IPv6 support, either single-topology or multitopology. A router operating in multitopology mode will not recognize the ability of the single-topology mode router to support IPv6 traffic, which will lead to holes in the IPv6 topology. To transition from single-topology support to the more flexible multitopology support, a multitopology transition mode is provided.

The multitopology transition mode allows a network operating in single-topology IS-IS IPv6 support mode to continue to work while upgrading routers to include multitopology IS-IS IPv6 support. While in transition mode, both types of TLVs (single-topology and multitopology) are sent in LSPs for all configured IPv6 addresses, but the router continues to operate in single-topology mode (that is, the topological restrictions of the single-topology mode are still in effect). After all routers in the area or domain have been upgraded to support multitopology IPv6 and are operating in transition mode, transition mode can be removed from the configuration. Once all routers in the area or domain are operating in multitopology IPv6 mode, the topological restrictions of single-topology mode are no longer in effect.

How to Configure IPv6 Routing: IS-IS Multitopology Support for IPv6

Configuring Multitopology IS-IS for IPv6

When multitopology IS-IS for IPv6 is configured, the **transition** keyword allows a user who is working with the single-topology SPF mode of IS-IS IPv6 to continue to work while upgrading to multitopology IS-IS. After every router is configured with the **transition** keyword, users can remove the **transition** keyword on each router. When transition mode is not enabled, IPv6 connectivity between routers operating in single-topology mode and routers operating in multitopology mode is not possible.

You can continue to use the existing IPv6 topology while upgrading to multitopology IS-IS. The optional **isis ipv6 metric** command allows you to differentiate between link costs for IPv6 and IPv4 traffic when operating in multitopology mode.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis** *area-tag*
4. **metric-style wide** [**transition**] [**level-1** | **level-2** | **level-1-2**
5. **address-family ipv6** [**unicast** | **multicast**]
6. **multi-topology** [**transition**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**router isis** *area-tag* **Example:** `Device(config)# router isis area2`	Enables IS-IS for the specified IS-IS routing process, and enters router configuration mode.
Step 4	**metric-style wide** [**transition**] [**level-1** | **level-2** | **level-1-2** **Example:** `Device(config-router)# metric-style wide level-1`	Configures a router running IS-IS to generate and accept only new-style TLVs.
Step 5	**address-family ipv6** [**unicast** | **multicast**] **Example:** `Device(config-router)# address-family ipv6`	Specifies the IPv6 address family, and enters address family configuration mode. • The **unicast** keyword specifies the unicast IPv6 unicast address family. By default, the router is placed in configuration mode for the unicast IPv6 address family if the **unicast** keyword is not specified with the **address-family ipv6** command.
Step 6	**multi-topology** [**transition**] **Example:** `Device(config-router-af)# multi-topology`	Enables multitopology IS-IS for IPv6. • The optional **transition** keyword allows an IS-IS IPv6 user to continue to use single-topology mode while upgrading to multitopology mode.

Customizing IPv6 IS-IS

Perform this task to configure a new administrative distance for IPv6 IS-IS, configure the maximum number of equal-cost paths that IPv6 IS-IS will support, configure summary prefixes for IPv6 IS-IS, and configure an IS-IS instance to advertise the default IPv6 route (::/0). It also explains how to configure the hold-down period between partial route calculations (PRCs) and how often Cisco IOS XE software performs the SPF calculation when using multitopology IS-IS.

You can customize IS-IS multitopology for IPv6 for your network, but you likely will not need to do so. The defaults for this feature are set to meet the requirements of most customers and features. If you change the defaults, refer to the IPv4 configuration guide and the IPv6 command reference to find the appropriate syntax.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis** *area-tag*
4. **address-family ipv6** [**unicast** | **multicast**]

5. **default-information originate** [**route-map** *map-name*]
6. **distance** *value*
7. **maximum-paths** *number-paths*
8. **summary-prefix** *ipv6-prefix prefix-length* **level-1** | **level-1-2**| **level-2**]
9. **prc-interval** *seconds* [*initial-wait*] [*secondary-wait*
10. **spf-interval** [**level-1** | **level-2**] *seconds initial-wait*] [*secondary-wait*
11. **exit**
12. **interface** *type number*
13. **isis ipv6 metric** *metric-value* [**level-1** | **level-2** | **level-1-2**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router isis** *area-tag* **Example:** `Router(config)# router isis area2`	Enables IS-IS for the specified IS-IS routing process, and enters router configuration mode.
Step 4	**address-family ipv6** [**unicast**	**multicast**] **Example:** `Router(config-router)# address-family ipv6`	Specifies the IPv6 address family, and enters address family configuration mode. • The **unicast** keyword specifies the unicast IPv6 unicast address family. By default, the router is placed in configuration mode for the unicast IPv6 address family if the **unicast** keyword is not specified with the **address-family ipv6** command.
Step 5	**default-information originate** [**route-map** *map-name*] **Example:** `Router(config-router-af)# default-information originate`	(Optional) Injects a default IPv6 route into an IS-IS routing domain. • The **route-map** keyword and *map-name* argument specify the conditions under which the IPv6 default route is advertised. • If the **route map** keyword is omitted, then the IPv6 default route will be unconditionally advertised at Level 2.

