Configuring Fibre Channel Write Acceleration

Configuring Fibre Channel Routing Services and Protocols

This chapter describes Fibre Channel routing services and protocols.

This chapter includes the following sections:

Information About FSPF

Fabric Shortest Path First (FSPF) is the standard path selection protocol used by Fibre Channel fabrics. The FSPF feature is enabled by default on all Fibre Channel switches. Except in configurations that require special consideration, you do not need to configure any FSPF services. FSPF automatically calculates the best path between any two switches in a fabric. FSPF provides these features:

- Dynamically compute routes throughout a fabric by establishing the shortest and quickest path between any two switches.
- Select an alternative path in the event of the failure of a given path. FSPF supports multiple paths and automatically computes an alternative path around a failed link. It provides a preferred route when two equal paths are available.

FSPF is the protocol currently standardized by the T11 committee for routing in Fibre Channel networks. The FSPF protocol has the following characteristics and features:

- Supports multipath routing.
- Bases path status on a link state protocol.
- Routes hop by hop, based only on the domain ID.
- Runs only on E ports or TE ports and provides a loop free topology.
- Runs on a per VSAN basis. Connectivity in a given VSAN in a fabric is guaranteed only for the switches configured in that VSAN.
- Uses a topology database to keep track of the state of the links on all switches in the fabric and associates a cost with each link.
- Guarantees a fast reconvergence time in case of a topology change. Uses the standard Dijkstra algorithm, but there is a static dynamic option for a more robust, efficient, and incremental Dijkstra algorithm. The reconvergence time is fast and efficient as the route computation is done on a per VSAN basis.

This section includes the following topics:

FSPF Global Configuration

By default, FSPF is enabled on switches in the Cisco MDS 9000 Family.

Some FSPF features can be globally configured in each VSAN. By configuring a feature for the entire VSAN, you do not have to specify the VSAN number for every command. This global configuration feature also reduces the chance of typing errors or other minor configuration errors.

Note FSPF is enabled by default. Generally, you do not need to configure these advanced features.

Caution The default for the backbone region is 0 (zero). You do not need to change this setting unless your region is different from the default. If you are operating with other vendors using the backbone region, you can change this default to be compatible with those settings.

About SPF Computational Hold Times

The SPF computational hold time sets the minimum time between two consecutive SPF computations on the VSAN. Setting this to a small value means that FSPF reacts faster to any fabric changes by recomputing paths on the VSAN. A small SPF computational hold time uses more switch CPU time.

About Link State Record Defaults

Each time a new switch enters the fabric, a link state record (LSR) is sent to the neighboring switches, and then flooded throughout the fabric. Table 1: LSR Default Settings , on page 2 displays the default settings for switch responses.

Table 1: LSR Default Settings

LSR Option	Default	Description
Acknowledgment interval (RxmtInterval)	5 seconds	The time a switch waits for an acknowledgment from the LSR before retransmission.
Refresh time (LSRefreshTime)	30 minutes	The time a switch waits before sending an LSR refresh transmission.
Maximum age (MaxAge)	60 minutes	The time a switch waits before dropping the LSR from the database.

The LSR minimum arrival time is the period between receiving LSR updates on this VSAN. Any LSR updates that arrive before the LSR minimum arrival time are discarded.

The LSR minimum interval time is the frequency at which this switch sends LSR updates on a VSAN.

About FSPF Link Cost

FSPF tracks the state of links on all switches in the fabric, associates a cost with each link in its database, and then chooses the path with a minimal cost. The cost associated with an interface can be administratively

changed to implement the FSPF route selection. The integer value to specify cost can range from 1 to 65,535. The default cost for 1 Gbps is 1000 and for 2 Gbps is 500.

About Hello Time Intervals

You can set the FSPF Hello time interval to specify the interval between the periodic hello messages sent to verify the health of the link. The integer value can range from 1 to 65,535 seconds.

Note This value must be the same in the ports at both ends of the ISL.

About Dead Time Intervals

You can set the FSPF dead time interval to specify the maximum interval for which a hello message must be received before the neighbor is considered lost and removed from the database. The integer value can range from 1 to 65,535 seconds.

