DOCSIS 3.0 Downstream Bonding

The DOCSIS 3.0 Downstream Bonding feature helps cable operators offer new, more bandwidth-intensive services by adding one or more additional downstream quadrature amplitude modulation (QAM) channels to the standard broadband DOCSIS system.

Your software release may not support all the features that are documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. The Feature Information Table at the end of this document provides information about the documented features and lists the releases in which each feature is supported.

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

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Hardware Compatibility Matrix for the Cisco cBR Series Routers

Note The hardware components that are introduced in a given Cisco IOS-XE Release are supported in all subsequent releases unless otherwise specified.

Table 1: Hardware Compatibility Matrix for the Cisco cBR Series Routers

Cisco CMTS Platform	Processor Engine	Interface Cards
Cisco cBR-8 Converged Broadband Router	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 Supervisor: • PID—CBR-SUP-250G • PID—CBR-CCAP-SUP-160G	**Cisco IOS-XE Release 16.5.1 and Later Releases** Cisco cBR-8 CCAP Line Cards: • PID—CBR-LC-8D30-16U30 • PID—CBR-LC-8D31-16U30 • PID—CBR-RF-PIC • PID—CBR-RF-PROT-PIC • PID—CBR-CCAP-LC-40G • PID—CBR-CCAP-LC-40G-R • PID—CBR-CCAP-LC-G2-R • PID—CBR-SUP-8X10G-PIC • PID—CBR-2X100G-PIC Digital PICs: • PID—CBR-DPIC-8X10G • PID—CBR-DPIC-2X100G Cisco cBR-8 Downstream PHY Module: • PID—CBR-D31-DS-MOD Cisco cBR-8 Upstream PHY Modules: • PID—CBR-D31-US-MOD

Information About DOCSIS 3.0 Downstream Bonding

DOCSIS 3.0 Downstream Bonding enables high-speed broadband access and helps cable operators offer more bandwidth-intensive services by adding one or more additional downstream quadrature amplitude modulation (QAM) channels to the standard broadband DOCSIS system. This new set of downstream channels is grouped into one larger channel, known as a bonded channel.

Channel bonding combines several RF channels into one virtual channel. Data rates in this virtual channel range from hundreds of megabits to potentially gigabits per second, creating more available bandwidth in the network.

Receive Channel Profile

An RCP is an encoding that represents the receive channels and receive modules of a cable modem. A cable modem communicates to the CMTS one or more RCP encodings within its registration request using either verbose description, which contains complete subtype encoding defined in DOCSIS 3.0, or simple description, which only contains RCP identifiers.

The cable modem reporting method is configurable within the MAC domain and communicated to cable modems via the MDD.

You must define an RCP-ID to describe the cable modem's capabilities for that RCP-ID and to input information about cable modems which are not defined on the system. Once configured the RCP-ID is available to the entire system since it is not meant to be card specific or mac-domain specific. The path selection module ensures that the RCP ID is accurately transmitted as part of the RCC profile.

The CableLabs MULPI specification defines standard RCPs which are automatically created by the CMTS.

Receive Channel Configuration

A cable modem reports its ability to receive multiple channels with one or more RCP encodings in a REG-REQ or REG-REQ-MP message. Each receive channel profile describes a logical representation of the cable modem’s downstream physical layer in terms of receive channels (RCs) and receive modules (RMs). The CMTS initially configures the cable modem’s receive channels and receive modules with an RCC encoding in the registration response.

This feature supports any arbitrary RCP ID configuration and receive channel configuration on a Cisco cBR Series Converged Broadband Router.

RCC Template

You can configure one or more RCC templates for an RCP. An RCC template configures the physical layer components described by an RCP, including receive modules and receive channels to specific downstream frequencies. The template also specifies the interconnections among receive modules, or between a receive module and a receive channel. An RCC template can be associated only to the cable interface (MAC domain).

A cable modem's RCP ID is matched with an RCC, when RCC templates are configured. A cable modem's RCP ID may be matched with an RCC generated by an RCC template when RCC templates are configured. The path selection module ensures that the RCP ID that is transmitted as part of the RCC profile is accurate.

At time of registration, if there are multiple valid RCCs that can be assigned to the CM after going through the sequence of checks outlined in the CableLabs MULPI specifications then the RCC with the most channels will be the one selected. If there are multiple valid RCCs of equal size then the RCC with the least amount of cable modems will be selected.

Channel Assignment

The CMTS assigns a receive channel configuration encoding to a DOCSIS 3.0-certified cable modem operating in a Multiple Receive Channel (MRC) mode during cable modem registration.

