



# Configuring Dense Wavelength Division Multiplexing Controllers

This module describes the configuration of dense wavelength division multiplexing (DWDM) controllers.

DWDM is an optical technology that is used to increase bandwidth over existing fiber-optic backbones. DWDM can be configured on supported 10-Gigabit Ethernet (GE) or Packet-over-SONET/SDH physical layer interface modules (PLIMs). After you configure the DWDM controller, you can configure an associated 10-Gigabit Ethernet interface.

## Feature History for Configuring DWDM Controller Interfaces

Release	Modification
Release 5.2.3	Support for OTN Termination was included.

- [Prerequisites for Configuring DWDM Controller Interfaces, on page 1](#)
- [Information About the DWDM Controllers, on page 2](#)
- [Information about IPoDWDM, on page 2](#)
- [How to Configure DWDM Controllers, on page 3](#)
- [Forward Error Correction \(FEC\), on page 7](#)
- [Configuring IPoDWDM , on page 9](#)
- [Configuration Examples, on page 12](#)
- [Additional References, on page 13](#)

## Prerequisites for Configuring DWDM Controller Interfaces

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

## Information About the DWDM Controllers

DWDM support in Cisco IOS XR software is based on the Optical Transport Network (OTN) protocol that is specified in ITU-T G.709. This standard combines the benefits of SONET/SDH technology with the multiwavelength networks of DWDM.

To enable multiservice transport, OTN uses the concept of a wrapped overhead (OH). To illustrate this structure:

- Optical channel payload unit (OPU) OH information is added to the information payload to form the OPU. The OPU OH includes information to support the adaptation of client signals.
- Optical channel (OCh) OH is added to form the OCh. The OCh provides the OTN management functionality and contains four subparts: the OPU, and frame alignment signal (FAS).

**Figure 1: OTN Optical Channel Structure**



These are the conditions for OTU Port configuration:

- OTU4 can be configured at slice level only.
- Slice reset occurs immediately after commit.
- Interface is removed from the slice.
- Slice is powered back up in OTU4 mode.
- Two 100 GigE interfaces are created.

## Information about IPoDWDM

Cisco IOS XR software includes the IP over Dense Wavelength Division Multiplexing (IPoDWDM) feature.

IPoDWDM currently provides the following software features:

- Shared Risk Link Group (SRLG)

### Shared Risk Link Group (SRLG)

The Shared Risk Link Group (SRLG) provides shared risk information between the DWDM optical layer (L0) and the router layer (L3), and the applications that use the shared risk information. An SRLG is a set of links that share a resource whose failure may affect all links in the set.

System administrators can configure the following IPoDWDM features:

### Signal Logging

DWDM statistic data, such as EC, UC and alarms, are collected and stored in the log file on the DWDM line card.

# How to Configure DWDM Controllers

The DWDM controllers are configured in the physical layer control element of the Cisco IOS XR software configuration space. This configuration is done using the **controller dwdm** command, and is described in the following task:



**Note** All interface configuration tasks for Gigabit Ethernet interfaces still must be performed in interface configuration mode.

## Configuring the Optical Parameters

This task describes how to configure the wavelength parameters for the DWDM controller to set the operational wavelength of a tunable SFP+ module. The DWDM controllers are configured in the physical layer control element of the Cisco IOS XR software configuration space.

### SUMMARY STEPS

1. **configure**
2. **controller dwdm** *interface-path-id*
3. **admin-state out-of-service**
4. **commit**
5. **wavelength** *channel-number*
6. **commit**
7. **admin-state in-service**
8. Do one of the following:
  - **end**
  - 
  - **commit**
9. **show controllers dwdm** *interface-path-id* **optics**

### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>configure</b> <b>Example:</b> RP/0/RP0/CPU0:router# configure	Enter the XR Config mode.
Step 2	<b>controller dwdm</b> <i>interface-path-id</i> <b>Example:</b> RP/0/RP0/CPU0:router(config)# controller dwdm 0/1/0/0	Specifies the DWDM controller name in the notation <i>rack/slot/module/port</i> and enters DWDM configuration mode.

	Command or Action	Purpose
	<p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)#</pre>	
<b>Step 3</b>	<p><b>admin-state out-of-service</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# admin-state out-of-service</pre>	Specifies the DWDM interface administrative state. You must put the controller in <b>out-of-service</b> state before you can use the DWDM configuration commands.
<b>Step 4</b>	<p><b>commit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# commit</pre>	Saves configuration changes. This performs the shutdown from the previous step. After the controller has been shut down, you can proceed with the wavelength configuration.
<b>Step 5</b>	<p><b>wavelength channel-number</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# wavelength 1</pre>	Configures the channel number corresponding to the first wavelength. Values can range from 1 to 96. Use the <b>show controller dwdm</b> command with the <b>wavelength-map</b> keyword to determine which channels and wavelengths are supported on a specific controller.
<b>Step 6</b>	<p><b>commit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# commit</pre>	Saves configuration changes.
<b>Step 7</b>	<p><b>admin-state in-service</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# admin-state in-service</pre>	Places the DWDM port in In-Service (IS) state, to support all normal operation.
<b>Step 8</b>	<p>Do one of the following:</p> <ul style="list-style-type: none"> <li>• end</li> <li>•</li> <li>• commit</li> </ul> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# end</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul>