Note This value must be the same in the ports at both ends of the ISL.

Caution An error is reported at the command prompt if the configured dead time interval is less than the hello time interval.

About Retransmitting Intervals

You can specify the time after which an unacknowledged link state update should be transmitted on the interface. The integer value to specify retransmit intervals can range from 1 to 65,535 seconds.

Note This value must be the same on the switches on both ends of the interface.

About Disabling FSPF for Specific Interfaces

You can disable the FSPF protocol for selected interfaces. By default, FSPF is enabled on all E ports and TE ports. This default can be disabled by setting the interface as passive.

Note FSPF must be enabled at both ends of the interface for the protocol to work.

FSPF Routes

FSPF routes traffic across the fabric, based on entries in the FSPF database. These routes can be learned dynamically, or configured statically.

About Fibre Channel Routes

Each port implements forwarding logic, which forwards frames based on its FC ID. Using the FC ID for the specified interface and domain, you can configure the specified route (for example FC ID 111211 and domain ID 3) in the switch with domain ID 1 (see Figure 1: Fibre Channel Routes , on page 4).

Figure 1: Fibre Channel Routes
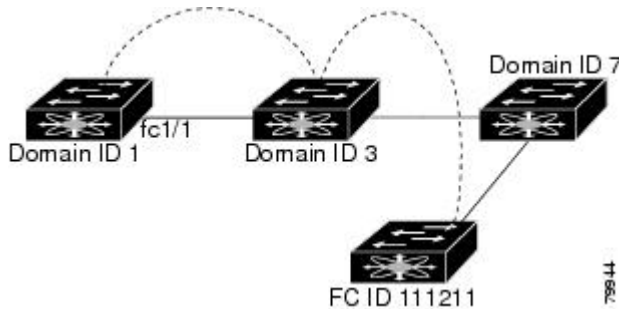
Note   Other than in VSANs, runtime checks are not performed on configured and suspended static routes.

About Broadcast and Multicast Routing

Broadcast and multicast in a Fibre Channel fabric uses the concept of a distribution tree to reach all switches in the fabric.

FSPF provides the topology information to compute the distribution tree. Fibre Channel defines 256 multicast groups and one broadcast address for each VSAN. Switches in the Cisco MDS 9000 Family only use broadcast routing. By default, they use the principal switch as the root node to derive a loop-free distribution tree for multicast and broadcast routing in a VSAN.

Caution   All switches in the fabric should run the same multicast and broadcast distribution tree algorithm to ensure the same distribution tree.

To interoperate with other vendor switches (following FC-SW3 guidelines), the Cisco SAN-OS and Cisco NX-OS Release 4.1(1b) and later releases uses the lowest domain switch as the root to compute the multicast tree in interop mode.

About Multicast Root Switch

By default, the **native** (non-interop) mode uses the principal switch as the root. If you change the default, be sure to configure the same mode in all switches in the fabric. Otherwise, multicast traffic could encounter potential loop and frame-drop problems.

Note   The operational mode can be different from the configured interop mode. The interop mode always uses the lowest domain switch as the root.

Use the **mcast root lowest vsan** command to change the multicast root from the principal switch to lowest domain switch.

In-Order Delivery

In-order delivery (IOD) of data frames guarantees frame delivery to a destination in the same order that they were sent by the originator.

Some Fibre Channel protocols or applications cannot handle out-of-order frame delivery. In these cases, switches in the Cisco MDS 9000 Family preserve frame ordering in the frame flow. The source ID (SID), destination ID (DID), and optionally the originator exchange ID (OX ID) identify the flow of the frame.

On any given switch with IOD enabled, all frames received by a specific ingress port and destined to a certain egress port are always delivered in the same order in which they were received.