With the implementation of this feature, the DOCSIS 3.0-certified cable modem reports its receiving capabilities and characteristics using the receive channel profile type, length, value (TLV) list in the registration request message. Based on this report, the CMTS assigns an RCC encoding that is compatible with the reported RCP.

Cable modems operating in MRC mode are assigned an RCC encoding associated with an RCP. RCC encodings may be derived from RCC templates or from a wideband-cable interface configuration.

Downstream Traffic Forwarding

DOCSIS 3.0 introduces the concept of assigning downstream service flows of cable modems, which are operating in an MRC mode, to downstream (DS) channels or bonding groups. Forwarding interfaces assigned to service flows (SFs) can be either DS channel interfaces (integrated cable interfaces) or downstream bonding groups (wideband interfaces).

Note Valid interfaces that are available for SF assignment must be a subset of the cable modem's assigned RCC encoding.

Service Flow Priority in Downstream Extended Header

The purpose of the feature is to be able to reflect the traffic priority of downstream packets into the DOCSIS extended header. The priority is derived from the service flow that the packet is mapped to. Priority refers to the service flow priority specified in the CM configuration file, or the Cisco CMTS service class configuration.

The service flow priority can be set using cable modem configuration file, or dynamic configuration.

By default, this feature is disabled on Cisco cBR-8 router, user can use **cable service flow priority** command to enable this feature.

How to Configure RCP and RCC Encoding

The following tasks describe how to configure a receive channel profile and configuration encoding for a receive channel profile:

Configuring the RCP ID

You must configure the RCP IDs with the cable modem capabilities that are not defined in the CMTS. This is done to supplement the standard MULPI RCP IDs already created by the CMTS.

Before you begin

Restrictions

The configurations are subject to RCC Templates and RCP Interactions as follows:

- RCC templates can only be created for an RCP that is already defined on the system. By default the system will contain the RCPs that are specified in the MULPI spec.
- When defining RCC templates for a particular RCP, error checking will be done to ensure that the information being configured in the RCC template does not violate the corresponding RCP information. For example, if the RCP information indicates that there are 2 receive modules then the RCC template configuration will not allow the user to configure more than 2 modules.
- Once an RCP is included in an RCC template users will not be allowed to modify the RCP. Only an RCP which is not being used by any RCC template can be modified

- A valid RCP that can be applied to an rcc-template must contain the following;
  - center-frequency-spacing
  - At least one module which defines the minimum and maximum center frequency range.
  - Rules of inheritance.
  - rcc-template inherit definition from the associated user-defined RCP, such as center-frequency-spacing.
  - rcc-template channel frequencies must fall within the range of the minimum and maximum center frequency per the corresponding RCP module.
  - common-module definition is applicable to the rcc-template module referenced with the same index.
  - rcc-template module channel frequencies overrides the same channel from the corresponding common-module.

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	**cable rcp-id** *rcp-id*
	Example:
	`Router(config)#cable rcp-id 00 10 00 01 08`
	`Router(config-rcp)#`
		Defines the RCC template.
		• *rcp-id* - Specifies an RCP ID in Hex.
		This command changes the input mode to the RCC configuration mode.

Step 4	**name** *word* **Example:** `Router(config-rcp)# name rcp-id_1`	**name** —Assigns a name ro the RCP ID • *word*—Use a string to name the RCP ID. **Note** Do not include space between words in the name
Step 5	**center-frequency-spacing** *frequency* **Example:** `Router(config-rcp)#center-frequency-spacing 6`	Assigns a center frequency space to the RCP ID. The valid values are 6 and 8.

Step 6	**module** *module index* **minimum-center-frequency** *Hz* **maximum-center-frequency** *Hz*
	Example:
	`Router(config-rcp)# module 1`
	`minimum-center-frequency 120000000`
	`maximum-center-frequency 800000000`
		Configures a receive module configuration for the selected RCP.
		• *module index* - Specifies the module number for the receivemodule. The valid range is 1 to 12.
		• **minimum-center-frequency** - Specifies the minimum center frequency for the channels of the receivemodule channel.

	Command or Action	Purpose
		• *Hz*- Specifies the center frequency value in Hz. The valid range is from 111000000 to 999000000. • **maximum-center-frequency** - Specifies the maximum center frequency for the channels of the receive module channel.
Step 7	**module** *module index* **number-of-adjacent-channels** *Integrer* **Example:** `Router(config-rcp)#module 2 number-of-adjacent-channels 10 Router(config-rcp)#`	Specifies the frequency band for the receive module. The valid values are 1-255.
Step 8	**module** *module index* **connected-module** *module index* **Example:** `Router(config-rcp)# module 1 connected-module 0`	Specifies a receive channel configuration for the selected RCP. • **connected-receive-module**— (Optional) Specifies a nested receive module in the RCC template. Generally, only one receive module is configured for an RCC template. • *module index*—Specifies the module number for the receive module. The valid range is 1 to 12.
Step 9	**number-of-channels** *Number of channel* **Example:** `Router (config-rcp)#number-of-channels 8`	Specifies the number of receive channels in the RCP ID.
Step 10	**primary-capable-channels** *Number of channel* **Example:** `Router(config-rcp)# primary-capable-channels 1`	Specifies the number of receive channels that are defined as primary capable channels.

