



Reducing Link Failure and Topology Change Notification Times in IS-IS Networks

The tasks in this module explain how to customize Intermediate System-to-Intermediate System (IS-IS) to reduce the amount of time required for routers to send link failure and topology change information to neighbors. You can adjust the IS-IS timers and thereby decrease the time required for a device to send routing updates.

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Prerequisites for Reducing Link Failure and Topology Change Notification Times in IS-IS Networks

Before performing the tasks in this module, you should be familiar with the concepts described in the ""Overview of IS-IS Fast Convergence"" module.

Information About Reducing Link Failure and Topology Change Notification Times in IS-IS Networks

IS-IS LSP Generation Interval and Lifetime

If you increase the link-state Protocol Data Unit (PDU) LSP tuning values to their maximum, flooding will be significantly reduced, as will resource consumption by the flooding mechanism. The maximum period a router is allowed to wait before regenerating its LSP is approximately 18.7 hours.

IS-IS Throttling Timers That Affect Fast Convergence

You can configure IS-IS to react more rapidly to isolated events that are likely to be real link failures and to react more stably to frequent events that are unlikely to be actual link failures. The convergence speed and stability of IS-IS is affected by the values that you set for various throttling timers. The throttling timers impose a trade-off between reaction time to external events and the amount of resources dedicated to maintaining the information in the Routing Information Base (RIB). You should become familiar with the following.

IS-IS PDUs

IS-IS encapsulates data into a data-link PDU. There are four different PDU types and each can be Level 1 or Level 2:

- **LSP** --An LSP is a PDU that is sent between two IS-IS neighbors. The LSP contains information about neighbors and path costs, including adjacencies to neighbors, connected IP prefixes, Open Systems Interconnection (OSI) end systems, and area addresses. LSPs are used by the receiving routers to maintain their routing tables.
- **IIH** --An IS-IS Hello PDU is used to establish and maintain adjacencies. By default, an Intermediate-to-Intermediate Hello (IIH) is padded to the maximum transmission unit (MTU) size.
- **PSNP** --A partial sequence number PDU (PSNP) contains summaries of only a subset of known LSPs. A PSNP is used to acknowledge and request link-state information by soliciting newer versions of a complete LSP, or acknowledging receipt of an updated LSP, respectively.
- **CSNP** --A complete sequence number PDU (CSNP) contains summaries of all LSPs known by the issuing router.

LSP-Related Intervals and Exponential Backoff Timers

The following timers and intervals relate to LSPs that are generated by the IS-IS router:

- **LSP refresh interval** --Specifies the number of seconds (0 to 65535) the router will wait before refreshing (re-creating and reflooding) its own LSP.
- **Maximum LSP lifetime** --Specifies the value of the lifetime in the LSP header. Lifetime is used by all IS-IS routers in order to age out and purge old LSPs.

The following exponential backoff timers have been implemented in IS-IS to control the events of SPF calculation, Partial Route Calculations (PRC) computation, and LSP generation:

- **PRC interval** --Specifies the number of seconds between two consecutive PRCs. When changes that do not affect the topology, such as advertised external prefixes, are detected, the PRC is triggered.
- **LSP generation interval** --Specifies the number of seconds between creating new versions of a given LSP on a per-node basis.
- **SPF interval** --Specifies the number of seconds between two consecutive SPF calculations.

The purpose of these exponential backoff timers is to react quickly to the first events but, under constant churn, to slow down in order to prevent the CPU of the router from collapsing. The exponential backoff algorithm operates as follows:

1. An initial event triggers the SPF, PRC, or LSP generation.
2. The initial wait time that is configured for the interval determines the time between the initial event and the start of the SPF, PRC, or LSP generation.
3. The incremental wait time that is configured for the interval determines the amount of time that the router will wait in between the consecutive SPF execution, PRC execution, or LSP generation. This incremental value will increase exponentially between the incremental events until the maximum value is reached. For example, the incremental value will be (1x incremental value) between the first and second events, (2 x incremental value) between the second and third event, (4 x incremental value) between the third and fourth event, (8 x incremental value) between the fourth and fifth event, and so on, until the configured maximum interval--amount of time in seconds that the router will wait in between consecutive SPF execution, PRC execution, or LSP generation--has been reached.
4. If no new triggers have been received after two times the configured maximum wait-interval value, the network stabilizes, returning to a steady state and fast behavior. The initial wait-time interval will be reinstated.

See the to configure the recommended settings for the SPF, PRC, and LSP generation timers.

IS-IS Hello PDU Timers

The different IS-IS Hello timers need to be adapted according to the adjacency convergence time required for each subnet. Where a rapid adjacency loss has been detected, the timers need to be reduced. These timers should be modified if necessary after deployment and after an accurate monitoring of the network stability and convergence has occurred.