	Command or Action	Purpose
Step 6	**distance** *value* **Example:** `Router(config-router-af)# distance 90`	(Optional) Defines an administrative distance for IPv6 IS-IS routes in the IPv6 routing table. • The *value*argument is an integer from 10 to 254. (The values 0 to 9 are reserved for internal use).
Step 7	**maximum-paths** *number-paths* **Example:** `Router(config-router-af)# maximum-paths 3`	(Optional) Defines the maximum number of equal-cost routes that IPv6 IS-IS can support. • This command also supports IPv6 Border Gateway Protocol (BGP) and Routing Information Protocol (RIP). • The *number-paths* argument is an integer from 1 to 64. The default for BGP is one path; the default for IS-IS and RIP is 16 paths.
Step 8	**summary-prefix** *ipv6-prefix prefix-length* **level-1** | **level-1-2**| **level-2**] **Example:** `Router(config-router-af)# summary-prefix 2001:DB8::/24`	(Optional) Allows a Level 1-2 router to summarize Level 1 prefixes at Level 2, instead of advertising the Level 1 prefixes directly when the router advertises the summary. • The *ipv6-prefix* argument in the **summary-prefix** command must be in the form documented in RFC 2373 where the address is specified in hexadecimal using 16-bit values between colons. • The *prefix-length* argument is a decimal value that indicates how many of the high-order contiguous bits of the address comprise the prefix (the network portion of the address). A slash mark must precede the decimal value.
Step 9	**prc-interval** *seconds* [*initial-wait*] [*secondary-wait* **Example:** `Router(config-router-af)# prc-interval 20`	(Optional) Configures the hold-down period between PRCs for multitopology IS-IS for IPv6.
Step 10	**spf-interval** [**level-1** | **level-2**] *seconds initial-wait*] [*secondary-wait* **Example:** `Router(config-router-af)# spf-interval 30`	(Optional) Configures how often Cisco IOS XE software performs the SPF calculation for multitopology IS-IS for IPv6.
Step 11	**exit** **Example:** `Router(config-router-af)# exit`	Exits address family configuration mode, and returns the router to router configuration mode. • Repeat this step to exit router configuration mode and return the router to global configuration mode.

	Command or Action	Purpose
Step 12	**interface** *type number* **Example:** `Router(config-router)# interface GigabitEthernet 0/0/1`	Specifies the interface type and number, and enters interface configuration mode.
Step 13	**isis ipv6 metric** *metric-value* [**level-1** | **level-2** | **level-1-2** **Example:** `Router(config-if)# isis ipv6 metric 20`	(Optional) Configures the value of an multitopology IS-IS for IPv6 metric.

Verifying IPv6 IS-IS Configuration and Operation

SUMMARY STEPS

1. **enable**
2. **show ipv6 protocols** [**summary**]
3. **show isis** [*process-tag*] [**ipv6** | *****] **topology**
4. **show clns** [*process-tag*] **neighbors** *interface-type interface-number*] [**area**] [**detail**]
5. **show clns** *area-tag* **is-neighbors** [*type number*] [**detail**]
6. **show isis** [*process-tag*] **database** [**level-1**] [**level-2**] [**l1**] [**l2**] [**detail**] [**lspid**]
7. **show isis ipv6 rib** [*ipv6-prefix*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ipv6 protocols** [**summary**] **Example:** `Device# show ipv6 protocols`	Displays the parameters and current state of the active IPv6 routing processes.
Step 3	**show isis** [*process-tag*] [**ipv6** | *****] **topology** **Example:** `Device# show isis topology`	Displays a list of all connected routers running IS-IS in all areas.
Step 4	**show clns** [*process-tag*] **neighbors** *interface-type interface-number*] [**area**] [**detail**] **Example:**	Displays end system (ES), intermediate system (IS), and multitopology IS-IS (M-ISIS) neighbors.