Use IOD only if your environment cannot support out-of-order frame delivery.
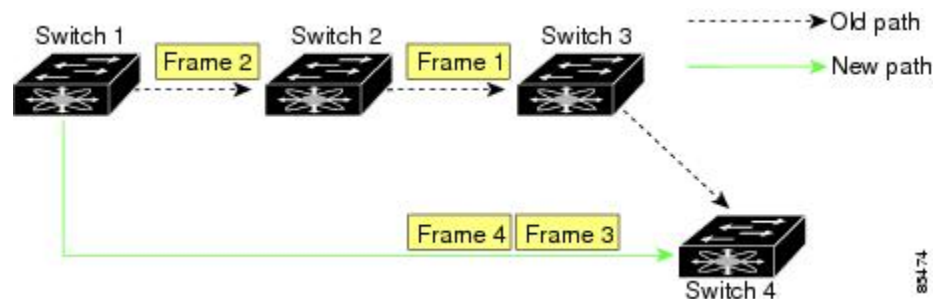
Tip   If you enable the in-order delivery feature, the graceful shutdown feature is not implemented.

About Reordering Network Frames

When you experience a route change in the network, the new selected path may be faster or less congested than the old route.

Figure 2: Route Change Delivery

If the in-order guarantee feature is enabled, the frames within the network are treated as follows:

• Frames in the network are delivered in the order in which they are transmitted.

• Frames that cannot be delivered in order within the network latency drop period are dropped inside the network.

About Reordering PortChannel Frames

When a link change occurs in a PortChannel, the frames for the same exchange or the same flow can switch from one path to another faster path.

Figure 3: Link Congestion Delivery
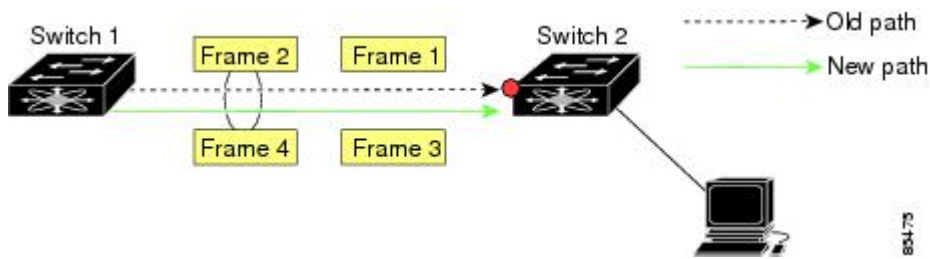
The in-order delivery feature attempts to minimize the number of frames dropped during PortChannel link changes when the in-order delivery is enabled by sending a request to the remote switch on the PortChannel to flush all frames for this PortChannel.

Note Both switches on the PortChannel must be running Cisco SAN-OS Release 3.0(1) for this IOD enhancement. For earlier releases, IOD waits for the switch latency period before sending new frames.

When the in-order delivery guarantee feature is enabled and a PortChannel link change occurs, the frames crossing the PortChannel are treated as follows:

- Frames using the old path are delivered before new frames are accepted.

- The new frames are delivered through the new path after the switch latency drop period has elapsed and all old frames are flushed.

Frames that cannot be delivered in order through the old path within the switch latency drop period are dropped. See the Configuring the Drop Latency Time, on page 12.

About Enabling In-Order Delivery

You can enable the in-order delivery feature for a specific VSAN or for the entire switch. By default, in-order delivery is disabled on switches in the Cisco MDS 9000 Family.

Tip We recommend that you only enable this feature when devices that cannot handle any out-of-order frames are present in the switch. Load-balancing algorithms within the Cisco MDS 9000 Family ensure that frames are delivered in order during normal fabric operation. The load-balancing algorithms based on source FC ID, destination FC ID, and exchange ID are enforced in hardware without any performance degradation. However, if the fabric encounters a failure and this feature is enabled, the recovery will be delayed because of an intentional pausing of fabric forwarding to purge the fabric of resident frames that could potentially be forwarded out-of-order.

About Flow Statistics

If you enable flow counters, you can enable a maximum of 1 K entries for aggregate flow and flow statistics for Generation 1 modules, and 2 K entries for Generation 2 modules. Be sure to assign an unused flow index to a module for each new flow. Flow indexes can be repeated across modules. The number space for flow index is shared between the aggregate flow statistics and the flow statistics.