What to do next

Verify RCP ID configurations using the **show cable rcps** command.

```
Router# show cable rcps
RCP ID  : 00 10 00 01 08
  Name  : rcp-id 1
  Center Frequency Spacing      : 6
  Max number of Channels        : 8
  Primary Capable Channel       : 1
  Number of Modules             : 2
   Module[1]:
     Number of Adjacent Channels: 10
     Minimum Center Frequency-Hz: 111000000
     Maximum Center Frequency-Hz: 999000000
   Module[2]:
     Number of Adjacent Channels: 10
```

```
     Minimum Center Frequency-Hz: 120000000
     Maximum Center Frequency-Hz: 800000000

RCP ID  : 00 10 00 00 02
  Name  : rcp-id 2
  Center Frequency Spacing      : 6
  Max number of Channels        : 2
  Primary Capable Channel       : 1
  Number of Modules             : 1
   Module[1]:
     Number of Adjacent Channels: 10
Minimum Center Frequency-Hz: 111000000
     Maximum Center Frequency-Hz: 867000000
     Connected Module           : 64
```

Configuring the RCC Templates

You must configure an RCC template with a unique RCP ID for a particular CMTS. A valid RCC template consists of a configured RCP ID, RMs, and RCs. There is dependency between the RCC templates and the RCP since information present in the RCP configuration is also present in RCC templates.

Each RCC encoding contains all operational DS channels with their channel parameters, including the frequency match RC attribute specified in the RCC template. An RCC template specifies the intended receive channel assignment in the available DS spectrum.

Note If an RCC template is removed from a MAC domain through configuration, the CMTS removes all RCC encodings derived from the RCC template, and all cable modems assigned to the RCC encoding are marked offline.

Before you begin

At least one RC must be configured as a primary Receive Channel (RC).

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	**cable rcc-templates frequency-based** *id*
	Example:
	`Router(config)#cable rcc-templates frequency-based 1`
	`Router(config-rcc-freq-based)#`
		id—Specifies an RCC template. The valid range is 1-64.

	Command or Action	Purpose
Step 4	**rcp-id** *id* **Example:** `Router(config-rcc-freq-based)#rcp-id 00 10 00 01 08`	*id*—Specifies an RCP ID for the RCC template. The valid range is 00 00 00 00 00 to FF FF FF FF. By default, the RCP ID is set to 00 00 00 00 00.
Step 5	**common-module** *module-index* **channel** *grouplist* **start-frequency** *Hz* **Example:** `Router(config-rcc-freq-based)# common-module 1 channels 0-6 start-frequency 555000000`	Specifies module configurations that are common for a selected set of channels assigned to the selected RCP ID. • *Module-index*—Specifies the index value for the receive module. The valid range is 1 to 12. • **channels**—Specifies the list of channels to which the common configurations apply. • *grouplist*—Specifies the list of channels to which a specific list of configurations apply. The range of values are 1-64. • **start-frequency** —Specifies the start frequency value in Hz. • *Hz*—Specifies the frequency value for the start frequency for the common module. Thevalidrangeisfrom 111000000 to 999000000.
Step 6	**rcc-template** *Id* **Example:** `Router(config-rcc-freq-based)# rcc-template 1`	Specifies an RCC template ID to configure the selected RCC template. • *Id*—Specifies the ID of the RCC template. The valid range is from 1-8.
Step 7	**cm-attribute-mask** *value* **Example:** `Router (config-rcc-freq-based-tmplt)# cm-attribute-mask 1`	(Optional) Configured to be used to match against the cm attribute mask define in CM 's configuration file. • *value*—The valid range is 00 00 00 00 00 to FF FF FF FF.
Step 8	**module***module-index* **channel** *grouplist* **start-frequency** *Hz*. **Example:** `Router(config-rcc-freq-based)# common-module 1 channels 0-6 start-frequency 555000000`	Specifies module configurations that are common for a selected set of channels assigned to the selected RCP ID. • *Module-index*—Specifies the index value for the receive module. The valid range is 1 to 12. • **channels**—Specifies the list of channels to which the common configurations apply. • *grouplist*—Specifies the list of channels to which a specific list of configurations apply. The range of values are 1-64. • **start-frequency** —Specifies the start frequency value in Hz.