	Command or Action	Purpose
		<ul style="list-style-type: none"> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul>
<b>Step 9</b>	<b>show controllers dwdm <i>interface-path-id</i> optics</b> <b>Example:</b> <pre>RP/0/RP0/CPU0:router# show controller dwdm 0/1/0/0 optics</pre>	Displays the output power level, input power level, and wavelength information.

## Configuring G.709 Parameters

This task describes how to customize the alarm display and the thresholds for alerts and forward error correction (FEC). You need to use this task only if the default values are not correct for your installation.

### Before you begin

The **g709 disable**, **loopback**, and **g709 fec** commands can be used only when the controller is in the shutdown state. Use the **admin-state** command.

### SUMMARY STEPS

- configure**
- controller dwdm *interface-path-id***
- Do one of the following:
  - admin-state maintenance**
  - 
  - admin-state out-of-service**
- commit**
- g709 disable**
- g709 fec {disable | standard}**
- g709 report *alarm* disable**
- Do one of the following:
  - end**
  - 
  - commit**
- admin-state in-service**
- show controllers dwdm *interface-path-id* g709**

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<b>configure</b> <b>Example:</b>	Enters global configuration mode.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router# configure	
<b>Step 2</b>	<b>controller dwdm interface-path-id</b> <b>Example:</b> RP/0/RP0/CPU0:router(config)# controller dwdm 0/1/0/0	Specifies the DWDM controller name in the notation <i>rack/slot/module/port</i> and enters DWDM configuration mode.
<b>Step 3</b>	Do one of the following: <ul style="list-style-type: none"> <li>• <b>admin-state maintenance</b></li> <li>•</li> <li>• <b>admin-state out-of-service</b></li> </ul> <b>Example:</b> RP/0/RP0/CPU0:router(config-dwdm)# admin-state out-of-service	Disables the DWDM controller. You must disable the controller before you can use the DWDM configuration commands.
<b>Step 4</b>	<b>commit</b> <b>Example:</b> RP/0/RP0/CPU0:router(config-dwdm)# commit	Saves configuration changes. This performs the shutdown from the previous step. When the controller has been shut down, you can proceed with the configuration.
<b>Step 5</b>	<b>g709 disable</b> <b>Example:</b> RP/0/RP0/CPU0:router(config-dwdm)# g709 disable	(Optional) Disables the G.709 wrapper. The wrapper is enabled by default. <b>Note</b> The <b>g709 disable</b> command is available on the Cisco 4-Port 10-Gigabit Ethernet DWDM PLIM only.
<b>Step 6</b>	<b>g709 fec {disable   standard}</b> <b>Example:</b> RP/0/RP0/CPU0:router(config-dwdm)# g709 fec disable	(Optional) Configures the forward error correction mode (FEC) for the DWDM controller. By default, enhanced FEC is enabled.
<b>Step 7</b>	<b>g709 report alarm disable</b> <b>Example:</b> RP/0/RP0/CPU0:router(config-dwdm)# g709 odu bdi disable	(Optional) Disables the logging of selected optical channel alarms to the console for a DWDM controller. By default, all alarms are logged to the console.
<b>Step 8</b>	Do one of the following: <ul style="list-style-type: none"> <li>• <b>end</b></li> <li>•</li> <li>• <b>commit</b></li> </ul> <b>Example:</b> RP/0/RP0/CPU0:router(config-dwdm)# end	Saves configuration changes. <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul> Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:

	Command or Action	Purpose
	<p><b>Example:</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router (config-dwdm) # commit</pre>	<ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul>
<b>Step 9</b>	<p><b>admin-state in-service</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router (config-dwdm) # admin-state in-service</pre>	Places the DWDM port in In Service (IS) state, to support all normal operation.
<b>Step 10</b>	<p><b>show controllers dwdm interface-path-id g709</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router# show controller dwdm 0/1/0/0 optics</pre>	Displays the G.709 Optical Transport Network (OTN) protocol alarms and counters for Bit Errors, along with the FEC statistics and threshold-based alerts.

## What to Do Next

All interface configuration tasks for the Gigabit Ethernet interfaces still must be performed in interface configuration mode. Refer to the corresponding modules in this book for more information.