Generation 1 modules allow a maximum of 1024 flow statements per module. Generation 2 modules allow a maximum of 2048-128 flow statements per module.

Note   For each session, fcflow counter will increment only on locally connected devices and should be configured on the switch where the initiator is connected.

Licensing Requirements for FSPF

The following table shows the licensing requirements for this feature:

License	License Description
ENTERPRISE_PKG	The enterprise license is required to enable Fibre Channel routing services and protocols. For a complete explanation of the licensing scheme, see the *Cisco MDS 9000 Family NX-OS Licensing Guide* .

Default Settings

lists the default settings for FSPF features.

Table 2: Default FSPF Settings

Parameters	Default
FSPF	Enabled on all E ports and TE ports.
SPF computation	Dynamic.
SPF hold time	0.
Backbone region	0.
Acknowledgment interval (RxmtInterval)	5 seconds.
Refresh time (LSRefreshTime)	30 minutes.
Maximum age (MaxAge)	60 minutes.
Hello interval	20 seconds.
Dead interval	80 seconds.
Distribution tree information	Derived from the principal switch (root node).
Routing table	FSPF stores up to 16 equal cost paths to a given destination.
Load balancing	Based on destination ID and source ID on different, equal cost paths.
In-order delivery	Disabled.

Parameters	Default
Drop latency	Disabled.
Static route cost	If the cost (metric) of the route is not specified, the default is 10.
Remote destination switch	If the remote destination switch is not specified, the default is direct.
Multicast routing	Uses the principal switch to compute the multicast tree.

Configuring FSPF

This section includes the following topics:

Configuring FSPF on a VSAN

To configure an FSPF feature for the entire VSAN, follow these steps:

Procedure

Step 1   Expand a Fabric, expand a VSAN and select FSPF for a VSAN that you want to configure for FSPF.

You see the FSPF configuration in the Information pane.

Step 2   The RegionID, **Spf Comp Holdtime**, LSR Min Arrival, and LSR Min Interval field values are applied across all interfaces on the VSAN. You can change them here or, if they do not exist create them here.

Step 3   Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes.

Resetting FSPF to the Default Configuration

To return the FSPF VSAN global configuration to its factory default, follow these steps:

Procedure

Step 1   Expand a Fabric, expand a VSAN, and select FSPF for a VSAN that you want to configure for FSPF.

You see the FSPF configuration in the Information pane.

Step 2   Check the SetToDefault check box for a switch.

Step 3   Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes.

Enabling or Disabling FSPF

To enable or disable FSPF, follow these steps:

Procedure

Step 1	Expand a Fabric, expand a VSAN, and select FSPF for a VSAN that you want to configure for FSPF.

You see the FSPF configuration in the Information pane. |
| **Step 2** | Set the Status Admin drop-down menu to up to enable FSPF or to down to disable FSPF. |
| **Step 3** | Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes. |

Configuring FSPF Link Cost

To configure FSPF link cost, follow these steps:

Procedure

Step 1	Expand Switches, expand FC Interfaces, and then select Physical.

You see the interface configuration in the Information pane. |
| **Step 2** | Click the FSPF tab.

You see the FSPF interface configuration in the Information pane. |
| **Step 3** | Double-click in the Cost field of a switch and change the value. |
| **Step 4** | Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes. |

Configuring Hello Time Intervals

To configure the FSPF Hello time interval, follow these steps:

Procedure

Step 1	Expand Switches, expand FC Interfaces, and then select Physical.

You see the interface configuration in the Information pane. |
| **Step 2** | Click the FSPF tab.

You see the FSPF interface configuration in the Information pane. |
| **Step 3** | Change the Hello Interval field for a switch. |
| **Step 4** | Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes. |

Configuring Dead Time Intervals

To configure the FSPF dead time interval, follow these steps:

Procedure

Step 1 Expand Switches, expand FC Interfaces, and then select Physical.

You see the interface configuration in the Information pane.

Step 2 Click the FSPF tab.

You see the FSPF interface configuration in the Information pane.