	Command or Action	Purpose
		• *Hz*—Specifies the frequency value for the start frequency for the common module. The valid range is from 111000000 to 999000000. Repeat Step 3 and Step 7 to configure other frequency based RCC templates.

What to do next

The following configuration examples show the cable rcc-template configuration:

```
cable rcc-templates frequency-based 2
  rcp-id 00 10 00 01 08
  common-module 1 channels 1-4 start-frequency 381000000
  rcc-template 1
  module 1 channels 5-8 start-frequency 501000000
  rcc-template 2
  module 1 channels 5-8 start-frequency 669000000
  rcc-template 3

cable rcc-templates frequency-based 1
  rcp-id 00 10 00 01 08
  rcc-template 1
  cm-attribute-mask 2
  module 1 channels 1-4 start-frequency 381000000
  module 2 channels 5-8 start-frequency 501000000
  rcc-template 2
  module 1 channels 1-4 start-frequency 381000000
  module 2 channels 5-8 start-frequency 669000000
  rcc-template 3
  module 1 channels 1-4 start-frequency 381000000
```

After defining an RCC template, you must assign the template to a cable interface.

Assigning an RCC Template to a MAC Domain (Cable Interface)

The CMTS derives an RCC or RCCs from the RCC template for each MAC Domain Downstream Service Group (MD-DS-SG).

The following information is required for RCC assignment to cable modems:

- RCC templates assigned to the MAC domain.
- DS channel physical parameters including frequency and connected-receive-module index .
- DS channel primary capable indicator.
- DS channel membership to the MD-DS-SG.
- Cable modem membership to the MD-DS-SG.

This section describes how to assign an RCC template to a MAC Domain.

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	**interface cable** *slot*/*subslot*/*port* **Example:** `Router(config)# interface cable 1/0/0`	Enters MAC domain configuration mode. • *slot*—Specifies the chassis slot number of the interface line card. • *subslot*—Specifies the secondary slot number of the interface line card. Valid subslot is 0. • *MD index*—Specifies the MAC Domain index number. Valid values are 0-15.
Step 4	**cable rcc-template frequency-based** *Id* **Example:** `Router(config-if)# cable rcc-template frequency-based 1`	Assigns the RCC template to the specified cable interface. • *Id*—Specifies the template you want to assign to the cable interface. The valid range is from 1 to 64.

What to do next

Verify RCC template binding to MD.

The following example shows the RCC template binding using the **show cable mac-domain rcc**

```
Router#show cable mac-domain c1/0/0 rcc

RCC-ID   RCP               RCs MD-DS-SG CMs   WB/RCC-TMPL
1        00 00 00 00 00    4   0        2     WB (Wi1/0/0:0)
2        00 00 00 00 00    4   0        2     WB (Wi1/0/0:1)
3        00 00 00 00 00    4   0        0     WB (Wi1/0/1:2)
4        00 00 00 00 00    4   0        0     WB (Wi1/0/2:3)
8        00 10 00 01 08    8   5        0     RCC-TMPL (1:1)
9        00 10 00 01 08    8   5        0     RCC-TMPL (1:2)
10       00 10 00 01 08    4   5        0     RCC-TMPL (1:3)
14       00 10 00 01 08    8   5        0     RCC-TMPL (2:1)
15       00 10 00 01 08    8   5        0     RCC-TMPL (2:2)
16       00 10 00 01 08    4   5        0     RCC-TMPL (2:3)
```