## Forward Error Correction (FEC)

FEC feature allows you to enable or disable RS-FEC (Reed-Solomon Codec for Ethernet IEEE 802.3 Clause 91) for 100G optics. The 100G optics can operate in both FEC and non-FEC mode. In FEC mode, these optics can cover an extended range. In non-FEC mode, 100G optics can interoperate with other optics.

FEC is a mechanism to recover lost packets on a link by sending extra “parity” packets for every group (N) of packets. As long as the receiver receives a subset of packets in the group (N-1) and the parity packet, up to a single lost packet in the group can be recovered.

FEC is supported on these optics:

- QSFP-100G-ER4L-S
- CPAK-100G-ER4F

## Configuring FEC on an Interface

By default the interfaces operate in non-FEC mode. To enable FEC on an interface, use the **fec standard** command in the interface configuration mode.




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**Note** The standard FEC refers to RS-FEC. The RS-FEC stands for Reed Solomon Forward Error Correction.

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The RS-FEC is only supported on these 100G optic interfaces:

- QSFP-100G-ER4L-S
- CPAK-100G-ER4F

```
RP/0/RP0/CPU0:ios#(config)# interface HundredGigE 0/6/0/8
RP/0/RP0/CPU0:ios#(config-if)# fec standard
RP/0/RP0/CPU0:ios#(config)# commit
```

### Verification

Use the **show controllers** command to verify the FEC configuration:

```
RP/0/RP0/CPU0:ios# show controllers hundredGigE 0/6/0/8
```

```
Thu Jul 25 05:58:38.162 UTC
Operational data for interface HundredGigE0/6/0/8:

State:
Administrative state: enabled
Operational state: Down (Reason: Link loss or low light, no loopback)
LED state: Yellow On

Phy:
Media type: fiber over 4 lane optics (25km reach) (lite)
Optics:
Vendor: CISCO
Part number: CISxxxx/101
Serial number: xxxxxx
Digital Optical Monitoring:
Transceiver Temp: 45.996 C

Alarms key: (H) Alarm high, (h) Warning high
(L) Alarm low, (l) Warning low
Wavelength Tx Power Rx Power Laser Bias
Lane (nm) (dBm) (mW) (dBm) (mW) (mA)
-----
1 0 0.7 1.1628 0.5 1.1238 218.560
2 0 0.6 1.1368 0.5 1.1169 218.560
3 0 0.6 1.1389 0.7 1.1790 218.560
4 0 0.6 1.1497 0.8 1.1948 218.560

DOM alarms:
Not available
Statistics:
FEC:
Corrected Codeword Count: 0
Uncorrected Codeword Count: 0

MAC address information:
Operational address: e41f.0fae.7865
```



```

Burnt-in address: e41f.0fae.7865
No unicast addresses in filter
Operating in multicast promiscuous mode

Autonegotiation disabled.

Operational values:
Speed: 100Gbps
Duplex: Full Duplex
Flowcontrol: None
Loopback: None (or external)
MTU: 1514
MRU: 1514
Inter-packet gap: standard (12)
BER monitoring:
Signal Degrade: 1e-255 (no-alarm)
Signal Fail: 1e-0 (report-alarm)
Forward error correction: Standard (Reed-Solomon)

```

The show command confirms that RS-FEC is enabled on the HundredGigE0/6/0/8 interface.

## Configuring IPoDWDM

This section provides the following configuration procedures:

### Configuring the Optical Layer DWDM Ports

Use the following procedure to configure the Optical Layer DWDM ports.

#### SUMMARY STEPS

1. **configure**
2. **controller dwdm** *interface-path-id*
3. **network port id** *id-number*
4. **network connection id** *id-number*
5. Do one of the following:
  - **end**
  - 
  - **commit**

#### DETAILED STEPS

	Command or Action	Purpose
Step 1	<b>configure</b> <b>Example:</b> RP/0/RP0/CPU0:router# <code>config</code>	Enters global configuration mode.
Step 2	<b>controller dwdm</b> <i>interface-path-id</i> <b>Example:</b>	Specifies the DWDM controller and enters DWDM controller mode.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router(config)# controller dwdm 0/1/0/1	
<b>Step 3</b>	<p><b>network port id</b> <i>id-number</i></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# network port id 1/0/1/1</pre>	Assigns an identifier number to a port for the Multi Service Transport Protocol (MSTP).
<b>Step 4</b>	<p><b>network connection id</b> <i>id-number</i></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# network connection id 1/1/1/1</pre>	Configures a connection identifier for the Multi Service Transport Protocol (MSTP).
<b>Step 5</b>	<p>Do one of the following:</p> <ul style="list-style-type: none"> <li>• <b>end</b></li> <li>•</li> <li>• <b>commit</b></li> </ul> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# end</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul>

## Configuring the Administrative State of DWDM Optical Ports

Use the following procedure to configure the administrative state and optionally set the maintenance embargo flag.