Step 3 Double-click the Dead Interval field for a switch and provide a new value.

Step 4 Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes.

Configuring Retransmitting Intervals

To configure the FSPF retransmit time interval, follow these steps:

Procedure

Step 1 Expand Switches, expand FC Interfaces, and then select Physical.

You see the interface configuration in the Information pane.

Step 2 Click the FSPF tab.

You see the FSPF interface configuration in the Information pane.

Step 3 Double-click the ReTx Interval field and enter a value.

Step 4 Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes.

Disabling FSPF for Specific Interfaces

To disable FSPF for a specific interface, follow these steps:

Procedure

Step 1 Expand Switches, expand FC Interfaces, and then select Physical.

You see the interface configuration in the Information pane.

Step 2 Click the FSPF tab.

You see the FSPF interface configuration in the Information pane.

Step 3 Set a switch Admin Status drop-down menu to down.

Step 4 Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes.

Configuring Fibre Channel Routes

To configure a Fibre Channel route using Device Manager, follow these steps:

Procedure

Step 1   Click FC > Advanced > Routes.

You see the FC Static Route Configuration dialog box.

Step 2   Click Create to create a static route.

You see the Create Route dialog box.

Step 3   Select the VSAN ID that you are configuring this route.

Step 4   Fill in the destination address and destination mask for the device you are configuring a route.

Step 5   Select the interface that you want to use to reach this destination.

Step 6   Select the next hop domain ID and route metric.

Step 7   Select either the local or remote radio button.

Step 8   Click Create to save these changes or click Close to discard any unsaved changes.

Setting the Multicast Root Switch

To use the lowest domain switch for the multicast tree computation, follow these steps:

Procedure

Step 1   Expand a fabric, expand a VSAN, and then select Advanced for the VSAN that you want to configure FSPF on.

You see the advanced Fibre Channel configuration in the Information pane.

Step 2   Click the Multicast Root tab.

You see the multicast root configuration in the Information pane.

Step 3   Set the Config Mode drop-down menu to lowestDomainSwitch.

Step 4   Click Apply Changes to save these changes or click Undo Changes to discard any unsaved changes.

Enabling In-Order Delivery for a VSAN

To use the lowest domain switch for the multicast tree computation, follow these steps:

Procedure

Step 1   Expand a fabric and select **All** VSANS.

Step 2	Select the Attributes tab.
	You see the general VSAN attributes in the Information pane.
Step 3	Check the InOrder Delivery check box to enable IOD for the switch.
Step 4	Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes.

Configuring the Drop Latency Time

To configure the drop latency time for a switch, follow these steps:

Procedure

Step 1	Expand a fabric and select All VSANS.
	You see the VSAN configuration in the Information pane.
Step 2	Click the Attributes tab.
	You see the general VSAN attributes in the Information pane.
Step 3	Double-click the Network Latency field and change the value.
Step 4	Click Apply Changes to save these changes, or click Undo Changes to discard any unsaved changes.

Verifying FSPF Configuration

To display FSPF configuration information, perform one of the following tasks:

Command	Purpose
show in-order-guarantee	Displays the In-Order Delivery Status
show fcdroplatency	Displays Latency information
show fcflow stats aggregated module 2	Displays Aggregated Flow Details for the Specified Module
show fcflow stats module 2	Displays Flow Details for the Specified Module
show fcflow stats usage module 2	Displays Flow Index Usage for the Specified Module
show fspf vsan 1	Displays FSPF Information for a Specified VSAN
show fspf database vsan 1	Displays FSPF Database Information
show fspf vsan 1 interface fc1/1	Displays FSPF Interface Information

For detailed information about the fields in the output from these commands, refer to the *Cisco MDS 9000 Family Command Reference* .

This section contains the following topics:

Displaying the FSPF Database

The FSPF database for a specified VSAN includes the following information:

- Link State Record (LSR) type
- Domain ID of the LSR owner
- Domain ID of the advertising router
- LSR age
- LSR incarnation member
- Number of links

To display the FSPF database using Device Manager, follow these steps:

Procedure

Step 1   Choose FC > Advanced > FSPF.