	Command or Action	Purpose
	`Device# show clns neighbors detail`	
Step 5	**show clns** *area-tag* **is-neighbors** [*type number*] [**detail**] **Example:** `Device# show clns is-neighbors detail`	Displays IS-IS adjacency information for IS-IS neighbors. • Use the **detail** keyword to display the IPv6 link-local addresses of the neighbors.
Step 6	**show isis** [*process-tag*] **database** [**level-1**] [**level-2**] [**l1**] [**l2**] [**detail**] [**lspid**] **Example:** `Device# show isis database detail`	Displays the IS-IS link-state database. • In this example, the contents of each LSP are displayed using the **detail** keyword.
Step 7	**show isis ipv6 rib** [*ipv6-prefix*] **Example:** `Device# show isis ipv6 rib`	Displays the IPv6 local RIB.

Configuration Examples for IPv6 Routing: IS-IS Multitopology Support for IPv6

Example: Configuring the IS-IS IPv6 Metric for Multitopology IS-IS

The following example sets the value of an IS-IS IPv6 metric to 20:

```
interface GigabitEthernet 0/0/1
 isis ipv6 metric 20
```

Example: Configuring IS-IS for IPv6

In the following example, output information about the parameters and current state of that active IPv6 routing processes is displayed using the **show ipv6 protocols**command:

```
Device# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static"
IPv6 Routing Protocol is "isis"
  Interfaces:
    GigabitEthernet0/0/3
    GigabitEthernet0/0/1
    Serial1/0/1
    Loopback1 (Passive)
    Loopback2 (Passive)
    Loopback3 (Passive)
    Loopback4 (Passive)
```

```
    Loopback5 (Passive)
  Redistribution:
    Redistributing protocol static at level 1
  Address Summarization:
    L2: 2001:DB8:33::/16  advertised with metric 0
    L2: 2001:DB8:44::/16  advertised with metric 20
    L2: 2001:DB8:66::/16  advertised with metric 10
    L2: 2001:DB8:77::/16  advertised with metric 10
```

In the following example, output information about all connected routers running IS-IS in all areas is displayed using the **show isis topology**command:

```
Device# show isis topology
IS-IS paths to level-1 routers
System Id       Metric  Next-Hop        Interface       SNPA
0000.0000.000C
0000.0000.000D  20      0000.0000.00AA  Se1/0/1         *HDLC*
0000.0000.000F  10      0000.0000.000F  GE0/0/1         0050.e2e5.d01d
0000.0000.00AA  10      0000.0000.00AA  Se1/0/1         *HDLC*
IS-IS paths to level-2 routers
System Id       Metric  Next-Hop        Interface       SNPA
0000.0000.000A  10      0000.0000.000A  GE0/0/3         0010.f68d.f063
0000.0000.000B  20      0000.0000.000A  GE0/0/3         0010.f68d.f063
0000.0000.000C  --
0000.0000.000D  30      0000.0000.000A  GE0/0/3         0010.f68d.f063
0000.0000.000E  30      0000.0000.000A  GE0/0/3         0010.f68d.f063
```

In the following example, output information to confirm that the local router has formed all the necessary IS-IS adjacencies with other IS-IS neighbors is displayed using the **show clns is-neighbors**command. To display the IPv6 link-local addresses of the neighbors, specify the **detail** keyword.

```
Device# show clns is-neighbors detail
System Id      Interface   State  Type Priority  Circuit Id         Format
0000.0000.00AA Se1/0/1     Up     L1   0         00                 Phase V
  Area Address(es): 49.0001
  IPv6 Address(es): FE80::YYYY:D37C:C854:5
  Uptime: 17:21:38
0000.0000.000F Et0/0/1     Up     L1   64        0000.0000.000C.02  Phase V
  Area Address(es): 49.0001
  IPv6 Address(es): FE80::XXXX:E2FF:FEE5:D01D
  Uptime: 17:21:41
0000.0000.000A Et0/0/3     Up     L2   64        0000.0000.000C.01  Phase V
  Area Address(es): 49.000b
  IPv6 Address(es): FE80::ZZZZ:F6FF:FE8D:F063
  Uptime: 17:22:06
```

In the following example, detailed output information that displays both end system (ES) and intermediate system (IS) neighbors is displayed using the **show clns neighbors** command with the **detail** keyword.

```
Device# show clns neighbors detail
System Id          Interface    SNPA            State  Holdtime  Type Protocol
0000.0000.0007     GE3/3        aa00.0400.6408  UP     26        L1   IS-IS
Area Address(es): 20
IP Address(es): 172.16.0.42*
Uptime: 00:21:49
0000.0C00.0C35     GE3/2        0000.0c00.0c36  Up     91        L1   IS-IS
Area Address(es): 20
IP Address(es): 192.168.0.42*
Uptime: 00:21:52
```

```
0800.2B16.24EA     GE3/3        aa00.0400.2d05  Up     27         L1   M-ISIS
Area Address(es): 20
IP Address(es): 192.168.0.42*
IPv6 Address(es): FE80::2B0:8EFF:FE31:EC57
Uptime: 00:00:27
0800.2B14.060E     GE3/2        aa00.0400.9205  Up     8          L1   IS-IS
Area Address(es): 20
IP Address(es): 192.168.0.30*
Uptime: 00:21:52
```