The following example shows the RCC template binding using the **show cable mac-domain rcc** *id* command.

```
Router#show cable mac-domain c1/0/0 rcc 8
```

```
RCC ID                  : 8
RCP                     : 00 10 00 01 08
Created Via             : rcc-template - 1:1
CM attribute mask       : 0x2
Receive Channels        : 8
  Receive Channel       : 1
    Center Frequency    : 381000000
    Primary Capability  : YES
    Receive Module Conn : 1
  Receive Channel       : 2
    Center Frequency    : 387000000
    Primary Capability  : NO
    Receive Module Conn : 1
  Receive Channel       : 3
    Center Frequency    : 393000000
    Primary Capability  : NO
    Receive Module Conn : 1
  Receive Channel       : 4
    Center Frequency    : 399000000
    Primary Capability  : NO
    Receive Module Conn : 1
  Receive Channel       : 5
    Center Frequency    : 501000000
    Primary Capability  : NO
    Receive Module Conn : 2
  Receive Channel       : 6
    Center Frequency    : 507000000
    Primary Capability  : NO
    Receive Module Conn : 2
  Receive Channel       : 7
    Center Frequency    : 513000000
    Primary Capability  : NO
    Receive Module Conn : 2
  Receive Channel       : 8
    Center Frequency    : 519000000
    Primary Capability  : NO
    Receive Module Conn : 2
Receive Modules         : 2
  Receive Module        : 1
    First Frequency     : 381000000
  Receive Module        : 2
    First Frequency     : 501000000
```

```
Router#show cable mac-domain c9/0/2 rcc 9

RCC ID                  : 9
RCP                     : 00 10 00 01 08
Created Via             : rcc-template - 1:2
CM attribute mask       : 0x0
Receive Channels        : 8
  Receive Channel       : 1
    Center Frequency    : 381000000
    Primary Capability  : YES
    Receive Module Conn : 1
  Receive Channel       : 2
    Center Frequency    : 387000000
    Primary Capability  : NO
    Receive Module Conn : 1
  Receive Channel       : 3
    Center Frequency    : 393000000
    Primary Capability  : NO
    Receive Module Conn : 1
  Receive Channel       : 4
```

```
    Center Frequency    : 399000000
    Primary Capability  : NO
    Receive Module Conn : 1
  Receive Channel       : 5
    Center Frequency    : 669000000
    Primary Capability  : NO
    Receive Module Conn : 2
  Receive Channel       : 6
    Center Frequency    : 675000000
    Primary Capability  : NO
    Receive Module Conn : 2
  Receive Channel       : 7
    Center Frequency    : 681000000
    Primary Capability  : NO
    Receive Module Conn : 2
  Receive Channel       : 8
    Center Frequency    : 687000000
    Primary Capability  : NO
    Receive Module Conn : 2
Receive Modules         : 2
  Receive Module        : 1
    First Frequency     : 381000000
  Receive Module        : 2
    First Frequency     : 669000000

Router#show cable mac-domain c1/0/0 rcc 10

RCC ID                  : 10
RCP                     : 00 10 00 01 08
Created Via             : rcc-template - 1:3
CM attribute mask       : 0x0
Receive Channels        : 4
  Receive Channel       : 1
    Center Frequency    : 381000000
    Primary Capability  : YES
    Receive Module Conn : 2
  Receive Channel       : 2
    Center Frequency    : 387000000
    Primary Capability  : NO
    Receive Module Conn : 2
  Receive Channel       : 3
    Center Frequency    : 393000000
    Primary Capability  : NO
    Receive Module Conn : 2
  Receive Channel       : 4
    Center Frequency    : 399000000
    Primary Capability  : NO
    Receive Module Conn : 2
Receive Modules         : 1
  Receive Module        : 2
    First Frequency     : 381000000
```

Verifying the RCC Configuration

To verify the runtime RCCs on a cable interface, use the **show cable mac-domain rcc** command.

```
Router#show cable mac-domain c1/0/0 rcc

RCC-ID   RCP                RCs MD-DS-SG CMs   WB/RCC-TMPL
1        00 00 00 00 00     4   0        2     WB (Wi1/0/0:0)
```

```
2         00 00 00 00 00       4    0         2      WB (Wi1/0/0:1)
3         00 00 00 00 00       4    0         0      WB (Wi1/0/1:2)
4         00 00 00 00 00       4    0         0      WB (Wi1/0/2:3)
8         00 10 00 01 08       8    5         0      RCC-TMPL (1:1)
9         00 10 00 01 08       8    5         0      RCC-TMPL (1:2)
10        00 10 00 01 08       4    5         0      RCC-TMPL (1:3)
14        00 10 00 01 08       8    5         0      RCC-TMPL (2:1)
15        00 10 00 01 08       8    5         0      RCC-TMPL (2:2)
16        00 10 00 01 08       4    5         0      RCC-TMPL (2:3)
```

Note A zero (0) value in the RCP or MD-DS-SG field indicates that the RCC encoding is configured directly through a wideband interface configuration and not through any RCC template.

How to Configure Attribute Masks

DOCSIS 3.0 introduces the concept of assigning service flows to channels or bonding groups based on binary attributes. The attribute masks configured on a cable, modular, integrated or wideband interface are called provisioned attribute masks.

The two types of attributes are as follows:

- Specification-defined attributes—Contain default values based on the characteristics of the channel or bonding group.
- Operator-defined attributes—Default to zero.

The operator can configure a provisioned attribute mask for each channel and provisioned bonding group to assign values to the operator-defined binary attributes. The operator can also assign new values to override the default values of the specification-defined attributes.

The operator can configure a required attribute mask and a forbidden attribute mask for a service flow in the cable modem configuration file. These required and forbidden attribute masks are optionally provided on the DOCSIS 3.0 service flows and are matched with the provisioned attribute masks of the interfaces.