You see the FSPF dialog box.

Step 2   Click the LSDB LSRs tab.

You see the FSPF database information.

Step 3   Click Close to close the dialog box.

Displaying FSPF Statistics

To view FSPF statistics using DCNM-SAN, follow these steps:

Procedure

Step 1   Expand a Fabric, expand a VSAN, and then select FSPF in the Logical Domains pane.

You see the FSPF configuration dialog box.

Step 2   Click the Statistics tab.

You see the FSPF VSAN statistics in the Information pane.

Step 3   Click the Interface Statistics tab.

You see the FSPF interface statistics in the Information pane.

Configuration Examples for FSPF

This section provides examples of topologies and applications that demonstrate the benefits of FSPF.

Note The FSPF feature can be used on any topology.

Fault Tolerant Fabric

Figure 4: Fault Tolerant Fabric , on page 14 depicts a fault tolerant fabric using a partial mesh topology. If a link goes down anywhere in the fabric, any switch can still communicate with all others in the fabric. In the same way, if any switch goes down, the connectivity of the rest of the fabric is preserved.

Figure 4: Fault Tolerant Fabric
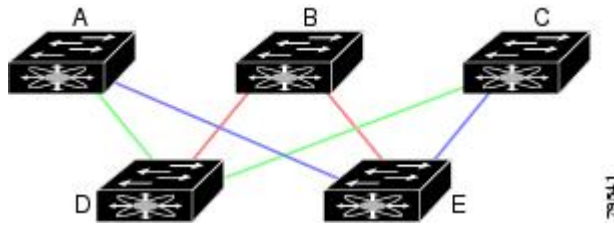
For example, if all links are of equal speed, the FSPF calculates two equal paths from A to C: A-D-C (green) and A-E-C (blue).

Redundant Links

To further improve on the topology in Figure 4: Fault Tolerant Fabric , on page 14, each connection between any pair of switches can be replicated; two or more links can be present between a pair of switches. Figure 5: Fault Tolerant Fabric with Redundant Links , on page 14 shows this arrangement. Because switches in the Cisco MDS 9000 Family support PortChanneling, each pair of physical links can appear to the FSPF protocol as one single logical link.

By bundling pairs of physical links, FSPF efficiency is considerably improved by the reduced database size and the frequency of link updates. Once physical links are aggregated, failures are not attached to a single link but to the entire PortChannel. This configuration also improves the resiliency of the network. The failure of a link in a PortChannel does not trigger a route change, thereby reducing the risks of routing loops, traffic loss, or fabric downtime for route reconfiguration.

Figure 5: Fault Tolerant Fabric with Redundant Links
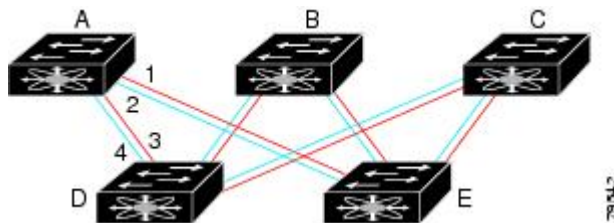
For example, if all links are of equal speed and no PortChannels exist, the FSPF calculates four equal paths from A to C: A1-E-C, A2-E-C, A3-D-C, and A4-D-C. If PortChannels exist, these paths are reduced to two.

Failover Scenarios for PortChannels and FSPF Links

The SmartBits traffic generator was used to evaluate the scenarios displayed in Figure 6: Failover Scenario Using Traffic Generators, on page 15. Two links between switch 1 and switch 2 exist as either equal-cost

ISLs or PortChannels. There is one flow from traffic generator 1 to traffic generator 2. The traffic was tested at 100 percent utilization at 1 Gbps in two scenarios:

- Disabling the traffic link by physically removing the cable (see Table 3: Physically Removing the Cable for the SmartBits Scenario, on page 15).

- Shutting down either switch 1 or switch 2 (see Table 4: Shutting Down the Switch for the SmartBits Scenario, on page 15).