- **Hello interval** --Number of seconds during two consecutive transmissions of IIH PDUs.
- **Hello interval minimum** --When the hello interval is configured, the hold time is set to one second. The significance of the hello multiplier changes if Fast Hellos are used; the hello multiplier becomes the number of hellos that will be sent per second.
- **Hello multiplier** --An integer from 1 to 300 that is used to calculate the hold time. The hold time is the number of seconds during which the router will wait for an IIH before declaring that its neighbor is lost. The router multiplies the hello interval by the hello multiplier to determine the hold time. To avoid unnecessary adjacency resets, increase the default value of 3 on interfaces where frequent losses of IIH PDUs are detected.
- **IS-IS retransmit interval** --Specifies the number of seconds between the resending of IS-IS link-state PDU transmissions for point-to-point links.

CSNP Interval

The CSNP interval specifies the number of seconds between the two consecutive transmissions of CSNP PDUs. CSNP are generated by the designated router (DIS) in order for all routers connected to a broadcast media to synchronize their databases and by adjacent routers on a point-to-point network while setting up an adjacency. CSNPs are used to keep all router databases up to date. The lower the value of the CSNP interval, the faster the speed of the synchronization. However, a CSNP interval that is too low will trigger intensive PSNP PDU transmissions. All routers that are not synchronized with the DIS (Designated Intermediate System) and that, therefore, need additional LSPs in their database send PSNPs.

SPF, PRC, and LSP generation exponential backoff timers need to be tuned according to the level of stability of the network and the stability required in the routing domain. For instance, setting low values will trigger a fast convergence with a potential risk of high resource utilization if flapping routes cause network churn. Setting high values will keep the network stable with slower convergence.

It is recommended to leave the default value for the LSP generation interval at 5 seconds and also to increase the maximum lifetime for LSPs to 65,535 seconds, in order to conserve CPU usage for generation and refreshing of LSPs.

If you are using a routing algorithm based on SPF and if you use values for the initial required delay that are fewer than 40 milliseconds, SPF may start before the LSP that triggered SPF is flooded to neighbors. The router should always flood, at least, the LSP that triggered SPF before the router runs the SPF computation. LSP flooding is required in order to guarantee that the network update in the LSP is propagated around the network as quickly as possible.

How to Reduce Link Failure and Topology Change Notification Times in IS-IS Networks

Tuning SPF PRC and LSP Generation Exponential Backoff Timers

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis** *[area-tag]*
4. **spf-interval** *[level-1 | level-2] spf-max-wait [spf-initial-wait spf-second-wait]*
5. **prc-interval** *prc-max-wait [prc-initial-wait prc-second-wait]*
6. **lsp-gen-interval** *[level-1 | level-2] lsp-max-wait [lsp-initial-wait lsp-second-wait]*
7. **max-lsp-lifetime** *[hours] value*
8. **lsp-refresh-interval** *seconds*
9. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3	router isis [area-tag] Example: <pre>Router(config)# router isis</pre>	Enables IS-IS as an IP routing protocol and assigns a tag to a process, if required. • Enters router configuration mode.
Step 4	spf-interval [level-1 level-2] spf-max-wait [spf-initial-wait spf-second-wait] Example: <pre>Router(config-router)# spf-interval 5 1 20</pre>	Customizes IS-IS throttling of SPF calculations. Note The recommended values for the <i>spf-max-wait</i> , <i>spf-initial-wait</i> , and <i>spf-second-wait</i> arguments are 5, 1, and 20, respectively.
Step 5	prc-interval prc-max-wait [prc-initial-wait prc-second-wait] Example: <pre>Router(config-router)# prc-interval 5 1 20</pre>	Customizes IS-IS throttling of PRC calculations. Note The recommended values for the <i>prc-max-wait</i> , <i>prc-initial-wait</i> , and <i>prc-second-wait</i> arguments are 5, 1, and 20, respectively.
Step 6	lsp-gen-interval [level-1 level-2] lsp-max-wait [lsp-initial-wait lsp-second-wait] Example: <pre>Router(config-router)# lsp-gen-interval 5 1 20</pre>	Sets the minimum interval at which LSPs are generated. Note The recommended values for the <i>lsp-max-wait</i> , <i>lsp-initial-wait</i> , and <i>lsp-second-wait</i> arguments are 5, 1, and 20, respectively.
Step 7	max-lsp-lifetime [hours] value Example: <pre>Router(config-router)# max-lsp-lifetime 65535</pre>	Sets the maximum time for which LSPs persist without being refreshed. • To reduce network resources used for LSP generation, increase the LSP maximum lifetime value of 65535.
Step 8	lsp-refresh-interval seconds Example:	Sets the minimum interval at which LSPs are refreshed.

	Command or Action	Purpose
	Router(config-router)# lsp-refresh-interval 65000	To reduce network resources used for LSP refresh, increase the value to the LSP refresh interval to maximum value of 65000 seconds.
Step 9	end Example: Router(config-router)# end	Returns to privileged EXEC mode.