Each service flow is optionally configured with the following TLV parameters:

- Service flow required attribute mask—To configure this, assign a service flow to a channel that has a 1-bit in all positions of its provisioned attribute mask corresponding to the 1-bit in the service flow required attribute mask.
- Service flow forbidden attribute mask—To configure this, assign a service flow to a channel that has a 0-bit in all positions of its provisioned attribute mask corresponding to the 1-bit in the service flow forbidden attribute mask.

Additionally, in a cable modem-initiated dynamic service request, the cable modem can include a required attribute mask and a forbidden attribute mask for a service flow. The CMTS assigns service flows to channels or bonding groups so that all required attributes are present and no forbidden attributes are present in the cable modem configuration file.

The table below lists the supported binary attributes for channels and bonding groups.

Table 2: Binary Attributes

Bit Position	Definition
Bit 0	Bonded—This bit is zero for all individual channel interfaces and one for all bonding groups.
Bit 1	Low latency—This bit is set when the interface can provide relatively low latency service. This bit is set to zero for all channels, and left up to the operator to define.
Bit 2	High availability—This bit is set to zero for all channels, and left up to the operator to define.
Bit 3:15	Reserved—Set to zero.
Bit 16:31	Operator defined—Set to zero by default.

You can configure provisioned attribute masks for cable, integrated cable, wideband cable, and modular cable interfaces.

Prerequisites

- To assign an interface to a wideband cable modem's service flow, the interface must be a subset of the cable modem's RCC.
- To assign a service flow to an integrated cable (IC) channel, the corresponding integrated cable interface must be configured and operational.

Restrictions

- The service flow from a narrowband cable modem is always assigned to the primary interface of the cable modem. No attribute checking is performed in this case.

This section describes the following:

Configuring Provisioned Attributes for an Integrated Cable Interface

The default provisioned attribute is zero for an integrated cable interface.

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	**interface integrated-cable** {*slot/port* | *slot/subslot/port*}*:rf-channel* **Example:**	Specifies the cable interface line card on a Cisco CMTS router: • *slot*—Chassis slot number of the cable interface line card.

	Command or Action	Purpose
	`Router(config)# interface integrated-cable 1/0/0:0`	• *subslot*—subslot number of the cable interface line card. Valid subslot is always 0. • *port*—Downstream port number. • *rf-channel*—RF channel number with a range of 0 to 3.
Step 4	**cable attribute-mask** *mask* **Example:** `Router(config-if)# cable attribute-mask 800000ff`	Specifies the mask for the interface.

Configuring Provisioned Attributes for a Wideband Cable Interface

The default provisioned attribute is 0x80000000 for a wideband cable interface, and the zero bit is automatically added to the wideband cable interface whenever an attribute is configured for that interface.

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	**interface wideband-cable** {*slot/port* | *slot/subslot/port*}:*wideband-channel* **Example:** `Router(config)# interface wideband-cable 1/0/1:4`	Specifies the wideband cable interface and enters interface configuration mode:
Step 4	**cable downstream attribute-mask** *mask* **Example:** `Router(config-if)# cable downstream attribute-mask 800000ff`	Specifies the mask for the interface.

Verifying the Attribute-Based Service Flow Assignments

To verify the attribute-based assignment of service flows on a cable interface, use the **show interface cable service-flow** or **show interface wideband-cable service-flow** command as shown in the following example:

```
Router# show interface cable 3/0 service-flow
```

```
Sfid  Sid   Mac Address     QoS  Param Index Type  Dir  Curr  Active  DS-ForwIf/
                           Prov Adm   Act             State Time    US-BG/CH
17    4     001c.ea37.9aac  3    3     3     P     US   act   13h21m  CH 3
18    N/A   001c.ea37.9aac  4    4     4     P     DS   act   13h21m  Wi3/0:0
21    6     001c.ea37.9b5a  3    3     3     P     US   act   13h21m  CH 4
22    N/A   001c.ea37.9b5a  4    4     4     P     DS   act   13h21m  Wi3/0:0
23    7     0016.925e.654c  3    3     3     P     US   act   13h21m  CH 3
24    N/A   0016.925e.654c  4    4     4     P     DS   act   13h21m  In3/0:0

Router# show interface wideband-cable 5/1:0 service-flow
Sfid  Sid   Mac Address     QoS Param Index Type  Dir Curr   Active  DS-ForwIf/
                           Prov  Adm  Act           State  Time    US-BG/CH
3     8193  ffff.ffff.ffff  3     3    3   S(s)  DS  act    2h06m   Wi5/1:0
```

The table below shows descriptions for the fields displayed by this command:

Table 3: show interface cable service-flow Field Descriptions

Field	Description
Sfid	Identifies the service flow identification number. **Note** Primary service flow IDs are displayed even for offline cable modems because they are needed for modem re-registration.
Sid	Identifies the service identification number (upstream service flows only).
Mac Address	Identifies the MAC address for the cable modem.
QoS Parameter Index Prov	Identifies the QoS parameter index for the provisioned state of this flow.
QoS Parameter Index Adm	Identifies the QoS parameter index for the Admitted state of this flow.
QoS Parameter Index Act	Identifies the QoS parameter index for the Active state of this flow.
Type	Indicates if the service flow is the primary flow or a secondary service flow. Secondary service flows are identified by an “S” (created statically at the time of registration, using the DOCSIS configuration file) or “D” (created dynamically by the exchange of dynamic service messages between the cable modem and CMTS).
Dir	Indicates if this service flow is DS or US.
Curr State	Indicates the current run-time state of the service flow.
Active Time	Indicates the length of time this service flow has been active.
DS-ForwIf/US-BG/CH BG/DS	Indicates the bonding group ID or the downstream RFID of the forwarding interface assigned to the downstream service flow.

How to Enable Service Flow Priority in Downstream Extender Header

The following tasks describe how to enable service flow priority in downstream extender header:

Enabling Service Flow Priority in Downstream Extender Header

This section describes how to enable service flow priority in downstream extender header on the Cisco cBR-8 routers:

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	**cable service flow priority** **Example:** `Router(config)# cable service flow priority`	Enables the service flow priority in downstream extender header.

Verifying the Enablement of the Service Flow Priority in Downstream Extended Header

To verify the enablement of the service flow priority in downstream extended header, use the **show running-config | in service flow** or **show cable modem** [*ip-address* | *mac-address*] **verbose** command as shown in the following example:

```
Router# show running-config | in service flow
cable service flow priority

Router# show cable modem 100.1.2.110 verbose

MAC Address                     : 0025.2e2d.74f8
IP Address                      : 100.1.2.110
IPv6 Address                    : 2001:420:3800:909:7964:98F3:7760:ED2
Dual IP                         : Y
Prim Sid                        : 1
Host Interface                  : C3/0/0/U0
MD-DS-SG / MD-US-SG             : N/A / N/A
MD-CM-SG                        : 0x900000
Primary Downstream              : In3/0/0:32 (RfId : 12320, SC-QAM)
Wideband Capable                : Y
```

```
DS Tuner Capability                : 8
RCP Index                          : 6
RCP ID                             : 00 00 00 00 00
Downstream Channel DCID RF Channel : 191   3/0/0:32 (SC-QAM)
UDC Enabled                        : N
US Frequency Range Capability      : Standard (5-42 MHz)
Extended Upstream Transmit Power   : 0dB
Multi-Transmit Channel Mode        : N
Upstream Channel                   : US0
Ranging Status                     : sta
Upstream SNR (dB)                  : 39.8
Upstream Data SNR (dB)             : 36.12
Received Power (dBmV)              : -1.00
Timing Offset             (97.6 ns): 1799
Initial Timing Offset              : 1799
Rng Timing Adj Moving Avg(0.381 ns): 0
Rng Timing Adj Lt Moving Avg       : 0
Rng Timing Adj Minimum             : 0
Rng Timing Adj Maximum             : 0
Pre-EQ Good                        : 0
Pre-EQ Scaled                      : 0
Pre-EQ Impulse                     : 0
Pre-EQ Direct Loads                : 0
Good Codewords rx                  : 8468
Corrected Codewords rx             : 0
Uncorrectable Codewords rx         : 0
Phy Operating Mode                 : atdma
sysDescr                           :
Downstream Power                   : 0.00 dBmV (SNR = ----- dB)
MAC Version                        : DOC3.0
QoS Provisioned Mode               : DOC1.1
Enable DOCSIS2.0 Mode              : Y
Service Flow Priority              : N
Modem Status                       : {Modem= online, Security=disabled}
Capabilities                       : {Frag=Y, Concat=Y, PHS=Y}
Security Capabilities              : {Priv=, EAE=N, Key_len=}
L2VPN Capabilities                 : {L2VPN=N, eSAFE=N}
L2VPN type                         : {CLI=N, DOCSIS=N}
Sid/Said Limit                     : {Max US Sids=16, Max DS Saids=15}
Optional Filtering Support         : {802.1P=N, 802.1Q=N, DUT=N}
Transmit Equalizer Support         : {Taps/Symbol= 1, Num of Taps= 24}
CM Capability Reject              : {15,22,23,24,25,26,27,28,29,35,36,38}
Flaps                              : 3(Oct 8  16:22:23)
Errors                             : 0 CRCs, 0 HCSes
Stn Mtn Failures                   : 0 aborts, 2 exhausted
Total US Flows                     : 1(1 active)
Total DS Flows                     : 1(1 active)
Total US Data                      : 294 packets, 25903 bytes
Total US Throughput                : 143 bits/sec, 0 packets/sec
Total DS Data                      : 91 packets, 10374 bytes
Total DS Throughput                : 0 bits/sec, 0 packets/sec
LB group ID assigned               : 1
LB group ID in config file         : N/A
LB policy ID                       : 0
LB policy ID in config file        : 0
LB priority                        : 0
Tag                                : d30
Required DS Attribute Mask         : 0x0
Forbidden DS Attribute Mask        : 0x0
Required US Attribute Mask         : 0x0
Forbidden US Attribute Mask        : 0x0
Service Type ID                    :
Service Type ID in config file     :
Active Classifiers                 : 0 (Max = NO LIMIT)
```

```
CM Upstream Filter Group           : 0
CM Downstream Filter Group         : 0
CPE Upstream Filter Group          : 0
CPE Downstream Filter Group        : 0
DSA/DSX messages                   : permit all
Voice Enabled                      : NO
DS Change Times                    : 0
Boolean Services                   : 0
CM Energy Management Capable       : N
CM Enable Energy Management        : N
CM Enter Energy Management         : NO
Battery Mode                       : N
Battery Mode Status                :
Number of Multicast DSIDs Support  : 16
MDF Capability Mode                : 2
IGMP/MLD Version                   : MLDv2
FCType10 Forwarding Support        : Y
Features Bitmask                   : 0x0
Total Time Online                  : 6h00m   (6h00m    since last counter reset)
CM Initialization Reason           : POWER_ON
```