Figure 6: Failover Scenario Using Traffic Generators

Table 3: Physically Removing the Cable for the SmartBits Scenario

PortChannel Scenario		FSPF Scenario (Equal cost ISL)	
Switch 1	Switch 2	Switch 1	Switch 2
110 msec (~2K frame drops)		130+ msec (~4k frame drops)	
100 msec (hold time when a signal loss is reported as mandated by the standard)			

Table 4: Shutting Down the Switch for the SmartBits Scenario

PortChannel Scenario		FSPF Scenario (Equal cost ISL)	
Switch 1	Switch 2	Switch 1	Switch 2
~0 msec (~8 frame drops)	110 msec (~2K frame drops)	130+ msec (~4K frame drops)	
No hold time needed	Signal loss on switch 1	No hold time needed	Signal loss on switch 1

Field Descriptions for FSPF

This section displays the field descriptions for this feature.

FSPF General

Field	Description
AdminStatus	The desired state of FSPF on this VSAN.
OperStatus	State of FSPF on this VSAN.

Field	Description
SetToDefault	Enabling this changes each value in this row to its default value. If all the configuration parameters have their default values and if the VSAN is suspended, then the row is deleted automatically.
RegionId	The autonomous region of the local switch on this VSAN.
DomainId	The domain ID of the local switch on this VSAN.
SpfHoldTime	The minimum time between two consecutive SPF computations on this VSAN. The smaller value means that routing will react to the changes faster but the CPU usage is greater.
SpfDelay	The time between when FSPF receives topology updates and when it starts the Shortest Path First (SPF) computation on this VSAN. The smaller value means that routing will react to the changes faster but the CPU usage is greater.
MinLsArrival	The minimum time after accepting a Link State Record (LSR) on this VSAN before accepting another update of the same LSR on the same VSAN. An LSR update that is not accepted because of this time interval is discarded.
MinLsInterval	The minimum time after this switch sends an LSR on this VSAN before it will send another update of the same LSR on the same VSAN.
LsRefreshTime	The interval between transmission of refresh LSRs on this VSAN.
LSRMaxAge	The maximum age an LSR will be retained in the FSPF database on this VSAN. It is removed from the database after MaxAge is reached.
CreateTime	When this entry was last created.
CheckSum	The total checksum of all the LSRs on this VSAN.

FSPF Interfaces

Field	Description
SetToDefault	Enabling this changes each value in this row to its default value. If all the configuration parameters have their default values and if the interface is down, then the row is deleted automatically.
Cost	The administrative cost of sending a frame on this interface on this VSAN. The value 0 means that the cost has not been configured. Once the value has been configured, the value cannot again be 0; so, obviously the value cannot be set to 0. If the value is 0 and the corresponding interface is up, the agent sets a value calculated using the ifSpeed of the interface. Otherwise, the value is used as the cost. The following formula is used to calculate the link cost:Link Cost = { fspfIfCost if fspfIfCost > 0 {(1.0625e12 / Baud Rate) if fspfIfCost == 0 where Baud Rate is the ifSpeed of the interface.
AdminStatus	The desired state of FSPF on this interface on this VSAN.

Field	Description
HelloInterval	Interval between the periodic hello messages sent on this interface on this VSAN to verify the link health. Note that this value must be same on both the interfaces on each end of the link on this VSAN.
DeadInterval	Maximum time for which no hello messages can be received on this interface on this VSAN. After this time, the interface is assumed to be broken and removed from the database. This value must be greater than the hello interval specified on this interface on this VSAN.
RetransmitInterval	Time after which an unacknowledged link update is retransmitted on this interface on this VSAN.
Neighbour State	The state of FSPF's neighbor state machine, which is the operational state of the interaction with the neighbor's interface which is connected to this interface.
Neighbour DomainId	The domain ID of the neighbor on this VSAN.
Neighbour PortIndex	The index, as known by the neighbor, of the neighbor's interface which is connected to this interface on this VSAN.
CreateTime	When this entry was last created.