In the following example, detailed output information about LSPs received from other routers and the IPv6 prefixes they are advertising is displayed using the **show isis database**command with the **detail** keyword specified:

```
Device# show isis database detail
IS-IS Level-1 Link State Database
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
0000.0C00.0C35.00-00  0x0000000C   0x5696        325           0/0/0
  Area Address: 47.0004.004D.0001
  Area Address: 39.0001
  Metric: 10   IS 0000.0C00.62E6.03
  Metric: 0    ES 0000.0C00.0C35
 --More--
0000.0C00.40AF.00-00* 0x00000009   0x8452        608           1/0/0
  Area Address: 47.0004.004D.0001
  Topology: IPv4 (0x0) IPv6 (0x2)
  NLPID: 0xCC 0x8E
  IP Address: 172.16.21.49
  Metric: 10   IS 0800.2B16.24EA.01
  Metric: 10   IS 0000.0C00.62E6.03
  Metric: 0    ES 0000.0C00.40AF
  IPv6 Address: 2001:DB8::/32
  Metric: 10   IPv6 (MT-IPv6) 2001:DB8::/64
  Metric: 5    IS-Extended cisco.03
  Metric: 10   IS-Extended cisco1.03
  Metric: 10    IS (MT-IPv6) cisco.03
IS-IS Level-2 Link State Database:
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
0000.0000.000A.00-00  0x00000059   0x378A        949               0/0/0
  Area Address: 49.000b
  NLPID:        0x8E
  IPv6 Address: 2001:DB8:1:1:1:1:1:1
  Metric: 10         IPv6 2001:DB8:2:YYYY::/64
  Metric: 10         IPv6 2001:DB8:3:YYYY::/64
  Metric: 10         IPv6 2001:DB8:2:YYYY::/64
  Metric: 10         IS-Extended 0000.0000.000A.01
  Metric: 10         IS-Extended 0000.0000.000B.00
  Metric: 10         IS-Extended 0000.0000.000C.01
  Metric: 0          IPv6 11:1:YYYY:1:1:1:1:1/128
  Metric: 0          IPv6 11:2:YYYY:1:1:1:1:1/128
  Metric: 0          IPv6 11:3:YYYY:1:1:1:1:1/128
  Metric: 0          IPv6 11:4:YYYY:1:1:1:1:1/128
  Metric: 0          IPv6 11:5:YYYY:1:1:1:1:1/128
0000.0000.000A.01-00  0x00000050   0xB0AF        491               0/0/0
  Metric: 0          IS-Extended 0000.0000.000A.00
  Metric: 0          IS-Extended 0000.0000.000B.00
```

The following example shows output from the **show isis ipv6 rib** command. An asterisk (*) indicates prefixes that have been installed in the primary IPv6 RIB as IS-IS routes. Following each prefix is a list of all paths in order of preference, with optimal paths listed first and suboptimal paths listed after optimal paths.

```
Device# show isis ipv6 rib

IS-IS IPv6 process "", local RIB
  2001:DB8:88:1::/64
    via FE80::210:7BFF:FEC2:ACC9/GigabitEthernet2/0/0, type L2  metric 20 LSP [3/7]
    via FE80::210:7BFF:FEC2:ACCC/GigabitEthernet2/1/0, type L2  metric 20 LSP [3/7]
* 2001:DB8:1357:1::/64
    via FE80::202:7DFF:FE1A:9471/GigabitEthernet2/1/0, type L2  metric 10 LSP [4/9]
* 2001:DB8:45A::/64
    via FE80::210:7BFF:FEC2:ACC9/GigabitEthernet2/0/0, type L1  metric 20 LSP [C/6]
    via FE80::210:7BFF:FEC2:ACCC/GigabitEthernet2/1/0, type L1  metric 20 LSP [C/6]
    via FE80::210:7BFF:FEC2:ACC9/GigabitEthernet2/0/0, type L2  metric 20 LSP [3/7]
    via FE80::210:7BFF:FEC2:ACCC/GigabitEthernet2/1/0, type L2  metric 20 LSP [3/7]
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*
IPv6 commands	*Cisco IOS IPv6 Command Reference*
Cisco IOS IPv6 features	*Cisco IOS IPv6 Feature Mapping*
IPv6 Routing: IS-IS Multitopology Support for IPv6	" *Reducing Link Failure and Topology Change Notification Times in IS-IS Networks* " module

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IPv6 Routing: IS-IS Multitopology Support for IPv6

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.