Enabling IS-IS Fast Flooding of LSPs

It is recommended that you keep the default values for the **isis retransmit-interval** and **isis retransmit-throttle-interval** commands when you configure the **fast-flood** command.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis** *[area-tag]*
4. **fast-flood** *lsp-number*
5. **end**
6. **show running-config**

DETAILED STEPS

Procedure

	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 <i>[area-tag]</i> Example: Router(config)# router isis	Enables IS-IS as an IP routing protocol and assigns a tag to a process, if required, and enters router configuration mode.
Step 4	fast-flood <i>lsp-number</i> Example:	Fast-floods LSPs.

	Command or Action	Purpose
	<code>Router(config-router)# fast-flood 20</code>	It is recommended that you keep the default values for the isis retransmit-interval and isis retransmit-throttle-interval commands when you configure the fast-flood command.
Step 5	end Example: <code>Router(config-router)# end</code>	Returns to privileged EXEC mode.
Step 6	show running-config Example: <code>Router# show running-config</code>	(Optional) Verifies that fast flooding has been enabled.

Monitoring IS-IS Network Convergence Time

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **isis display delimiter** [*return count* | *character count*]
4. **exit**
5. **show isis database** [*level-1*] [*level-2*] [*l1*] [*l2*] [*detail*] [*lspid*]
6. **show isis** [*area-tag*] **routes**
7. **show isis spf-log**
8. **show isis** [*process-tag*] **topology**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: <code>Router> enable</code>	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	configure terminal Example: <code>Router# configure terminal</code>	Enters global configuration mode.

	Command or Action	Purpose
Step 3	isis display delimiter [<i>return count</i> <i>character count</i>] Example: <pre>Router(config)# isis display delimiter return 2</pre>	(Optional) Makes output from multiarea displays easier to read by specifying the delimiter to use to separate displays of information.
Step 4	exit Example: <pre>Router(config)# exit</pre>	Returns to privileged EXEC mode.
Step 5	show isis database [<i>level-1</i>] [<i>level-2</i>] [<i>l1</i>] [<i>l2</i>] [<i>detail</i>] [<i>lspid</i>] Example: <pre>Router# show isis database detail</pre>	(Optional) Displays the IS-IS link-state database.
Step 6	show isis [<i>area-tag</i>] routes Example: <pre>Router# show isis financetag routes</pre>	(Optional) Displays the IS-IS Level 1 forwarding table for IS-IS learned routes.
Step 7	show isis spf-log Example: <pre>Router# show isis spf-log</pre>	(Optional) Displays how often and why the router has run a full SPF calculation.
Step 8	show isis [<i>process-tag</i>] topology Example: <pre>Router# show isis financetag topology</pre>	(Optional) Displays a list of all connected routers in all areas. • If a process tag is specified, output is limited to the specified routing process. When "null" is specified for the process tag, output is displayed only for the router process that has no tag specified. If a process tag is not specified, output is displayed for all processes.

Configuration Examples for Reducing Link Failure and Topology Change Notification Times in IS-IS Networks

Example Tuning IS-IS LSP Generation

The following example configures the router to reduce LSP flooding and the consequent resource consumption by tuning the LSP values to their maximums. Adjusting the IS-IS timers will decrease the time required for the router to send routing updates.


```
Router> enable
Router# configure terminal
Router(config)# router isis
Router(config-router)# isis tag 200
Router(config-router)# lsp-gen-interval 5
Router(config-router)# max-lsp-lifetime 65535
Router(config-router)# lsp-refresh-interval 65000
```

Example Tuning IS-IS Fast-Flooding of LSPs

In the following example, the **fast-flood** command is entered to configure the router to flood the first seven LSPs that invoke SPF, before the SPF computation is started. When the **show running-config** command is entered, the output confirms that fast-flooding has been enabled on the router.

```
Router> enable
Router# configure terminal
Router(config)# router isis first
Router(config-router)# fast-flood 7
Router(config-router)# end
Router# show running-config | include fast-flood

fast-flood 7
```

Where to Go Next

To configure features to improve IS-IS network convergence times and scalability, complete the optional tasks in one or more of the following modules:

- "Setting Best Practice Parameters for IS-IS Fast Convergence"
- "Reducing Failure Detection Times in IS-IS Networks"
- "Reducing Alternate-Path Calculation Times in IS-IS Networks"

Additional References

The following sections provide references related to IS-IS configuration tasks to achieve fast convergence and scalability.

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IS-IS commands: complete command syntax, command mode, defaults, command history, usage guidelines, and examples	<i>Cisco IOS IP Routing: ISIS Command Reference</i>

Related Topic	Document Title
Overview of Cisco IS-IS conceptual information with links to all the individual IS-IS modules	"Integrated IS-IS Routing Protocol Overview"
Customizing IS-IS for fast convergence and scalability	"Overview of IS-IS Fast Convergence" module
IPv6 Routing: IS-IS Multitopology Support for IPv6	"IPv6 Routing: IS-IS Multitopology Support for IPv6" module

RFCs

RFC	Title
No new or modified RFCs are supported, and support for existing RFCs has not been modified.	--

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 Reducing Link Failure and Topology Change Notification Times in IS-IS Networks

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.