FSPF Interface Stats

Field	Description
CreateTime	When this entry was last created.
ErrorRxPkts	Number of invalid FSPF control frames received on this interface on this VSAN since the creation of the entry.
InactivityExpirations	Number of times the inactivity timer has expired on this interface on this VSAN since the creation of the entry.
LsuRxPkts	Number of Link State Update (LSU) frames received on this interface on this VSAN since the creation of the entry.
LsuTxPkts	Number of Link State Update (LSU) frames transmitted on this interface on this VSAN since the creation of the entry.
RetransmittedLsuTxPkts	Number of LSU frames retransmitted on this interface on this VSAN since the creation of the entry.
LsaRxPkts	Number of Link State Acknowledgement (LSA) frames received on this interface on this VSAN since the creation of the entry.
LsaTxPkts	Number of Link State Acknowledgement (LSA) frames transmitted on this interface on this VSAN since the creation of the entry.
HelloTxPkts	Number of HELLO frames transmitted on this interface on this VSAN since the creation of the entry.

Field	Description
HelloRxPkts	Number of HELLO frames received on this interface on this VSAN since the creation of the entry.

FSPF LSDB Links

Field	Description
NbrDomainId	The domain ID of the neighbor on the other end of this link on this VSAN.
PortIndex	The source E_port of this link, as indicated by the index value in the LSR received from the switch identified by the domain ID.
NbrPortIndex	The destination E_port of this link, as indicated by the index value in the LSR received from the switch identified by NbrDomainId.
Cost	The cost of sending a frame on this link on this VSAN. Link cost is calculated using a formula link cost = S * (1.0625e12/Baud Rate) where S (value of Cost on the interface on the switch corresponding to the domain Id) is the administratively set cost factor for this interface.

FSPF LSDB LSRs

Field	Description
AdvDomainId	Domain ID of the switch that is advertising the LSR on the behalf of the switch owning it.
Age	Time since this LSR was inserted into the database.
IncarnationNumber	The link state incarnation number of this LSR. This is used to identify most recent instance of an LSR while updating the topology database when an LSR is received. The updating of an LSR includes incrementing its incarnation number prior to transmission of the updated LSR. So most recent LSR is the one with larger incarnation number.
CheckSum	The checksum of the LSR.
Links	Number of entries associated with this LSR.
External	Indicates of this is an external LSR advertised by local switch.

FSPF Statistics

Field	Description
SpfComputations	The number of times the SPF computation has been done on this VSAN since the creation of the entry.
ErrorRxPkts	Number of invalid FSPF control frames received on all the interface on this VSAN since the creation of the entry.

Field	Description
ChecksumErrors	The number of FSPF checksum errors occurred on this on this VSAN since the creation of the entry.
LsuRxPkts	Total number of Link State Update (LSU) frames received on all the interfaces on this VSAN since the creation of the entry.
LsuTxPkts	Total number of Link State Update (LSU) frames transmitted on all the interfaces on this VSAN since the creation of the entry.
RetransmittedLsuTxPkts	Total number of LSU frames retransmitted on all the interfaces on this VSAN since the creation of the entry.
LsaRxPkts	Total number of Link State Acknowledgement (LSA) frames received on all the interfaces on this VSAN since the creation of the entry.
LsaTxPkts	Total number of Link State Acknowledgement (LSA) frames transmitted on all the interfaces on this VSAN since the creation of the entry.
HelloTxPkts	Total number of HELLO frames transmitted on all interfaces on this VSAN since the creation of the entry.
HelloRxPkts	Total number of HELLO frames received on all the interfaces on this VSAN since the creation of the entry.
MaxAgeCount	The number of times any LSR reached fspfMaxAge in this VSAN since the creation of the entry.

Additional References

For additional information related to implementing VSANs, see the following section:

Related Document

Related Topic	Document Title
Cisco MDS 9000 Family Command Reference	Cisco MDS 9000 Family Command Reference

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	–

RFCs

RFC	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified.	–

MIBs

MIBs	MIBs Link
• CISCO-FC-ROUTE-MIB	To locate and download MIBs, go to the following URL: http://www.cisco.com/en/US/products/ps5989/prod_technical_reference_list.html