Enabling Verbose Reporting for Receive Channel Profiles

A receive channel profile is an encoding that represents the receive channels and receive modules of a cable modem. A cable modem communicates to the CMTS one or more RCP encodings within its registration request using either verbose description, which contains complete subtype encodings defined in DOCSIS 3.0, or simple description, which only contains RCP identifiers.

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	**interface cable** {*slot/port* | *slot/subslot/port*} **Example:** `Router(config)# interface cable7/0/0`	Specifies the cable interface line card on a Cisco CMTS router: • *slot*—Chassis slot number of the cable interface line card. • *subslot*—subslot number of the cable interface line card. Valid subslot is 0. • *port*—Downstream port number.
Step 4	**cable rcp-control verbose** **Example:** `Router(config-if)# cable rcp-control verbose`	Enables RCP reporting with verbose description.

Configuration Example for an RCC Template

The following sample shows an RCP ID configuration:

```
...
!
cable rcp-id 00 10 00 01 08
  center-frequency-spacing 6
  module 1 minimum-center-frequency 120000000 maximum-center-frequency 800000000 module 1
number-of-adjacent-channels 10
  module 2 minimum-center-frequency 120000000 maximum-center-frequency 800000000 module 2
 number-of-adjacent-channels 10
  number-of-channels 8
  primary-capable-channels 1
!
```

The following sample shows an RCC template configuration:

```
...
!
cable rcc-templates frequency-based 1
  rcp-id 00 10 00 01 08
  rcc-template 1
  cm-attribute-mask 2
  module 1 channels 1-4 start-frequency 381000000
  module 2 channels 5-8 start-frequency 501000000
  rcc-template 2
  module 1 channels 1-4 start-frequency 381000000
  module 2 channels 5-8 start-frequency 669000000
  rcc-template 3
  module 1 channels 1-4 start-frequency 381000000
!
```

The following sample shows an RCC template configuration using the **common-module** option:

```
...
!
cable rcc-templates frequency-based 2
   rcp-id 00 10 00 01 08
   common-module 1 channels 1-4 start-frequency 381000000
   rcc-template 1
   module 1 channels 5-8 start-frequency 501000000
   rcc-template 2
   module 1 channels 5-8 start-frequency 669000000
   rcc-template 3
!
```

The following sample shows the assignment of an RCC template to MAC Domain:

```
...
!
configure terminal
interface c1/0/0
 cable rcc-templates frequency-based 1
 end

...
```

Additional References

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

Feature Information for DOCSIS 3.0 Downstream Bonding

Use Cisco Feature Navigator to find information about the platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to the https://cfnng.cisco.com/ link. An account on the Cisco.com page is not required.

Note The following table lists the software release in which a given feature is introduced. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 4: Feature Information for Downstream Interface Configuration

Feature Name	Releases	Feature Information
DOCSIS 3.0 Downstream Bonding	Cisco IOS XE Everest 16.6.1	This feature was integrated on the Cisco cBR Series Converged Broadband Router.
Service Flow Priority in Downstream Extended Header	Cisco IOS XE Everest 16.6.1	This feature was integrated on the Cisco cBR Series Converged Broadband Router.