### SUMMARY STEPS

1. **configure**
2. **controller dwdm** *interface-path-id*
3. **admin-state** {**in-service** | **maintenance** | **out-of-service**}
4. **exit**
5. Do one of the following:

- **interface pos** *interface-path-id*
  - 
  - **interface tengige** *interface-path-id*
- 6. maintenance disable**
- 7. Do one of the following:**
- **end**
  - 
  - **commit**

**DETAILED STEPS**

	<b>Command or Action</b>	<b>Purpose</b>
<b>Step 1</b>	<p><b>configure</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router# config</pre>	Enters global configuration mode.
<b>Step 2</b>	<p><b>controller dwdm</b> <i>interface-path-id</i></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config)# controller dwdm 0/1/0/1</pre>	Specifies the DWDM controller and enters DWDM controller mode.
<b>Step 3</b>	<p><b>admin-state</b> {<b>in-service</b>   <b>maintenance</b>   <b>out-of-service</b>}</p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# admin-state maintenance</pre>	Specifies the transport administration state.
<b>Step 4</b>	<p><b>exit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# exit</pre>	Exits to the previous mode.
<b>Step 5</b>	<p>Do one of the following:</p> <ul style="list-style-type: none"> <li>• <b>interface pos</b> <i>interface-path-id</i></li> <li>•</li> <li>• <b>interface tengige</b> <i>interface-path-id</i></li> </ul> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config)# interface pos 1/0/1/1</pre> <p><b>Example:</b></p> <p><b>Example:</b></p>	Specifies the interface and enters interface configuration mode.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router(config)# interface tengige 1/0/1/1	
<b>Step 6</b>	<p><b>maintenance disable</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# maintenance disable</pre>	Provisions the maintenance embargo flag, which prevents maintenance activities from being performed on an interface.
<b>Step 7</b>	<p>Do one of the following:</p> <ul style="list-style-type: none"> <li>• <b>end</b></li> <li>•</li> <li>• <b>commit</b></li> </ul> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# end</pre> <p><b>Example:</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-dwdm)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul>

## Configuration Examples

This section includes the following examples:

### Turning On the Laser: Example



**Note** This is a required configuration. The DWDM cards will not operate without this configuration.

The following example shows how to turn on the laser and place a DWDM port in In Service (IS) state:

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

RP/0/RP0/CPU0:Router(config)# controller dwdm 0/1/0/1

RP/0/RP0/CPU0:Router(config-dwdm)# admin-state in-service
RP/0/RP0/CPU0:Router(config-dwdm)# commit
```

## Turning Off the Laser: Example

The following example shows how to turn off the laser, stop all traffic and place a DWDM port in Out of Service (OOS) state:

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:Router(config)# controller dwdm 0/1/0/1
RP/0/RP0/CPU0:Router(config-dwdm)# admin-state out-of-service
RP/0/RP0/CPU0:Router(config-dwdm)# commit
```

## IPoDWDM Configuration: Examples

This section includes the following examples:

### Optical Layer DWDM Port Configuration: Examples

The following example shows how to configure Optical Layer DWDM ports.

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# controller dwdm 0/1/0/1
RP/0/RP0/CPU0:router(config-dwdm)# network port id 1/0/1/1
RP/0/RP0/CPU0:router(config-dwdm)# network connection id 1/1/1/1
```

### Administrative State of DWDM Optical Ports Configuration: Examples

The following examples show how to configure the administrative state and optionally set the maintenance embargo flag:

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# controller dwdm 0/1/0/1
RP/0/RP0/CPU0:router(config-dwdm)# admin-state in-service
RP/0/RP0/CPU0:router(config-dwdm)# exit
RP/0/RP0/CPU0:router(config)# interface tengige 1/0/1/1
RP/0/RP0/CPU0:router(config-if)# maintenance disable
RP/0/RP0/CPU0:router(config-if)# commit
```

## Additional References

These sections provide references related to DWDM controller configuration.

### Related Documents

Related Topic	Document Title
Cisco IOS XR interface configuration commands	<i>Cisco IOS XR Interface and Hardware Component Command Reference</i>

Related Topic	Document Title
Initial system bootup and configuration information for a router using Cisco IOS XR software	<i>Cisco IOS XR Getting Started Guide</i>
Cisco IOS XR AAA services configuration information	<i>Cisco IOS XR System Security Configuration Guide</i> and <i>Cisco IOS XR System Security Command Reference</i>

### Standards

Standards	Title
ITU-T G.709/Y.1331	Interfaces for the optical transport network (OTN)

### MIBs

MIBs	MIBs Link
—	To locate and download MIBs for selected platforms using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>
OTN-MIB	IPoDWDM MIB

### RFCs

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

### Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	<a href="http://www.cisco.com/support">http://www.cisco.com/support</a>